# Watershed Diagnostic Study
# of the Upper Mississinewa River Watershed, Phase III

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Indiana Lake and River Enhancement Program
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Prepared for:

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# 1.0 EXECUTIVE SUMMARY

## 1.1 BACKGROUND

The Phase 3 Watershed Diagnostic Study of The Upper Mississinewa River Watershed was undertaken by the Delaware and Randolph County Soil & Water Conservation Districts under the Indiana Lake and River Enhancement Program (LARE) as part of their effort to better understand the entire Mississinewa River System. The Phase 3 study covered the watershed of the Mississinewa River and its tributaries from Albany to Wheeling (HUC 05120103030). The project was initiated in the spring of 2004, with field work conducted through the fall of 2005.

This LARE Watershed Diagnostic Study was conducted by Cedar Eden Environmental, LLC of Saranac Lake, NY – Michael R. Martin, CLM, principal investigator. Additional sample collection was provided by Commonwealth Biomonitoring, Indianapolis, IN. Bacteriological analyses were performed by Hoosier Microbiological Laboratory, Muncie, IN and Commonwealth Biomonitoring. Water quality analyses were performed by F.X. Browne Inc.'s laboratory in Marshalls Creek, PA. Macroinvertebrate analyses were conducted by PhycoTech, Inc., St. Joseph, MI.

The objectives of this study of the Upper Mississinewa River watershed were to develop a long-term watershed management plan that evaluated historical information, described the current condition and trends in the river and its subwatersheds, evaluated land use impacts, identified potential nonpoint source water quality problems, identified priority subwatersheds for management practices, proposed specific direction for future work, and predicted and assessed success factors for future work.

## 1.2 THE RIVER

The study watershed extends along a 21.5 mile length of the Mississinewa River from Albany to Wheeling. There are at least 25 streams and ditches flowing into the river along the study length, although many may only flow seasonally.

## 1.3 THE WATERSHED

The Mississinewa River Phase III watershed covers approximately 66,088 acres (26,745 ha) in northern Delaware County, and includes the drainages from Pike Creek, Campbell Creek, Rees Ditch and Boseman Ditch. A small portion of the watershed lies in Jay County at the headwaters of Rees Ditch. Another small portion of the watershed lies in Randolph County, at the headwaters of Campbell Creek. Soils in the watershed were mostly silt-loams, with 15 percent of the soils being hydric, and 98 percent of the soils listed as unsuitable for septic systems.

Land use in the Mississinewa River watershed was predominantly row crops (77.6%) and pasture/hay (11.4%). Forest accounted for 6.9 percent of the watershed, open water and wetlands accounted for 1.9 percent of the watershed, and residential areas accounted for 1 percent. Boseman Ditch and Pike Creek subwatersheds had the highest percentage of row crops, at 84.9 percent and 85.6 percent, respectively. Holdren Ditch and Unnamed Ditch had the lowest percentage of row crops, at 68.3 percent and 72.4 percent, respectively.

Cropland land cover in the Mississinewa River watershed was predominantly soybeans (38.1%), corn (26.8%), pastureland/CRP/non agricultural (19.2%)., and woods/wooded pastureland (8.8%). The watershed cover consisted of 67.3 percent croplands (corn, soybean, winter wheat, small grain/hay, and other crops). Cropland cover ranged from 63.9% in the Holdren Ditch subwatershed to 76.3% in the Pike Creek subwatershed.

## 1.4 Water Quality

Water quality within the watershed was characterized by high concentrations of nutrients (phosphorus and nitrogen) and high counts of E. coli bacteria. Biological integrity ranged from severely impaired to slightly impaired, based on QHIE measurements and moderately impaired to slightly impaired based upon mIBI measurements.

Campbell Creek was consistently was among the group of stations having the highest concentrations of E. coli (high and low flow, the highest at low flow), turbidity (high and low flow), total phosphorus (high flow), soluble reactive phosphorus (high flow), and TKN (organic nitrogen, high flow). Campbell Creek also had the highest total phosphorus (TP) and total nitrogen (TN) flux (mass transport) during high flow conditions – both TP and TN flux were three times higher in Campbell Creek than any other subwatersheds.

Pike Creek was among the group of stations having the highest concentrations of E. coli (the highest at high flow), total phosphorus (high and particularly low flow), soluble reactive phosphorus (high and low flow, the highest at high flow), and nitrate nitrogen (high flow). Pike Creek also the highest TP and TN flux at low flow conditions. Station PC04 was the station most often exhibiting these high concentrations, while PC01 and PC02 were consistently among the lowest concentrations inmost cases. This would indicate that water quality is being improved during the course of its flow from the headwaters to the mouth of Pike Creek.

No other streams were consistently in the group of subwatersheds with high concentrations of the measured pollutants. Rees Ditch (RD04), however, was among the highest for total nitrogen (high and low flow), nitrate nitrogen (high flow), organic nitrogen (TKN, low flow). Rees Ditch had the second highest TN flux at low flow conditions.

## 1.5 NONPOINT SOURCE PROBLEM AREAS

A total of 27 nonpoint source problem areas were identified. The main NPS problems were streambank erosion, lack of buffers, and animal access to streams. There was one NPS problem area identified in the Campbell Creek subwatershed for streambank erosion. There were eleven NPS problem areas identified in the Pike Creek subwatershed. These include one animal access to streams, five streambank erosion, and five buffers. There were two NPS problem areas identified in the Rees Ditch subwatershed, for manure management and buffers. The remaining NPS problem areas were identified in the Holdren Ditch subwatershed (3), the Unnamed Ditch subwatershed (1), and the Mississinewa direct drainage (9). These included four animals in streams, six streambank erosion (one of which is also nutrient management), and three buffers.

## 1.6 PRIORITY SUBWATERSHEDS

Based upon an analysis of the Phase III watershed diagnostic study results, the Campbell Creek and Pike Creek subwatersheds should receive the highest priority for implementation of BMPs, especially with regard to the management E. coli, nutrients, and sediments. Rees Ditch should receive secondary priority for nitrogen management.

NPS modeling identified Pike Creek and Campbell Creek as the two subwatersheds contributing the most phosphorus, nitrogen, and suspended solids.

## 1.7 MANAGEMENT RECOMMENDATIONS

Recommendations were made in three categories: Animals in Streams/Stream Crossings, Streambank Erosion, and Vegetative Buffers. For animals in streams and stream crossings, the use of permanent stream crossings was recommended only where <u>necessary</u>. The installation of stream fencing and watering facilities are recommended to remove the animals from the streams. For streambank erosion, the use of anchored live material is recommended to stabilize streambanks and restore habitat. Vegetative buffer strips are recommended for all areas where fields come in contact with the drainage ways of the Phase III watershed.

# 2.0 INTRODUCTION

The Phase 3 Watershed Diagnostic Study of The Upper Mississinewa River Watershed was undertaken by the Delaware and Randolph County Soil & Water Conservation Districts under the Indiana Lake and River Enhancement Program (LARE) as part of their effort to better understand the entire Mississinewa River System. The Phase 3 study covered the watershed of the Mississinewa River and its tributaries from Albany to Wheeling. The project was initiated in the spring of 2004, with field work conducted through the fall of 2005.

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## 2.1 PROJECT OBJECTIVES

The objectives of this study of the Upper Mississinewa River watershed were to develop a long-term watershed management plan that evaluated historical information, described the current condition and trends in the river and its subwatersheds, evaluated land use impacts, identified potential nonpoint source water quality problems, identified priority subwatersheds for management practices, proposed specific direction for future work, and predicted and assessed success factors for future work

## 2.2 DESCRIPTION OF WATERSHED

The Mississinewa River Phase III watershed covers approximately 66,088 acres (26,745 ha) in northern Delaware County, and includes the drainages from Pike Creek, Campbell Creek, Rees Ditch and Boseman Ditch (Figure 2.1). A small portion of the watershed lies in Jay County at the headwaters of Rees Ditch. Another small portion of the watershed lies in Randolph County, at the headwaters of Campbell Creek. The study watershed extends along a 21.5 mile length of the Mississinewa River from Albany to Wheeling. There are at least 25 streams and ditches flowing into the river along the study length, although many may only flow seasonally.

The watershed is situated in the Clayey High Lime Till Plains EPA Level 4 ecoregion within the Eastern Corn Belt Plains Level 3 Ecoregion. Major subwatersheds that were monitored during the study include Boseman Ditch (4,131 acres), Campbell Creek (13,500 acres), Holdren Ditch (1,675 aces), Pike Creek (15,566 acres), Rees Ditch (8,400 acres), and Unnamed Ditch (1080 acres) (see Water Quality Monitoring section for station locations and descriptions).

Figure 2.1 – Location of Watershed

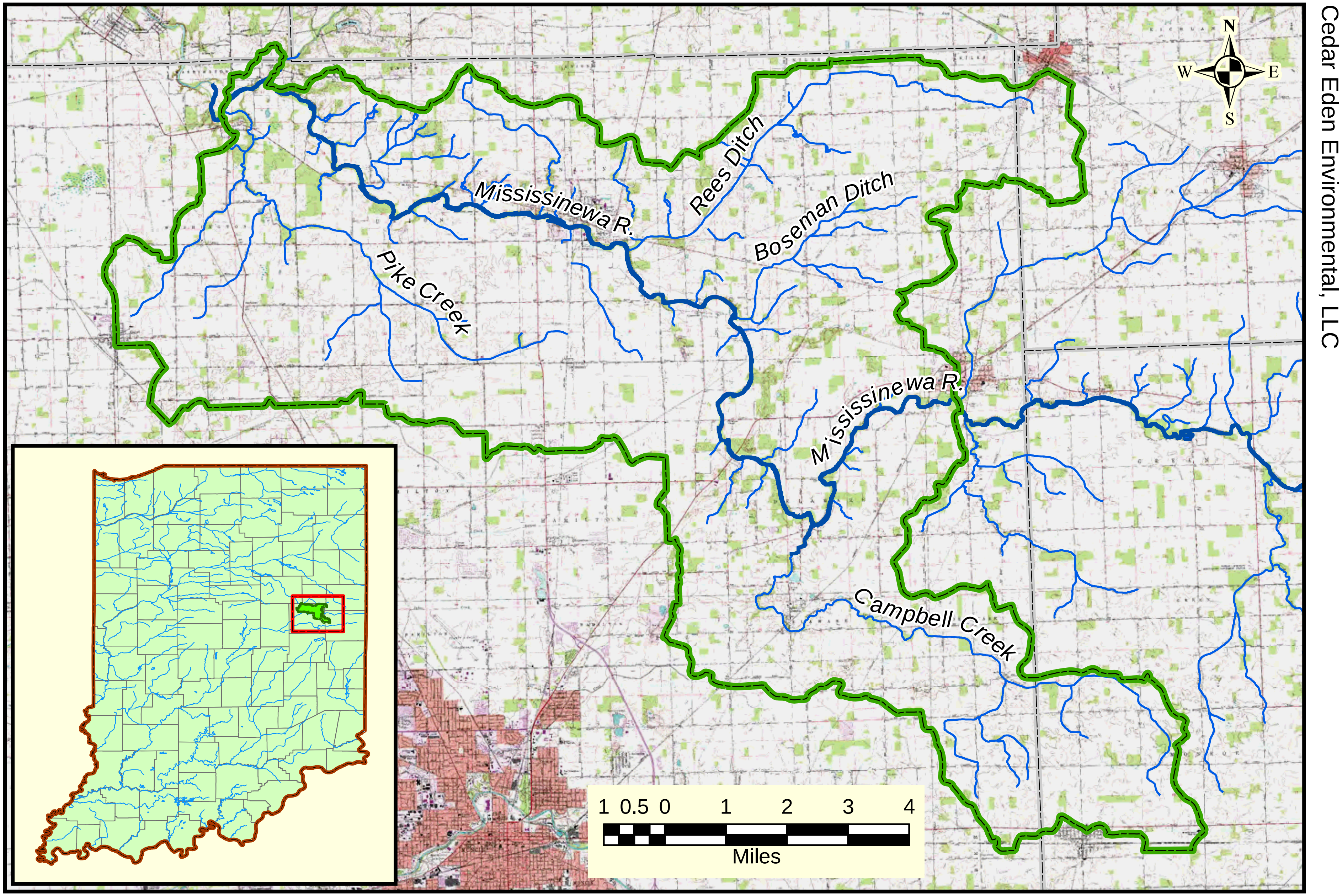


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Figure 2.1 Location of Mississinewa River Phase III Watershed

## 2.3 WATERSHED & RIVER HISTORY AND USAGE

### 2.3.1 WATERSHED GEOLOGY

The Mississinewa watershed lies within the Bluffton Hill Plain of the Central Till Plain of glaciated northern Indiana. The underlying bedrock lies entirely within the Silurian System and consists primarily of Pleasant Mills formation, with an intrusion of limestone and/or dolomite (Louisville Limestone through Brassfield Limestone, or Salamonie Dolomite, Cataract Formation, and Brassfield Limestone) in the central watershed extending from the lower end of Campbell Creek northward up throughout the Rees and Boseman Ditch subwatersheds.

The surficial geology consists of till deposition (silty clay-loam to clay-loam) of the Huron-Erie Lobe laid down during the Wisconsinan age, with undifferentiated outwash along the riparian zone of the Mississinewa River. There is a small deposit of Holocene alluvium along the Mississinewa River at the end of the project watershed (Mississinewa River west of Eaton and north of the Eaton-Wheeling Pike). Unconsolidated sediments within the watershed have minimum thickness generally of 0 to 50 feet. An area of thicker unconsolidated sediments exists within the Boseman and Rees Ditch subwatersheds, with a minimum thickness of 100 to 150 feet and maximum thickness of up to 200 feet [1]. An unconsolidated sand and gravel aquifer runs along the north side of the Mississinewa River through the entire watershed, interrupted only by the topographic ridge at Route 67 (see Section 2.3.4 Topography). The remainder of the watershed is underlain by carbonate-rock aquifers.

Bedrock geology and surficial geology within the watershed are presented in Figures 2.2 and 2.3, respectively. Unconsolidated sediment depths are presented in Figures 2.4 and 2.5.

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[1] *Indiana Geological Survey, GIS Atlas: BEDROCK_GEOL_MM48_IN: Bedrock Geology of Indiana (Indiana Geological Survey, 1:500,000, Polygon Shapefile); PHYSIOGRAPHY_SR61_IN: Physiographic Regions of Indiana (Indiana Geological Survey, 1:500,000, Polygon Shapefile); SURFICIAL_GEOL_MM49_IN: Quaternary Geologic Map of Indiana (Indiana Geological Survey, 1:500,000, Polygon Shapefile); UNCONSOL_TH_MM37_IN: Thickness Ranges of Unconsolidated Deposits in Indiana (Indiana Geological Survey, 1:500,000, Polygon Shapefile)*

Figure 2.2 & 2.3 – Bedrock and Surficial Geology

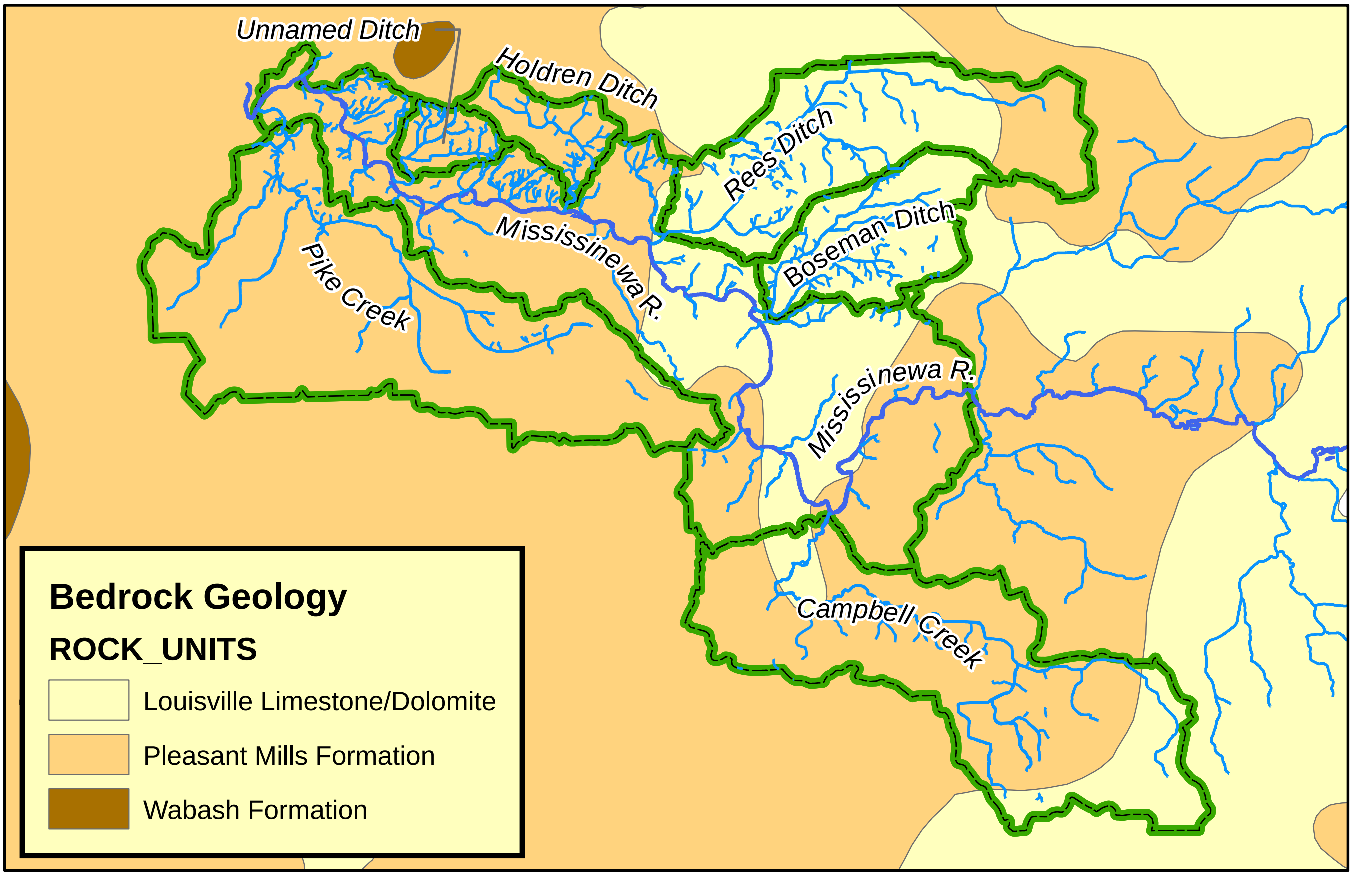


Figure 2.2 Bedrock Geology

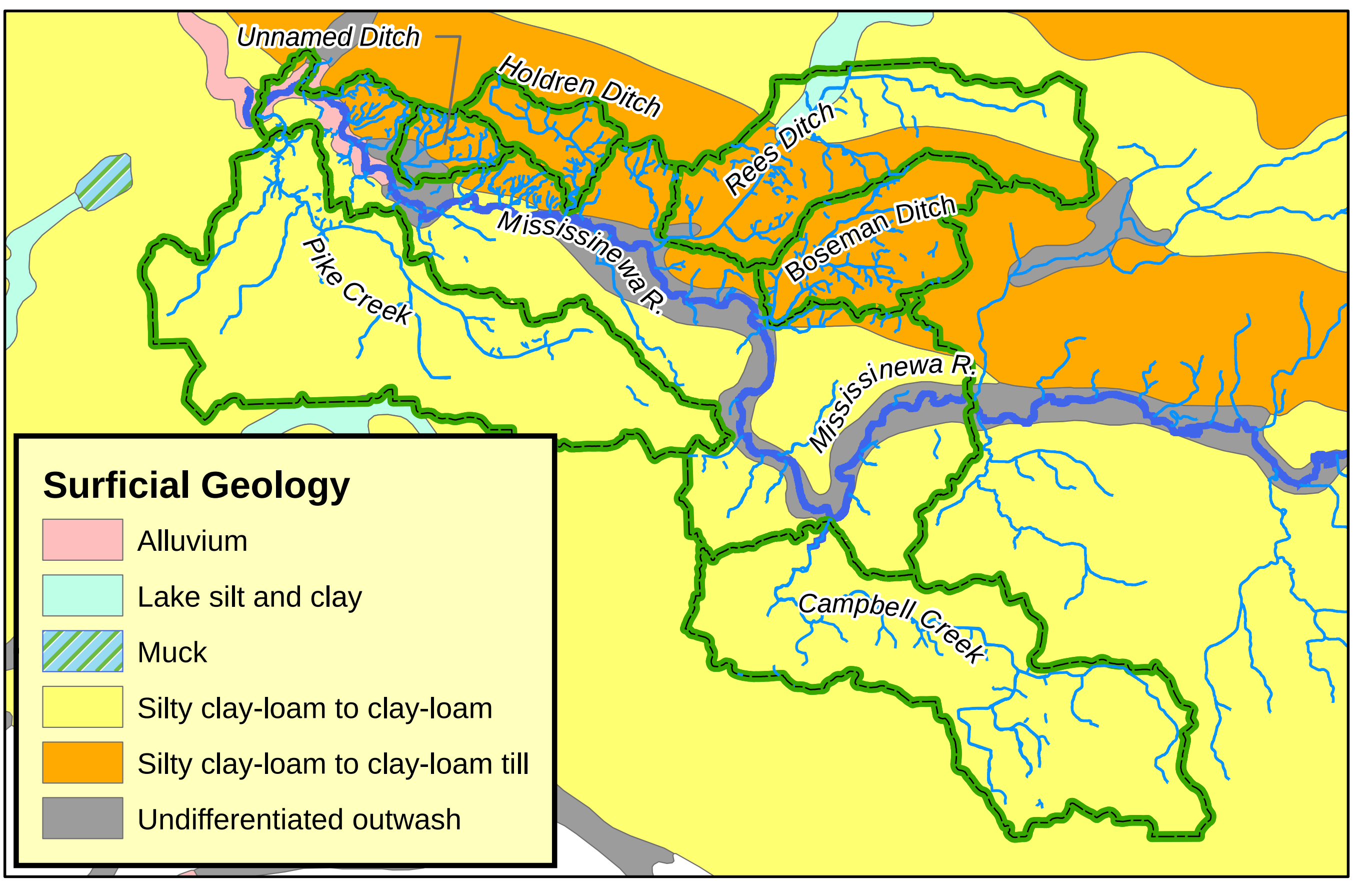


Figure 2.3 Surficial Geology

Figure 2.4 and 2.5 – Unconsolidated Sediment Depth

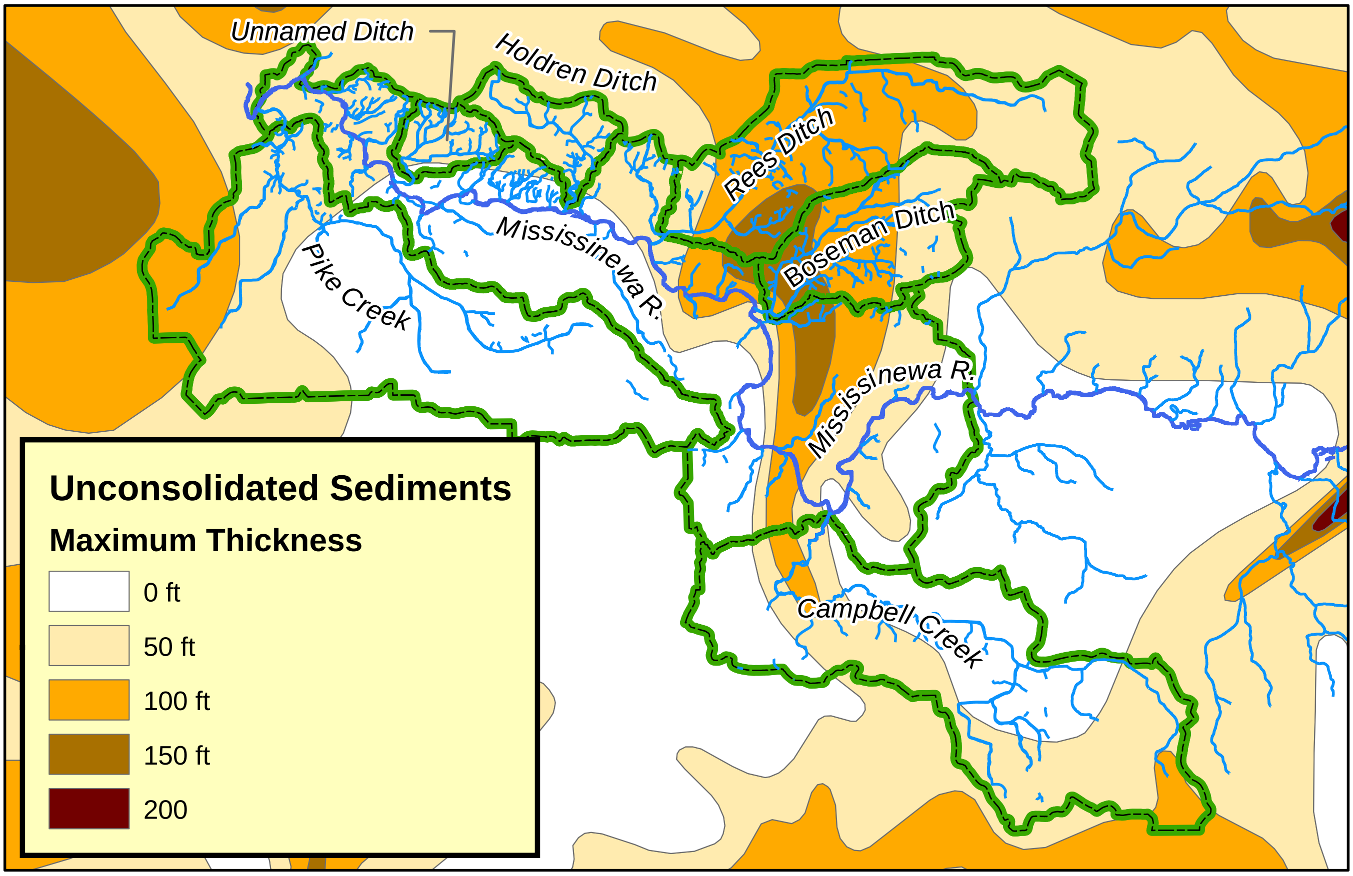


Figure 2.4 Minimum thickness of unconsolidated sediments

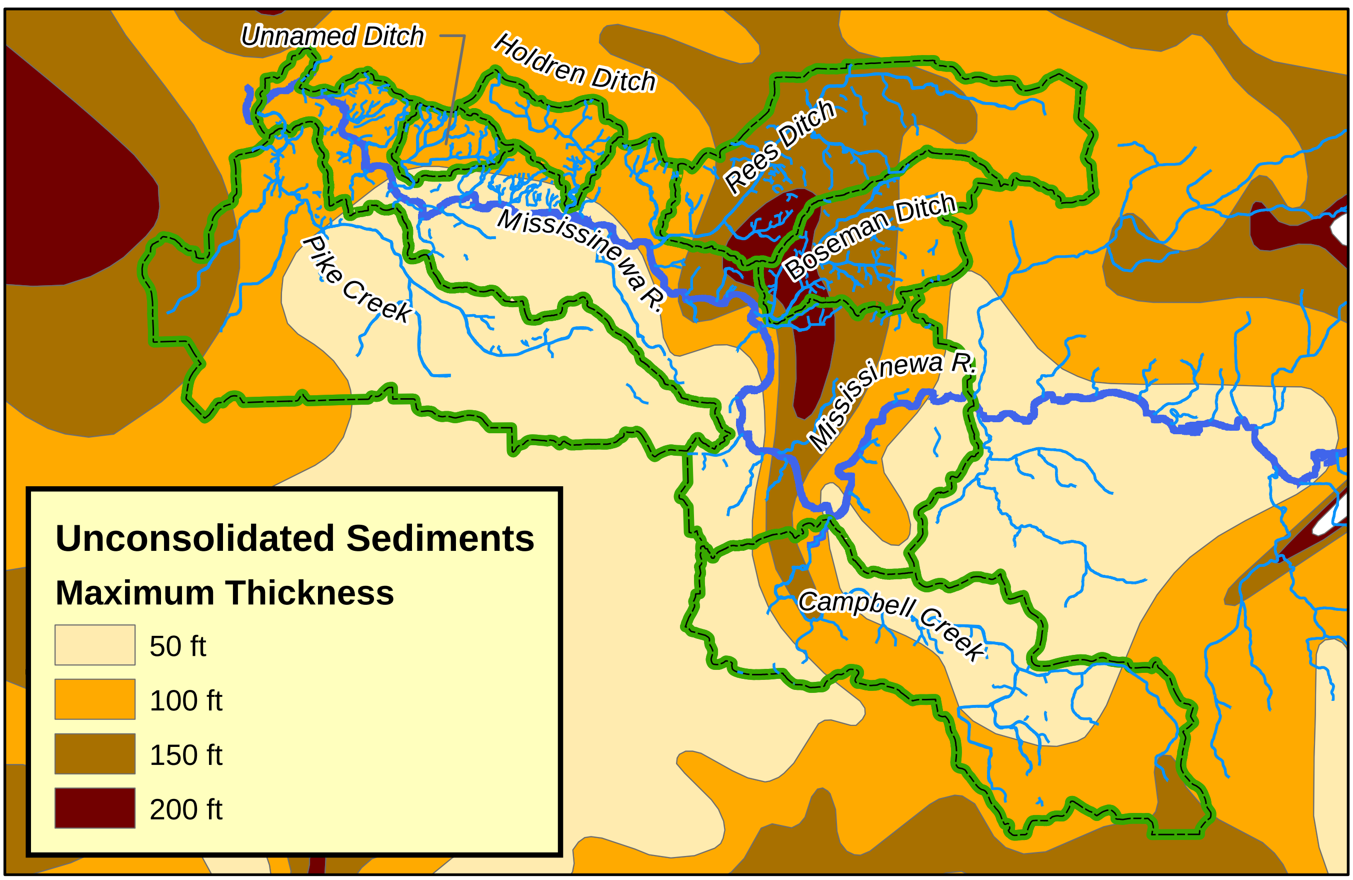


Figure 2.5 Maximum thickness of unconsolidated sediments

### 2.3.2 CLIMATE

#### *NORMAL CONDITIONS*

The normal climatic conditions for northeast Indiana are:

normal precipitation: 36.17 inches, with about 28 percent falling during spring (Mar - May) and 30 percent during summer (Jun - Aug) and 24 % in fall (Sep - Nov)

mean annual temperature: 49.1 °F, with a mean maximum temperature of 59.2 °F and a mean minimum temperature of 39.1 °F

warmest month is July, with a mean daily average temperature of 72.7 °F and mean daily maximum temperature of 83.9 °F

coldest month is January, with a mean daily average temperature of 22.4 °F and mean daily minimum temperature of 14.4 °F

3000 growing degree days for corn

#### *CLIMATE DURING THE STUDY*

Summary of the Day Climate data was obtained from the National Climatic Data Center for the Farmland 5 NNW Cooperative Weather Station (COOPID 122825), located at the eastern tip of the Campbell Creek arm of the watershed (40°11'N by 85°07'W). Additional hourly climate information for Farmland was obtained from the Indiana State Climate Office at Purdue University. General climatic parameters are summarized in Table 2.2. Overall, 2004 was slightly cooler and drier than 2005. Precipitation data for 2004 and 2005 are shown in Figure 2.6, together with points indicating the sampling dates.

Weather conditions on the sampling dates were as follows:
4/13/04 – Min Temp: 35°F, Max Temp: 47°F, Precipitation: 0.10"
Precipitation in preceding 2 weeks: 0.7"
8/11/04: – Min Temp: 54°F, Max Temp: 76°F, Precipitation: 0.00"
Precipitation in preceding 2 weeks: 1.8"
9/16/05: – Min Temp: 59°F, Max Temp: 77°F, Precipitation: 2.06"
Precipitation in preceding 2 weeks: 0.2"

**Table 2.2**
**Climatic Conditions in 2004**

| Parameter | Total | Minimum | Maximum | Mean |
|---|---|---|---|---|
| **Daily Precipitation (in.)** | 34.88 | 0.00 | 1.92 | 0.095 |
| **Daily Minimum Temperature (°F)** | - - - | -19.0 | 71.0 | 40.5 |
| **Daily Maximum Temperature (°F)** | - - - | 2.0 | 90.0 | 60.9 |
| **Daily Evaporation (in.)** | 33.84 | 0.00 | 0.38 | 0.18 |
| **Climatic Conditions in 2005** | | | | |
| **Daily Precipitation (in.)** | 45.10 | 0.00 | 3.31 | 0.124 |
| **Daily Minimum Temperature (°F)** | - - - | -7.0 | 78.0 | 40.9 |
| **Daily Maximum Temperature (°F)** | - - - | 12.0 | 96.0 | 61.1 |
| **Daily Evaporation (in.)** | 37.68 | 0.00 | 0.45 | 0.18 |

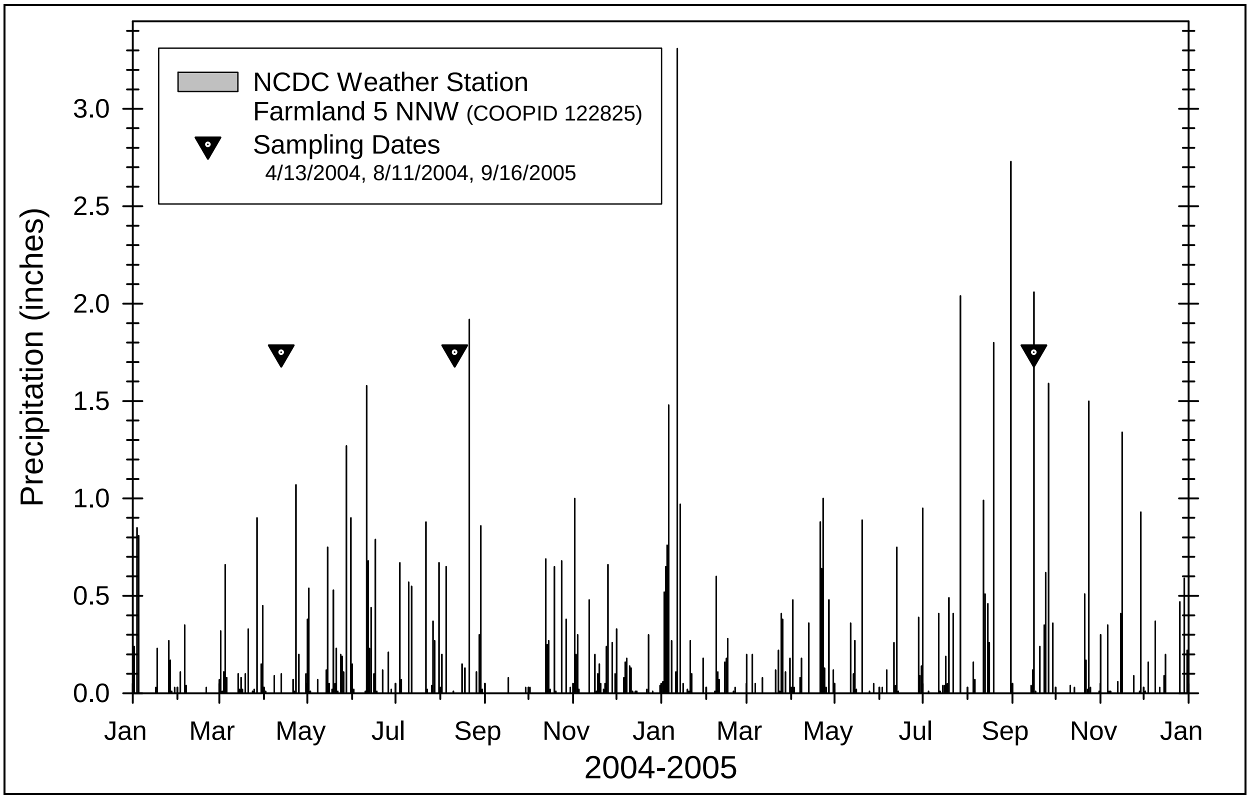


**Figure 2.6** Daily precipitation at Farmland for 2004 & 2005, with indicators for sampling dates

The April 13, 2004 sampling date was preceded by a day with a minimum temperature of 33°F, a maximum temperature of 46°F, and 0.09 inches of precipitation. Conditions during the sampling were cool and dry, with a temperature range of 34°F to 38°F and 0.00 inches of precipitation. The August 11, 2004 sampling date was preceded by a day with a minimum temperature of 57°F, a maximum temperature of 74°F, and 0.01 inches of precipitation. Conditions during the sampling were seasonably cool and dry, with a temperature range of 58°F to 68°F and 0.00 inches of precipitation. The September 16, 2005 sampling date was preceded by a day with a minimum temperature of 58°F, a maximum temperature of 77°F, and 0.87 inches of precipitation. Conditions during the sampling were seasonable and dry, with a temperature range of 65°F to 67°F and 0.00 inches of precipitation.

### 2.3.3 MISSISSINEWA RIVER HYDROLOGY

Hydrologic data for the Mississinewa River was obtained from the USGS Gauging Station near Ridgefield (USGS 03325500). An analysis of discharge is presented in Table 2.3. Overall, the Mississinewa River had less daily discharge, both total and maximum, in 2004 compared to 2005. Discharge data for 2004 and 2005 are shown in Figure 2.7, together with points indicating the sampling dates. Mississinewa River discharge at Ridgeville and estimated discharge for the top of the study watershed in Albany on the sampling dates were:

4/13/04 – 42.0 cfs at Ridgeville, 85.0 cfs at MR03 (Albany)
8/11/04: – 5.5 cfs at Ridgeville, 11.1 cfs at MR03 (Albany)
9/16/05: – 887.0 cfs at Ridgeville, 1,794.8 cfs at MR03 (Albany)

**Table 2.3**
**Daily Discharge (cfs) of Mississinewa in Ridgeville in 2004 & 2005**

| Year | Total | Minimum | Maximum | Mean | Median |
|---|---|---|---|---|---|
| **2004** | 51,085 | 5 | 3,400 | 130 | 37 |
| **2005** | 101,458 | 3 | 4,920 | 264 | 51 |

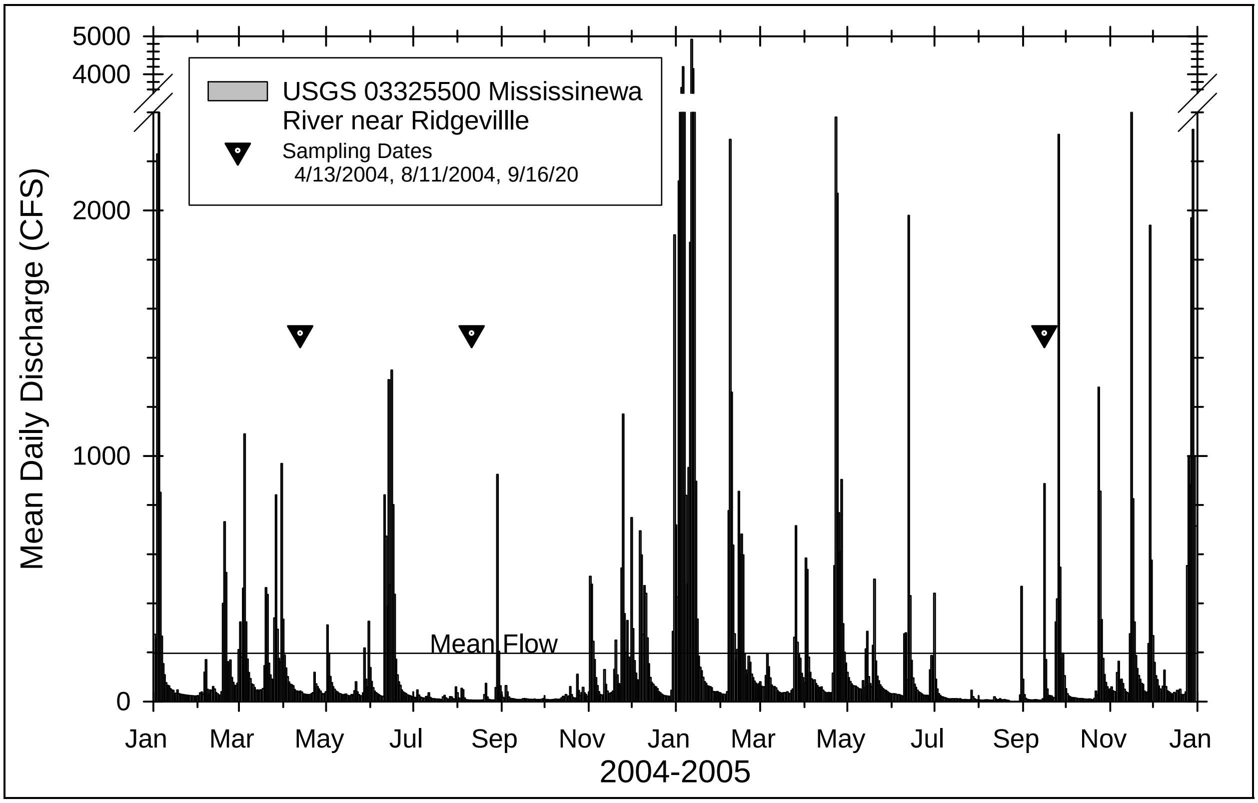


**Figure 2.7** Daily discharge at Ridgeville for 2004 & 2005, with indicators for sampling dates

The project originally called for two sampling dates, one to represent high flow conditions and one to represent low flow conditions. A review of the data following the two initial sampling dates indicated that high flow conditions were not well represented. Therefore, a third sampling occurred in 2005 to obtain samples at a higher flow regime. A statistical analysis of flow conditions in 2004 and 2005 is represented in Figure 2.8 as a box & whisker plot. This figure shows mean and median discharge of the Mississinewa River at Ridgeville for 2004 and 2005, as well as the 5$^{th}$, 25$^{th}$, 75$^{th}$, and 95$^{th}$ percentile of discharge for that location. The figure also shows the Ridgeville discharge levels for the three sampling dates.

This analysis shows that the August 2004 sampling run represented low flow conditions since the discharge on that date was at or below the 5$^{th}$ percentile for both years. The April

2004 sampling run represented the median discharge for both years. The September 2005 sampling run represented high flow conditions since the discharge on that date was more than 500 cfs greater than (more than twice) the 95th percentile discharge for 2004 and 150 cfs greater than the 95th percentile discharge for 2005.

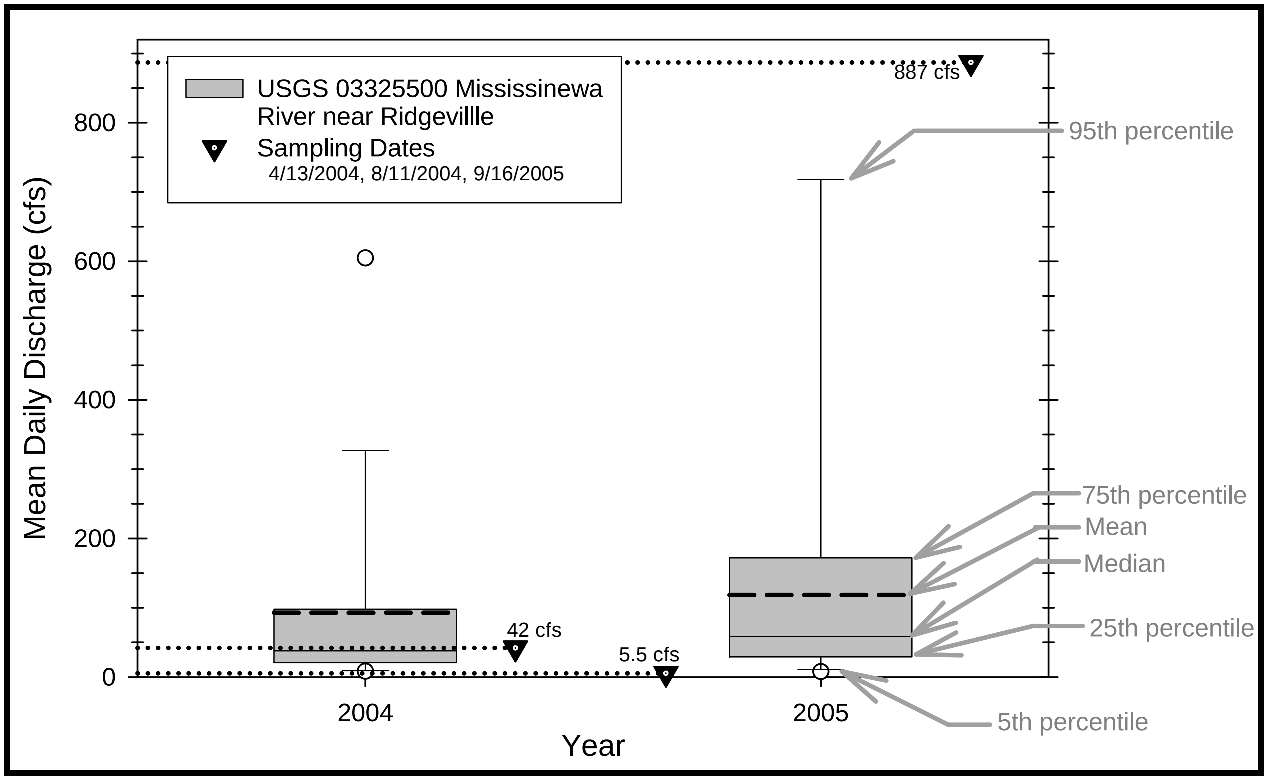


**Figure 2.8** Discharge conditions at Ridgeville USGS Station in 2004, 2005 and the sampling dates

### 2.3.4 TOPOGRAPHY

The Mississinewa River watershed is characterized by gently sloping to flat lands to the west of Route 67 and south of the Mississinewa River (Figure 2.8.5). A well-defined ridge runs along Route 67 north east to the watershed boundary north of Albany, separating the lower elevation southwest watershed from the higher and more hilly Campbell Creek drainage. The watershed north of the Mississinewa is also higher in elevation and tends to have more topographic relief.

The highest points in the watershed are above 1.030 feet in elevation and include the radio tower hill just off 250 North near the intersection with 750 East and Monroe Central high School in the upper reach of the Campbell Creek watershed near Parker. The lowest elevation in the watershed is along the Mississinewa River as it exits the study watershed below Pike Creek at an elevation of 840 feet.

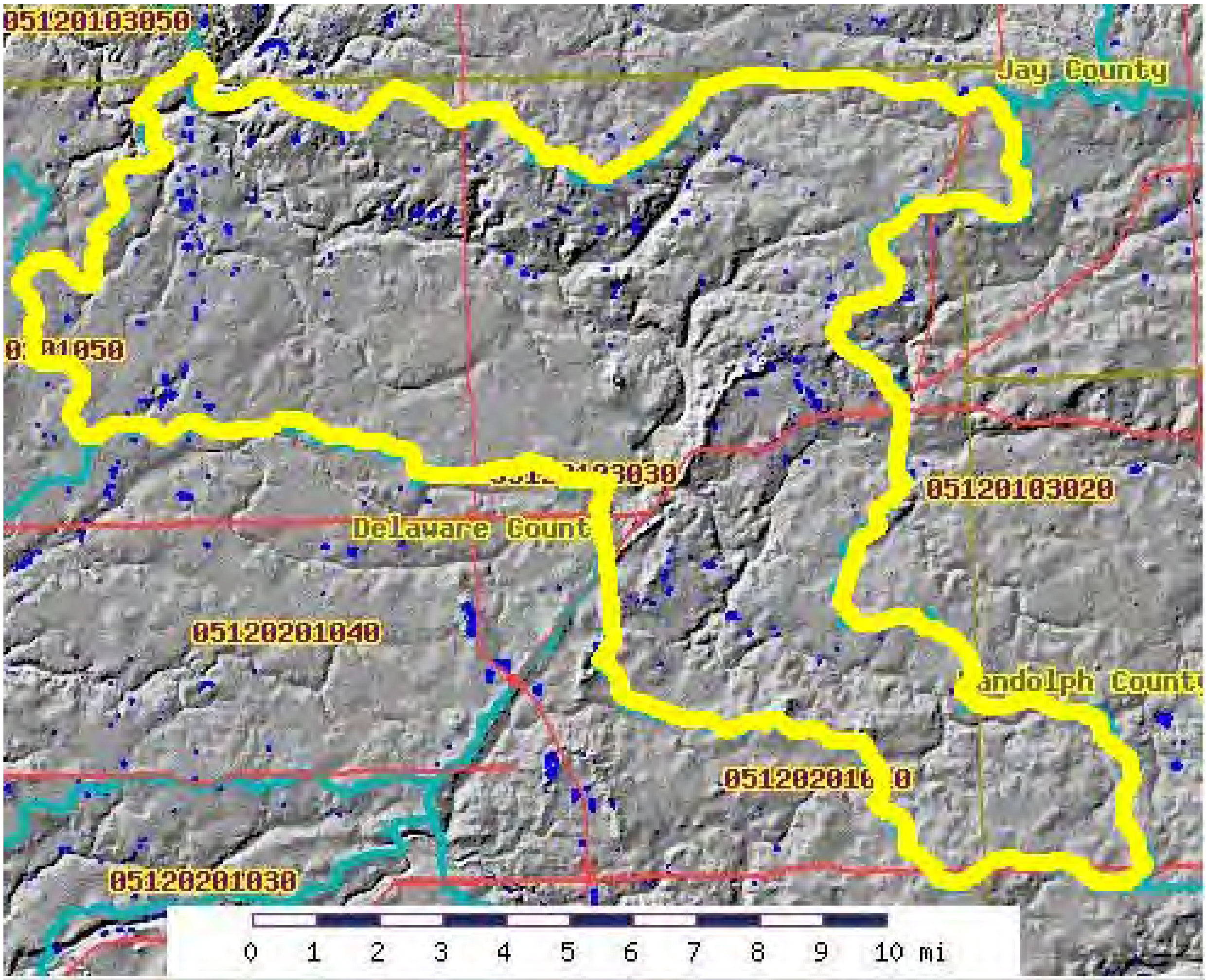


Figure 2.8.5 Digital Elevation Map (DEM) for the Upper Mississinewa watershed (source: HYMAPS-OWL, Agricultural & Biological Engineering Department, Purdue University)

### 2.3.5 SOILS

Digital soils information for Delaware County was obtained from the Natural Resources Conservation Service, covering the majority of the watershed. Digital soils are available for the small portions of the watershed in other counties from the USDA Web Soil Survey but were not described for this report (http://websoilsurvey.nrcs.usda.gov/app/.). The soils database was analyzed for the watershed and major subwatersheds for soil particle size, hydric soils, septic suitability, and farmland status.

Major soil classes within the watershed were Blount (silt-loams, 0 to 2 percent slopes) (32.4%), Pewamo (silty clay loam, 0 to 1 percent slopes) (28.0%), and Glynwood (silt loam, 1 to 4 percent slopes, eroded) (15.5%). Soil class composition of the watershed is presented in Table 2.4. Soil class distribution was similar in the major subwatersheds, with the exception of Unnamed Ditch. The major soil classes in the Unnamed Ditch subwatershed were Blount (33.0%), Glynwood (23.5%), Sloan (10.2%) and Digby (silt loams, 0 to 1 percent slopes) (10.1%).

Soil particle size is presented in Figure 2.9. The predominant soil particle size within the watershed was fine (83.2%), followed by fine-loamy (10.8%). The majority of the subwatersheds were dominated by fine, ranging in percent composition from 89.8 percent (Holdren Ditch) to 94.4 percent (Boseman Ditch). Unnamed Ditch was dominated by fine soils (68.6%) and fine-loamy soils (30.6%), while Rees Ditch was dominated by fine-loamy soils (49.3%), fine soils (17.5%), fine-loamy of sandy or sandy skeletal soils (13.2%), and fine-silty soils (10.6%). Fine-loamy soils tended to prevail along the Mississinewa River and Rees Ditch, while the upper watershed consisted of predominantly fine soils. Highly erodible soils account for 17 to 37 percent of cropland in Delaware County[2],

Hydric soil distribution is presented in Figure 2.10. Hydric soils comprised 15 percent of the watershed and between 10.6 percent (Unnamed Ditch) and 19.9 percent (Pike Creek) in the subwatersheds.

Soil suitability for septic systems is presented in Figure 2.11. The majority of the watershed soils (97.9%) are very limited for septic systems. Soil limitations include limited dept to saturation zone (5.7%), low filtering capacity (3.9%), flooding (6.8%), ponding (33.3%), and restricted permeability (48.2%). These are the types of limitations one would expect from soils that are predominately fine or fine-loamy.

Farmland classification is presented in Figure 2.12. There are 12,519 acres (18.6%) of prime farm land within the watershed and an additional 28 acres of Farmland of Statewide Importance. The farmlands of statewide importance include scattered small plots of land between 0.8 acres and 5.9 acres in size within the Pike Creek, Campbell Creek and Mississinewa direct drainages. The largest parcels include two sections on 800 North just west of Albany and a parcel south of 850 North Road south of Stockport. The watershed contains 44,902 acres (66.78%) of land considered “prime farmland if drained,” 3,044 acres (4.5%) of land considered “prime farmland if drained and either protected from flooding or not frequently flooded during the growing season,” and 1,050 acres (1.6%) of land considered “prime farmland if protected from flooding or not frequently flooded during the growing season.”

[2] *1997 Census of Agriculture*

| Table 2.4<br>Distribution of Soil by Class in Mississinewa River Watershed | | |
|---|---|---|
| **Soil Class** | **Description** | **Percent** |
| Bellcreek | Fine, smectitic, mesic Fluvaquentic Endoaquolls | **0.6%** |
| Belmore | Fine-loamy, mixed, active, mesic Typic Hapludalfs | **0.8%** |
| Benadum | Fine-silty, mixed, active, nonacid, mesic Thapto-Histic Fluvaquents | **< 0.1%** |
| Blount | Fine, illitic, mesic Aeric Epiaqualfs | **32.4%** |
| Casco | Fine-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Inceptic Hapludalfs | **0.2%** |
| Digby | Fine-loamy, mixed, active, mesic Aeric Endoaqualfs | **1.9%** |
| Eel | Fine-loamy, mixed, superactive, mesic Fluvaquentic Eutrudepts | **0.5%** |
| Eldean | Fine, mixed, superactive, mesic Typic Hapludalfs | **1.6%** |
| Fox | Fine-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Typic Hapludalfs | **1.8%** |
| Glynwood | Fine, illitic, mesic Aquic Hapludalfs | **15.5%** |
| Houghton | Euic, mesic Typic Haplosaprists | **0.2%** |
| Lash | Coarse-loamy, mixed, superactive, mesic Fluventic Hapludolls | **1.1%** |
| Lickcreek | Fine-loamy, mixed, active, mesic Typic Argiudolls | **0.7%** |
| Martinsville | Fine-loamy, mixed, active, mesic Typic Hapludalfs | **0.1%** |
| Milford | Fine, mixed, superactive, mesic Typic Endoaquolls | **1.2%** |
| Millgrove | Fine-loamy, mixed, superactive, mesic Typic Argiaquolls | **2.1%** |
| Mississinewa | Fine, illitic, mesic Aquic Hapludalfs | **2.7%** |
| Morley | Fine, illitic, mesic Oxyaquic Hapludalfs | **1.2%** |
| Muskego | Coprogenous, euic, mesic Limnic Haplosaprists | **< 0.1%** |
| Ockley | Fine-loamy, mixed, active, mesic Typic Hapludalfs | **0.1%** |
| Pella | Fine-silty, mixed, superactive, mesic Typic Endoaquolls | **0.8%** |
| Pewamo | Fine, mixed, active, mesic Typic Argiaquolls | **28.0%** |
| Pits, gravel | not used | **0.1%** |
| Pits, quarry | not used | **< 0.1%** |
| Rawson | Fine-loamy, mixed, active, mesic Oxyaquic Hapludalfs | **0.5%** |
| Rensselaer | Fine-loamy, mixed, superactive, mesic Typic Argiaquolls | **0.1%** |
| Shoals | Fine-loamy, mixed, superactive, nonacid, mesic Fluvaquentic Endoaquepts | **1.0%** |
| Sloan | Fine-loamy, mixed, superactive, mesic Fluvaquentic Endoaquolls | **3.0%** |
| Southwest | Fine-silty, mixed, superactive, nonacid, mesic Typic Fluvaquents | **0.9%** |
| Udorthents | Loamy, mixed, active, calcareous, mesic Typic Udorthents | **0.2%** |
| Water | n/a | **0.8%** |

Figure 2.9 & 2.10 – Soil Particle and Hydric Soils

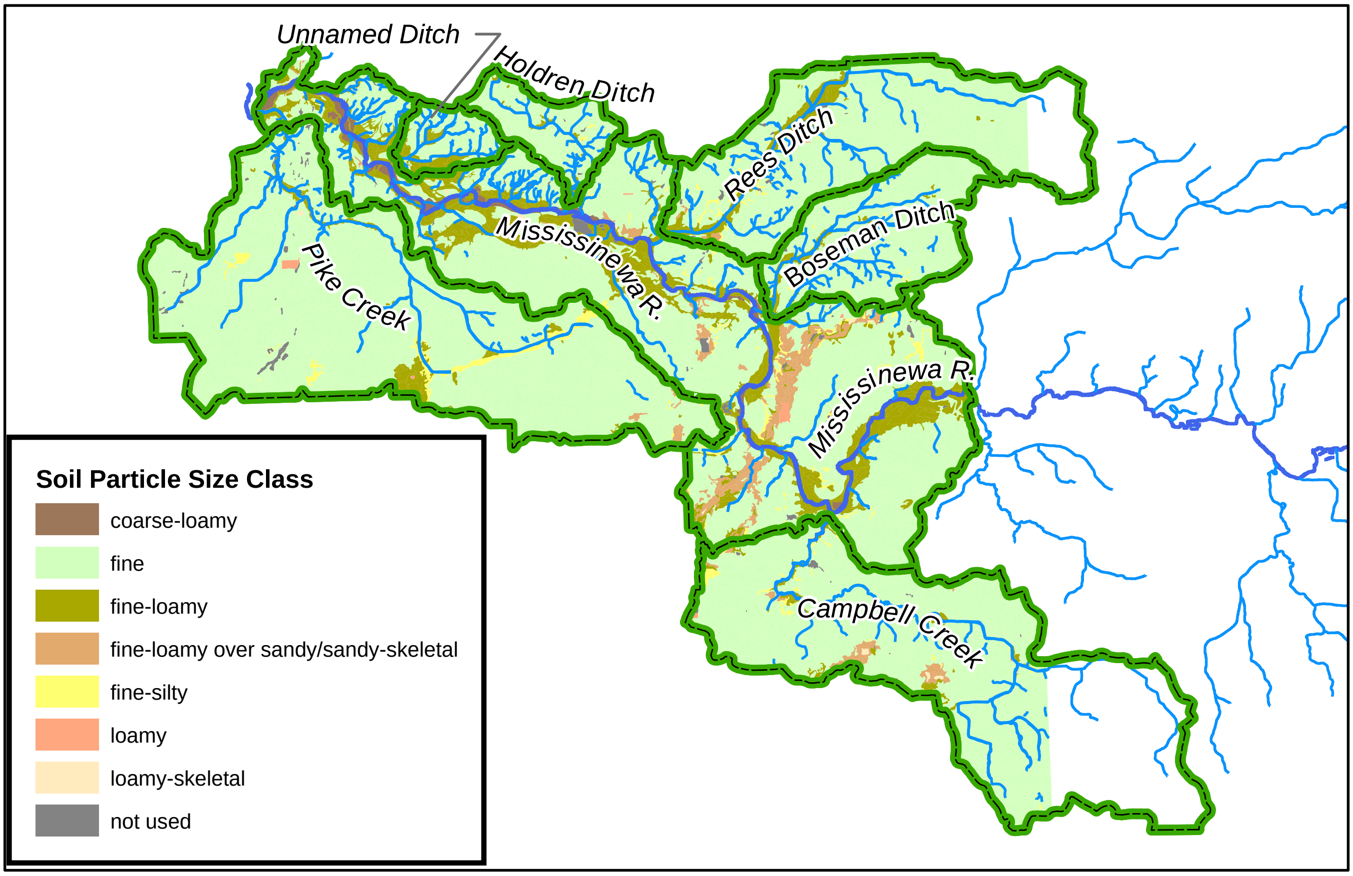


Figure 2.9 Soil Particle Size

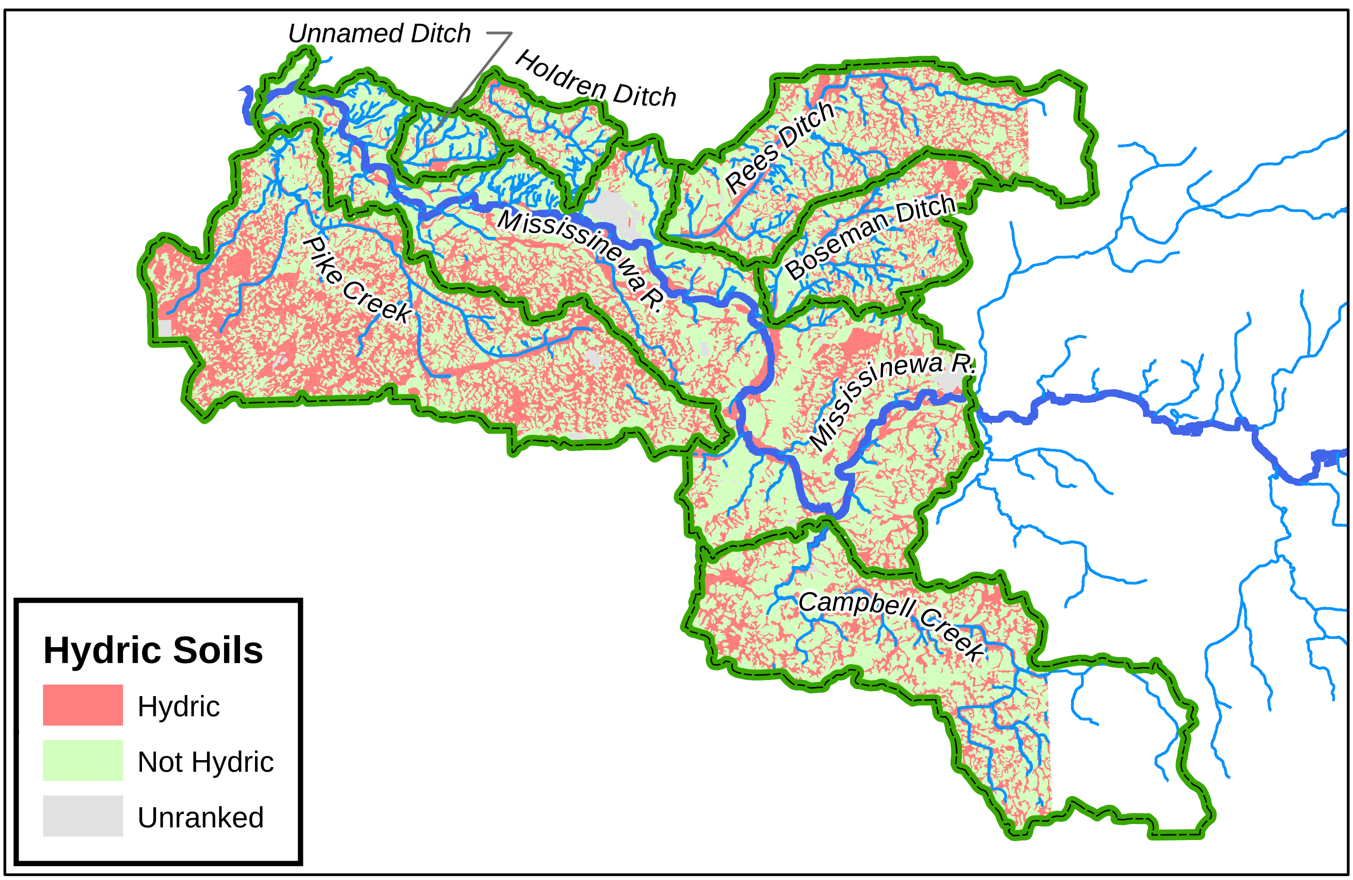


Figure 2.10 Hydric Soils

Figure 2.11 & 2.12 – Septic Limitations and Farmland

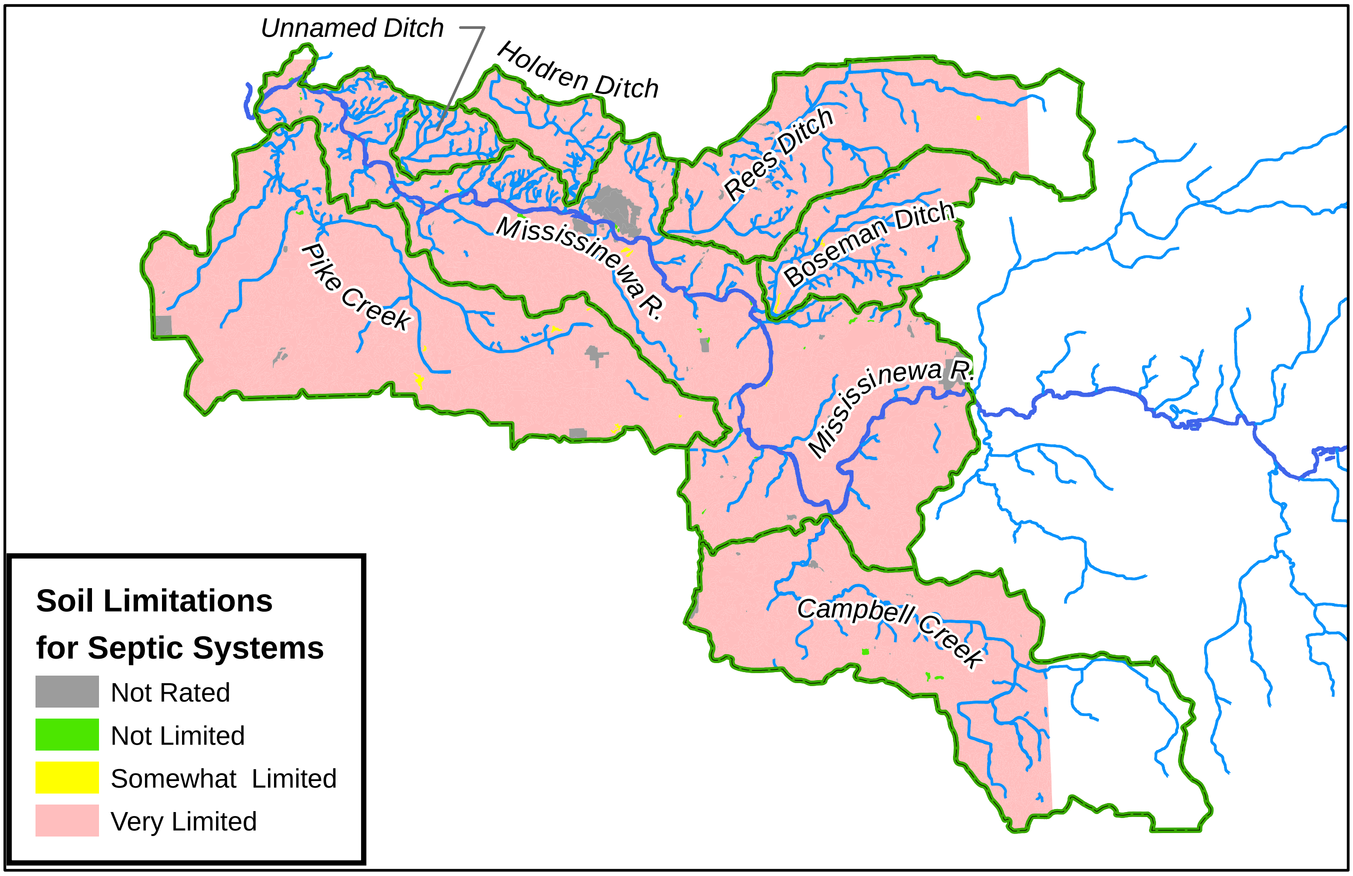


Figure 2.11 Soil Limitations for Septic Systems

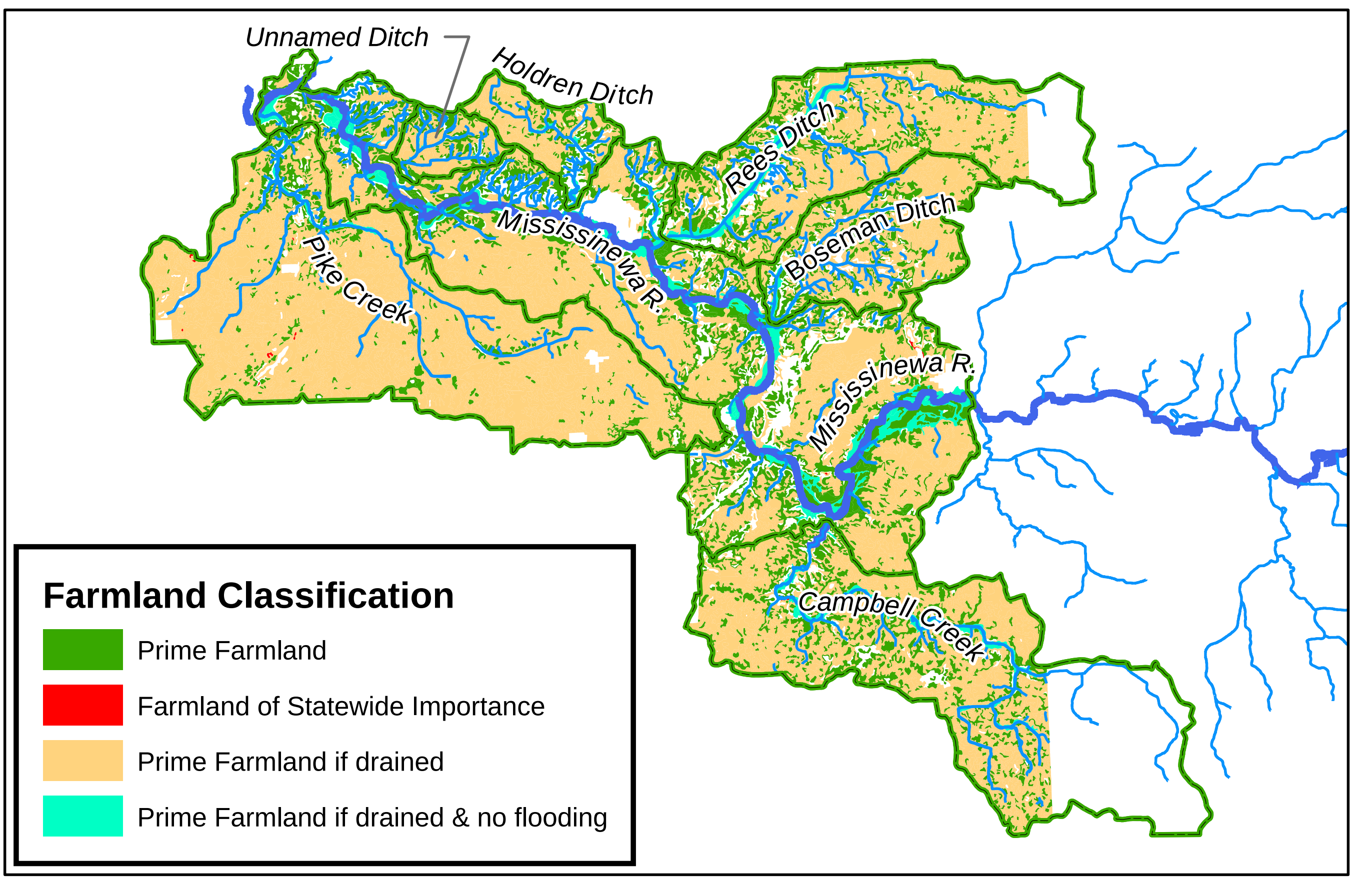


Figure 2.12 Soil Farmland Classification

### 2.3.6 LAND USE

#### *CURRENT LAND USE*

Land use in the Mississinewa River watershed was determined by GIS analysis of the National Land Cover Data (NLCD) for Indiana (USGS & US EPA 2000). The base data set for this project was leaves-off Landsat TM data, nominal-1992 acquisitions (August 1990 - Sept 1994). The spectral reflectance of the satellite imagery was converted into up to 21 land use classes based upon the NLCD Land Cover Classification System Key (Rev. July 20, 1999). The Indiana data layer was obtained in GeoTIFF file format and converted to GIS Grid format using ArcGIS. The Mississinewa River watershed and subwatershed boundaries were projected to match the grid projection and used to clip out a land use grid for the watershed and subwatershed areas.

In addition to the NLCD data, the USDA National Agricultural Statistics Service 2003 Crops coverage was used to obtain additional information on land use within the watershed and subwatersheds. The USDA-NASS 2003 Indiana Cropland Data Layer is a raster, geo-referenced, categorized land cover data layer produced using satellite imagery from the Thematic Mapper (TM) instrument on Landsat 5 and the Enhanced Thematic Mapper (ETM+) on Landsat 7. The imagery was collected between the dates of April 11, 2003 and August 26, 2003. The approximate scale is 1:100,000 with a ground resolution of 30 meters by 30 meters. The Indiana data layer is aggregated to 13 standardized categories for display purposes with the emphasis being agricultural land cover. The Indiana data layer was obtained in GeoTIFF file format and converted to GIS Grid format using ArcGIS. The Mississinewa River watershed and subwatershed boundaries were projected to match the grid projection and used to clip out a crop coverage grid for the watershed and subwatershed areas.

Land use and crop cover in the Mississinewa River watershed are presented in Figure 2.13 and Figure 2.14, respectively. Based on the NLCD data, land use in the Mississinewa River watershed was predominantly row crops (77.6%) and pasture/hay (11.4%). Forest accounted for 6.9 percent of the watershed, open water and wetlands accounted for 1.9 percent of the watershed, and residential areas accounted for 1 percent. Boseman Ditch and Pike Creek subwatersheds had the highest percentage of row crops, at 84.9 percent and 85.6 percent, respectively. Holdren Ditch and Unnamed Ditch had the lowest percentage of row crops, at 68.3 percent and 72.4 percent, respectively.

Based on the Cropland Data, land cover in the Mississinewa River watershed was predominantly soybeans (38.1%), corn (26.8%), pastureland/CRP/non agricultural (19.2%)., and woods/wooded pastureland (8.8%). The watershed cover consisted of 67.3 percent croplands (corn, soybean, winter wheat, small grain/hay, and other crops). Cropland cover ranged from 63.9% in the Holdren Ditch subwatershed to 76.3% in the Pike Creek subwatershed.

Figure 1.13 & 2.14 – Land Use and Crop Cover

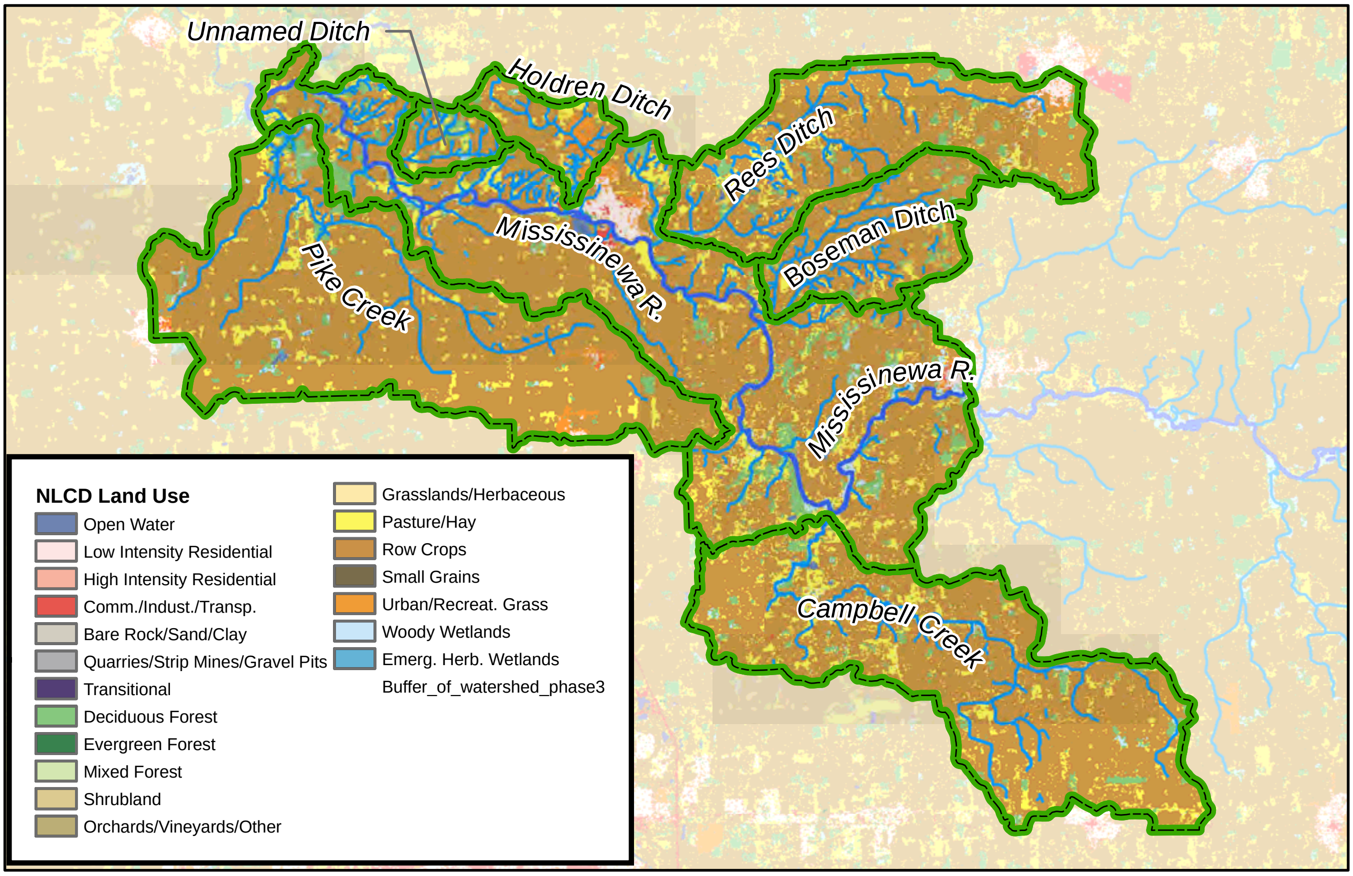


Figure 2.13 NLCD Land Use

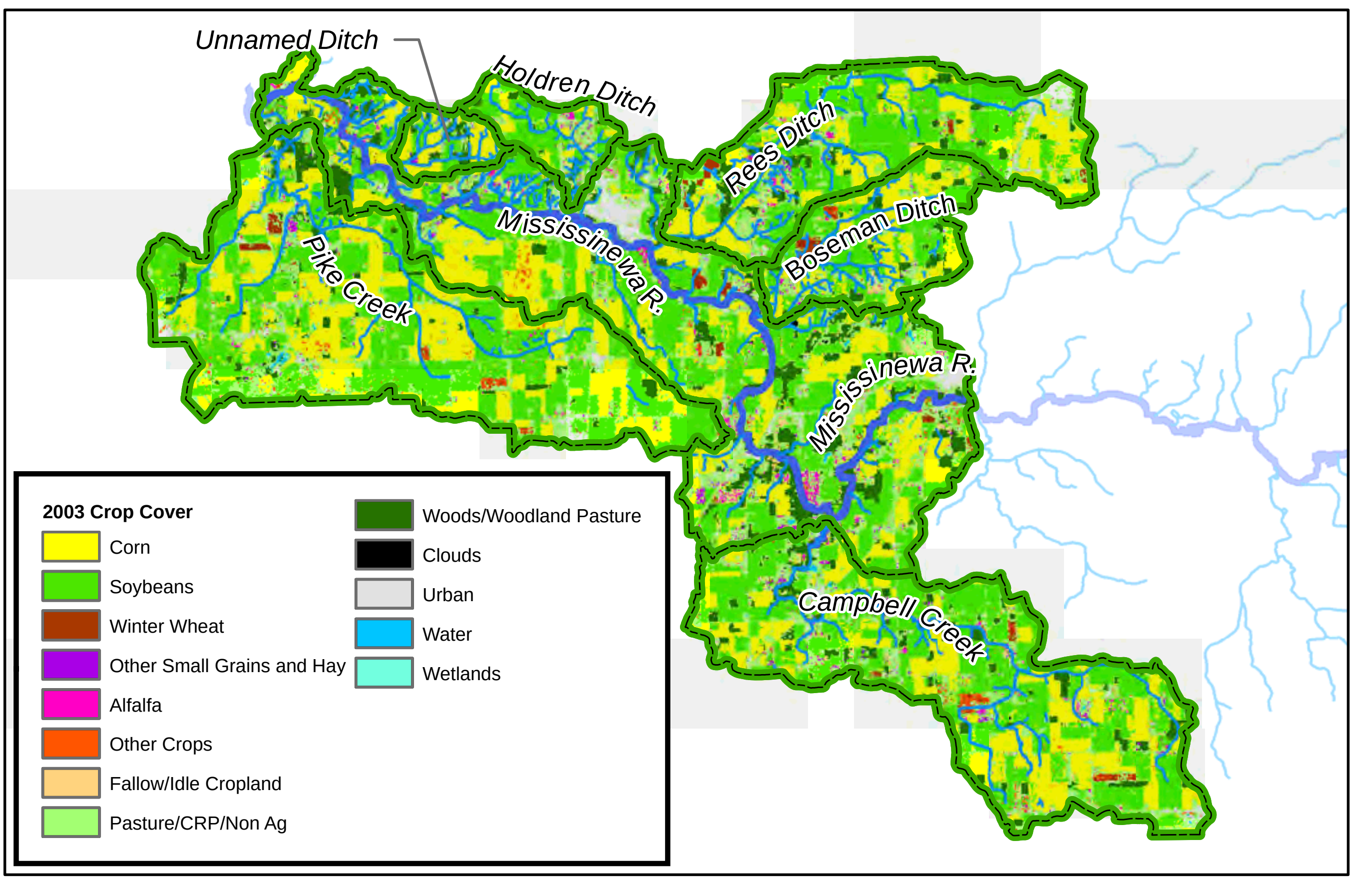


Figure 2.14 2003 Crop Cover

On the positive side, greater than 50 percent of the crop acres in Delaware County are practicing no-till farming, including greater than 33 percent for corn acreage and greater than 70 percent for soybean acreage[3].

### LAND USE TRENDS

Undoubtedly, agriculture has been a part of the Mississinewa River watershed for a great deal of time. Historically, this has resulted in changes to the watershed due to tiling and draining of wetlands, as well as increased sediment- and nutrient-rich runoff. US Census Bureau data were used within a GIS to determine population statistics. The area-weighted population of the watershed was 3,224.7 in 2000, with an area-weighted mean population density of 40.9 people per square mile. Area-weighted population densities within the subwatersheds ranged from 17/mi2 in Boseman Ditch subwatershed to 51.6/mi2 in the Campbell Creek subwatershed.

Population trends in the Mississinewa River watershed are shown in Figure 2.15. Population exhibited a peak in 1900 followed by a decline that lasted into the 1930s. Population and population density steadily increased in the watershed until a maximum was reached in 1980. This was followed by a decline in 1990 and stable conditions from 1990 – 2000.

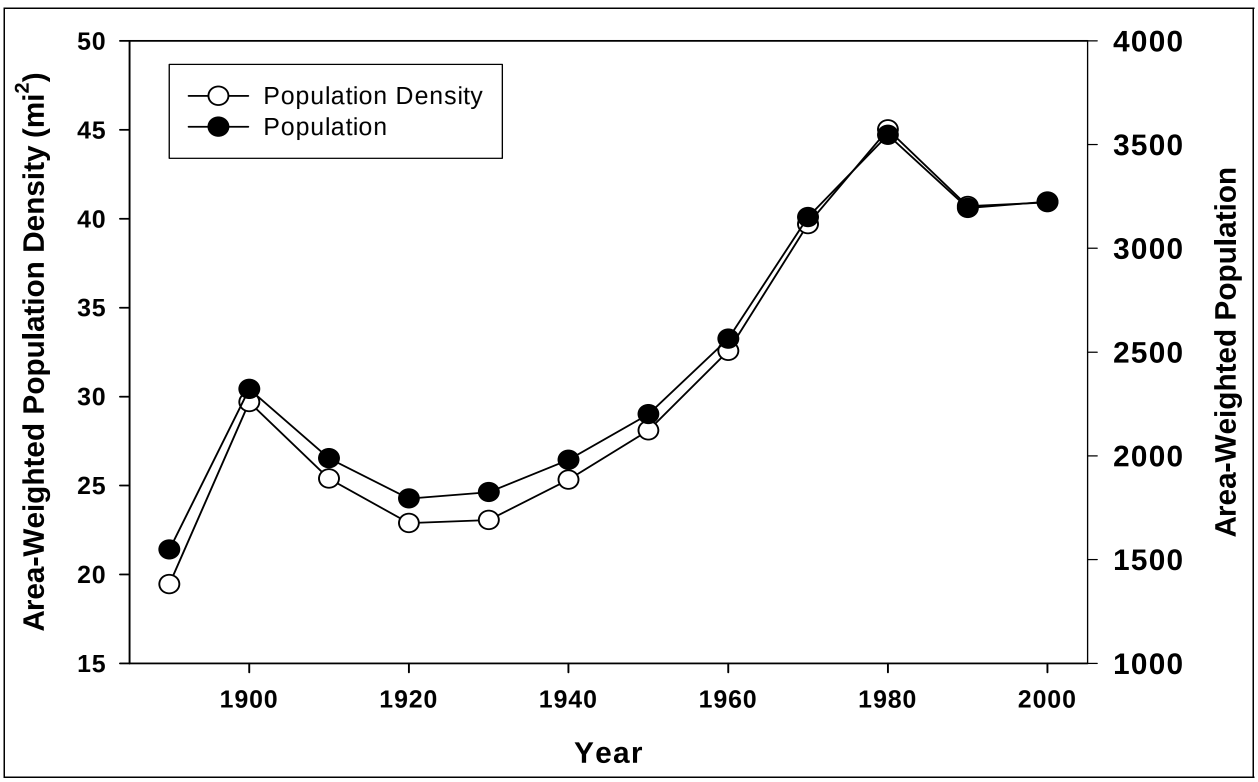


**Figure 2.15** Historical population trends in the Mississinewa River Watershed

[3] *Conservation Technology Information Center*

### 2.3.7 WATER & WETLANDS

A wetlands GIS layer was created by obtaining digital National Wetlands Inventory (NWI) data for each of the topographic quadrangles in the watershed. These data were merged together and clipped by the watershed boundary to create a watershed wetlands layer. A GIS hydrology (stream) layer was created by heads-up digitizing of streams and ditches on 1:24000 USGS digital topographic quadrangles (DRGs).

General wetland types are presented in Figure 2.16. Based upon GIS analysis of the NWI data, the Mississinewa watershed contains approximately 658 wetlands with a total area of 2,078 acres. The average wetland size is 3.2 acres and the median wetland size is 1.2 acres. The watershed contains 23.8 acres of lacustrine wetlands, 200.5 acres of riverine wetlands, and 1,853.3 acres of palustrine wetlands. The palustrine wetland types include aquatic bed (1.7 acres), emergent (221.2 acres), forested (1,424.8 acres), scrub-shrub (8.0 acres), and unconsolidated bottom (197.6 acres).

### 2.3.8 FLOOD PLAIN

The 100 year floodplain within the watershed is shown in Figure 2.17. The floodplain in the Mississinewa River watershed is relatively narrow, following the Mississinewa River, Rees Ditch to its headwaters, and the lower portion of Campbell Creek. The floodplain is widest towards the upper reaches of Rees Ditch and along the Mississinewa River just south of Albany. Within the study watershed, there are 4,783 acres of 100-year floodplain and 335 acres of 500-year floodplain for a total floodplain acreage of 5,118 acres.

### 2.3.9 NATURAL FEATURES

No significant natural features as classified by the USGS Geographic Names Information System (GNIS) exist within the watershed.[4] Features included within the GNIS would include the following: prairie, basin cliff, flat, bottom, gap, rock, hills, ridges, hollows. The dataset contains natural features named on USGS 1:24000 quadrangles and other source map data.

Despite the lack of features in the GNIS database, the watershed does contain some unique natural features, primarily glacial terminal moraine origin. The watershed lies at a bend in the Mississinewa Moraine. An esker forms a well-defined ridge that runs along Route 67 north east to the watershed boundary north of Albany, separating the lower elevation southwest watershed from the higher and more hilly Campbell Creek drainage. Soils on this esker are of the Fox-Muncie complex typically found on eskers and kames. A number of unique natural features were noted during the field investigation. There are presented in Map 1.

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[4] *Indiana Geological Survey, GIS Atlas: NATURAL_FEATURES_USGS_IN: Natural Features in Indiana (U.S. Geological Survey, 1:24000, Point Shapefile)*

Figure 2.16 – Wetlands

Figure 2.17 – Flood Plain

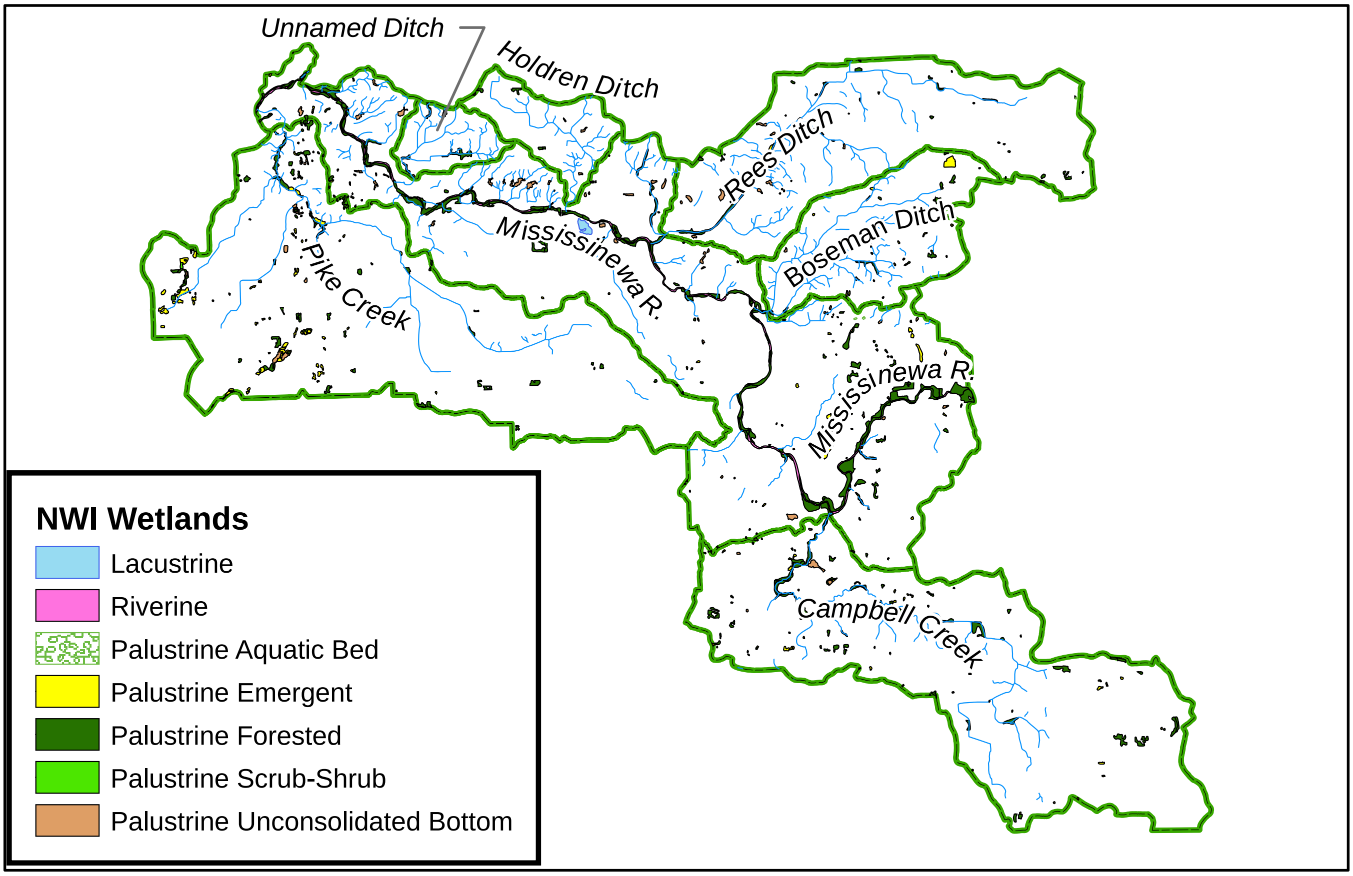


Figure 2.16 Wetlands

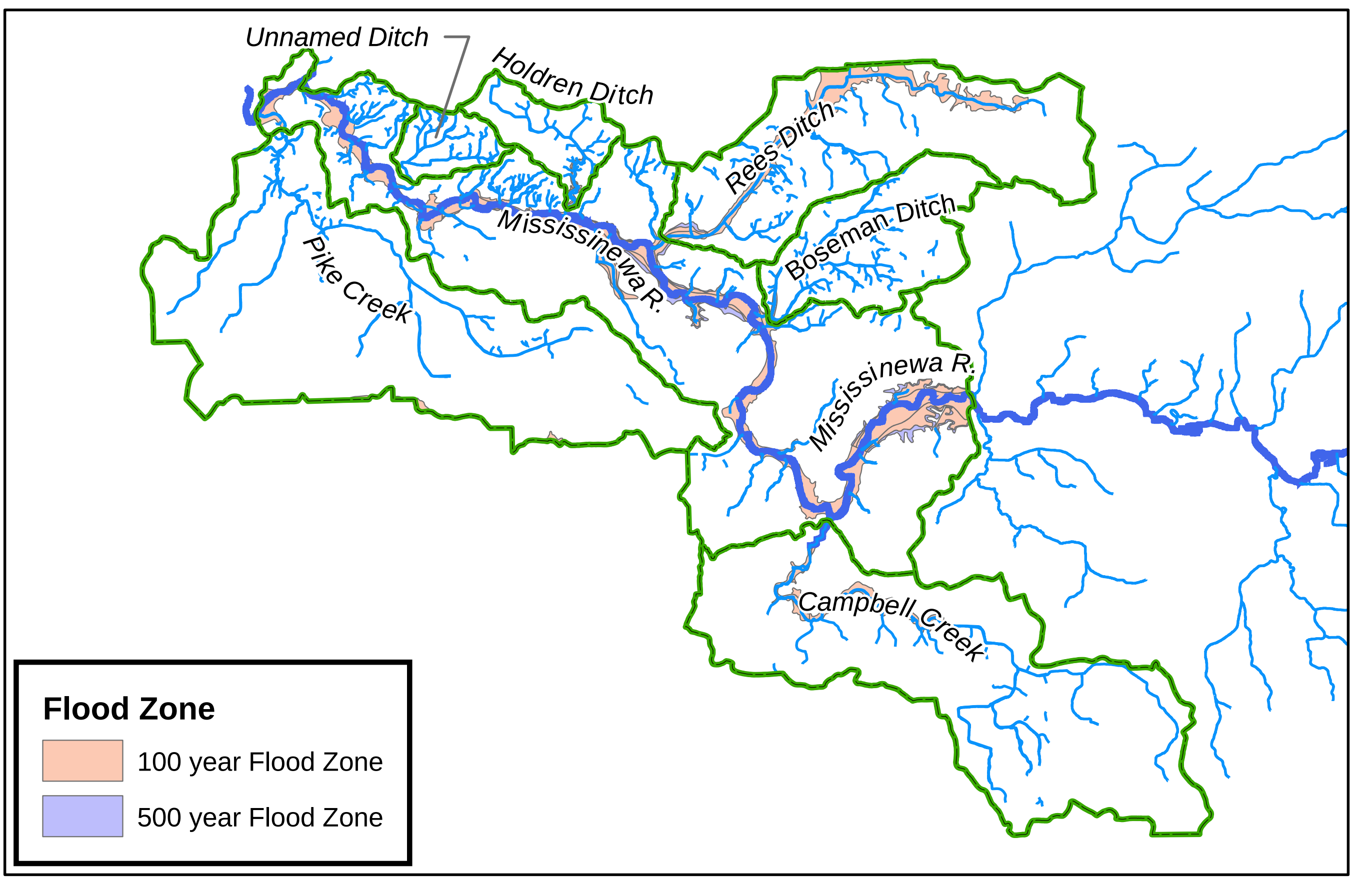


Figure 2.17 Floodplains

## 2.3.10 ENDANGERED AND THREATENED SPECIES

### *INDIANA BAT (ENDANGERED)*

The Mississinewa River watershed is within the range of the federally endangered Indiana bat (*Myotis sodalis*). Indiana bats are found in the cavernous limestone areas of the Midwestern, southern, and eastern United States. This range extends from the Ozarks of Oklahoma in the west, north to southern Wisconsin, as far east as Vermont, and as far south as northern Florida. During their winter hibernation, they are found throughout the Ohio Valley but are absent from southern Michigan, northern Indiana, and south of Tennessee (Thomson, 1982). In winters, Indiana bats live in caves and mines that are appropriate for hibernation, with a cool, stable temperature. In spring, females migrate north from their hibernacula and form maternity colonies in predominantly agricultural areas of Missouri, Iowa, Illinois, Indiana, and Michigan. These colonies, consisting of 50 to 150 adults and their young, normally roost under the loose bark of dead, large-diameter trees throughout summer; however, living shagbark hickories (*Carya ovata*) and tree cavities are also used occasionally (Humphrey et al. 1977; Gardner et al. 1991; Callahan 1993; Kurta et al. 1993). Normally, Indiana bats leave the hibernation sites from April to June (Thomson, 1982). In the summer, males and females live apart from each other, with the females forming nursery colonies in hollow trees or under bark. Indiana bats leave their roosts about a half an hour after sunset to forage. They prefer to forage near the canopy in dense forests. (Kurta, 1995).

Karst topography in Indiana is located in the lower third of the state; therefore it is not believed that there are any over-wintering sites within the Mississinewa River watershed. Indiana bats may forage and breed within the watershed, however.

### *BALD EAGLE (THREATENED)*

The Mississinewa River watershed is also within the range of the federally threatened Bald Eagle (*Haliaeetus leucocephalus*). The Bald Eagle is close to being delisted by the US Fish and Wildlife Service. Today there are an estimated 7,066 nesting pairs of bald eagles due to recovery efforts by the Service, other Federal agencies, Tribes, State and local governments, conservation organizations, universities, corporations and thousands of individual Americans. Five regional recovery plans were created for the bald eagle. The delisting criteria for all five plans were met or exceeded by the year 2000.[5]

Bald Eagles live near large bodies of open water such as lakes, marshes, seacoasts and rivers, where there are plenty of fish to eat and tall trees for nesting and roosting. Bald eagles may be occasional winter visitors to lakes in northern Indiana, but there is no specific habitat for them within the Mississinewa River watershed and they are not known to nest in the area.

## 2.3.11 NATURAL RESOURCE EXTRACTION SITES

[5] *Service Extends Comment Period on Removing the Bald Eagle from the Endangered Species Act, Seeks Comment on Management Tools. US Fish & Wildlife Service News Release. 5/19/06. Note: The public comment period closed on June 19, 2006.*

There are two active sand and gravel pits in the Mississinewa watershed: Fowler Sand & Gravel located on 500 East Road east of Granville and Shideler Pit located on 800 North Road south of Granville in main river drainage. There are 21 abandoned sand and gravel pits in the watershed, including three in the Campbell Creek drainage, three in the Pike Creek drainage, four in the Rees Ditch drainage, one in the Unnamed Ditch drainage, and ten located long the Mississinewa direct drainage. There is also one abandoned quarry on the south bank of Mississinewa across the river from Eaton. Locations of these sites are presented in Map 1.

There are also several petroleum sites in the Mississinewa watershed, including 3 Shut-in Gas wells (2 in upper Rees Ditch, one in Gaston on southwest edge of Pike Creek) and two Oil or Gas Wells, both located in upper Campbell Creek drainage near Mount Pleasant. There are also a recorded 243 other petroleum sites in the watershed classified as other petroleum test wells. Locations of these sites are presented in Map 1.

## 2.4 Previous Studies & Significant Reports

### 2.4.1 EPA STORET Ambient Stream Monitoring

Data exists within EPA's STORET for an ambient stream monitoring site located on the Mississinewa River in Randolph County approximately 14.7 river miles upstream from study watershed. Data are available for this stations from 1975-1979 to 1995-1997. The data are summarized in Table 2.5.

### 2.4.2 IDEM Mississinewa River Watershed Restoration Action Strategy

In May 2001 the IDEM Office of Water Management released the Mississinewa River Watershed Restoration Action Strategy (WRAS) to assist restoration and protection efforts of stakeholders within the watershed (IDEM OWM 2001a, 2001b). The WRAS was divided into two parts: *Part I, Characterization and Responsibilities* and *Part II, Concerns and Recommendations*. The overall goal and purpose of Part I of the Watershed Restoration Action Strategy (WRAS) was to provide a reference point and map to assist local citizens with improving water quality. Part II addressed the major water quality concerns and recommended management strategies.

This Strategy broadly covered the entire watershed and was not intended to dictate management and activities at the stream site or segment level. The WRAS points out that "water quality management decisions and activities for individual portions of the watershed are most effective and efficient when managed through sub-watershed plans. However, these subwatershed plans must also consider the impact on the watershed as a whole."

| Table 2.5<br>EPA STORET Data (Mean Values) from Randolph Ambient Stream Monitoring Site | | | | | |
|---|---|---|---|---|---|
| Parameter | 1975-1979 | 1980-1984 | 1985-1989 | 1990-1994 | 1994-1997 |
| Alkalinity, Total (mg/L as $CaCO_3$) | | 240.68 | 258.12 | 256.92 | 268.67 |
| Ammonia, Unionized (mg/L as N) | 0.00 | 0.00 | 0.00 | 0.00 | |
| BOD, 5 Day, 20°C (mg/L) | 2.90 | 1.64 | 1.63 | 1.08 | 0.20 |
| Chloride, Total In Water (mg/L) | 27.57 | 30.34 | 35.50 | | |
| Hardness, Total (mg/L as $CaCO_3$) | | 330.61 | 344.17 | 343.88 | 369.67 |
| Mercury, Total (µg/L) | 0.19 | 0.13 | | 0.02 | 0.01 |
| Nitrite Plus Nitrate, Total (mg/L as N) | 4.39 | 3.74 | 4.12 | 3.72 | 4.11 |
| Nitrogen, Ammonia, Total (mg/L as N) | 0.14 | 0.09 | 0.05 | 0.04 | |
| Nitrogen, Kjeldahl, Total (mg/L as N) | | 0.69 | 0.95 | 0.60 | |
| Oxygen, Dissolved (mg/L) | 9.00 | 8.93 | 9.56 | 9.99 | 11.14 |
| Ph (su) | 7.73 | 7.72 | 7.73 | 7.71 | 8.07 |
| Phosphorus, Total (mg/L as P) | 0.28 | 0.28 | 0.42 | 0.16 | 0.13 |
| Residue, Total Nonfiltrable (TSS) (mg/L) | 63.57 | 86.59 | 23.88 | 27.13 | 6.08 |
| Specific Conductance (µmhos/cm at 25°C) | 747.14 | 677.73 | 599.12 | 599.54 | 668.50 |
| Sulfate, Total (mg/L as $SO_4$) | 66.86 | 81.77 | 92.25 | | |
| Temperature, Water (°C) | 15.00 | 12.82 | 11.49 | 12.93 | 12.93 |

### 2.4.3 Indiana Unified Watershed Assessment

In 2000-2001, the Indiana Unified Watershed Assessment program conducted an analysis of watershed conditions statewide at the HUC-11 scale using available fishery, habitat assessment, and water quality data (IDEM OWM 2001c). Hydrologic Unit Scores for the Phase I, Phase II, and Phase III watersheds are presented in Table 2.6.

| Table 2.6<br>Hydrologic Unit Scores for the Upper Mississinewa Watershed | | | |
|---|---|---|---|
| Parameter | Phase III | Phase II | Phase I |
| Critical Biodiversity Resource | 2 | 2 | 2 |
| Aquifer Vulnerability | 5 | 5 | 4 |
| Pop. Using Surface Water for Drinking Water | 2 | 2 | 2 |
| Residential Septic System Density | 4 | 1 | 2 |
| Degree of Urbanization | 2 | 2 | 2 |
| Livestock Density | 3 | 4 | 4 |
| Percent Cropland | 4 | 4 | 4 |
| Mineral Extraction Activities | 2 | 2 | 2 |

*(range 1-5, with 1 indicating minimum impairment and 5 indicating severe impairment)*

### 2.4.4 Mississinewa River Phase I and Phase II Studies

A comprehensive phased study of the Mississinewa River drainage within Indiana began in 1999 with the initiation of the Phase I study. The Randolph County SWCD received funding from the IDNR LARE program to study and prioritize water quality problems in the uppermost end of this watershed, which ran from the Indiana-Ohio border to Ridgeville, In (HUC 05120103010). The study was completed in February 2001 (Harza 2001).

The SWCDs of Randolph, Jay, and Delaware County received additional LARE funding in 2002 to conduct the Phase II study of that portion of the Mississinewa River watershed from Ridgeville to Albany (HUC 05120103020). The Phase II study encompassed 85,760 acres and included the tributary drainages of Days Creek, Bush Creek, Halfway Creek, Bear Creek, and Mud Creek. Twelve stations were sampled during the Phase II study in 2003, and the study was completed in 2005 (Commonwealth Biomonitoring 2005)

The Phase II study made the following conclusions:

> Nutrient values at most sites were elevated compared to many other Indiana streams in agricultural areas, especially during wet weather. Other water quality measurements fell within ranges suitable for most forms of freshwater aquatic life. *E. coli* bacteria were present at concentrations exceeding Indiana water quality standards at most sites during wet weather. Concentrations were considerably lower during dry weather. The source of bacterial contamination was not identified. Aquatic habitat quality was generally good at most sites, especially within the Mississinewa River itself. At some sites, habitat quality was impaired by channelization and lack of stream bank vegetation.

### 2.4.5 Taylor University 319 Watershed Study

The Taylor University Environmental Research Group conducted a land use and sediment loading study of the Mississinewa River Watershed, and their final report entitled "Land Use and Sediment Loading in the Mississinewa Watershed" was completed in April 2005. The purpose of their study was to create a field-validated model of sediment loading in two selected subwatersheds in the Mississinewa watershed that could be used to evaluate and prioritize all 48 HUC-14 subwatersheds. The Revised Universal Soil Loss Equation (RUSLE) was used with a GIS interface to calculate sediment loadings in all subwatersheds. The model was calibrated using water quality data that was collected in the Walnut Creek and the Barren Creek subwatersheds. Once the model was calibrated, it was used to evaluate sediment loadings from other subwatershed in the Mississinewa River watershed. The Taylor study also conducted QHEI evaluations at five stations in the two study subwatersheds and evaluated numerous Best Management Practices for sediment reduction.

Based on the Taylor study, the Rees Ditch subwatershed had the lowest sediment load ranking. The Campbell Creek subwatershed had a moderate sediment load ranking. The eastern portion of the Phase III Mississinewa River watershed, including that portion of the direct drainage of the Mississinewa River and the Boseman Ditch subwatershed had a moderately high sediment load ranking. The western portion of the Phase III watershed, downstream of Rees Ditch, including the subwatersheds of Pike Creek, Holdren Ditch, Unnamed Ditch, and that portion of the Mississinewa River direct drainage had the highest sediment load ranking.

### 2.4.6 Fisheries

The DNR Division of Fish & Wildlife has conducted several fisheries surveys and reports that included the Upper Mississinewa area. They are:

A Fisheries Survey of the Mississinewa River in Indiana. E. Braun, 1982.
A Fisheries Survey of the Mississinewa River, E. Braun, 1990.
A Fisheries Survey of the Mississinewa River Upstream of Mississinewa Reservoir and the Little Mississinewa River, E. Braun, 1998.
Mississinewa River Rainbow Trout Introduction WP#202120 – 2003 Progress Report, E. Braun, 2004.

The Randolph County Wildlife Management Area lies just upstream of Albany, southeast of State Road 1 and State Road 28. This area is technically outside of the watershed in this study but indicative of the high quality of water resources that is possible in the area. In 2002 and 2003, the river segment in this area was found to be one of only a few locations in Indiana which is suitable for trout survival. Water quality was monitored upstream of the State road 1 bridge in Randolph County monthly from April to June, 2003 and 2004, and was compared to 2002 data. While turbidity was high during a storm event (432 NTU), dissolved oxygen and cold water temperatures were less than desirable, but adequate to support a trout fishery.

In the most recent fishery survey (1998), four sampling sites were within the portion of the watershed included in this diagnostic study at River Mile 64.68, RM 69.2, RM 75.8 and RM 82.4. Parameters measured were stream average width, average and maximum depth, subjective and aesthetic ratings, all metrics for the Qualitative Habitat Evaluation Index (describing fish habitat quality), and an electrofishing survey. The QHEI scored the lowest at the site in Wheeling (58.5 out of 100 possible points) and ranged from 70 to 74 in the other sites. Pool habitat was limited in some sites where bedrock was the dominant bottom type.

The number of species captured at these sites ranged from 25 to 33 including the highest numbers of species sensitive to water quality (12-14 per site). Fewer carp were found in these stations that at other sites along the river. Orangespotted sunfish, brindled madtom, mottled sculpin, and six darter species were collected. Three species of redhorse sucker (golden, black and silver) and northern hogsucker were found in these segments. Central stonerollers were found at stations above Wheeling; this herbivore prefers shallow rocky substrate with some algal growth.

Total Index of Biotic Integrity (IBI) scores ranged from 48 to 56 along these sites. Interpretation of these scores rates these fish communities in the “good” class approaching “excellent” at the upper end but showing some stress. Presence of tolerant species, omnivores, lower numbers of carnivores, and fewer lithophilic (gravel-loving) spawners lowered the scores.

This middle section of the river showed higher quality fish communities than either the downstream urban areas or the upstream channelized reaches. At three of the sites, fish community scores showed improvement from 1990 to 1998. Smallmouth and rock bass populations were substantially better than in previous surveys. Instream and riparian habitat was reasonably good and did not seem to be a major impairment, suggesting that other factors such as turbidity and nutrients may be affecting the fisheries resource. Implementation of conservation practices could be a key factor in maintaining and enhancing the high quality fish community that appears to be possible along this portion of the river.

A fish community assessment was conducted via electrofishing on June 8, 1994 by IDEM Biological Studies Section that included three stations within Delaware County (Sobat 2004). Locations within the Mississinewa River Phase III watershed included Campbell Creek at CR500 E, Mississinewa River at the 700N bridge, and the Mississinewa River at the Granville bridge OR CR370 Bridge at Station MR01 (Location given as Granville bridge but coordinates given are for CR370 bridge, Phase III station MR01). In addition, since the coordinates are in question, Granville bridge could refer either to the bridge near the intersection of Old Granville Road and Gregory Road or the one lane bridge where Gregory Road crosses the river.

In Campbell Creek, 491 individuals from 15 species were caught. The dominant species were creek chub (36 percent), bluntnose minnow (22 percent) and green sunfish (18 percent). This station had a fish IBI of 38. In the Mississinewa River at the 700N bridge, 691 individuals from 28 species were caught. The dominant species were bluntnose minnow (23 percent) and rainbow darter (13 percent). This station had a fish IBI of 46. In the Mississinewa River at the Granville bridge, 528 individuals from 27 species were caught. The dominant species were bluntnose minnow (23 percent), longear sunfish (16 percent), rock bask (16 percent), and spotfin shiner (13 percent). This station had a fish IBI of 50.

An IBI score of 28 – 24 equates to a biotic integrity rating of poor due to the scarcity or absence of top carnivores and many expected species and dominance of omnivores and tolerant species. An IBI score of 40 – 44 equates to a biotic integrity rating of fair due to the absence of intolerant and sensitive species and a skewed trophic structure. An IBI score of 48 – 52 equates to a biotic integrity rating of good due to a decreased species richness dominated by intolerant species, with sensitive species present. (Karr et al. 1986). Based on these ranges, Campbell Creek at CR500 had a biotic integrity of poor to fair, the Mississinewa River at 700N bridge had a biotic integrity of fair to good, and the Mississinewa River at Granville bridge hat a biotic integrity of good. IDEM considers a fish IBI greater than 36 as fully supporting aquatic life use in rivers and streams (IDEM 2006).

The Indiana Department of Natural Resources Fisheries Section conducted a fisheries survey in 1998.

## 2.5 Potential Pollution Sources

### 2.5.1 Point Sources

There are five permitted NPDES facilities within the watershed, including two municipal treatment plants (Albany & Eaton), a manufacturing plant (Rock-Tenn Company), a food processing plant (New Meridian Foods), and an office complex (Paws, Inc.). There are six recorded NPDES discharge locations within the watershed associated with these five facilities. The Eaton wastewater treatment facility has two combined sewer overflow and one wastewater outfall that discharge into the Mississinewa River. The Albany wastewater treatment facility has one outfall that discharges to the Mississinewa River. Paws, Inc. has two discharges into artificial wetlands and then into tributaries of the Mississinewa River. In addition to the recorded discharge locations, New Meridian Foods has a discharge into the Mississinewa River via an unnamed ditch and Rock-Tenn Company has a discharge from its treatment ponds into the Mississinewa River[6]. The NPDES facilities are listed in Table 2.7 and shown on Map 1.

**Table 2.7**
**NPDES permitted facilities in Mississinewa River Watershed**

| Facility | Permit No | Location | Town |
|---|---|---|---|
| **Albany Municipal STP** | IN0022136 | Dowden Road | Albany |
| **Eaton Municipal STP** | IN0021652 | State Road E and Indiana Ave | Eaton |
| **New Meridian Inc** | IN0038016 | 201 West Babb Road | Eaton |
| **Paws, Inc.** | IN0055271 | 0.1 mi East of CR 316E | Albany |
| **Rock-Tenn Company** | IN0005002 | 800A South Romy Street | Eaton |

### 2.5.2 LAND QUALITY SITES

In addition to the NPDES point sources, there are additional listed sites of concern within the watershed[7]. These are shown on Map 1 and listed below.

Brownfield Sites (1)
- Garage repair shop, Albany

Commissioner's Bulletin Sites (1)
- Muncie Race Track/Albany Battery

Combined Animal Feeding Operations (3)
- Sprong, 800 North Road near Center Road, Studebaker Ditch in Pike Creek subwatershed
- Chalfont Farms, 200 North Rd east of Parker, upper Campbell Creek subwatershed
- Muncie Sow Unit, 350 East Rd south of 1100 North, Rees Ditch subwatershed

Leaking Underground Storage Tanks (7-10)
- Unidentified facility outside Parker – may be outside watershed boundary
- Monroe Central School, near Parker – may be outside watershed boundary
- Albany Machine Shop, Albany – may be outside watershed boundary
- Albany Liquor, Albany
- Ferrellgas, Albany
- Marsh Village Pantry, Albany
- Hucks Food Store, Dunkirk

[6] *IDEM Office of Water Quality*
[7] *IDEM Office of Land Quality*

Pak-A-Sak, Dunkirk
Eaton Stop & Shop, Eaton
Public Service Indiana, Gaston
Registered Underground Storage Tanks (approx. 28)
Voluntary Remediation Sites (1)
Wheeling, in Pike Creek subwatershed near downstream extent of study watershed
Industrial Waste Sites – small quantity generator (1)
Colony Printing & Labeling, Eaton
Solid Waste Sites (1)
Muncie Race Track/Albany Battery

### USE IMPAIRMENT

The main stem of the Mississinewa River within the project study area was listed as impaired on the IDEM 2004 303(d) list. The entire river within the study watershed was listed as impaired due to the presence of PCBs and mercury and a portion of the river was also listed for the presence of *Escherichia coli* (E. coli) bacteria. The upper reach of the river, from Albany to Rees Ditch, as well as the lower one mile of the river upstream from Wheeling, was listed for a primary cause of PCBs and a secondary cause of mercury. The segment of the river from Rees Ditch to Wheeling was listed for a primary cause of E. coli bacteria, a secondary cause of PCBs, and a tertiary cause of mercury.

## 2.6 RECREATIONAL RESOURCES

The main recreational use of the Mississinewa River in the study section appears to be fishing. A favorite fishing spot is along Gregory Road from the bend at the artesian spring to the one lane bridge. Special Boat Service, located on East Gregory Road in Albany, runs a river guide service specializing in kayak trips along the Mississinewa River. The 1998 DNR fisheries survey showed fishable populations of smallmouth and rock bass, suggesting that this recreational resource could provide further economic value to the communities in Delaware or Randolph Counties if public access to the river with parking facilities were provided. The DNR public access program could provide assistance in acquiring and construction a DNR boat ramp site with support from local residents.

# 3.0 WATER QUALITY

## 3.1 MONITORING STATIONS

Twenty stations were established in the study watershed, including three on the Mississinewa River and seventeen stations on tributaries to the river. Stations were selected to cover major subwatersheds and to further divide those subwatersheds into smaller units to provide more precision in identifying sources of water quality problems. Station ID, location and description are presented in Table 3.1. A map of station locations is presented in Figure 3.1. Subwatershed area for each station is shown in Table 3.2.

**Table 3.1**
**Monitoring Stations in Mississinewa River Watershed**

| Station | Location (UTM) | | Description |
|---|---|---|---|
| **BD01** | 644078.19 | 4463946.07 | Bosman Ditch Downstream on 450 East Road |
| **BD02** | 645610.66 | 4466036.65 | Bosman Ditch on 550 East Road |
| **BD03** | 645624.11 | 4465350.45 | Unnamed Trib to Bosman Ditch on 550 East Road |
| **CC01** | 645735.20 | 4458409.78 | Campbell Creek Downstream on 500 North Road |
| **CC02** | 647625.14 | 4455961.50 | Campbell Creek at 650 East Road |
| **CC03** | 650974.05 | 4454365.90 | Campbell Creek Main Stem on 850 East Road |
| **CC04** | 650829.96 | 4454271.69 | Campbell Creek South Fork on 850 East Road |
| **HD01** | 638651.61 | 4466847.43 | Holdren Ditch on Eaton/Wheeling Pike |
| **MR01** | 631040.64 | 4470033.09 | Mississinewa River Downstream |
| **MR02** | 636890.31 | 4466949.11 | Mississinewa River Below Eaton |
| **MR03** | 648873.08 | 4461671.82 | Mississinewa River Below Albany |
| **PC01** | 630998.66 | 4468984.82 | Pike Creek Downstream near Wheeling |
| **PC02** | 630353.89 | 4466875.82 | Hedgeland Ditch on North Wheeling Ave |
| **PC03** | 633882.63 | 4465914.65 | Studebaker Ditch on 1000 North Road |
| **PC04** | 636950.17 | 4462873.50 | Studebaker Ditch on North Center Road |
| **RD01** | 641335.92 | 4466030.61 | Rees Ditch Downstream on Eaton/Albany Pike |
| **RD02** | 641063.19 | 4466054.63 | Unnamed Trib to Rees Ditch on Eaton/Albany Pike |
| **RD03** | 645132.96 | 4469323.30 | Rees Ditch on 1200 North Road |
| **RD04** | 651134.76 | 4469761.10 | Rees Ditch below Dunkirk |
| **UD01** | 634494.76 | 4467552.70 | Unnamed Ditch on Eaton/Wheeling Pike |

Figure 3.1 – Station Locations

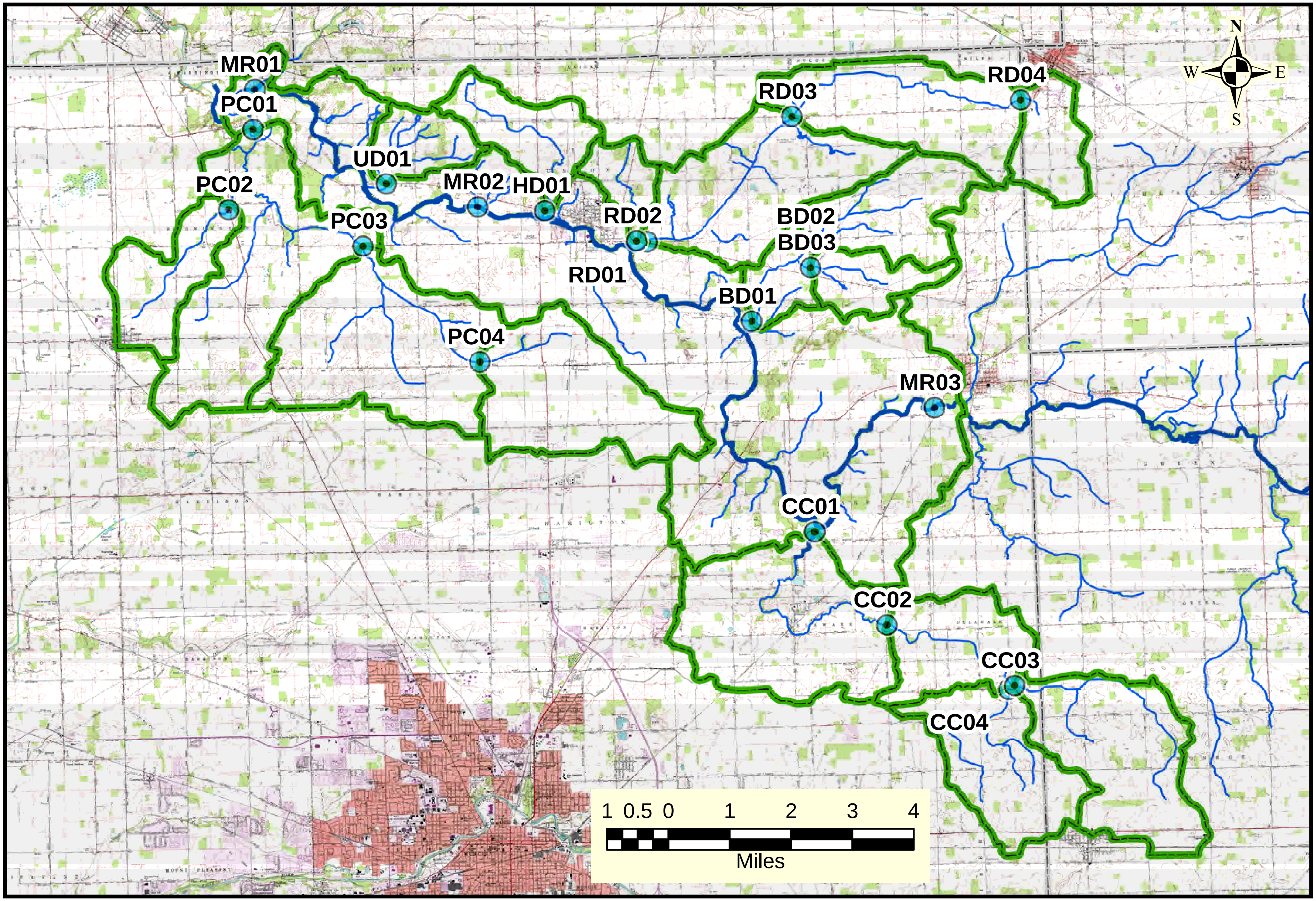


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Figure 3.1 Location of Phase III Water Quality Stations

| Table 3.2<br>Subwatershed areas in the Mississinewa River Phase III Watershed | | |
|---|---|---|
| **Subwatershed (Station)** | **Stations within Subwatershed** | **Area (ac)** |
| **Boseman Ditch (BD01)** | **- - - - - - - - - -** | **4,131** |
| | BD02 – Boseman Ditch | 2,188 |
| | BD03 – Trib. to Boseman Ditch | 1,066 |
| **Campbell Creek (CC01)** | **- - - - - - - - - -** | **13,500** |
| | CC02 – Campbell Creek midway | 8,659 |
| | CC03 – Campbell Creek | 3,669 |
| | CC04 – Trib. to Campbell Creek | 2,837 |
| **Holdren Ditch (HD01)** | **- - - - - - - - - -** | **1,675** |
| **Pike Creek (PC01)** | **- - - - - - - - - -** | **15,566** |
| | PC02 – Hedgeland Ditch | 1,812 |
| | PC03 – Studebaker Ditch midway | 8,684 |
| | PC04 – Studebaker Ditch upstream | 3,750 |
| **Rees Ditch (RD01)** | **- - - - - - - - - -** | **8,400** |
| | RD02 – Trib. To Rees Ditch | 761 |
| | RD03 – | 4586 |
| | RD04 – | 1266 |
| Mississinewa River (MR01) | | |
| **Mississinewa Direct** | **- - - - - - - - - -** | **21,737** |

Note: Subwatershed areas do not tally since sub-subwatersheds often contain upstream sub-subwatersheds

## 3.2 METHODOLOGY

### 3.2.1 WATER QUALITY

Water quality monitoring was conducted following standard accepted practices for river and stream survey work consistent with the requirements of LARE Watershed Diagnostic Studies. Samples were collected on April 13 and August 11. 2004. After review of the data, it was decided that an additional sampling of a restricted set of parameters would be conducted to better represent high flow conditions. The additional sampling was conducted on September 16, 2005. On the 2004 sampling dates, sample parameters included flow, dissolved oxygen (DO), temperature, E coli bacteria, pH, specific conductivity, turbidity, total phosphorus (TP), soluble reactive phosphorus (SRP), nitrate+nitrite nitrogen ($NO_2$+$NO_3$), total Kjeldahl nitrogen (TKN), and ammonia. Total nitrogen was calculated as the sum of TKN, $NH_4$, and $NO_{2+}NO_3$.

Bacteriological samples were taken to a local analytical laboratory immediately following collection for the day. All other water quality samples were preserved, where appropriate, and then shipped priority overnight to the F. X. Browne, Inc. laboratory in Marshalls Creek, PA. Sample analyses were conducted following Standard Methods (APHA 1992).

Wet and dry weather stream sampling was accomplished by the collection of grab samples that were placed in appropriately preserved sample containers, place on ice, and shipped or delivered to the laboratories for analysis. Stream flows were determined by measuring a cross-sectional profile and measuring interval flow across a stream transect using a Marsh-McBirney flow meter. Flow measurements on September 16, 2005 were estimated based on width times depth times velocity (accuracy within 50%). Mississinewa River flows were calculated from flow and area data for the USGS Gauging Station 03325500 at Ridgeville in Randolph County, Latitude 40°16'48", Longitude 84°59'33", Gage datum 965.28 feet above sea level. River flow at the three Mississinewa River stations was calculated using the following formula: Target CFS = Target Drainage Area x Ridgeville Flow / Ridgeville Drainage Area. For the purposes of flow calculation and due to station location, Station MR01 included the entire Lick Creek drainage (NOT part of the study) but did not include the Pike Creek Drainage.

### 3.2.2 MACROINVERTEBRATES & HABITAT ASSESSMENT

Macroinvertebrate samples were collected on August 11, 2004 at each of the tributary samples were flow was evident (BD01, BD02, CC01, CC03, CC04, HD01, PC01, PC02, PC03, PC04, RD01, RD03, RD04, UD01, following EPA♣s Rapid Bioassessment Protocol Second Edition (Barbour et al. 1999). Macroinvertebrates were collected using the Multi-Habitat Approach, using a D-Frame Dip Net and a total of 20 jabs or kicks taken from all major habitat types in each reach. Macroinvertebrates were separated from larger materials collected during the sampling process. The remaining material and macroinvertebrates were placed in a collection jar and preserved in the field using 70 percent ethanol. All macroinvertebrates were counted in each sample, with total counts ranging from 23 organisms at CC01 to 423 organisms at BD01. Macroinvertebrates were identified to the lowest practical level, which was genus in most cases. Out of 181 taxa identified, 138 (76%) were identified to genus.

Key metrics based on taxa at each station were calculated for macroinvertebrate community richness, composition, tolerance, and trophic (feeding measures)/habit. These included:

- **Richness Measures**
  - o Total Taxa, No. EPT Taxa, No. Ephemeroptera Taxa, No. Plecoptera Taxa, No. Trichoptera Taxa
- **Composition Measures**
  - o % EPT, % Ephemeroptera, % Chironomidae
- **Tolerance Measures**
  - o No. Intolerant Tax, % Tolerant Taxa, Hilsenhoff Biotic Index, % Dominant Taxa for 2, 3, 4 & 5 taxa)
- **Trophic/Habit Measures**
  - o No. Clinger Taxa, % Clinger Taxa, % Filterer Taxa, % Grazer & Scraper Taxa

Habitat assessment was conducted using the Qualitative Habitat Evaluation Index (QHEI) method (Rankin 1989, Rankin 1995, OhioEPA 1999) at all stations where flow was present (stations where macroinvertebrate samples were collected). At each site, the field personnel discussed each metric and its options and reached a consensus before making an entry, taking into account stream conditions at, above, and below the sampling point. Calculations of metric 6, Map Gradient, were made with the assistance of a GIS.

## 3.3 River & STREAM ECOLOGY

### 3.3.1 Important Water Quality Factors

#### *Dissolved Oxygen and Temperature*

The amount and distribution of dissolved oxygen in an ecosystem can affect the health of aquatic organisms and nutrient cycles. For normal growth and reproduction, adult warm water fish (i.e. bass and pike) require oxygen concentrations of at least 5.0 milligrams per liter (mg/L), and adult cold water fish (i.e. trout and salmon) require at least 6.5 mg/L of dissolved oxygen (US EPA 1986). Rivers and streams receive most of their oxygen from the atmosphere through gas exchange at the surface. Aquatic plants also contribute oxygen to the water. The amount of oxygen varies with current speed and turbulence – fast flowing, turbulent, unpolluted streams are usually saturated with oxygen, while pools, slow-moving, and stagnant water may have relatively low oxygen levels. Low levels of oxygen will usually occur in areas polluted with organic waste (Giller and Malmqvist 1998).

#### *pH*

The pH level is a measure of acidity (concentration of hydrogen ions in water), reported in standard units on a logarithmic scale that ranges from one to fourteen. On the pH scale, seven is neutral, lower numbers are more acid, and higher numbers are more basic. In general, pH values between 6.0 and 8.0 are considered optimal for the maintenance of a healthy lake ecosystem. Many species of fish and amphibians have difficulty with growth and reproduction when pH levels fall below 5.5 standard units. Lake acidification status can be assessed from pH as follows:

| | |
|---|---|
| pH less than 5.0 | Critical (impaired) |
| pH between 5.0 and 6.0 | Endangered (threatened) |
| pH greater than 6.0 | Satisfactory (acceptable) |

#### *Specific Conductivity*

Conductivity is a measure of the ability of water to conduct electric current, which is related to the amount of dissolved ions within the water. Conductivity in streams and rivers is affected by the geology of the area through which the water flows. Streams that run through granite bedrock will have lower conductivity, and those that flow through limestone and clay soils will have higher conductivity values. Higher conductivity values are indicative of a wide variety of pollutants, including organic sources such as animal and human waste and inorganic sources, such as fertilizers and industrial discharges. Conductivities may be naturally high in water that drains from bogs and marshes. Clean, clear-water streams might typically have conductivities of less than 100 micromhos per centimeter (μmhos/cm), whereas streams impacted by pollutants may have conductivities greater than 500 μmhos/cm.

### *NITROGEN*

Nitrogen is one of the three main nutrients of life, along with phosphorus and carbon. Most forms of nitrogen occur naturally in low concentrations in surface waters, while high concentrations indicate pollution from agricultural activities and wastewater, including septic system. Nitrate is an inorganic form of nitrogen. Nitrate nitrogen concentrations are naturally low in unimpacted streams and rivers and elevated where agricultural runoff and wastewater are present. Organic nitrogen is un-oxidized, organically bound form of nitrogen that includes proteins, peptides, urea, and numerous synthetic compounds. High organic nitrogen increases the oxygen demand in aquatic systems. Ammonia is an organic form of nitrogen that can be toxic to aquatic organisms at elevated concentrations. Total Kjeldahl nitrogen (TKN) is a measure of all organic forms of nitrogen. Total nitrogen is a measure of all forms of nitrogen, including organic nitrogen, ammonia, and inorganic forms (TKN + nitrate and nitrite nitrogen).

### *PHOSPHOROUS*

Phosphorus is one of the three main nutrients of life, along with nitrogen and carbon. Total phosphorus is a measure of all forms of phosphorus, both organic and inorganic. Total phosphorus concentrations are naturally low in most rivers and streams, but high in rivers and streams located in agricultural and urban areas, or that receive wastewater discharges. High phosphorus levels in streams increase the growth of plants and algae, reducing the quality of the habitat and causing low oxygen levels at night when the plants and algae are respiring but not photosynthesizing

### *TURBIDITY*

Turbidity is a measure of the cloudiness of a river or stream. Turbidity in water is caused by suspended matter, such as silt and clay, finely divided organic and inorganic matter, soluble organic color compounds, and plankton and other microscopic organisms. Turbidity measures the optical scattering and absorption of light by the presence of these factors in water. Higher turbidity values are indicative of the presence of one or more of the turbidity-causing factors is present in a sample, but can not indicate which factor or factors is at fault.

#### *Escherichia coli (E. coli)*

E. coli is a type of fecal coliform bacteria that comes from human and animal waste. EPA recommends E. coli as the best indicator of health risk from water contact in recreational waters; Disease-causing bacteria, viruses and protozoans may be present in water that has elevated levels of E. coli. Certain strains of E. coli, such as E. coli O157:H7, produce powerful toxins. The Indiana water quality standard for E. coli bacteria in waters for recreational use is that, during the months of April through October, E. coli bacteria counts shall not excee125 per 100 mL as a geometric mean based on five or more samples equally spaced over a thirty day period nor exceed 235 per 100 mL milliliters in any one sample in a thirty day period.[8].

IDEM evaluates E. coli data for human health and recreational use assessment as follows: for data sets consisting of ten (10) or more grab samples where no five (5) of which are equally spaced over a 30-day period, the criteria below are applied (IDEM 2006):

Not Supporting Use: More than 10% of samples >576 cfu/100ml or more than one (1) sample >2,400 cfu/100ml

Supporting Use: No more than 10% of measurements >576 cfu/100ml and no more than one (1) sample >2400 cfu/100ml

## 3.4 Results

### 3.4.1 Units of measure

Results are often presented as concentrations in milligrams per liter (mg/L) or its equivalent of parts per million (ppm) and micrograms per liter (µg/L) or its equivalent of parts per billion (ppb). The various units of measure are related as follows:

1 mg/L = 1 ppm; 1 µg/L = 1 ppb, 1 ppm = 1,000 ppb
0.020 mg/L (ppm) = 20 µg/L (ppb)

### 3.4.2 Water Quality Monitoring

Results of the river and tributary water quality monitoring are presented in Table 3.3 through Table 3.5. Key water quality parameters for each station, sorted by value, are presented in Figure 3.2 through Figure 3.19. For these analyses, August was considered to represent low flow conditions and September 2005 was considered to represent high flow conditions. A box plot is included in each figure to show the statistical distribution of the data for all stations combined.

[8] *327 IAC 2-1-6 Minimum surface water quality standards, Sec. 6(d)*

**Table 3.3 – Water Quality Data for April 13, 2004**

| Station | Drainage | Time | Flow cfs | DO mg/L | Temp °C | DO Sat % | E. coli cfu per 100 mL | pH su | Cond µmhos/cm | Turb NTU | TP mg/L | SRP mg/L | NO2/NO3 mg/L | TKN mg/L | NH3 mg/L | *TN mg/L | *TP flux kg/day | *TN flux kg/day | *TN:TP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BD01 | *Boseman Ditch* | 11:00 AM | 2.1 | 12.50 | 5.7 | 99.7% | 50 | 7.9 | 619 | 1.7 | 0.026 | 0.006 | 0.88 | 0.24 | <0.10 | 1.12 | 0.13 | 5.67 | 43.1 |
| BD02 | *Boseman Ditch* | 10:15 AM | 0.5 | 11.82 | 4.9 | 92.3% | 620 | 7.8 | 589 | 4.0 | 0.046 | 0.016 | 1.40 | 0.46 | <0.10 | 1.86 | 0.06 | 2.45 | 40.4 |
| BD03 | *Boseman Ditch* | 10:40 AM | 0.3 | 12.21 | 5.2 | 96.1% | 970 | 7.9 | 585 | 3.6 | 0.043 | 0.015 | 2.50 | 0.29 | <0.10 | 2.79 | 0.03 | 2.20 | 64.9 |
| CC01 | *Campbell Creek* | 11:45 AM | 5.0 | 12.00 | 7.0 | 98.9% | 530 | 7.9 | 643 | 4.3 | 0.067 | 0.019 | 0.13 | 0.48 | <0.10 | 0.61 | 0.82 | 7.47 | 9.1 |
| CC02 | *Campbell Creek* | 12:00 PM | nd | 11.57 | 5.6 | 92.0% | 190 | 7.8 | 662 | 4.5 | 0.058 | 0.012 | 0.20 | 0.47 | <0.10 | 0.67 | | | 11.6 |
| CC03 | *Campbell Creek* | 1:00 PM | 1.3 | 12.45 | 5.2 | 98.0% | 430 | 7.8 | 673 | 4.1 | 0.047 | 0.009 | 0.83 | 0.32 | <0.10 | 1.15 | 0.15 | 3.68 | 24.5 |
| CC04 | *Campbell Creek* | 12:40 PM | 1.1 | 13.94 | 6.1 | 112.3% | 980 | 7.9 | 705 | 3.9 | 0.043 | 0.013 | 0.32 | 0.38 | <0.10 | 0.70 | 0.12 | 1.95 | 16.3 |
| HD01 | *Holdren Ditch* | 8:00 AM | 0.8 | 11.01 | 6.0 | 88.5% | 160 | 7.8 | 673 | 2.8 | 0.032 | <0.001 | 0.30 | 0.32 | <0.10 | 0.62 | 0.06 | 1.23 | 19.4 |
| MR01 | *Mississinewa* | 6:45 AM | 133.9 | 10.07 | 7.7 | 84.4% | 510 | 8.0 | 661 | 2.5 | 0.049 | 0.017 | 1.60 | 0.37 | <0.10 | 1.97 | 16.05 | 645.44 | 40.2 |
| MR02 | *Mississinewa* | 7:45 AM | 107.1 | 10.50 | 7.9 | 88.4% | 390 | 8.1 | 632 | 2.2 | 0.050 | 0.170 | 1.60 | 0.40 | <0.10 | 2.00 | 13.10 | 523.91 | 40.0 |
| MR03 | *Mississinewa* | 11:30 AM | 85.0 | 11.60 | 7.1 | 95.8% | 7,000 | 8.1 | 638 | 2.2 | 0.046 | 0.013 | 1.90 | 0.34 | <0.10 | 2.24 | 9.57 | 465.81 | 48.7 |
| PC01 | *Pike Creek* | 6:30 AM | 10.0 | 9.97 | 6.7 | 81.5% | 220 | 7.9 | 624 | 3.4 | 0.036 | 0.002 | 1.70 | 0.36 | <0.10 | 2.06 | 0.88 | 50.30 | 57.2 |
| PC02 | *Pike Creek* | 6:00 AM | 0.5 | 9.30 | 5.3 | 73.4% | 1,600 | 7.8 | 637 | 3.1 | 0.062 | 0.014 | 4.00 | 0.72 | 0.13 | 4.72 | 0.08 | 5.98 | 76.1 |
| PC03 | *Pike Creek* | 7:15 AM | 3.9 | 9.97 | 5.2 | 78.5% | 4,000 | 7.8 | 704 | 2.2 | 0.023 | 0.002 | 3.50 | 0.31 | <0.10 | 3.81 | 0.22 | 36.24 | 165.7 |
| PC04 | *Pike Creek* | 8:20 AM | 1.2 | 11.14 | 5.2 | 87.7% | 15,000 | 7.7 | 707 | 2.5 | 0.047 | 0.010 | 3.90 | 0.28 | 0.13 | 4.18 | 0.14 | 12.44 | 88.9 |
| RD01 | *Rees Ditch* | 9:00 AM | 4.7 | 10.96 | 6.2 | 88.5% | 1,090 | 7.8 | 699 | 3.6 | 0.043 | 0.003 | 0.40 | 0.28 | <0.10 | 0.68 | 0.49 | 7.75 | 15.8 |
| RD02 | *Rees Ditch* | 8:40 AM | 0.3 | 12.63 | 5.2 | 99.4% | 100 | 8.0 | 672 | 2.7 | 0.033 | 0.008 | 0.49 | 0.31 | <0.10 | 0.80 | 0.02 | 0.53 | 24.2 |
| RD03 | *Rees Ditch* | 9:25 AM | 2.1 | 9.83 | 6.2 | 79.4% | 1,340 | 7.5 | 723 | 5.9 | 0.048 | 0.004 | 0.42 | 0.31 | <0.10 | 0.73 | 0.24 | 3.67 | 15.2 |
| RD04 | *Rees Ditch* | 9:45 AM | 0.5 | 7.37 | 5.6 | 58.6% | 4,000 | 7.6 | 780 | 2.1 | 0.083 | 0.046 | 2.80 | 0.68 | <0.10 | 3.48 | 0.09 | 3.85 | 41.9 |
| UD01 | *Unnamed Ditch* | 7:00 AM | 0.3 | 10.04 | 5.9 | 80.5% | 70 | 7.8 | 599 | 2.7 | 0.026 | 0.005 | 2.10 | 0.33 | <0.10 | 2.43 | 0.02 | 1.90 | 93.5 |

*Calculated values

| Station | Drainage | Time | Flow cfs | DO mg/L | Temp °C | DO Sat % | E. coli cfu per 100 mL | pH su | Cond µmhos/cm | Turb NTU | TP mg/L | SRP mg/L | NO2/NO3 mg/L | TKN mg/L | NH3 mg/L | *TN mg/L | *TP flux kg/day | *TN flux kg/day | *TN:TP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BD01 | *Boseman Ditch* | 12:00 PM | 0.7 | 12.72 | 17.1 | 131.9% | 1,000 | 7.7 | 684 | 2.2 | 0.028 | 0.010 | 0.50 | 0.33 | <0.10 | 0.83 | 0.05 | 1.48 | 29.6 |
| BD02 | *Boseman Ditch* | 12:42 PM | 0.0 | 10.38 | 19.9 | 113.9% | <1,000 | 7.6 | 565 | 9.2 | 0.098 | 0.027 | 0.04 | 0.65 | <0.10 | 0.69 | 0.00 | 0.00 | 7.0 |
| BD03 | *Boseman Ditch* | 12:30 PM | 0.0 | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | 0.00 | 0.00 | |
| CC01 | *Campbell Creek* | 2:30 PM | 0.9 | - - - | - - - | - - - | 780 | 7.9 | 725 | 8.1 | 0.133 | 0.084 | 0.22 | 0.56 | <0.10 | 0.78 | 0.29 | 1.70 | 5.9 |
| CC02 | *Campbell Creek* | 3:00 PM | 0.2 | 10.75 | 24.2 | 128.2% | 4,000 | 7.7 | 746 | 32.5 | 0.172 | 0.061 | 0.02 | 0.65 | <0.10 | 0.67 | 0.08 | 0.31 | 3.9 |
| CC03 | *Campbell Creek* | 4:00 PM | 0.5 | 7.28 | 18.00 | 76.9% | 3,000 | 7.7 | 853 | 6.6 | 0.116 | 0.070 | 0.09 | 0.60 | <0.10 | 0.69 | 0.15 | 0.91 | 5.9 |
| CC04 | *Campbell Creek* | 3:45 PM | 0.2 | 10.52 | 18.1 | 111.3% | 10,000 | 7.7 | 838 | 3.7 | 0.064 | 0.030 | 0.02 | 0.29 | <0.10 | 0.31 | 0.03 | 0.15 | 4.8 |
| HD01 | *Holdren Ditch* | 11:00 AM | 1.3 | 11.94 | 18.7 | 127.9% | 1,000 | 7.8 | 782 | 2.3 | 0.020 | 0.007 | 0.04 | 0.24 | <0.10 | 0.28 | 0.06 | 0.91 | 14.0 |
| MR01 | *Mississinewa* | 7:45 AM | 17.5 | 7.17 | 19.9 | 78.7% | 1,000 | 8.0 | 709 | 23.1 | 0.300 | 0.169 | 1.30 | 1.20 | <0.10 | 2.50 | 12.87 | 107.26 | 8.3 |
| MR02 | *Mississinewa* | 10:30 AM | 14.0 | 7.80 | 21.2 | 87.8% | 1,000 | 8.0 | 618 | 36.1 | 0.420 | 0.260 | 1.80 | 1.50 | <0.10 | 3.30 | 14.41 | 113.20 | 7.9 |
| MR03 | *Mississinewa* | 2:30 PM | 11.1 | 7.40 | 21.3 | 83.5% | 46,000 | 7.9 | 607 | 36.7 | 0.470 | 0.300 | 1.90 | 1.10 | <0.10 | 3.00 | 12.80 | 81.70 | 6.4 |
| PC01 | *Pike Creek* | 7:30 AM | 2.9 | 8.06 | 17.6 | 84.4% | 630 | 7.9 | 658 | 6.9 | 0.095 | 0.049 | 0.12 | 0.55 | <0.10 | 0.67 | 0.67 | 4.73 | 7.1 |
| PC02 | *Pike Creek* | 7:00 AM | 0.1 | 6.55 | 16.8 | 71.8% | 1,000 | 7.8 | 731 | 4.0 | 0.191 | 0.117 | 0.28 | 0.88 | 0.15 | 1.16 | 0.03 | 0.17 | 6.1 |
| PC03 | *Pike Creek* | 9:00 AM | 0.7 | 10.14 | 17.0 | 104.9% | 1,110 | 7.6 | 692 | 3.4 | 0.075 | 0.047 | 0.02 | 0.33 | <0.10 | 0.35 | 0.13 | 0.62 | 4.7 |
| PC04 | *Pike Creek* | 10:00 AM | 0.0 | 7.35 | 17.5 | 76.8% | 5,000 | 7.5 | 862 | 4.3 | 0.210 | 0.154 | 0.06 | 0.68 | 0.15 | 0.74 | 0.02 | 0.07 | 3.5 |
| RD01 | *Rees Ditch* | 11:30 AM | 1.8 | 10.56 | 19.1 | 114.1% | 1,110 | 7.7 | 739 | 5.6 | 0.066 | 0.029 | 0.48 | 0.41 | <0.10 | 0.89 | 0.29 | 3.89 | 13.5 |
| RD02 | *Rees Ditch* | 11:30 AM | 0.0 | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | - - - | 0.00 | 0.00 | |
| RD03 | *Rees Ditch* | 1:00 PM | 0.3 | 11.46 | 20.0 | 126.0% | 60 | 7.5 | 789 | 7.5 | 0.061 | 0.010 | 0.07 | 0.60 | <0.10 | 0.67 | 0.04 | 0.43 | 11.0 |
| RD04 | *Rees Ditch* | 2:00 PM | 0.0 | 7.70 | 18.9 | 82.8% | 2,000 | 7.7 | 1049 | 10.6 | 0.137 | 0.069 | 0.42 | 0.97 | 0.22 | 1.39 | 0.00 | 0.00 | 10.1 |
| UD01 | *Unnamed Ditch* | 8:00 AM | 0.0 | 3.56 | 17.1 | 36.9% | 3,000 | 7.3 | 587 | 3.7 | 0.077 | 0.022 | 0.22 | 0.66 | 0.14 | 0.88 | 0.00 | 0.01 | 11.4 |

Table 3.4 – Water Quality Data for August 11, 2004

*Calculated values

**Table 3.5 – Water Quality Data for September 19, 2005**

| Station | Drainage | Time | Flow cfs | DO mg/L | Temp °C | DO Sat % | E. coli cfu per 100 mL | pH su | Cond µmhos/cm | Turb NTU | TP mg/L | SRP mg/L | NO2/NO3 mg/L | TKN mg/L | NH3 mg/L | *TN mg/L | *TP flux kg/day | *TN flux kg/day | *TN:TP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BD01 | *Boseman Ditch* | - - - | 30.0 | 6.8 | 20 | 74.8% | 2100 | - - - | - - - | 58.0 | 0.511 | 0.244 | 2.60 | 2.30 | - - - | 4.90 | 37.51 | 359.71 | 9.6 |
| BD02 | *Boseman Ditch* | - - - | 10.0 | 5.8 | 20 | 63.8% | 3300 | - - - | - - - | 66.0 | 0.528 | 0.260 | 4.75 | 1.58 | - - - | 6.33 | 12.92 | 154.90 | 12.0 |
| BD03 | *Boseman Ditch* | - - - | 10.0 | 6.6 | 20 | 72.6% | 2700 | - - - | - - - | 46.0 | 0.489 | 0.269 | 1.45 | 1.34 | - - - | 2.79 | 11.97 | 68.27 | 5.7 |
| CC01 | *Campbell Creek* | - - - | 100.0 | 6.1 | 20 | 67.1% | 9750 | - - - | - - - | 64.0 | 1.286 | 0.507 | 1.90 | 3.06 | - - - | 4.96 | 314.68 | 1213.71 | 3.9 |
| CC02 | *Campbell Creek* | - - - | 50.0 | 4.9 | 20 | 53.9% | 5950 | - - - | - - - | 52.0 | 0.758 | 0.464 | 2.05 | 2.11 | - - - | 4.16 | 92.74 | 508.98 | 5.5 |
| CC03 | *Campbell Creek* | - - - | 20.0 | 4.3 | 20 | 47.3% | 1760 | - - - | - - - | 34.0 | 0.559 | 0.392 | 1.50 | 2.07 | - - - | 3.57 | 27.36 | 174.72 | 6.4 |
| CC04 | *Campbell Creek* | - - - | 20.0 | 6.0 | 20 | 66.0% | 6750 | - - - | - - - | 44.0 | 0.766 | 0.570 | 2.34 | 2.24 | - - - | 4.58 | 37.49 | 224.15 | 6.0 |
| HD01 | *Holdren Ditch* | - - - | 0.7 | 6.4 | 20 | 70.4% | 2940 | - - - | - - - | 12.0 | 0.882 | 0.392 | 4.37 | 1.44 | - - - | 5.81 | 1.51 | 9.95 | 6.6 |
| MR01 | *Mississinewa* | - - - | 2827.7 | 7.2 | 20 | 79.2% | 700 | - - - | - - - | 52.0 | 0.197 | 0.068 | 0.35 | 0.66 | - - - | 1.01 | 1363.11 | 6988.53 | 5.1 |
| MR02 | *Mississinewa* | - - - | 2260.8 | 6.6 | 20 | 72.6% | 2400 | - - - | - - - | 38.0 | 0.365 | 0.165 | 1.00 | 0.84 | - - - | 1.84 | 2019.25 | 10179.25 | 5.0 |
| MR03 | *Mississinewa* | - - - | 1794.8 | 6.3 | 20 | 69.3% | 2800 | - - - | - - - | 46.0 | 0.461 | 0.184 | 2.10 | 1.29 | - - - | 3.39 | 2024.60 | 14888.06 | 7.4 |
| PC01 | *Pike Creek* | - - - | 8.0 | 7.5 | 20 | 82.5% | 738 | - - - | - - - | 3.0 | 0.077 | 0.02 | 0.05 | 0.36 | - - - | 0.41 | 1.51 | 8.03 | 5.3 |
| PC02 | *Pike Creek* | - - - | 2.0 | 5.8 | 20 | 63.8% | 458 | - - - | - - - | 5.6 | 0.277 | 0.2 | 0.12 | 0.57 | - - - | 0.69 | 1.36 | 3.38 | 2.5 |
| PC03 | *Pike Creek* | - - - | 3.0 | 6.4 | 20 | 70.4% | 3000 | - - - | - - - | 8.4 | 0.178 | 0.034 | 1.38 | 0.90 | - - - | 2.28 | 1.31 | 16.74 | 12.8 |
| PC04 | *Pike Creek* | - - - | 1.0 | 5.4 | 20 | 59.4% | 15000 | - - - | - - - | 15.0 | 0.710 | 0.608 | 4.73 | 0.98 | - - - | 5.71 | 1.74 | 13.97 | 8.0 |
| RD01 | *Rees Ditch* | - - - | 60.0 | 6.0 | 20 | 66.0% | 7,800 | - - - | - - - | 42.0 | 0.336 | 0.112 | 1.46 | 1.26 | - - - | 2.72 | 49.33 | 399.35 | 8.1 |
| RD02 | *Rees Ditch* | - - - | 0.5 | 5.2 | 20 | 57.2% | 100 | - - - | - - - | 26.0 | 0.338 | 0.032 | 0.01 | 0.89 | - - - | 0.90 | 0.41 | 1.10 | 2.7 |
| RD03 | *Rees Ditch* | - - - | 30.0 | 5.2 | 20 | 57.2% | 2000 | - - - | - - - | 44.0 | 0.235 | 0.099 | 1.38 | 0.87 | - - - | 2.25 | 17.25 | 165.17 | 9.6 |
| RD04 | *Rees Ditch* | - - - | 1.0 | 5.2 | 20 | 57.2% | 3000 | - - - | - - - | 24.0 | 0.379 | 0.237 | 4.74 | 1.05 | - - - | 5.79 | 0.93 | 14.17 | 15.3 |
| UD01 | *Unnamed Ditch* | - - - | 0.6 | 4.1 | 20 | 45.1% | 150 | - - - | - - - | 3.7 | 0.060 | 0.034 | 0.29 | 0.84 | - - - | 1.13 | 0.09 | 1.66 | 18.8 |

*Calculated values

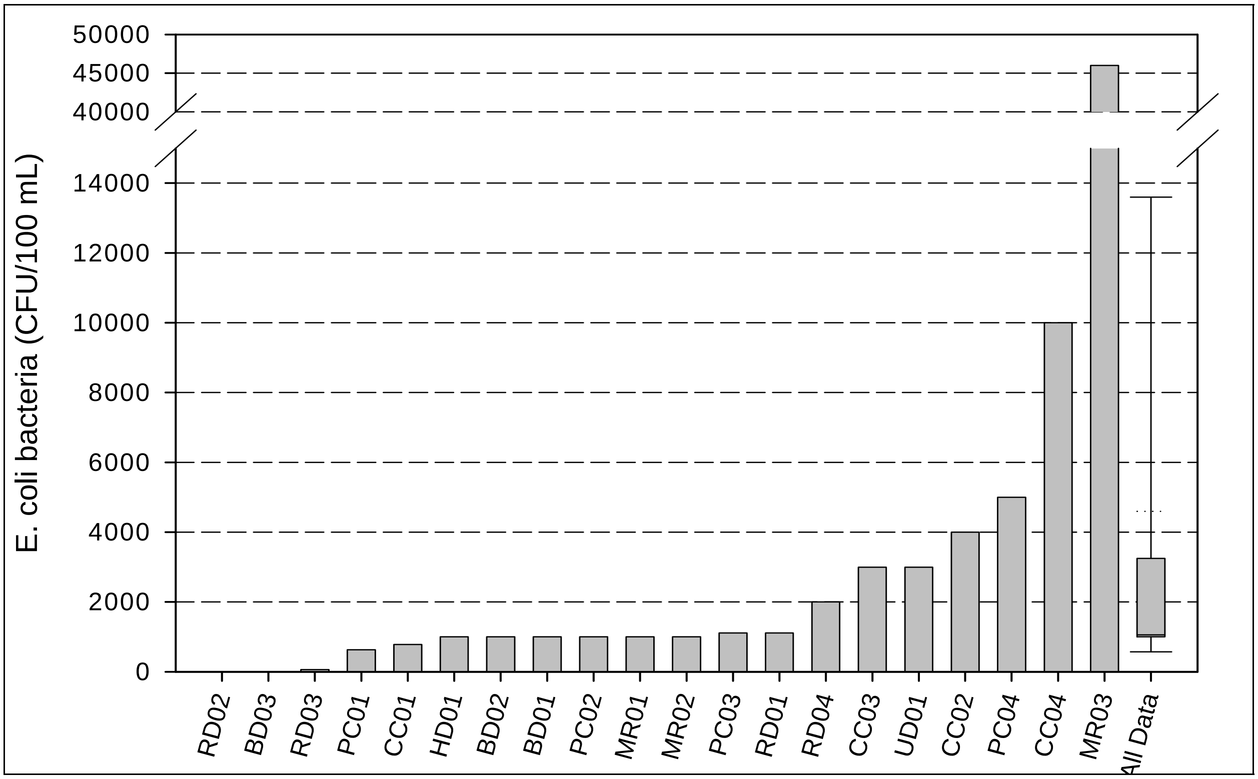


**Figure 3-2** E. coli concentrations for August 2004 representing low flow conditions

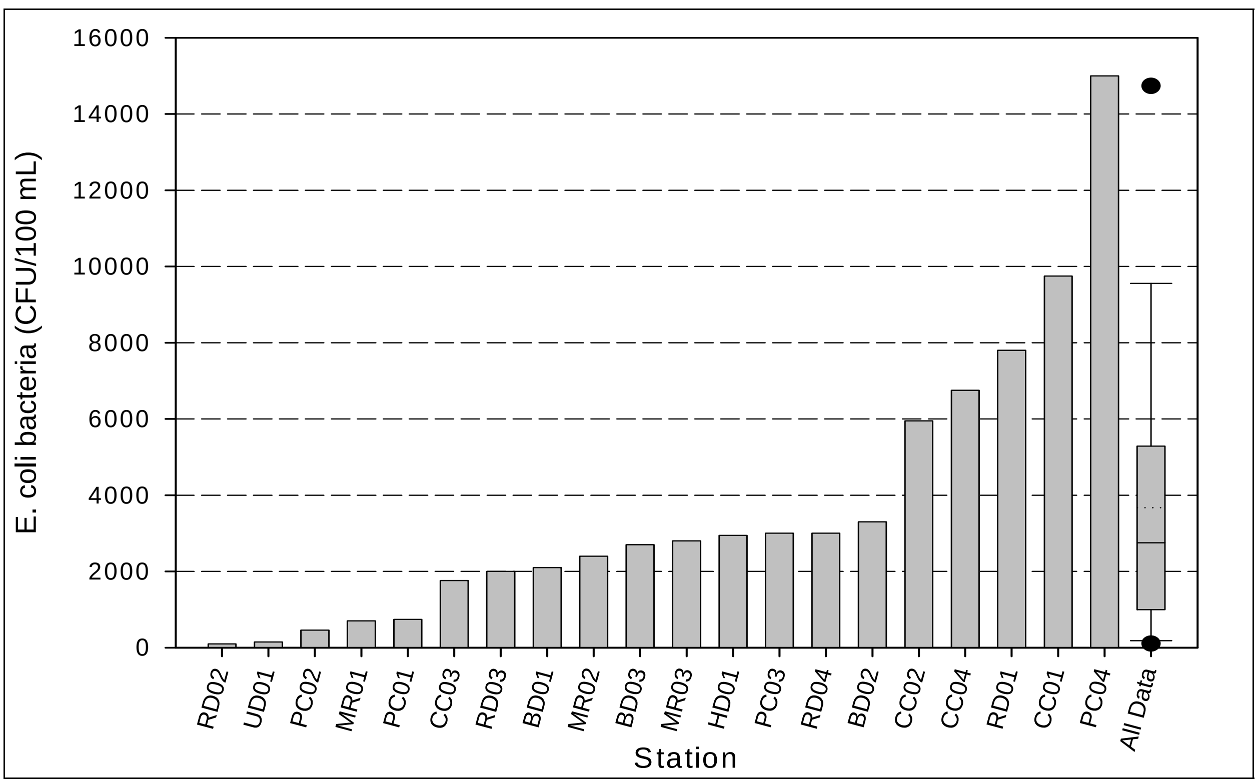


**Figure 3-3** E. coli concentrations for September 2005 representing high flow conditions

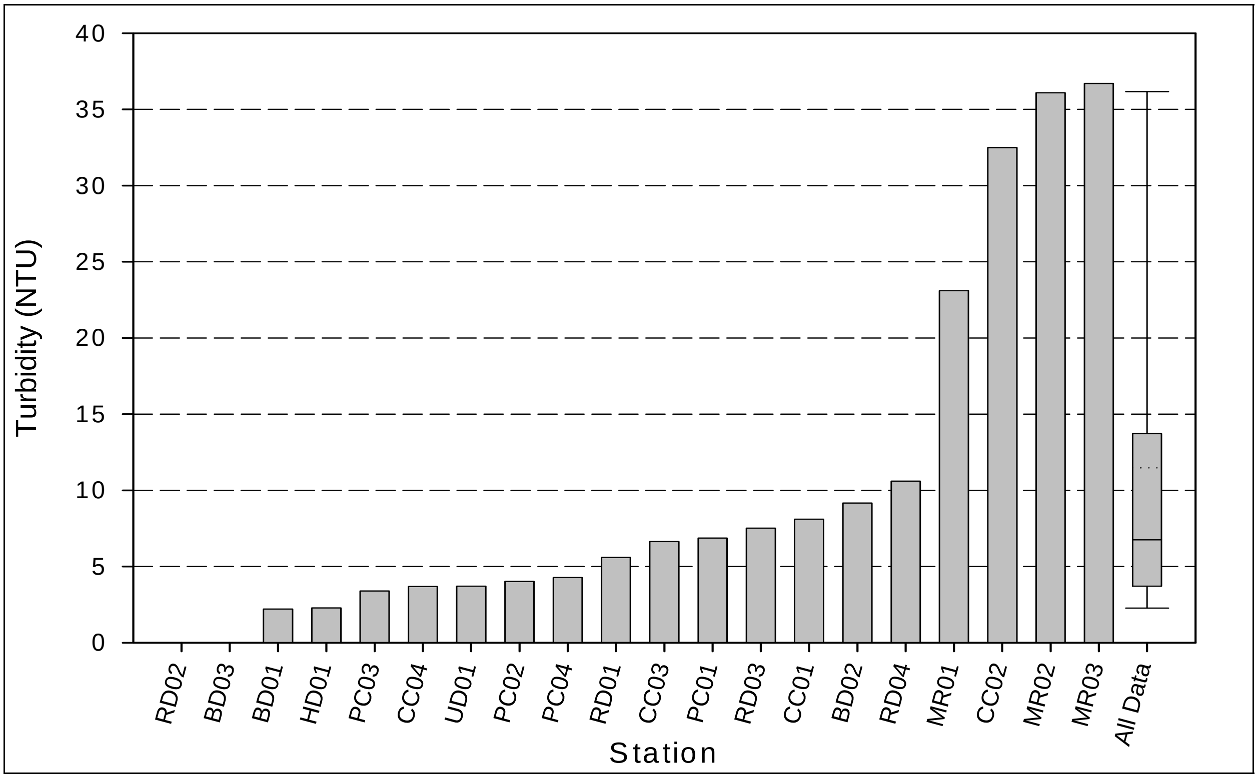


**Figure 3-4** Turbidity for August 2004 representing low flow conditions

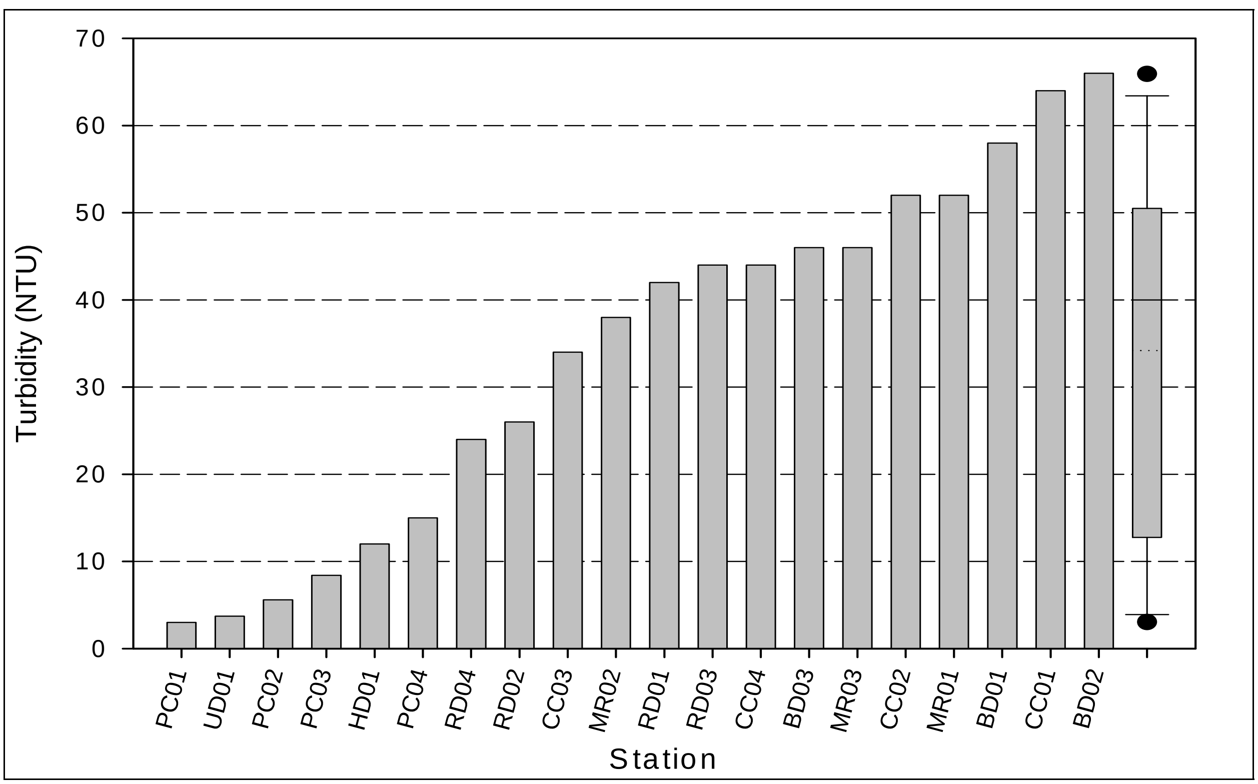


**Figure 3-5** Turbidity for September 2005 representing high flow conditions

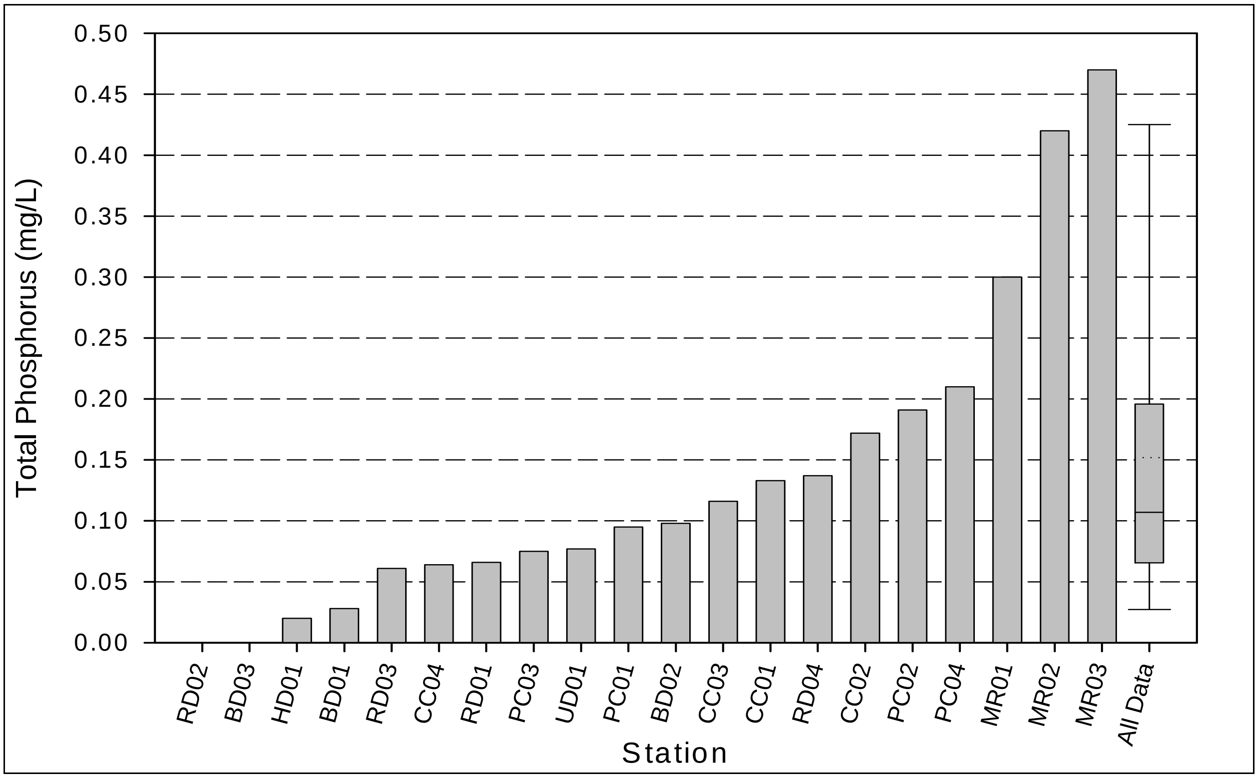


**Figure 3-6** Total phosphorus concentrations for August 2004 representing low flow conditions

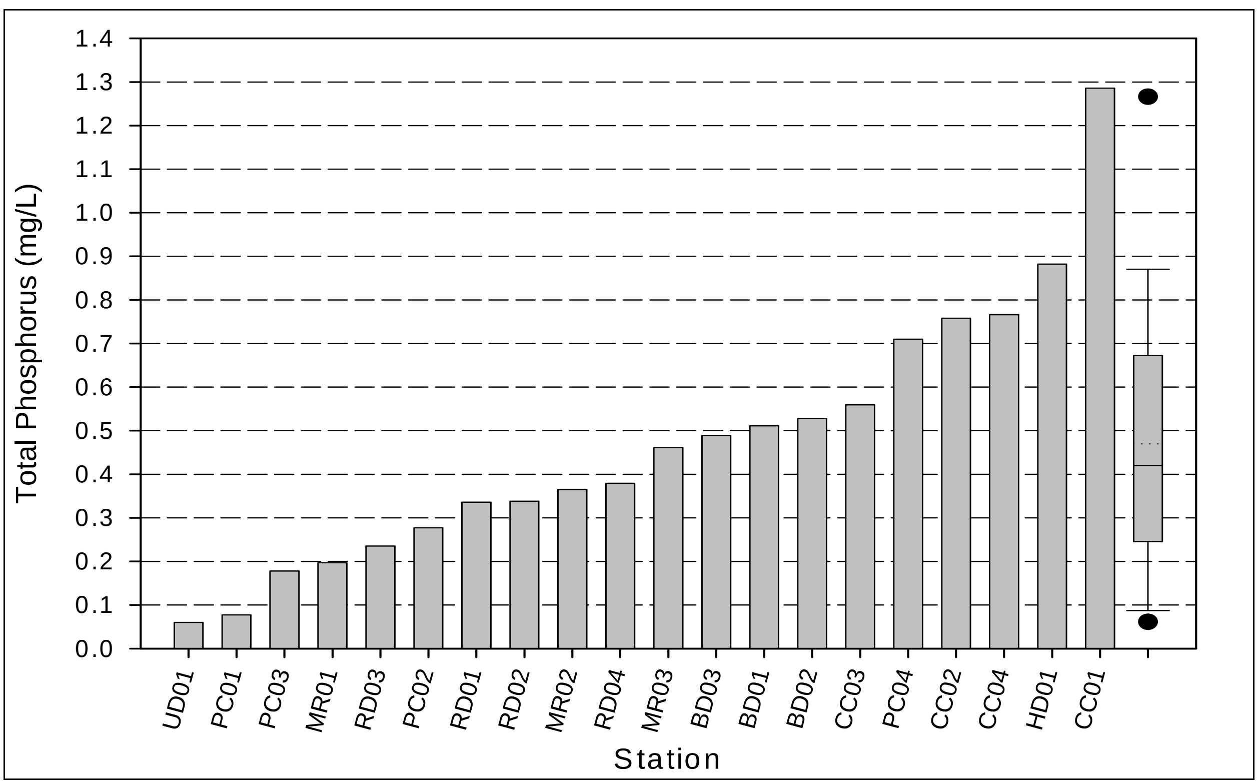


**Figure 3-7** Total phosphorus concentrations for September 2005 representing high flow conditions

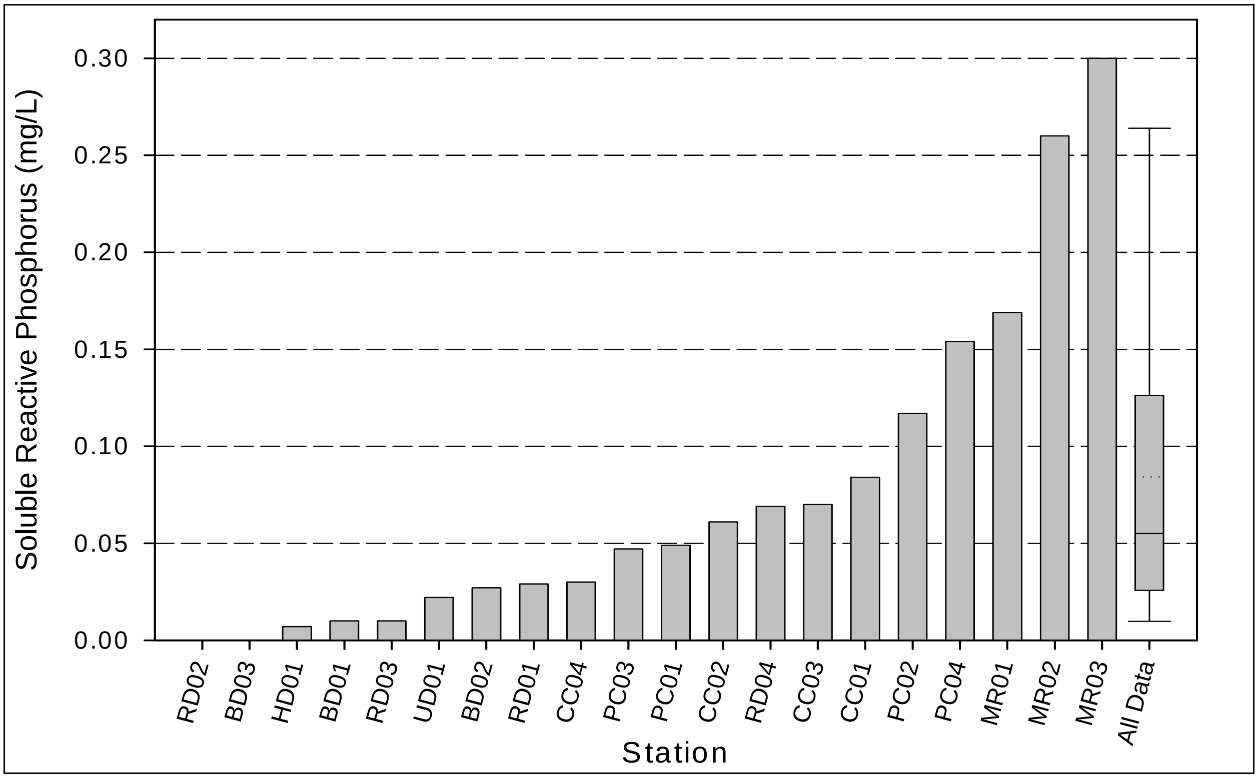


**Figure 3-8** SRP concentrations for August 2004 representing low flow conditions

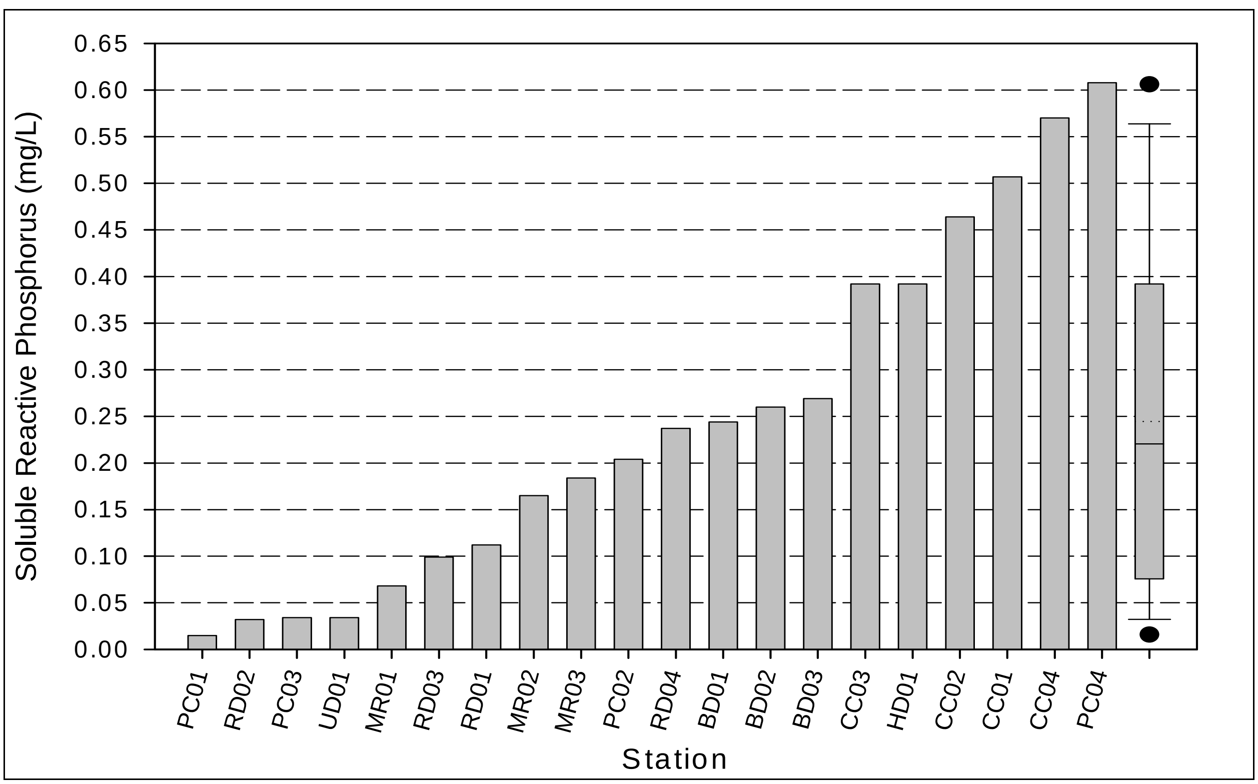


**Figure 3-9** SRP concentrations for September 2005 representing high flow conditions

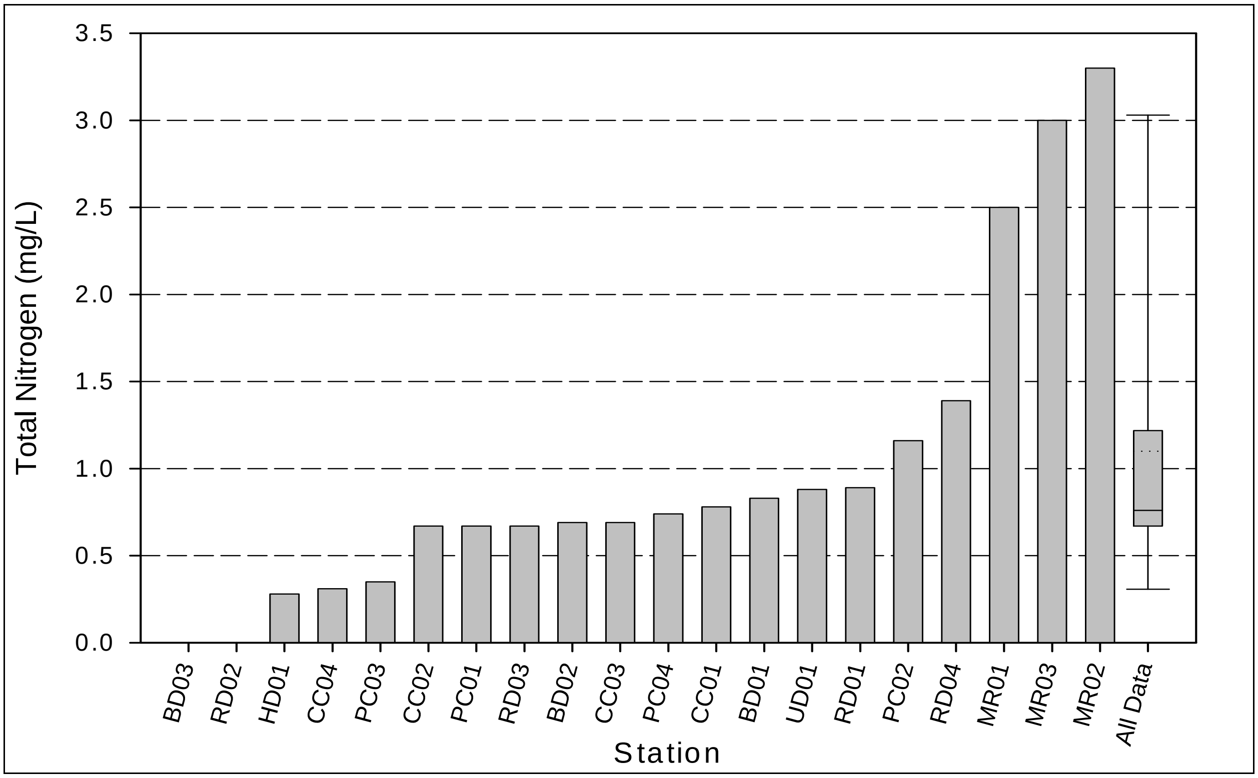


**Figure 3-10** Total nitrogen concentrations for August 2004 representing low flow conditions

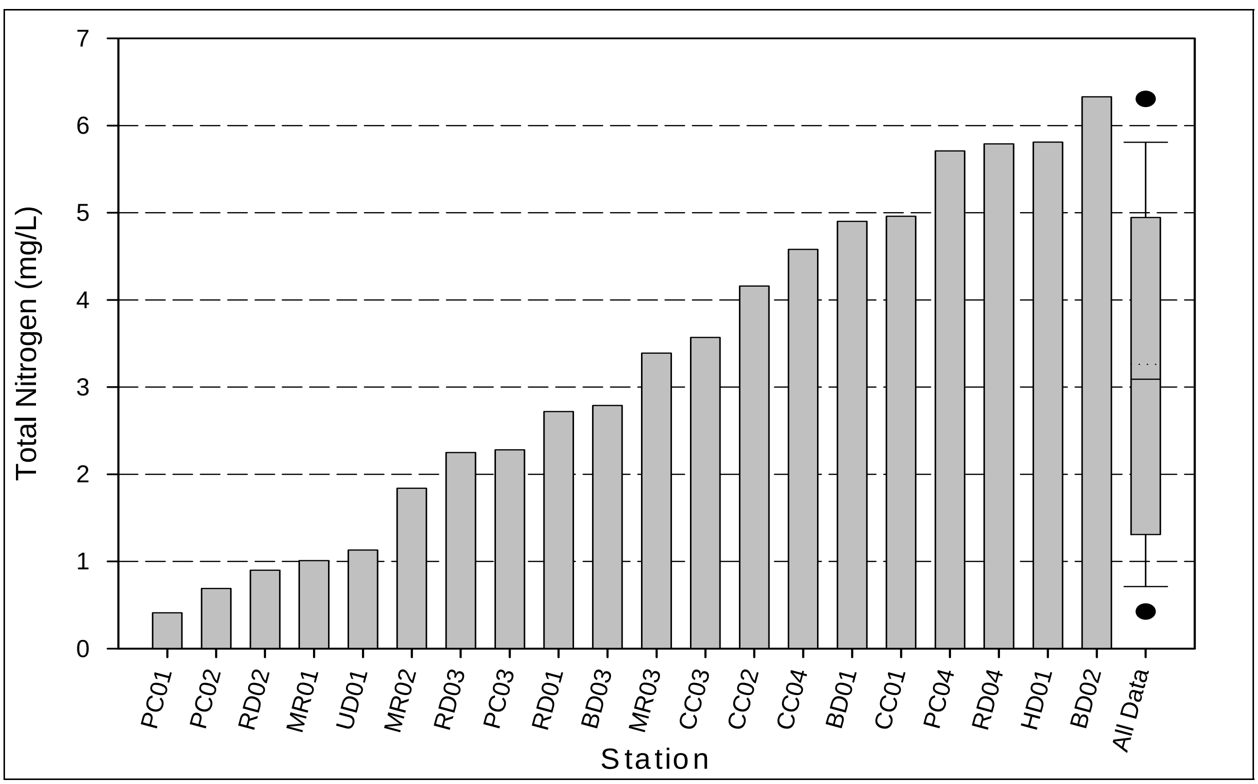


**Figure 3-11** Total nitrogen concentrations for September 2005 representing high flow conditions

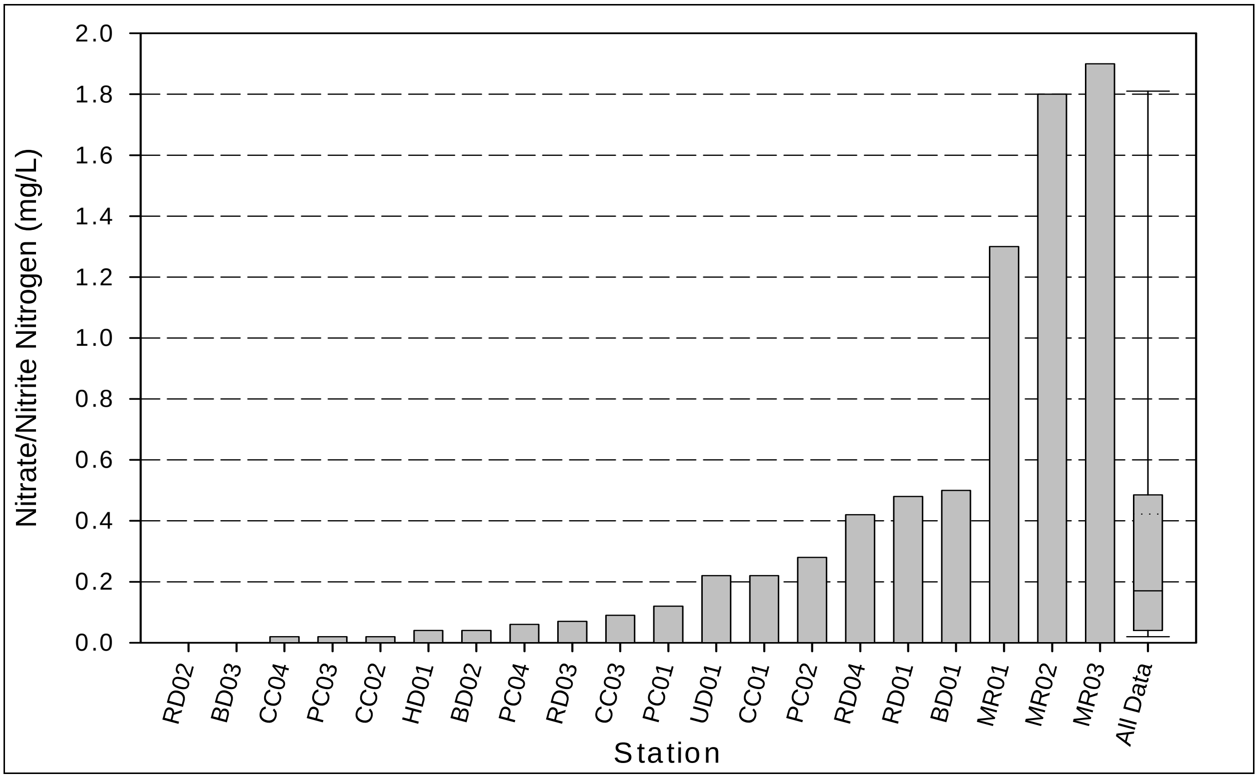


**Figure 3-12** Nitrate/nitrite concentrations for August 2004 representing low flow conditions

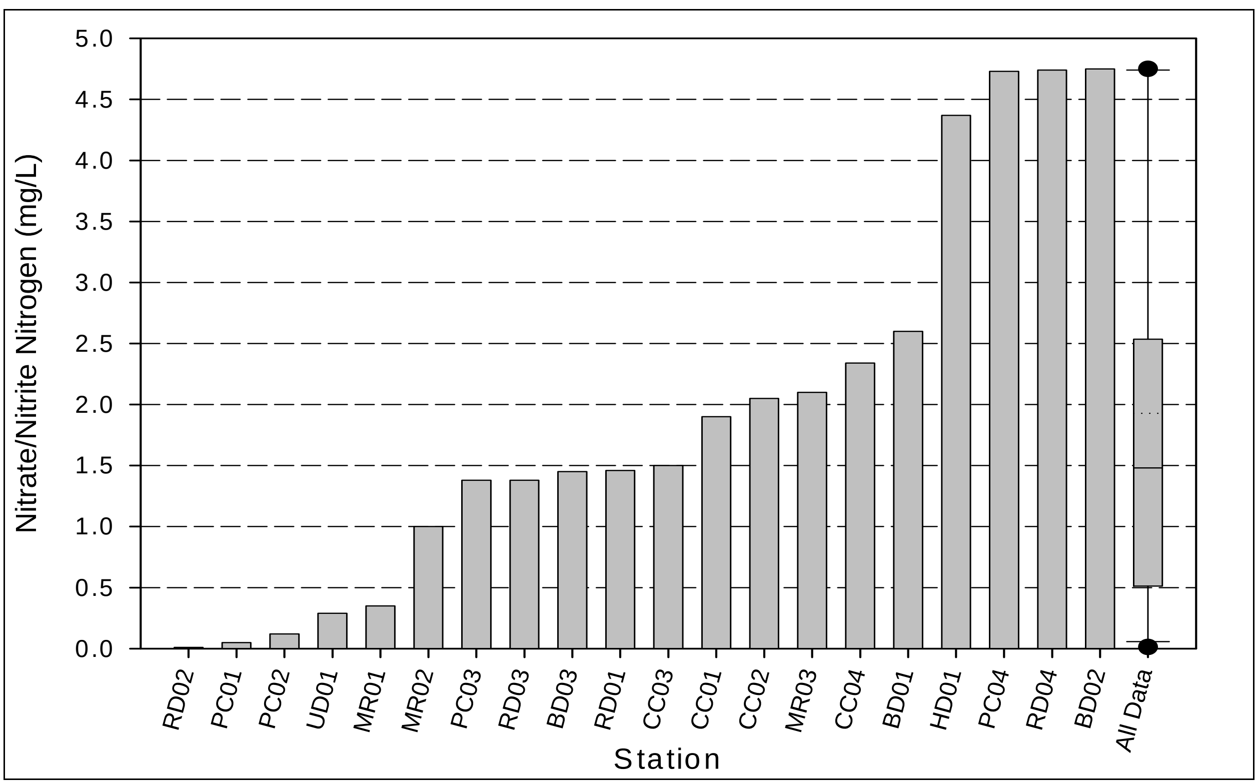


**Figure 3-13** Nitrate-nitrite concentrations for September 2005 representing high flow conditions

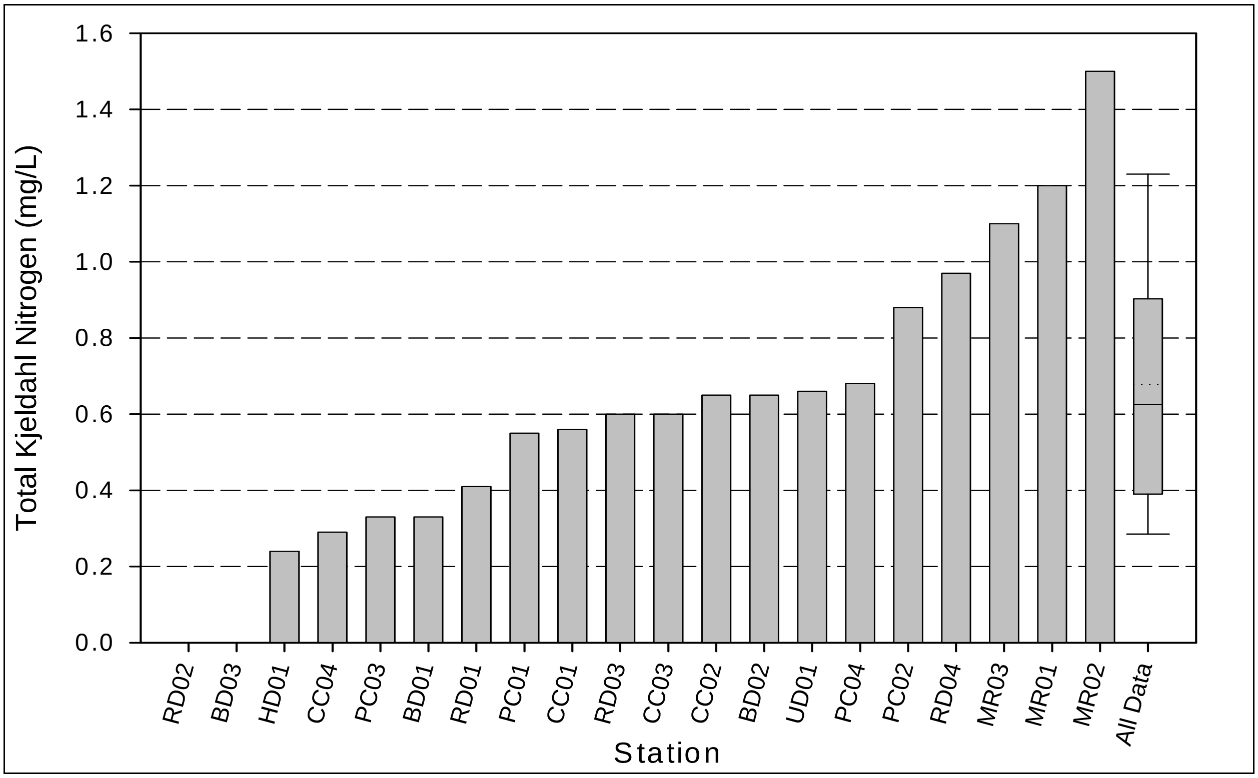


**Figure 3-14** TKN concentrations for August 2004 representing low flow conditions

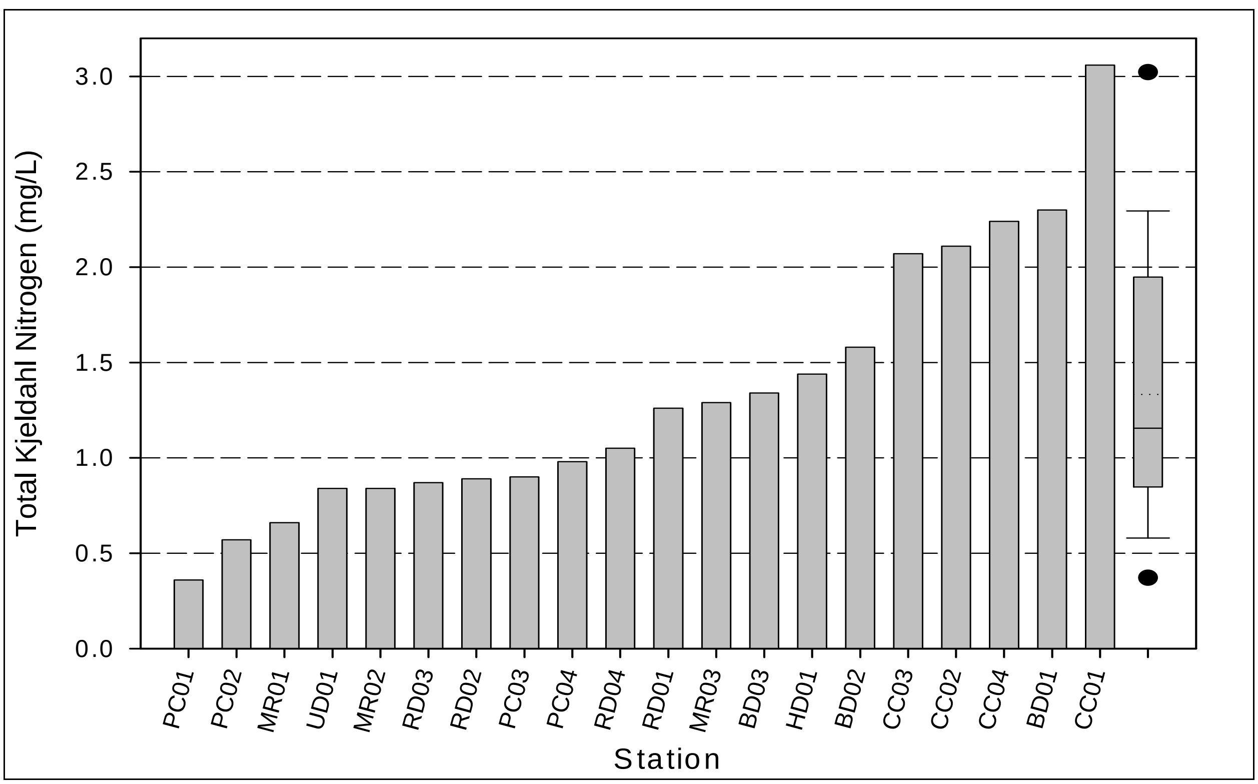


**Figure 3-15** TKN concentrations for September 2005 representing high flow conditions

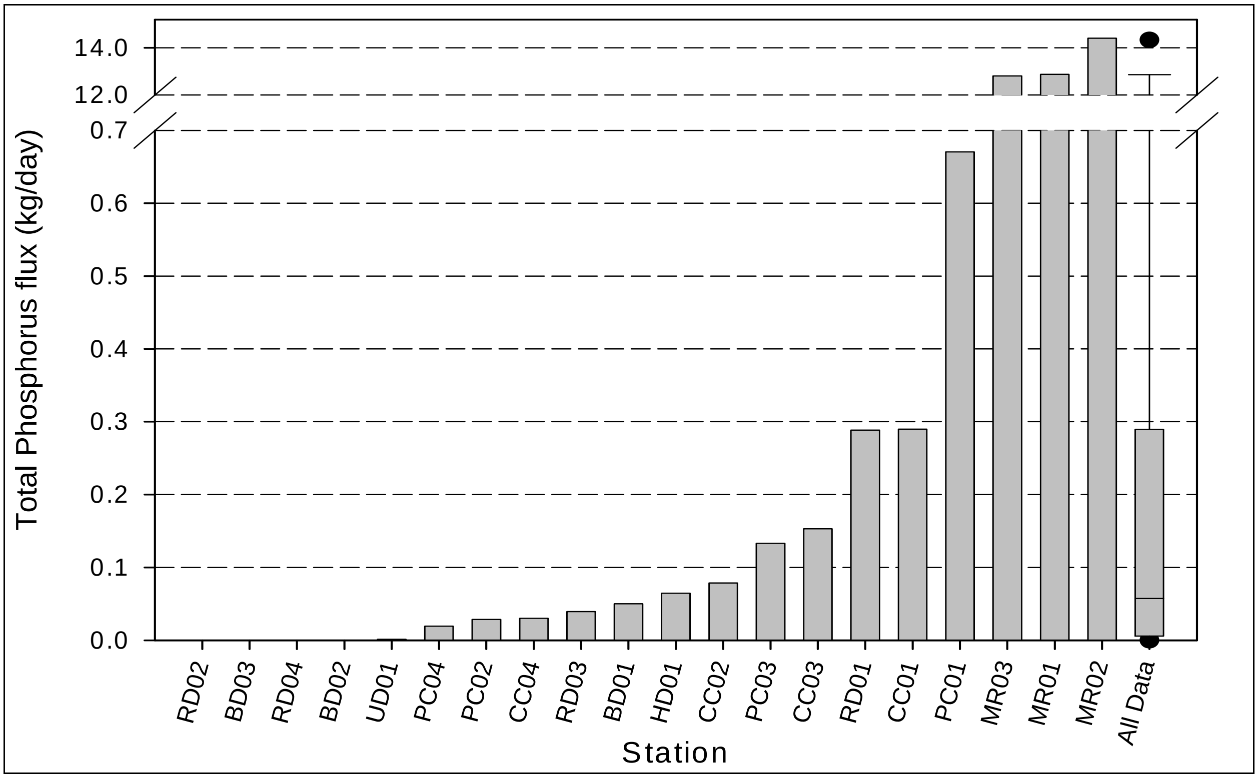


**Figure 3-16** TP flux (mass transport) for August 2004 representing low flow conditions

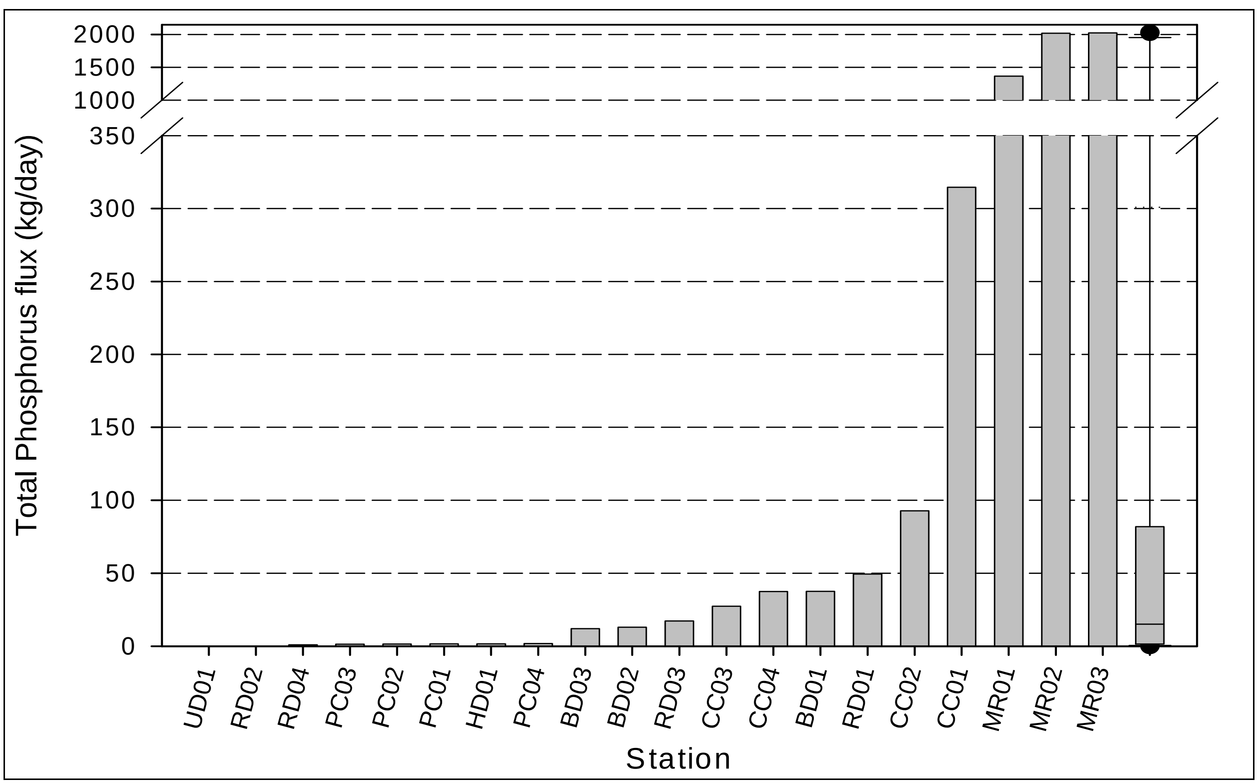


**Figure 3-17** TP flux (mass transport) for September 2005 representing high flow conditions

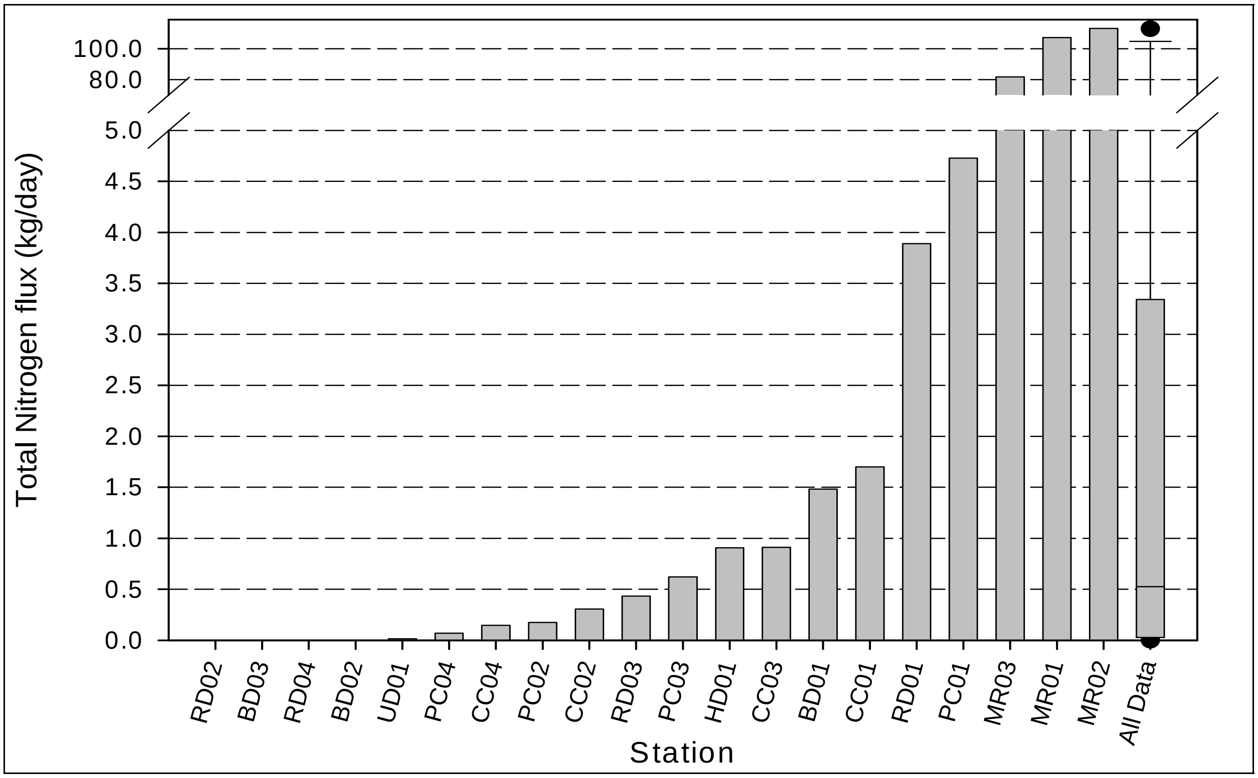


**Figure 3-18** TN flux (mass transport) for August 2004 representing low flow conditions

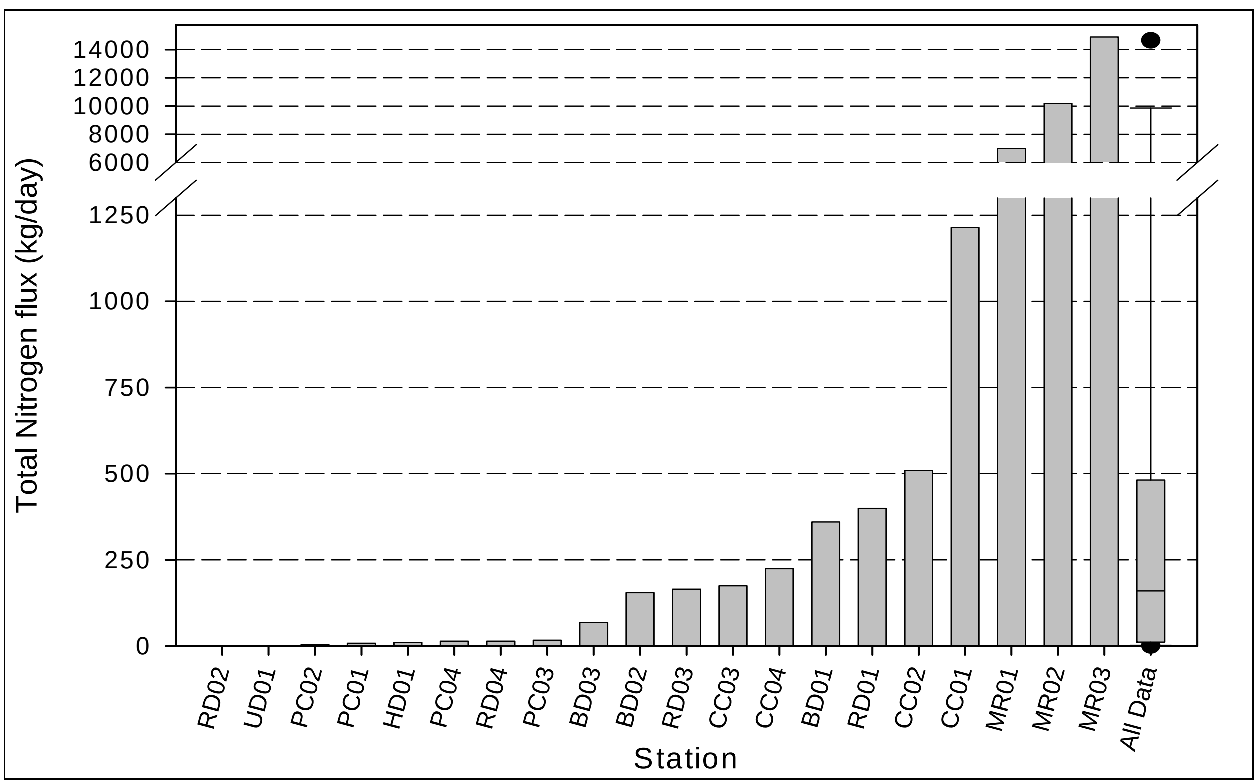


**Figure 3-19** TN flux (mass transport) for September 2005 representing high flow conditions

### 3.4.3 MACROINVERTEBRATE SURVEY

The types of macroinvertebrates present in a stream are indicative of the quality of the water. A healthy stream will have good species diversity, with many different taxa represented in the sample. In an impacted stream, most of the individuals will be represented by only a few taxa. An HBI (Hilsenhoff Biotic Index) of 0 indicates good water quality while an HBI of 10 represents poor water quality. A high EPT (Ephemeroptera, Plecoptera and Tricoptera) Index and Percent EPT represent good water quality, since these three orders of macroinvertebrates (mayflies, stoneflies and caddisflies) represented by those metrics are intolerant to pollution and are usually not found in impacted streams. In streams with good water quality, the percent dominant species will be low, which is an indication of good species diversity.

Results of the macroinvertebrate surveys are presented in Tables 3.6 and 3.7.

The IDEM mIBI (macroinvertebrate Index of Biotic Integrity) is a multi-metric index used by IDEM to assess the biological integrity of a stream or river. The IDEM mIBI is an average of classification scores for ten metrics. An mIBI value was calculated using the Mississinewa River Phase III macroinvertebrate data. Differences between IDEM mIBI protocol and that used in this study were:

- ID to lowest taxon used here rather than family
- All individuals counted rather than squares (Total count/# of squares sorted metric was not used to calculate the mIBI)

The mIBI scores are related to the biological integrity of streams and rivers as follows:

- mIBI = 0 – 2: severely impaired
- mIBI = 2 – 4: moderately impaired
- mIBI = 4 – 6: slightly impaired
- mIBI = 6 – 8: not impaired

In addition, IDEM 303d methodology relates the mIBI score to the assessment of a stream for supporting aquatic life use (IDEM 2002). According to that ranking system, an mIBI of greater than or equal to 4 fully supports the use, while an mIBI of less than 2 is not supporting that use. An mIBI between 2 and 4 is partially supporting the use. IDEM 305b methodology also relates the mIBI to use support (IDEM 2006), stating an mIBI of greater than or equal to 2.2 is fully supporting use (kick sample), while an mIBI of less than 2.2 is not supporting use (kick samples).

The mIBI results for each station, sorted by value, are presented in Figure 3.21. A box plot is included in the figure to show the statistical distribution of the data for all stations combined.

| Table 3.6 – Macroinvertebrate Indices for the Mississinewa River Watershed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Richness | | | | | Composition | | | Biological Integrity |
| Station | N | Total Taxa | EPT taxa | Ephemerop-tera taxa | Plecop-tera taxa | Trichop-tera taxa | % EPT | % Ephemeroptera | % Chironomids | mIBI |
| *Response | | ▼ | ▼ | ▼ | ▼ | ▼ | ▼ | ▼ | ▲ | ▲ |
| BD01 | 423 | 10 | 3 | 2 | 0 | 1 | 1.4% | 1.2% | 95.3% | 3.1 |
| BD02 | 86 | 21 | 1 | 0 | 0 | 1 | 1.1% | 0.0% | 10.9% | 3.6 |
| CC01 | 23 | 6 | 3 | 0 | 0 | 3 | 34.8% | 0.0% | 52.2% | 3.1 |
| CC03 | 207 | 12 | 3 | 2 | 0 | 1 | 5.8% | 5.3% | 69.1% | 3.1 |
| CC04 | 43 | 6 | 2 | 1 | 0 | 1 | 4.7% | 2.3% | 83.7% | 2.2 |
| HD01 | 140 | 18 | 3 | 1 | 0 | 2 | 47.9% | 40.8% | 26.1% | 5.1 |
| PC01 | 191 | 22 | 6 | 2 | 0 | 4 | 69.2% | 23.7% | 2.4% | 7.1 |
| PC02 | 104 | 17 | 3 | 1 | 0 | 2 | 8.9% | 0.7% | 4.4% | 4.0 |
| PC03 | 50 | 12 | 1 | 1 | 0 | 0 | 2.0% | 2.0% | 8.0% | 3.1 |
| PC04 | 267 | 17 | 2 | 1 | 0 | 1 | 3.0% | 0.7% | 0.0% | 4.5 |
| RD01 | 111 | 11 | 3 | 1 | 0 | 2 | 4.3% | 0.9% | 84.3% | 2.9 |
| RD03 | 86 | 8 | 2 | 2 | 0 | 0 | 39.5% | 39.5% | 38.4% | 3.6 |
| RD04 | 36 | 6 | 1 | 1 | 0 | 0 | 27.8% | 27.8% | 44.4% | 2.7 |
| UD01 | 63 | 15 | 1 | 1 | 0 | 0 | 7.9% | 7.9% | 41.3% | 2.9 |

*Arrows indicate response of metric to increased perturbation
(i.e., metric response to worse water quality)

| Table 3.7 – Macroinvertebrate Indices for the Mississinewa River Watershed | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Tolerance | | | | | | | Trophic/Habit | | | | |
| Station | N | Intolerant taxa | % Tolerant taxa | Hilsenhoff Biotic Index | % Dominant Taxa: 2 taxa | % Dominant Taxa: 3 taxa | % Dominant Taxa: 4 taxa | % Dominant Taxa: 5 taxa | Clinger taxa | % Clinger taxa | % Filterer taxa | % Grazer & Scraper taxa |
| *Response | | ▼ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▼ | ▼ | ▼▲ | ▼ |
| BD01 | 423 | 4 | 0.2% | 1.00 | 96.9% | 97.9% | 98.3% | 98.8% | 2 | 0.5% | 0.0% | 0.5% |
| BD02 | 86 | 3 | 37.0% | 2.87 | 42.4% | 53.3% | 60.9% | 67.4% | 4 | 31.5% | 1.1% | 30.4% |
| CC01 | 23 | 4 | 0.0% | 1.26 | 73.9% | 82.6% | 91.3% | 95.7% | 3 | 34.8% | 21.7% | 13.0% |
| CC03 | 207 | 5 | 0.5% | 0.83 | 78.7% | 87.0% | 91.8% | 95.7% | 1 | 1.0% | 0.0% | 1.0% |
| CC04 | 43 | 3 | 2.3% | 0.98 | 90.7% | 93.0% | 95.3% | 97.7% | 1 | 2.3% | 0.0% | 2.3% |
| HD01 | 140 | 6 | 2.8% | 0.65 | 66.9% | 73.9% | 78.2% | 81.7% | 4 | 8.5% | 4.2% | 4.2% |
| PC01 | 191 | 11 | 4.3% | 1.15 | 50.2% | 62.1% | 70.6% | 79.1% | 5 | 24.2% | 5.7% | 18.5% |
| PC02 | 104 | 6 | 7.4% | 2.49 | 50.4% | 73.3% | 77.8% | 82.2% | 4 | 50.4% | 3.7% | 46.7% |
| PC03 | 50 | 3 | 48.0% | 1.30 | 52.0% | 62.0% | 70.0% | 78.0% | 3 | 16.0% | 0.0% | 16.0% |
| PC04 | 267 | 2 | 44.3% | 0.98 | 42.3% | 54.8% | 64.6% | 72.1% | 2 | 8.9% | 0.0% | 8.9% |
| RD01 | 111 | 5 | 1.7% | 0.94 | 87.8% | 91.3% | 93.9% | 94.8% | 1 | 2.6% | 0.0% | 2.6% |
| RD03 | 86 | 2 | 5.8% | 1.00 | 75.6% | 81.4% | 87.2% | 93.0% | 1 | 5.8% | 0.0% | 5.8% |
| RD04 | 36 | 1 | 13.9% | 1.25 | 72.2% | 83.3% | 91.7% | 97.2% | 1 | 8.3% | 0.0% | 8.3% |
| UD01 | 63 | 2 | 25.4% | 2.22 | 60.3% | 68.3% | 74.6% | 79.4% | 1 | 19.0% | 0.0% | 19.0% |

*Arrows indicate response of metric to increased perturbation
(i.e., metric response to worse water quality)

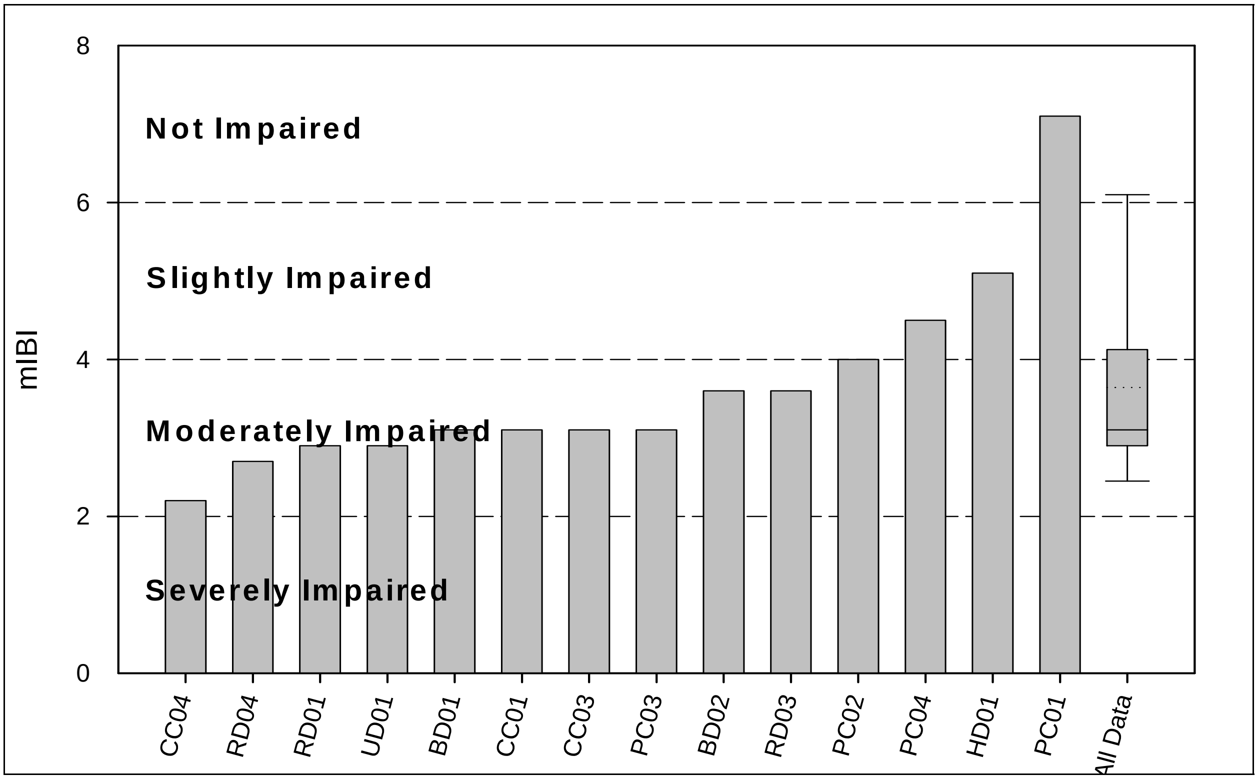


**Figure 3-20** mIBI at the Mississinewa Phase III Stations

### 3.4.4 HABITAT SURVEY

The Qualitative Habitat Evaluation Index (QHEI) is a physical habitat index designed by Ohio EPA to provide a quantified evaluation of the general stream habitat characteristic that are important to fish communities (OhioEPA. 1999, Rankin 1989). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The QHEI consists of six separate metrics which are calculated separately and then summed together for a maximum score of 100. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the metrics used to determine the QHEI score. The QHEI score gives an estimate of the suitability of a stream segment to provide warmwater habitat for aquatic organisms, and can be interpreted as follows:

QHEI > 75: Steam segment capable of supporting exceptional warmwater faunas

QHEI > 60: Unimpaired - Stream segment suitable for Warmwater Habitat without use impairment

QHEI between 45 and 60: Slightly impaired - Stream segment may meet Warmwater Habitat in some circumstances, but it may show a level of impairment that requires classification as Modified Warmwater Habitat

QHEI between 32 and 45: Moderately impaired - Stream segment meets Modified Warmwater Habitat

QHEI < 32: Severely impaired - Stream segment may be suitable for Modified Warmwater Habitat only if the watershed is greater than 3 square miles. Even then, this may not be possible. Where Modified Warmwater Habitat is not possible, the stream segment is classified as a Limited Resource Water.

IDEM considers a QHEI total score of less than 51 indicative of poor habitat (IDEM 2006). The QHEI metrics and scores for this study are presented in Table 3.8. QHEI results sorted by value are presented in Figure 3.21.

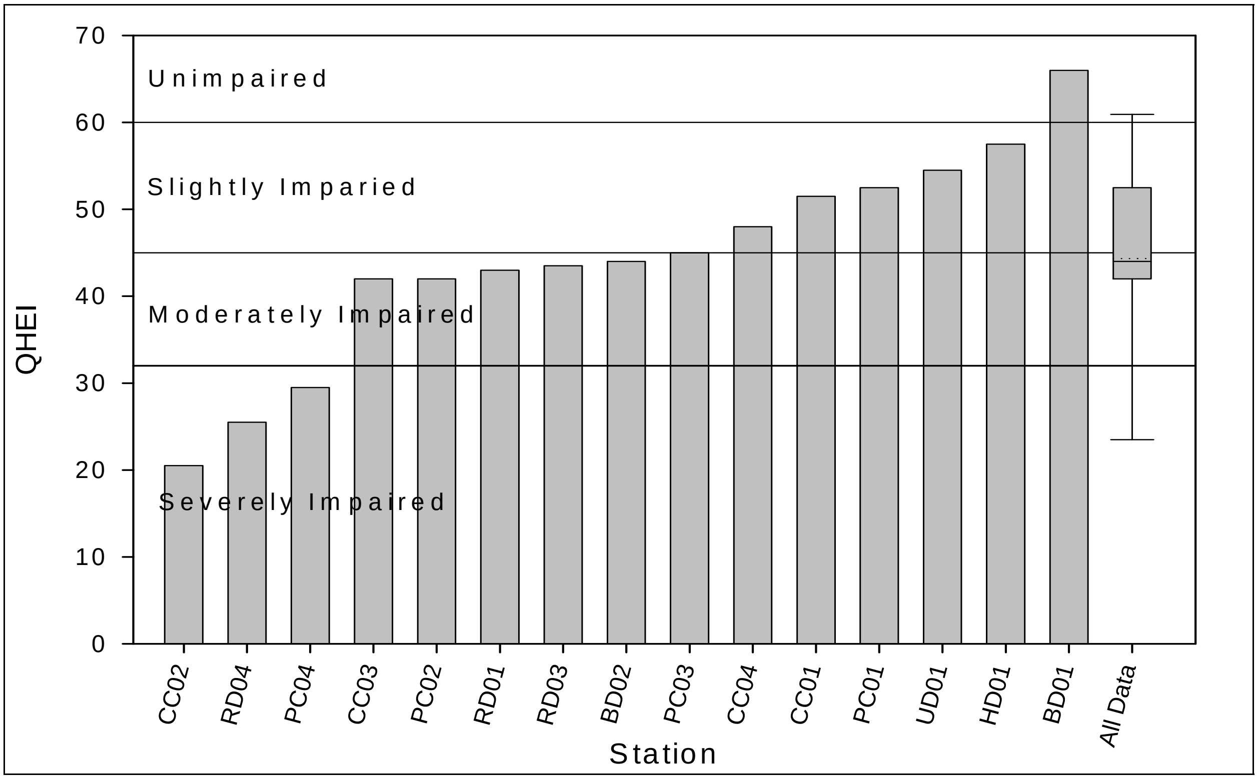


**Figure 3-21** QHEI values at each station showing degree of impairment for warmwater habitat

| Table 3.8 – QHEI Metric Scores and Values for the Mississinewa River Phase III Watershed | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Drainage | Date | Time | Substrate | Instream Cover | Channel Morph | Riparian & Erosion | Pool/Glide Riffle/Run A | Pool/Glide Riffle/Run B | Gradient | *QHEI |
| BD01 | *Boseman Ditch* | 8/11/2004 | 12:00 PM | 18.0 | 16.0 | 9.0 | 6.0 | 3.0 | 4.0 | 10.0 | 66.0 |
| BD02 | *Boseman Ditch* | 8/11/2004 | 12:42 PM | 11.0 | 10.0 | 7.0 | 5.0 | 5.0 | 0.0 | 6.0 | 44.0 |
| BD03 | *Boseman Ditch* | 8/11/2004 | 12:30 PM | Not Assessed - No Flow | | | | | | | |
| CC01 | *Campbell Creek* | 8/11/2004 | 2:30 PM | 11.0 | 4.0 | 14.0 | 6.5 | 6.0 | 0.0 | 10.0 | 51.5 |
| CC02 | *Campbell Creek* | 8/11/2004 | 3:00 PM | 1.0 | 3.0 | 5.0 | 1.5 | 4.0 | 0.0 | 6.0 | 20.5 |
| CC03 | *Campbell Creek* | 8/11/2004 | 4:00 PM | 13.0 | 6.0 | 7.0 | 5.0 | 5.0 | 0.0 | 6.0 | 42.0 |
| CC04 | *Campbell Creek* | 8/11/2004 | 3:45 PM | 14.0 | 5.0 | 11.0 | 4.0 | 6.0 | 4.0 | 4.0 | 48.0 |
| HD01 | *Holdren Ditch* | 8/11/2004 | 11:00 AM | 16.0 | 6.0 | 11.5 | 3.0 | 7.0 | 4.0 | 10.0 | 57.5 |
| MR01 | *Mississinewa* | 8/11/2004 | 7:45 AM | Not Assessed | | | | | | | |
| MR02 | *Mississinewa* | 8/11/2004 | 10:30 AM | Not Assessed | | | | | | | |
| MR03 | *Mississinewa* | 8/11/2004 | 2:30 PM | Not Assessed | | | | | | | |
| PC01 | *Pike Creek* | 8/11/2004 | 7:30 AM | 17.0 | 6.0 | 9.0 | 4.5 | 3.0 | 5.0 | 8.0 | 52.5 |
| PC02 | *Pike Creek* | 8/11/2004 | 7:00 AM | 10 | 9 | 11 | 5 | 3 | 0 | 4.0 | 42.0 |
| PC03 | *Pike Creek* | 8/11/2004 | 9:00 AM | 15.0 | 7.0 | 7.0 | 5.0 | 4.0 | 3.0 | 4.0 | 45.0 |
| PC04 | *Pike Creek* | 8/11/2004 | 10:00 AM | 1.0 | 10.0 | 4.5 | 6.0 | 4.0 | 0.0 | 4.0 | 29.5 |
| RD01 | *Rees Ditch* | 8/11/2004 | 11:30 AM | 15.0 | 5.0 | 7.0 | 3.0 | 5.0 | 0.0 | 8.0 | 43.0 |
| RD02 | *Rees Ditch* | 8/11/2004 | 11:30 AM | Not Assessed - No Flow | | | | | | | |
| RD03 | *Rees Ditch* | 8/11/2004 | 1:00 PM | 12.0 | 10.0 | 6.0 | 4.5 | 5.0 | 0.0 | 6.0 | 43.5 |
| RD04 | *Rees Ditch* | 8/11/2004 | 2:00 PM | 1.0 | 5.0 | 8.0 | 4.5 | 3.0 | 0.0 | 4.0 | 25.5 |
| UD01 | *Unnamed Ditch* | 8/11/2004 | 8:00 AM | 13.0 | 15.0 | 8.0 | 4.5 | 4.0 | 0.0 | 10.0 | 54.5 |

*Calculated values

# 4.0 WATERSHED NPS INVESTIGATION

## 4.1 METHODOLOGY

Cedar Eden Environmental, LLC conducted an evaluation of the watershed to determine potential sources on nonpoint source pollutants. Specific target areas included stream banks, stream road crossings, and farms. A complete windshield survey was conducted along every road within the watershed and sites that were accessible, such as along roads or within a short walking distance from a road were investigated. The location of the problem area was marked on a map, GPS coordinates were recorded, photographs were taken, and field notes were made. Using information gathered in the field, the locations of the problem areas were added to the GIS for the Phase III watershed. Existing examples of good BMPs were also noted, as well as unique natural features.

## 4.2 RESULTS

Nonpoint source problem areas and existing BMPS are shown on Map 1. Table 4.1 serves as a key to Map 1, and lists identified NPS problem areas, along with a description, severity rating, and recommended BMPs. A total of 27 nonpoint source problem areas were identified. The main NPS problems were streambank erosion, lack of buffers, and animal access to streams.

| Table 4.1 Nonpoint source problem areas | | | | |
|---|---|---|---|---|
| Map ID | Type | Severity | Description | Recommended BMP |
| 1 | Animals in Stream | Major | unimproved stream crossing, animal access to ditch | Armored crossing, fence out stream, alternate water source |
| 2 | Streambank Erosion | Minor | lawn collapse into stream | Vegetative streambank stabilization |
| 3 | Streambank Erosion | Minor | grassed bank undercut | Vegetative streambank stabilization |
| 4 | Animals in Stream & Streambank Erosion | Major | Craw Ditch (UD) eroded and deep bank cuts, cattle with free access to ditch along its length | Streambank stabilization, fencing and alternate water source (Note: Landowner states he signed up for riparian buffer restoration |
| 5 | No Buffers | Major | Studebaker ditch, field with limited buffers | Vegetative buffer strips |
| 6 | Streambank Erosion | Minor | Good buffers, streambank eroding at turn below road | Vegetative streambank stabilization |
| 7 | Streambank Erosion | | Studebaker Ditch, eroded banks | Vegetative streambank stabilization |
| 8 | Buffers | | Fields have no buffers | Vegetative buffer strips |
| 9 | Streambank Erosion | | Ditch in grassed field with eroding banks | Vegetative streambank stabilization |
| 10 | Manure Management | | Manure stacked between sheds | Manure management plan, manure pit (?) |
| 11 | No Buffers | Major | Good buffers, but ditch was cut to drain fields directly to Rees Ditch | Fix buffers, install filtered drain inlet or small wetland |
| 12 | Animals in Stream | | Large number of alpacas in wetland, habitat destruction | Seek alternate grazing area |
| 13 | Streambank Erosion | Minor | Small stream with significant gulley and streambank erosion | Establish ground cover, install vegetative stabilization (may be fixed) |
| 14 | Roadside | Minor | Culvert not functioning properly, road bed eroding | Fix culvert and road |
| 15 | Streambank Erosion | Major | Campbell Creek, deep cut eroding banks, animal access to stream | Vegetative streambank stabilization, fence out stream |
| 16 | Buffers/Roadside | Minor | Headwaters Hayden Ditch, no buffers | Vegetative buffer strips |
| 17 | No Buffers | Minor | Love Ditch, no buffers | Vegetative buffer strips |
| 18 | Streambank Erosion | | Hedgeland Ditch, cut & eroding banks | Vegetative streambank stabilization |
| 19 | Streambank Erosion | Minor | Wooded stream with muddy, eroding banks, stream blockage with non-natural debris, fallen trees with intact roots | Understory bank planting, remove obstacles to flow, leave tree roots |
| 20 | Animals in Stream | Major | Full animal access to stream, erosion and animal waste issues | fence out stream, alternate water source, stabilize area |
| 21 | Animals in Stream | | Animals (elk) with full access to stream | fence out stream, alternate water source, stabilize area |
| 22 | No Buffers | Major | Holdren Ditch headwaters, fields with no buffers | Vegetative buffer strips |
| 23 | Streambank Erosion Manure management | Major | Holdren Ditch, gulley erosion in field, steep bank erosion, no buffers, manure spread near stream | Stabilize field, streambank regarding, vegetative streambank erosion, buffers, manure management plan, alternate spreading site |
| 24 | No Buffers | | Champion Run, grassed buffers to south, no buffers to north | Vegetative buffer strips |
| 25 | No Buffers | | Deep roadside ditch, no field buffers | Vegetative buffer strips |
| 26 | No Buffers | | Swearengen Ditch, no buffers | Vegetative buffer strips |
| 27 | Streambank Erosion | | Eroding drainage channel | Vegetative streambank stabilization |

# 5.0 NONPOINT SOURCE POLLUTION MODELING

## 5.1 INTRODUCTION & METHODOLOGY

The pollutant budgets for a watershed are calculated by balancing inputs and outputs to the watershed. Developing a pollutant budget based on a mass balance equation requires a considerable amount of watershed monitoring and is beyond the scope of LARE program studies. However, these budgets can also be estimated by using land use information for a given watershed and literature values of expected pollutant contributions for each of the various land uses. These values are called export coefficients and describe the amount of a pollutant contributed for a given area of land use. Nutrient budgets (nitrogen and phosphorus) for the Phase III watershed were calculated in such a manner. Land use areas for each watershed were obtained using NLCD land use and a GIS and these land use categories were combined into more general groups. A number of export coefficients were evaluated, primarily those of Reckhow (1980). The evaluation of Reckhow coefficients included median values, common values, and median values of a subset selected for their source similarity to northern Indiana. The selective median coefficients were chosen for the purpose of this modeling. Loading coefficients used in this study are presented in Table 5.1.

Suspended solids land use export coefficients were based on those in Holdren et al (2001), modified for present day land use practices. The coefficients in Holdren et al. were based on studies from 1980 and 1994. The large range of suspended solids coefficients was averaged and 1/3 of that value was selected. Loading coefficients used in this study are presented in Table 5.1.

Model development and calibration are beyond the scope of a LARE diagnostic study. The results of this modeling should only be considered as relative values for comparative purposes between watersheds. The relative values were also used to compare this analysis with the results of the Taylor study. Loading coefficients used in this study are presented in Table 5.1.

| Table 5.1<br>Loading Coefficients Used for Determining Relative Pollutant Budgets | | | |
|---|---|---|---|
| **Land Use Category** | **TP (kg/ha/yr)** | **TN (kg/ha/yr)** | **TSS** (kg/ha/yr) |
| Water | 0 | 0 | 0 |
| Pasture & Hay | 0.745 | 8.545 | 2.75 |
| Row Crops | 1.4 | 7.97 | 128 |
| Forest | 0.068 | 2.0 | 20.5 |
| Residential | 0.725 | 4.335 | 73 |

## 5.2 RESULTS

Results of the nutrient and sediment loading calculations are presented in Table 5.2.

| Table 5.2<br>Estimates of Nutrient and Sediment Loads by Subwatershed | | | | | | |
|---|---|---|---|---|---|---|
| | **Total Load (kg/yr)** | | | **Total Load (tons/yr)** | | |
| **Drainage** | **TP** | **TN** | **TSS** | **TP** | **TN** | **TSS** |
| **Phase III** | 31,904 | 198,386 | 2,753,762 | 35.2 | 218.7 | 3,035.5 |
| **Boseman** | 2,108 | 12,824 | 183,998 | 2.3 | 14.1 | 202.8 |
| **Campbell** | 6,706 | 41,835 | 570,820 | 7.4 | 46.1 | 629.2 |
| **Holdren** | 726 | 4,720 | 62,051 | 0.8 | 5.2 | 68.4 |
| **Pike** | 8,007 | 48,129 | 706,043 | 8.8 | 53.1 | 778.3 |
| **Rees** | 4,054 | 25,378 | 346,827 | 4.5 | 28.0 | 382.3 |
| **Unnamed** | 483 | 3,073 | 42,124 | 0.5 | 3.4 | 46.4 |

# 6.0 INSTITUTIONAL RESOURCES

## 6.1 EXISTING INSTITUTIONAL RESOURCES

There are a number of institutional resources available to assist in the implementation of a Mississinewa River Watershed Management Program. In addition to the institutions listed below, there may be private, not-for-profit, and environmental groups that can assist in preserving and protecting the valuable resources of the Ball Lake watershed.

### 6.1.1 AGRICULTURE, SOILS, & LAND MANAGEMENT

Nikki McClain
NRCS, District Conservationist
3641 N. Briarwood Lane
Muncie, Indiana 47304
(765) 747-5531

Delaware-Muncie Metropolitan Planning Commission
100 West Main Street
Muncie, IN 47305-2872
(765) 747-7740

Sheri Hole, District Administrator
Delaware County Soil & Water Conservation District
3641 N. Briarwood Lane
Muncie, Indiana 47304
(765) 747-5531 ext. 3

Randolph County Planning Commission
100 South Main Street
Winchester, Indiana 47394-1832
(765) 584-7070

Randolph County Soil & Water Conservation District
975 E. Washington Street
Winchester, IN 47394-9221
(765) 584-4505

Jim Norris, IDNR Resource Specialist
975 E. Washington Street, Suite 2
Winchester, IN 47394
(765)584-4505 ext. 3

Delaware County Farm Service Agency
Will Herr, Executive Director
3641 N. Briarwood Lane
Muncie, Indiana 47304-5227
(765) 747-5531

Randolph County Farm Service Agency
Nancy Best, Executive Director
975 E. Washington Street
Winchester, IN 47394-9221
(765) 584-4505

Purdue University Extension
Delaware County Building
100 West Main Street, Room 202
Muncie, IN 47305
(765) 747-7732

### 6.1.2 Wetlands & Wildlife

US Fish & Wildlife Service
Bloomington Field Offices
620 South Walker Street
Bloomington, IN 47403-2121
(812) 334-4261

IDNR District 8 Wildlife Biologist
Wilbur Wright FWA
2239 N. SR 103
New Castle, IN 47362
(765) 529-6319

IDNR District 4 Fisheries Biologist
1353 South Governors Drive
Columbia City, IN 46725-9539
(260) 244-6805

### 6.1.3 Water Quality

Indiana Lake Management Society
207 South Wayne Street, Suite B
Angola, IN 46703

Delaware County Health Department
100 West Main Street, Room 207
Muncie, Indiana 47305
(765) 747-7721

LARE Biologist
IDNR Division of Fish & Wildlife
402 W. Washington St., Rm. 273
Indianapolis, IN 46204
(317) 234-4407

IDEM Office of Water Management
Assessment Branch
Biological Studies Section
2525 North Shadeland Ave
Indianapolis, IN 46219
(317)308-3183

### 6.1.4 Recreation

Division of Outdoor Recreation
Department of Natural Resources
402 West Washington
Indianapolis, IN 46204
Tel: 317-232-4751

# 7.0 WATERSHED MANAGEMENT RECOMMENDATIONS

## 7.1 PRIORITY SUBWATERSHEDS

### 7.1.1 SUBWATERSHED RANKING BASED UPON WATER QUALITY

#### *COMBINED RANKING ANALYSIS*

A considerable amount of water quality data were collected, and have been analyzed, and presented as part of this watershed diagnostic study. In order to summarize this collective data and identify those watersheds with the poorest or most-impacted water quality, a ranked analysis was made of those stations which exceeded the 75th percentile for a number of parameters, with the axes so that values greater than 75th percentile were towards worse water quality or greater degree of water quality impairment. The parameters within this analysis were QHEI, mIBI, and, at conditions of both low and high flow, E. coli, turbidity, total phosphorus, soluble reactive phosphorus, total nitrogen, nitrate-nitrite nitrogen, total Kjeldahl nitrogen, total phosphorus flux, and total nitrogen flux.

A tally was made of the number of times each stream station appeared in the top 25th percentile for any parameter and flow condition. This rank analysis was then further summarized based upon major subwatershed. The results of this analysis are presented in Figure 7-1 and Figure 7-2. The values are unitless, and a subwatershed with four stations could theoretically have a total of 80 if each station was in the top 25th percentile for all parameters and flow conditions. Normalizing for the number of stations, the maximum value would be 20.

The Mississinewa River stations show up consistently due to their greater collection area and higher flows. The three Mississinewa River stations exceeded the 75th percentile 32 times (10.7 when normalized for number of stations). The ranking analysis, excluding the Mississinewa River stations, identifies Campbell Creek as the highest ranked subwatershed, exceeding the 75th percentile in the analyzed parameters 27 times (normalized rank of 6.8), nearly three times as many times as the next highest ranked subwatershed. The next highest ranked subwatershed was Pike Creek, exceeding the 75th percentile in the analyzed parameters 10 times (normalized rank of 2.5). This was followed by the Rees Ditch subwatershed (9 times, normalized rank of 2.3), the Boseman Ditch subwatershed (7 times, normalized rank of 2.3) and the Holdren Ditch subwatershed (4 times, normalized rank of 4.0). Note Holdren Ditch was ranked second after Campbell Creek when normalized for number of stations. The Holdren Ditch subwatershed is small compared to Campbell Creek and Pike Creek, and it might not be valid to compare a subwatershed with one station to another with four stations.

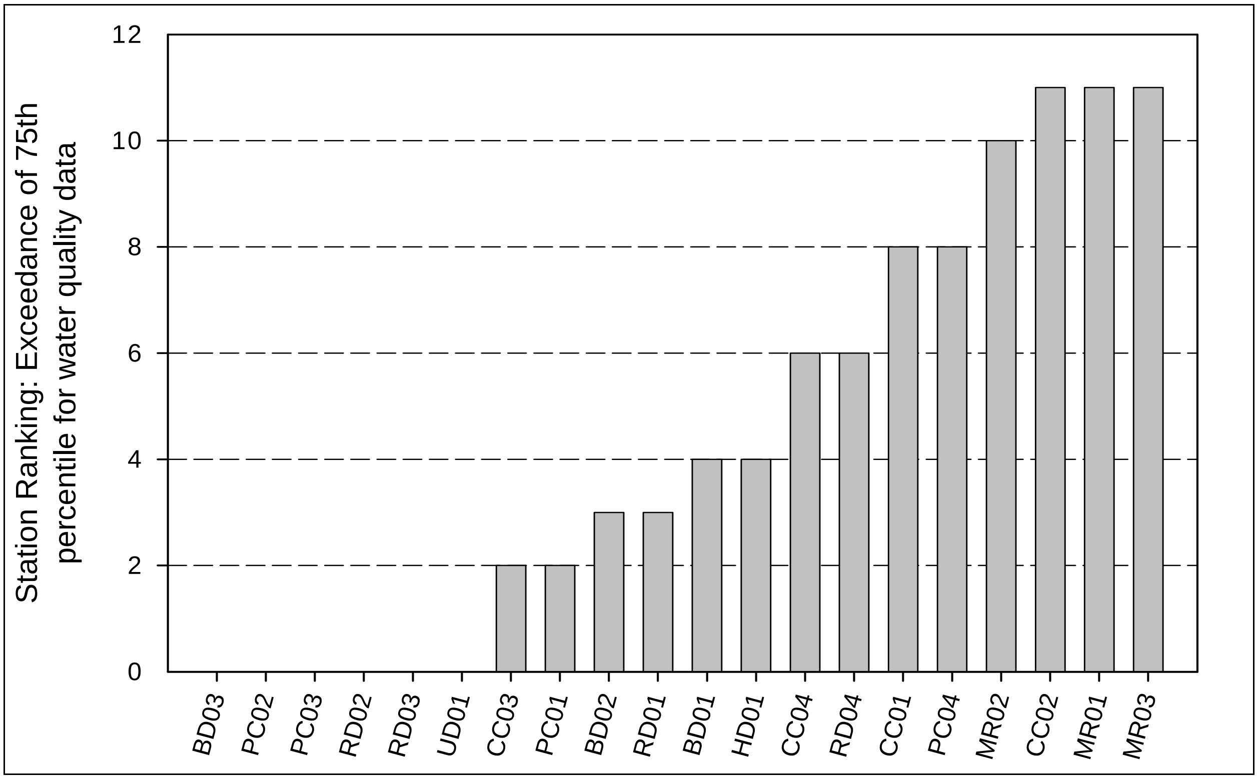


**Figure 7-1** Station ranking based on number of times exceeding 75th percentile for water quality

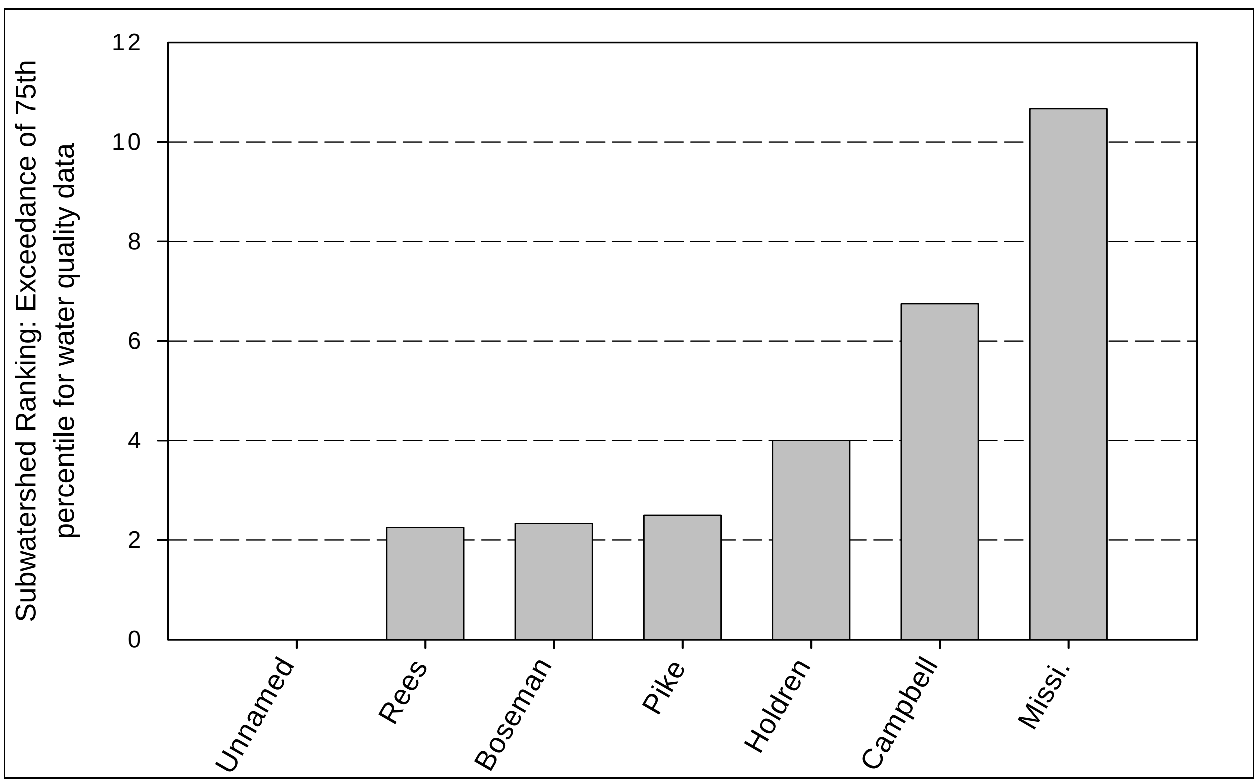


**Figure 7-2** Subwatershed ranking based on number of times exceeding 75th percentile for water quality normalized for number of stations in subwatershed

### *RANKING ON WATER QUALITY PARAMETERS*

Campbell Creek was consistently was among the group of stations having the highest concentrations of E. coli (high and low flow, <u>the</u> highest at low flow), turbidity (high and low flow), total phosphorus (high flow), soluble reactive phosphorus (high flow), and TKN (organic nitrogen, high flow). Campbell Creek also had the highest total phosphorus (TP) and total nitrogen (TN) flux (mass transport) during high flow conditions – both TP and TN flux were three times higher in Campbell Creek than any other subwatersheds.

Pike Creek was among the group of stations having the highest concentrations of E. coli (<u>the</u> highest at high flow), total phosphorus (high and particularly low flow), soluble reactive phosphorus (high and low flow, <u>the</u> highest at high flow), and nitrate nitrogen (high flow). Pike Creek also the highest TP and TN flux at low flow conditions. Station PC04 was the station most often exhibiting these high concentration, while PC01 and PC02 were consistently among the lowest concentrations inmost cases. This would indicate that water quality is being improved during the course of its flow from the headwaters to the mouth of Pike Creek.

No other streams were consistently in the group of subwatersheds with high concentrations of the measured pollutants. Rees Ditch (RD04), however, was among the highest for total nitrogen (high and low flow), nitrate nitrogen (high flow), organic nitrogen (TKN, low flow). Rees Ditch had the second highest TN flux at low flow conditions.

### *RANKING BASED UPON BIOLOGICAL INTEGRITY*

Based upon QHEI, CC02, RD04 and PC04 were severely impaired. CC02, in the Campbell Creek subwatershed, was a relatively stagnant silted-over section of the creek just below an area of extremely eroding streambank. RD04, in the headwaters of Rees Ditch, is a deep, slow-moving section in a residential area. PC04, in the Pike Creek subwatershed, is located towards the headwaters of Studebaker Ditch, in an agricultural area with good buffers downstream but poor or non-existent buffers upstream. The streambed consisted of deep silt.

A subwatershed QHEI ranking was determined using the mean QHEI for all stations within each subwatershed. Based on this analysis, the Rees Ditch subwatershed was the most impaired (QHEI = 37.2). Campbell Creek subwatershed was the second most impaired (QHEI =40.5), followed by the Pike Creek subwatershed (QHEI = 42.3). These three subwatersheds had average QHEI values indicative of moderate impairment. The remaining subwatersheds all had QHEI values of around 55 or greater (slightly impaired). The Holdren Ditch subwatershed was the least impaired (QHEI = 57.5)

A subwatershed mIBI rankings was determined using the mean mIBI for all stations within each subwatershed. Based on this analysis, the Campbell Creek subwatershed was most impaired (mIBI = 2.8), followed by the Unnamed Ditch subwatershed (mIBI = 2.9), the Rees Ditch subwatershed (mIBI = 3.0), and the Boseman Ditch subwatershed (mIBI = 3.3). All of these subwatersheds had an mIBI consistent with moderate impairment. The Pike Creek (mIBI = 4.7) and Holdren Ditch (mIBI = 5.1) subwatersheds had mIBIs consistent with slight impairment.

A 1994IDEM fish survey identified Campbell Creek at as having a biotic integrity of poor to fair (see Section 2.4.6). No other subwatersheds were surveyed.

### 7.1.2 Subwatershed Ranking Based Upon Modeling

The NPS modeling identified Pike Creek and Campbell Creek as the two subwatersheds contributing the most phosphorus, nitrogen, and suspended solids.

### 7.1.3 Priority Subwatersheds for Implementation

Based upon the above analyses of the Phase III watershed diagnostic study results, the Campbell Creek and Pike Creek subwatersheds should receive the highest priority for implementation of BMPs, especially with regard to the management E. coli, nutrients, and sediments. Rees Ditch should receive secondary priority for nitrogen management.

Where appropriate, these subwatersheds should be targeted first for land management practices. However, no opportunity should be passed up to control nutrients or erosion in any part of the Phase III watershed.

## 7.2 Watershed Management Recommendations

There was one NPS problem area identified in the Campbell Creek subwatershed. This was NPS 15 – Streambank Erosion.

There were eleven NPS problem areas identified in the Pike Creek subwatershed. These were NPS 1, NPS 2, NPS 3, NPS 5, NPS 6, NPS 7, NPS 8, NPS 16, NPS 17, NPS 18. and NPS 24. These include one Animals in Stream, five Streambank Erosion, and five Buffers.

There were two NPS problem areas identified in the Rees Ditch subwatershed. These were NPS 10 and NPS 11, Manure Management and Buffers, respectively.

The remaining NPS problem areas were identified in the Holdren Ditch subwatershed (3) the Unnamed Ditch subwatershed (1), and the Mississinewa direct drainage (9). These included four Animals in Stream, six Streambank Erosion (one of which is also nutrient management), and three Buffers.

### 7.2.1 Recommendation One – Animals in Streams/Stream Crossings

Allowing animal access to streams and using unimproved stream crossings for equipment results in the destruction of the streambank, causing increased erosion at the access site and often downstream as well. In addition, allowing animals access to stream results in the deposition of animal waste directly into the stream and along its banks, resulting in elevated nutrient and E. coli concentrations.

#### *Specific Site Recommendations*

It is recommended that NPS Site 1 be improved by creating a permanent stream crossing for vehicles and livestock, if no alternative to access to the owner's fields across Hayden Ditch is available, such as going around via 950 North Road. In addition, a watering facility should be developed and fencing should be used to exclude animal access to Hayden Ditch.

It is recommended that watering facilities should be developed and fencing should be used to exclude animal access to water at NPS Sites 20 and 21. NPS Site 20 includes a large length of ditch that runs through the barnyard, with livestock freely passing across for the entire length. If a livestock crossing is unavoidable, then a permanent stream crossing should be established here, and the remaining ditch fenced off. NPS Site 21 consists of a drainage ditch running through a field, with livestock having ready access. It does not appear that the ditch is necessary for a stream crossing or water access. Therefore, this drainage way should be completely fenced off.

NPS Site 12 site appears to be a case where livestock are being allowed to graze in a wooded wetland that has been partially cleared of trees. An alternative pasture site should be identified and the wetland area allowed to reestablish itself.

NPS Site 4 consists of pastureland along Unnamed (Craw) Ditch, with livestock having full access to a highly eroded streambank. No livestock were observed in this pastureland at any time during the study. The owner stated that he was under contract for riparian bank restoration.

Stream crossing methods are discussed in NRCS Conservation Practice Standards 578. Stream fencing methods are discussed in NRCS Conservation Practice Standards 382. Watering facility methods are discussed in NRCS Conservation Practice Standards 614.

### 7.2.2 Recommendation Two – Streambank Erosion

Erosion is one of the major sources of nonpoint source pollution in watersheds. Nutrients and other pollutants adhere to eroded soil particles negatively affecting the streams and the soil and pollutants are transported downstream and into the Mississinewa River. A number of the streams and ditches in the Phase III watershed had eroded streambanks and lack adequate vegetation.

Restoration of erosion along streambanks is a successful way to significantly reduce sediment and nutrient loadings within the Mississinewa Phase III watershed for a reasonable price. By using vegetative streambank erosion measures, the erosion area is eliminated and the area acts as a vegetative buffer that can also reduce sediments and nutrients that enter the stream with stormwater runoff.

#### *SPECIFIC SITE RECOMMENDATIONS*

There are no specific site recommendations for streambank erosion. It is recommended, however, that vegetative methods be used as much as possible to restore the identified sites. The use of vegetative streambank restoration not only provides streambank protection, but also enhances the habitat character of the stream where it is used.

#### *STREAMBANK STABILIZATION METHODS*

There are a variety of methods designed to stabilize eroded streambanks and to reduce continued erosion and sedimentation. Some methods reduce the amount and velocity of water in the stream, others involve relatively high cost structural controls such as rip-rap and gabions, and still others involve relatively low-cost vegetative controls such as willow twigs, grasses, shrubs, or wetland vegetation. It is recommended that the bioengineering approach of using anchored live material such as shown in the figure to the right (FISRWG 1998) be used wherever practical to stabilize the severely eroded streambank areas noted on the nonpoint source problem area map.

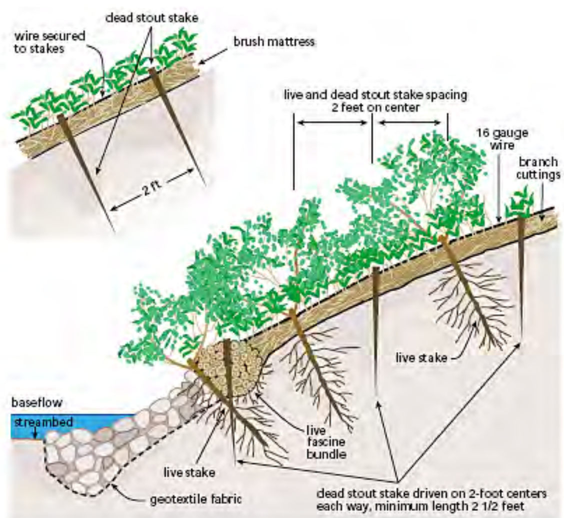


*Figure 8.40: Cutting systems. Details of brushmattress technique.*
Source: USDA-NRCS 1996a.
*Note: Rooted/leafed condition of the living plant material is not representative at the time of installation.*

Streambank channel stabilization and vegetative establishment for disturbed slopes are discussed in NRCS Conservation Practice Standards 584 and 580, respectively.

### 7.2.3 RECOMMENDATION THREE – VEGETATIVE BUFFERS

Vegetated buffers along stream and ditch channels serve to filter out sediments and nutrients in overland runoff. County agencies should work with the farmers to institute grassed buffers along all waterways in the watershed. A minimum buffer width of 25 feet as measured from the top of bank is recommended. However, greater buffer widths provide both increased filtration and wildlife habitat benefit. Additionally, an evaluation of tile inlets should be conducted to assess the use of vegetative buffers around these facilities. SWCDs should work with the farmers to ensure a good buffer around all tile inlets.

#### *SPECIFIC SITE RECOMMENDATIONS*

There re no specific site recommendations for vegetative buffers. A number of NPS Sites were identified with inadequate or non-existent buffers. These sites should be addressed by subwatershed priority. It is interesting to note that most of the NPS sites with stream buffer issues were located within the two priority subwatersheds, Campbell Creek and Pike Creek.

In addition to the NPS sites, several excellent examples of buffer use and created habitat were observed within the watershed. In particular, the buffers along Packard Run upstream and downstream of 800 North Road, a SWCD Buffer Project, exhibited excellent vegetative diversity and were providing excellent habitat for numerous songbirds.

## 7.3 Funding Sources

There are a number of potential sources of funding for implementing the Mississinewa River management alternatives.  Some of the main funding sources are described in the following sections.

**Lake and River Enhancement Program (LARE)**

The LARE program provides funding for construction activities associated with recommendations in a diagnostic study. A maximum of $300,000 may be available for activities within the Mississinewa River watershed, with a requirement of 25 percent matching funds or in-kind service.

The LARE program also provides funding for Watershed Land Treatment (WLT). These grants can be applied for annually by the county Soil & Water Conservation Districts. Often the LARE WLT funds can be coordinated with federal conservation programs to offer landowners greater incentives to implement best management practices. The lake association should coordinate its restoration efforts with the county SWCDs to access some of this funding.

The LARE program accepts "pre-applications" each year for funding that will become available in July. Submission of a pre-application form is required from any lake organization interested in acquiring funding for diagnostic, engineering feasibility, design or construction projects. Organizations which are interested should complete the pre-application form and return it to the LARE office by January 31 for the year in which funding is desired.

For more information about the LARE program, contact the LARE coordinator (see Section 9) or visit the LARE Program website at
http://www.in.gov/dnr/soilcons/programs/lare.html

**Nonpoint Source Pollution Management Grant (319 Grants)**

In Indiana, the IDEM administers the federal Clean Water Act Section 319 Nonpoint Source Pollution Management Grant program. This program may be used to address nonpoint source pollution such as streambank erosion in the Mississinewa River watershed. A maximum of $300,000 may be available, with a requirement of 25 percent matching funds or in-kind service. Applications for the Federal Section 319 Grants are due October 1. Projects selected for funding will be able to start work July 1 in the year following the application.

The Watershed Management Section administers the Section 319 Grant Program in Indiana. To obtain more information about applying for a Section 319(h) grant, contact:

IDEM Office of Water Management
100 N. Senate Avenue
P.O. Box 6015
Indianapolis, IN 46206-6015
(317) 233-8803

or visit the IDEM 319 Grant web page at
http://www.in.gov/idem/water/planbr/wsm/319main.html

**Watershed Protection and Flood Prevention Program**

This federal program is administered by the local county offices of the Natural Resource County Service. Relevant funding priorities for the Mississinewa River watershed include watershed protection, flood prevention, erosion and sediment control, fish and wildlife habitat enhancement, wetland creation and restoration, and public recreation in small watersheds. The amount of the money available is variable, but flood control projects are fully funded with no match, while agricultural water management, recreation and fish and wildlife construction projects require a 50 percent match. Eligible project sponsors (Local or state agency, county, municipality, town or township, soil and water conservation district, flood prevention/flood control district, Indian tribe or tribal organization, or other subunit of state government )may submit formal requests for assistance to the NRCS state Conservationist in each state at any time.

For more information, contact the local NRCS representative (see Section 9) or go to http://www.epa.gov/owow/watershed/wacademy/fund/prevent.html

**Conservation Reserve Program**

This federal program is administered by the county offices of the Farm Services Agency and provides cost-sharing and incentive payments to farmers to establish and maintain vegetation on their properties. Much of the Mississinewa River watershed contains eligible lands for this program, since the program is targeted at farm lands with a high potential of degrading water quality under normal usage and areas that might make good habitat if not farmed. These target areas include highly erodible land, riparian zones, and farmed wetlands. A 50 percent match is required for construction and planting.

For more information, contact the county Farm Services Agency office (see Section 9) or go to http://www.fsa.usda.gov/dafp/cepd/crp.htm

**Wetlands Reserve Program**

This federal program is administered by the local county offices of the Natural Resource County Service and provides funding to landowners for the restoration of wetlands on agricultural land. Landowners receive cost-sharing and incentive payments to restore wetlands in farmed wetlands, drained and tiled lands, riparian zones, and lands adjacent to protected wetlands. No match is required.

For more information, contact the local NRCS representative (see Section 9) or go to http://www.nrcs.usda.gov/programs/wrp/

**Wildlife Habitat Incentive Program (WHIP)**

This federal program is administered by the local county offices of the Natural Resource County Service and provides funding and technical support to landowners for the development and improvement of wildlife habitat on private lands. A 25 percent match is required.

For more information, contact the local NRCS representative (see Section 9) or go to http://www.nrcs.usda.gov/programs/whip/

**North American Wetland Conservation Act Grant Program**

This federal program is funded by the US Department of the Interior and administered through its local Fish and Wildlife Service offices. A North American Wetlands Conservation Act standard grant proposal is a 4-year plan of action supported by a NAWCA grant and partner funds to conserve wetlands and wetlands-dependent fish and wildlife through acquisition (including easements and land title donations), restoration and/or enhancement, with a grant request between $51,000 and $1,000,000. Small grants (up to $50,000) are administered separately. Match must be non-Federal and at least equal the grant request (referred to as a 1:1 match). Match is eligible up to 2 years prior to the year the proposal is submitted and grant and match funds are eligible after the proposal is submitted and through the project period.

For more information, contact the North American Waterfowl Management Plan Joint Venture Coordinator for Indiana at:

Barbara Pardo, Joint Venture Coordinator (barbara_pardo@fws.gov)
Paul Richert, Assistant Joint Venture Coordinator (paul_richert@fws.gov)
U.S. Fish and Wildlife Service
One Federal Drive
Fort Snelling, MN 55111-4056

or visit the following NAWCA websites:

Small Grants Program
http://www.fws.gov/birdhabitat/NAWCA/USsmallgrants.html

Standard Grants Program
http://www.fws.gov/birdhabitat/Grants/NAWCA/Standard/index.shtm

**Land and Water Conservation Fund**

This federal program provides funding for park, wildlife, and open space land acquisition. It is administered by the IDNR Division of Outdoor Recreation and provides matching grants to States and local governments for the acquisition and development of public outdoor recreation areas and facilities. The Land and Water Conservation Fund applicants may request amounts ranging from a minimum of $10,000 up to a maximum of $200,000. Only park and recreation boards established under Indiana law are eligible. Applications must be submitted or post-marked by June 1. In order to be eligible for these moneys, Mississinewa River must be ranked by IDNR on their statewide recreation plan and the County must work with a local park and recreation board.

The Land and Water Conservation Fund is a reimbursing program, the project sponsor does not receive the grant funds at the time of application approval. The sponsor must have the local matching 50% of the project cost available prior to the application. The sponsoring park and recreation board is reimbursed 50% of the actual costs of the approved project. In order to receive the money reserved for the project, a billing must be submitted to your grant coordinator that enables the participants to request the federal share of the cost incurred throughout the grant term.

For more information contact:

Bob Bronson
State & Community Outdoor Recreation Planning Section
Division of Outdoor Recreation
Indiana Department of Natural Resources
402 West Washington Street, Room 271
Indianapolis, Indiana 46204-2782
(317) 232-4070

or visit the LWCF website at http://www.in.gov/dnr/outdoor/grants/lwcf.html

**Conservation Technical Assistance (CTA)**

The purpose of the program is to assist land users, communities, units of state and local government, and other Federal agencies in planning and implementing conservation systems. The purpose of the conservation systems are to reduce erosion, improve soil and water quality, improve and conserve wetlands, enhance fish and wildlife habitat, improve air quality, improve pasture and range condition, reduce upstream flooding, and improve woodlands. The objective of the program is to: Assist individual land users, communities, conservation districts, and other units of State and local government and Federal agencies to meet their goals for resource stewardship and assist individuals to comply with State and local requirements. NRCS assistance to individuals is provided through conservation districts in accordance with the Memorandum of Understanding signed by the Secretary of Agriculture, the Governor of the State, and the conservation district. Assistance is provided to land users voluntarily applying conservation and to those who must comply with local or State laws and regulations. Assistance is also provided to agricultural producers to comply with the highly erodible land (HEL) and wetland (Swampbuster) provisions of the 1985 Food Security Act as amended by the Food, Agriculture, Conservation and Trade Act of 1990 (16 U.S.C. 3801 et. seq.); the Federal Agriculture Improvement and Reform Act of 1996, and wetlands requirements of Section 404 of the Clean Water Act. NRCS makes HEL and wetland determinations and helps land users develop and implement conservation plans to comply with the law. They also provide technical assistance to participants in USDA cost-share and conservation incentive programs. NRCS collects, analyzes, interprets, displays, and disseminates information about the condition and trends of the Nation's soil and other natural resources so that people can make good decisions about resource use and about public policies for resource conservation. They also develop effective science-based technologies for natural resource assessment, management, and conservation.

**Conservation of Private Grazing Land Initiative (CPGL)**

The Conservation of Private Grazing Land initiative ensures that technical, educational, and related assistance is provided to those who own private grazing lands. It is not a cost-share program. This technical assistance will offer opportunities for: better grazing land management; protecting soil from erosive wind and water; using more energy-efficient ways to produce food and fiber; conserving water; providing habitat for wildlife; sustaining forage and grazing plants; using plants to sequester greenhouse gases and increase soil organic matter; and using grazing lands as a source of biomass energy and raw materials for industrial products.

**Environmental Quality Incentives Program (EQIP)**

The Environmental Quality Incentives Program provides technical, educational, and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost effective manner. The program provides assistance to farmers and ranchers in complying with Federal, State, and tribal environmental laws, and encourages environmental enhancement. The program is funded through the Commodity Credit Corporation. The purposes of the program are achieved through the implementation of a conservation plan, which includes structural, vegetative, and land management practices on eligible land. Five to ten year contracts are made with eligible producers. Cost-share payments may be made to implement one or more eligible structural or vegetative practices, such as animal waste management facilities, terraces, filter strips, tree planting, and permanent wildlife habitat. Incentive payments can be made to implement one or more land management practices, such as nutrient management, pest management, and grazing land management.

Fifty percent of the funding available for the program is targeted at natural resource concerns relating to livestock production. The program is carried out primarily in priority areas that may be watersheds, regions, or multi-state areas, and for significant statewide natural resource concerns that are outside of geographic priority areas.

**Watershed Program and Flood Prevention Program (WF 08 or FP 03)**

The Small Watershed Program works through local government sponsors and helps participants solve natural resource and related economic problems on a watershed basis. Projects include watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in watersheds that are less than 250,000 acres in size. Both technical and financial assistance are available.

# 8.0 PUBLIC INFORMATION

## 8.1 PUBLIC INFORMATION HANDOUTS

A public information PowerPoint presentation was developed to provide background information on the program and to provide a midpoint status report. An additional PowerPoint presentation is being developed to describe the findings and recommendations of the Mississinewa River Phase III Diagnostic Study.

## 8.2 PUBLIC MEETINGS

A public meeting was held on (date) to present the mid-project PowerPoint. The public meeting for the final presentation has not been scheduled yet.

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