APPENDIX TABLE OF CONTENTS

Contents	
A. PUBLIC INPUT	A7
B. GEOLOGY & HYDROLOGY	A8
C. LAND USE	A11
D. DEMOGRAPHICS	A14
E. DESKTOP SURVEY	A19
F. ENDANGERED SPECIES	A22
G. OTHER RELEVANT HISTORICAL STUDIES	A28
H. EXISTING IDEM DATA	A35
I. EXISTING STORET DATA	A42
J. EXISTING LARE DATA	A46
K. SAMPLE SITE DATA	A51
L. NITRATE DATA	A53
M. PHOSPHORUS DATA	A60
N. TSS DATA	A67
O. E. COLI DATA	A74
P. DISSOLVED OXYGEN DATA	A81
Q. BIOLOGICAL DATA	A82
R. LOAD REDUCTION SCENARIOS	A83
S. MEETING ULTIMATE GOALS—MODELS	A92
T. MISC TABLES/FIGURES	A102
U. BEST MANAGEMENT PRACTICES	A109
V. SSO OVERFLOWS	A111

APPENDIX TABLE OF TABLES

Contents	
TABLE B.1 | Geomorphological Studies	A9
TABLE D.1 | ESRI LifeMode Groups	A15
TABLE D.2 | Major Cities In Watershed Area	A16
TABLE F.1 | State or Federally Endangered Species in Entire Watershed	A22
TABLE F.2 | Endangered and Threatened Species Blackford County, IN	A23
TABLE F.3 | Endangered and Threatened Species Darke County, OH	A23
TABLE F.4 | Endangered and Threatened Species Delaware County, IN	A24
TABLE F.5 | Endangered and Threatened Species Randolph County, IN	A25
TABLE F.6 | Endangered and Threatened Species Grant County, IN	A26
TABLE F.7 | Endangered and Threatened Species Jay County, IN	A27
TABLE G.1 | Hydrologic Unit Scores for the Upper Mississinewa Watershed	A33
TABLE H.1 | IDEM Sampling Sites	A35
TABLE H.2 | Annual Sample Frequency at IDEM Sample Sites	A36
TABLE H.3 | Annual Parameter Averages at IDEM Sample Sites	A37
TABLE H.4 | Major IDEM Sampling Site Averages	A38
TABLE I.1 | Count of sampling events found in STORET database	A42
TABLE I.2 | Count of sampling events found in STORET database	A44
TABLE J.1 | LARE Phase One Site Locations and Water Quality Averages (For Tributary Subwatersheds Only).	A46

TABLE J.2 | LARE Phase Two Site Locations and Water Quality Averages (For Tributary Subwatersheds Only).	A46
TABLE J.3 | LARE Phase Three Site Locations and Water Quality Averages (For Tributary Subwatersheds Only).	A46
TABLE J.4 | LARE Phase 4 Water Quality Averages (For Tributary Subwatersheds Only). Data reported in 2012.	A47
TABLE J.5 | STORET and LARE Subwatershed Counts	A49
TABLE K.1 | Study Schedule (See Section 8 in WMP)	A51
TABLE K.2 | Study Parameters	A51
TABLE K.3 | Sensitivity Of In Field Equipment	A51
TABLE K.4 | Headwaters Mississinewa River	A52
TABLE K.5 | Massey Creek-Mississinewa River	A52
TABLE K.6 | IDEM Sample Sites For TMDL	A52
TABLE L.1 | Descriptive Statistics for Nitrate (mg/L) Data Collected at UMRW Sites	A53
TABLE L.2 | Nitrate Averages Separated by Flow Rate	A54
TABLE L.3 | Count of Exceedances1 for Nitrate	A56
TABLE L.4 | Counts and percentages of nitrate exceedances at high and low flows	A56
TABLE L.5 | Calculated Nitrate Loads: Current Load, Target Load, and Load Reduction Needed	A57
TABLE M.1 | Descriptive Statistics for Phosphorus (mg/L) Data Collected at UMRW Sites	A60
TABLE M.2 | Phosphorus Averages Separated by Flow Rate	A61
TABLE M.3 | Count of Exceedances1 for Phosphorus	A63
TABLE M.4 | Calculated Phosphorus Loads: Current Load, Target Load, and Load Reduction Needed	A64
TABLE N.1 | Descriptive Statistics for TSS Data (mg/L) Collected at UMRW Sites	A67
TABLE N.2 | TSS Averages Separated by Flow Rate	A68
TABLE N.3 | Count of Exceedances1 for TSS	A70
TABLE N.4 | Calculated TSS Loads: Current Load, Target Load, and Load Reduction Needed	A71
TABLE O.1 | Descriptive Statistics for E. Coli Data (cfu/100mL) Collected at UMRW Sites	A74
TABLE O.2 | E. coli Averages Separated by Flow Rate	A75
TABLE O.3 | Count of Exceedances1 for E. coli	A77
TABLE O.4 | Calculated E. coli Loads: Current Load, Target Load, and Load Reduction Needed	A78
TABLE P.1 | Count of Exceedances for Dissolved Oxygen (Separated by Flow)	A81
TABLE Q.1 | HBI scores and narratives (Macros only)	A82
TABLE Q.2 | Results From The Bureau Of Water Quality	A82
TABLE R.1 | TSS (sediment) loading data for Lugar Creek	A83
TABLE R.2 | BMPs, BMP efficiencies, rates of use, and resulting TSS load reductions for Lugar Creek	A83
TABLE R.3 | Nitrate loading data for Gray Branch	A84
TABLE R.4 | BMPs, rates of use, and resulting nitrate load reductions for Gray Branch	A84
TABLE R.5 | Nitrate loading data for Little Mississinewa River	A85
TABLE R.6 | BMPs, rates of use, and resulting nitrate load reductions for Little Mississinewa River	A85
TABLE R.7 | Nitrate loading data for Halfway Creek	A86
TABLE R.8 | BMPs, rates of use, and resulting nitrate load reductions for Halfway Creek	A86
TABLE R.9 | Phosphorus loading data for Halfway Creek	A87
TABLE R.10 | BMPs, BMP efficiencies, rates of use, and resulting phosphorus load reductions for Halfway Creek	A87
TABLE R.11 | Nitrate loading data for Pike Creek	A88
TABLE R.12 | BMPs, rates of use, and resulting nitrate load reductions for Pike Creek	A88
TABLE R.13 | TSS (sediment) loading data for Campbell Creek	A89
TABLE R.14 | BMPs, BMP efficiencies, rates of use, and resulting TSS load reductions for Campbell Creek	A89
TABLE R.15 | Nitrate loading data for Little Lick Creek	A90
TABLE R.16 | BMPs, rates of use, and resulting nitrate load reductions for Little Lick Creek	A90
TABLE R.17 | Phosphorus loading data for Little Lick Creek	A91
TABLE R.18 | BMPs, BMP efficiencies, rates of use, and resulting phosphorus load reductions for Little Lick Creek	A91

TABLE S.1 | TSS (sediment) loading data for Lugar Creek	A92
TABLE S.2 | BMPs, BMP efficiencies, rates of use, and resulting TSS load reductions for Lugar Creek	A92
TABLE S.3 | Nitrate loading data for Gray Branch	A93
TABLE S.4 | BMPs, rates of use, and resulting nitrate load reductions for Gray Branch	A93
TABLE S.5 | Nitrate loading data for Little Mississinewa River	A94
TABLE S.6 | BMPs, rates of use, and resulting nitrate load reductions for Little Mississinewa River	A94
TABLE S.7 | Nitrate loading data for Halfway Creek	A95
TABLE S.8 | BMPs, rates of use, and resulting nitrate load reductions for Halfway Creek	A95
TABLE S.9 | Phosphorus loading data for Halfway Creek	A96
TABLE S.10 | BMPs, BMP efficiencies, rates of use, and resulting phosphorus load reductions for Halfway Creek	A96
TABLE S.11 | Nitrate loading data for Pike Creek	A97
TABLE S.12 | BMPs, rates of use, and resulting nitrate load reductions for Pike Creek	A97
TABLE S.13 | TSS (sediment) loading data for Campbell Creek	A98
TABLE S.14 | BMPs, BMP efficiencies, rates of use, and resulting TSS load reductions for Campbell Creek	A98
TABLE S.15 | Nitrate loading data for Little Lick Creek	A99
TABLE S.16 | BMPs, rates of use, and resulting nitrate load reductions for Little Lick Creek	A99
TABLE S.17 | Phosphorus loading data for Little Lick Creek	A100
TABLE S.18 | BMPs, BMP efficiencies, rates of use, and resulting phosphorus load reductions for Little Lick Creek	A100
TABLE S.19 | Nitrate loading data for Deer Creek	A101
TABLE S.20 | BMPs, rates of use, and resulting nitrate load reductions for Deer Creek	A101
TABLE T.1 | Water Quality Results for Tributary Subwatersheds (average of all samples)	A102
TABLE T.2 | Comparison of Loading Data at Mississinewa River Sites and Subwatershed Sites	A102
TABLE T.3 | Rivers Mean1	A103
TABLE T.4 | Rivers Mean2	A103
TABLE T.5 | Mean Values for Various Water Quality Parameters	A104
TABLE T.6 | Water Quality Data for Fall Creek	A105
TABLE T.7 | Parameter	A105
TABLE T.8 | Load Reduction Cost-estimates (Appendix S)	A108
TABLE V.1 | SSO Overflows in Headwaters Mississinewa HUC 10 from 2014-2015	A111
TABLE V.2 | SSO Overflows in Massey Creek HUC 10 from 2014-2015	A112
TABLE V.3 | SSO Overflows in Big Lick Creek HUC 10 from 2014-2015	A113
TABLE V.4 | SSO Overflows in Halfway Creek HUC 10 from 2014-2015	A114
TABLE V.5 | SSO Overflows in Pike Creek HUC 10 from 2014-2015	A114

APPENDIX TABLE OF FIGURES

Contents	
FIG. A.1 | HUC 12 landowner response percentage.	A7
FIG. A.2 | Landowners response from mailing campaign.	A7
FIG. A.3 | Landowners targeted with mailing campaign.	A7
FIG. B.1 | D Soils	A8
FIG. B.2 | C Soils	A8
FIG. B.3 | Topography In 100 Foot Intervals	A8
FIG. B.4 | Hydric Soils	A8
FIG. B.5 | Drainage (Total Mi)	A10
FIG. B.6 | Sediment Transport Prediction	A10
FIG. B.7 | Bifurcation Ratio	A10

FIG. B.8 | Drainage Density	A10
FIG. B.9 | Stream Frequency	A10
FIG. B.10 | Relief Ratio	A10
FIG. C.1 | Cropland %	A11
FIG. C.2 | Urban %	A11
FIG. C.3 | Ecological %	A11
FIG. C.4 | CFO	A11
FIG. C.5 | Fertilizer and Pesticide Applications	A11
FIG. C.6 | Phosphorus Ton/Ac/Yr	A12
FIG. C.7 | Nitrogen Ton/Ac/Yr	A12
FIG. C.8 | Conventional Tillage Corn %	A12
FIG. C.9 | Conventional Tillage Soybean %	A12
FIG. C.10 | Conventional Tillage Corn Ac	A12
FIG. C.11 | Conventional Tillage Soybean Ac	A12
FIG. C.12 | Average Conventional Sediment Tons/Ac Year	A12
FIG. C.13 | 319 Sediment Study	A12
FIG C.14 | CFO Concentrations in Ohio	A13
FIG. D.1 | Population Density	A14
FIG. D.2 | ESRI Life Mode Groups	A14
FIG. D.3 | Population Growth	A14
FIG. D.5 | Unincorporated Areas	A14
FIG. D.6 | Marion Population	A16
FIG. D.8 | Housing Units	A17
FIG. D.9 | Incorporated Housing Units	A17
FIG. D.10 | Unincorporated Housing Units	A17
FIG. D.11 | % Incorporated	A17
FIG. D.12 | % Unincorporated	A17
FIG. D.13 | Wells	A17
FIG. D.14 | CSO	A17
FIG. D.15 | Estimated Septic Systems	A17
FIG. D.16 | Regulated Point Sources	A18
FIG. D.17 | Inst Control Landfill	A18
FIG. D.18 | Population Change	A18
FIG. D.19 | Population Density	A18
FIG. E.1 | Vehicular Track Sites	A19
FIG. E.2 | Vehicular Track Sites	A19
FIG. E.3 | Vehicular Storage Sites	A19
FIG. E.4 | Vehicular Storage Sites	A19
FIG. E.5 | Construction Storage	A20
FIG. E.6 | Construction Storage	A20
FIG. E.7 | Quarries	A20
FIG. E.8 | Quarry	A20
FIG. E.9 | Golf Courses	A20
FIG. E.10 | Golf Courses	A20
FIG. E.11 | Sports Facilities	A21
FIG. E.12 | Sports Facilities	A21
FIG. E.13 | Derelict Properties	A21

FIG. E.14 | Derelict Properties	A21
FIG. E.15 | Junk Storage Sites	A21
FIG. E.16 | Junk Storage Sites	A21
FIG. I.1 - I.6 | Storet Subwatershed Averaging	A43
FIG. I.7 - I.12 | Storet Ranking Diagrams	A45
FIG. J.1 - J.4 | LARE Rankings: All phase subwatersheds ranked per phase.	A47
FIG. J.5 - J.8 | LARE Rankings: All phase subwatersheds ranked collectively across phases.	A48
FIG. J.9 | E. coli (MR03 as 2000)	A48
FIG. J.10 | Turbidity (NTU)	A49
FIG. L.1 | Mainstem Subwatershed Averages for Nitrate	A55
FIG. L.2 | Tributary Subwatershed Averages for Nitrate	A55
FIG. L.3 | Monthly Nitrate Samples for samples classified as high flow events.	A58
FIG. L.4 | Drainage size vs. X times target load.	A58
FIG. L.5 | Drainage size vs. X times target load for Mainstem Subwatersheds at High Flow and Low Flow events.	A59
FIG. L.6 | Drainage size vs. X times target load for Tributary Subwatersheds at High Flow and Low Flow events.	A59
FIG. M.1 | Mainstem Subwatershed Averages for Phosphorus	A62
FIG. M.2 | Tributary Subwatershed Averages for Phosphorus	A62
FIG. M.3 | Monthly Phosphorus Samples for samples classified as high flow events.	A65
FIG. M.4 | Drainage size vs. X times target load.	A65
FIG. M.5 | Drainage size vs. X times target load for Mainstem Subwatersheds at High Flow and Low Flow events.	A66
FIG. M.6 | Drainage size vs. X times target load for Tributary Subwatersheds at High Flow and Low Flow events.	A66
FIG. N.1 | Mainstem Subwatershed Averages for TSS	A69
FIG. N.2 | Tributary Subwatershed Averages for TSS	A69
FIG. N.3 | Monthly TSS Samples for samples classified as high flow events.	A72
FIG. N.4 | Drainage size vs. X times target load.	A72
FIG. N.5 | Drainage size vs. X times target load for Mainstem Subwatersheds at High Flow and Low Flow events.	A73
FIG. N.6 Drainage size vs. X times target load for Tributary Subwatersheds at High Flow and Low Flow events.	A73
FIG. O.1 | Mainstem Subwatershed Averages for E. coli	A76
FIG. O.2 | Tributary Subwatershed Averages for E. coli	A76
FIG. O.3 | Monthly E. coli Samples for samples classified as high flow events.	A79
FIG. O.4 | Drainage size vs. X times target load.	A79
FIG. O.5 | Drainage size vs. X times target load for Mainstem Subwatersheds at High Flow and Low Flow events.	A80
FIG. O.6 | Drainage size vs. X times target load for Tributary Subwatersheds at High Flow and Low Flow events.	A80
FIG. Q.1 | HBI Qual	A82
FIG. T.1 | Subwatershed Drainage Areas	A103
FIG. T.2 | Population Decentralization in Eastern United States	A106
FIG. T.3 | Dead Zone	A106
FIG. T.4 | Sample On-farm Network Data	A107
FIG. T.4 | Sample On-farm Network Data	A105

APPENDIX TABLE OF MAPS

Contents	
MAP D.1 | Development of towns along major waterways and railways.	A15
MAP G.1 | Prioritization of the Mississinewa Watershed (IN)	A32
MAP H.1 | Idem Sampling Locations Extracted from the IDEM AIMS Database	A35
MAP H.2 | Recreational rivers in Indiana analyzed in conjunction with the Historic Water Quality discussion (Section 7)	A39
MAP H.3 | Ecoregions	A40
MAP H.4 | Suitable Soils for Drainage Water Management	A41
MAP I.1 | STORET MAINSTEM SITES	A42
MAP I.2 | STORET SUBWATERSHED SITES	A44
MAP J.1 | LARE Mississinewa mainstem sites	A50

A. PUBLIC INPUT

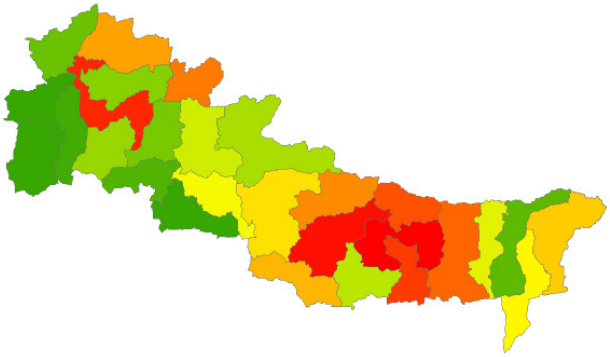


FIG. A.1 | HUC 12 landowner response percentage.
The color gradient follows the visible spectrum, moving from reds to oranges to yellows to greens. Highest values are represented by red and lowest values by green.

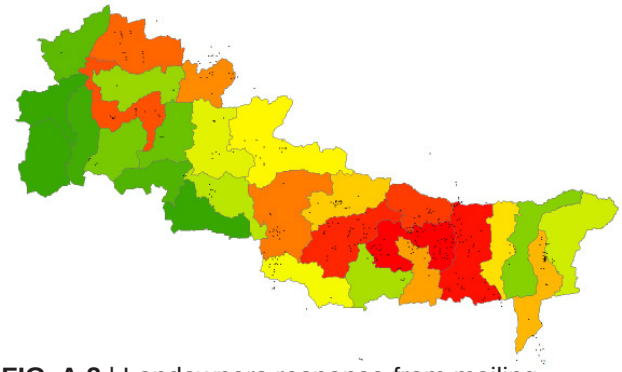


FIG. A.2 | Landowners response from mailing campaign.
The color gradient follows the visible spectrum, moving from reds to oranges to yellows to greens. Highest values are represented by red and lowest values by green. Dots indicate the properties of landowners who responded.

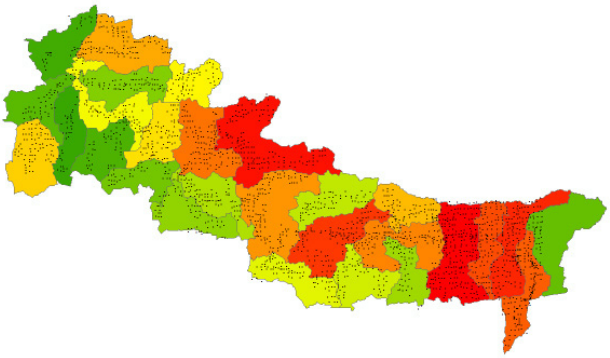


FIG. A.3 | Landowners targeted with mailing campaign.
The color gradient follows the visible spectrum, moving from reds to oranges to yellows to greens. Highest values are represented by red and lowest values by green. Dots indicate the properties of landowners who were targeted.

B. GEOLOGY & HYDROLOGY

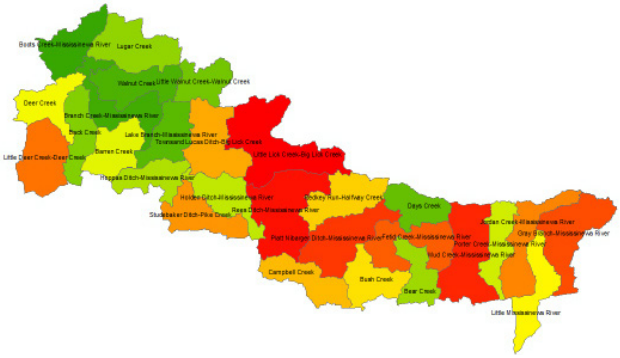


FIG. B.1 | D Soils
Subwatersheds are ranked on a gradient (red high and green low) based on the presence of D soil types. The highest percentage of poorly drained D soils are Blackford County and in the Tri-County Region.

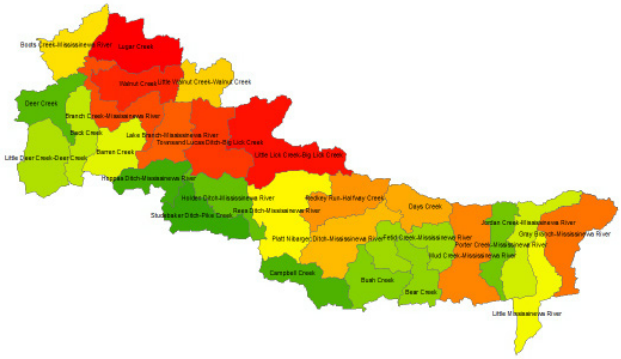


FIG. B.2 | C Soils
Subwatersheds are ranked on a gradient (red high and green low) based on the presence of C soil types. The highest percentage of moderately drained C soils are in the northwestern part of the watershed in Blackford and Grant County.

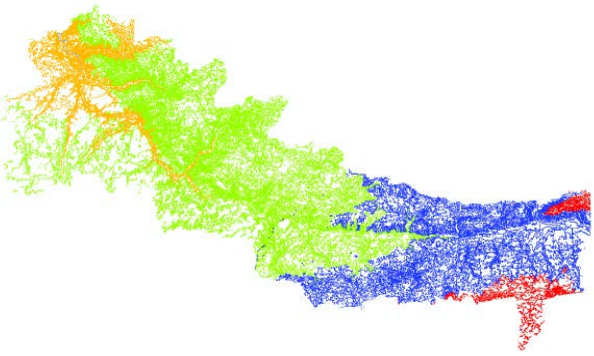


FIG. B.3 | Topography In 100 Foot Intervals
There is a 380 feet change in elevation over the course of the watershed. This change in elevation is represented in 100 foot intervals. The highest elevation is 1170 feet above sea level and lowest elevation is 790 feet above sea level.

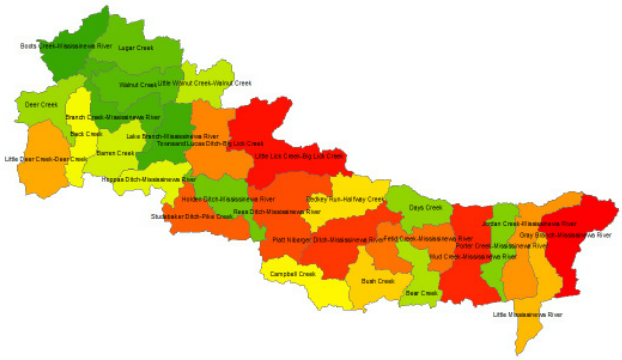


FIG. B.4 | Hydric Soils
Subwatersheds are ranked on a gradient (red high and green low) based on hydric soil percentage. Hydric soils are prevalent throughout the watershed region. Subwatersheds with limited grade have the highest concentration of hydric soils.

TABLE B.1 | Geomorphological Studies									
PARAMETERS	Rb	Dd	Fu	Rr	Rf	Rc	Re	RN	Rank (Dd, Fu,Rr)
Back Creek	2.1	9.7	80.2	7.8	0.3	0.4	1.2	970.9	14.0
Barren Creek	2.1	9.5	76.3	8.3	0.6	0.5	1.8	760.2	19.0
Bear Creek	2.1	9.3	81.6	12.4	0.4	0.3	1.4	1117.0	8.7
Boots Creek-Mississinewa River	1.9	9.7	80.3	22.8	2.4	0.4	3.6	1065.1	6.7
Branch Creek-Mississinewa River	2.0	9.3	75.5	8.5	0.2	0.1	1.1	1389.3	20.0
Bush Creek	2.0	9.1	80.0	16.2	0.8	0.4	2.1	1180.8	11.3
Campbell Creek	1.9	8.9	76.5	12.1	0.3	0.3	1.3	1392.5	16.3
Days Creek	1.9	10.1	83.0	14.0	1.1	0.4	2.2	910.1	3.0
Deer Creek	2.2	7.7	64.0	11.2	0.8	0.3	2.0	691.8	21.3
Fetid Creek-Mississinewa River	1.8	8.7	80.4	9.0	0.4	0.2	1.7	1038.3	16.0
Gray Branch-Mississinewa River	1.8	2.2	16.5	12.0	0.6	0.3	2.3	294.4	19.5
Holden Ditch-Mississinewa River	1.9	9.9	79.3	11.5	0.4	0.3	1.5	1290.4	10.7
Hoppas Ditch-Mississinewa River	2.1	9.8	79.4	14.0	1.0	0.3	2.1	879.9	9.0
Jordan Creek-Mississinewa River	2.0	8.2	71.1	17.4	1.0	0.2	2.6	1153.0	16.3
Lake Branch-Mississinewa River	2.2	9.4	80.5	24.9	2.2	0.4	3.3	1133.9	7.0
Little Deer Creek-Deer Creek	2.1	7.7	64.0	3.6	0.5	0.6	1.9	306.9	26.3
Little Lick Creek-Big Lick Creek	1.9	7.2	79.2	10.5	1.1	0.2	3.7	787.3	21.0
Little Mississinewa River	2.0	9.6	78.1	9.6	0.2	0.3	1.0	1626.7	16.0
Little Walnut Creek-Walnut Creek	2.2	9.6	81.9	8.7	0.7	0.4	1.7	674.5	10.7
Lugar Creek	1.9	8.4	80.5	10.9	0.5	0.4	1.9	1169.3	14.7
Mud Creek-Mississinewa River	2.0	7.6	79.9	16.6	1.0	0.4	3.0	1217.5	14.7
Platt Nibarger Ditch-Mississinewa River	2.0	7.9	81.4	8.6	0.7	0.3	2.4	712.5	16.7
Porter Creek-Mississinewa River	1.9	9.7	81.9	36.2	3.0	0.3	3.7	1357.2	3.0
Redkey Run-Halfway Creek	2.0	9.2	81.0	7.8	0.4	0.4	1.6	922.5	15.3
Rees Ditch-Mississinewa River	2.1	7.3	77.3	11.4	1.1	0.3	3.4	801.0	20.3
Studebaker Ditch-Pike Creek	2.0	9.6	78.4	7.5	0.4	0.3	1.5	862.4	18.0
Townsand Lucas Ditch-Big Lick Creek	2.0	7.9	79.6	10.7	0.6	0.4	2.2	952.6	17.7
Walnut Creek	1.9	9.0	82.3	11.7	0.4	0.3	1.5	1350.5	10.0

Bifurcation ratio (Rb) is the ratio of the number of stream segments of one order to the number of segments of the next higher order.[1]
Drainage density (Dd) is an areal morphometric relationship of the total length of streams per unit area.[2]
Stream frequency (Fu) is the total number of stream channels per unit area.[3]
Relief Ratio (Rr) measures the overall steepness of the watershed (Shumn, 1956).[4]
Form factor (Rf) is the ratio between the watershed area and the squared watershed length.
Circulatory Ratio (Rc) is the ratio between the area of the watershed and the area of the circle of the same perimeter as that of the watershed.[5]
Elongation Ratio (Re) is the ratio between the maximum length of the watershed and the diameter of the circle having the same area as that of the watershed.[6]

REGIONAL CHARACTERIZATION
Geomorphological rankings (Table B.1) correlate to observed topographical differences (based on 100 foot intervals, FIG B.3). Collectively, these studies have justified the categorization of the UMRW into five zones: Eastern Uplands, Tri-County Flatlands, Big Lick Creek, Grant County FlatLands, and the Northwestern Mississinewa River Moraine Valley. However, these categorizations are very similar to the HUC10 boundary delineations. Thefore, the HUC 10 delineations will be used as a basis of discussion in the subwatershed section and discussed in the final conclusions and recommendations.

1 Schumn, S.A. (1956). The evolution of drainage systems and slopes in bad lands at Perth, Amboi, New Jersey. Geol. Soc. Ame. Bull. 67 (5), pp. 597-646.
2 Horton RE (1932) Drainage basin characteristics. Trans Am Geophys Union 13:350–361
3 Ibid.
4 Schumn, S.A. (1956). The evolution of drainage systems and slopes in bad lands at Perth, Amboi, New Jersey. Geol. Soc. Ame. Bull. 67 (5), pp. 597-646.
5 Ibid.
6 Ibid.

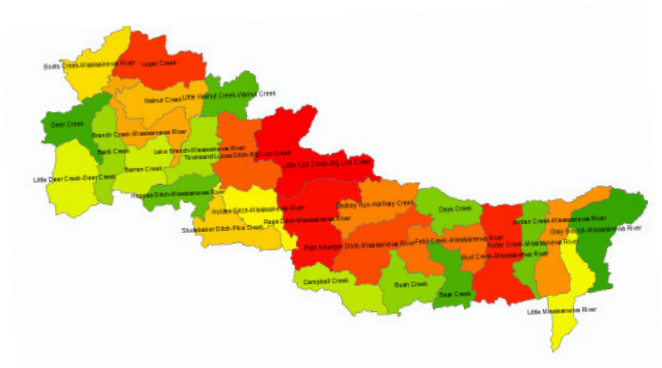


FIG. B.5 | Drainage (Total Mi)
Subwatersheds are ranked on a gradient (red high and green low) based on the presence of surficial drainage networks. The highest concentration of streams per Subwatershed are in Northern Grant County, Balckford County, and the Tri-county Region.

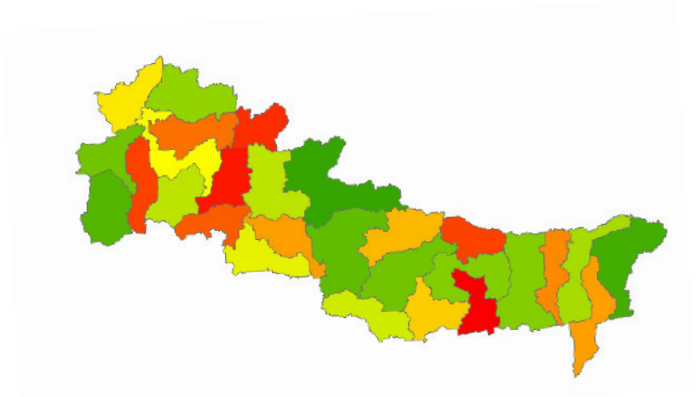


FIG. B.6 | Sediment Transport Prediction
Rankings for drainage density (Dd) stream frequency (Fu) and relief ratio (Rr) were averaged and subsequently ranked to prioritize subwatersheds with the greatest sediment transport potential (red high and green low).

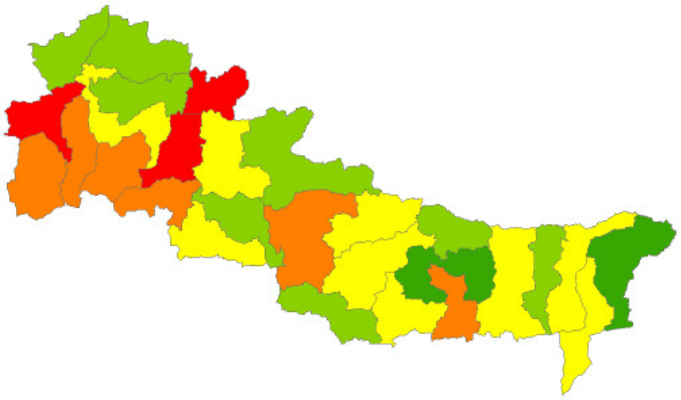


FIG. B.7 | Bifurcation Ratio
Subwatersheds are ranked on a gradient (red high and green low) based on the the ratio of the number of stream segments of one order to the number of segments of the next higher order. Definition of bifurcation ration taken from Ritter et al., 2011.

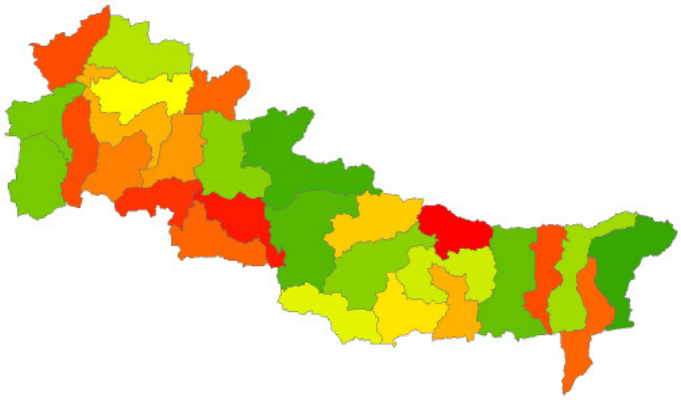


FIG. B.8 | Drainage Density
Subwatersheds are ranked on a gradient (red high and green low) based on the areal morphometric relationship of the total length of streams per unit area. Definition of drainage density taken from Ritter et al., 2011.

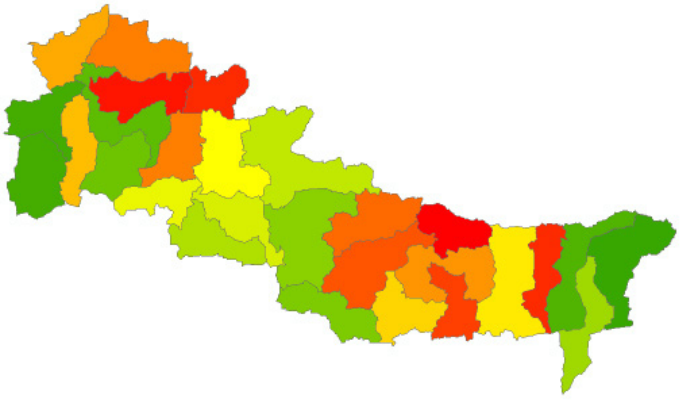


FIG. B.9 | Stream Frequency
Subwatersheds are ranked on a gradient (red high and green low) based on the total number of stream channels per unit area. Definition of stream frequency taken from Prasad, 2007.

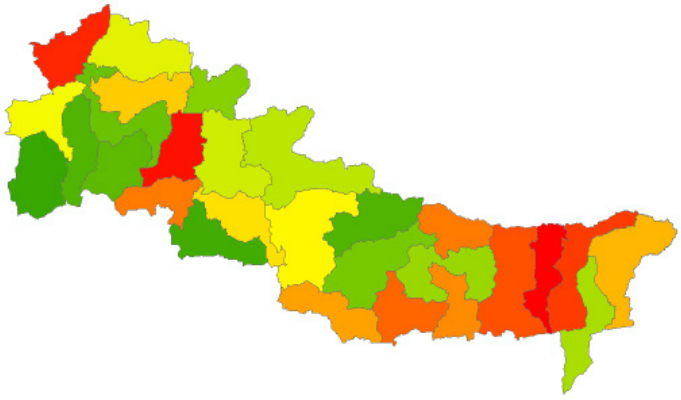


FIG. B.10 | Relief Ratio
Subwatersheds are ranked on a gradient (red high and green low) based on the measure of the overall steepness of the watershed. Definition of drainage density taken from Ritter et al., 2011.

C. LAND USE

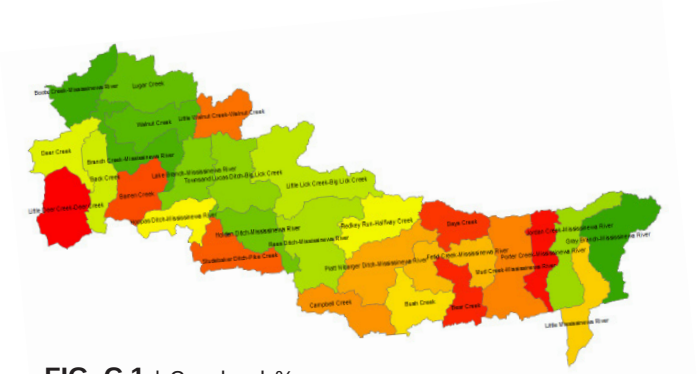


FIG. C.1 | Cropland %
Subwatersheds are ranked on a gradient (red high and green low) based on percentage of cropland. Subwatersheds with the highest percentage of crop land are Randolph and Jay Counties and in portion of southern Grant County.

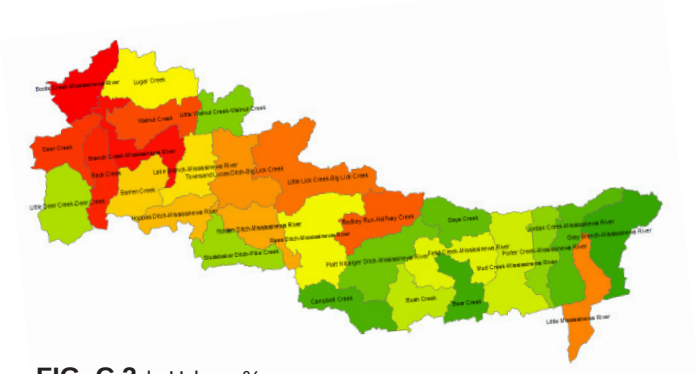


FIG. C.2 | Urban %
Subwatersheds are ranked on a gradient (red high and green low) based on percent Urbanized. The highest urban landuse is identified in Grant County Blackford County with elevated levels near Albany, Eaton, Desoto, Red Key. Little Mississinewa Subwatershed also has a high percentage of Urbanized lands.

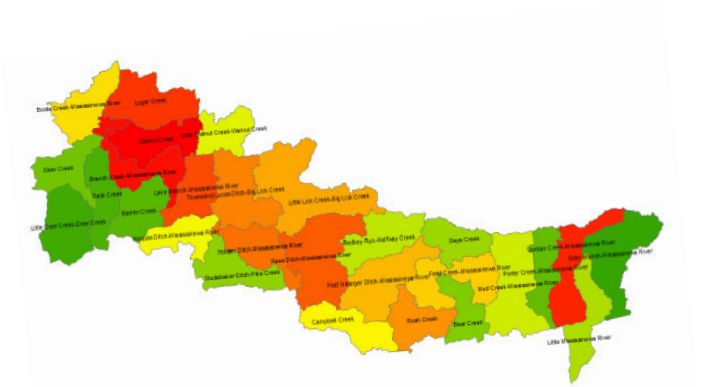


FIG. C.3 | Ecological %
Subwatersheds are ranked on a gradient (red high and green low) based on percent ecological. The highest concentration of ecological lands are in Grant County east of Marion. These lands are on poorly drained soils.

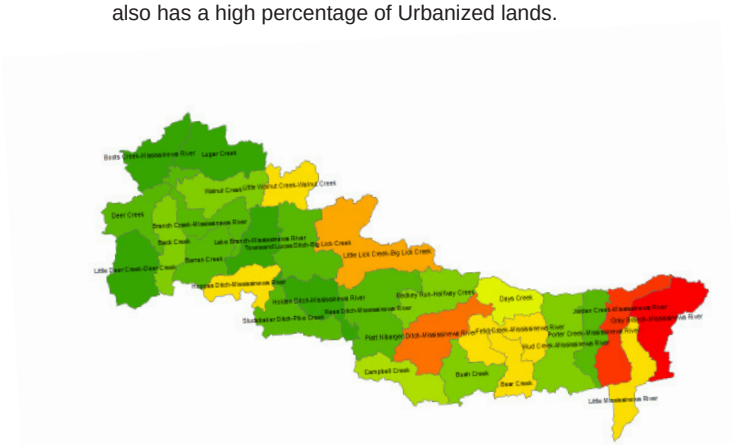


FIG. C.4 | CFO
Subwatersheds are ranked on a gradient (red high and green low) based on presence of CFOs. The highest percentage of CFOs are in Darke County.

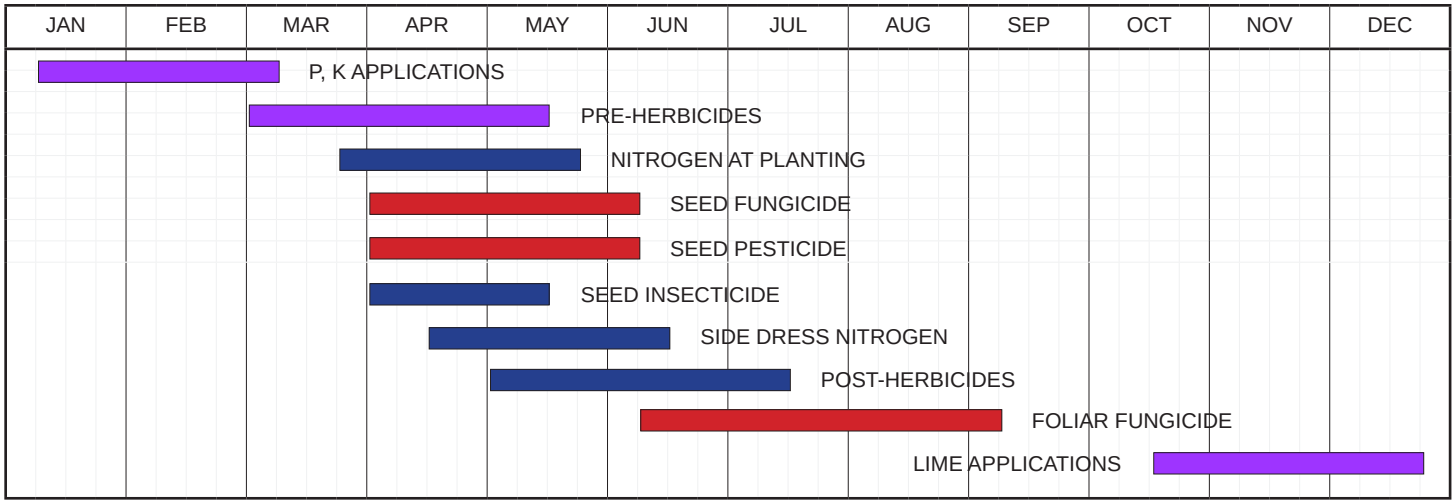


FIG. C.5 | Fertilizer and Pesticide Applications
Timing of field application for various agricultural fertilizers and pesticides. Bars indicate typical time frame in which product is applied.

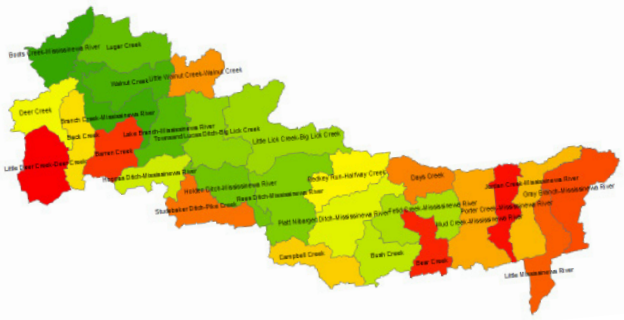


FIG. C.6 | Phosphorus Ton/Ac/Yr
Subwatersheds are ranked on a gradient (red high and green low) based on estimated Phosphorus discharge. Estimate is derived from acres of cropland.

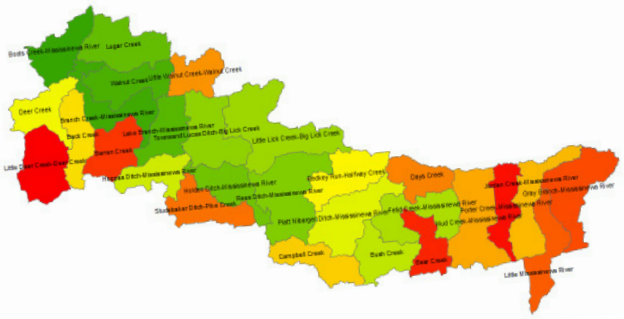


FIG. C.7 | Nitrogen Ton/Ac/Yr
Subwatersheds are ranked on a gradient (red high and green low) based on estimated Phosphorus discharge. Estimate is derived from acres of cropland.

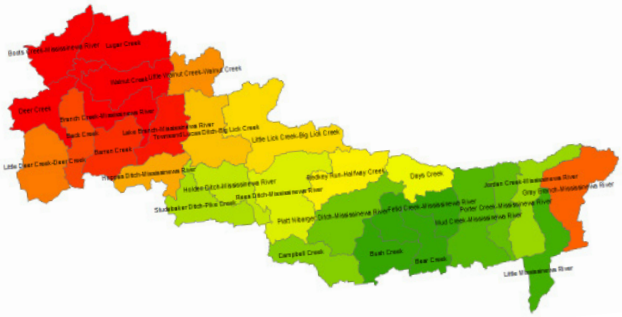


FIG. C.8 | Conventional Tillage Corn %
Subwatersheds are ranked on a gradient (red high and green low) based on conventional corn tillage percentage. State transect data for each county was averaged based on the percentage in each county.

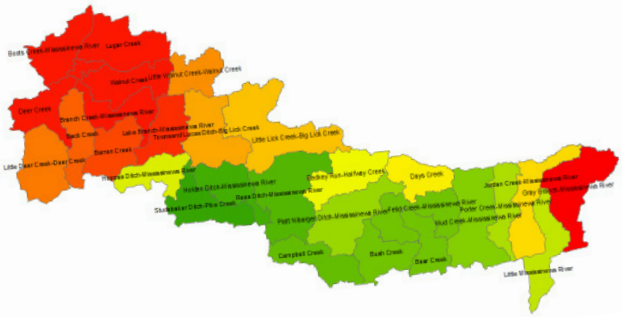


FIG. C.9 | Conventional Tillage Soybean %
Subwatersheds are ranked on a gradient (red high and green low) based on conventional soy tillage percentage. State transect data for each county was averaged based on the percentage in each county.

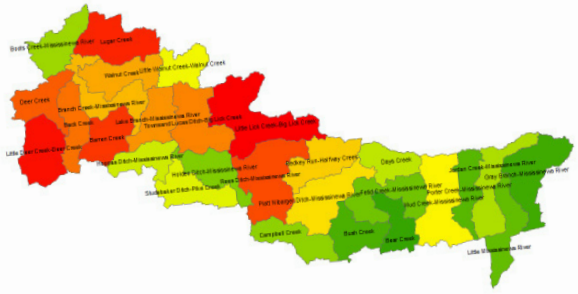


FIG. C.10 | Conventional Tillage Corn Ac
Subwatersheds are ranked on a gradient (red high and green low) based on conventional corn acreage. Subwatershed conventional tillage averages were assigned to acres of agricultural land use.

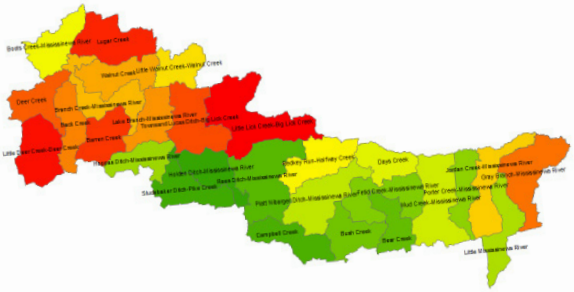


FIG. C.11 | Conventional Tillage Soybean Ac
Subwatersheds are ranked on a gradient (red high and green low) based on conventional soy acreage. Subwatershed conventional tillage averages were assigned to acres of agricultural land use.

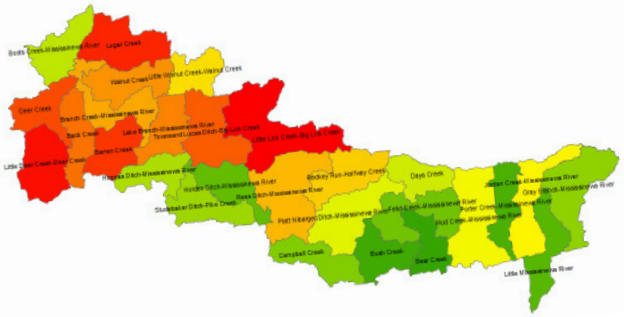


FIG. C.12 | Average Conventional Sediment Tons/Ac Year
Subwatersheds are ranked on a gradient (red high and green low) based on estimated sediment discharge from the conventionally tilled farm fields.

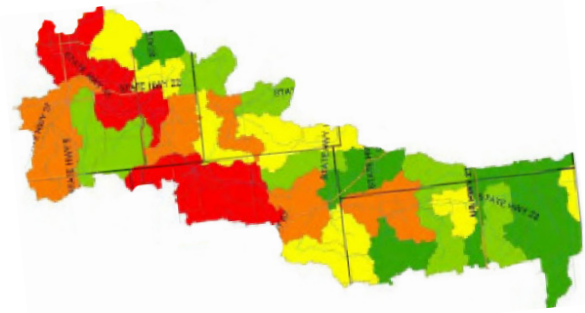


FIG. C.13 | 319 Sediment Study
A Taylor 319 study estimates sediment discharge higher in Grant County and also includes Hoppas, Studebaker, and Holden Ditch. This model also includes streambank erosion as a source increasing the relative rankings of these Subwatersheds (Buck Creek study).

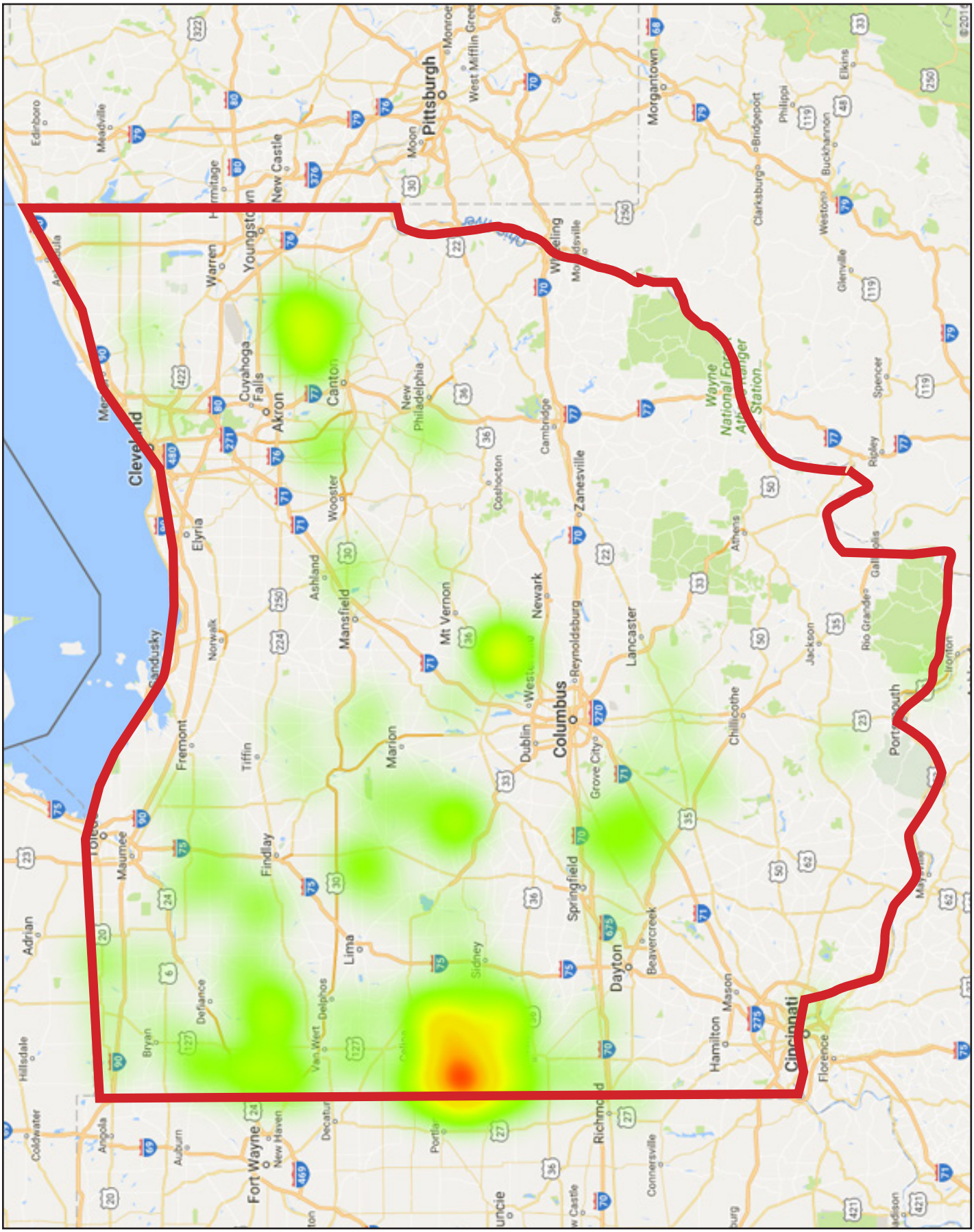


FIG C.14 | CFO Concentrations in Ohio

Heat density map representing CFO density in Ohio and bordering states. The color gradient follows the visible spectrum, moving from reds to oranges to yellows to greens. Highest values are represented by red and lowest values by green.

D. DEMOGRAPHICS

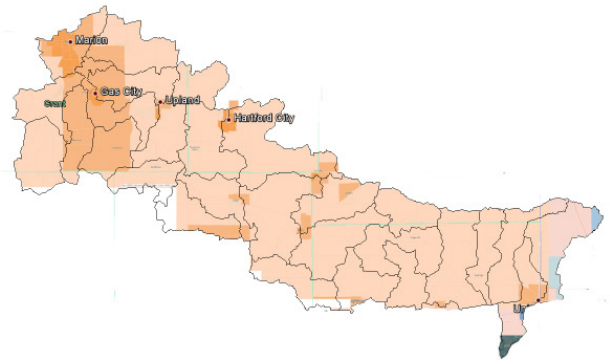


FIG. D.1 | Population Density
Population density map based on census Tracts. Darker colors show higher density. Further demographic discussion is found on page 60 of the WMP.

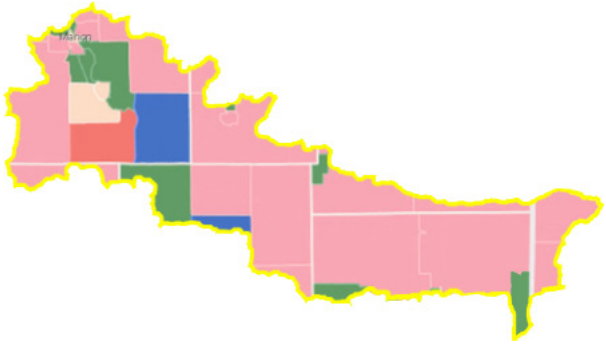


FIG. D.2 | ESRI Life Mode Groups
Table D.1 on the following page describes the life mode group represented by each color.

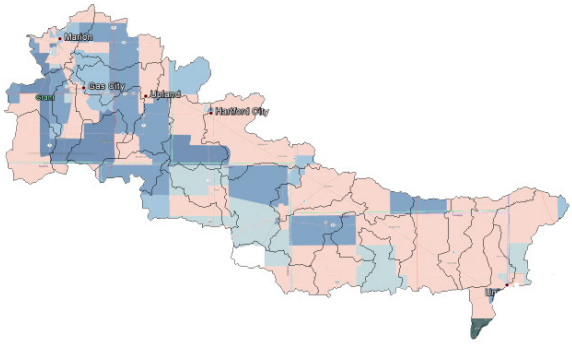


FIG. D.3 | Population Growth
Blue census tracts represent ares of growth within the watershed while beige colors represent zero growth or decline.

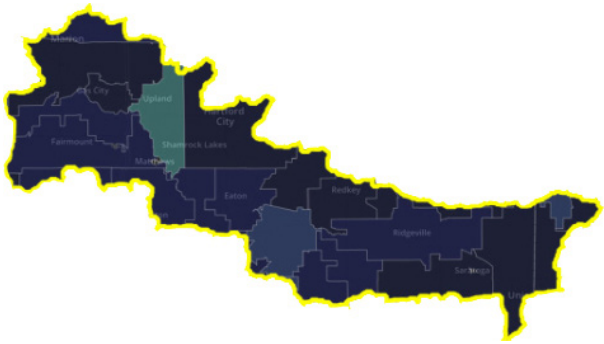


FIG. D.4 | ZIP Code Ranking
Lighter colored Zip Code areas have higher median household incomes. The Upland area zip code has the highest median income within the Upper Missis-sinewa River Watershed.

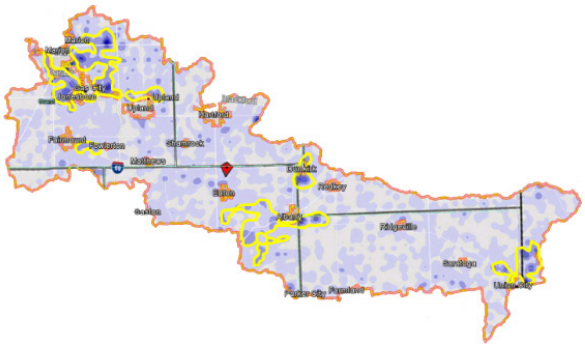
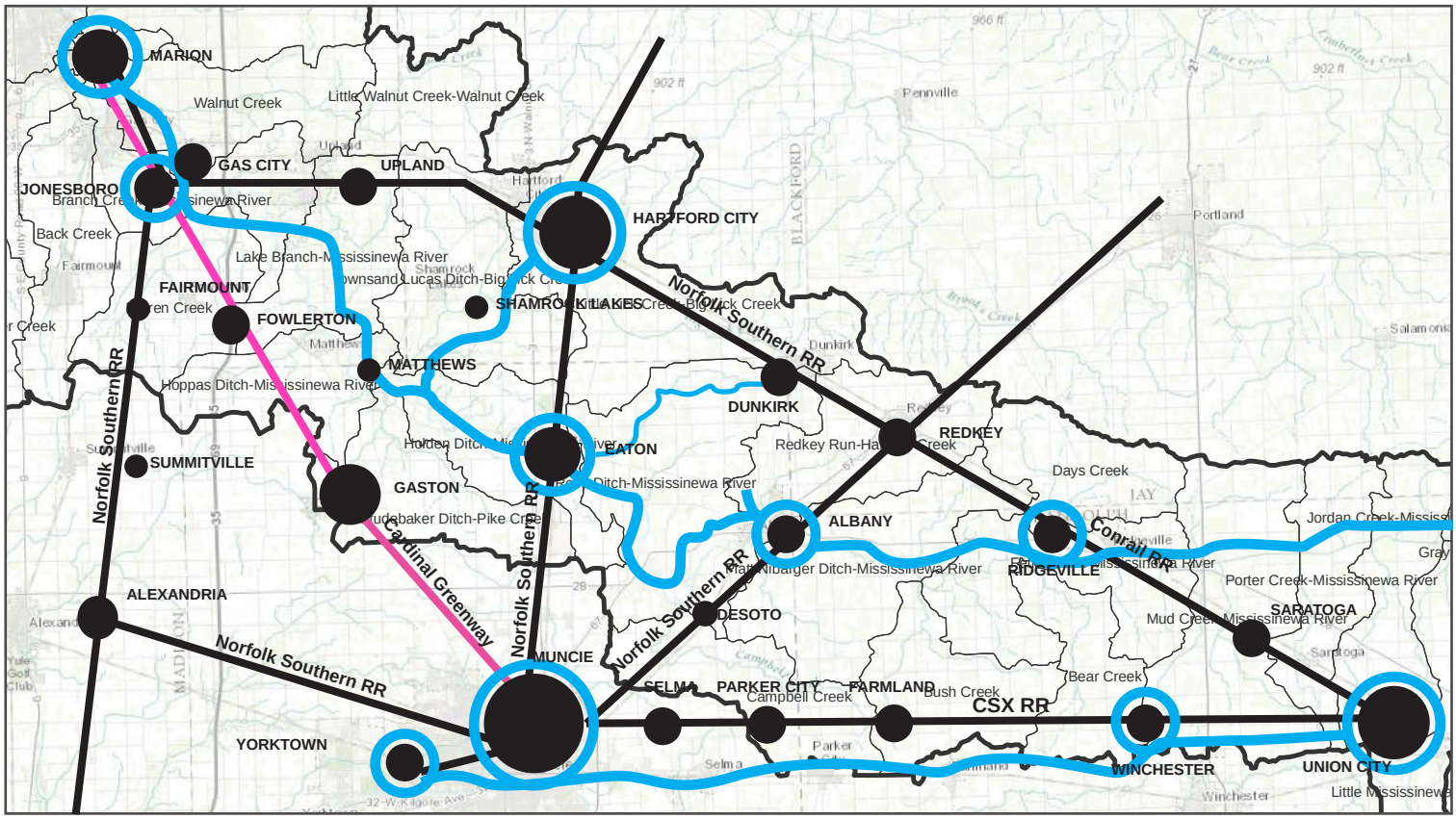


FIG. D.5 | Unincorporated Areas
Yellowed outlines high concentrations of homes in non-incorporated areas. There is high home density outside of Marion and outside of Albany.



MAP D.1 | Development of towns along major waterways and railways.

TABLE D.1 | ESRI LifeMode Groups

LifeMode Group	L11 Factories and Farms	L10 Traditional Living	L12 American Quilt	L2 Upscale Avenues	L5 Senior Styles
Names	Southern Satellites, Salt of the Earth, Home Town	Rustbelt Traditions	Rooted Rural	Gren Acres (Blue)	Simple Living, Rustbelt Retirees, Prosperous Empty Nesters, Heartland Communities
Household Type	Married-Couple Families, Mixed	Mixed	Married-Couple Families	Married-Couple Families	MC w/No Kids; Singles, Mixed
Median Age	40	36.2	44.4	42.8	43.7
Income	Lower Middle, Middle	Middle	Lower Middle	Upper Middle	Lower Middle, Middle, Upper Middle
Employment	Skilled/Prof/Mgmt/Services	Skilled/Prof/Mgmt/Srvc	Skilled/Prof/Mgmt/Srvc	Prof/Mgmt/Skilled	Prof/Mgmt/Skilled/Srvc
Education	No HS Diploma; HS Grad, Some College	HS Grad; Some College	No HS Diploma; HS Grad	Some College	No HS Diploma; HS Grad, Some College, Bach/Grad
Residential	Single Family; Mobile Home	Single Family	Single Family; Mobile Home	Single Family	Multiunits; Single Family
Race/Ethnicity	White	White	White	White	White
Activity	Shop at Wal-Mart, Gardening, outdoor projects, Play football, go fishing	Buy children's and baby products	Own dog(s)	Do gardening, wood-working	Go fishing, do furniture refinishing, Play bingo, Attend golf tournament, Work on lawn, garden, DIY projects
Financial	Use full-service bank, Own CD longer than 6 months, Have personal education loan	Use credit union	Use full-service bank	Have home equity credit line	Own annuities, Own CD longer than 6 months, Own shares in mutual fund (bonds)
Activity	Do gardening, go hunting, target shooting, Attend country music shows	Do painting, drawing	Go hunting, fishing, horseback riding	Attend country music shows	Order from QVC, Belong to fraternal orders, unions, etc., Refinish furniture, Order products from Avon
Media	Listen to country music, Watch CMT, Watch syndicated TV	Watch cable TV	Watch rodeos, tractor pulls on TV	Watch auto racing on TV	Watch syndicated TV, Watch news shows on TV, Read newspapers, Watch cable TV
VehicleSegment	Own/Lease truck, Own motorcycle, Own/ Lease domestic vehicle	Own/Lease domestic vehicle	Own an ATV/UTV	Drive 20,000+ miles annually	Own/Lease domestic vehicle, Own/Lease Pontiac, Own/Lease Buick

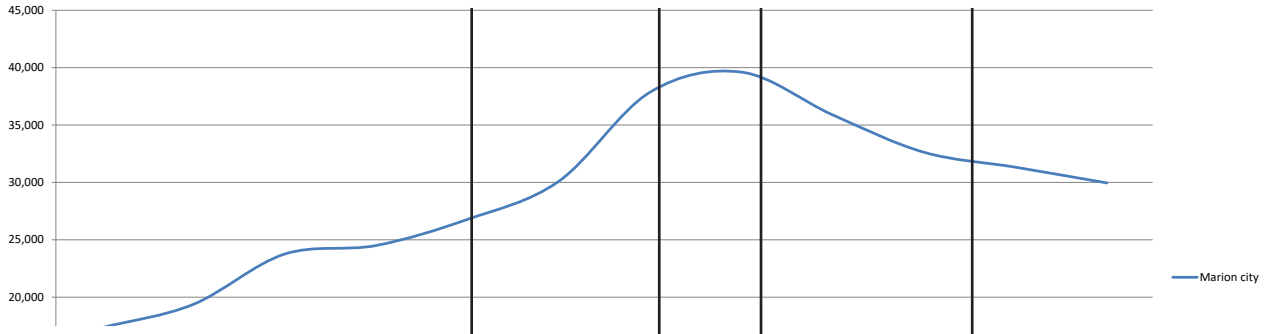


FIG. D.6 | Marion Population

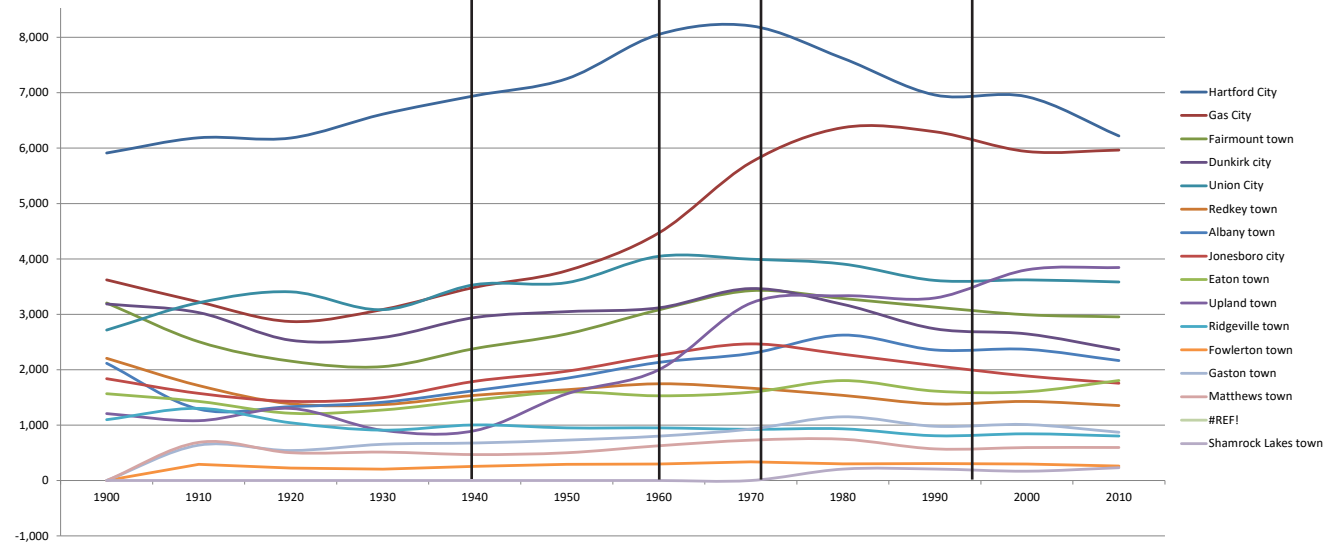


FIG. D.7 | Watershed Population

TABLE D.2 | Major Cities In Watershed Area

City	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
Early Towns												
Marion City	17,337	19,359	23,747	24,496	26,767	30,081	37,854	39,607	35,874	32,618	31,320	29,948
Hartford City	5,912	6,187	6,183	6,613	6,946	7,253	8,053	8,207	7,622	6,960	6,928	6,220
Gas City (Harrisburg)	3,622	3,224	2,870	3,087	3,488	3,787	4,469	5,742	6,370	6,296	5,940	5,965
Upland town	1,208	1,080	1,301	906	900	1,565	1,999	3,202	3,335	3,295	3,803	3,845
Agricultural Towns												
Fairmount town	3,205	2,506	2,155	2,056	2,382	2,646	3,080	3,427	3,286	3,130	2,992	2,954
Dunkirk city	3,187	3,031	2,532	2,583	2,942	3,048	3,117	3,465	3,180	2,739	2,646	2,362
Union City	2,716	3,209	3,406	3,084	3,535	3,572	4,047	3,995	3,908	3,612	3,622	3,584
Redkey town	2,206	1,714	1,386	1,370	1,538	1,639	1,746	1,667	1,537	1,383	1,427	1,353
Albany town	2,116	1,289	1,333	1,413	1,623	1,846	2,132	2,293	2,625	2,357	2,368	2,165
Jonesboro city	1,838	1,573	1,429	1,496	1,791	1,973	2,260	2,466	2,279	2,073	1,887	1,756
Eaton town	1,567	1,428	1,214	1,273	1,453	1,598	1,529	1,594	1,804	1,614	1,603	1,805
Ridgeville town	1,098	1,302	1,042	909	1,003	950	950	924	933	808	843	803
Train Towns												
Fowlerton town	0	293	225	204	255	292	297	337	300	306	298	261
Gaston town	0	638	541	654	677	729	801	928	1,150	979	1,010	871
Matthews town	0	688	502	513	468	501	627	728	745	571	595	596
Shamrock Lakes town	0	0	0	0	0	0	0	0	206	207	168	231

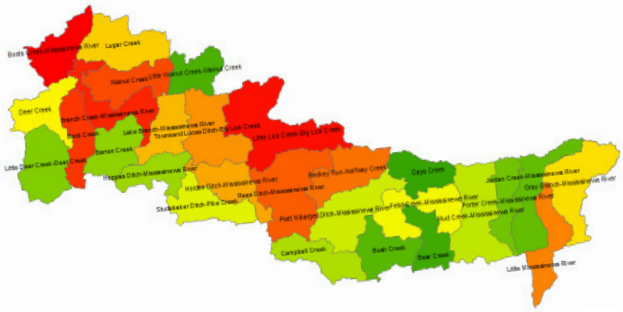


FIG. D.8 | Housing Units
Subwatersheds are ranked on a gradient (red high and green low) based on housing units.

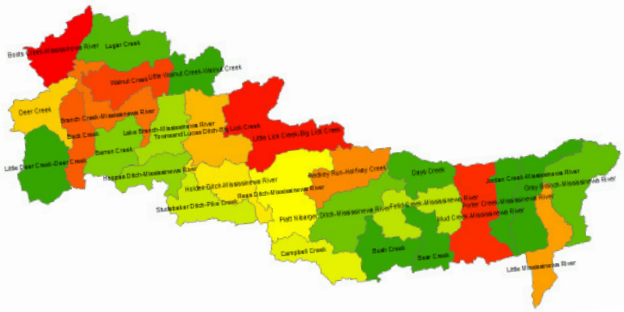


FIG. D.9 | Incorporated Housing Units
Subwatersheds are ranked on a gradient (red high and green low) based on acres of incorporated area.

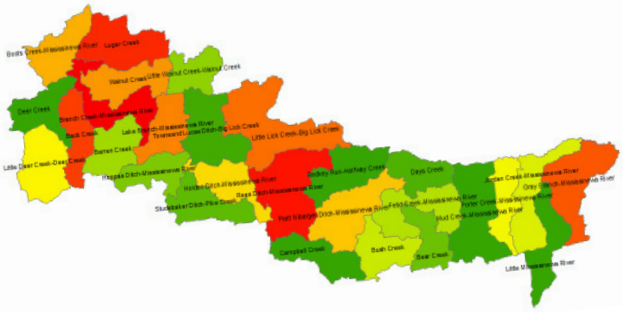


FIG. D.10 | Unincorporated Housing Units
Subwatersheds are ranked on a gradient (red high and green low) based on unincorporated housing units. High concentration in the west Albany area.

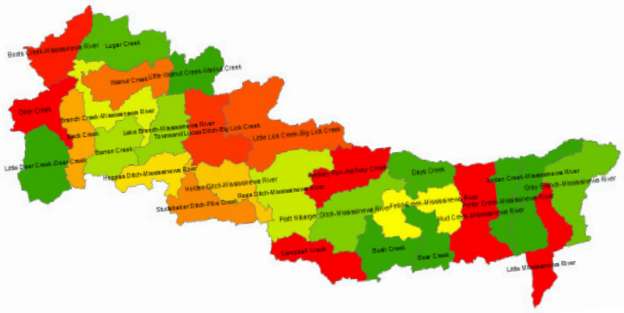


FIG. D.11 | % Incorporated
Subwatersheds are ranked on a gradient (red high and green low) based on % incorporated acres. Something is wrong here.

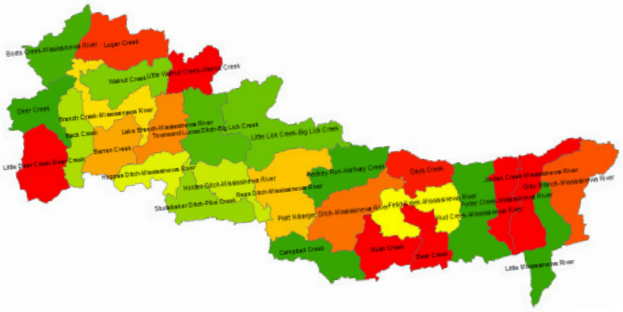


FIG. D.12 | % Unincorporated
Subwatersheds are ranked on a gradient (red high and green low) based on % incorporated acres. Something is wrong here.

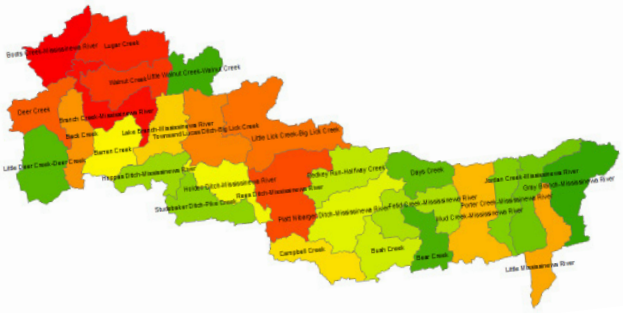


FIG. D.13 | Wells
Subwatersheds are ranked on a gradient (red high and green low) based on number of wells. Map ties to population density and household units.

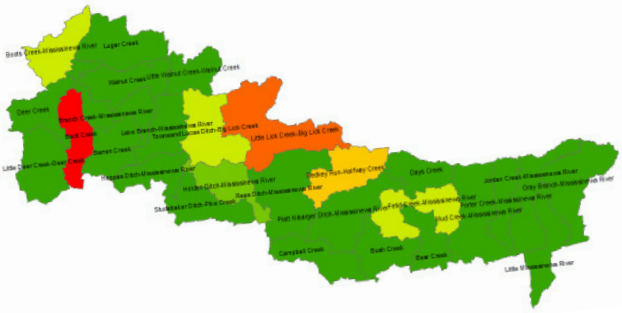


FIG. D.14 | CSO
Subwatersheds are ranked on a gradient (red high and green low) based on the number of CSO present.

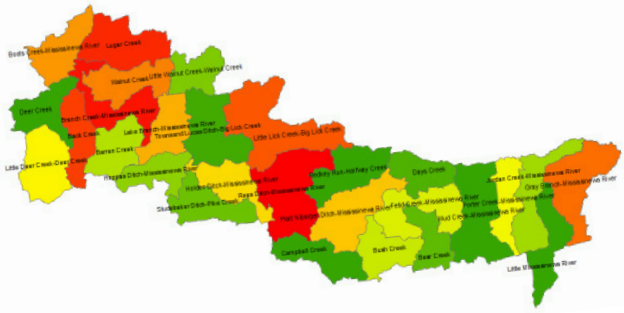


FIG. D.15 | Estimated Septic Systems
Subwatersheds are ranked on a gradient (red high and green low) based on estimated amount of septic systems. Derived from unincorporated housing units per subwatershed.

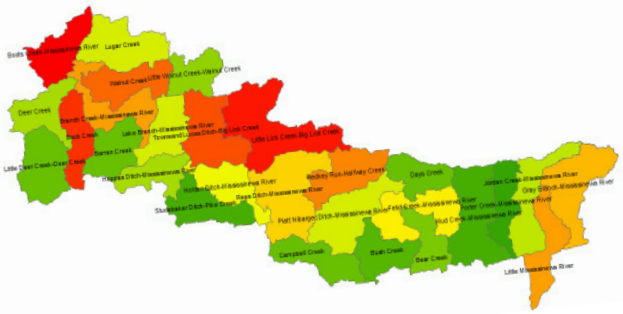


FIG. D.16 | Regulated Point Sources
Subwatersheds are ranked on a gradient (red high and green low) based on presence of Regulated Point Sources. The highest amount of point sources are in Hartford City and Marion.

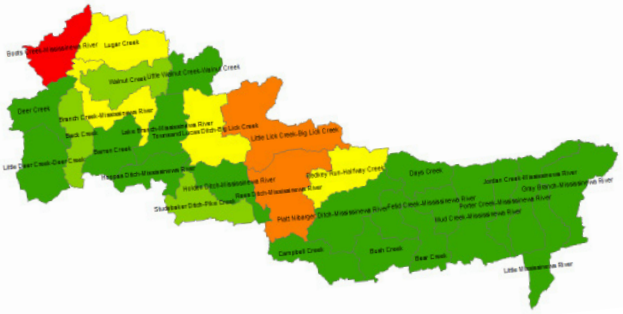


FIG. D.17 | Inst Control Landfill
Subwatersheds are ranked on a gradient (red high and green low) based on landfills and industrial controls. The highest concentrations are in Grant and Blackford Counties.

FIG. D.18 | Population Change
Subwatersheds are ranked on a gradient (red high and green low) based on acres of land with population increase. Areas that are seeing the highest population change are suburban areas around Albany and Upland.

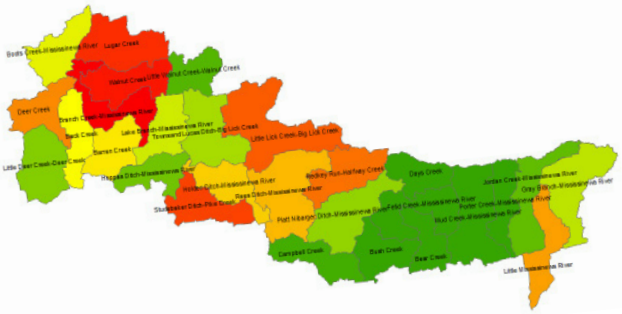


FIG. D.19 | Population Density
Subwatersheds are ranked on a gradient (red high and green low) based on acres of land with existing elevated population density. Subwatersheds northeast of Marion are ranked highest while unincorporated areas near Hartford City, Albany, Desoto, Eaton, and Redkey also have elevated levels.

E. DESKTOP SURVEY

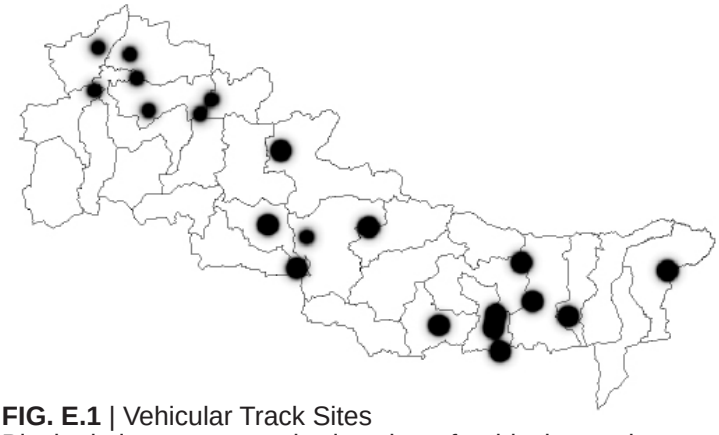


FIG. E.1 | Vehicular Track Sites
Black circles represent the location of vehicular track sites.

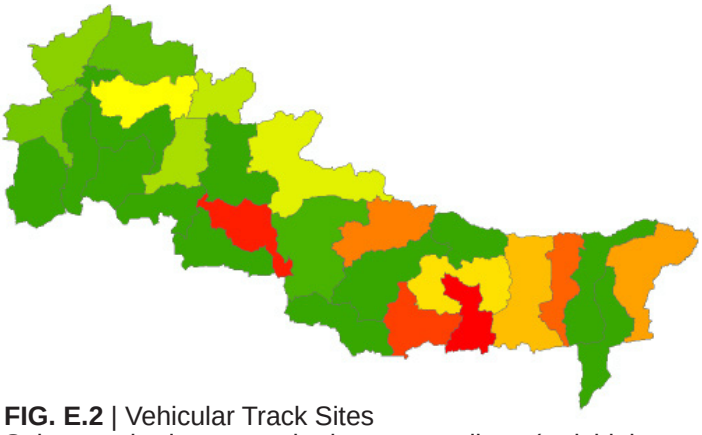


FIG. E.2 | Vehicular Track Sites
Subwatersheds are ranked on a gradient (red high and green low) based on the number of vehicular track sites identified.

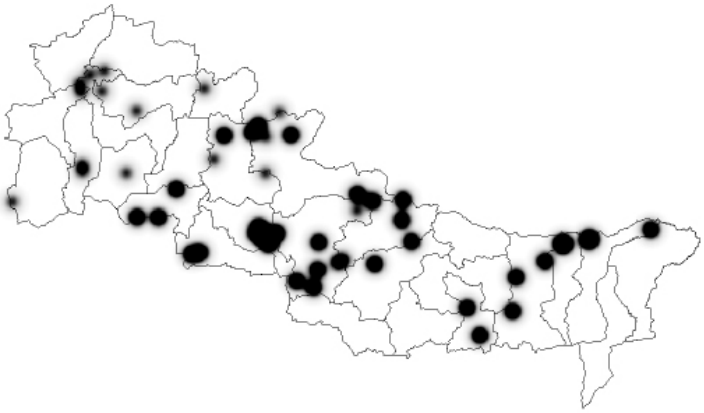


FIG. E.3 | Vehicular Storage Sites
Black circles represent the location of vehicular storage sites.

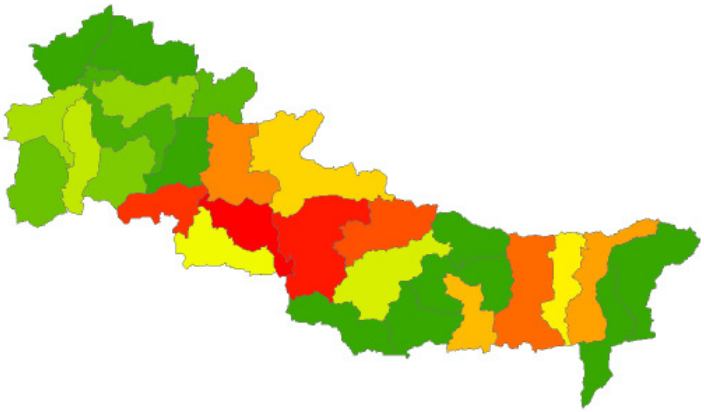


FIG. E.4 | Vehicular Storage Sites
Subwatersheds are ranked on a gradient (red high and green low) based on the number of vehicular storage sites identified.

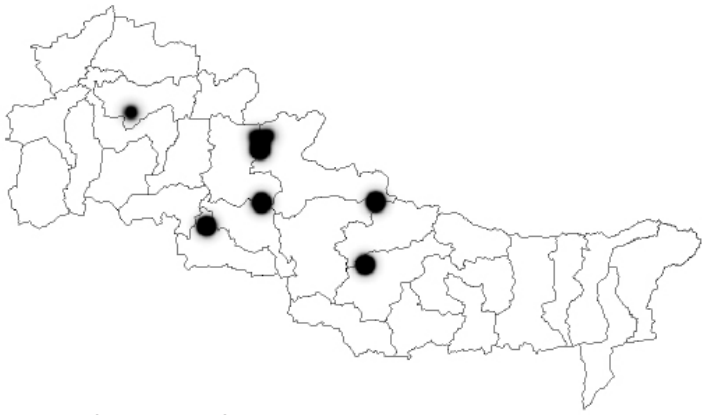


FIG. E.5 | Construction Storage
Black circles represent the location of construction storage sites.

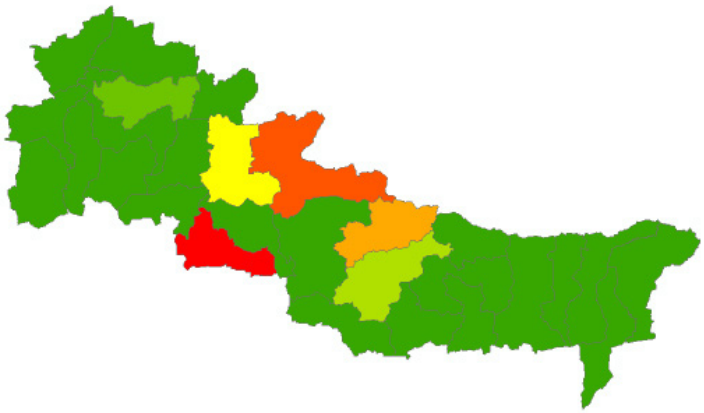


FIG. E.6 | Construction Storage
Subwatersheds are ranked on a gradient (red high and green low) based on the number of construction storage sites identified.

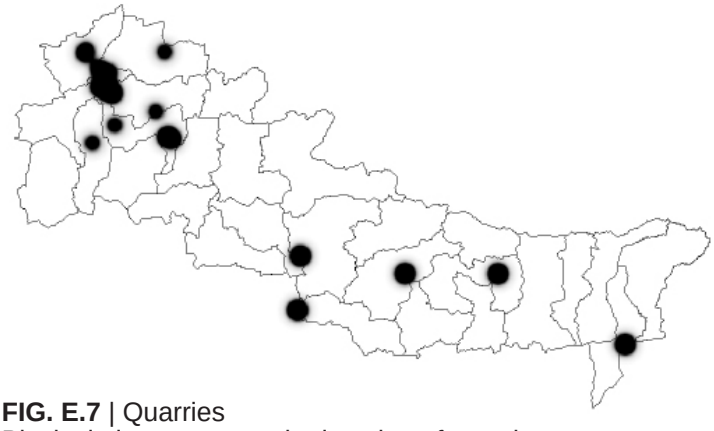


FIG. E.7 | Quarries
Black circles represent the location of quarries.

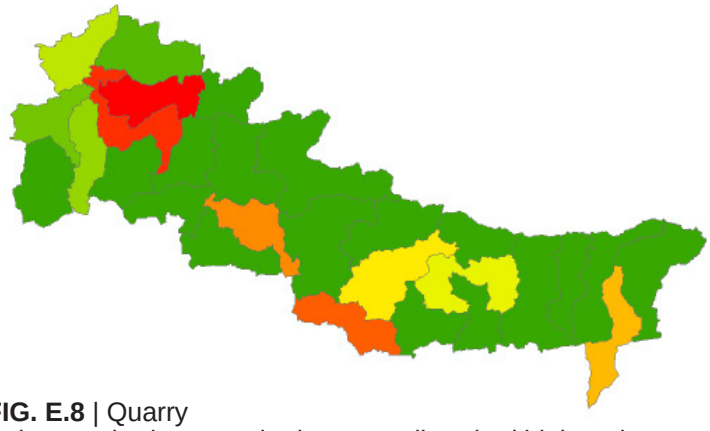


FIG. E.8 | Quarry
Subwatersheds are ranked on a gradient (red high and green low) based on the number of quarries identified.

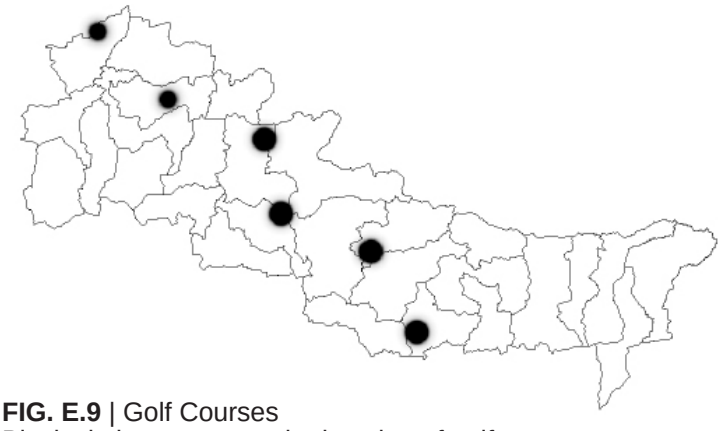


FIG. E.9 | Golf Courses
Black circles represent the location of golf courses.

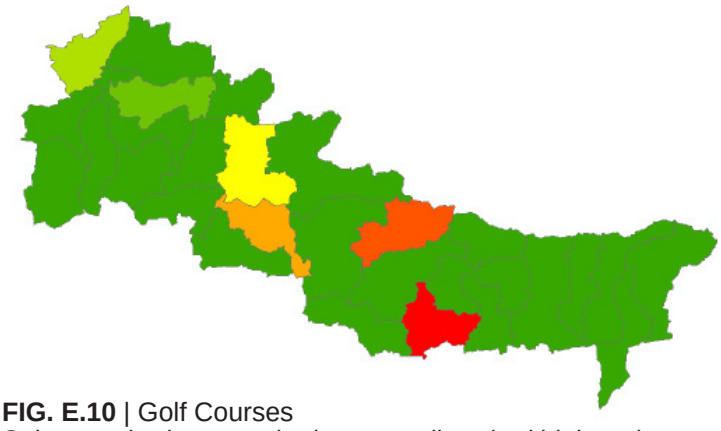


FIG. E.10 | Golf Courses
Subwatersheds are ranked on a gradient (red high and green low) based on the number of golf courses identified.

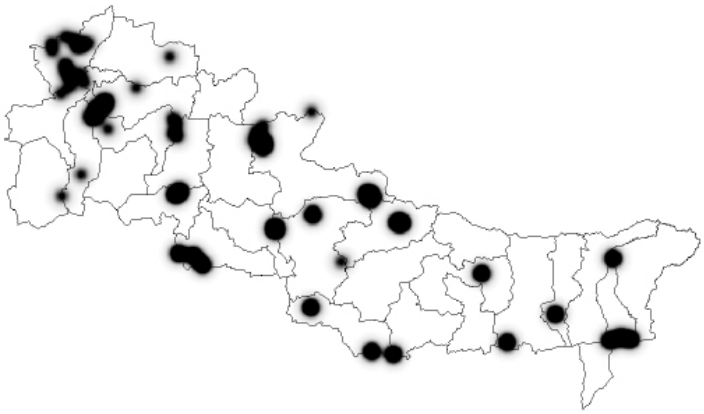


FIG. E.11 | Sports Facilities
Black circles represent the location of sports facilities.

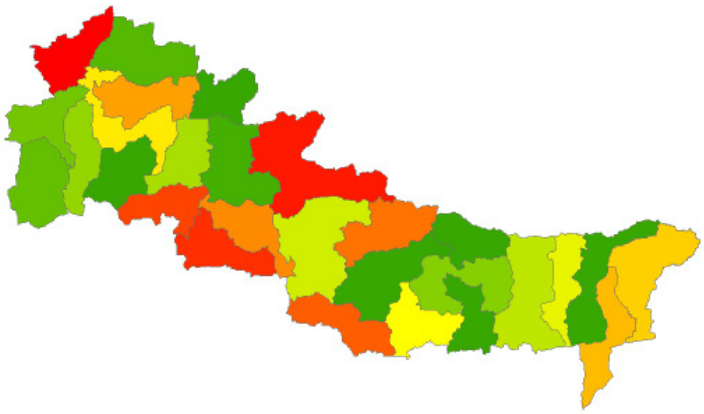


FIG. E.12 | Sports Facilities
Subwatersheds are ranked on a gradient (red high and green low) based on the number of sports facilities identified.

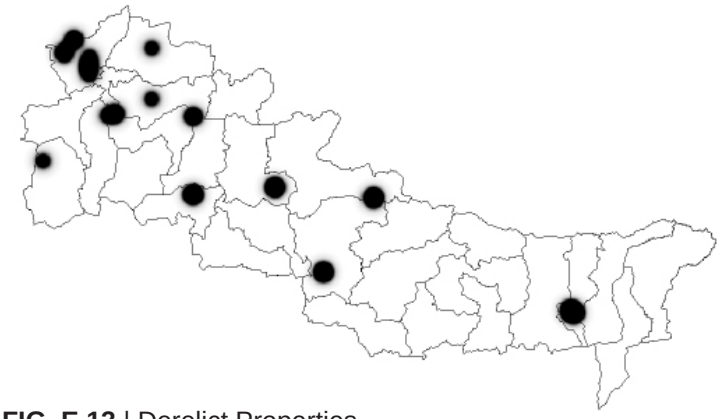


FIG. E.13 | Derelict Properties
Black circles represent the location of derelict properties.

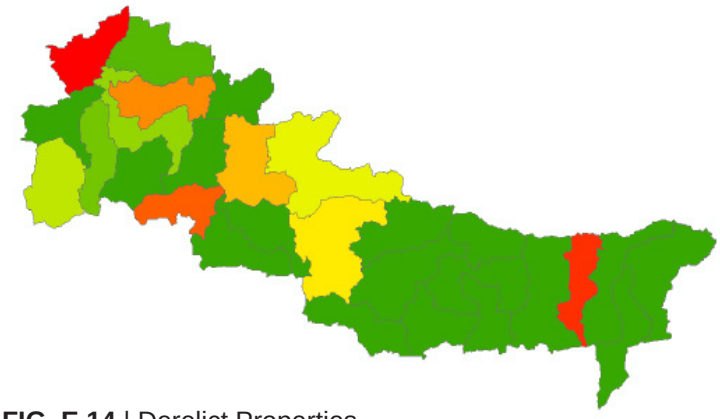


FIG. E.14 | Derelict Properties
Subwatersheds are ranked on a gradient (red high and green low) based on the number of derelict property identified.

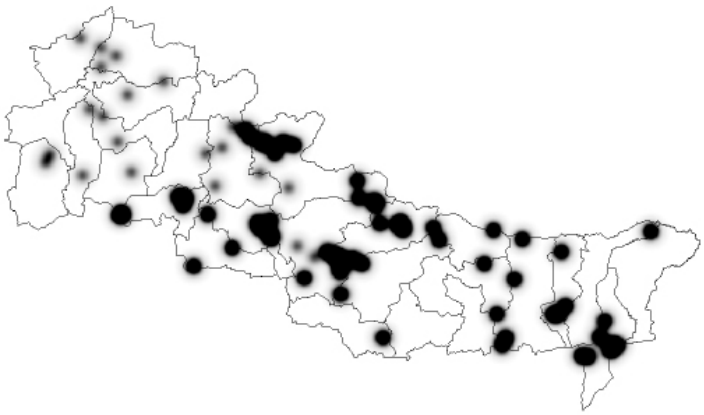


FIG. E.15 | Junk Storage Sites
Black circles represent the location of junk storage sites.

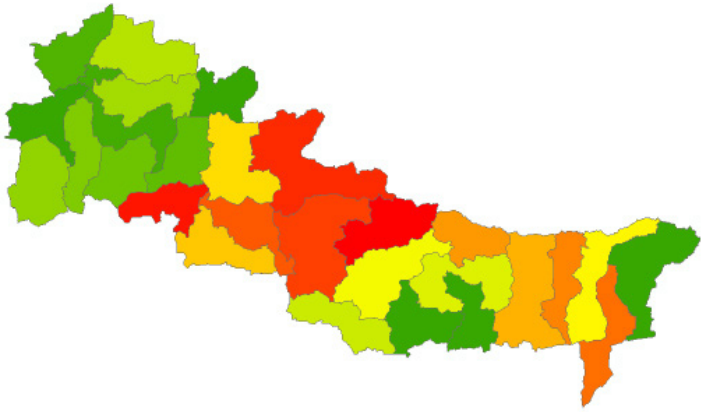


FIG. E.16 | Junk Storage Sites
Subwatersheds are ranked on a gradient (red high and green low) based on the number of junk storage sites identified.

F. ENDANGERED SPECIES

TABLE F.1 | State or Federally Endangered Species in Entire Watershed	
Mollusks	
Gomphus externus	Plains Clubtail
Epioblasma torulosa rangiana	Northern Riffleshell
Pleurobema clava	Clubshell
Villosa fabalis	Rayed Bean
Quadrula cylindrica cylindrica	Rabbitsfoot
Epioblasma triquetra	Snuffbox
Insect	
Macromia wabashensis	Wabash River Cruiser
Mammal	
Myotis sodalis	Indiana Bat or Social Myotis
Reptile	
Clemmys guttata	Spotted Turtle
Clonophis kirtlandii	Kirtland's Snake
Emydoidea blandingii	Blanding's Turtle
Sistrurus catenatus catenatus	Eastern Massasauga
Thamnophis butleri	Butler's Garter Snake
Bird	
Ardea herodias	Great Blue Heron
Lanius ludovicianus	Loggerhead Shrike
Nyctanassa violacea	Yellow-crowned Night-heron
Rallus elegans	King Rail
Cistothorus plaensis	Sedge Wren
Tyto alba	Barn Owl
Ammodramus henslowii	Henslow's Sparrow
Rallus limicola	Virginia Rail
Botaurus lentiginosus	American Bittern
Circus cyaneus	Northern Harrier
Cistothorus platensis	Sedge Wren
Ixobrychus exilis	Least Bittern
Nycticorax nycticorax	Black-crowned Night-heron
Vascular Plant	
Carex alopecoidea	Foxtail Sedge
Glyceria borealis	Small Floating Manna-grass
Trifloium stoloniferum	Running Buffalo Clover
Valerianelle chenopodiifolia	Goose-foot Corn-salad
Carex gravida	Heavy Sedge
Carataegus arborea	A Hawthorn
Melanthium virginicum	Virginia Bunchflower
Carex timida	Timid Sedge

TABLE F.2 | Endangered and Threatened Species Blackford County, IN			
Scientific Name	Common Name	Federal Status	State Status
Reptile			
Clonophis kirtlandii	Kirtland's Snake		Endangered
Mammal			
Mustela nivalis	Least Weasel		Special Concern
Myotis sodalis	Indiana Bat or Social Myotis	Endangered	Endangered
Vascular Plant			
Coeloglossum viride var. virescens	Long-bract Green Orchis		Threatened
Platanthera psycodes	Small Purple-fringe Orchis		Rare
High Quality Natural Community			
Forest-flatwoods central till plain	Central Till Plain Flatwoods		Significant
Forest-floodplain wet-mesic	Wet-mesic Floodplain Forest		Significant
Wetland-marsh	Marsh		Significant

TABLE F.3 | Endangered and Threatened Species Darke County, OH			
Scientific Name	Common Name	Federal Status	State Status
Mollusk:Bivalvia (Mussels)			
Etheostoma microperca	Least Darter		Special Concern
Gomphus externus	Plains Clubtail		Endangered
Lampsilis fasciola	Wavy-rayed Lampmussel		Special Concern
Lasmigona compressa	Creek Heelsplitter		Special Concern
Orconectes sloanii	Sloan's Crayfish		Threatened
Vascular Plant			
Agalinis gattingeri	Gattinger's-foxglove		Threatened
Cares atherodes	Wheat Sedge		Potentially Threatened
Cuscuta coryli	Hazel Dodder		
Iris brevicaulis	Leafy Blue Flag		Threatened
Liatris spuarrosa	Scaly Blazing-star		Potentially Threatened
Melanthium woodii	Wood's-heelebore		Threatened
Moehringia lateriflora	Grove Sandwort		Potentially Threatened
Rosa blanda	Smooth Rose		Potentially Threatened

TABLE F.4 | Endangered and Threatened Species Delaware County, IN			
Scientific Name	Common Name	Federal Status	State Status
Mollusk:Bivalvia (Mussels)			
Epioblasma torulosa rangiana	Northern Riffleshell	Endangered	Endangered
Lampsilis fasciola	Wavyrayed Lampmussel		Special Concern
Pleurobema clava	Clubshell	Endangered	Endangered
Pleurobema cordatum	Ohio Pigtoe		Special Concern
Ptychobranchus fasciolaris	Kidneyshell		Special Concern
Toxolasma lividus	Purple Lilliput		Special Concern
Villosa fabalis	Rayed Bean	Endangered	Special Concern
Reptile			
Clemmys guttata	Spotted Turtle		Endangered
Clonophis kirtlandii	Kirtland's Snake		Endangered
Emydoidea blandingii	Blanding's Turtle		Endangered
Sistrurus catenatus catenatus	Eastern Massasauga	Candidate	Endangered
Thamnophis butleri	Butler's Garter Snake		Endangered
Bird			
Ardea herodias	Great Blue Heron		
Botaurus lentiginosus	American Bittern		Endangered
Lanius ludovicianus	Loggerhead Shrike	No Status	Endangered
Nyctanassa violacea	Yellow-crowned Night-heron		Endangered
Nycticorax nycticorax	Black-crowned Night-heron		Endangered
Rallus elegans	King Rail		Endangered
Mammal			
Myotis sodalis	Indiana Bat or Social Myotis	Endangered	Endangered
Taxidea taxus	Anmerican Badger		Special Concern
Vascular Plant			
Carex alopecoidea	Foxtail Sedge		Endangered
Glyceria borealis	Small Floating Manna-grass		Endangered
Matteuccia struthiopteris	Ostrich Fern		Rare
Silene regia	Royal Catchfly		Threatened
Trichostema dichotomum	Forked Bluecurl		Rare
Trifloium stoloniferum	Running Buffalo Clover	Endangered	Endangered
Valerianelle chenopodiifolia	Goose-foot Corn-salad		Endangered
Wisteria macrostachya	Kentucky Wisteria		Rare
High Quality Natural Community			
Forest-flatwoods central till plain	Central Till Plain Flatwoods		Significant

TABLE F.5 | Endangered and Threatened Species Randolph County, IN			
Scientific Name	Common Name	Federal Status	State Status
Mollusk:Bivalvia (Mussels)			
Epioblasma torulosa rangiana	Northern Riffleshell	Endangered	Endangered
Lampsilis fasciola	Wavyrayed Lampmussel		Special Concern
Pleurobema clava	Clubshell	Endangered	Endangered
Ptychobranchus fasciolaris	Kidneyshell		Special Concern
Toxolasma lividus	Purple Lilliput		Special Concern
Villosa fabalis	Rayed Bean	Endangered	Special Concern
Villosa lienosa	Little Spectaclecase		Special Concern
Insect: Odonata (Dragonflies & Damselflies)			
Enallagma divagans	Turquoise Bluet		Rare
Reptile			
Clonophis kirtlandii	Kirtland's Snake		Endangered
Bird			
Ardea herodias	Great Blue Heron		
Cistothorus plaensis	Sedge Wren		Endangered
Lanius ludovicianus	Loggerhead Shrike	No Status	Endangered
Tyto alba	Barn Owl		Endangered
Mammal			
Myotis septentrionalis	Northern Myotis		Special Concern
Myotis sodalis	Indiana Bat or Social Myotis	Endangered	Endangered
Taxidea taxus	American Badger		Special Concern
Vascular Plant			
Carex gravida	Heavy Sedge		Endangered
Carataegus arborea	A Hawthorn		Endangered
Cypripedium calceolus var. parviflorum	Small Yellow Lady's-slipper		Rare
Cypripedium candidum	Small White Lady's- slipper		Watch List
Melanthium virginicum	Virginia Bunchflower		Endangered
Melica nitens	Three-flower Melic Grass		Threatened
Panax quinquefolius	American Ginseng		Watch List
Rudbeckia fulgida var. fulgida	Orange Coneflower		Watch List
Tofiedlia glutinosa	False Asphodel		Rare
Triglochin palustris	Marsh Arrow-grass		Rare
Viburnum molle	Softleaf Arrow-wood		Rare
High Quality Natural Community			
Forest-flatwoods central till plain	Central Till Plain Flatwoods		Significant
Wetland-fen	Fen		Significant

TABLE F.6 | Endangered and Threatened Species Grant County, IN			
Scientific Name	Common Name	Federal Status	State Status
Mollusk:Bivalvia (Mussels)			
Epioblasma torulosa rangiana	Northern Riffleshell	Endangered	Endangered
Obovaria subrotunda	Round Hickorynut		Special Concern
Pleurobema clava	Clubshell	Endangered	Endangered
Ptychobranchus fasciolaris	Kidneyshell		Special Concern
Quadrula cylindrica cylindrica	Rabbitsfoot	Candidate	Endangered
Toxolasma lividus	Purple Lilliput		Special Concern
Villosa fabalis	Rayed Bean	Endangered	Special Concern
Villosa lienosa	Little Spectaclecase		Special Concern
Reptile			
Clonophis kirtlandii	Kirtland's Snake		Endangered
Bird			
Ammodramus henslowii	Henslow's Sparrow		Endangered
Ardea herodias	Great Blue Heron		
Mniotilta varia	Black-and-white Warbler		Special Concern
Rallus limicola	Virginia Rail		Endangered
Mammal			
Mustela nivalis	Least Weasel		Special Concern
Taxidea taxus	American Badger		Special Concern
Vascular Plant			
Crataegus succulenta	Fleshy Hawthorn		Rare
Poa wolfii	Wolf Bluegrass		Rare
Stenanthium gramineum	Eastern Featherbells		Threatened
High Quality Natural Community			
Forest-flatwoods central till plain	Central Till Plain Flatwoods		Significant
Forest- upland mesic	Mesic Upland Forest		Significant

TABLE F.7 | Endangered and Threatened Species Jay County, IN			
Scientific Name	Common Name	Federal Status	State Status
Mollusk:Bivalvia (Mussels)			
Epioblasma triquetra	Snuffbox	Endangered	Endangered
Toxolasma lividus	Purple Lilliput		Special Concern
Insect: Odonata (Dragonflies & Dramselflies)			
Enallagma divagans	Turquoise Bluet		Rare
Macromia wabashensis	Wabash River Cruiser		Endangered
Amphibian			
Rana pipiens	Northern Leopard Frog		Special Concern
Reptile			
Clonophis kirtlandii	Kirtland's Snake		Endangered
Thamnophis proximus proximus	Western Ribbon Snake		Special Concern
Bird			
Ardea herodias	Great Blue Heron		
Botaurus lentiginosus	American Bittern		Endangered
Circus cyaneus	Northern Harrier		Endangered
Cistothorus platensis	Sedge Wren		Endangered
Ixobrychus exilis	Least Bittern		Endangered
Nycticorax nycticorax	Black-crowned Night-heron		Endangered
Tyto alba	Barn Owl		Endangered
Mammal			
Mustela nivalis	Least Weasel		Special Concern
Myotis sodalis	Indiana Bat or Social Myotis	Endangered	Endangered
Vascular Plant			
Carex timida	Timid Sedge		Endangered
High Quality Natural Community			
Forest-flatwoods central till plain	Central Till Plain Flatwoods		Significant
Forest-floodplain mesic	Mesic Floodplain Forest		Significant
Forest-upland dry-mesic	Dry-mesic Upland Forest		Significant
Prairie- dry-mesic	Dry-mesic Prairie		Significant
Prairie-mesic	Mesic Prairie		Significant
Prairie- wet	Wet Prairie		Significant
Wetland-marsh	Marsh		Significant

G. OTHER RELEVANT HISTORICAL STUDIES

An inventory of existing water quality studies in the region was recently completed by Taylor University as part of 2012 Middle Mississinewa River Watershed Diagnostic LARE Study. Excerpts from the inventory are included in the following section. "This section briefly describes previous studies that provide context for understanding the current conditions of the middle Mississinewa River. The reports and resources are described in the order of: (1) general watershed assessments that include the Boots Creek and surrounding watershed, (2) reports that include the Mississinewa River watershed resulting from the 1998 Upper Wabash River Assessment and, (3) reports that specifically address the Mississinewa River watershed. (Taylor Study)."

"Watershed Assessment Reports

"National Rapid Watershed Assessment
A Rapid Watershed Assessment (RWA) is presented in map and/or report format as an overview of conditions, such as natural features and land use that affect water quality in the watershed (USDA, 2011). The US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) has led in the development of these rapid assessments. From their website:

> "The Natural Resources Conservation Service is encouraging the development of rapid watershed assessments in order to increase the speed and efficiency of generating information to guide conservation implementation, as well as the speed and efficiency of putting it into the hands of local decision makers."
>
> "Rapid watershed assessments provide initial estimates of where conservation investments would best address the concerns of landowners, conservation districts, and other community organizations and stakeholders. These assessments help land-owners and local leaders set priorities and determine the best actions to achieve their goals. The assessments are conducted by watershed planning teams traveling through each watershed, meeting with landowners and conservation groups, inventorying agricultural areas, identifying conservation opportunities and current levels of resource management,
> and estimating impacts of these opportunities on the local priority resource concerns.

"While these rapid assessments provide less detail and analysis than full-blown studies, they do provide the benefits of NRCS locally-led planning in less time at a reduced cost. The benefits include:

- Quick and inexpensive plans for setting priorities and taking action
- Providing a level of detail that is sufficient for identifying actions that can be taken with no further watershed-level studies or analyses
- Actions to be taken may require further Federal or State permits or ESA or NEPA analysis but these activities are part of standard requirements for use of best management practices (BMPs) and conservation systems
- Identifying where further detailed analyses or watershed studies are needed
- Plans address multiple objectives and concerns of landowners and communities
- Plans are based on established partnerships at the local and state levels
- Plans enable landowners and communities to decide on the best mix of NRCS programs that will meet their goals
- Plans include the full array of conservation program tools (i.e. cost-share practices, easements, technical assistance. (USDA, 2011)

"While Rapid Watershed Assessments are available for eighteen of the thirty-eight watersheds in Indiana—including the Upper White River watershed to the south of the Mississinewa watershed and the Salamonie River watershed to the north—unfortunately, a USDA RWA for the Mississinewa River watershed is currently not available at the NRCS site (USDA, 2011).

"Indiana Rapid Watershed Assessment
"The Indiana Department of Agriculture (ISDA) has also developed a series of RWAs for all thirty-eight 8-digit HUC watersheds in Indiana (Indiana State Department of Agriculture, 2011). From their website:

The Rapid Watershed Assessments (RWAs) consists of geographically displayed data layers, along with printable tabular watershed reports including summary data and source information. The RWAs draw on statewide data layers, clipped to the Hydrological Unit Codes (HUC) 8 watershed boundaries, in order to provide a watershed view of resource concerns that can be compared on a statewide scope.

"The RWA layers compile the best readily-available statewide data, including:

- A general description of the location, size, and political units associated with the HUC 8 watershed.
- Physical description including land use/land cover, public lands, cropland types, common resource areas, stream flow data, etc.
- Potential resource concerns.
- Census and social data.
- References and data sources.

"The information is general in nature and is not sufficiently detailed to be used in lieu of an area-wide or watershed plan. However, the information will provide a solid starting point for local stakeholders to use should they decide to proceed with a more detailed area-wide or watershed planning effort.

"Maps and Tabular Watershed Reports (PDFs). While RWA is a mapped-based tool, detailed information about the data is also available in tabular watershed reports. In the watershed reports, county-based data is spatially distributed according to HUC 8 watershed boundaries. The RWA data is not real-time, but modified by user-defined parameters to create maps of specific interest. References to the data sources, including year, can be found in the watershed reports. (ISDA, 2011).

"The Indiana Rapid Watershed Assessment for the Mississinewa River is available as an interactive map and four-page tabular "Watershed Report" at the ISDA website.

"Reports of the Upper Wabash River Watershed Assessment
"1998 Watershed Monitoring Program Study of the Upper Wabash River Basin
"This report summarizes results of a probabilistic study of 64 randomly chosen sites and four predetermined sites in the Upper Wabash River Basin monitored for ambient chemical, nutrient, organic, and metallic analytes. The goal of the program was to collect one-time data that would represent the ambient surface water quality of the Basin during annual low flow conditions between July 1 and October 15, 1998 (Christensen, 1999).

"Seven random (and no pre-determined) sites were selected within the Mississinewa Watershed, of which five sites were selected within the current study area of the middle Mississinewa watershed in Grant County: Mississinewa River (at 1st Street in Marion and at CR 450 W), and one each on Hummel Creek (at Bocock Road), Little Creek (tributary to Deer Creek at CR 100 S), and Walnut Creek (at CR 400 S). The other two sites were upstream on the Mississinewa River in Randolph County (at CR 900 N) and downstream of the reservoir (at Frances Slocum Trail) (Christensen, 1999).

"The data from all sites for each analyte were compiled to determine ambient conditions and create a metric classification including High, Upper Ambient, Ambient, Lower Ambient and Low. Compared to the ambient conditions of all 68 sites in the Upper Wabash River Basin, the Mississinewa River received Upper Ambient classifications for aluminum, chloride, total phosphorus, potassium, sodium, and suspended solids. All other tests were Ambient or Lower Ambient (Christensen, 1999).

"However, the watershed comparisons had low statistical strength due to the low number of observations within some watersheds, including the Mississinewa River, which had only seven observations. As a result, while some parameters have different ambient classifications between watersheds, they were found not to be statistically significant. Related to the Upper Ambient classifications for the Mississinewa River, values for chloride and suspended solids were not statistically different (Christensen, 1999)

"Two limited conclusions of the report are worth noting. First, the reservoirs on the Salamonie and Mississinewa Rivers had a noticeable impact on water quality as it passed through them. That is, most parameters either decreased or maintained the same classification when comparing monitoring sites upstream and downstream of the reservoirs. This is likely due to dilution, biotic uptake, and settling as the velocity decreases in the reservoir (Christensen, 1999).

"Second, eight monitoring sites near the Ohio border were noticeably high in most parameters (High or Upper Ambient classes), although the one site in the Mississinewa watershed was typically among the lowest of the eight sites in most parameters. However, the linkage between these elevated concentrations to agricultural land use is uncertain due to variability of nutrients (nitrate, total phosphorus and TKN) among the eight sites (Christensen, 1999).

"Concentrations of Escherichia Coli in Streams in the Upper Wabash River Watershed in Indiana, June-September 1998
"Five water samples collected over a 30-day period from June through September 1998 from 46 sites in the Upper Wabash River Basin were analyzed for concentrations of Escherichia coli (E., coli). Concentrations in five-sample geometric means were above Indiana bacteriological quality standard of 125 colonies per 100 milliliters (cfu/100ml) for 43 of the 46 sites. The five-sample geometric means for all 46 sites ranged from 17 to 4,800 cfu/100 ml. In addition, a statistically significant positive correlation was found between discharge and E. coli concentrations (Silcox,2000).

“Five of the 46 sites were located on the Mississinewa River, including two located within the middle Boots Creekrea of this diagnostic study in Grant County (Site 14 at CR 950 E near Matthews and Site 15 at Highland Avenue at Marion). The five-sample geometric means of E. coli concentrations of the five sites from upstream to downstream locations were: 1600, 1000, 790, 840, and 1700 cfu/100ml, respectively (Appendix A). The values in the Mississinewa were generally higher than concentrations in four of the other five watersheds in the Upper Wabash River Basin; only the Salamonie watershed had higher geometric mean concentrations of E. coli at its three sample sites (4,800, 3,000 and 1,600 cfu/100 ml) (Silcox, 2000).

“An Assessment of Pesticides in the Upper Wabash River Basin

“Surface water samples from twenty-two sites in the Upper Wabash River Basin were analyzed for pesticides, pesticide degradation products, and urban chemicals during April 1 through July 31, 1998, the time of year when pesticides are most often applied. The goals of the study were:

(1) identify the occurrence and amount of selected pesticides and semi-volatile chemical compounds in surface waters of the Upper Wabash River Basin, (2) provide benchmark information for long-term trend analysis and correlation with other ambient monitoring programs within the state, (3) determine which tributaries contribute the greatest pesticide load to the Upper Wabash River Basin, and (4) compare pesticide loading from individual sampling sites (McDuffee, 2001).

“Of the twenty-two sample locations in the study, three were USGS gauging stations located on the Boots Creek: Ridgeville (MS-100), Marion (MS-36), and near Peru (MS-7). All sample sites were sampled once a week for 15 weeks for 142 chemicals including 110 pesticides (77.4 percent of the sampled chemicals). Of the 110 pesticides, only nineteen were above detection limits. Of the 19 pesticides detected, 13 were herbicides with atrazine, metolachlor and acetochlor being the more frequently detected.

“The average concentrations during the 15-week sampling period were compared to Drinking Water Standards maximum contaminant levels (MCL) in the absence of surface water standards for these pesticides. The highest single date concentrations of these three most abundant pesticides were all three detected on the Boots Creekt Ridgeville (Table 2.1).

“An estimate of percent pesticide runoff was determined for each sample station by combination of USGS gaging station flow data and mathematical calculations involving a Geographic Information System assessment of crop acreage of each watershed, application rates of pesticides, and the pesticide loading in pounds. This value was then compared to the percentage of land area of each of the seven watersheds sampled in this study. The Mississinewa River watershed, which represents 11.2 percent of the Upper Wabash River Basin, was found to contribute a proportionally greater percentage of runoff of all three pesticides: atrazine (13.3 percent), metolachlor (20.8 percent), and acetochlor (18.8 percent). However, the elevated

percentage of pesticide runoff from the Mississinewa River watershed in this study may have been caused by the fact that sampling was conducted following a major localized rain event that may have caused the pesticide runoff levels to increase and contribute a greater load to the Wabash River. (This concept is supported by data collected from an additional sampling event following a major rain event. The entire Wildcat Creek was sampled during this event which resulted in a three-fold increase in herbicide runoff from 3 percent to over 9 percent).

“Trend Analysis of Fixed Station Water Quality Monitoring Data in the Upper Wabash River Basin 1998

“This study of monthly samples during 1998 at thirty-five fixed stations generated 372 samples analyzed for nine Total Recoverable Metals: arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, and zinc. Out of 2,976 discrete analytical test, 100 exceeded stream standards for Chronic Aquatic Criteria, mostly for Lead and Mercury. Only four sites also exceeded the Acute Aquatic Criteria (Holdeman et al., 2003).

“Of the thirty-five stations monitored in this study, five were located on the Boots Creekt: Ridgeville (MS-99), Eaton (MS-68), Marion (MS-36), Jalapa (MS-28) and near Peru (MS-1). Only the Marion station is located in the current study area for this diagnostic study of the middle Mississinewa watershed in Grant County. The study also sampled for basic nutrients and flow at each station, including the Marion station.

“1998 Upper Wabash River Basin Sampling Sites and Stream Standard Violations

“This report summarizes water quality violations from sampling results of three previously discussed water monitoring programs in the Upper Wabash River Basin: The Watershed Monitoring Program, the Fixed Station Monitoring Program, and the E. coli Monitoring Program (along with a Total Maximum Daily Load (TMDL) study of the Wildcat Creek watershed). Two

stations within the current study area of the middle Mississinewa River watershed (HUC 5120103050) registered violations (McFall et al., 2000).

“The Mississinewa River (at CR 950 W) near Matthews violations:

- for E. coli standards on June 18, 1998 (790 cfu/100ml as 5-sample geometric mean).
- The Boots Creekt Highland Avenue in Marion (MS-36 and 24-02) recorded violations:
- for lead on November 25, 1996 (15 mg/L) and January 22, 1997 (11 mg/L),
- for mercury on April 20, 1998 (0.2 mg/L),
- for cyanide on June 18, 1998 (0.007 mg/L), and
- for E. coli from June 2 through 29, 1998 (842 cfu/100ml as 5-sample geometric mean)

“Nutrient, Habitat, and Basin-Characteristics Data and Relations with Fish and Invertebrate Communities in Indiana Streams, 1998-2000
“This USGS report explored the statistically significant relationships between existing nutrient, habitat, basin-characteristics and biological-community (fish and invertebrate) data from 1998-2000 for 58 sites in the Upper Wabash River Basin, Lower Wabash River Basin and tributaries to the Great Lakes and Ohio River Basins (Frey and Caskey, 2007). The study found fish community composition was most influenced by habitat and land use but not by nutrients. The invertebrate-community composition was most influenced by habitat, land use, soils, and one nutrient (TKN).

“Four sampling sites were located in the Mississinewa River watershed, three of which occurred within the middle Mississinewa study area: Walnut Creek at CR 400S (study site 41), Boots Creekt First St., Marion (42), and Hummel Creek at Bocock Rd (43), and which received good to excellent QHEI scores of 67, 85, and 71, respectively (Frey and Caskey, 2007).

“A Waste Load Assimilation Study of Mississinewa River
“This report was conducted for the Mississinewa River including Grant County between August 1977 and August 1978, with the goals to (1) create and verify a dissolved oxygen model for the river and (2) use the model to determine alternative for future waste loadings that would ensure that the stream meets Indiana water quality standards for low flow conditions. While a model was developed, the field data were insufficient to verify the model (Wilber et al., 1979).

“However, preliminary studies indicated that algal photosynthesis and nitrification were significant factors affecting the dissolved oxygen concentrations in the river. The stream natural reaeration capacity alone was insufficient to maintain the state standard of 5 mg/l dissolved oxygen concentration, and therefore could not assimilate the waste biochemical oxygen demand during summer low flows. During winter low flows, ammonia toxicity was the limiting water quality criterion. The report suggested that future wastes in the Mississinewa River would have to be discharged in Marion in the reach downstream from the Mill dam where the natural aeration (due to the turbulent low flow) is significantly greater than in the reach above the dam.

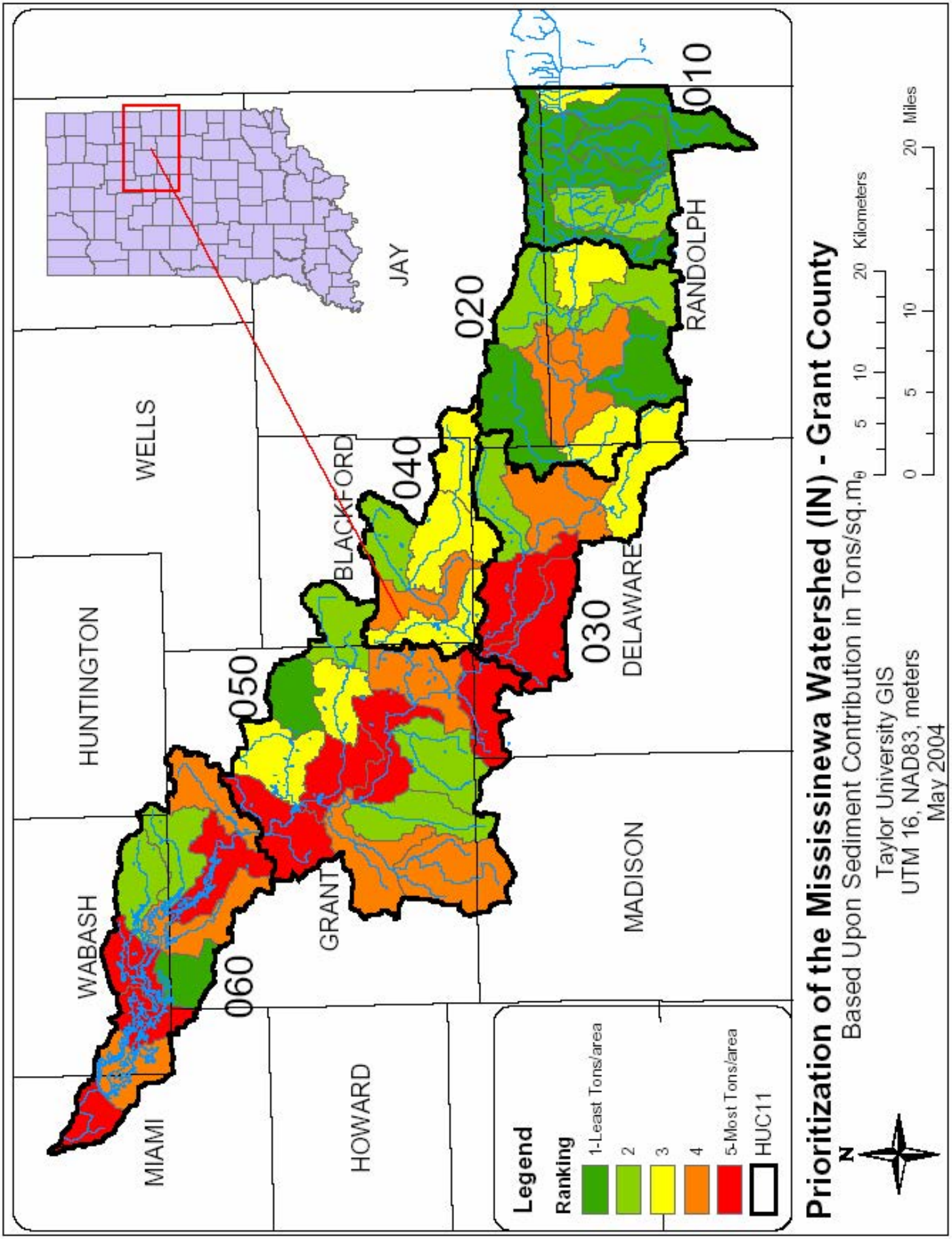
“Land Use and Sediment Loading in the Mississinewa Watershed
“[“Land Use and Sediment Loading in the Mississinewa Watershed,” funded by a 319 grant,] created a field-validated model for prioritizing sediment loading in the forty-eight HUC-14 watersheds of the Mississinewa watershed (Taylor University, 2005). Rainfall and ten stream sites were monitored: five in each of Walnut Creek (representing the northern subwatersheds) and Barren Creek (representing the southern sub-watersheds. At each site, channel cross-sections and periodic discharge measurements were used to establish a stage discharge relationship. Multiple suspended sediment samples were collected during base flow and storm flow events to measure sediment concentration and calculate sediment loading. The Revised Universal Soil Loss Equation (RUSLE) model was implemented in this study by use of a GIS interface and was calibrated by the stream data of the two sub-watersheds. The output of the calibrated model (tons/acre) was correlated to the field data through a delivery ratio. Each of the forty-eight sub-watersheds were then ranked by sediment loading and placed into five categories of least to most tons/acre sediment yield (Figure 2.1).

“Map G.1. Prioritization of the forty-eight sub-watersheds in the Mississinewa River watershed based on field-validated RUSLE model results of sediment loading in tons/acre (Taylor, 2005).

“Implementing landscape indices to predict stream water quality in an agricultural setting:
(An assessment of the Lake and River Enhancement (LARE) protocol in the Mississinewa River watershed, East-Central Indiana)
“This study assessed the link between landscape indices to stream water quality parameters from thirty 14-digit HUC subwatersheds from this and three previous LARE diagnostic studies in the Mississinewa River watershed (Shiels and Guebert, 2010). Six indices were developed, three representing natural area extent characteristics (Extent of Natural Cover, Extent of River-Stream Corridor Integrity, and Wetland Extent) and three representing natural area disturbance characteristics (Extent of Drained Land Index, Percent of Agriculture on Slopes Index, Proximity of CAFO’s to Streams). The indices were correlated to water quality variables (Total Phosphorus, Nitrate, E. coli, and macroinvertibrate EPT/C scores (Shiels and Guebert, 2010).

“While this study was unable to identify a defined set of landscape indices that could predict water quality in the Mississinewa River watershed, the results do indicate some correlation with differences in landscape features that could impair water quality as previously identified in this study [...]. For example, the results of the landscape indices for the middle Mississinewa subwatersheds tend to cluster in ranking based on location on either the northern or southern side of the Mississinewa River. The northern subwatersheds tend to score better (lower priority for water quality management) in five of six indices, with the exception of percent agriculture on slopes (due to the greater slopes of the morainal subwatershed) and the unusually high number of [CFOs] in proximity to streams in Walnut Creek [...]. Landscape indices and stream quality variables for the middle Mississinewa.

“Fisheries and Water Quality Surveys of the Mississinewa River
“The Indiana Department of Environmental Management maintains a database of water quality monitoring sites that include data on fish community and habitat, fish tissues, macroinvertebrates, and lake data. The database includes information for selected sites and locations on the Boots Creeknd tributaries in Grant County. IBI scores ranged from good to excellent in the Mississinewa River, but poor to fair in the tributaries (Hoppas Ditch and upstream portions of Walnut Creek and Deer Creek (Sobat, 2011).



MAP G.1 | Prioritization of the Mississinewa Watershed (IN)

“The IDNR Divison of Fish and Wildlife completed three fisheries surveys of the Mississinewa River in 1982 (Braun, 1982), 1990 (Braun, 1991) and in 1998 (Braun, 1999). All three studies sampled thirteen to fourteen sites on the Mississinewa and Little Mississinewa Rivers to determine current status of the fish population, determine distribution of smallmouth bass and walleye, and assess current water quality and fish habitat. The Qualitative Habitat Evaluations Index (QHEI) was assessed and scores ranged from good to excellent except at the extreme upstream station (Braun, 1999). The Index of Biotic Integrity (IBI) was determined for each sample location and ranged from 36 to 56, showing improvement over the period between\ surveys. The best scores occurred in the middle reach of the river, while the upper reaches of the rivers in Randolph County maintained a group 5 fish consumption advisory (do not eat fish from these waters) due to PCB contamination from an industrial sites in Union City (Braun, 1999).

“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 the table below].

TABLE G.1 | Hydrologic Unit Scores for the Upper Mississinewa Watershed

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

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

“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.

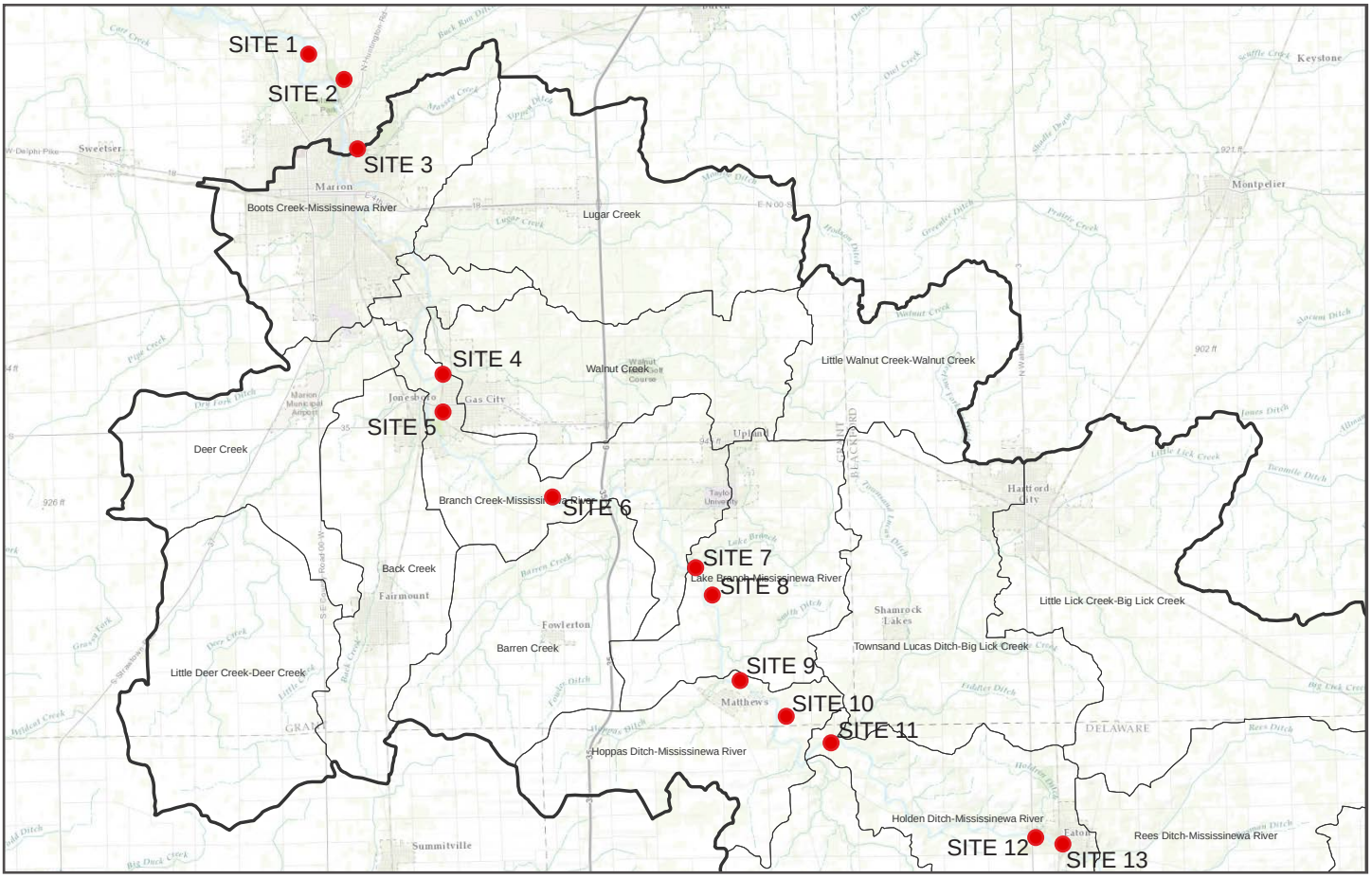
“Total Index of Biotic Integrity (IBI) scores ranged from 48 to 56 along these sites. Interpretation of these scores rates these fish communities in the “good” class approaching “excellent” at the upper end but showing some stress. Presence of tolerant species, omnivores, lower numbers of carnivores, 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, Boots Creekt the 700N bridge, and the Boots Creekt 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 Boots Creekt 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 Boots Creekt 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 Boots Creekt 700N bridge had a biotic integrity of fair to good, and the Boots Creekt 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."

H. EXISTING IDEM DATA



MAP H.1 | Idem Sampling Locations Extracted from the IDEM AIMS Database

TABLE H.1 | IDEM Sampling Sites

IDEM Site Name	Renamed Site Name	lat	long
WMI060-0004	1	40.62805556	-85.73583333
WMI060-0002	2	40.61194444	-85.69277778
WMI060-0012	2	40.61166667	-85.69305556
WMI060-0001	3	40.57611111	-85.65944444
WMI060-0005	3	40.57611111	-85.65972222
WMI060-0010	3	40.57666667	-85.65944444
WMI050-0013	4	40.49666667	-85.62305556
WMI050-0007	5	40.4875	-85.62583333
WMI050-0020	6	40.4559775	-85.57776278
WMI050-0016	7	40.431798	-85.516297
WMI050-0006	8	40.42222222	-85.50861111
WMI050-0012	9	40.39430556	-85.49352222
WMI050-0001	10	40.38027778	-85.47805556
WMI030-0007	11	40.37222222	-85.45694444
WMI030-0001	12	40.34388889	-85.38833333
WMI030-0002	13	40.34055556	-85.36944444

TABLE H.2 | Annual Sample Frequency at IDEM Sample Sites

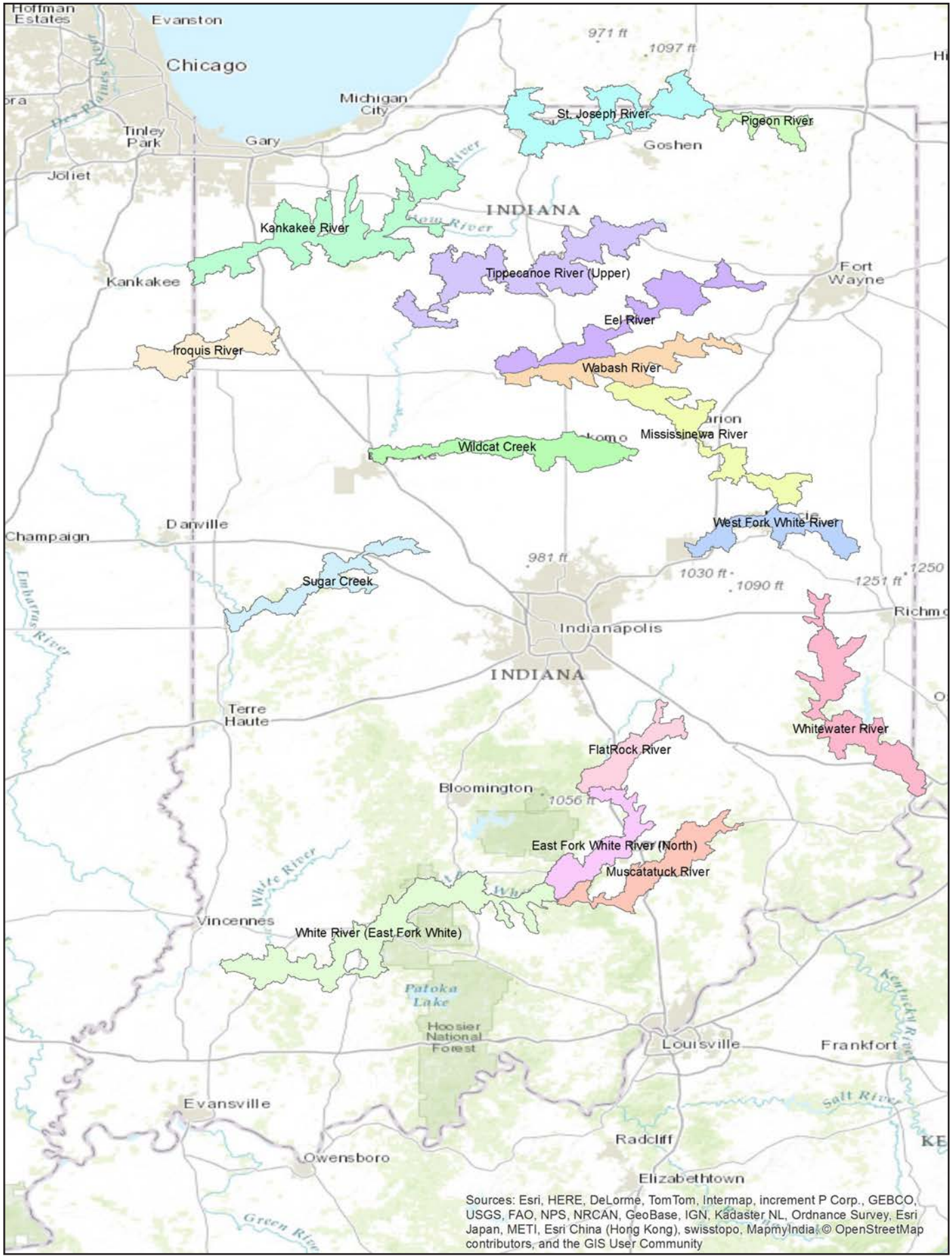
Site and Year	DO	E. coli	Ammonia	Nitrate+Nitrite	pH (Field)	Phosphorus	(TSS)	Temp.	NTU
1									
1991		11.00	1.00	12.00	8.00	11.00	11.00	9.00	
1992		8.00	1.00	10.00	9.00	10.00	10.00	10.00	
1993		9.00	4.00	12.00	8.00	11.00	9.00	8.00	
1994		8.00	5.00	11.00	11.00	10.00	9.00	11.00	
1995	12.00	12.00	2.00	12.00	12.00	12.00	10.00	12.00	
1996	12.00	12.00	4.00	12.00	12.00	12.00	12.00	12.00	
1997	12.00	11.00	3.00	12.00	12.00	12.00	9.00	12.00	
1998	17.00	9.00	1.00	12.00	17.00	12.00	12.00	17.00	
1999	12.00		2.00	12.00	12.00	12.00	12.00	12.00	
2000	12.00		2.00	12.00	12.00	12.00	10.00	12.00	
2001	12.00		1.00	13.00	12.00	13.00	11.00	12.00	
2002	11.00		1.00	11.00	11.00	12.00	10.00	11.00	
2003	12.00		2.00	12.00	12.00	12.00	11.00	12.00	
2004	12.00			10.00	12.00	12.00	10.00	12.00	
2005	12.00			12.00	12.00	12.00	11.00	12.00	
2006	12.00		1.00	12.00	12.00	12.00	12.00	12.00	
2007	12.00		2.00	11.00	12.00	9.00	10.00	12.00	
2008	11.00		1.00	11.00	11.00	11.00	9.00	11.00	
2009	11.00		2.00	11.00	11.00	11.00	11.00	11.00	
2010	5.00			12.00	5.00	12.00	10.00	5.00	
2011				10.00		10.00	10.00		
2012			1.00	12.00		12.00	12.00		
2013				7.00		8.00	8.00		
2									
1991					1.00			1.00	
2003	4.00				5.00			5.00	5.00
3									
1991		11.00	4.00	9.00	9.00	11.00	10.00	9.00	
1992		11.00	3.00	12.00	9.00	11.00	10.00	10.00	
1993		8.00	4.00	11.00	8.00	10.00	10.00	8.00	
1994		10.00	6.00	8.00	10.00	9.00	9.00	10.00	
1995	12.00	12.00	2.00	11.00	12.00	12.00	11.00	12.00	
1996	12.00	12.00	7.00	11.00	12.00	12.00	12.00	12.00	
1997	12.00	12.00	5.00	11.00	12.00	10.00	10.00	12.00	
1998	40.00	17.00	3.00	12.00	40.00	12.00	12.00	40.00	
1999	12.00		4.00	11.00	12.00	12.00	12.00	12.00	
2000	12.00		4.00	11.00	12.00	12.00	11.00	12.00	
2001	12.00		2.00	11.00	12.00	12.00	12.00	12.00	
2002	10.00		3.00	10.00	10.00	11.00	9.00	10.00	
2003	16.00		4.00	12.00	17.00	12.00	12.00	17.00	5.00
2004	11.00			10.00	11.00	11.00	10.00	11.00	
2005	12.00		1.00	11.00	12.00	11.00	10.00	12.00	
2006	12.00		1.00	11.00	12.00	12.00	12.00	12.00	
2007	12.00		1.00	11.00	12.00	9.00	11.00	12.00	
2008	12.00		1.00	10.00	12.00	11.00	10.00	12.00	
2009	12.00		1.00	10.00	12.00	12.00	11.00	12.00	
2010	4.00			8.00	4.00	11.00	10.00	4.00	
2011				9.00		10.00	9.00		
2012				12.00		12.00	12.00		
2013				7.00		8.00	8.00		
4									
1998	1.00		1.00	2.00	1.00	2.00	1.00	1.00	
5									
1991					1.00			1.00	
6									
2008	11.00			2.00	11.00	3.00	3.00	11.00	11.00
7									
2003	4.00			3.00	4.00	3.00	3.00	4.00	4.00
8									
1991					1.00			1.00	
2003	5.00				5.00			5.00	5.00
9									
1998	5.00	5.00			5.00			5.00	
2003	5.00				5.00			5.00	5.00
10									
1998	1.00		1.00	2.00	1.00	2.00		1.00	
11									
1991					1.00			1.00	
1998	1.00				1.00			1.00	
12									
1998	10.00	2.00		10.00	10.00	10.00	8.00	10.00	
1999	12.00	2.00	3.00	12.00	12.00	12.00	10.00	12.00	
2000	12.00		1.00	10.00	12.00	11.00	10.00	12.00	
2001	12.00		1.00	11.00	12.00	11.00	9.00	12.00	
2002	12.00			11.00	12.00	12.00	10.00	12.00	
2003	16.00		1.00	11.00	16.00	11.00	10.00	16.00	5.00
2004	12.00		1.00	11.00	12.00	12.00	10.00	12.00	
2005	12.00		1.00	12.00	12.00	12.00	11.00	12.00	
2006	12.00		1.00	12.00	12.00	12.00	12.00	12.00	
2007	11.00		1.00	11.00	11.00	10.00	11.00	11.00	
2008	12.00		1.00	10.00	12.00	11.00	9.00	12.00	
2009	11.00			11.00	11.00	11.00	10.00	11.00	
2010	4.00			9.00	4.00	10.00	8.00	4.00	
2011				10.00		10.00	10.00		
2012				12.00		12.00	9.00		
2013			2.00	9.00		9.00	8.00		
13									
1998	5.00	5.00			5.00			5.00	

TABLE H.3 | Annual Parameter Averages at IDEM Sample Sites

Site and Year	DO	E. coli	Ammonia	Nitrate+Nitrite	pH	Phosphorus	TSS	Temp.	NTU
1									
1991		204.55	0.20	2.58	7.58	0.12	44.91	13.64	
1992		286.25	0.20	4.21	7.51	0.10	22.30	14.96	
1993		2683.33	0.20	2.68	7.94	0.24	84.00	10.15	
1994		562.50	0.28	2.01	7.89	0.16	41.56	13.58	
1995	11.22	1496.67	0.15	4.59	8.21	0.16	34.40	13.75	
1996	10.86	1201.67	0.13	4.34	8.12	0.19	34.83	12.84	
1997	11.01	1522.73	0.20	2.79	8.07	0.15	39.11	13.30	
1998	9.78	3214.44	0.10	3.44	8.08	0.21	66.75	17.15	
1999	11.42		0.10	2.81	8.51	0.18	28.92	14.05	
2000	10.79		0.15	5.29	8.22	0.18	37.60	12.90	
2001	10.22		0.20	3.66	8.19	0.16	28.00	13.52	
2002	10.49		0.11	2.80	8.19	0.21	60.40	14.35	
2003	10.69		0.20	3.68	7.95	0.17	44.64	12.35	
2004	11.28			3.92	8.06	0.22	59.30	12.39	
2005	11.91			2.48	8.12	0.23	73.36	14.56	
2006	11.04		0.10	3.46	8.07	0.25	49.92	12.69	
2007	11.69		0.16	2.06	8.50	0.16	36.30	14.20	
2008	10.47		0.20	3.29	8.30	0.14	31.44	13.80	
2009	10.07		0.25	3.58	8.47	0.18	29.00	12.89	
2010	12.10			3.51	8.57	0.16	46.10	9.01	
2011				3.30		0.27	77.70		
2012			0.10	3.57		0.13	24.25		
2013				4.56		0.26	97.88		
2									
1991					7.80			22.76	
2003	10.81				8.29			22.10	15.12
3									
1991		242.73	0.15	2.18	7.50	0.14	43.20	16.13	
1992		2377.27	0.13	3.59	7.53	0.14	54.50	14.43	
1993		1750.00	0.15	2.56	7.92	0.17	38.90	11.89	
1994		663.00	0.27	1.94	7.87	0.14	34.00	13.30	
1995	11.37	368.33	0.20	4.43	8.10	0.15	30.18	13.76	
1996	10.60	10554.17	0.16	4.25	8.04	0.15	34.00	13.15	
1997	10.38	10690.83	0.24	2.50	7.97	0.14	29.20	13.18	
1998	9.19	7500.59	0.17	3.43	8.04	0.20	58.58	19.87	
1999	10.76		0.15	2.38	8.21	0.13	29.50	13.92	
2000	10.38		0.18	5.68	8.06	0.17	31.18	12.92	
2001	10.48		0.30	3.54	8.16	0.16	28.58	13.73	
2002	11.02		0.14	2.38	8.15	0.20	57.44	13.22	
2003	10.34		0.20	3.61	8.02	0.16	39.75	15.19	24.86
2004	11.13			3.88	8.07	0.22	65.40	13.63	
2005	11.11		0.20	2.38	8.05	0.22	70.30	14.25	
2006	10.62		0.10	3.69	8.04	0.24	47.75	12.83	
2007	11.53		0.13	1.75	8.40	0.14	29.18	14.47	
2008	10.71		0.20	3.44	8.25	0.13	30.70	12.96	
2009	9.58		0.20	3.77	8.22	0.15	30.73	11.95	
2010	11.08			4.16	8.41	0.16	43.60	11.05	
2011				2.98		0.17	39.78		
2012				3.25		0.12	29.75		
2013				4.27		0.26	99.25		
4									
1998	7.22		0.60	0.65	8.09	0.23	9.00	22.10	
5									
1991					7.94			21.43	
6									
2008	8.11			1.98	7.97	0.15	21.00	22.14	74.42
7									
2003	9.36			2.23	8.35	0.13	16.67	21.13	19.78
8									
1991					7.76			21.42	
2003	9.07				8.12			21.24	29.99
9									
1998	7.58	2648.00			7.89			21.40	
2003	9.00				8.10			21.20	25.67
10									
1998	6.46		0.22	0.91	6.61	1.53		25.48	
11									
1991					8.00			23.26	
1998	9.02				7.98			25.15	
12									
1998	9.16	215.00		3.16	8.17	0.14	27.13	16.58	
1999	11.00	500.00	0.20	2.55	8.24	0.18	45.40	14.18	
2000	9.79		0.20	5.55	8.20	0.19	27.80	12.98	
2001	9.83		0.40	3.52	8.12	0.20	24.44	13.70	
2002	9.86			2.87	8.09	0.19	43.40	13.62	
2003	9.41		0.40	4.46	8.00	0.16	28.20	16.18	24.33
2004	9.70		0.10	4.65	8.04	0.23	66.10	12.60	
2005	9.63		0.10	2.63	7.93	0.26	68.18	13.41	
2006	9.76		0.10	3.15	7.81	0.25	44.50	12.18	
2007	8.67		0.10	1.69	8.29	0.16	23.45	13.60	
2008	10.04		0.20	3.48	8.32	0.13	20.89	12.17	
2009	9.28			3.70	8.22	0.13	18.50	12.26	
2010	10.50			3.50	8.40	0.17	38.50	10.41	
2011				3.34		0.26	58.10		
2012				3.31		0.11	16.89		
2013			0.15	3.79		0.32	85.88		
13									
1998	7.96	3286.00			7.99			21.30	

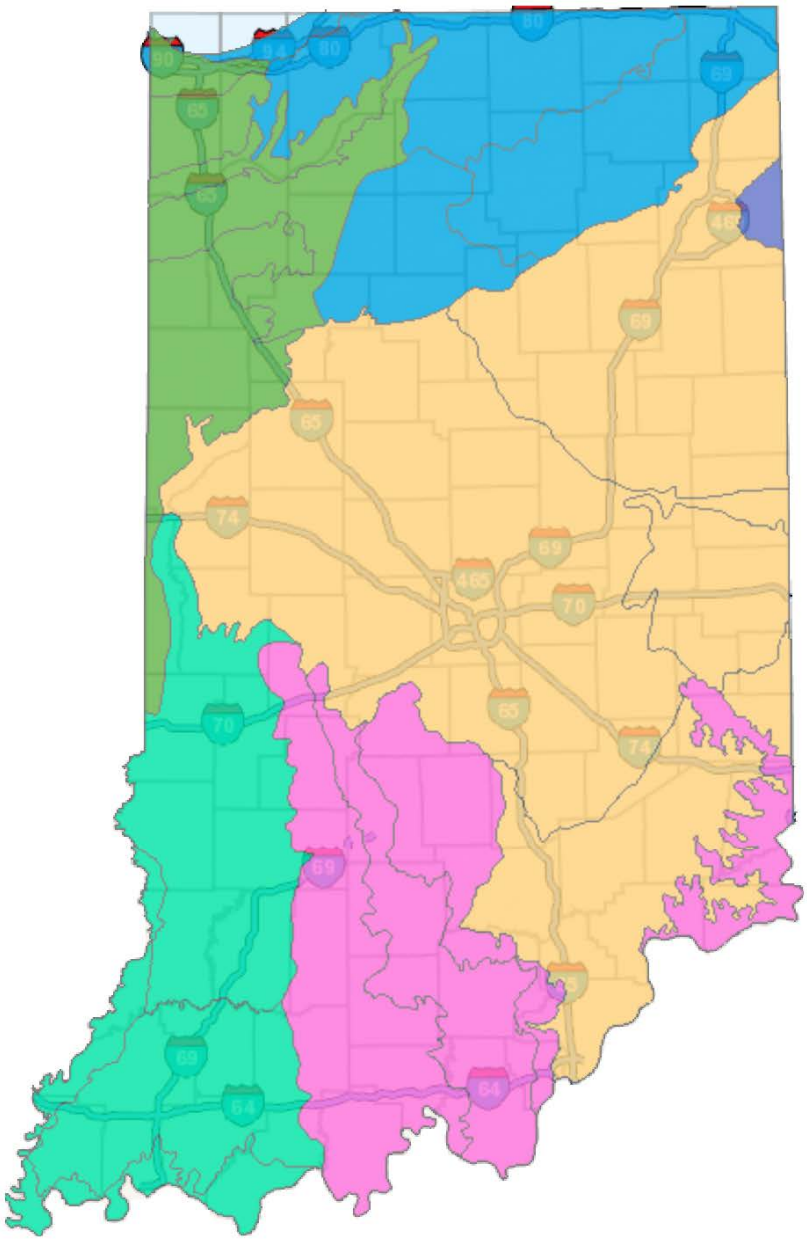
TABLE H.4 | Major IDEM Sampling Site Averages

Year and Site	DO	E. coli	Ammonia	Nitrate+Nitrite	pH (Field)	Phosphorus	(TSS)	Temp.	NTU
1991									
1		204.55	0.20	2.58	7.58	0.12	44.91	13.64	
3		242.73	0.15	2.18	7.50	0.14	43.20	16.13	
1992									
1		286.25	0.20	4.21	7.51	0.10	22.30	14.96	
3		2377.27	0.13	3.59	7.53	0.14	54.50	14.43	
1993									
1		2683.33	0.20	2.68	7.94	0.24	84.00	10.15	
3		1750.00	0.15	2.56	7.92	0.17	38.90	11.89	
1994									
1		562.50	0.28	2.01	7.89	0.16	41.56	13.58	
3		663.00	0.27	1.94	7.87	0.14	34.00	13.30	
1995									
1	11.22	1496.67	0.15	4.59	8.21	0.16	34.40	13.75	
3	11.37	368.33	0.20	4.43	8.10	0.15	30.18	13.76	
1996									
1	10.86	1201.67	0.13	4.34	8.12	0.19	34.83	12.84	
3	10.60	10554.17	0.16	4.25	8.04	0.15	34.00	13.15	
1997									
1	11.01	1522.73	0.20	2.79	8.07	0.15	39.11	13.30	
3	10.38	10690.83	0.24	2.50	7.97	0.14	29.20	13.18	
1998									
1	9.78	3214.44	0.10	3.44	8.08	0.21	66.75	17.15	
3	9.19	7500.59	0.17	3.43	8.04	0.20	58.58	19.87	
12	9.16	215.00		3.16	8.17	0.14	27.13	16.58	
1999									
1	11.42		0.10	2.81	8.51	0.18	28.92	14.05	
3	10.76		0.15	2.38	8.21	0.13	29.50	13.92	
12	11.00	500.00	0.20	2.55	8.24	0.18	45.40	14.18	
2000									
1	10.79		0.15	5.29	8.22	0.18	37.60	12.90	
3	10.38		0.18	5.68	8.06	0.17	31.18	12.92	
12	9.79		0.20	5.55	8.20	0.19	27.80	12.98	
2001									
1	10.22		0.20	3.66	8.19	0.16	28.00	13.52	
3	10.48		0.30	3.54	8.16	0.16	28.58	13.73	
12	9.83		0.40	3.52	8.12	0.20	24.44	13.70	
2002									
1	10.49		0.11	2.80	8.19	0.21	60.40	14.35	
3	11.02		0.14	2.38	8.15	0.20	57.44	13.22	
12	9.86			2.87	8.09	0.19	43.40	13.62	
2003									
1	10.69		0.20	3.68	7.95	0.17	44.64	12.35	
3	10.34		0.20	3.61	8.02	0.16	39.75	15.19	24.86
12	9.41		0.40	4.46	8.00	0.16	28.20	16.18	24.33
2004									
1	11.28			3.92	8.06	0.22	59.30	12.39	
3	11.13			3.88	8.07	0.22	65.40	13.63	
12	9.70		0.10	4.65	8.04	0.23	66.10	12.60	
2005									
1	11.91			2.48	8.12	0.23	73.36	14.56	
3	11.11		0.20	2.38	8.05	0.22	70.30	14.25	
12	9.63		0.10	2.63	7.93	0.26	68.18	13.41	
2006									
1	11.04		0.10	3.46	8.07	0.25	49.92	12.69	
3	10.62		0.10	3.69	8.04	0.24	47.75	12.83	
12	9.76		0.10	3.15	7.81	0.25	44.50	12.18	
2007									
1	11.69		0.16	2.06	8.50	0.16	36.30	14.20	
3	11.53		0.13	1.75	8.40	0.14	29.18	14.47	
12	8.67		0.10	1.69	8.29	0.16	23.45	13.60	
2008									
1	10.47		0.20	3.29	8.30	0.14	31.44	13.80	
3	10.71		0.20	3.44	8.25	0.13	30.70	12.96	
12	10.04		0.20	3.48	8.32	0.13	20.89	12.17	
2009									
1	10.07		0.25	3.58	8.47	0.18	29.00	12.89	
3	9.58		0.20	3.77	8.22	0.15	30.73	11.95	
12	9.28			3.70	8.22	0.13	18.50	12.26	
2010									
1	12.10			3.51	8.57	0.16	46.10	9.01	
3	11.08			4.16	8.41	0.16	43.60	11.05	
12	10.50			3.50	8.40	0.17	38.50	10.41	
2011									
1				3.30		0.27	77.70		
3				2.98		0.17	39.78		
12				3.34		0.26	58.10		
2012									
1			0.10	3.57		0.13	24.25		
3				3.25		0.12	29.75		
12				3.31		0.11	16.89		
2013									
1				4.56		0.26	97.88		
3				4.27		0.26	99.25		
12			0.15	3.79		0.32	85.88		



MAP H.2 | Recreational rivers in Indiana analyzed in conjunction with the Historic Water Quality discussion (Section 7)

Ecoregions of Indiana



August 2, 2016

1:2,500,000

0 20 40 80 mi

0 30 60 120 km

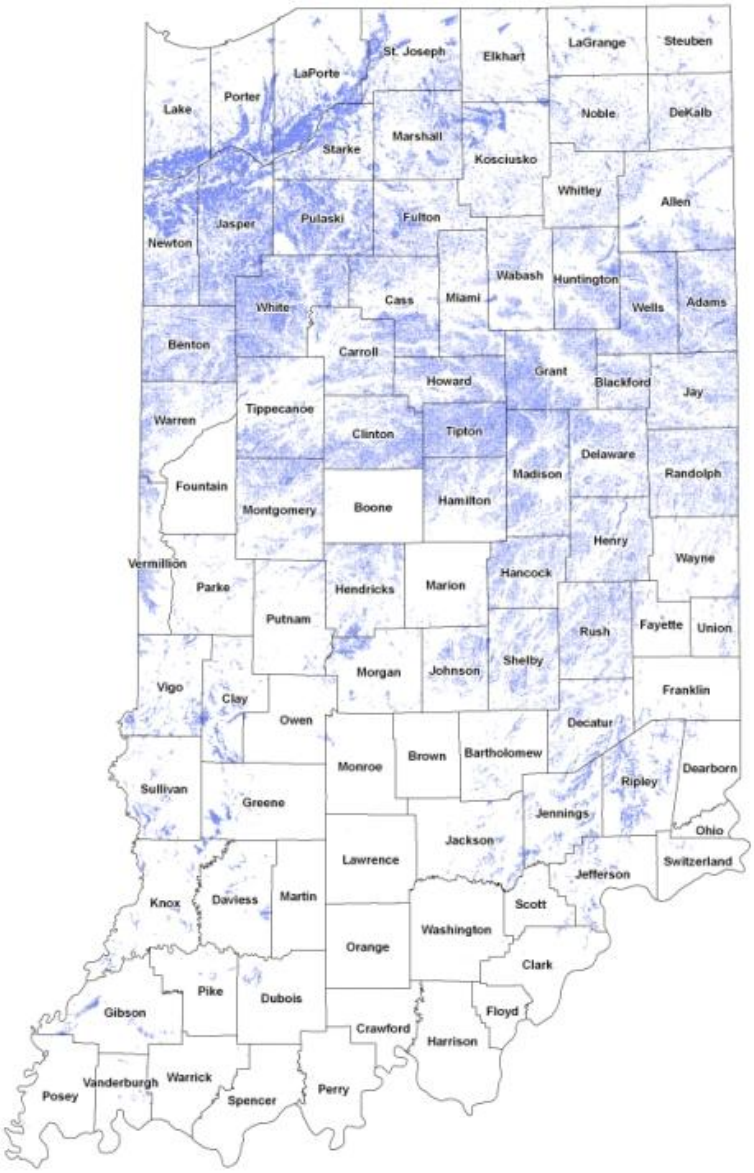
Ecoregions

- Central Corn Belt Plains
- Eastern Corn Belt Plains
- Huron/Erie Lake Plains
- Interior Plateau
- Interior River Valleys and Hills
- Southern Michigan/Northern Indiana Drift Plains

Indiana Department of Transportation (INDOT), U.S. Census Bureau (USCB), Indiana Geographic Information Council (IGIC), UITS, Indiana Spatial Data Portal
U.S. Environmental Protection Agency, U.S. Geological Survey

Suitable Soils for Drainage Water Management

Indiana



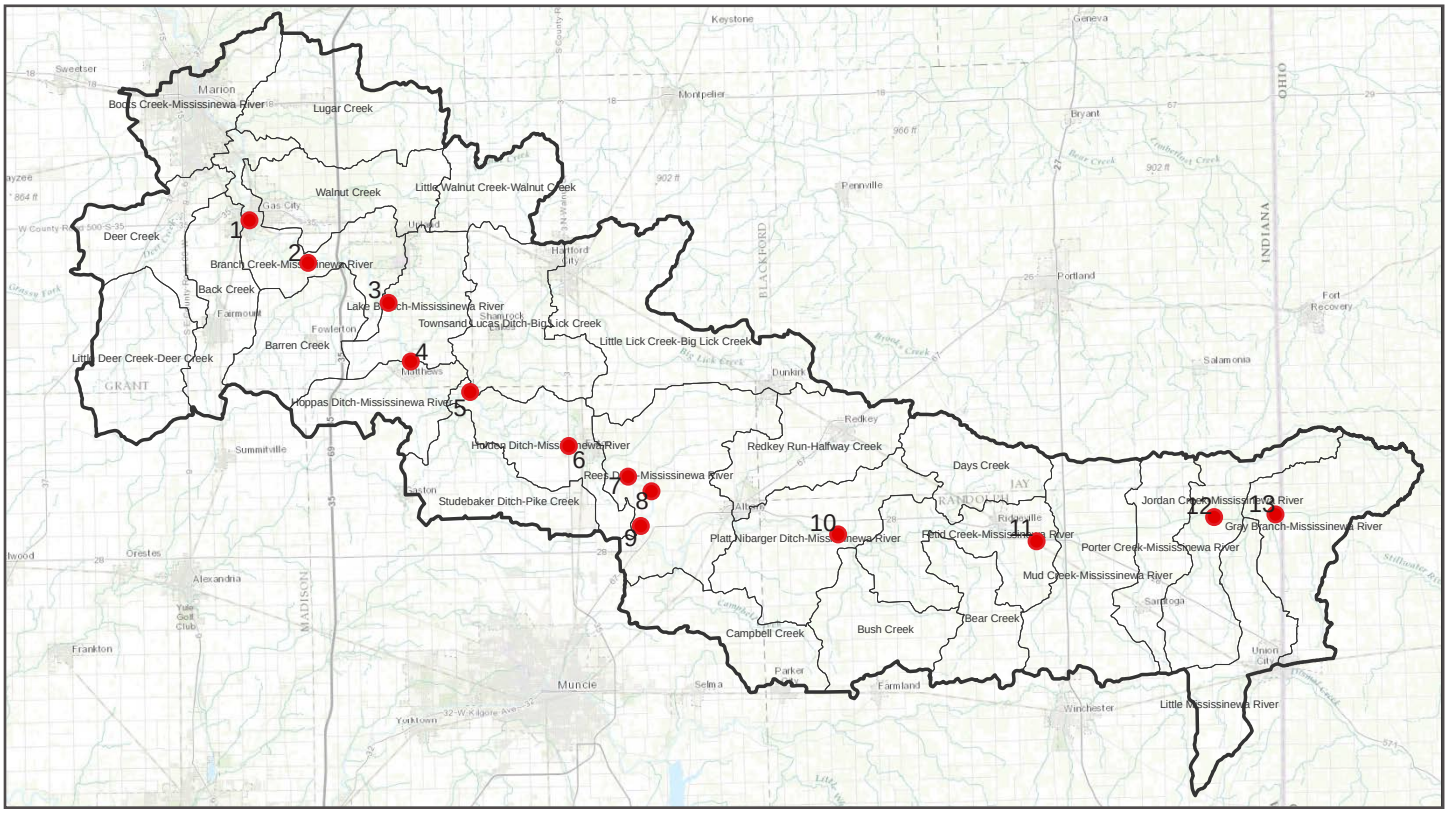
Geoprocessing Procedure
Soils Spatial and Tabular data obtained
from the Soil Data Mart 8/24/2011
Selection Criteria:
1. Major Components. Percent Composition > 40%
2. Representative slope <= 1 percent.
3. Representative value of the Hydric
Definition Growing Season Minimum
Depth of Water Table < 18 inches depth.
Extent of Cultivated Crops obtained from
the 2006 National Land Cover Dataset (NLCD), USGS.
The soil map units selected were converted to
30 meter raster data and intersected with the
reclassified Cultivated Cropland extracted from
the NLCD.
Coincident areas less than 15 acres were deleted.

1:1,500,000

Coordinate System: USA Contiguous Albers Equal Area Conic USGS version
Projection: Albers
Datum: North American 1983
False Easting: 0.0000
False Northing: 0.0000
Central Meridian: -96.0000
Standard Parallel 1: 29.5000
Standard Parallel 2: 45.5000
Latitude Of Origin: 23.0000
Units: Meter

November 16, 2011
Central National Technology Support Center
Fort Worth, TX Map 2012- 25

I. EXISTING STORET DATA



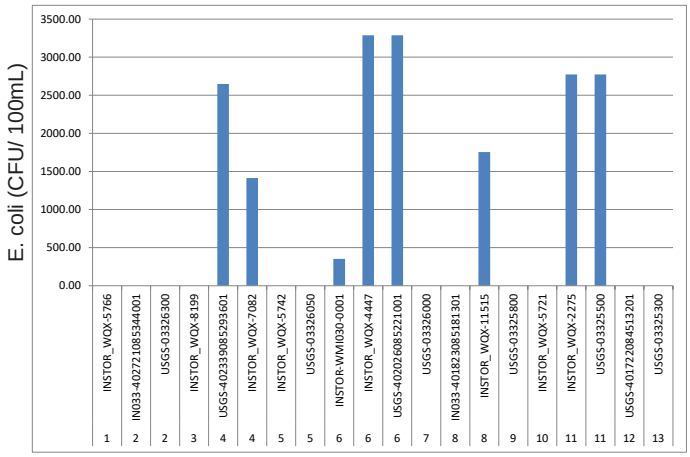
MAP I.1 | STORET MAINSTEM SITES

TABLE I.1 | Count of sampling events found in STORET database

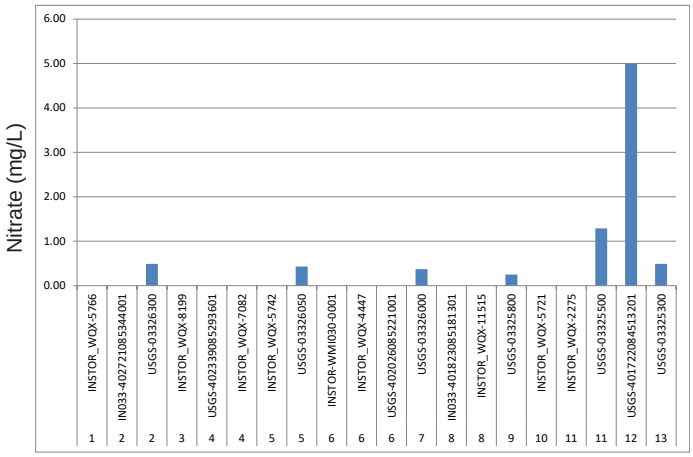
STORET NAME	Site #	Escherichia coli	*Nitrate*	Kjeldahl nitrogen	Total suspended solids	Phosphorus	Turbidity	Total number of laboratory analyses performed
INSTOR_WQX-5766	1							0
IN033-402721085344001	2							0
USGS-03326300	2		2					2
INSTOR_WQX-8199	3			3	3	3	4	13
INSTOR_WQX-7082	4	10					10	20
USGS-402339085293601	4	5					4	9
INSTOR_WQX-5742	5							0
USGS-03326050	5		2					2
INSTOR_WQX-4447	6	5					5	10
INSTOR-WMI030-0001	6	5		38	53	38	77	211
USGS-03326000	7		2					2
IN033-401823085181301	8							0
INSTOR_WQX-11515	8	5		3	3	3	10	24
USGS-03325800	9		2					2
INSTOR_WQX-5721	10							0
INSTOR_WQX-2275	11	5					5	10
USGS-03325500	11	5	2				5	12
USGS-401722084513201	12		2	2		2		6
USGS-03325300	13		2					2

FIG. I.1 - I.6 | Storet Subwatershed Averaging

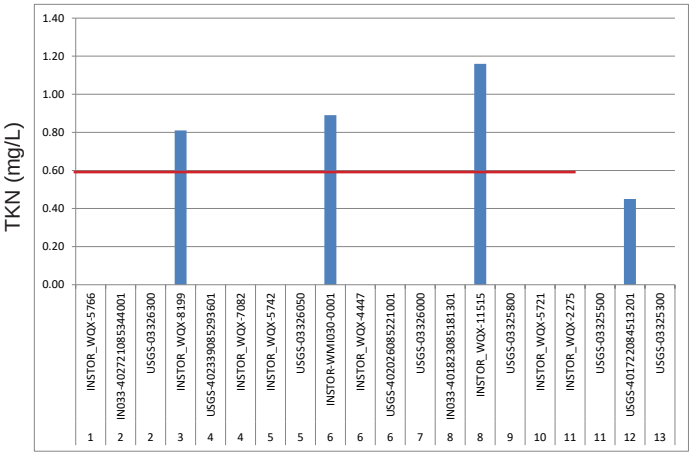
Mainstem Mississinewa River data was extracted from the STORET data set and analyzed independently. These sites also include multiple year averages, with great inconsistency in season, methodology, and storm events. Data in this database was sampled from 1963 to present day. Sample site locations are shown in MAP J.1. Average sample values are meant to characterize the mainstem of the Mississinewa River as it flows westward through predominantly agricultural areas to urban areas. Using this data set, we can make gross conclusions that nitrogen is higher in the upstream agricultural area (Site 12), phosphorus and sediment are relatively consistent (most limited amount of comparable data) and that E. coli, NTU, and TSS spikes at Site 6 downstream of Albany, Indiana.



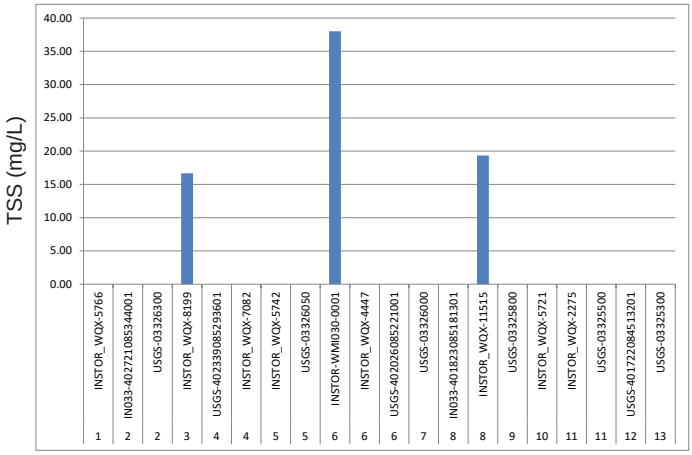
E. coli



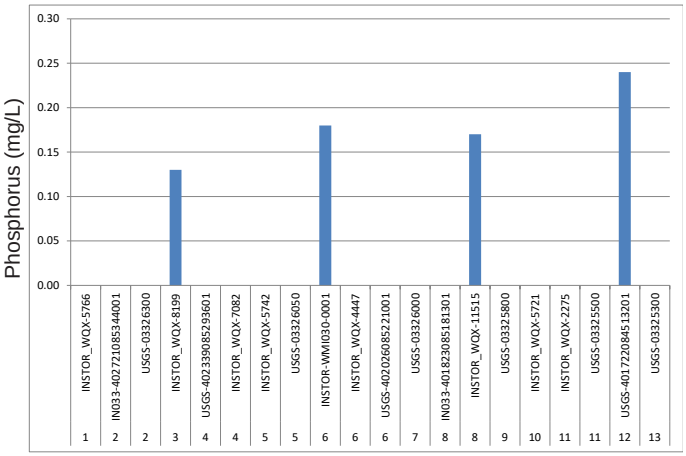
Nitrate



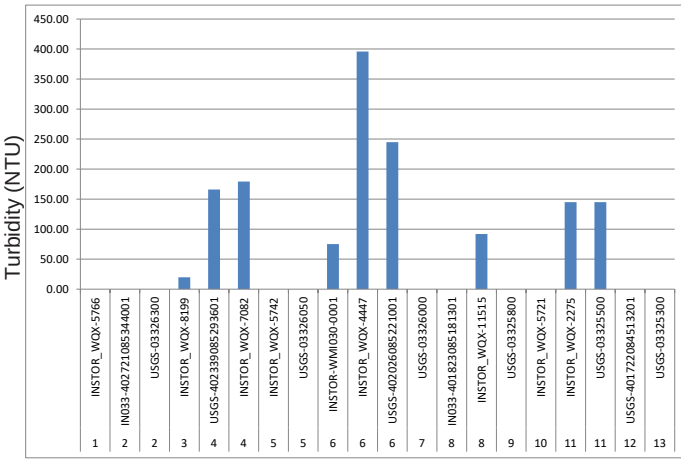
Kjeldahl Nitrogen



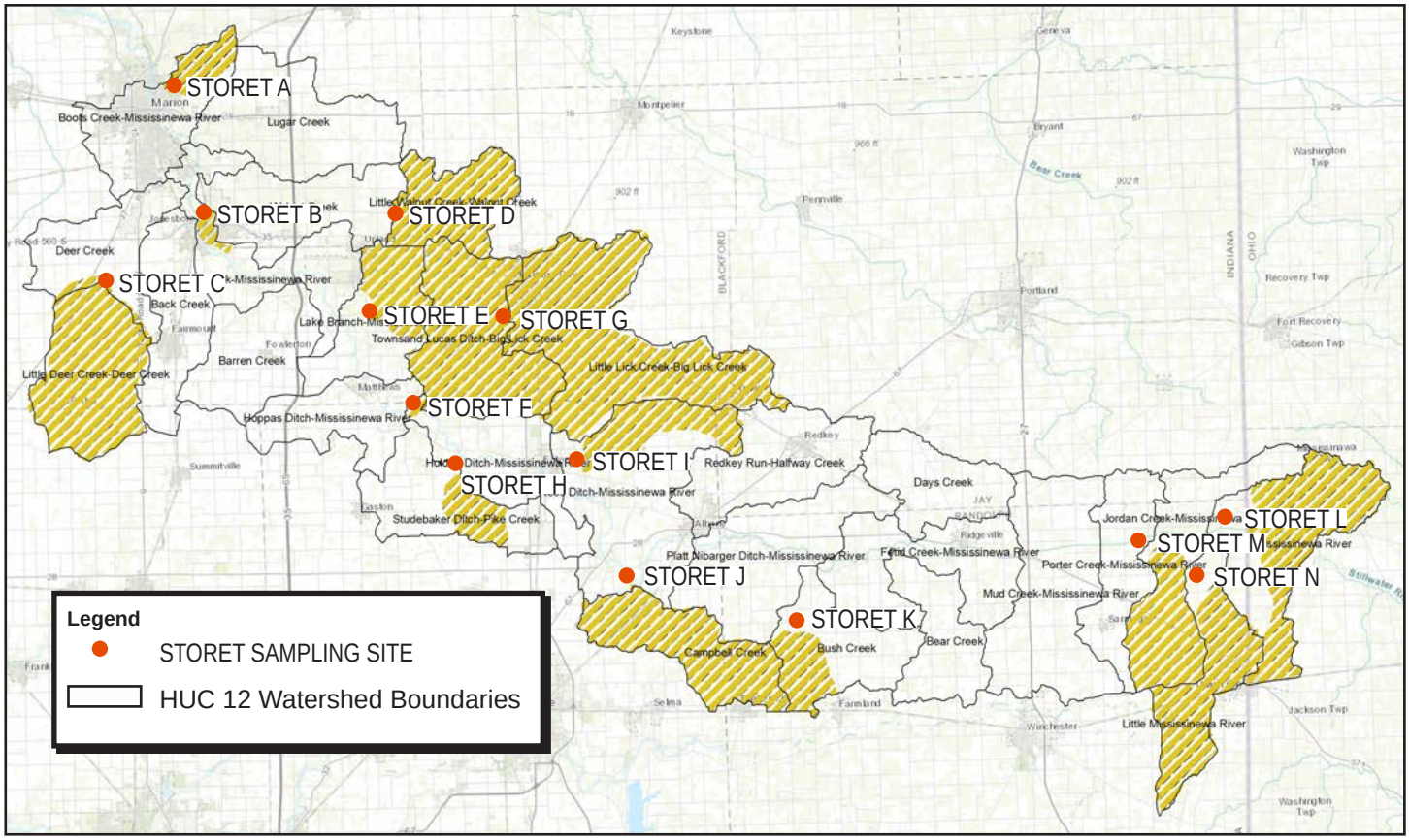
TSS



Phosphorus



Turbidity



MAP I.2 | STORET SUBWATERSHED SITES

TABLE I.2 | Count of sampling events found in STORET database

Row Labels	Site #	Ammonia as NH3	*E. coli*	Kjeldahl nitrogen	Phosphorus	Total suspended solids	Turbidity	Total number of laboratory analyses performed
Boots Creek	A	24	10	53	54	156	119	416
Branch Creek	B	0	5	2	3	4	12	26
Little Deer Creek	C	0	0	0	0	1	1	2
Little Walnut Creek	D	0	0	0	0	1	1	2
Lake Branch	E	0	9	3	3	3	12	30
Big Lick Creek	F	5	7	4	5	4	13	38
Little Lick Creek	G	58	60	68	67	62	125	440
Studebaker Ditch	H	0	0	0	0	0	0	0
Rees Ditch	I	0	0	0	0	0	3	3
Campbell Creek	J	0	0	0	0	0	0	0
Bush Creek	K	0	10	4	4	4	15	37
Gray Branch	L	0	0	0	0	0	0	0
Jordan Creek	M	0	10	5	5	6	18	44
Little Mississinewa River	N	5	10	7	8	8	22	60

FIG. I.7 - I.12 | Storet Ranking Diagrams
Generated from Subwateshed Data extracted from STORET Database. See Table 7.8 in WMP.

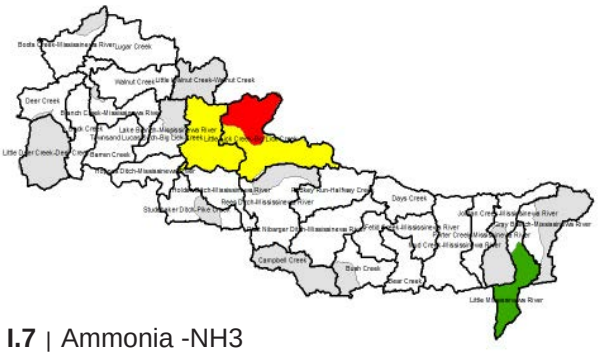


FIG. I.7 | Ammonia -NH3
Subwatersheds are ranked on a gradient (red high and green low; white no data) based on the average concentration of ammonia calculated using data from STORET database.

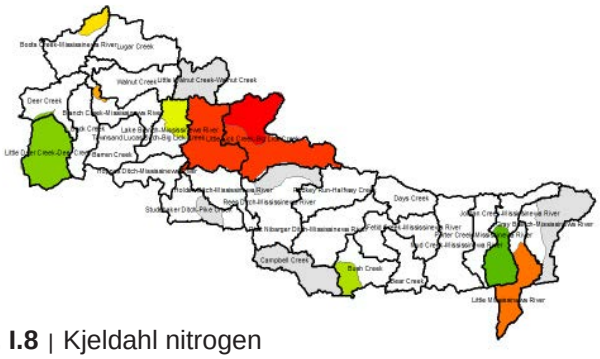


FIG. I.8 | Kjeldahl nitrogen
Subwatersheds are ranked on a gradient (red high and green low; white no data) based on the average concentration of Kjeldahl nitrogen calculated using data from STORET database.

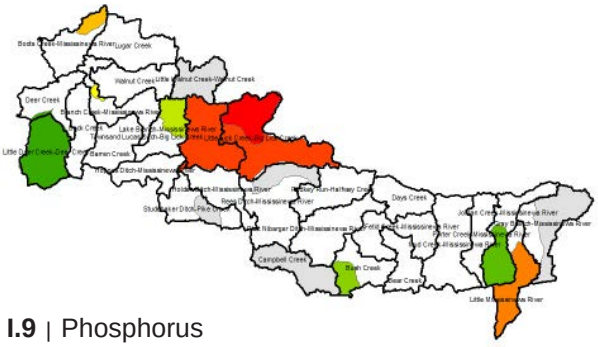


FIG. I.9 | Phosphorus
Subwatersheds are ranked on a gradient (red high and green low; white no data) based on the average concentration of phosphorus calculated using data from STORET database.

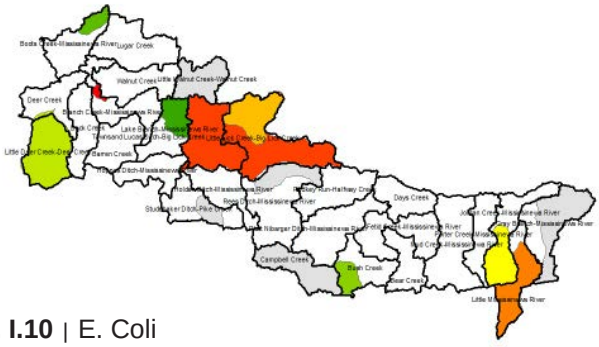


FIG. I.10 | E. Coli
Subwatersheds are ranked on a gradient (red high and green low; white no data) based on the average concentration of E. coli calculated using data from STORET database.

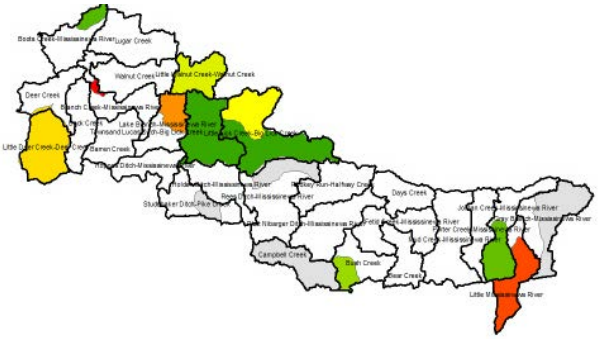


FIG. I.11 | TSS
Subwatersheds are ranked on a gradient (red high and green low; white no data) based on the average concentration of E. coli calculated using data from STORET database.

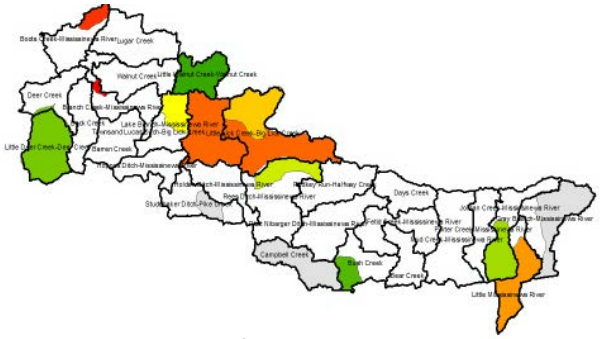


FIG. I.12 | Turbidity (NTU)
Subwatersheds are ranked on a gradient (red high and green low; white no data) based on the average concentration of phosphorus calculated using data from STORET database.

J. EXISTING LARE DATA

TABLE J.1 | LARE Phase One Site Locations and Water Quality Averages (For Tributary Subwatersheds Only). Data reported in 1999.

SITE ID	PHASE	SITE NAME	COUNTY	LAT.	LONG.	E. COLI (mg/100L)	Turbidity (NTU)	Total P (mg/L)	N+N (mg/L)
UM1	1	Mud Creek	Randolph	0	0	20,490.00	37.95	0.35	9.40
UM2	1	Clear Creek	Randolph	0	0	24,943.33	50.75	0.25	7.80
UM3	1	Miller Creek	Randolph	0	0	3,683.33	48.60	0.25	5.90
UM4	1	Harshman Creek	Randolph	0	0	1,356.67	46.95	0.21	3.60
UM5	1	Jordan Creek	Randolph	0	0	5,110.00	31.55	0.38	16.00
UM6	1	Goshen Creek	Randolph	0	0	483.33	46.15	0.29	9.90

TABLE J.2 | LARE Phase Two Site Locations and Water Quality Averages (For Tributary Subwatersheds Only). Data reported in 2003.

SITE ID	PHASE	SITE NAME	COUNTY	LAT.	LONG.	E. COLI (mg/100L)	Turbidity (NTU)	Orthophos-phate (mg/L)	Total P (mg/L)	Ammonia (mg/L)	NITRATE (mg/L)
Site 10	2	Days Creek	Randolph	40.17.48	85.04.00	198.00	106.90	0.33	0.39	0.20	9.75
Site 11	2	Platt Nibarger Ditch	Randolph	40.17.64	85.08.60	1,041.50	74.85	0.39	0.47	0.30	14.50
Site 12	2	Halfway Creek	Delaware	40.19.27	85.13.69	3,119.00	90.55	0.37	0.41	0.30	15.25
Site 13	2	Ridge Run	Randolph	40.16.66	85.02.19	2,835.50	120.35	0.29	0.38	0.10	2.65
Site 23	2	Acid Creek		0	0	23		0.46			0.4
Site 16	2	Halfway Creek		0	0	750		1.0			2.5
Site 17	2	Halfway Creek		0	0	25		.56			.7
Site 4	2	Fetid Creek	Randolph	40.16.77	85.01.61	2,345.00	118.40	0.43	0.48	0.25	6.85
Site 5	2	Bear Creek	Randolph	40.16.77	85.04.53	1,524.50	114.15	0.34	0.40	0.15	3.90
Site 6	2	Heuss Ditch	Randolph	40.16.50	85.07.36	1,372.50	164.60	0.31	0.36	0.20	5.55
Site 7	2	Bush Creek	Randolph	40.15.00	85.08.34	861.50	159.65	0.29	0.34	0.20	4.55
Site 8	2	Elkhorn Creek	Randolph	40.15.00	85.09.13	3,064.00	83.65	0.38	0.43	0.20	12.25
Site 9	2	Mud Creek	Delaware	40.17.25	85.14.16	276.00	68.15	0.41	0.46	0.20	7.50

TABLE J.3 | LARE Phase Three Site Locations and Water Quality Averages (For Tributary Subwatersheds Only). Data reported in 2009.

SITE ID	PHASE	SITE NAME	COUNTY	LOCATION (UTM)		E. COLI (mg/100L)	Turbidity (NTU)	Total P (mg/L)	NO2/NO3 (mg/L)	Ammonia (mg/L)	*TN (mg/L)
BD01	3	Bosman Ditch	Delaware	644078.19	4463946.07	1,050.00	20.63	0.19	1.33		2.28
BD02	3	Bosman Ditch	Delaware	645610.66	4466036.65	1,960.00	26.40	0.22	2.06		2.96
BD03	3	Unamed Trib to Bosman Ditch	Delaware	645624.11	4465350.45	1,835.00	24.80	0.27	1.98		2.79
CC01	3	Campbell Creek	Delaware	645735.20	4458409.78	3,686.67	25.47	0.50	0.75		2.12
CC02	3	Campbell Creek	Delaware	647625.14	4455961.50	3,380.00	29.67	0.33	0.76		1.83
CC03	3	Campbell Creek	Delaware	650974.05	4454365.90	1,730.00	14.90	0.24	0.81		1.80
CC04	3	Campbell Creek	Delaware	650829.96	4454271.69	5,910.00	17.20	0.29	0.89		1.86
HD01	3	Holdren Ditch	Delaware	638651.61	4466847.43	1,366.67	5.70	0.31	1.57		2.24
PC01	3	Pike Creek	Delaware	630998.66	4468984.82	529.33	4.43	0.07	0.62		1.05
PC02	3	Hedgeland Ditch	Delaware	630353.89	4466875.82	1,019.33	4.23	0.18	1.47	0.14	2.19
PC03	3	Studebaker Ditch	Delaware	633882.63	4465914.65	2,703.33	4.67	0.09	1.63		2.15
PC04	3	Studebaker Ditch	Delaware	636950.17	4462873.50	11,666.67	7.27	0.32	2.90	0.14	3.54
RD01	3	Rees Ditch	Delaware	641335.92	4466030.61	3,333.33	17.07	0.15	0.78		1.43
RD02	3	Unnamed Trib to Reese Ditch	Delaware	641063.19	4466054.63	100.00	14.35	0.19	0.25		0.85
RD03	3	Reese Ditch	Delaware	645132.96	4469323.30	1,133.33	19.13	0.11	0.62		1.22
RD04	3	Reese Ditch	Delaware	651134.76	4469761.10	3,000.00	12.23	0.20	2.65	0.22	3.55
UD01	3	Unnamed Ditch	Delaware	634494.76	4467552.70	1,073.33	3.37	0.05	0.87	0.14	1.48

TABLE J.4 | LARE Phase 4 Water Quality Averages (For Tributary Subwatersheds Only). Data reported in 2012.										
SITE ID	PHASE	NAME	COUNTY	LAT	LONG	E. COLI*	NTU	ORTHO-PHOS	TotalP	NITRATE
1	4	Buck Creek	Grant	40°35'17.47"N	85°39'37.52"W	672.56	16.63	0.08	0.06	2.83
2	4	Massey Creek	Grant	40°34'16.93"N	85°39'02.62"W	161.7	20.48	0.03	0.04	1.97
3	4	Lugar Creek	Grant	40°32'19.96"N	85°37'40.00"W	555.32	12.80	0.11	0.04	2.07
4	4	Walnut Creek	Grant	40°30'07.13"N	85°36'55.89"W	570.32	14.65	0.05	0.05	1.80
5	4	Lake Branch	Grant	40°25'56.50"N	85°30'49.85"W	723.08	11.98	0.09	0.06	4.57
6	4	Smith Ditch	Grant	40°24'09.04"N	85°29'32.64"W	0	53.70	0.04	0.05	2.40
7	4	Boots Creek	Grant	40°33'41.60"N	85°39'42.81"W	1276.38	12.63	0.02	0.02	2.10
8	4	Deer Creek	Grant	40°30'30.29"N	85°38'14.72"W	413.14	3.63	0.04	0.03	2.53
9	4	Back Creek	Grant	40°29'25.39"N	85°37'36.19"W	248.9	6.28	0.07	0.05	3.50
10	4	Barren Creek	Grant	40°27'07.52"N	85°32'42.46"W	304.16	8.83	0.02	0.02	3.23
11	4	Hoppas Ditch	Grant	40°23'39.95"N	85°30'03.70"W	917.14	14.35	0.10	0.06	2.70

FIG. J.1 - J.4 | LARE Rankings: All phase subwatersheds ranked per phase.

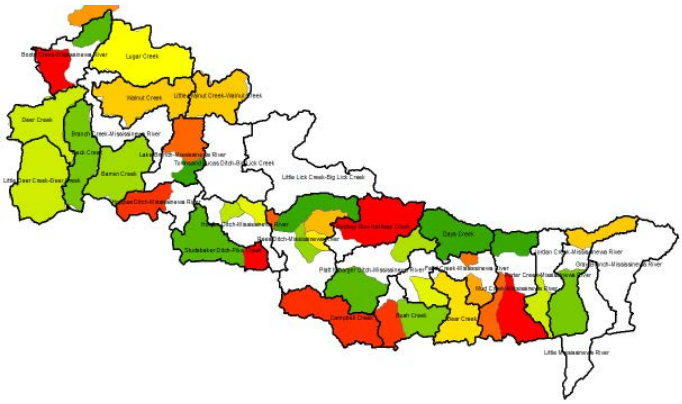


FIG. J.1 | E. Coli Ranking
Subwatersheds are ranked on a gradient (red high and green low) based on surface water E. coli concentrations.

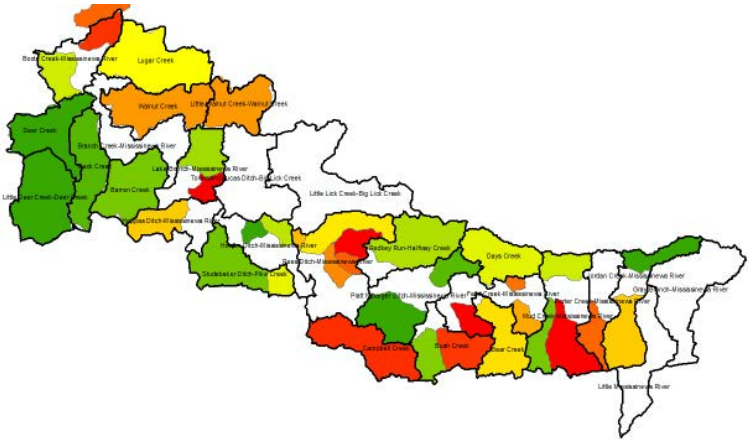


FIG. J.2 | NTU Ranking
Subwatersheds are ranked on a gradient (red high and green low) based on surface water NTUs.

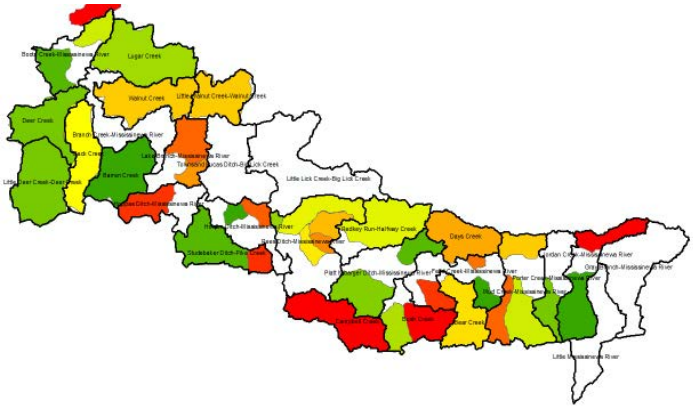


FIG. J.3 | Phosphorus Ranking
Subwatersheds are ranked on a gradient (red high and green low) based on surface water phosphorus concentrations.

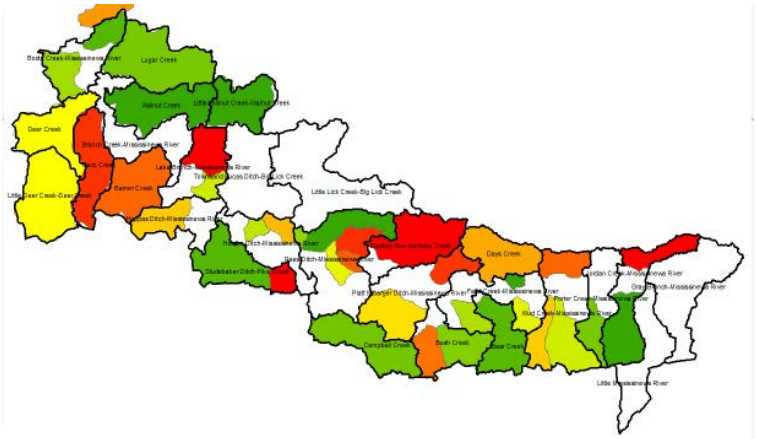


FIG. J.4 | Nitrogen Ranking
Subwatersheds are ranked on a gradient (red high and green low) based on surface water nitrogen concentrations.

FIG. J.5 - J.8 | LARE Rankings: All phase subwatersheds ranked collectively across phases.

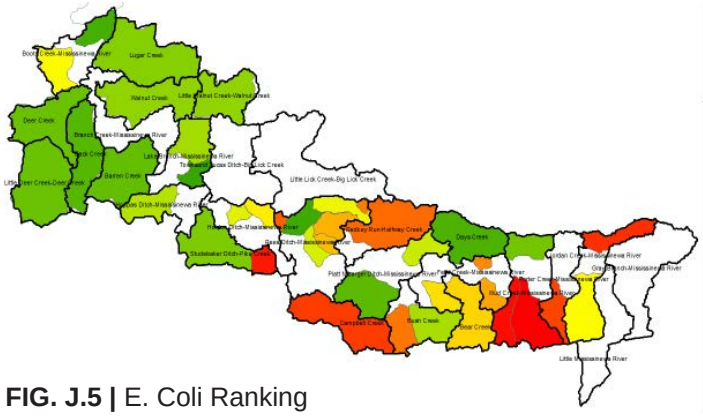


FIG. J.5 | E. Coli Ranking
Subwatersheds are ranked on a gradient (red high and green low) based on surface water E. coli concentrations.

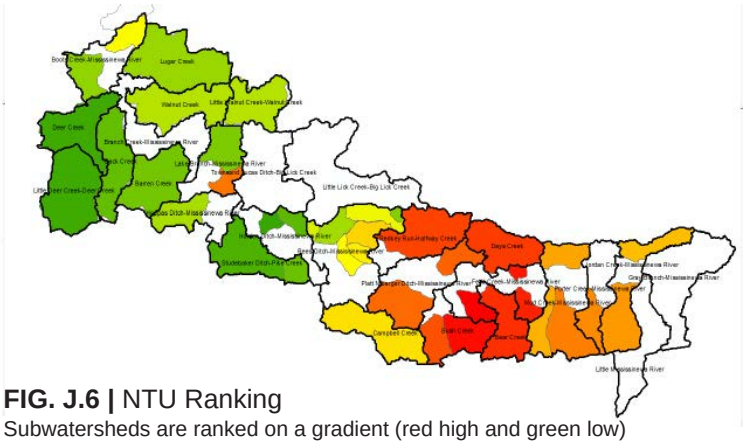


FIG. J.6 | NTU Ranking
Subwatersheds are ranked on a gradient (red high and green low) based on surface water NTUs.

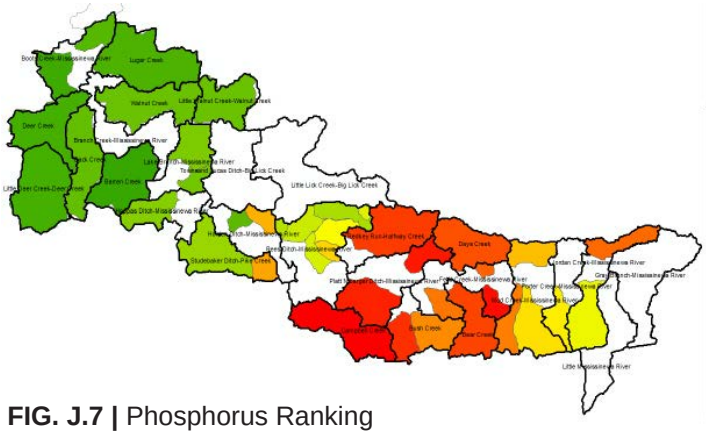


FIG. J.7 | Phosphorus Ranking
Subwatersheds are ranked on a gradient (red high and green low) based on surface water phosphorus concentrations.

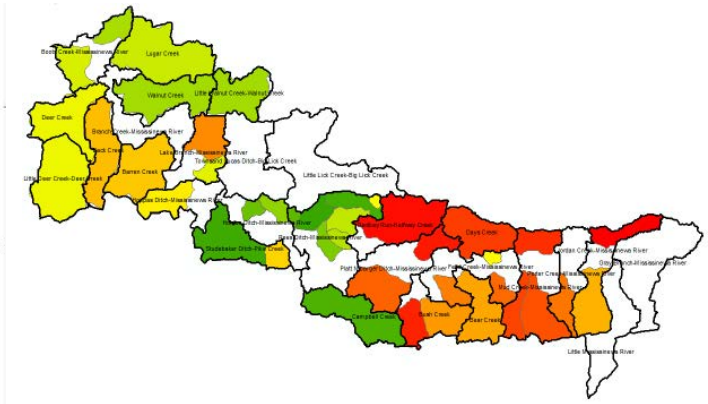


FIG. J.8 | Nitrogen Ranking
Subwatersheds are ranked on a gradient (red high and green low) based on surface water nitrogen concentrations.

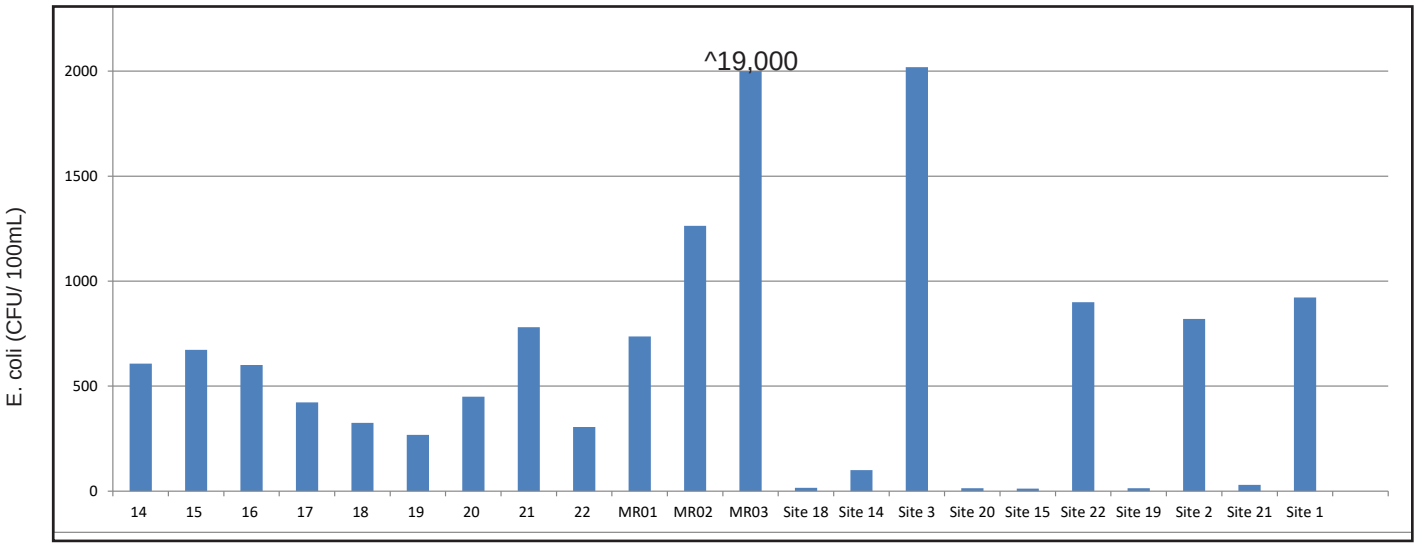


FIG. J.9 | E. coli (MR03 as 2000)
Average E. coli results from LARE mainstem sites (all phases) represented from west to east. See FIG J.4.

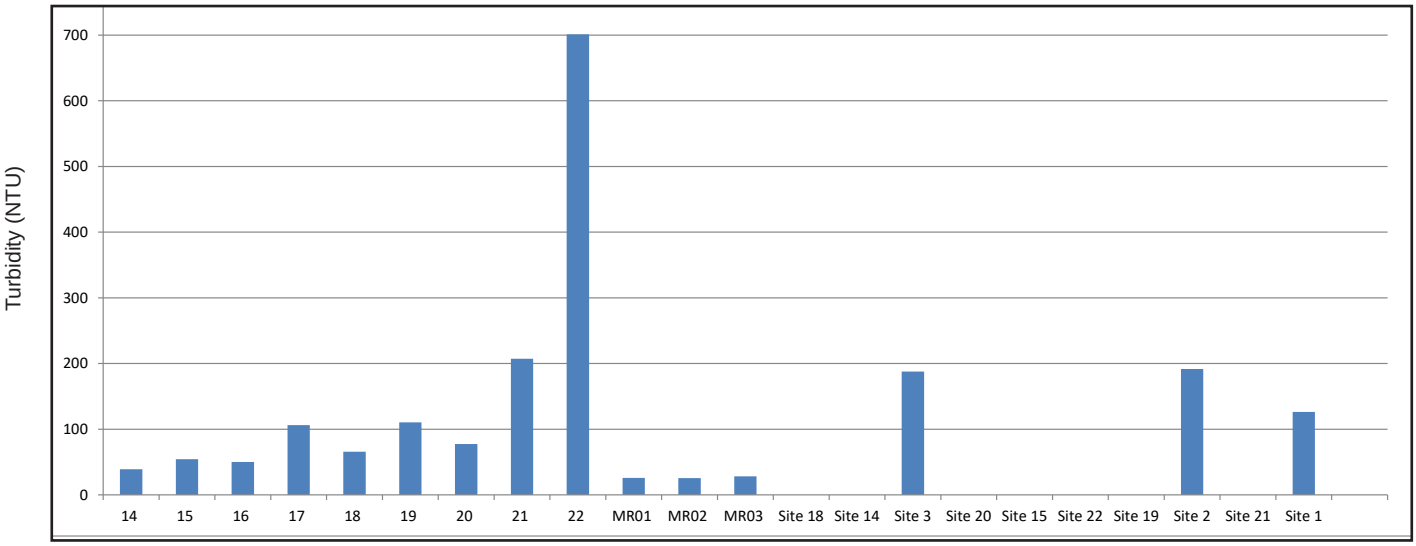
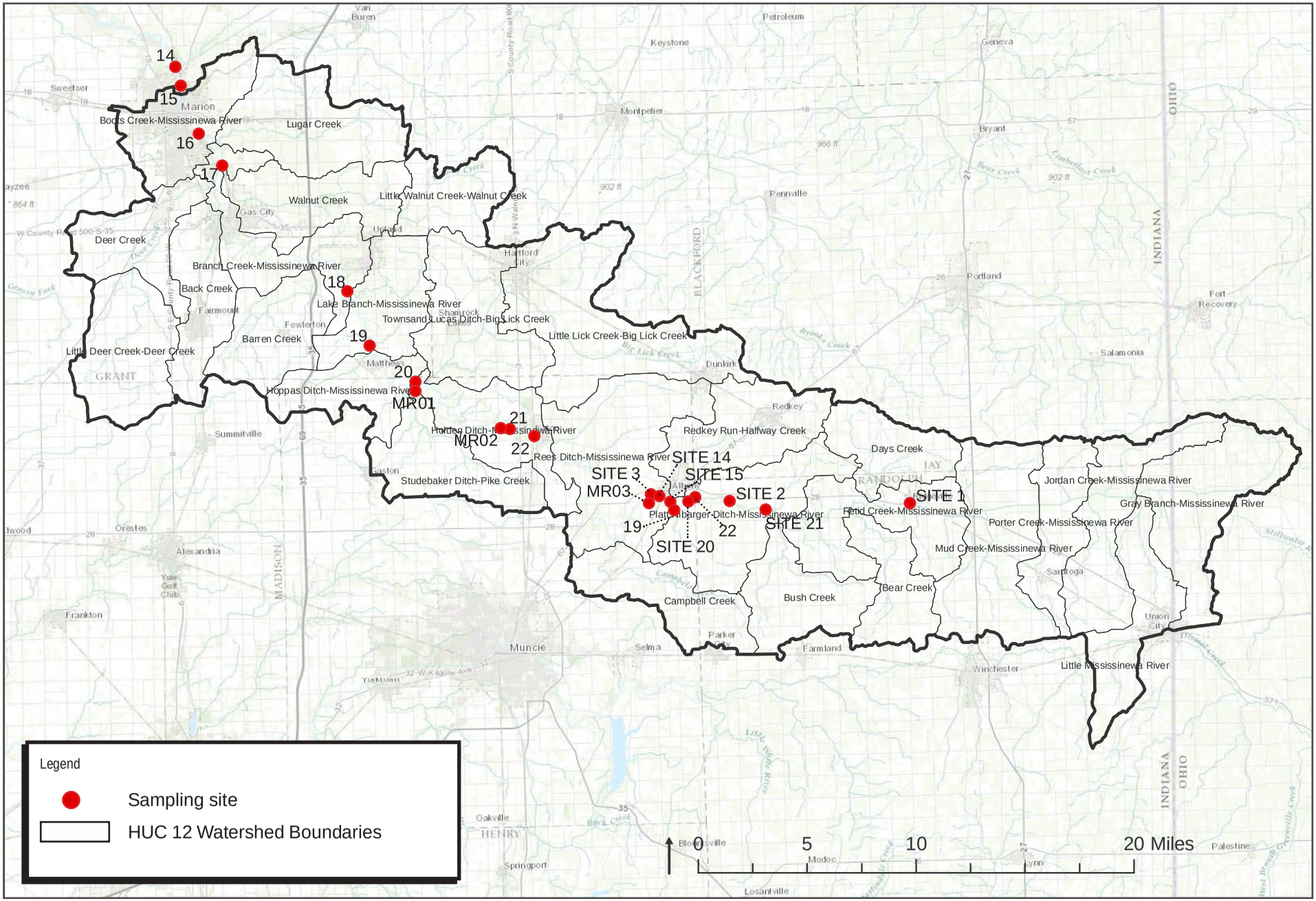


FIG. J.10 | Turbidity (NTU)
Average Turbidity results from LARE mainstem sites (all phases), represented from west to east. See FIG J.4.

TABLE J.5 | STORET and LARE Subwatershed Counts

Row Labels	Ammonia as NH3	E. coli	Nitrate	Nitrite	Nitrogen	Phosphorus	TSS	Total number of laboratory analyses performed
Fetid Creek		86				313	359	758
Holden Ditch		11				186	162	359
Boots Creek		10				54	156	220
Little Lick Creek		60				67	62	189
Mississinewa River	4	45	14	2	9	46	59	175
Little Mississinewa River		10			5	8	8	31
Deer Creek		10			3	6	6	25
Jordan Creek		10				5	6	21
Bush Creek		10				4	4	18
Lick Creek		7				5	4	16
Lake Branch		9				3	3	15
Branch Creek		5				3	4	12
Hoppas Creek		4	2				1	7
Big Lick Creek			2		3			5
Elkhorn Creek					3			3
Harshman Ditch					3			3
Little Deer Creek							1	1
LIttle Walnut Creek							1	1
Total number of laboratory analyses performed from samples collected at all sites		277	18	2	26	700	836	1859



MAP J.1 | LARE Mississinewa mainstem sites

K. SAMPLE SITE DATA

The following tables identify schedule, parameters, and equipment sensitivity for data collected as part of this Watershed Management Planning process. “Current Water Quality Data” discussed in Section 8 of the WMP. Total suspended solids, phosphorus, nitrate and E. coli were analyzed in the lab. PH, dissolved oxygen, and temperature were analyzed in the field using a YSI Pro Plus instrument. Turbidity was measured in the field via a transparency/turbidity tube. Habitat analysis, fish and macroinvertebrates were analyzed in the field.

TABLE K.1 | Study Schedule (See Section 8 in WMP)

Activity	Frequency	Start Date	End Date
Chemical Sample collection: Nitrate, Total Phosphorus, Total Suspended Solids	Monthly	April 2014	March 2015
Flow (monthly all sites)	Monthly	April 2014	March 2015
Physical (monthly all sites) Turbidity, Dissolved Oxygen, pH, Temperature	Monthly	April 2014	March 2015
Bacteriological sampling (monthly all sites) e. coli via lab	Monthly	April 2014	March 2015
Macroinvertebrate sampling	One Sample	Summer 2014	Summer 2014
Habitat Evaluation	One Sample	Summer 2014	Summer 2014
Fish sampling	One Sample	Summer 2014	Summer 2014

TABLE K.2 | Study Parameters

Parameter	Method	Method Detection Limit	Units	Holding Time
pH	EPA 150.1	NA	S.U.	Analyze within 15 min
DO*	SM 18th, 4500-O G.	0.1	mg/L	Analyze within 15 min
Temperature*	EPA 170.1	0.1	OC	Analyze within 15 min
TSS	SM 2540D	10.0/250 ml	mg/L	7 days
PO4-3-P	ASTM D515-88	0.0016	mg/L	28 days
(NO3+NO2)-N	EPA 353.2	0.07	mg/L	24 hrs
E. coli	EPA 1603	1/100 ml	CFUs/100 ml	8 hours
Flow	Buchanan & Somers	NA	m3/s	
Habitat Analysis	Rankin, 1989	NA	NA	
Fish	Ohio and US EPA	NA	Narrative	
Macroinvertebrates	IDEM mIBI	NA	Narrative	

TABLE K.3 | Sensitivity Of In Field Equipment

Parameter	Instrument	Detection Limit
pH	YSI Pro Plus	0-14 units
DO	YSI Pro Plus	0-50 mg/l
Temp	YSI Pro Plus	-5 to 70ºC

TABLE K.4 | Headwaters Mississinewa River				
Site #	Latitude	Longitude	Stream Name	Description
HM-1	40°17'6.47"N	84°55'9.83"W	Gray Branch-Mississinewa River	Located on the N 300 E Bridge at the intersection of the Mississinewa River.
HM-2	40°17'21.82"N	84°52'53.12"W	Mud Creek-Mississinewa River	Located at the N 500 E Bridge at the intersection of the Mississinewa River.
HM-3	40°17'16.46"N	84°49'55.60"W	Porter Creek-Mississinewa River	Located at the E 850 N Bridge at the intersection of Porter Creek.
HM-4	40°17'36.45"N	84°49'27.83"W	Jordan Creek-Mississinewa River	Located on the N 800 E Bridge at the intersection of the Mississinewa River.

TABLE K.5 | Massey Creek-Mississinewa River				
Site #	Latitude	Longitude	Stream Name	Description
MC- 1	40°34'34.77"N	85°39'34.41"W	Mississinewa River	Intersection of the W Highland Ave Bridge and the Branch Creeketween North Washington Street and N Matter Park Road.
MC- 2	40°32'19.98"N	85°37'39.52"W	Lugar Creek	Stone Road bridge North of Stonecrest Manor Mobile Home 2801 Stone Rd, Marion, IN 46953.
MC- 3	40°31'26.30"N	85°37'27.24"W	Mississinewa River	East 38th Street Bridge located between Riverside Ave and Stone Road
MC- 4	40°30'30.16"N	85°38'14.88"W	Deer Creek	Bridge at South Lincoln Blvd located between E 49th Street and E 54th Street.
MC- 5	40°27'31.37"N	85°42'3.47"W	Little Deer Creek-Deer Creek	Sampling site at CO Rd 650 S Bride located between Strawtown Pike and S 100 W.
MC- 6	40°29'20.99"N	85°37'43.93"W	Back Creek	Sampling site located in the Southwest intersection of the East Jonesboro Bypass and State Road 15.
MC- 7	40°30'7.48"N	85°36'55.41"W	Walnut Creek	Bridge near intersection of S Garthwaite Road and E Tulip Drive. North of Mississinewa High School.
MC- 8	40°29'30.24"N	85°29'1.03"W	Little Walnut Creek- Walnut Creek	Site located on S 1000 E Bridge south of Co Road 400 S.
MC- 9	40°27'7.72"N	85°31'35.51"W	Mississinewa	Site located on the Co Road 700 S Bridge just west of South 800 E.
MC-10	40°27'7.63"N	85°32'42.42"W	Barren Creek	Sampling site located on Co Road 700 S Bridge between US35 and S 700 E.
MC-11	40°25'21.47"N	85°30'30.38"W	Mississinewa	26 Bridge just east of Wheeling Pike

TABLE K.6 | IDEM Sample Sites For TMDL					
Site #	IDEM Site #	Latitude	Longitude	Stream Name	Description
EM-1	WMI-03-0006	40°25’47.28”N	85°23’20.95”W	Upper Big Lick Creek	Located at CR 100 W.
EM-2	WMI-03-0009	40°22”37.62”N	85°26’52.32”W	Big Lick Creek	Located at CR 1275 N.
EM-3	WMI-04-0012	40°22’20.85”N	85°27’23.16”	Mississinewa River-Holden	Located at CR 364 W.
EM-4	WMI-04-0011	40°21’47.35”N	85°27’25.75	Pike Creek	Located on Eaton-Wheeling Pike
EM-5	WMI-04-0017	40°19’7.85	85°19’10.26”	Mississinewa River-Rees	Located at CR 371 E.
EM-6	WMI-04-0014	40°15’39.93	85°17’21.55	Campbell Creek	Located on Schindel Road.
EM-7	WMI-02-0017	40°17’52.10	85°14’13.45	Halfway Creek	Located on Water Street.
EM-8	WMI-02-0018	40°17’30.21	85°14’14.83	Mississinewa River-Platt	Located on Strong Road.
EM-9	WMI-02-0009	40°16’17.70	85°8’42.17	Bush Creek	Located at CR 750 N.
EM-10	WMI-02-0007	40°17’6.76	85°5’33.82	Mississinewa River-Fetid	Located at CR 600 W.
EM-11	WMI-02-0012	40°16’45.83	85°4’32.05	Bear Creek	Site is located at CR 800 N just upstream of pour point of Bear Creek subwatershed.
EM-12	WMI-02-0006	40°17’29.43	85°	Days Creek	Site is located at St Rd 28 just upstream of pour point of Days Creek subwatershed.
EM-13	WMI020-0002			Mississinewa River -Fetid	Located at CR 100 W, near Ridgeville.

L. NITRATE DATA

TABLE L.1 | Descriptive Statistics for Nitrate (mg/L) Data Collected at UMRW Sites								
Subwatersheds	Drainage	Average of Nitrate	Count of Nitrate	Min of Nitrate	Max of Nitrate	StdDev of Nitrate	75th	25th
Back Creek	16.00	2.49	12.00	1.27	4.72	1.09	3.23	0.31
Barren Creek	21.00	3.59	12.00	0.11	9.23	2.85	5.51	-0.13
Bear Creek	15.00	6.07	6.00	0.10	24.00	9.01	12.15	-2.13
Big Lick Creek	76.00	1.90	8.00	0.80	5.90	1.69	3.04	-0.15
Bush Creek	20.00	2.31	8.00	0.05	11.00	3.66	4.78	-0.91
Campbell Creek	20.00	1.85	9.00	0.05	8.50	2.67	3.65	-0.61
Days Creek	17.00	4.10	6.00	0.20	13.00	5.07	7.52	-0.98
Deer Creek	45.00	3.24	12.00	0.37	6.80	2.01	4.59	0.14
Halfway Creek	25.00	1.69	9.00	0.05	6.10	1.80	2.91	-0.27
Little Deer Creek	26.00	3.45	12.00	0.02	8.21	2.42	5.08	0.02
Little Mississinewa River	21.00	5.26	12.00	0.78	11.10	3.38	7.54	0.17
Little Walnut Creek	17.00	2.03	12.00	0.03	8.41	2.29	3.58	-0.38
Lugar Creek	30.00	1.17	12.00	-	5.60	1.63	2.27	-0.36
Holden Ditch	424.00	2.74	8.00	0.50	11.00	3.42	5.04	-0.67
Rees Ditch	311.00	3.88	6.00	0.80	12.00	4.32	6.80	-0.71
Platt-Nibarger Ditch	240.00	3.67	9.00	0.05	16.00	4.97	7.02	-1.07
Fetid Creek	179.00	4.69	7.00	0.30	16.00	5.47	8.38	-0.97
Mud Creek	133.00	5.08	7.00	0.05	18.00	6.19	9.25	-1.17
Boots Creek	681.00	2.43	24.00	0.02	4.83	1.42	3.38	0.14
Branch Creek	629.00	2.66	12.00	0.50	5.76	1.52	3.68	0.17
Lake Branch	486.00	2.69	12.00	0.06	7.00	1.96	4.01	-0.02
Hoppas Ditch	472.00	2.85	12.00	0.38	6.15	1.88	4.11	0.07
Porter Creek	89.00	5.21	12.00	0.19	14.50	4.35	8.14	-0.29
Jordan Creek	79.00	5.62	12.00	0.32	15.20	4.47	8.64	-0.21
Gray Branch	31.00	6.56	12.00	0.04	17.90	6.07	10.65	-0.63
Pike Creek	21.00	2.20	9.00	0.10	9.10	2.89	4.15	-0.60
Upper Big Lick Creek	52.00	2.10	9.00	0.70	5.10	1.62	3.19	-0.05
Walnut Creek	39.00	1.42	12.00	0.07	6.70	1.84	2.66	-0.38
Grand Total	192.60	3.24	293.00	-	24.00	3.54	5.63	-0.56

TABLE L.2 | Nitrate Averages Separated by Flow Rate							
Subwatersheds	Drainage Area (sq mi)	Average flow rate (cfs)			Average of Nitrate (mg/L)		
		High Flow	Low Flow	Overall Avg. Flow	High Flow Samples	Low Flow Samples	Total Samples
Mainstem Subwatershed	401.80	1585.23	214.29	623.71	7.21	2.45	3.85
Holden Ditch	424.00	640.72	97.06	291.23	6.40	1.52	2.74
Rees Ditch	311.00	591.17	121.56	249.64	8.75	1.45	3.88
Platt-Nibarger Ditch	240.00	228.80	37.32	88.38	9.30	2.06	3.67
Fetid Creek	179.00	337.92	33.39	127.09	11.45	1.98	4.69
Mud Creek	133.00	264.73	24.21	124.43	9.83	1.51	5.08
Boots Creek	681.00	2398.25	317.44	1011.04	2.95	2.17	2.43
Branch Creek	629.00	2923.33	354.67	996.83	4.06	2.19	2.66
Lake Branch	486.00	2750.00	352.00	951.50	4.96	1.93	2.69
Hoppas Ditch	472.00	2740.00	355.67	951.75	5.22	2.05	2.85
Porter Creek	89.00	750.67	72.37	241.94	9.49	3.78	5.21
Jordan Creek	79.00	1146.50	57.24	420.33	9.55	3.65	5.62
Gray Branch	31.00	91.84	12.40	38.88	11.74	3.97	6.56
Tributary Subwatershed	28.69	148.61	25.86	63.38	4.70	1.78	2.73
Back Creek	16.00	98.61	39.22	63.97	2.95	2.17	2.49
Barren Creek	21.00	89.21	15.99	40.40	6.67	2.05	3.59
Bear Creek							6.07
Big Lick Creek	76.00	65.94	20.05	39.72	4.05	1.33	1.90
Bush Creek	20.00	20.11	2.90	8.63	7.05	0.52	2.31
Campbell Creek	20.00	35.43	4.03	16.59	4.27	0.75	1.85
Days Creek							4.10
Deer Creek	45.00	325.05	40.15	111.37	5.78	2.39	3.24
Halfway Creek	25.00	62.06	9.93	25.57	3.65	1.06	1.69
Little Deer Creek	26.00	281.93	40.36	106.24	6.56	2.44	3.45
Little Mississinewa River	21.00	118.46	12.35	38.88	6.91	4.70	5.26
Little Walnut Creek	17.00	145.85	8.46	45.93	3.69	1.53	2.03
Lugar Creek	30.00	204.29	31.35	65.94	3.72	0.71	1.17
Pike Creek	21.00	39.35	7.63	19.16	5.13	0.73	2.20
Upper Big Lick Creek	52.00	57.26	11.63	29.88	2.63	1.83	2.10
Walnut Creek	39.00	340.16	48.64	121.52	3.10	0.86	1.42

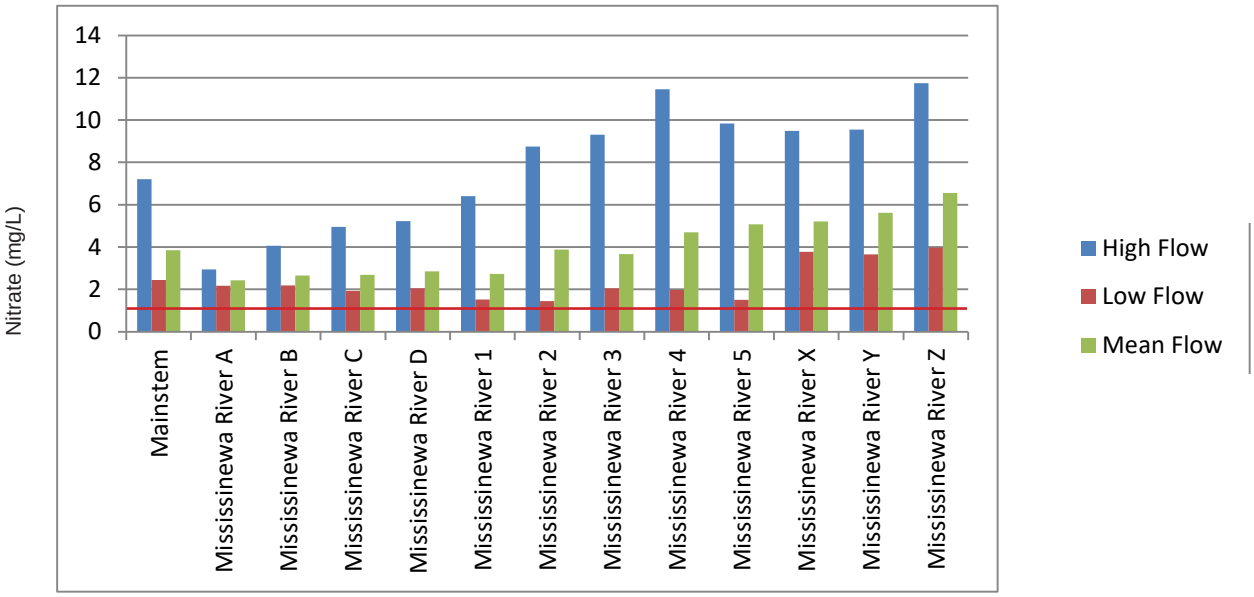


FIG. L.1 | Mainstem Subwatershed Averages for Nitrate

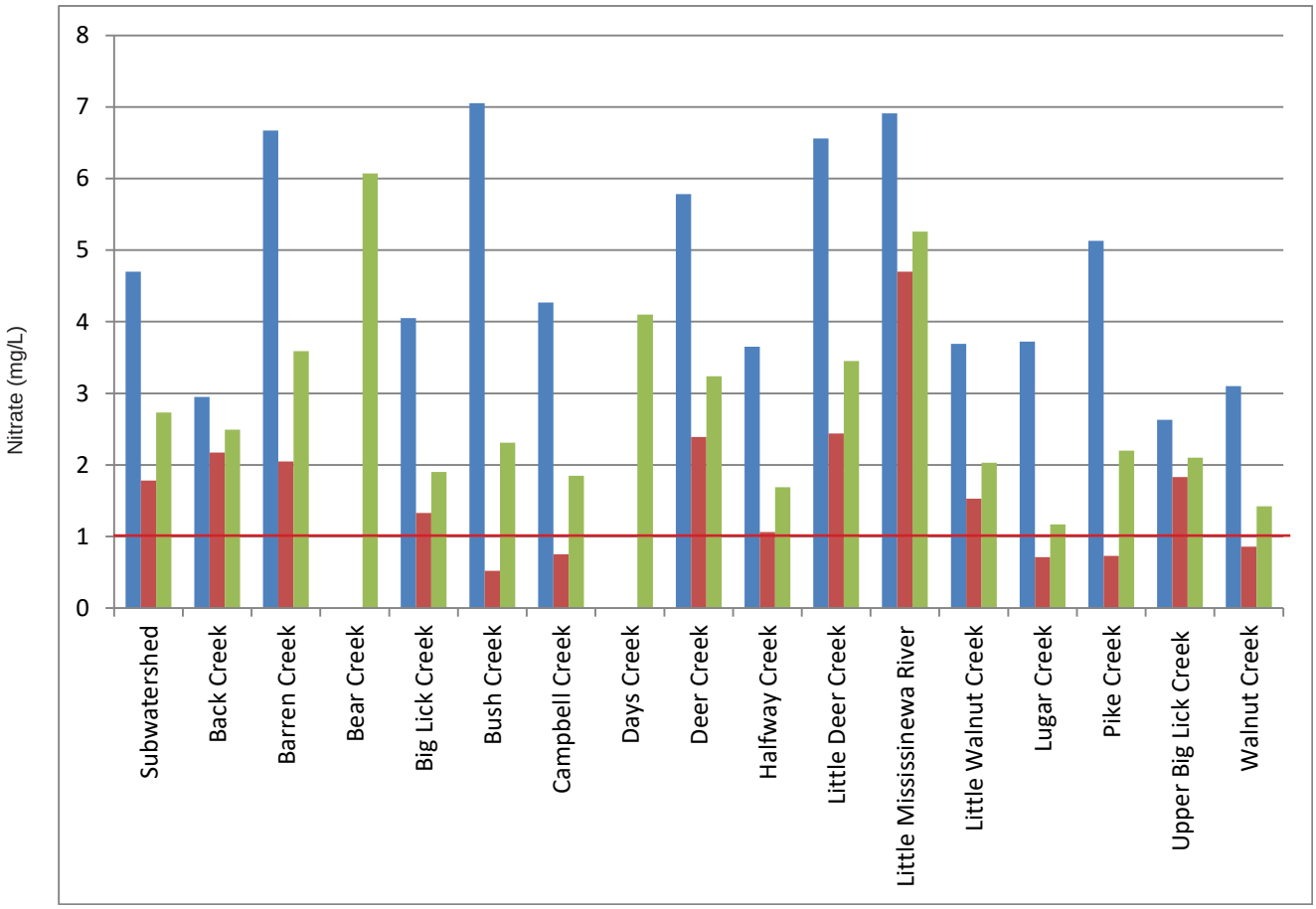


FIG. L.2 | Tributary Subwatershed Averages for Nitrate

TABLE L.3 | Count of Exceedances[1] for Nitrate				
Subwatershed	Number of Exceedences during High Flow	Number of Exceedences during Low Flow	No Flow Data Collected	Total Number of Exceedances
Back Creek	5.00	7.00		12.00
Barren Creek	4.00	5.00		9.00
Bear Creek	---	---	5.00	5.00
Big Lick Creek	2.00	2.00		4.00
Bush Creek	2.00	1.00	1.00	4.00
Campbell Creek	3.00	2.00		5.00
Days Creek	---	---	4.00	4.00
Deer Creek	3.00	6.00		9.00
Halfway Creek	2.00	2.00	1.00	5.00
Little Deer Creek	3.00	6.00	1.00	10.00
Little Mississinewa River	3.00	8.00		11.00
Little Walnut Creek	2.00	6.00	1.00	9.00
Lugar Creek	2.00	2.00		4.00
Holden Ditch	2.00	4.00		6.00
Rees Ditch	2.00	3.00		5.00
Platt-Nibarger Ditch	2.00	4.00		6.00
Fetid Creek	2.00	3.00		5.00
Mud Creek	3.00	2.00		5.00
Boots Creek	8.00	12.00		20.00
Branch Creek	3.00	8.00		11.00
Lake Branch	3.00	7.00		10.00
Hoppas Ditch	3.00	7.00		10.00
Porter Creek	3.00	8.00		11.00
Jordan Creek	4.00	7.00		11.00
Gray Branch	4.00	4.00		8.00
Pike Creek	3.00	2.00		5.00
Upper Big Lick Creek	2.00	4.00		6.00
Walnut Creek	2.00	2.00		4.00
Totals for all sites combined	77.00	124.00	13.00	214.00

TABLE L.4 | Counts and percentages of nitrate exceedances at high and low flows			
Flow	Total Count of Exceedances for Nitrate (for all sites)	Total Count of Samples Analyzed for Nitrate (for all sites containing flow data)	Percent of Samples in Exceedance (for all sites containing flow data)
High	77	80	96%
Low	124	192	65%

1 When an individual sample is above the target set for this watershed management plan, it is considered to be in exceedance. The target concentration for nitrate is 1 mg/L.

TABLE L.5 | Calculated Nitrate Loads: Current Load, Target Load, and Load Reduction Needed

	Drainage area (sq. mi.)	Average flow (cfs)		Average nitrate (mg/L)		Nitrate current load (ton/year)		Nitrate Target (mg/L)	Nitrate target load (ton/year)		Nitrate load reduction needed (ton/year)	
Subwatershed		High	Low	High	Low	High	Low	High	High	Low	High	Low
Mainstem Subwatershed	401.80	1585.23	214.29	7.21	2.45	6718.04	502.35	1.00	1420.43	179.14	5297.60	323.22
Holden Ditch	424.00	640.72	97.06	6.40	1.52	4785.36	157.34	1.00	710.66	83.05	4074.69	74.29
Rees Ditch	311.00	591.17	121.56	8.75	1.45	6078.05	142.36	1.00	599.36	86.33	5478.69	56.04
Platt-Nibarger Ditch	240.00	228.80	37.32	9.30	2.06	2193.55	125.51	1.00	214.21	34.41	1979.34	91.09
Fetid Creek	179.00	337.92	33.39	11.45	1.98	4239.44	71.12	1.00	325.87	24.31	3913.57	46.81
Mud Creek	133.00	264.73	24.21	9.83	1.51	2669.25	26.10	1.00	301.25	10.45	2368.01	15.65
Boots Creek	681.00	2398.25	317.44	2.95	2.17	7255.93	888.49	1.00	2359.31	312.28	4896.62	576.21
Branch Creek	629.00	2923.33	354.67	4.06	2.19	10539.53	904.24	1.00	2875.86	348.91	7663.67	555.33
Lake Branch	486.00	2750.00	352.00	4.96	1.93	11039.91	807.43	1.00	2705.35	346.28	8334.56	461.14
Hoppas Ditch	472.00	2740.00	355.67	5.22	2.05	12466.20	862.67	1.00	2695.51	349.89	9770.69	512.78
Porter Creek	89.00	750.67	72.37	9.49	3.78	5916.58	428.96	1.00	738.48	71.19	5178.10	357.77
Jordan Creek	79.00	1146.50	57.24	9.55	3.65	9680.09	303.65	1.00	1127.88	56.31	8552.21	247.34
Gray Branch	31.00	91.84	12.40	11.74	3.97	687.11	86.83	1.00	90.35	12.20	596.77	74.63
Tributary Subwatershed	28.69	148.61	25.86	4.70	1.78	608.51	50.39	1.00	133.43	22.45	475.08	27.94
Back Creek	16.00	98.61	39.22	2.95	2.17	300.22	92.74	1.00	97.01	38.59	203.21	54.15
Barren Creek	21.00	89.21	15.99	6.67	2.05	610.91	42.30	1.00	87.77	15.73	523.15	26.57
Bear Creek												
Big Lick Creek	76.00	65.94	20.05	4.05	1.33	274.74	22.18	1.00	61.75	19.72	212.99	2.46
Bush Creek	20.00	20.11	2.90	7.05	0.52	168.17	1.77	1.00	20.77	1.73	147.40	0.04
Campbell Creek	20.00	35.43	4.03	4.27	0.75	178.50	2.94	1.00	31.21	2.96	147.29	-0.02
Days Creek												
Deer Creek	45.00	325.05	40.15	5.78	2.39	1655.03	113.15	1.00	319.77	39.50	1335.26	73.65
Halfway Creek	25.00	62.06	9.93	3.65	1.06	332.20	13.85	1.00	70.22	8.53	261.97	5.33
Little Deer Creek	26.00	281.93	40.36	6.56	2.44	1542.13	121.90	1.00	277.35	39.70	1264.78	82.19
Little Mississinewa River	21.00	118.46	12.35	6.91	4.70	620.12	77.16	1.00	116.54	12.15	503.59	65.01
Little Walnut Creek	17.00	145.85	8.46	3.69	1.53	630.25	14.78	1.00	143.49	8.32	486.76	6.46
Lugar Creek	30.00	204.29	31.35	3.72	0.71	602.29	39.29	1.00	200.97	34.10	401.32	5.19
Pike Creek	21.00	39.35	7.63	5.13	0.73	232.20	6.68	1.00	37.09	6.82	195.11	-0.14
Upper Big Lick Creek	52.00	57.26	11.63	2.63	1.83	123.41	15.85	1.00	49.00	11.44	74.41	4.41
Walnut Creek	39.00	340.16	48.64	3.10	0.86	1101.49	54.24	1.00	334.64	47.85	766.85	6.39

Nitrate

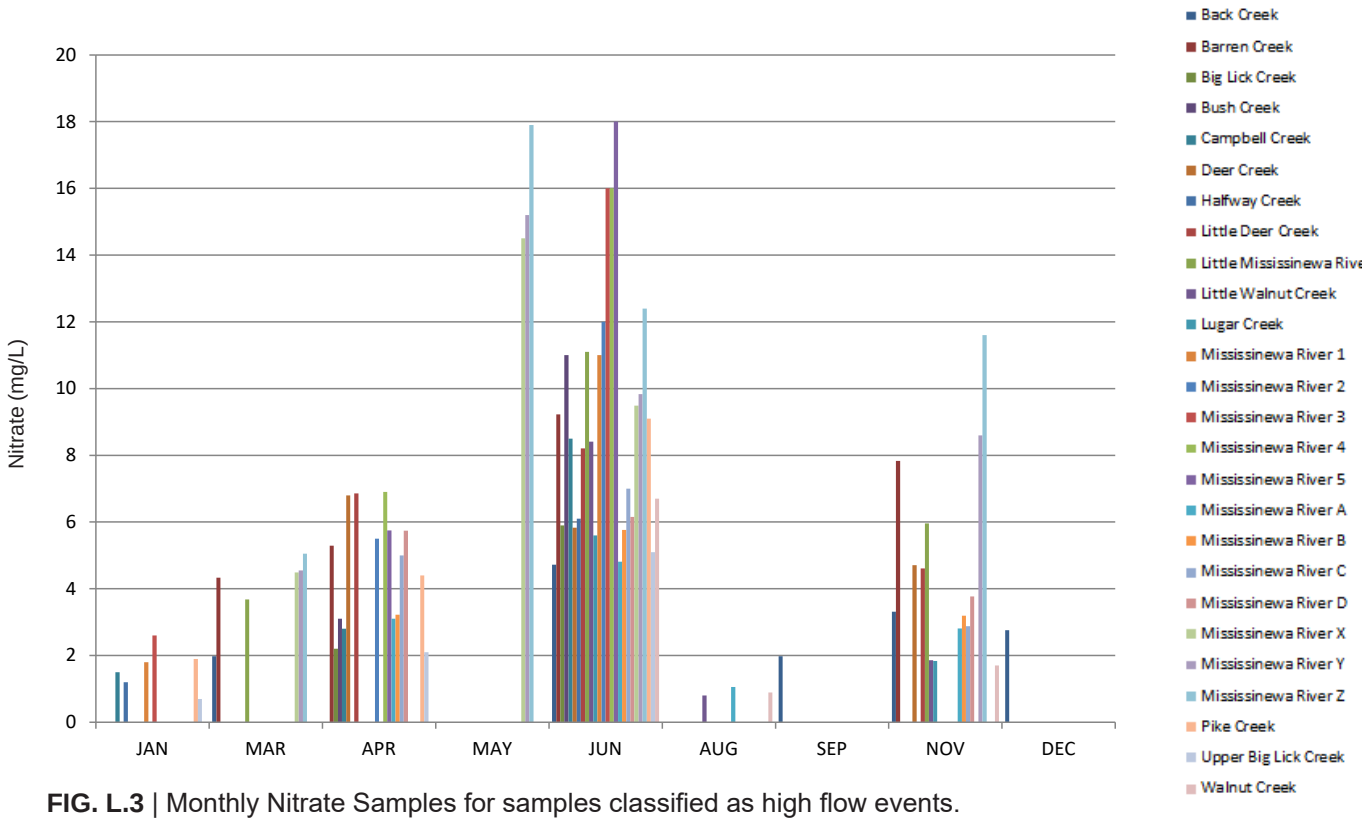


FIG. L.3 | Monthly Nitrate Samples for samples classified as high flow events.

Nitrate Mississinewa Watershed

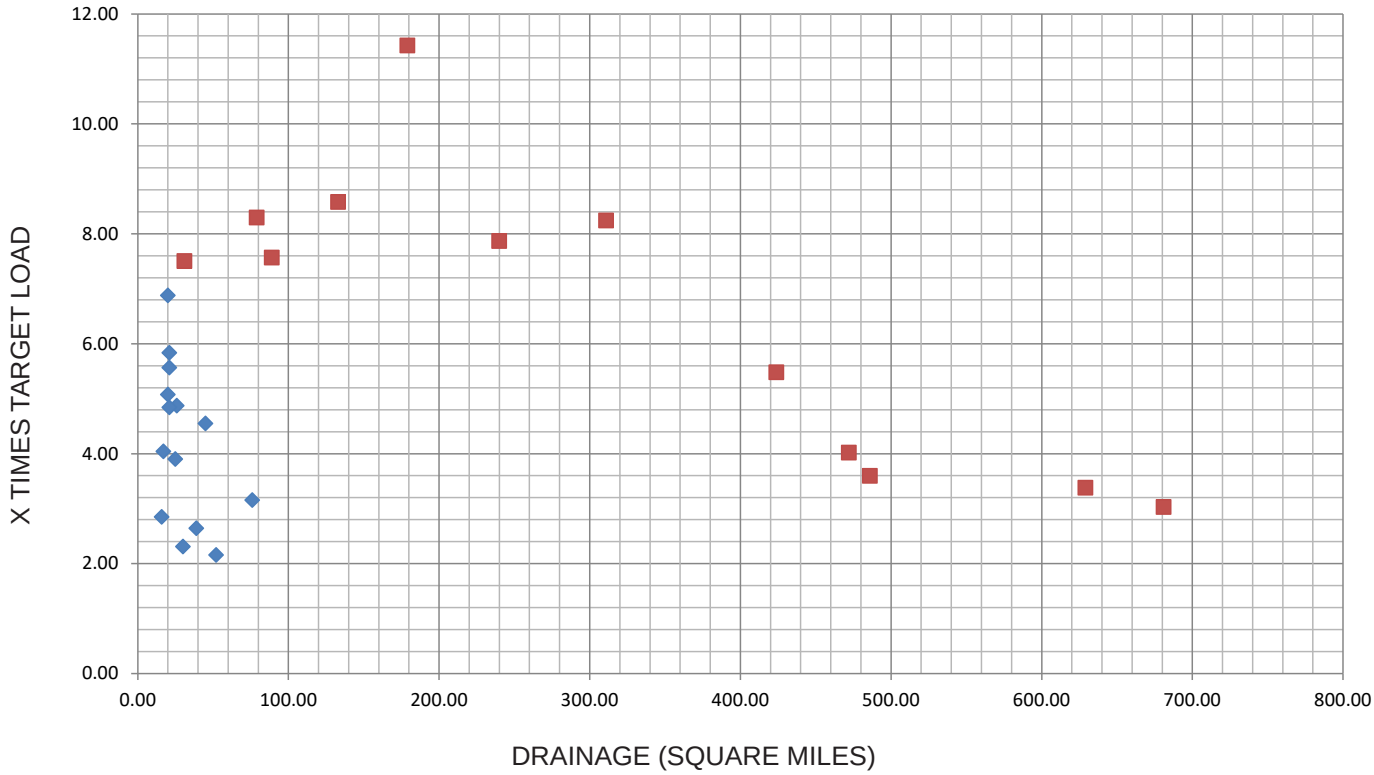


FIG. L.4 | Drainage size vs. X times target load.
"X times" represents how many times the average load (of all sample events) exceeds the target load.
Mainstem sites are represented by red squares and tributary sites by blue diamonds.

Nitrate Mississinewa Mainstem

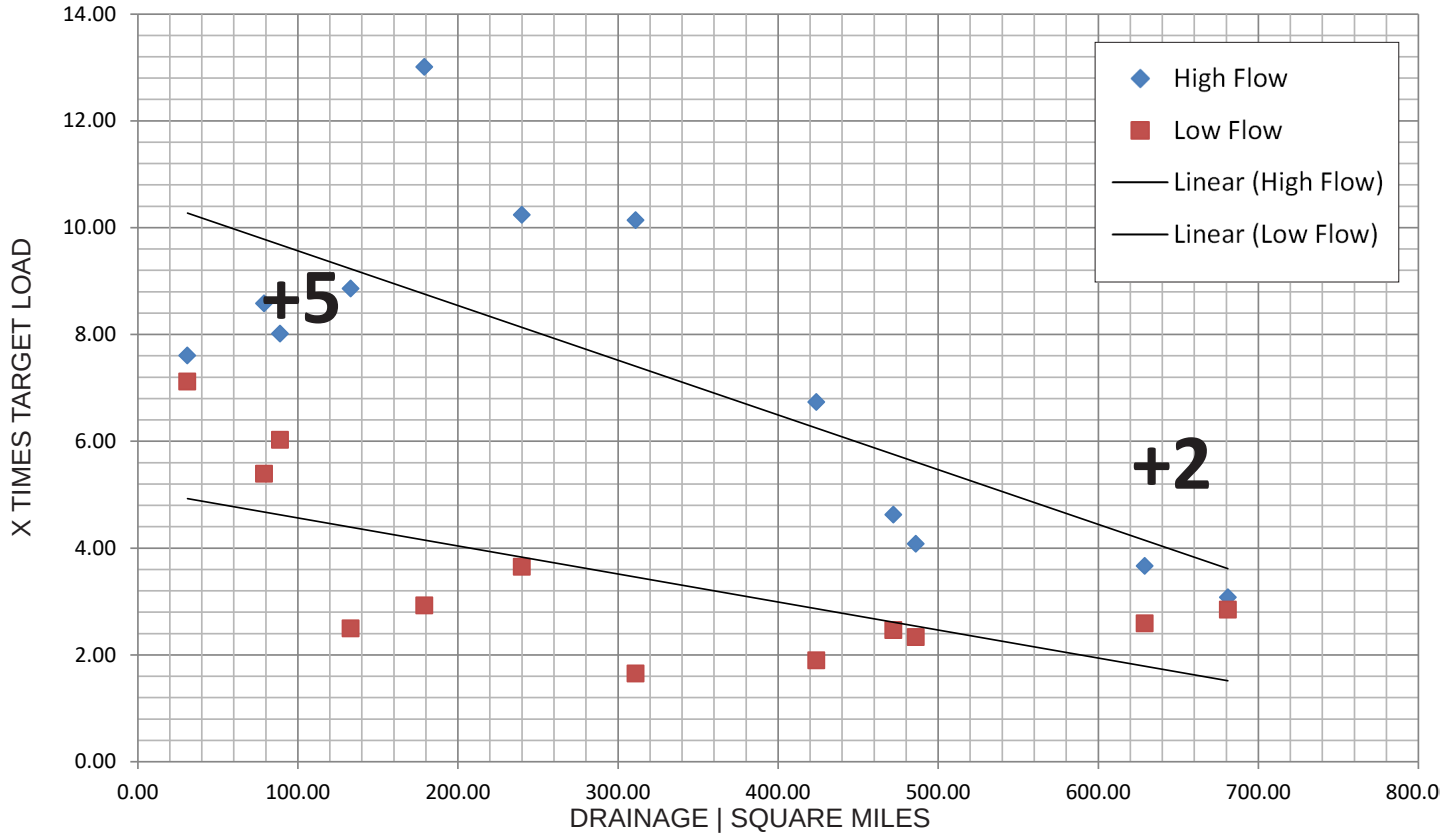


FIG. L.5 | Drainage size vs. X times target load for Mainstem Subwatersheds at High Flow and Low Flow events.

Nitrate+Nitrite Mississinewa ***Subwatersheds***

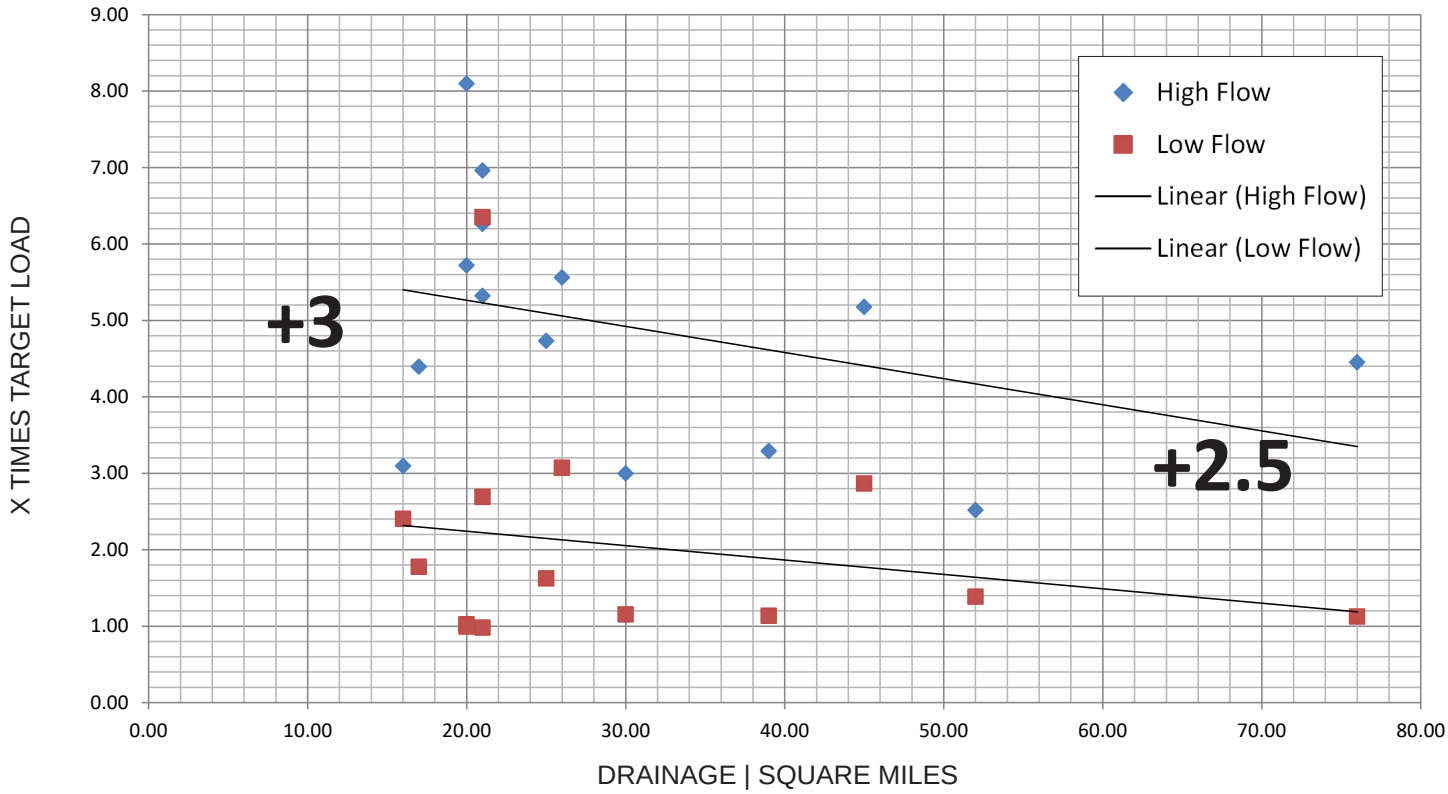


FIG. L.6 | Drainage size vs. X times target load for Tributary Subwatersheds at High Flow and Low Flow events.

M. PHOSPHORUS DATA

TABLE M.1 | Descriptive Statistics for Phosphorus (mg/L) Data Collected at UMRW Sites

Row Labels	Drainage	Average of PHOS	Count of PHOS	Min of PHOS	Max of PHOS	StdDev of PHOS	75th	25th
Back Creek	16.00	0.15	12.00	0.03	0.59	0.16	0.26	-0.02
Barren Creek	21.00	0.08	12.00	0.02	0.28	0.08	0.14	-0.01
Bear Creek	15.00	0.16	7.00	0.08	0.40	0.11	0.23	0.00
Big Lick Creek	76.00	0.34	9.00	0.16	0.98	0.25	0.51	-0.01
Bush Creek	20.00	0.18	9.00	0.08	0.34	0.11	0.25	0.01
Campbell Creek	20.00	0.23	10.00	0.03	0.80	0.25	0.40	-0.04
Days Creek	17.00	0.24	7.00	0.07	0.73	0.24	0.40	-0.03
Deer Creek	45.00	0.11	12.00	0.01	0.75	0.20	0.25	-0.06
Halfway Creek	25.00	0.23	10.00	0.07	0.60	0.16	0.34	0.00
Little Deer Creek	26.00	0.11	12.00	0.01	0.70	0.19	0.24	-0.05
Little Mississinewa River	21.00	0.31	12.00	0.07	0.83	0.20	0.44	0.01
Little Walnut Creek	17.00	0.26	12.00	0.06	0.78	0.26	0.44	-0.03
Lugar Creek	30.00	0.18	12.00	0.01	0.49	0.20	0.32	-0.03
Holden Ditch	424.00	0.24	9.00	0.06	0.63	0.18	0.36	0.00
Rees Ditch	311.00	0.29	7.00	0.16	0.74	0.20	0.42	0.00
Platt-Nibarger Ditch	240.00	0.22	10.00	0.03	0.73	0.20	0.36	-0.02
Fetid Creek	179.00	0.20	8.00	0.10	0.42	0.10	0.27	0.02
Mud Creek	133.00	0.26	8.00	0.08	0.67	0.20	0.39	-0.01
Boots Creek	681.00	0.24	24.00	0.03	0.88	0.25	0.41	-0.04
Branch Creek	629.00	0.41	12.00	0.05	1.63	0.47	0.73	-0.08
Lake Branch	486.00	0.25	12.00	0.06	0.82	0.23	0.41	-0.02
Hoppas Ditch	472.00	0.28	12.00	0.06	0.81	0.24	0.44	-0.02
Porter Creek	89.00	0.37	12.00	0.05	1.20	0.39	0.64	-0.06
Jordan Creek	79.00	0.37	12.00	0.05	1.21	0.39	0.63	-0.06
Gray Branch	31.00	0.30	12.00	0.08	1.08	0.27	0.48	-0.03
Pike Creek	21.00	0.13	10.00	0.03	0.28	0.07	0.18	0.01
Upper Big Lick Creek	52.00	0.38	10.00	0.15	0.98	0.26	0.56	0.01
Walnut Creek	39.00	0.21	12.00	0.03	0.76	0.24	0.37	-0.04
Grand Total	192.60	0.24	306.00	0.01	1.63	0.25	0.41	-0.03

TABLE M.2 | Phosphorus Averages Separated by Flow Rate							
Subwatersheds	Drainage Area (sq mi)	Average flow rate (cfs)			Average of Phosphorus (mg/L)		
		High Flow	Low Flow	Overall Average Flow	High Flow Samples	Low Flow Samples	Total Samples
Mainstem Subwatershed	401.80	1585.23	214.29	623.71	0.52	0.19	0.29
Holden Ditch	424.00	640.72	97.06	291.23	0.41	0.16	0.24
Rees Ditch	311.00	591.17	121.56	249.64	0.51	0.20	0.29
Platt-Nibarger Ditch	240.00	228.80	37.32	88.38	0.52	0.15	0.22
Fetid Creek	179.00	337.92	33.39	127.09	0.29	0.15	0.20
Mud Creek	133.00	264.73	24.21	124.43	0.40	0.12	0.26
Boots Creek	681.00	2398.25	317.44	1011.04	0.49	0.11	0.24
Branch Creek	629.00	2923.33	354.67	996.83	0.54	0.36	0.41
Lake Branch	486.00	2750.00	352.00	951.50	0.60	0.14	0.25
Hoppas Ditch	472.00	2740.00	355.67	951.75	0.64	0.15	0.28
Porter Creek	89.00	750.67	72.37	241.94	0.77	0.24	0.37
Jordan Creek	79.00	1146.50	57.24	420.33	0.56	0.27	0.37
Gray Branch	31.00	91.84	12.40	38.88	0.53	0.18	0.30
Tributary Subwatershed	28.69	148.61	25.86	63.38	0.36	0.13	0.20
Back Creek	16.00	98.61	39.22	63.97	0.25	0.08	0.15
Barren Creek	21.00	89.21	15.99	40.40	0.16	0.05	0.08
Bear Creek							0.16
Big Lick Creek	76.00	65.94	20.05	39.72	0.29	0.25	0.34
Bush Creek	20.00	20.11	2.90	8.63	0.25	0.14	0.18
Campbell Creek	20.00	35.43	4.03	16.59	0.53	0.12	0.23
Days Creek							0.24
Deer Creek	45.00	325.05	40.15	111.37	0.31	0.04	0.11
Halfway Creek	25.00	62.06	9.93	25.57	0.48	0.18	0.23
Little Deer Creek	26.00	281.93	40.36	106.24	0.32	0.04	0.11
Little Mississinewa River	21.00	118.46	12.35	38.88	0.45	0.26	0.31
Little Walnut Creek	17.00	145.85	8.46	45.93	0.65	0.14	0.26
Lugar Creek	30.00	204.29	31.35	65.94	0.46	0.15	0.18
Pike Creek	21.00	39.35	7.63	19.16	0.20	0.10	0.13
Upper Big Lick Creek	52.00	57.26	11.63	29.88	0.33	0.31	0.38
Walnut Creek	39.00	340.16	48.64	121.52	0.57	0.08	0.21

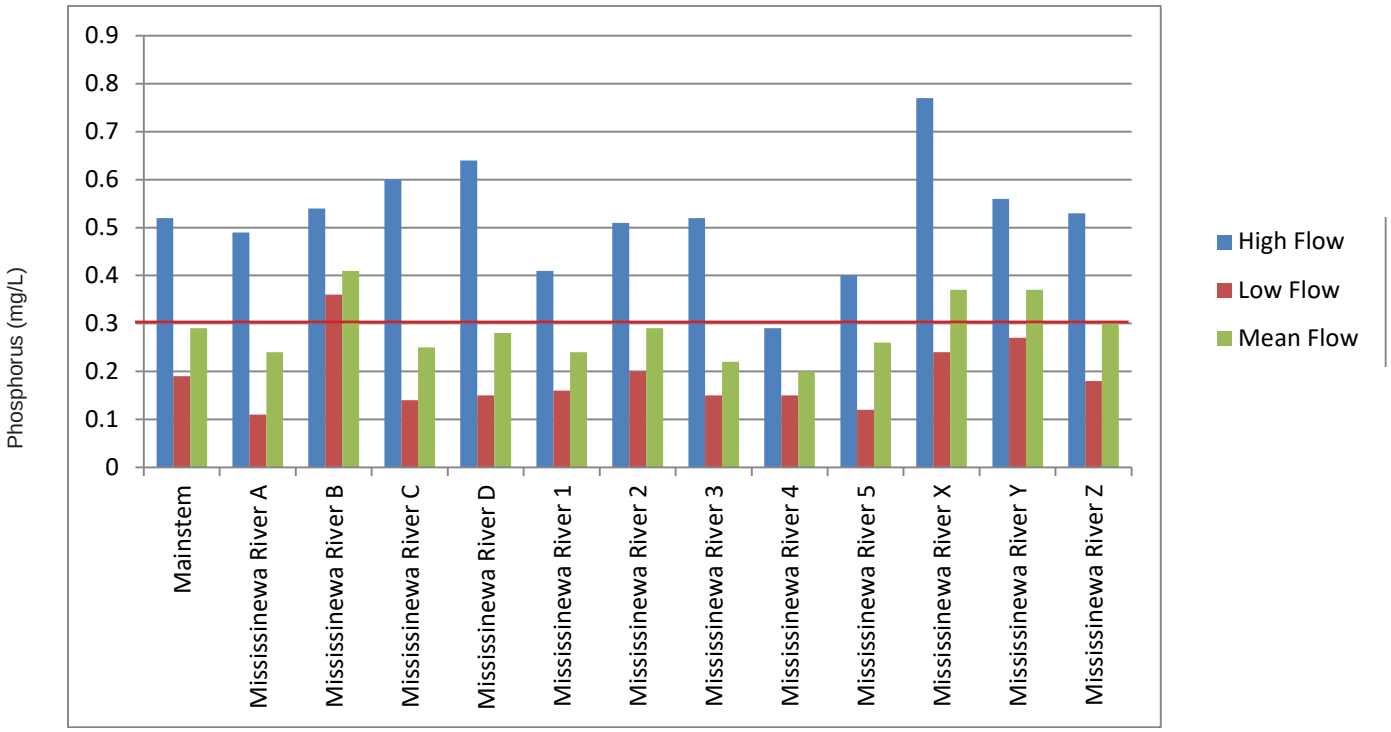


FIG. M.1 | Mainstem Subwatershed Averages for Phosphorus

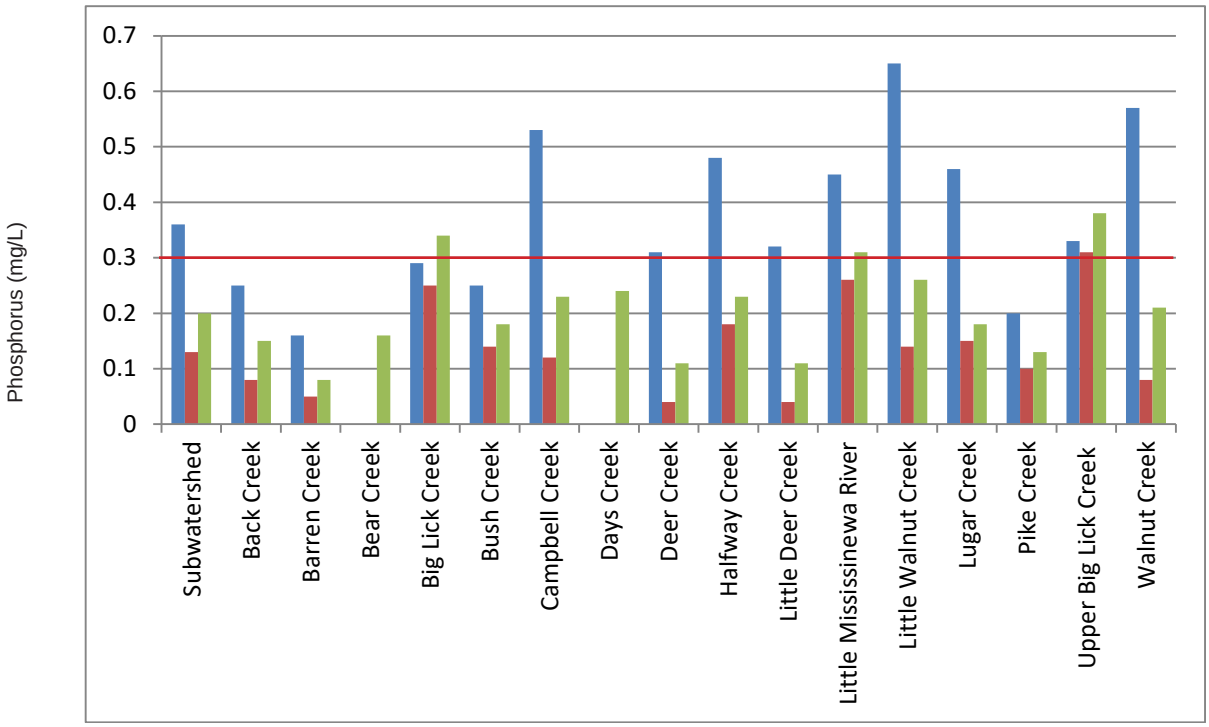


FIG. M.2 | Tributary Subwatershed Averages for Phosphorus

TABLE M.3 | Count of Exceedances[1] for Phosphorus				
Subwatershed	Number of Exceedences during High Flow	Number of Exceedences during Low Flow	No Flow Data Collected	Total Number of Exceedances
Back Creek	1.00			1.00
Bear Creek			1.00	1.00
Big Lick Creek	1.00	1.00	2.00	4.00
Bush Creek	1.00	1.00		2.00
Campbell Creek	2.00			2.00
Days Creek			2.00	2.00
Deer Creek	1.00			1.00
Halfway Creek	2.00			2.00
Little Deer Creek	1.00			1.00
Little Mississinewa River	1.00	5.00		6.00
Little Walnut Creek	3.00	1.00		4.00
Lugar Creek	2.00	2.00		4.00
Holden Ditch	2.00			2.00
Rees Ditch	1.00			1.00
Platt-Nibarger Ditch	2.00			2.00
Fetid Creek	1.00			1.00
Mud Creek	2.00			2.00
Boots Creek	6.00			6.00
Branch Creek	2.00	2.00		4.00
Lake Branch	3.00			3.00
Hoppas Ditch	3.00	1.00		4.00
Porter Creek	2.00	1.00		3.00
Jordan Creek	2.00	1.00		3.00
Gray Branch	3.00	1.00		4.00
Upper Big Lick Creek	2.00	1.00	1.00	4.00
Walnut Creek	3.00			3.00
Totals for all sites combined	49.00	17.00	6.00	72.00

1 When an individual sample is above the target set for this watershed management plan, it is considered to be in exceedance. The target concentration for phosphorus is 0.3 mg/L.

TABLE M.4 | Calculated Phosphorus Loads: Current Load, Target Load, and Load Reduction Needed

	Drainage area (sq. mi.)	Average flow (cfs)		Average phosphorus (mg/L)		Phosphorus current load (ton/year)		Phospho-rus Target (mg/L)	Phosphorus target load (ton/year)		Phosphorus load reduction needed (ton/year)	
Row Labels		High	Low	High	Low	High	Low	High	High	Low	High	Low
Mainstem	401.80	1585.23	214.29	0.52	0.19	883.13	38.27	0.30	401.97	53.61	481.16	-15.33
Holden Ditch	424.00	640.72	97.06	0.41	0.16	272.54	12.15	0.30	177.78	24.92	94.76	-12.76
Rees Ditch	311.00	591.17	121.56	0.51	0.20	362.96	24.72	0.30	179.81	35.56	183.15	-10.84
Platt-Nibarger Ditch	240.00	228.80	37.32	0.52	0.15	117.70	6.78	0.30	64.26	11.59	53.44	-4.81
Fetid Creek	179.00	337.92	33.39	0.29	0.15	93.17	3.33	0.30	87.31	7.29	5.86	-3.96
Mud Creek	133.00	264.73	24.21	0.40	0.12	115.94	1.32	0.30	90.36	3.14	25.58	-1.82
Boots Creek	681.00	2398.25	317.44	0.49	0.11	1592.92	41.74	0.30	707.79	93.68	885.12	-51.94
Branch Creek	629.00	2923.33	354.67	0.54	0.36	1897.94	122.32	0.30	862.76	104.67	1035.18	17.65
Lake Branch	486.00	2750.00	352.00	0.60	0.14	1876.82	57.45	0.30	811.60	103.89	1065.22	-46.44
Hoppas Ditch	472.00	2740.00	355.67	0.64	0.15	1918.40	68.52	0.30	808.65	104.97	1109.75	-36.45
Porter Creek	89.00	750.67	72.37	0.77	0.24	708.49	27.81	0.30	221.54	21.36	486.95	6.45
Jordan Creek	79.00	1146.50	57.24	0.56	0.27	581.02	28.53	0.30	338.36	16.89	242.66	11.64
Gray Branch	31.00	91.84	12.40	0.53	0.18	74.18	2.56	0.30	27.10	3.66	47.08	-1.10
Subwatershed	28.69	148.61	25.86	0.36	0.13	66.81	2.51	0.30	40.03	6.56	26.78	-4.05
Back Creek	16.00	98.61	39.22	0.25	0.08	31.36	3.33	0.30	29.10	11.58	2.26	-8.24
Barren Creek	21.00	89.21	15.99	0.16	0.05	17.14	0.66	0.30	26.33	4.72	-9.19	-4.06
Bear Creek												
Big Lick Creek	76.00	65.94	20.05	0.29	0.25	18.57	4.55	0.30	18.53	5.92	0.05	-1.37
Bush Creek	20.00	20.11	2.90	0.25	0.14	5.58	0.61	0.30	6.23	0.85	-0.65	-0.24
Campbell Creek	20.00	35.43	4.03	0.53	0.12	19.76	0.53	0.30	9.36	1.19	10.40	-0.66
Days Creek												
Deer Creek	45.00	325.05	40.15	0.31	0.04	178.58	1.49	0.30	95.93	11.85	82.65	-10.36
Halfway Creek	25.00	62.06	9.93	0.48	0.18	37.23	2.08	0.30	21.07	2.93	16.16	-0.85
Little Deer Creek	26.00	281.93	40.36	0.32	0.04	141.18	1.47	0.30	83.20	11.91	57.97	-10.44
Little Mississinewa River	21.00	118.46	12.35	0.45	0.26	75.52	2.32	0.30	34.96	3.65	40.56	-1.33
Little Walnut Creek	17.00	145.85	8.46	0.65	0.14	98.19	1.20	0.30	43.05	2.50	55.15	-1.29
Lugar Creek	30.00	204.29	31.35	0.46	0.15	90.90	8.33	0.30	60.29	9.25	30.61	-0.93
Pike Creek	21.00	39.35	7.63	0.20	0.10	8.31	0.86	0.30	11.13	2.25	-2.82	-1.39
Upper Big Lick Creek	52.00	57.26	11.63	0.33	0.31	16.72	2.91	0.30	14.70	3.43	2.02	-0.52
Walnut Creek	39.00	340.16	48.64	0.57	0.08	198.17	4.70	0.30	100.39	14.36	97.78	-9.66

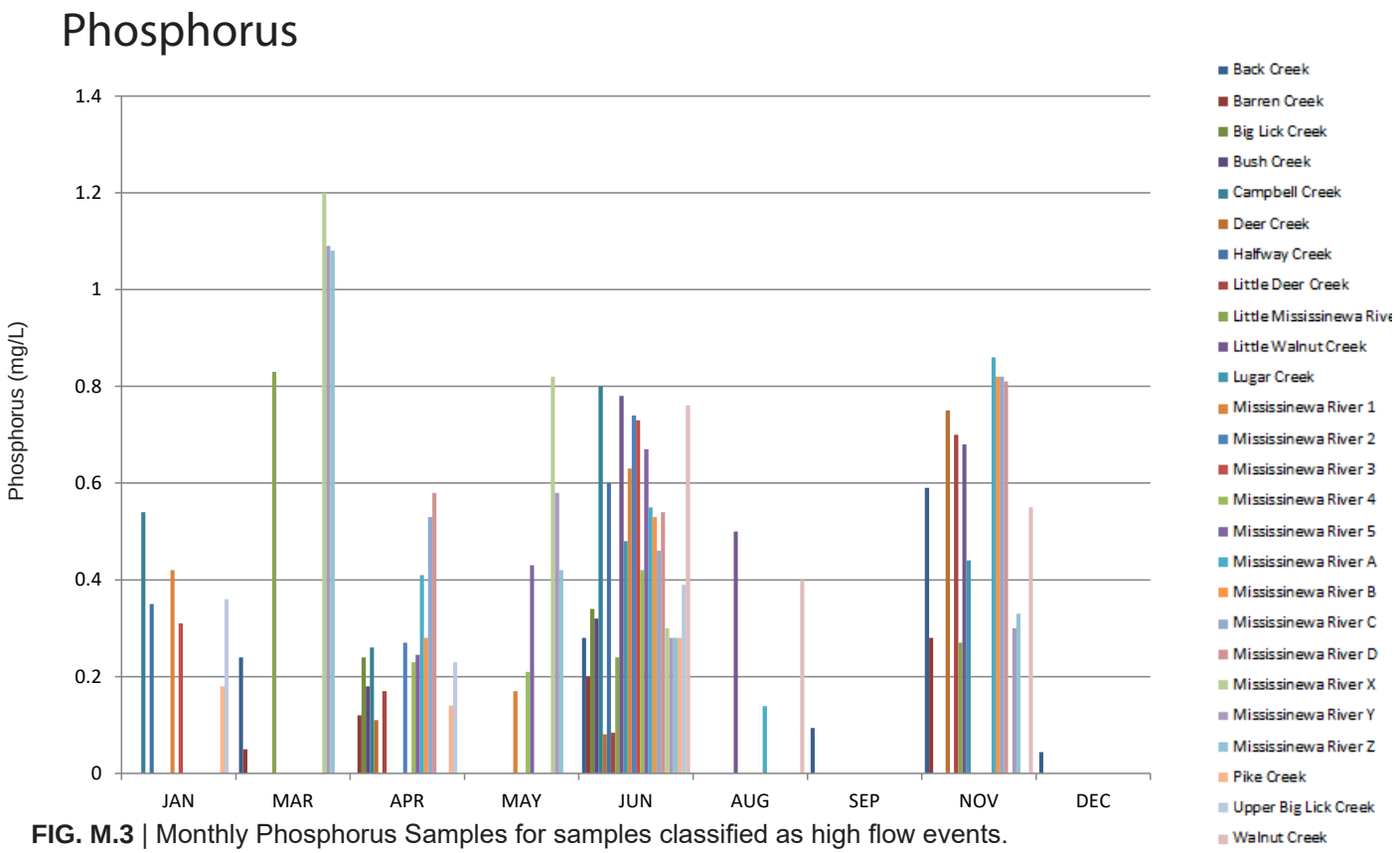


FIG. M.3 | Monthly Phosphorus Samples for samples classified as high flow events.

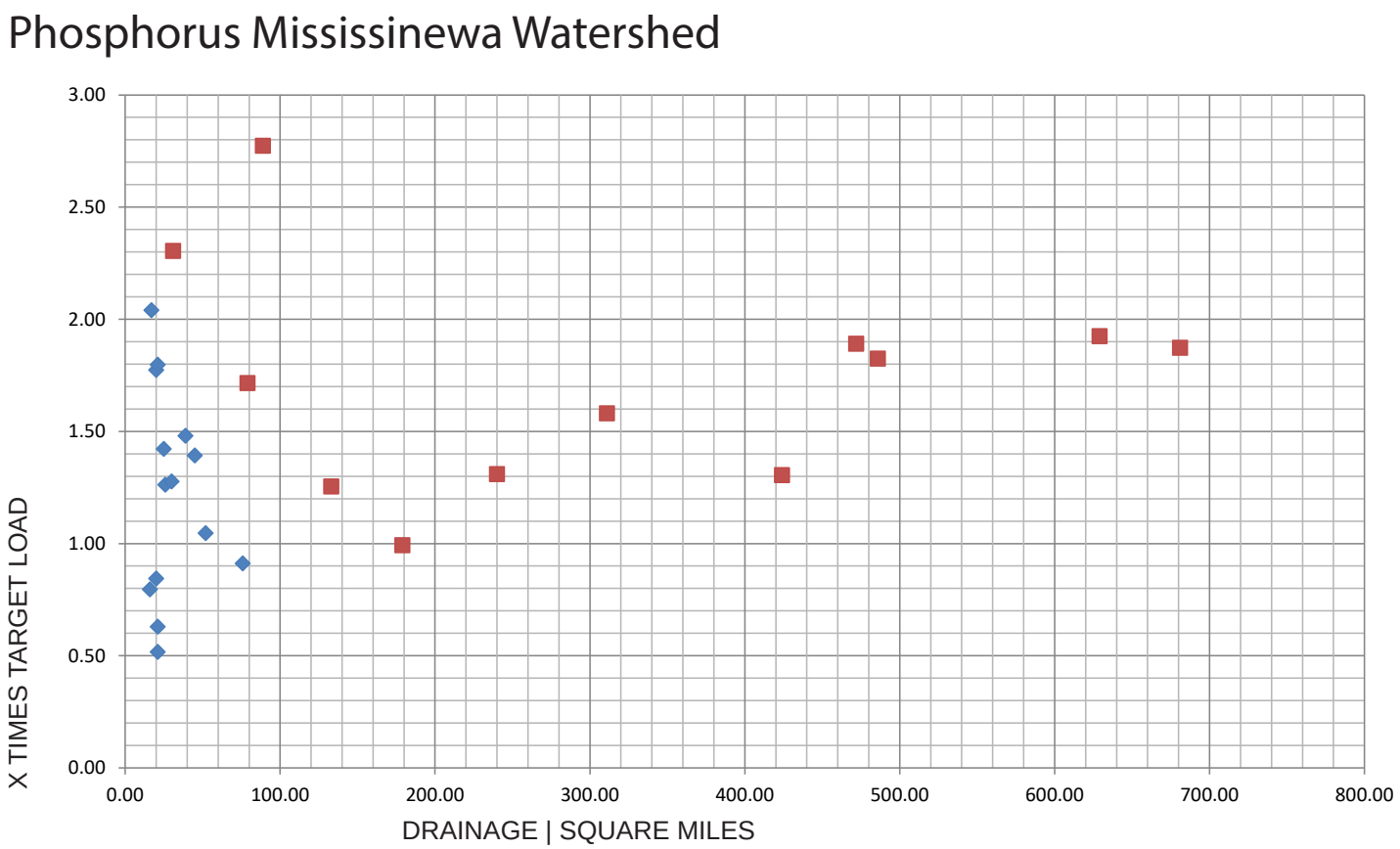


FIG. M.4 | Drainage size vs. X times target load.
"X times" represents how many times the average load (of all sample events) exceeds the target load.
Mainstem sites are represented by red squares and tributary sites by blue diamonds.

Phosphorus Mississinewa Mainstem

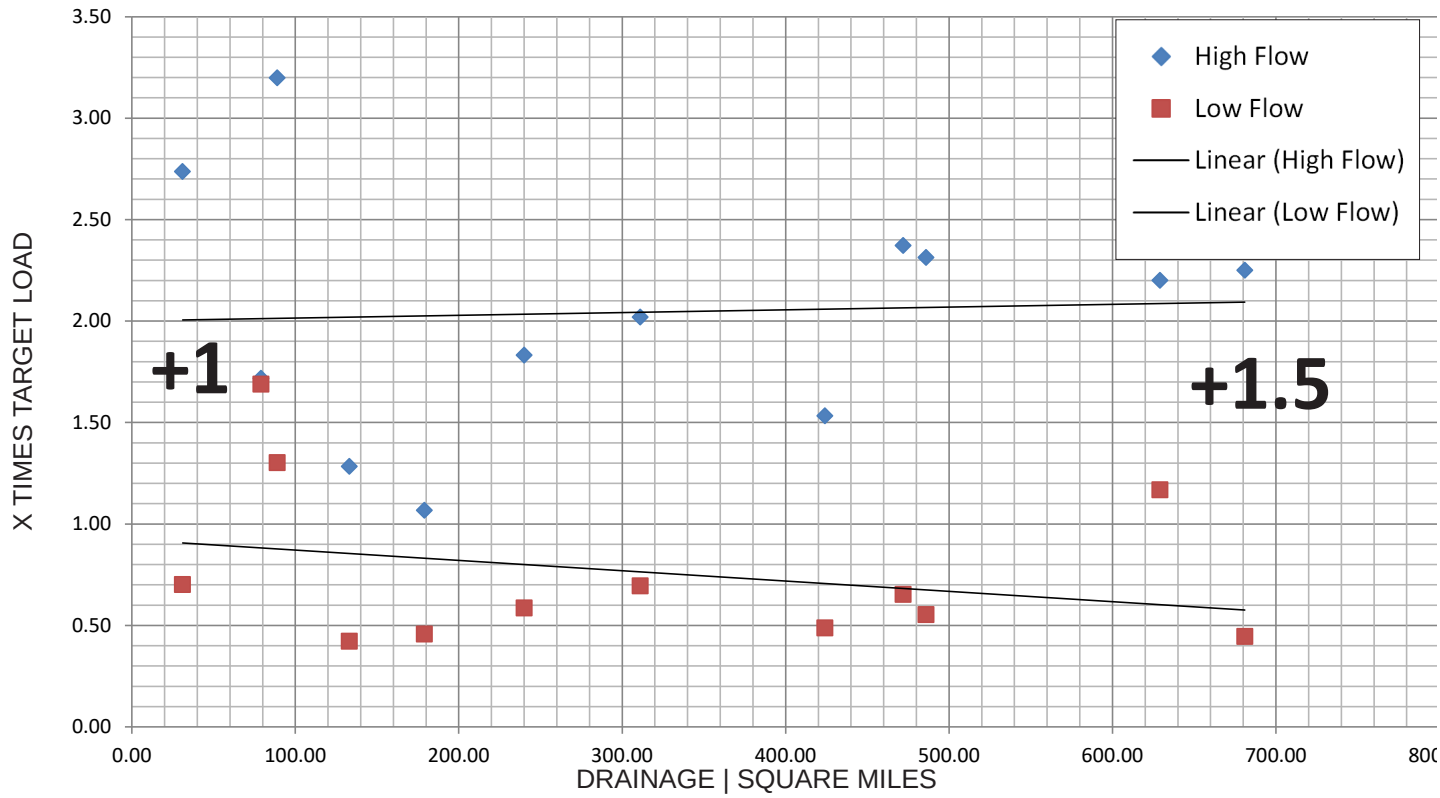


FIG. M.5 | Drainage size vs. X times target load for Mainstem Subwatersheds at High Flow and Low Flow events.

Phosphorus Mississinewa ***Subwatersheds***

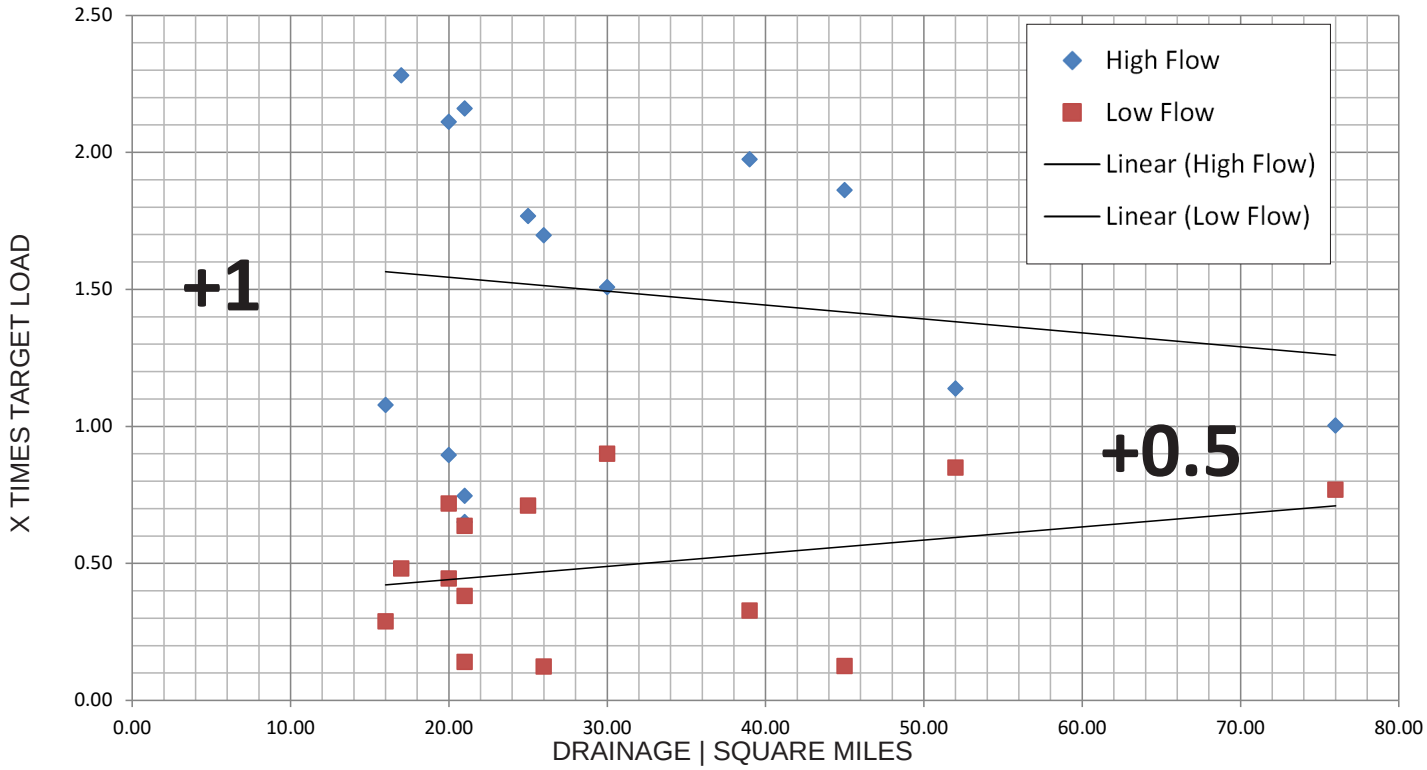


FIG. M.6 | Drainage size vs. X times target load for Tributary Subwatersheds at High Flow and Low Flow events.

N. TSS DATA

TABLE N.1 | Descriptive Statistics for TSS Data (mg/L) Collected at UMRW Sites								
Row Labels	Drainage	Average of TSS	Count of TSS	Min of TSS	Max of TSS	StdDev of TSS	75th	25th
Back Creek	16.00	29.64	12.00	0.80	177.00	52.63	65.17	-14.35
Barren Creek	21.00	16.11	12.00	2.00	64.00	20.20	29.74	-3.97
Bear Creek	15.00	11.50	7.00	0.50	44.00	19.01	24.33	-4.92
Big Lick Creek	76.00	29.89	9.00	0.50	160.00	51.07	64.36	-13.55
Bush Creek	20.00	9.50	9.00	0.50	43.00	14.12	19.03	-3.35
Campbell Creek	20.00	17.15	10.00	0.50	72.00	23.46	32.98	-5.11
Days Creek	17.00	28.79	7.00	0.50	90.00	38.83	55.00	-8.34
Deer Creek	45.00	13.52	12.00	1.60	61.00	17.70	25.46	-3.67
Halfway Creek	25.00	13.55	10.00	0.50	59.00	18.40	25.97	-3.98
Little Deer Creek	26.00	13.65	12.00	2.40	67.00	17.81	25.67	-3.68
Little Mississinewa River	21.00	50.50	12.00	2.00	405.00	113.12	126.85	-35.13
Little Walnut Creek	17.00	23.12	12.00	5.60	87.00	27.21	41.49	-4.88
Lugar Creek	30.00	41.44	12.00	0.80	227.00	65.82	85.87	-16.52
Holden Ditch	424.00	19.11	9.00	0.50	95.00	30.02	39.38	-7.47
Rees Ditch	311.00	31.21	7.00	0.50	100.00	32.22	52.96	-4.53
Platt-Nibarger Ditch	240.00	22.10	10.00	0.50	79.00	25.10	39.04	-4.25
Fetid Creek	179.00	26.69	8.00	0.50	110.00	37.67	52.11	-8.49
Mud Creek	133.00	28.63	8.00	0.50	89.00	36.95	53.57	-7.53
Boots Creek	681.00	58.46	24.00	0.25	363.00	97.00	123.94	-25.19
Branch Creek	629.00	51.28	12.00	4.00	250.00	72.70	100.35	-16.46
Lake Branch	486.00	55.17	12.00	1.60	201.00	73.35	104.68	-15.49
Hoppas Ditch	472.00	82.74	12.00	3.20	342.00	115.18	160.49	-25.59
Porter Creek	89.00	110.82	12.00	4.80	710.00	215.67	256.40	-62.25
Jordan Creek	79.00	85.87	12.00	4.00	615.00	176.90	205.28	-52.69
Gray Branch	31.00	66.22	12.00	4.40	445.00	126.25	151.43	-36.00
Pike Creek	21.00	6.00	10.00	0.50	20.00	7.59	11.12	-1.51
Upper Big Lick Creek	52.00	25.05	10.00	0.50	160.00	47.91	57.39	-13.69
Walnut Creek	39.00	34.57	12.00	1.60	207.00	59.00	74.39	-15.65
Grand Total	192.60	38.58	306.00	0.25	710.00	82.95	94.57	-25.25

TABLE N.2 | TSS Averages Separated by Flow Rate							
Subwatersheds	Drainage Area (sq mi)	Average flow rate (cfs)			Average of TSS (mg/L)		
		High Flow	Low Flow	Overall Average Flow	High Flow Samples	Low Flow Samples	Total Samples
Mainstem Subwatershed	401.80	1585.23	214.29	623.71	151.23	15.94	57.12
Holden Ditch	424.00	640.72	97.06	291.23	45.33	6.00	19.11
Rees Ditch	311.00	591.17	121.56	249.64	65.00	17.70	31.21
Platt-Nibarger Ditch	240.00	228.80	37.32	88.38	50.00	15.13	22.10
Fetid Creek	179.00	337.92	33.39	127.09	62.67	5.10	26.69
Mud Creek	133.00	264.73	24.21	124.43	56.75	0.50	28.63
Boots Creek	681.00	2398.25	317.44	1011.04	143.30	16.05	58.46
Branch Creek	629.00	2923.33	354.67	996.83	155.43	16.56	51.28
Lake Branch	486.00	2750.00	352.00	951.50	168.00	17.56	55.17
Hoppas Ditch	472.00	2740.00	355.67	951.75	221.00	36.66	82.74
Porter Creek	89.00	750.67	72.37	241.94	391.67	17.20	110.82
Jordan Creek	79.00	1146.50	57.24	420.33	232.10	12.75	85.87
Gray Branch	31.00	91.84	12.40	38.88	171.85	13.40	66.22
Tributary Subwatershed	28.69	148.61	25.86	63.38	57.46	8.52	23.36
Back Creek	16.00	98.61	39.22	63.97	60.98	7.26	29.64
Barren Creek	21.00	89.21	15.99	40.40	37.23	5.55	16.11
Bear Creek							11.50
Big Lick Creek	76.00	65.94	20.05	39.72	28.00	4.63	29.89
Bush Creek	20.00	20.11	2.90	8.63	26.50	3.25	9.50
Campbell Creek	20.00	35.43	4.03	16.59	38.67	9.17	17.15
Days Creek							28.79
Deer Creek	45.00	325.05	40.15	111.37	38.60	5.16	13.52
Halfway Creek	25.00	62.06	9.93	25.57	36.50	8.86	13.55
Little Deer Creek	26.00	281.93	40.36	106.24	34.60	5.85	13.65
Little Mississinewa River	21.00	118.46	12.35	38.88	162.93	13.02	50.50
Little Walnut Creek	17.00	145.85	8.46	45.93	55.53	13.01	23.12
Lugar Creek	30.00	204.29	31.35	65.94	164.00	17.56	41.44
Pike Creek	21.00	39.35	7.63	19.16	13.67	2.71	6.00
Upper Big Lick Creek	52.00	57.26	11.63	29.88	14.33	7.92	25.05
Walnut Creek	39.00	340.16	48.64	121.52	105.73	10.84	34.57

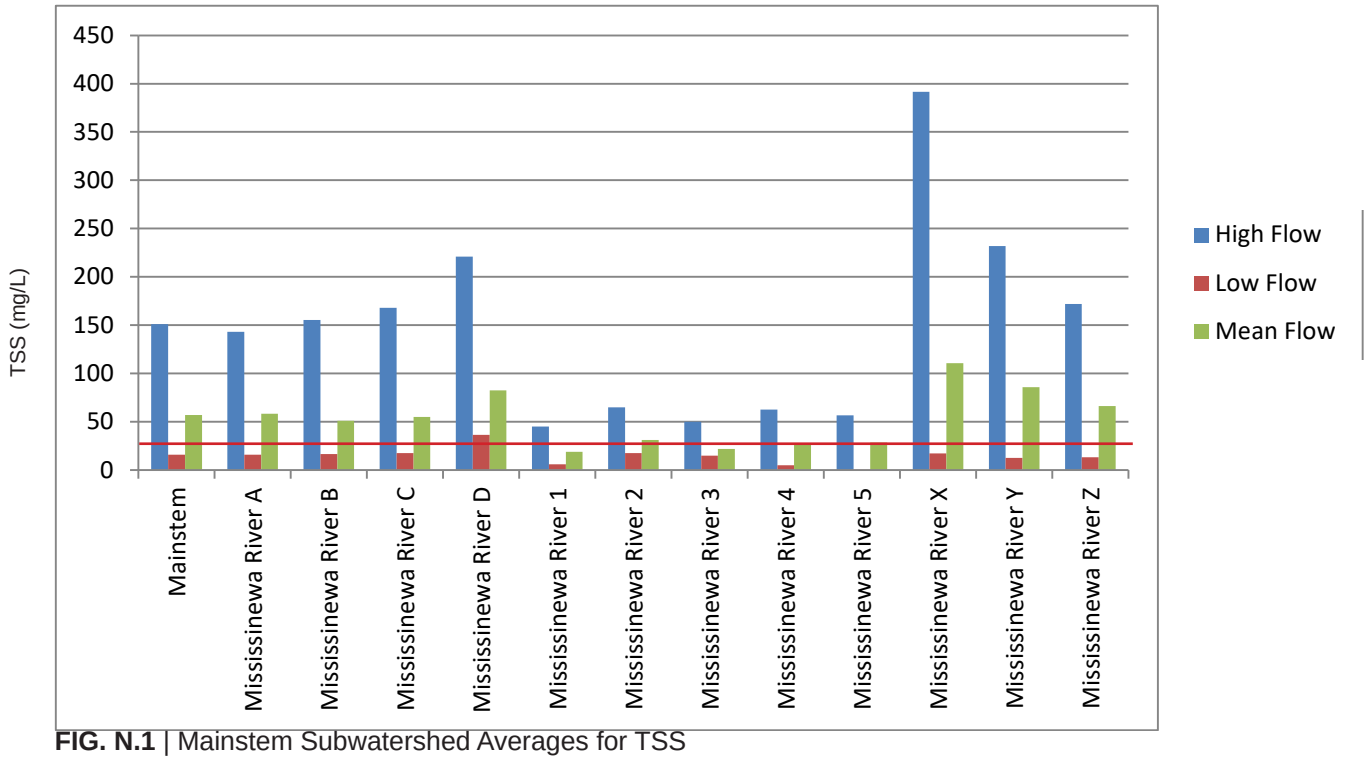


FIG. N.1 | Mainstem Subwatershed Averages for TSS

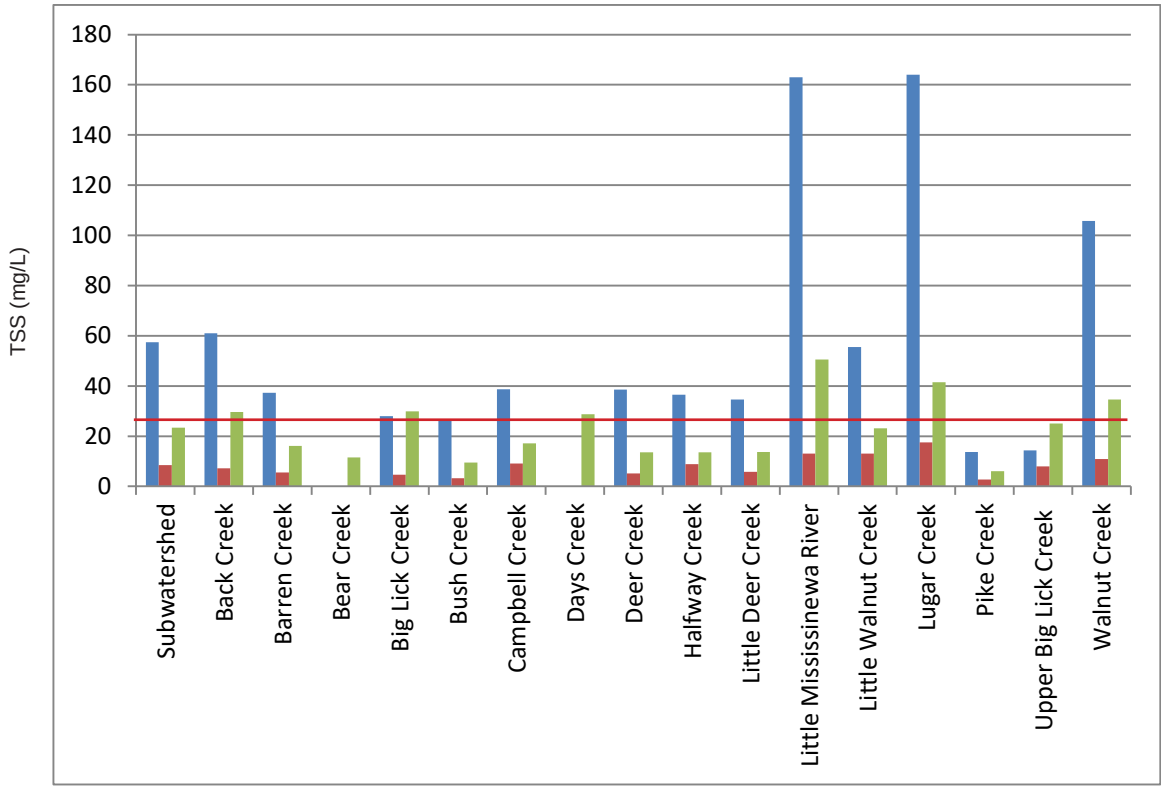


FIG. N.2 | Tributary Subwatershed Averages for TSS

TABLE N.3 | Count of Exceedances[1] for TSS				
Subwatershed	Number of Exceedences during High Flow	Number of Exceedences during Low Flow	No Flow Data Collected	Total Number of Exceedances
Back Creek	3.00			3.00
Barren Creek	3.00			3.00
Bear Creek			2.00	2.00
Big Lick Creek	1.00		2.00	3.00
Bush Creek	1.00			1.00
Campbell Creek	2.00	1.00		3.00
Days Creek			2.00	2.00
Deer Creek	2.00			2.00
Halfway Creek	1.00			1.00
Little Deer Creek	1.00			1.00
Little Mississinewa River	3.00	1.00		4.00
Little Walnut Creek	2.00	1.00		3.00
Lugar Creek	2.00	1.00		3.00
Holden Ditch	1.00			1.00
Rees Ditch	2.00	2.00		4.00
Platt-Nibarger Ditch	1.00	2.00		3.00
Fetid Creek	3.00			3.00
Mud Creek	4.00			4.00
Boots Creek	6.00	4.00		10.00
Branch Creek	3.00	1.00		4.00
Lake Branch	3.00	1.00		4.00
Hoppas Ditch	3.00	2.00		5.00
Porter Creek	3.00	2.00		5.00
Jordan Creek	4.00			4.00
Gray Branch	4.00	1.00		5.00
Upper Big Lick Creek			1.00	1.00
Walnut Creek	3.00	1.00		4.00
Totals for all sites combined	61.00	20.00	7.00	88.00

1 When an individual sample is above the target set for this watershed management plan, it is considered to be in exceedance. The target concentration for TSS is 25 mg/L.

TABLE N.4 | Calculated TSS Loads: Current Load, Target Load, and Load Reduction Needed

	Drainage area (sq. mi.)	Average flow (cfs)		Average TSS (mg/L)		TSS current load (ton/year)		TSS Target (mg/L)	TSS target load (ton/year)		TSS load reduction needed (ton/year)	
Subwatershed	High	High	Low	High	Low	High	Low	High	High	Low	High	Low
Mainstem Subwatershed	401.80	1585.23	214.29	151.23	15.94	215939.78	4603.05	25.00	33497.46	4467.33	182442.32	135.73
Holden Ditch	424.00	640.72	97.06	45.33	6.00	31227.66	408.14	25.00	14814.80	2076.35	16412.86	-1668.21
Rees Ditch	311.00	591.17	121.56	65.00	17.70	47936.26	2426.69	25.00	14983.92	2963.58	32952.33	-536.89
Platt-Nibarger Ditch	240.00	228.80	37.32	50.00	15.13	11582.27	831.90	25.00	5355.35	965.82	6226.92	-133.92
Fetid Creek	179.00	337.92	33.39	62.67	5.10	21729.82	146.35	25.00	7275.74	607.86	14454.08	-461.51
Mud Creek	133.00	264.73	24.21	56.75	0.50	16599.21	5.23	25.00	7529.84	261.31	9069.37	-256.09
Boots Creek	681.00	2398.25	317.44	143.30	16.05	333563.31	5276.49	25.00	58982.67	7807.07	274580.64	-2530.58
Branch Creek	629.00	2923.33	354.67	155.43	16.56	400998.40	6293.76	25.00	71896.60	8722.69	329101.81	-2428.93
Lake Branch	486.00	2750.00	352.00	168.00	17.56	387070.96	8277.68	25.00	67633.63	8657.10	319437.33	-379.43
Hoppas Ditch	472.00	2740.00	355.67	221.00	36.66	472343.44	20252.13	25.00	67387.69	8747.28	404955.75	11504.84
Porter Creek	89.00	750.67	72.37	391.67	17.20	387423.47	1544.05	25.00	18461.93	1779.79	368961.54	-235.74
Jordan Creek	79.00	1146.50	57.24	232.10	12.75	249930.52	831.57	25.00	28197.08	1407.70	221733.44	-576.13
Gray Branch	31.00	91.84	12.40	171.85	13.40	28356.74	189.76	25.00	2258.67	304.98	26098.08	-115.22
Tributary Subwatershed	28.69	148.61	25.86	57.46	8.52	11086.92	256.74	25.00	3335.84	546.99	7751.08	-290.25
Back Creek	16.00	98.61	39.22	60.98	7.26	5599.62	304.32	25.00	2425.23	964.64	3174.39	-660.31
Barren Creek	21.00	89.21	15.99	37.23	5.55	3549.52	85.33	25.00	2194.15	393.26	1355.37	-307.93
Bear Creek												
Big Lick Creek	76.00	65.94	20.05	28.00	4.63	1888.94	158.03	25.00	1543.81	493.12	345.13	-335.09
Bush Creek	20.00	20.11	2.90	26.50	3.25	641.24	24.66	25.00	519.27	71.22	121.97	-46.55
Campbell Creek	20.00	35.43	4.03	38.67	9.17	1562.48	65.39	25.00	780.20	99.24	782.28	-33.85
Days Creek												
Deer Creek	45.00	325.05	40.15	38.60	5.16	16348.40	232.74	25.00	7994.28	987.44	8354.12	-754.70
Halfway Creek	25.00	62.06	9.93	36.50	8.86	3260.05	150.76	25.00	1755.60	244.18	1504.44	-93.42
Little Deer Creek	26.00	281.93	40.36	34.60	5.85	14131.19	261.50	25.00	6933.70	992.60	7197.50	-731.10
Little Mississinewa River	21.00	118.46	12.35	162.93	13.02	33914.29	117.05	25.00	2913.47	303.78	31000.81	-186.74
Little Walnut Creek	17.00	145.85	8.46	55.53	13.01	9207.79	125.64	25.00	3587.14	208.03	5620.65	-82.38
Lugar Creek	30.00	204.29	31.35	164.00	17.56	28089.21	924.80	25.00	5024.21	771.06	23065.00	153.74
Pike Creek	21.00	39.35	7.63	13.67	2.71	575.14	21.84	25.00	927.21	187.63	-352.07	-165.79
Upper Big Lick Creek	52.00	57.26	11.63	14.33	7.92	708.62	96.40	25.00	1225.01	285.97	-516.39	-189.57
Walnut Creek	39.00	340.16	48.64	105.73	10.84	38421.69	752.49	25.00	8365.94	1196.27	30055.74	-443.78

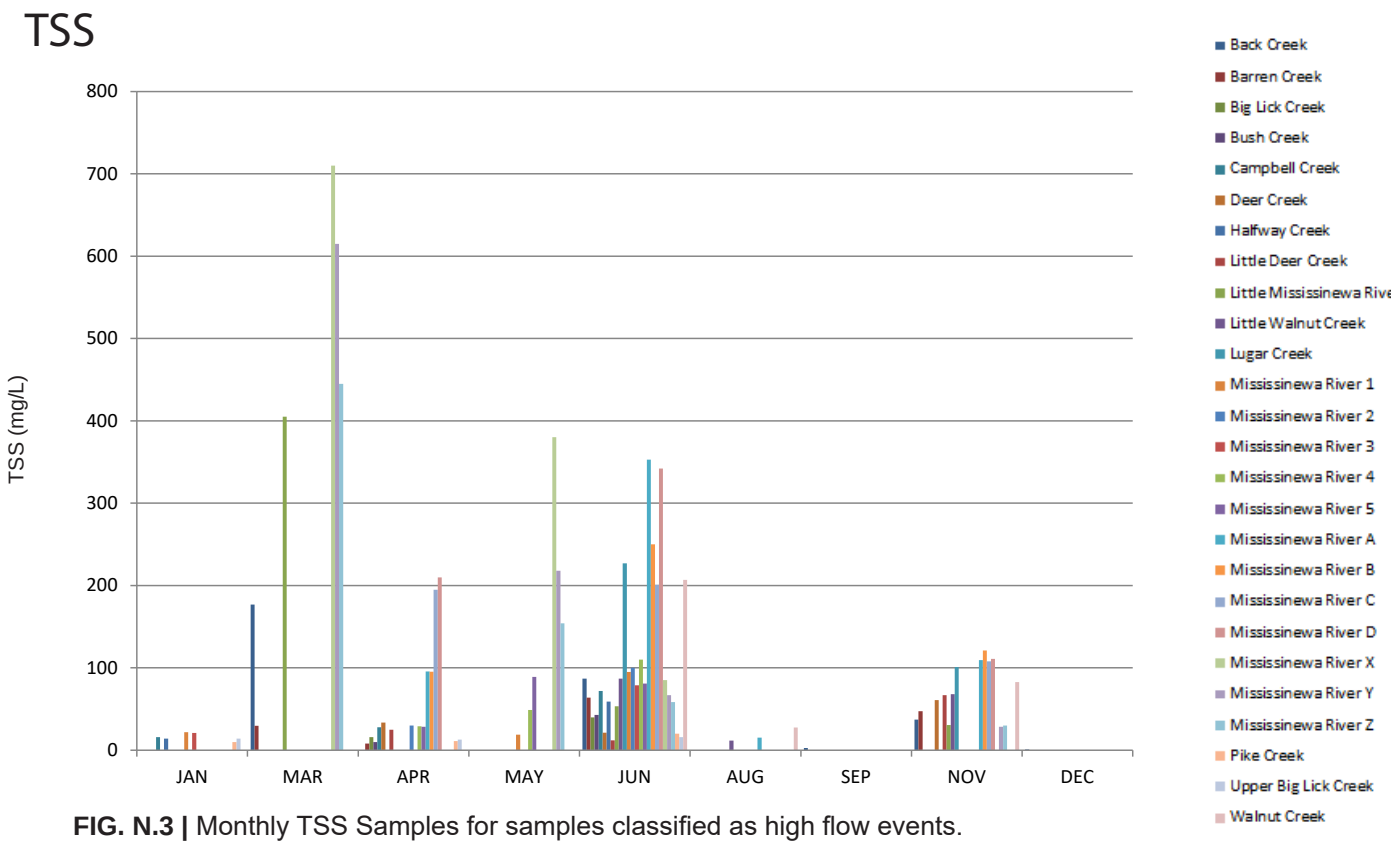


FIG. N.3 | Monthly TSS Samples for samples classified as high flow events.

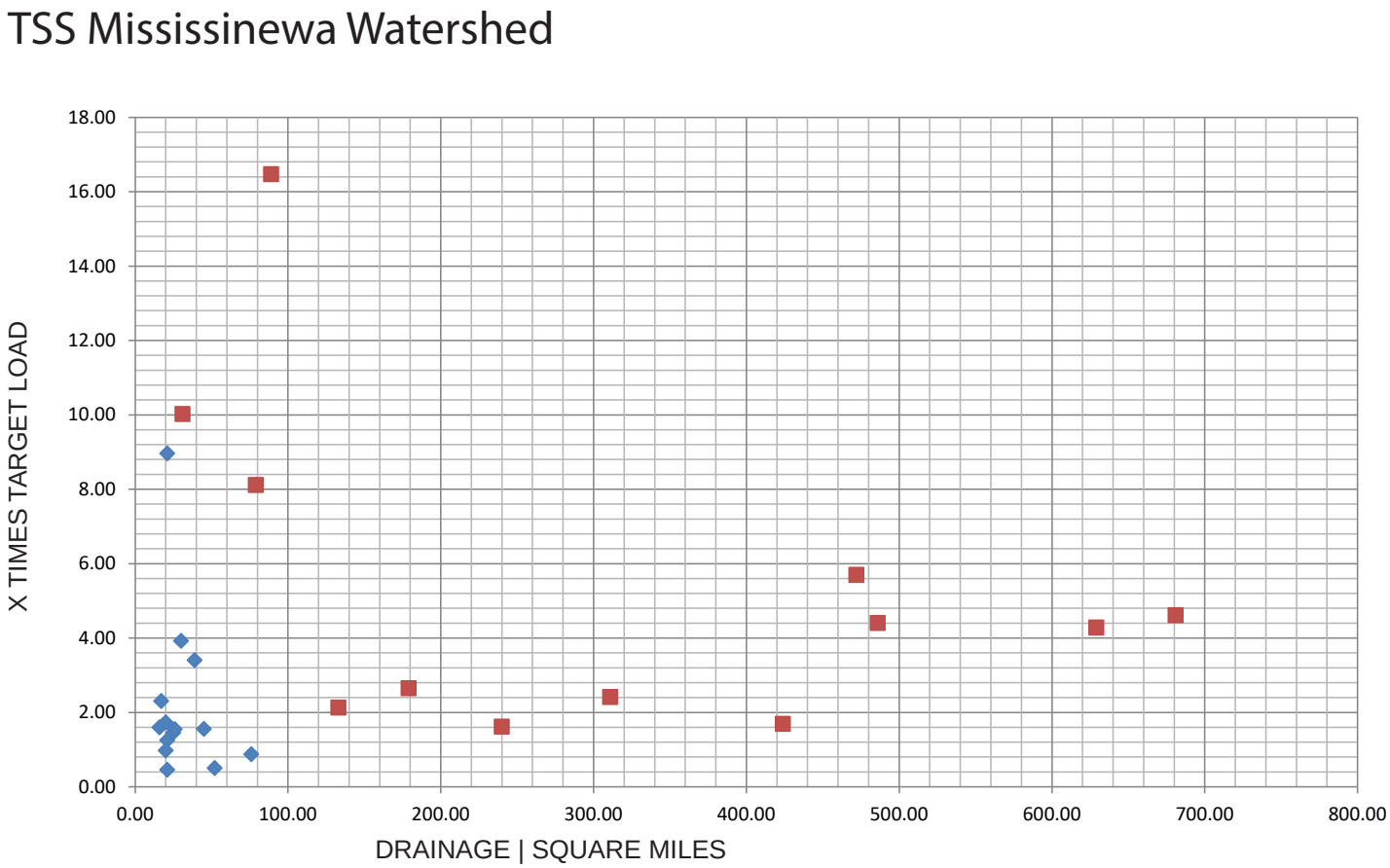


FIG. N.4 | Drainage size vs. X times target load.
"X times" represents how many times the average load (of all sample events) exceeds the target load.
Mainstem sites are represented by red squares and tributary sites by blue diamonds.

TSS Mississinewa Mainstem

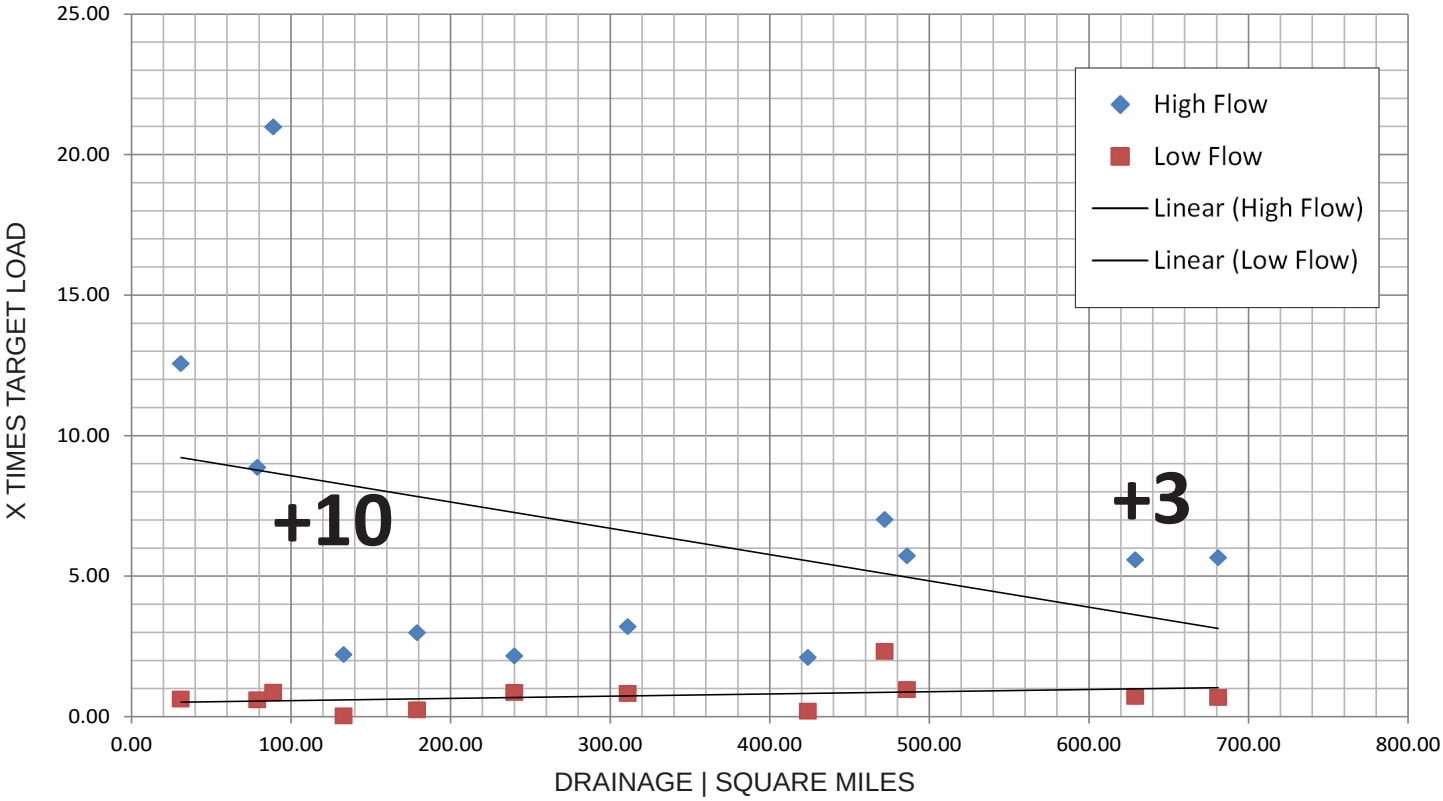


FIG. N.5 | Drainage size vs. X times target load for Mainstem Subwatersheds at High Flow and Low Flow events.

TSS Mississinewa ***Subwatersheds***

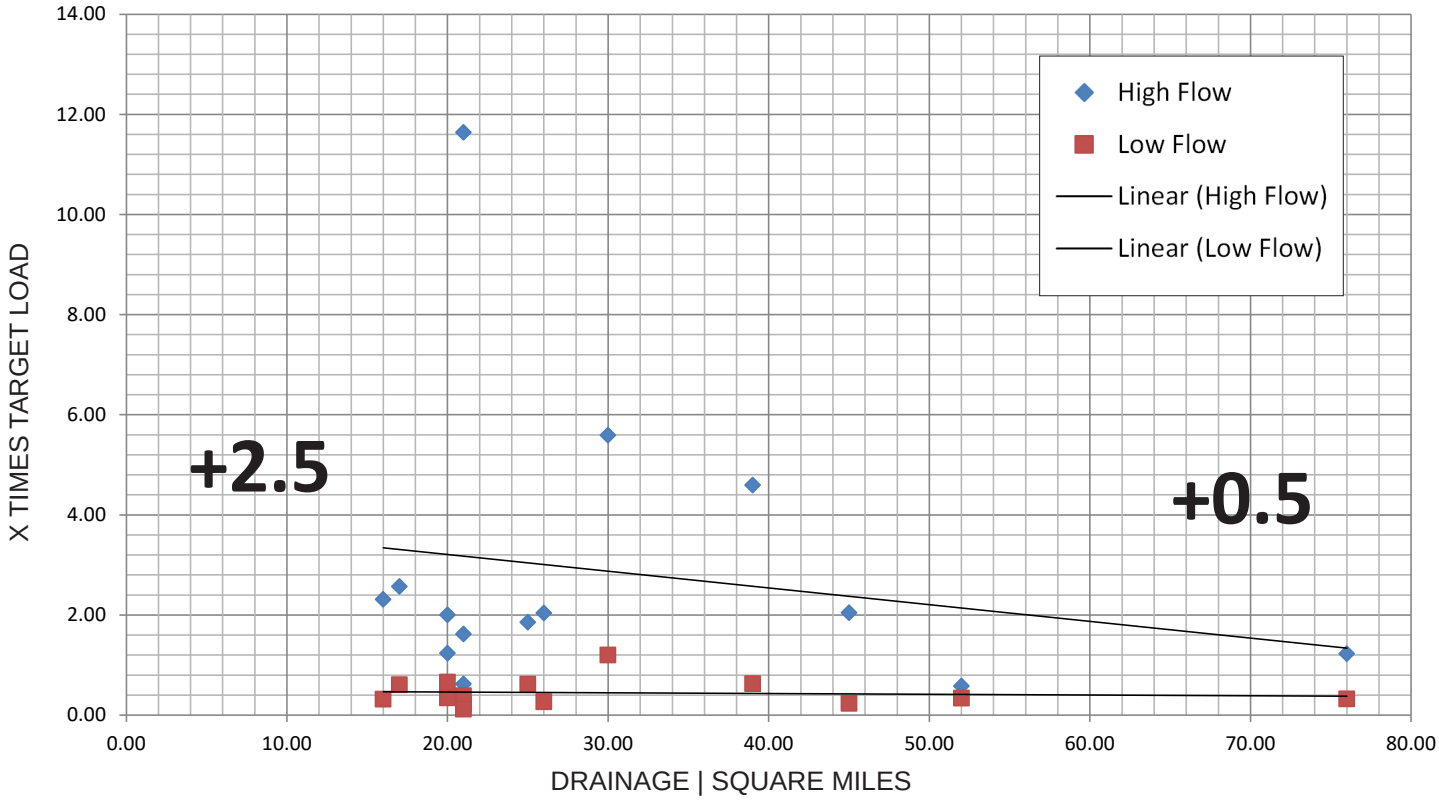


FIG. N.6 Drainage size vs. X times target load for Tributary Subwatersheds at High Flow and Low Flow events.

O. *E. COLI* DATA

TABLE O.1 | Descriptive Statistics for E. Coli Data (cfu/100mL) Collected at UMRW Sites

Row Labels	Drainage	Average of E. COLI	Count of E. COLI	Min of E. COLI	Max of E. COLI	StdDev of E. COLI	75th	25th
Back Creek	16.00	1523.25	12.00	117.00	6400.00	1739.21	2697.22	-297.37
Barren Creek	21.00	3630.83	12.00	47.00	29700.00	8419.32	9313.88	-2656.03
Bear Creek	15.00	929.27	10.00	83.00	2419.60	820.60	1483.18	-71.88
Big Lick Creek	76.00	3971.86	10.00	148.30	17329.00	5948.21	7986.90	-1419.30
Bush Creek	20.00	497.16	10.00	59.10	1553.10	495.59	831.69	-64.23
Campbell Creek	20.00	665.93	10.00	59.10	1986.30	709.05	1144.54	-106.63
Days Creek	17.00	886.30	10.00	53.80	4352.00	1339.63	1790.55	-322.32
Deer Creek	45.00	531.42	12.00	57.00	1600.00	536.64	893.65	-71.80
Halfway Creek	25.00	798.39	11.00	35.00	2419.60	771.29	1319.01	-91.94
Little Deer Creek	26.00	1059.42	12.00	103.00	8740.00	2435.33	2703.26	-765.29
Little Mississinewa River	21.00	1063.42	12.00	77.00	3500.00	1086.44	1796.76	-149.40
Little Walnut Creek	17.00	1137.42	12.00	10.00	7050.00	2012.20	2495.65	-547.15
Lugar Creek	30.00	1844.33	12.00	20.00	7330.00	2696.70	3664.60	-629.27
Holden Ditch	424.00	625.95	10.00	52.00	1986.30	719.51	1111.62	-124.40
Rees Ditch	311.00	927.21	10.00	46.40	6131.00	1859.78	2182.56	-546.02
Platt-Nibarger Ditch	240.00	640.11	11.00	43.50	3255.00	991.68	1309.49	-243.80
Fetid Creek	179.00	704.61	10.00	115.30	4106.00	1257.65	1553.52	-344.02
Mud Creek	133.00	981.20	11.00	71.70	4884.00	1479.51	1979.87	-355.21
Boots Creek	681.00	767.00	24.00	1.00	4100.00	1202.60	1578.75	-298.66
Branch Creek	629.00	758.58	12.00	47.00	3420.00	1151.50	1535.85	-278.11
Lake Branch	486.00	1510.83	12.00	30.00	6940.00	2219.87	3009.25	-520.41
Hoppas Ditch	472.00	1054.75	12.00	50.00	3400.00	1285.38	1922.38	-242.86
Porter Creek	89.00	870.08	12.00	37.00	2350.00	795.66	1407.16	-79.75
Jordan Creek	79.00	1075.00	12.00	113.00	2200.00	795.88	1612.22	-13.25
Gray Branch	31.00	1026.75	12.00	103.00	3400.00	1084.82	1759.00	-160.58
Pike Creek	21.00	459.95	11.00	228.20	866.40	203.78	597.51	56.64
Upper Big Lick Creek	52.00	4029.80	11.00	108.60	24196.00	7167.23	8867.68	-1955.89
Walnut Creek	39.00	1031.67	12.00	7.00	4800.00	1574.70	2094.59	-382.18
Grand Total	192.60	1235.19	327.00	1.00	29700.00	2729.21	3077.41	-842.06

TABLE O.2 | E. coli Averages Separated by Flow Rate							
Subwatersheds	Drainage Area (sq mi)	Average flow rate (cfs)			Average of E. coli (cfu/100 mL)		
		High Flow	Low Flow	Overall Average Flow	High Flow Samples	Low Flow Samples	Total Samples
Mainstem Subwatershed	401.80	1585.23	214.29	623.71	1905.69	485.79	907.92
Holden Ditch	424.00	640.72	97.06	291.23	1172.27	391.81	625.95
Rees Ditch	311.00	591.17	121.56	249.64	624.07	1057.13	927.21
Platt-Nibarger Ditch	240.00	228.80	37.32	88.38	2493.95	228.14	640.11
Fetid Creek	179.00	337.92	33.39	127.09	1893.43	195.11	704.61
Mud Creek	133.00	264.73	24.21	124.43	1843.82	262.35	981.20
Boots Creek	681.00	2398.25	317.44	1011.04	1789.63	255.69	767.00
Branch Creek	629.00	2923.33	354.67	996.83	1078.00	652.11	758.58
Lake Branch	486.00	2750.00	352.00	951.50	4017.67	675.22	1510.83
Hoppas Ditch	472.00	2740.00	355.67	951.75	2033.33	728.56	1054.75
Porter Creek	89.00	750.67	72.37	241.94	2016.67	487.89	870.08
Jordan Creek	79.00	1146.50	57.24	420.33	1852.50	686.25	1075.00
Gray Branch	31.00	91.84	12.40	38.88	2352.50	363.88	1026.75
Tributary Subwatershed	28.69	148.61	25.86	63.38	3081.94	743.05	1505.79
Back Creek	16.00	98.61	39.22	63.97	2794.60	615.14	1523.25
Barren Creek	21.00	89.21	15.99	40.40	8696.50	1098.00	3630.83
Bear Creek							929.27
Big Lick Creek	76.00	65.94	20.05	39.72	4776.40	976.93	3971.86
Bush Creek	20.00	20.11	2.90	8.63	939.30	361.18	497.16
Campbell Creek	20.00	35.43	4.03	16.59	1198.45	562.94	665.93
Days Creek							886.30
Deer Creek	45.00	325.05	40.15	111.37	956.67	389.67	531.42
Halfway Creek	25.00	62.06	9.93	25.57	2419.60	535.80	798.39
Little Deer Creek	26.00	281.93	40.36	106.24	3324.67	304.88	1059.42
Little Mississinewa River	21.00	118.46	12.35	38.88	1700.00	851.22	1063.42
Little Walnut Creek	17.00	145.85	8.46	45.93	1600.00	1099.00	1137.42
Lugar Creek	30.00	204.29	31.35	65.94	4330.00	1662.38	1844.33
Pike Creek	21.00	39.35	7.63	19.16	276.85	463.83	459.95
Upper Big Lick Creek	52.00	57.26	11.63	29.88	4058.50	1113.08	4029.80
Walnut Creek	39.00	340.16	48.64	121.52	2983.33	381.11	1031.67

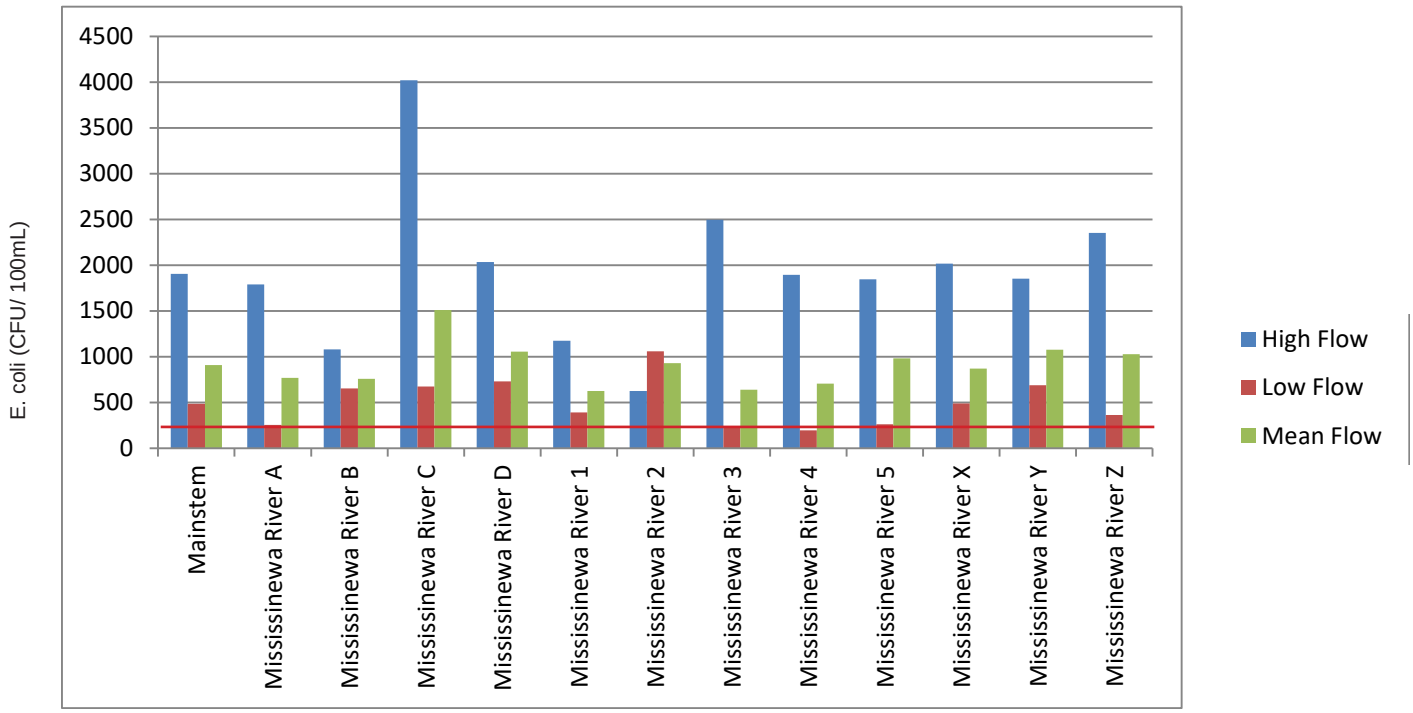


FIG. O.1 | Mainstem Subwatershed Averages for E. coli

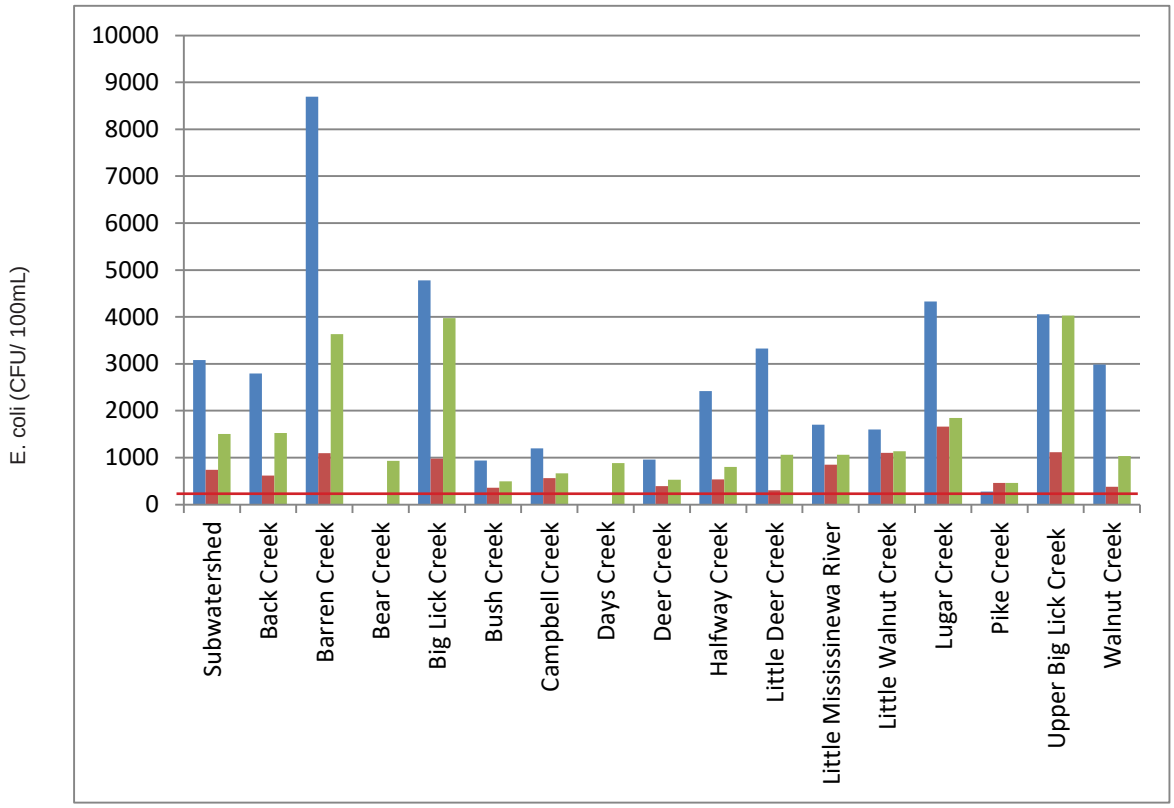


FIG. O.2 | Tributary Subwatershed Averages for E. coli

TABLE O.3 | Count of Exceedances[1] for E. coli				
Subwatershed	Number of Exceedences during High Flow	Number of Exceedences during Low Flow	No Flow Data Collected	Total Number of Exceedances
Back Creek	5.00	5.00		10.00
Barren Creek	3.00	5.00		8.00
Bear Creek			9.00	9.00
Big Lick Creek	2.00	2.00	3.00	7.00
Bush Creek	2.00	3.00	1.00	6.00
Campbell Creek	2.00	2.00	1.00	5.00
Days Creek			5.00	5.00
Deer Creek	3.00	4.00		7.00
Halfway Creek	1.00	4.00	3.00	8.00
Little Deer Creek	3.00	3.00	1.00	7.00
Little Mississinewa River	3.00	7.00		10.00
Little Walnut Creek	3.00	5.00		8.00
Lugar Creek	2.00	5.00		7.00
Holden Ditch	3.00	2.00		5.00
Rees Ditch	2.00	3.00		5.00
Platt-Nibarger Ditch	2.00	3.00		5.00
Fetid Creek	2.00	2.00		4.00
Mud Creek	4.00	3.00		7.00
Boots Creek	6.00	3.00		9.00
Branch Creek	2.00	3.00		5.00
Lake Branch	2.00	4.00		6.00
Hoppas Ditch	2.00	4.00		6.00
Porter Creek	3.00	6.00		9.00
Jordan Creek	4.00	6.00		10.00
Gray Branch	4.00	5.00		9.00
Pike Creek	1.00	6.00	3.00	10.00
Upper Big Lick Creek	2.00	4.00	2.00	8.00
Walnut Creek	3.00	2.00		5.00
Totals for all sites combined	71.00	101.00	28.00	200.00

1 When an individual sample is above the target set for this watershed management plan, it is considered to be in exceedance. The target concentration for E. coli is 235 mg/100 L.

TABLE O.4 | Calculated E. coli Loads: Current Load, Target Load, and Load Reduction Needed

	Drain-age area (sq. mi.)	Average flow (cfs)		Average E. coli (mg/L)		E. coli current load (ton/year)		E. coli Target (mg/L)	E. coli target load (ton/year)		E. coli load reduction needed (ton/year)	
Subwatershed		High	Low	High	Low	High	Low	High	High	Low	High	Low
Mainstem Subwatershed	401.80	1585.23	214.29	1905.69	485.79	3.0E+16	1.1E+15	235.00	2.8E+15	3.7E+14	2.7E+16	7.7E+14
Holden Ditch	424.00	640.72	97.06	1172.27	391.81	6.3E+15	3.5E+14	235.00	1.2E+15	2.0E+14	5.1E+15	1.5E+14
Rees Ditch	311.00	591.17	121.56	624.07	1057.13	3.7E+15	1.1E+15	235.00	1.2E+15	2.8E+14	2.5E+15	7.9E+14
Platt-Nibarger Ditch	240.00	228.80	37.32	2493.95	228.14	4.0E+15	7.3E+13	235.00	4.1E+14	7.7E+13	3.6E+15	-3.2E+12
Fetid Creek	179.00	337.92	33.39	1893.43	195.11	6.5E+15	5.7E+13	235.00	6.2E+14	7.1E+13	5.9E+15	-1.5E+13
Mud Creek	133.00	264.73	24.21	1843.82	262.35	4.3E+15	5.1E+13	235.00	5.6E+14	5.8E+13	3.7E+15	-6.8E+12
Boots Creek	681.00	2398.25	317.44	1789.63	255.69	5.9E+16	8.9E+14	235.00	5.0E+15	6.7E+14	5.4E+16	2.2E+14
Branch Creek	629.00	2923.33	354.67	1078.00	652.11	4.7E+16	3.1E+15	235.00	6.1E+15	7.4E+14	4.1E+16	2.4E+15
Lake Branch	486.00	2750.00	352.00	4017.67	675.22	1.1E+17	2.8E+15	235.00	5.8E+15	7.4E+14	1.0E+17	2.1E+15
Hoppas Ditch	472.00	2740.00	355.67	2033.33	728.56	5.6E+16	3.5E+15	235.00	5.7E+15	7.5E+14	5.0E+16	2.7E+15
Porter Creek	89.00	750.67	72.37	2016.67	487.89	1.3E+16	5.3E+14	235.00	1.6E+15	1.5E+14	1.1E+16	3.8E+14
Jordan Creek	79.00	1146.50	57.24	1852.50	686.25	1.6E+16	3.6E+14	235.00	2.4E+15	1.2E+14	1.4E+16	2.4E+14
Gray Branch	31.00	91.84	12.40	2352.50	363.88	2.4E+15	4.2E+13	235.00	1.9E+14	2.6E+13	2.2E+15	1.6E+13
Tributary Subwatershed	28.69	148.61	25.86	3081.94	743.05	3.4E+15	1.8E+14	235.00	3.1E+14	4.8E+13	3.1E+15	1.3E+14
Back Creek	16.00	98.61	39.22	2794.60	615.14	3.1E+15	2.2E+14	235.00	2.1E+14	8.2E+13	2.9E+15	1.4E+14
Barren Creek	21.00	89.21	15.99	8696.50	1098.00	5.4E+15	1.3E+14	235.00	1.9E+14	3.4E+13	5.2E+15	9.8E+13
Bear Creek												
Big Lick Creek	76.00	65.94	20.05	4776.40	976.93	3.2E+15	1.8E+14	235.00	1.3E+14	3.1E+13	3.1E+15	1.5E+14
Bush Creek	20.00	20.11	2.90	939.30	361.18	2.1E+14	1.2E+13	235.00	4.4E+13	4.9E+12	1.6E+14	7.2E+12
Campbell Creek	20.00	35.43	4.03	1198.45	562.94	5.1E+14	3.3E+13	235.00	7.6E+13	7.5E+12	4.4E+14	2.6E+13
Days Creek												
Deer Creek	45.00	325.05	40.15	956.67	389.67	3.6E+15	9.8E+13	235.00	6.8E+14	8.4E+13	2.9E+15	1.4E+13
Halfway Creek	25.00	62.06	9.93	2419.60	535.80	2.2E+15	6.8E+13	235.00	2.2E+14	2.1E+13	2.0E+15	4.6E+13
Little Deer Creek	26.00	281.93	40.36	3324.67	304.88	6.0E+15	9.9E+13	235.00	5.9E+14	8.5E+13	5.4E+15	1.5E+13
Little Mississinewa River	21.00	118.46	12.35	1700.00	851.22	1.6E+15	1.5E+14	235.00	2.5E+14	2.6E+13	1.4E+15	1.2E+14
Little Walnut Creek	17.00	145.85	8.46	1600.00	1099.00	1.8E+15	8.3E+13	235.00	3.1E+14	1.8E+13	1.5E+15	6.5E+13
Lugar Creek	30.00	204.29	31.35	4330.00	1662.38	5.8E+15	8.6E+14	235.00	4.3E+14	6.6E+13	5.4E+15	8.0E+14
Pike Creek	21.00	39.35	7.63	276.85	463.83	1.1E+14	3.1E+13	235.00	8.9E+13	1.4E+13	2.3E+13	1.7E+13
Upper Big Lick Creek	52.00	57.26	11.63	4058.50	1113.08	1.8E+15	1.1E+14	235.00	8.9E+13	2.2E+13	1.7E+15	8.6E+13
Walnut Creek	39.00	340.16	48.64	2983.33	381.11	8.4E+15	2.3E+14	235.00	7.1E+14	1.0E+14	7.7E+15	1.2E+14

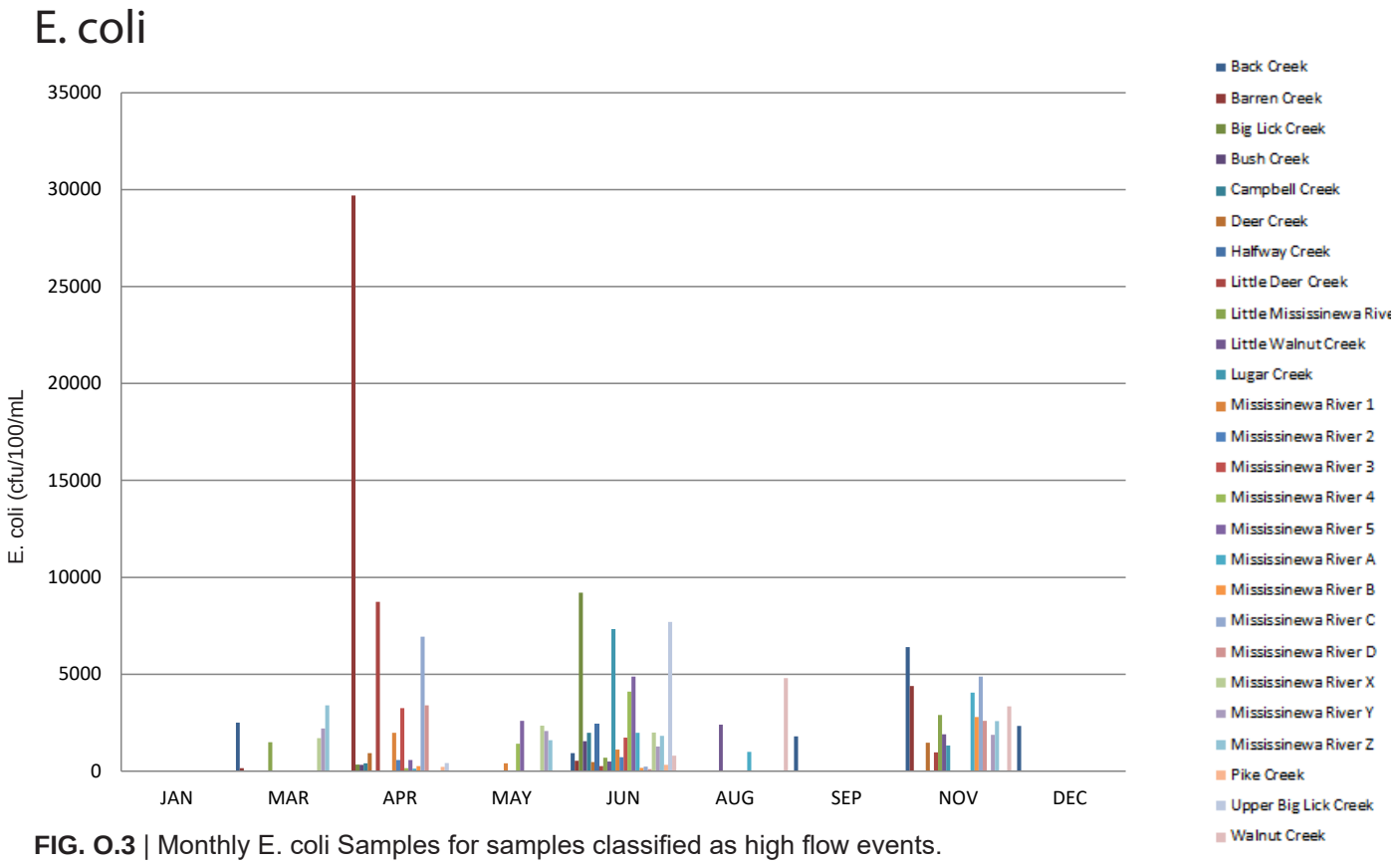


FIG. O.3 | Monthly E. coli Samples for samples classified as high flow events.

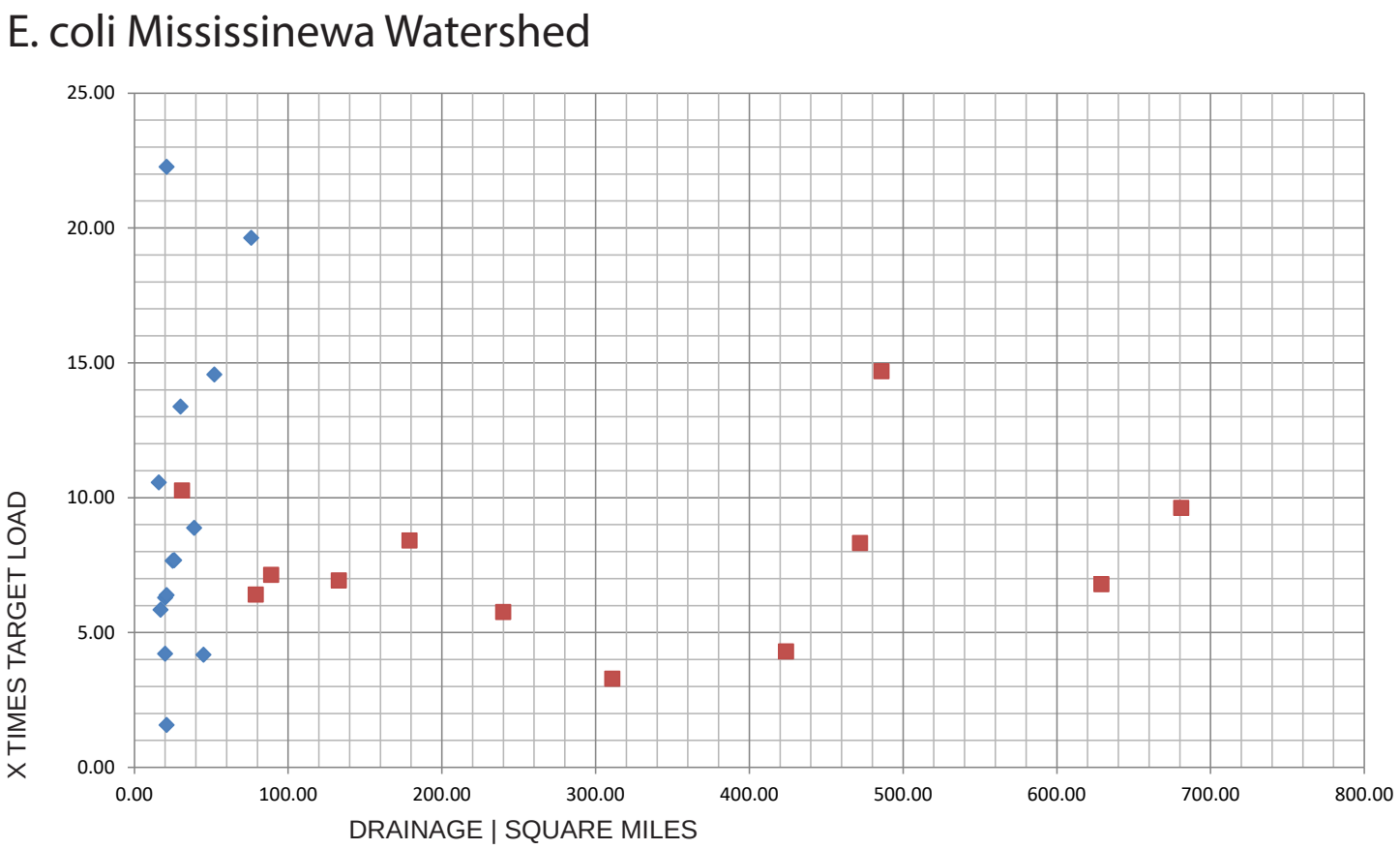


FIG. O.4 | Drainage size vs. X times target load.
"X times" represents how many times the average load (of all sample events) exceeds the target load.
Mainstem sites are represented by red squares and tributary sites by blue diamonds.

E. coli Mississinewa Mainstem

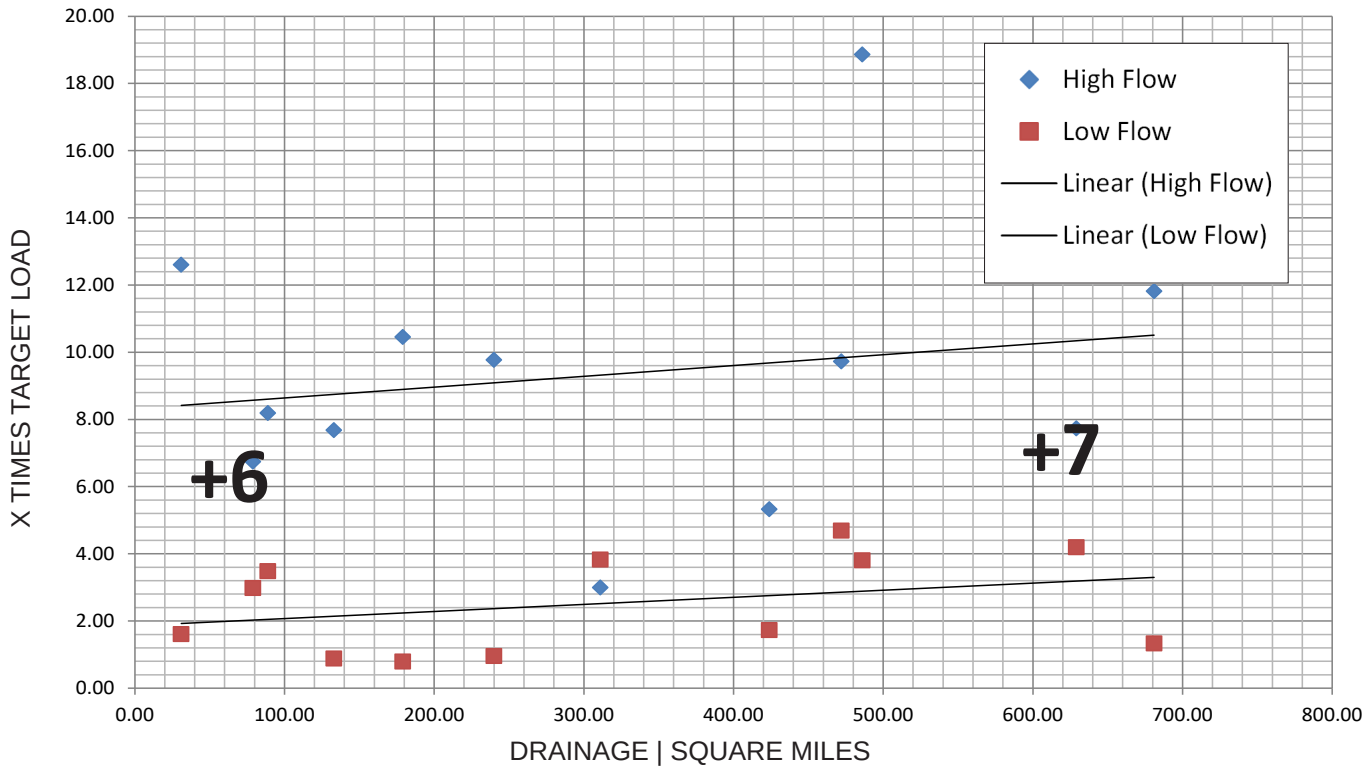


FIG. O.5 | Drainage size vs. X times target load for Mainstem Subwatersheds at High Flow and Low Flow events.

E. coli Mississinewa ***Subwatersheds***

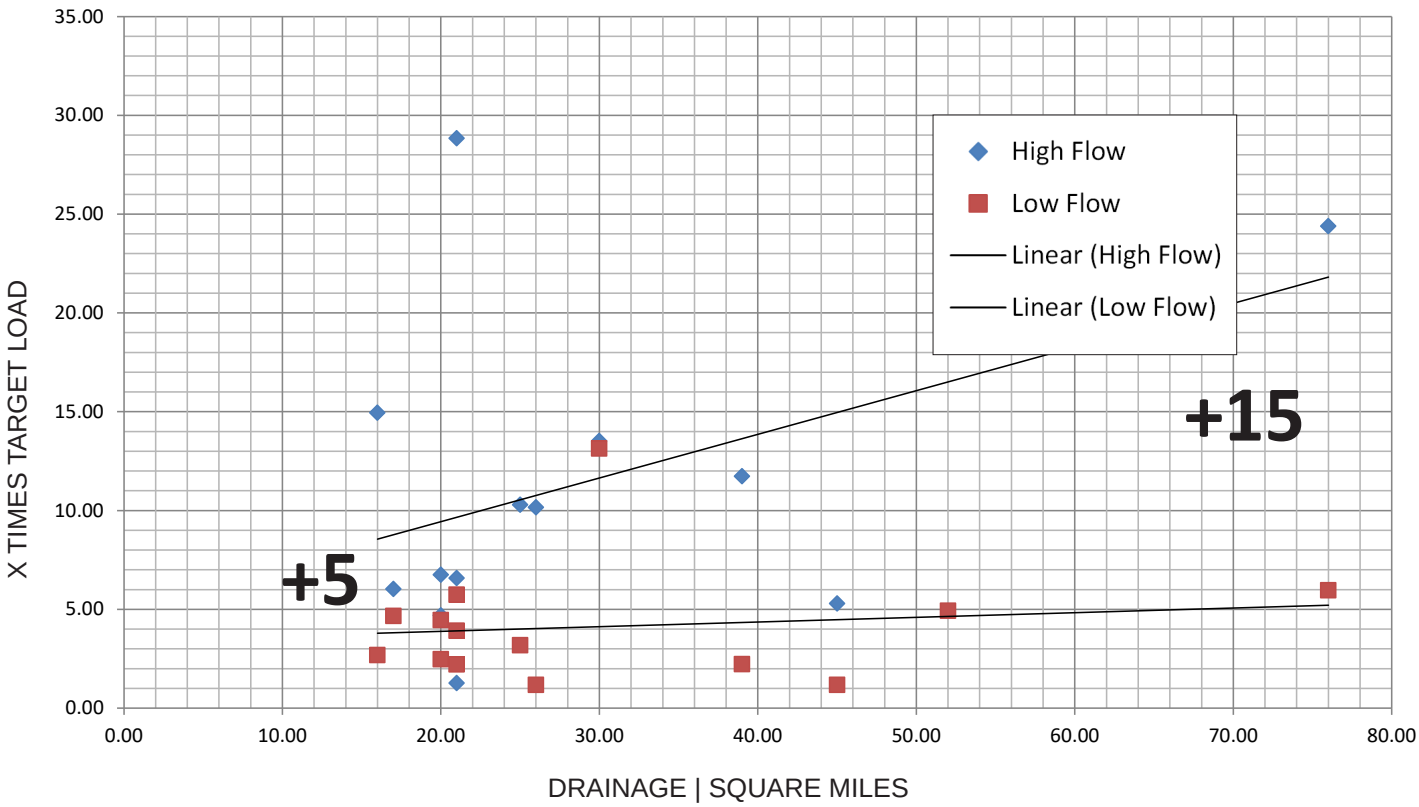


FIG. O.6 | Drainage size vs. X times target load for Tributary Subwatersheds at High Flow and Low Flow events.

P. DISSOLVED OXYGEN DATA

TABLE P.1 | Count of Exceedances for Dissolved Oxygen (Separated by Flow)			
Subwatershed	High Flow	Low Flow	No Flow Data Collected
Back Creek	1.00	1.00	
Barren Creek		2.00	
Bear Creek			3.00
Big Lick Creek		1.00	1.00
Bush Creek			3.00
Campbell Creek	1.00		1.00
Days Creek			1.00
Deer Creek		2.00	
Halfway Creek	1.00	3.00	3.00
Little Deer Creek			1.00
Little Mississinewa River	1.00	1.00	
Little Walnut Creek		2.00	
Lugar Creek			1.00
Holden Ditch	1.00	3.00	
Rees Ditch		1.00	
Platt-Nibarger Ditch	1.00	2.00	
Mud Creek		3.00	
Boots Creek		8.00	
Branch Creek		2.00	
Lake Branch		1.00	
Hoppas Ditch		3.00	
Porter Creek		1.00	
Jordan Creek	1.00		
Gray Branch		1.00	
Pike Creek	2.00	1.00	2.00
Upper Big Lick Creek	1.00	1.00	
Walnut Creek		2.00	
Grand Total	10.00	41.00	16.00

Q. BIOLOGICAL DATA

HBI
The Muncie Bureau of Water Quality also used the Hilsenhoff Biotic Index (HBI) to provide a water quality assessment. Species and community data gathered for the mIBI was also applied to the HBI. The Hilsenhoff Biotic Index (HBI) evaluates organic and nutrient stream pollution. The scale assigns tolerance levels for macroinverebrate families from 0 to 10, 0 being intolerant and 10 being the most tolerant of organic pollution. HBI scores are determined by multiplying the total number of individuals for each family by the family tolerance values. The sum of all products for a site is divided by the total number of individuals to determine the HBI score.

TABLE Q.1 | HBI scores and narratives (Macros only)

Total Score	Narrative Rating	Indication
0.00-3.5	Excellent	No apparent organic pollution
3.51-4.5	Very Good	Possible slight organic pollution
4.51-5.5	Good	Some organic pollution
5.51-6.5	Fair	Fairly significant organic pollution
6.51-7.5	Fairly Poor	Significant organic pollution
6.51 – 7.25	Poor	Very substantial pollution likely
7.26 – 10	Very Poor	Severe organic pollution likely

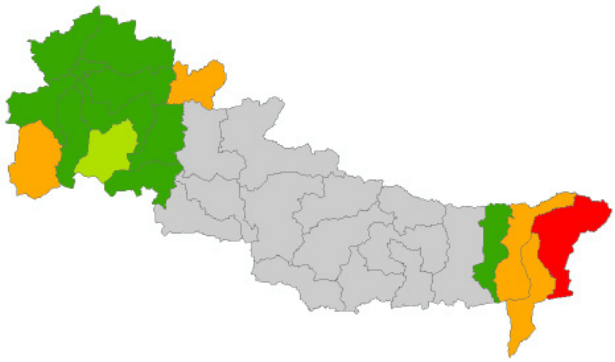


FIG. Q.1 | HBI Qual
Subwatersheds are ranked on a gradient (red high and green low) based on HBI scores. High scores indicate poor water quality; low scores indicate good water quality.

TABLE Q.2 | Results From The Bureau Of Water Quality

	HBI	HBI-Qual
Porter Creek-Mississinewa River	5.4	Good
Jordan Creek-Mississinewa River	5.63	Fair
Little Mississinewa River	5.87	Fair
Gray Branch-Mississinewa River	6.56	Fairly Poor
Boots Creek-Mississinewa River	3.39	Good
Lugar Creek	5.25	Good
Branch Creek-Mississinewa River	5.36	Good
Deer Creek	4.82	Good
Little Deer Creek-Deer Creek	5.65	Fair
Back Creek	5.43	Good
Walnut Creek	4.65	Good
Little Walnut Creek-Walnut Creek	5.76	Fair
Lake Branch-Mississinewa River	5.03	Good
Barren Creek	4.3	Very Good
Hoppas Ditch-Mississinewa River	5	Good

R. LOAD REDUCTION SCENARIOS

R.1 MASSEY CREEK HUC 10: LUGAR CREEK HUC 12—TSS

TABLE R.1 | TSS (sediment) loading data for Lugar Creek	
Total TSS Load (ton/yr)*	2,683
Load Reduction Needed (ton/yr)**	1,064
Acres of Cropland	13,600

*Based on high flow average cfs and high flow average TSS concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 25 mg/L

TABLE R.2 | BMPs, BMP efficiencies, rates of use, and resulting TSS load reductions for Lugar Creek			
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used*	Load Reductions (tons/yr)
Cover Crops and Filter Strips*	900**	8%	900
No Till***	220	2%	172
		Total Load Reduction (ton/yr)	1,072
		Percent Reduction Achieved	40%
		Percent Reduction Needed***	40%
		Remaining Load Reduction Needed (tons)	0
		Percent Progress Towards Goal	100%

*This scenario was created using Region 5. Region 5 reductions are based on BMPs placed in "contributing areas," meaining they are adjacent to a stream or river and their runoff enters these bodies of water. Load reductions from cover crops and filter strips are calculated together.
**This figure includes acreage for both cover crops and filter strips. Waterways adjacent to contributing areas where cover crops are planted should also have appropriately sized buffers. If appropriate buffers are already present, their area should be calculated and a buffer of equivalent size or greater should be planted elsewhere.
***No Till acres must also be implemented in "contributing areas" in order to cause estimated reductions.

R.2 HEADWATERS MISSISSINEWA RIVER HUC 10: GRAY BRANCH HUC 12—NITRATE

TABLE R.3 | Nitrate loading data for Gray Branch	
Total Nitrate Load (ton/yr)*	251
Load Reduction Needed (ton/yr)**	213
Acres of Cropland	16,931

*Based on average cfs and average nitrate concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 1 mg/L

TABLE R.4 | BMPs, rates of use, and resulting nitrate load reductions for Gray Branch					
		Column A	Column B	Column C = Column A x B x D	Column D
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used	Estimated % Nitrate-N Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Wetland Restoration	508	3%	100%	8	251
Prairie Restoration	85	1%	100%	1	226
Extended Rotations	85	1%	42%	1	224
Fertilizer Reduction Practices (MRTN, sidedress, no fall application)	16,254	100%	10%	24	130
Cover Crops	8,127	50%	25%	32	117
Filter Strips	13		25%		117
Drainage Water Management**	2,763	17%	33%	10	88
Saturated Buffer***		0%	50%	0	82
Bioreactors	163	1%	43%	1	74
			Total Load Reduction (ton/yr)	76.17	
			Percent Reduction Achieved	30%	
			Percent Reduction Needed	85%	
			Remaining Load Reduction Needed (tons)	174.9	
			Percent Progress Towards Goal	36%	

*Not all cropland is suitable for drainage water management. Percentages are based on figures and maps generated by the NRCS. Percentages estimate the maximum amount of land suitable for drainage water management.
**Not all buffers are suitable for converting into saturated buffers. Researchers in Iowa estimated that 20% of that state's buffers were suitable for conversion to saturated buffers. We used the same figure here. Actual percentages may vary.

R.3 HEADWATERS MISSISSINEWA RIVER HUC 10: LITTLE MISSISSINEWA RIVER HUC 12—NITRATE

TABLE R.5 | Nitrate loading data for Little Mississinewa River	
Total Nitrate Load (ton/yr)*	201
Load Reduction Needed (ton/yr)**	163
Acres of Cropland	10,905

*Based on average cfs and average nitrate concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 1 mg/L

TABLE R.6 | BMPs, rates of use, and resulting nitrate load reductions for Little Mississinewa River

BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used	Estimated % Nitrate-N Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Wetland Restoration	327	3%	100%	6	201
Prairie Restoration	55	1%	100%	1	195
Extended Rotations	55	1%	42%	0	194
Fertilizer Reduction Practices (MRTN, sidedress, no fall application)	10,523	100%	10%	19	194
Cover Crops	5,262	50%	29%	25	174
Filter Strips	12				
Drainage Water Management**	1,789	17%	33%	8	149
Saturated Buffer***	-	0%	50%	0	141
Bioreactors	105	1%	43%	1	141
			Total Load Reduction (ton/yr)	61	
			Percent Reduction Achieved	30%	
			Percent Reduction Needed	75%	
			Remaining Load Reduction Needed (tons)	140	
			Percent Progress Towards Goal	37%	

*Not all cropland is suitable for drainage water management. Percentages are based on figures and maps generated by the NRCS. Percentages estimate the maximum amount of land suitable for drainage water management.
**Not all buffers are suitable for converting into saturated buffers. Researchers in Iowa estimated that 20% of that state's buffers were suitable for conversion to saturated buffers. We used the same figure here. Actual percentages may vary.

R.4 HALFWAY CREEK HUC 10: HALFWAY CREEK HUC 12—NITRATE

TABLE R.7 | Nitrate loading data for Halfway Creek	
Total Nitrate Load (ton/yr)*	43
Load Reduction Needed (ton/yr)**	17
Acres of Cropland	12,705

*Based on average cfs and average nitrate concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 1 mg/L

TABLE R.8 | BMPs, rates of use, and resulting nitrate load reductions for Halfway Creek					
		Column A	Column B	Column C = Column A x B x D	Column D
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used	Estimated % Nitrate-N Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Wetland Restoration	381	3%	100%	1	43
Prairie Restoration	64	1%	100%	0	42
Extended Rotations	64	1%	42%	0	42
Fertilizer Reduction Practices (MRTN, sidedress, no fall application)	12,260	100%	10%	4	41
Cover Crops	6,130	50%	29%	5	37
Filter Strips					
Drainage Water Management	2,084	17%	33%	2	32
Saturated Buffer**	-	0%	50%	0	30
Bioreactors	123	1%	43%	0	30
			Total Load Reduction (ton/yr)	13	
			Percent Reduction Achieved	30%	
			Percent Reduction Needed	75%	
			Remaining Load Reduction Needed (tons)	30	
			Percent Progress Towards Goal	77%	

*Not all cropland is suitable for drainage water management. Percentages are based on figures and maps generated by the NRCS. Percentages estimate the maximum amount of land suitable for drainage water management.
**Not all buffers are suitable for converting into saturated buffers. Researchers in Iowa estimated that 20% of that state's buffers were suitable for conversion to saturated buffers. We used the same figure here. Actual percentages may vary.

R.5 HALFWAY CREEK HUC 10: HALFWAY CREEK HUC 12—PHOSPHORUS

TABLE R.9 | Phosphorus loading data for Halfway Creek	
Total Phosphorus Load (ton/yr)*	29
Load Reduction Needed (ton/yr)**	11
Acres of Cropland	12,705

*Based on high flow average cfs and high flow average phosphorus concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 0.3 mg/L

TABLE R.10 | BMPs, BMP efficiencies, rates of use, and resulting phosphorus load reductions for Halfway Creek					
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used*	Estimated % Phosphorus Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Fertilize Based on Soil Test Phosphorus	12,705	100%	no data	no data	29
Cover Crops	4,066	32%	29%	3	29
Conservation Tillage	4,447	35%	33%	8	27
Filter Strips	16		58%		18
			Total Load Reduction (ton/yr)	11	
			Percent Reduction Achieved	38%	
			Percent Reduction Needed***	38%	
			Remaining Load Reduction Needed (tons)	0	
			Percent Progress Towards Goal	100%	

*Percentage of cropland used, or percentage of area that is appropriate for the BMP. For example, "100%" is listed for buffers. This means 100% of land appropriate for a buffer, rather than 100% of the cropland.
**Acreage needed for buffers is difficult to assess. However, 45% of NHD mapped streams in Halfway Creek need a buffer; this percentage was used to calculate the load reduction.
***This is based on high flow averages, which results in an overestimation of the total phosphorus load.

R.6 PIKE CREEK HUC 10:
STUDEBAKER DITCH-PIKE CREEK HUC 12—NITRATE

TABLE R.11 | Nitrate loading data for Pike Creek	
Total Nitrate Load (ton/yr)*	41
Load Reduction Needed (ton/yr)**	23
Acres of Cropland	11,975

*Based on average cfs and average nitrate concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 1 mg/L

TABLE R.12 | BMPs, rates of use, and resulting nitrate load reductions for Pike Creek

		Column A	Column B	Column C = Column A x B x D	Column D
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used	Estimated % Nitrate-N Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Wetland Restoration	359.25	3%	100%	1	41
Prairie Restoration	60	1%	100%	0	40
Extended Rotations	60	1%	42%	0	40
Fertilizer Reduction Practices (MRTN, sidedress, no fall application)	11,556	100%	10%	4	39
Cover Crops	5,778	50%	25%	5	36
Filter Strips					
Drainage Water Management	1,964	17%	33%	2	30
Saturated Buffer**	-	0%	50%	0	29
Bioreactors	116	1%	43%	0	29
			Total Load Reduction (ton/yr)	12	
			Percent Reduction Achieved	30%	
			Percent Reduction Needed	75%	
			Remaining Load Reduction Needed (tons)	29	
			Percent Progress Towards Goal	54%	

*Not all cropland is suitable for drainage water management. Percentages are based on figures and maps generated by the NRCS. Percentages estimate the maximum amount of land suitable for drainage water management.
**Not all buffers are suitable for converting into saturated buffers. Researchers in Iowa estimated that 20% of that state's buffers were suitable for conversion to saturated buffers. We used the same figure here.
Actual percentages may vary.

R.7 PIKE CREEK HUC 10: CAMPBELL CREEK HUC 12—TSS

TABLE R.13 | TSS (sediment) loading data for Campbell Creek	
Total TSS Load (ton/yr)*	1562
Load Reduction Needed (ton/yr)**	782
Acres of Cropland	11,304

*Based on high flow average cfs and high flow average TSS concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 25 mg/L

TABLE R.14 | BMPs, BMP efficiencies, rates of use, and resulting TSS load reductions for Campbell Creek			
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used*	Load Reductions (tons/yr)
Cover Crops and Filter Strips*	500**	4%	700
No Till***	80	2%	88
		Total Load Reduction (ton/yr)	788
		Percent Reduction Achieved	50%
		Percent Reduction Needed***	50%
		Remaining Load Reduction Needed (tons)	0
		Percent Progress Towards Goal	100%

*This scenario was created using Region 5. Region 5 reductions are based on BMPs placed in "contributing areas," meaining they are adjacent to a stream or river and their runoff enters these bodies of water. Load reductions from cover crops and filter strips are calculated together.
**This figure includes acreage for both cover crops and filter strips. Waterways adjacent to contributing areas where cover crops are planted should also have appropriately sized buffers. If appropriate buffers are already present, their area should be calculated and a buffer of equivalent size or greater should be planted elsewhere.
***No Till acres must also be implemented in "contributing areas" in order to cause estimated reductions.

R.8 BIG LICK CREEK HUC 10: LITTLE LICK CREEK HUC 12—NITRATE

TABLE R.15 | Nitrate loading data for Little Lick Creek	
Total Nitrate Load (ton/yr)*	62
Load Reduction Needed (ton/yr)**	32
Acres of Cropland	23,051

*Based on average cfs and average nitrate concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 1 mg/L

TABLE R.16 | BMPs, rates of use, and resulting nitrate load reductions for Little Lick Creek					
		Column A	Column B	Column C = Column A x B x D	Column D
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used	Estimated % Nitrate-N Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Wetland Restoration	691.53	3%	100%	2	62
Prairie Restoration	115	1%	100%	0	60
Extended Rotations	115	1%	42%	0	60
Fertilizer Reduction Practices (MRTN, sidedress, no fall application)	22,244	100%	10%	6	60
Cover Crops	11,122	50%	25%	8	54
Filter Strips					
Drainage Water Management	3,782	17%	33%	3	46
Saturated Buffer**	-	0%	50%	0	43
Bioreactors	222	1%	43%	0	43
			Total Load Reduction (ton/yr)	19	
			Percent Reduction Achieved	30%	
			Percent Reduction Needed	75%	
			Remaining Load Reduction Needed (tons)	43	
			Percent Progress Towards Goal	59%	

*Not all cropland is suitable for drainage water management. Percentages are based on figures and maps generated by the NRCS. Percentages estimate the maximum amount of land suitable for drainage water management.
**Not all buffers are suitable for converting into saturated buffers. Researchers in Iowa estimated that 20% of that state's buffers were suitable for conversion to saturated buffers. We used the same figure here.
Actual percentages may vary.

R.9 BIG LICK CREEK HUC 10: LITTLE LICK CREEK HUC 12—PHOSPHORUS

TABLE R.17 | Phosphorus loading data for Little Lick Creek	
Total Phosphorus Load (ton/yr)*	19
Load Reduction Needed (ton/yr)**	2
Acres of Cropland	23,051

*Based on high flow average cfs and high flow average phosphorus concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 0.3 mg/L

TABLE R.18 | BMPs, BMP efficiencies, rates of use, and resulting phosphorus load reductions for Little Lick Creek					
		Column A	Column B	Column C = Column A x B x D	Column D
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used*	Estimated % Phosphorus Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Fertilize Based on Soil Test Phosphorus	23,051	100%	no data	no data	19
Cover Crops	4,149	18%	29%	1	19
Conservation Tillage	2,766	12%	33%	1	18
Filter Strips**			58%		17
			Total Load Reduction (ton/yr)	2	
			Percent Reduction Achieved	9%	
			Percent Reduction Needed***	9%	
			Remaining Load Reduction Needed (tons)	0	
			Percent Progress Towards Goal	100%	

*Percentage of cropland used, or percentage of area that is appropriate for the BMP. For example, "100%" is listed for buffers. This means 100% of land appropriate for a buffer, rather than 100% of the cropland.
**Acreage needed for buffers is difficult to assess. However, 45% of NHD mapped streams in Little Lick Creek need a buffer; this percentage was used to calculate the load reduction.
***This is based on high flow averages, which results in an overestimation of the total phosphorus load.

S. MEETING ULTIMATE GOALS—MODELS

S.1 MASSEY CREEK HUC 10: LUGAR CREEK HUC 12—TSS

TABLE S.1 | TSS (sediment) loading data for Lugar Creek	
Total TSS Load (ton/yr)*	2,683
Load Reduction Needed (ton/yr)**	1,064
Acres of Cropland	13,600

*Based on high flow average cfs and high flow average TSS concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 25 mg/L

TABLE S.2 | BMPs, BMP efficiencies, rates of use, and resulting TSS load reductions for Lugar Creek			
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used*	Load Reductions (tons/yr)
Cover Crops and Filter Strips*	900**	8%	900
No Till***	300	2%	234
		Total Load Reduction (ton/yr)	1,134
		Percent Reduction Achieved	42%
		Percent Reduction Needed***	40%
		Remaining Load Reduction Needed (tons)	0
		Percent Progress Towards Goal	100%

*This scenario was created using Region 5. Region 5 reductions are based on BMPs placed in "contributing areas," meaining they are adjacent to a stream or river and their runoff enters these bodies of water. Load reductions from cover crops and filter strips are calculated together.
**This figure includes acreage for both cover crops and filter strips. Waterways adjacent to contributing areas where cover crops are planted should also have appropriately sized buffers. If appropriate buffers are already present, their area should be calculated and a buffer of equivalent size or greater should be planted elsewhere.
***No Till acres must also be implemented in "contributing areas" in order to cause estimated reductions.

S.2 HEADWATERS MISSISSINEWA RIVER HUC 10: GRAY BRANCH HUC 12—NITRATE

TABLE S.3 | Nitrate loading data for Gray Branch	
Total Nitrate Load (ton/yr)*	251
Load Reduction Needed (ton/yr)**	213
Acres of Cropland	16,931

*Based on average cfs and average nitrate concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 1 mg/L

TABLE S.4 | BMPs, rates of use, and resulting nitrate load reductions for Gray Branch

		Column A	Column B	Column C = Column A x B x D	Column D
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used	Estimated % Nitrate-N Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Wetland Restoration	1,693	10%	100%	25	251
Prairie Restoration	169	1%	100%	2	226
Extended Rotations	15,069	100%	42%	94	224
Fertilizer Reduction Practices (MRTN, sidedress, no fall application)	15,069	100%	10%	13	130
Cover Crops and Filter Strips*	15,069	100%	25%	29	117
Drainage Water Management**	3,048	18%	33%	5	88
Saturated Buffer***	3,386	20%	50%	8	82
Bioreactors	15,069	100%	43%	32	74
			Total Load Reduction (ton/yr)	209	
			Percent Reduction Achieved	83%	
			Percent Reduction Needed	85%	
			Remaining Load Reduction Needed (tons)	4	
			Percent Progress Towards Goal	98%	

*Cover crops and filter strips are combined for ease of calculations since assessing total acreage needing filterstrips is difficult. Filter strips are regarded as having equal or greater effects on nitrate reductions.
They can capture some of the small percentage of dissolved nitrate in surface flow. Furthermore, conversion of cropland to a filterstrip means a 100% reduction in nitrogen fertilizer on that land.
**Not all cropland is suitable for drainage water management. Percentages are based on figures and maps generated by the NRCS. Percentages estimate the maximum amount of land suitable for drainage water management.
***Not all buffers are suitable for converting into saturated buffers. Researchers in Iowa estimated that 20% of that state's buffers were suitable for conversion to saturated buffers. We used the same figure here.
Actual percentages may vary.

S.3 HEADWATERS MISSISSINEWA RIVER HUC 10: LITTLE MISSISSINEWA RIVER HUC 12—NITRATE

TABLE S.5 | Nitrate loading data for Little Mississinewa River	
Total Nitrate Load (ton/yr)*	201
Load Reduction Needed (ton/yr)**	163
Acres of Cropland	10,905

*Based on average cfs and average nitrate concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 1 mg/L

TABLE S.6 | BMPs, rates of use, and resulting nitrate load reductions for Little Mississinewa River

BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used	Estimated % Nitrate-N Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Wetland Restoration	1,091	10%	100%	20	201
Prairie Restoration	109	1%	100%	2	181
Extended Rotations	9,705	100%	42%	75	179
Fertilizer Reduction Practices (MRTN, sidedress, no fall application)	9,705	100%	10%	10	104
Cover Crops and Filter Strips*	9,705	100%	25%	23	94
Drainage Water Management**	6,150	18%	33%	4	70
Saturated Buffer***	2,050	20%	50%	7	66
Bioreactors	161	80%	43%	20	59
			Total Load Reduction (ton/yr)	162	
			Percent Reduction Achieved	81%	
			Percent Reduction Needed	81%	
			Remaining Load Reduction Needed (tons)	1	
			Percent Progress Towards Goal	100%	

*Cover crops and filter strips are combined for ease of calculations since assessing total acreage needing filterstrips is difficult. Filter strips are regarded as having equal or greater effects on nitrate reductions.
They can capture some of the small percentage of dissolved nitrate in surface flow. Furthermore, conversion of cropland to a filterstrip means a 100% reduction in nitrogen fertilizer on that land.
**Not all cropland is suitable for drainage water management. Percentages are based on figures and maps generated by the NRCS. Percentages estimate the maximum amount of land suitable for drainage water management.
***Not all buffers are suitable for converting into saturated buffers. Researchers in Iowa estimated that 20% of that state's buffers were suitable for conversion to saturated buffers. We used the same figure here.
Actual percentages may vary.

S.4 HALFWAY CREEK HUC 10: HALFWAY CREEK HUC 12—NITRATE

TABLE S.7 | Nitrate loading data for Halfway Creek	
Total Nitrate Load (ton/yr)*	43
Load Reduction Needed (ton/yr)**	17
Acres of Cropland	12,705

*Based on average cfs and average nitrate concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 1 mg/L

TABLE S.8 | BMPs, rates of use, and resulting nitrate load reductions for Halfway Creek					
		Column A	Column B	Column C = Column A x B x D	Column D
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used	Estimated % Nitrate-N Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Wetland Restoration	381	3%	100%	1	43
Prairie Restoration	-	0%	100%	0	41
Fertilizer Reduction Practices (MRTN, sidedress, no fall application)	12,324	100%	10%	4	41
Cover Crops and Filter Strips	10,475	85%	25%	8	37
Drainage Water Management	1,906	15%	33%	1	29
Saturated Buffer	2,541	20%	50%	3	28
Bioreactors	-	0%	43%	0	25
			Total Load Reduction (ton/yr)	18	
			Percent Reduction Achieved	41%	
			Percent Reduction Needed	41%	
			Remaining Load Reduction Needed (tons)	0	
			Percent Progress Towards Goal	100%	

*Cover crops and filter strips are combined for ease of calculations since assessing total acreage needing filterstrips is difficult. Filter strips are regarded as having equal or greater effects on nitrate reductions.
They can capture some of the small percentage of dissolved nitrate in surface flow. Furthermore, conversion of cropland to a filterstrip means a 100% reduction in nitrogen fertilizer on that land.
**Not all cropland is suitable for drainage water management. Percentages are based on figures and maps generated by the NRCS. Percentages estimate the maximum amount of land suitable for drainage water management.
***Not all buffers are suitable for converting into saturated buffers. Researchers in Iowa estimated that 20% of that state's buffers were suitable for conversion to saturated buffers. We used the same figure here.
Actual percentages may vary.

S.5 HALFWAY CREEK HUC 10: HALFWAY CREEK HUC 12—PHOSPHORUS

TABLE S.9 | Phosphorus loading data for Halfway Creek	
Total Phosphorus Load (ton/yr)*	29
Load Reduction Needed (ton/yr)**	11
Acres of Cropland	12,705

*Based on high flow average cfs and high flow average phosphorus concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 0.3 mg/L

TABLE S.10 | BMPs, BMP efficiencies, rates of use, and resulting phosphorus load reductions for Halfway Creek

BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used*	Estimated % Phosphorus Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Fertilize Based on Soil Test Phosphorus	12,705	100%	no data	no data	29
Cover Crops	3,176	25%	29%	2	29
Conservation Tillage	3,812	30%	33%	3	27
Filter Strips	no data**	45%	58%	6	24
			Total Load Reduction (ton/yr)	11	
			Percent Reduction Achieved	38%	
			Percent Reduction Needed***	38%	
			Remaining Load Reduction Needed (tons)	0	
			Percent Progress Towards Goal	100%	

*Percentage of cropland used, or percentage of area that is appropriate for the BMP. For example, "100%" is listed for buffers. This means 100% of land appropriate for a buffer, rather than 100% of the cropland.
**Acreage needed for buffers is difficult to assess. However, 45% of NHD mapped streams in Halfway Creek need a buffer; this percentage was used to calculate the load reduction.
***This is based on high flow averages, which results in an overestimation of the total phosphorus load.

S.6 PIKE CREEK HUC 10: STUDEBAKER DITCH-PIKE CREEK HUC 12—NITRATE

TABLE S.11 | Nitrate loading data for Pike Creek	
Total Nitrate Load (ton/yr)*	41
Load Reduction Needed (ton/yr)**	23
Acres of Cropland	11,975

*Based on average cfs and average nitrate concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 1 mg/L

TABLE S.12 | BMPs, rates of use, and resulting nitrate load reductions for Pike Creek					
		Column A	Column B	Column C = Column A x B x D	Column D
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used	Estimated % Nitrate-N Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Wetland Restoration	1,198	10%	100%	4	41
Prairie Restoration	240	2%	100%	1	37
Fertilizer Reduction Practices (MRTN, sidedress, no fall application)	10,538	100%	10%	4	37
Cover Crops and Filter Strips	10,538	100%	25%	8	33
Drainage Water Management	2,108	20%	33%	1	22
Saturated Buffer	2,108	20%	50%	2	25
Bioreactors	2,529	24%	43%	2	21
			Total Load Reduction (ton/yr)	23	
			Percent Reduction Achieved	55%	
			Percent Reduction Needed	55%	
			Remaining Load Reduction Needed (tons)	0	
			Percent Progress Towards Goal	100%	

*Cover crops and filter strips are combined for ease of calculations since assessing total acreage needing filterstrips is difficult. Filter strips are regarded as having equal or greater effects on nitrate reductions.
They can capture some of the small percentage of dissolved nitrate in surface flow. Furthermore, conversion of cropland to a filterstrip means a 100% reduction in nitrogen fertilizer on that land.
**Not all cropland is suitable for drainage water management. Percentages are based on figures and maps generated by the NRCS. Percentages estimate the maximum amount of land suitable for drainage water management.
***Not all buffers are suitable for converting into saturated buffers. Researchers in Iowa estimated that 20% of that state's buffers were suitable for conversion to saturated buffers. We used the same figure here.
Actual percentages may vary.

S.7 PIKE CREEK HUC 10: CAMPBELL CREEK HUC 12—TSS

TABLE S.13 | TSS (sediment) loading data for Campbell Creek	
Total TSS Load (ton/yr)*	1562
Load Reduction Needed (ton/yr)**	782
Acres of Cropland	11,304

*Based on high flow average cfs and high flow average TSS concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 25 mg/L

TABLE S.14 | BMPs, BMP efficiencies, rates of use, and resulting TSS load reductions for Campbell Creek			
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used*	Load Reductions (tons/yr)
Cover Crops and Filter Strips*	500**	4%	700
No Till***	100	2%	110
		Total Load Reduction (ton/yr)	810
		Percent Reduction Achieved	52%
		Percent Reduction Needed***	50%
		Remaining Load Reduction Needed (tons)	0
		Percent Progress Towards Goal	100%

*This scenario was created using Region 5. Region 5 reductions are based on BMPs placed in "contributing areas," meaining they are adjacent to a stream or river and their runoff enters these bodies of water. Load reductions from cover crops and filter strips are calculated together.
**This figure includes acreage for both cover crops and filter strips. Waterways adjacent to contributing areas where cover crops are planted should also have appropriately sized buffers. If appropriate buffers are already present, their area should be calculated and a buffer of equivalent size or greater should be planted elsewhere.
***No Till acres must also be implemented in "contributing areas" in order to cause estimated reductions.

S.8 BIG LICK CREEK HUC 10: LITTLE LICK CREEK HUC 12—NITRATE

TABLE S.15 | Nitrate loading data for Little Lick Creek	
Total Nitrate Load (ton/yr)*	62
Load Reduction Needed (ton/yr)**	32
Acres of Cropland	23,051

*Based on average cfs and average nitrate concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 1 mg/L

TABLE S.16 | BMPs, rates of use, and resulting nitrate load reductions for Little Lick Creek					
		Column A	Column B	Column C = Column A x B x D	Column D
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used	Estimated % Nitrate-N Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Wetland Restoration	2,305	10%	100%	6	62
Prairie Restoration	-	0%	100%	0	56
Fertilizer Reduction Practices (MRTN, sidedress, no fall application)	20,746	100%	10%	6	56
Cover Crops and Filter Strips	20,746	100%	25%	13	50
Drainage Water Management	4,564	22%	33%	3	38
Saturated Buffer	4,149	20%	50%	3	35
Bioreactors	2,904	14%	43%	2	31
			Total Load Reduction (ton/yr)	32	
			Percent Reduction Achieved	52%	
			Percent Reduction Needed	52%	
			Remaining Load Reduction Needed (tons)	0	
			Percent Progress Towards Goal	100%	

*Cover crops and filter strips are combined for ease of calculations since assessing total acreage needing filterstrips is difficult. Filter strips are regarded as having equal or greater effects on nitrate reductions.
They can capture some of the small percentage of dissolved nitrate in surface flow. Furthermore, conversion of cropland to a filterstrip means a 100% reduction in nitrogen fertilizer on that land.
**Not all cropland is suitable for drainage water management. Percentages are based on figures and maps generated by the NRCS. Percentages estimate the maximum amount of land suitable for drainage water management.
***Not all buffers are suitable for converting into saturated buffers. Researchers in Iowa estimated that 20% of that state's buffers were suitable for conversion to saturated buffers. We used the same figure here.
Actual percentages may vary.

S.9 BIG LICK CREEK HUC 10: LITTLE LICK CREEK HUC 12—PHOSPHORUS

TABLE S.17 | Phosphorus loading data for Little Lick Creek	
Total Phosphorus Load (ton/yr)*	19
Load Reduction Needed (ton/yr)**	2
Acres of Cropland	23,051

*Based on high flow average cfs and high flow average phosphorus concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 0.3 mg/L

TABLE S.18 | BMPs, BMP efficiencies, rates of use, and resulting phosphorus load reductions for Little Lick Creek					
		Column A	Column B	Column C = Column A x B x D	Column D
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used*	Estimated % Phosphorus Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Fertilize Based on Soil Test Phosphorus	12,705	100%	no data	no data	19
Cover Crops	-	0%	29%	0	19
Conservation Tillage	2,305	10%	33%	1	19
Filter Strips	no data**	11%	58%	1	18
			Total Load Reduction (ton/yr)	2	
			Percent Reduction Achieved	9%	
			Percent Reduction Needed***	9%	
			Remaining Load Reduction Needed (tons)	0	
			Percent Progress Towards Goal	100%	

*Percentage of cropland used, or percentage of area that is appropriate for the BMP. For example, "100%" is listed for buffers. This means 100% of land appropriate for a buffer, rather than 100% of the cropland.
**Acreage needed for buffers is difficult to assess. However, 45% of NHD mapped streams in Little Lick Creek need a buffer; this percentage was used to calculate the load reduction.
***This is based on high flow averages, which results in an overestimation of the total phosphorus load.

S.10 MASSEY CREEK HUC 10: DEER CREEK HUC 12—NITRATE

TABLE S.19 | Nitrate loading data for Deer Creek	
Total Nitrate Load (ton/yr)*	355
Load Reduction Needed (ton/yr)**	245
Acres of Cropland	9,746

*Based on average cfs and average nitrate concentration
**Calculated using 319 Load Calculation Tool (found at www.in.gov/idem/nps/files/319_load_calculation_tool.xls) and based on a target concentration of 1 mg/L

TABLE S.20 | BMPs, rates of use, and resulting nitrate load reductions for Deer Creek					
		Column A	Column B	Column C = Column A x B x D	Column D
BMPs	Volume of Practice Installed (acres)	Percentage of Cropland Used	Estimated % Nitrate-N Reduction	Load Reductions (tons/yr)	Load Available for Treatment by BMP (tons/yr)
Wetland Restoration	975	10%	100%	36	355
Prairie Restoration	97	1%	100%	3	320
Fertilizer Reduction Practices (MRTN, sidedress, no fall application)	8,674	100%	10%	32	316
Cover Crops and Filter Strips*	8,674	100%	25%	71	285
Drainage Water Management**	6,072	70%	33%	49	214
Saturated Buffer***	1,735	20%	50%	16	164
Bioreactors	4,944	57%	43%	36	148
			Total Load Reduction (ton/yr)	243	
			Percent Reduction Achieved	69%	
			Percent Reduction Needed	69%	
			Remaining Load Reduction Needed (tons)	2	
			Percent Progress Towards Goal	99%	

*Cover crops and filter strips are combined for ease of calculations since assessing total acreage needing filterstrips is difficult. Filter strips are regarded as having equal or greater effects on nitrate reductions.
They can capture some of the small percentage of dissolved nitrate in surface flow. Furthermore, conversion of cropland to a filterstrip means a 100% reduction in nitrogen fertilizer on that land.
**Not all cropland is suitable for drainage water management. Percentages are based on figures and maps generated by the NRCS. Percentages estimate the maximum amount of land suitable for drainage water management.
***Not all buffers are suitable for converting into saturated buffers. Researchers in Iowa estimated that 20% of that state's buffers were suitable for conversion to saturated buffers. We used the same figure here.
Actual percentages may vary.

T. MISC TABLES/FIGURES

TABLE T.1 | Water Quality Results for Tributary Subwatersheds (average of all samples)											
			Nitrogen			Phosphorus			TSS		
Site	mi2	CFS	X	%	TR	X	%	TR	X	%	TR
Subwatershed mean	28	63	3.9	74%	160	1.3	23%	4.79	2.5	60%	2,015
Upper Big Lick Creek	52	29	2.16	54%	27	1.05	4%	0.33	0.5	-99%	-298
Lugar Creek	30	65	2.31	57%	93	1.28	22%	5.38	3.92	74%	4,735
Walnut Creek	39	121	2.64	62%	196	1.48	32%	17.2	3.4	71%	7,181
Back Creek	16	63	2.85	65%	116	0.8	-26%	-3.87	1.6	37%	937
Big Lick Creek	76	39	3.15	68%	72	0.91	-10%	-0.9	0.87	-15%	-108
Halfway Creek	25	25	3.9	74%	69	1.42	30%	2.93	1.45	31%	261
Little Walnut Creek	17	45	4.04	75%	137	2.04	51%	14.1	2.3	57%	1,472
Deer Creek	45	111	4.55	78%	389	1.39	28%	12.89	1.56	36%	1,522
Pike Creek	21	19	4.84	79%	64	0.63	-59%	-1.82	0.46	-118%	-221
Little Deer Creek	26	106	4.87	79%	404	1.26	21%	8.22	1.55	35%	1,431
Campbell Creek	20	16	5.07	80%	55	1.77	44%	3.03	1.73	42%	238.2
Little Mississinewa	21	38	5.57	82%	174	1.8	44%	9.15	8.96	89%	7,610
Barren Creek	21	40	5.83	83%	192	0.52	-94%	-5.77	1.25	20%	246
Bush Creek	20	8	6.88	85%	42	0.84	-19%	-0.34	0.98	-2%	-4.42

X = X Times Target, how many times mean load exceeds target load
% = Percent reduction needed to reach water quality targets
TR = Tons/yr. reduction need to meet water quality targets

TABLE T.2 | Comparison of Loading Data at Mississinewa River Sites and Subwatershed Sites			
	X Times Target	**% Reduction**	**Ton Reduction**
Nitrate+Nitrite			
Boots Creek average	8.4	88%	1339.55
Subwatershed average	3.9	74% (**-14%**)	160.79
Phosphorus			
Boots Creek average	1.75	43%	41.89
Subwatershed average	1.3	23% (**-20%**)	4.79
TSS			
Boots Creek average	6.97	86%	27,703.05
Subwatershed average	2.5	60% (**-26%**)	2,015.31

Individual sites are similarly analyzed in Part 13 of the WMP.
X = X Times Target, how many times mean load exceeds target load
% = Percent reduction needed to reach water quality targets
TR = Tons/yr. reduction need to meet water quality targets

White River Comparison (Albany drainage)

TABLE T.3 | Rivers Mean[1]	**N**	**P**	**TSS**	***E. coli***
Mississinewa	3.31	0.17	38.32	2085
White River	2.98	0.3	30.5	1083
Target	1	0.3	25	235

TABLE T.4 | Rivers Mean[2]	**N**	**P**	**TSS**	***E. coli***
Mississinewa	3.85	0.29	57	907
White River	2.35	0.27	53	2,101
Target	1	0.3	25	235

While averages vary, in same general cohorts for both data set with the exception of White River TSS, which was more impaired. All streams analyzed as part of the "Recreational Stream Study" (Part 7 of WMP) were grouped into three cohorts per parameter. The White and the Mississinewa River were in the worst cohort (red) and moderate cohort (orange) as depicted above. Neither the White or the Mississinewa were in the best cohort for any parameter.

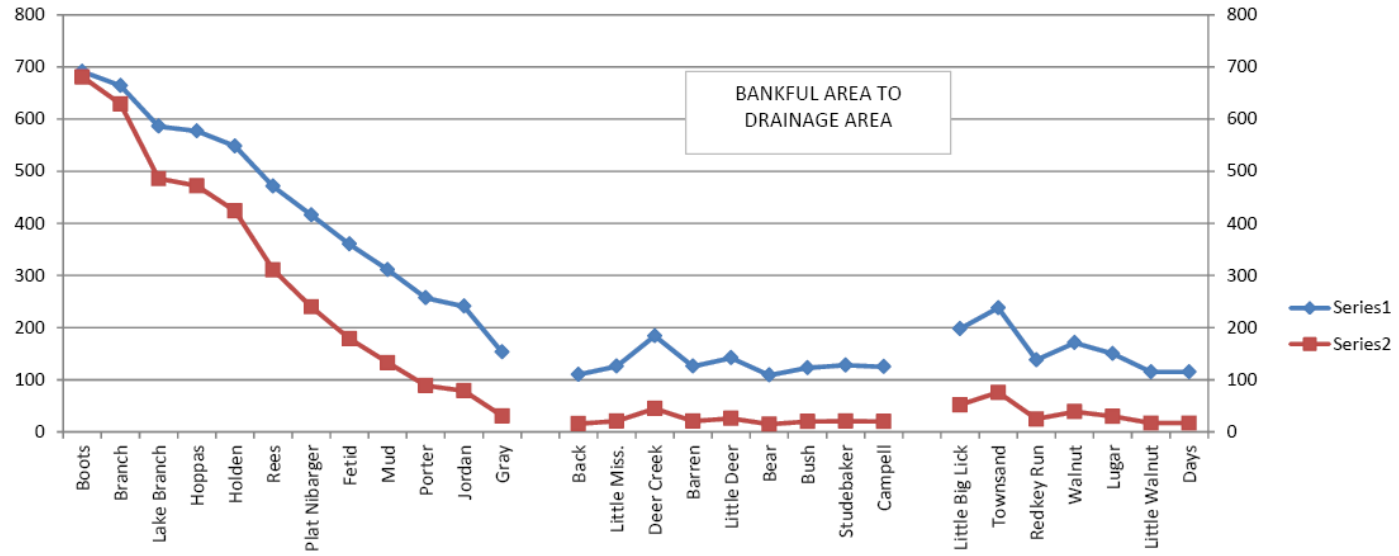


FIG. T.1 | Subwatershed Drainage Areas

Mississinewa Lake Water Quality

TABLE T.5 | Mean Values for Various Water Quality Parameters		
EPA STORET Lake Sampling	**Mean[3]**	**Indiana Max[4]**
Ammonia-nitrogen	0.31	22.5
Depth, Secchi disk depth	32.5	32.8
Dissolved oxygen (DO)	3.9	3-5
Inorganic nitrogen (nitrate and nitrite)	5.3	9.4
Kjeldahl nitrogen	1.18	27.05
Orthophosphate	0.008	
pH	7.8	
Phosphorus	0.12	2.81
Total suspended solids	9.6	
Turbidity	17.9	

[3]EPA STORET 1990-2015. Mean of all data points on Mississinewa Lake
[4]Data for 456 Indiana lakes collected during July and August 1998-2004 under the Indiana Clean Lakes Program.

DNR property managers at the Mississinewa Lake Reservoir indicated the following statements for consideration in our comparative analysis of Mississinewa Lake Reservoir and Geist Reservoir:

1. No consecutive *E. coli* impairments (swimming)
2. No blue green algae reported illnesses
3. Never exceeded moderate (yellow) threat level for algae
4. Fish cleaning station on site
5. The Mighty Mississinewa Triathlon has never been canceled for water quality reasons.

Geist Reservoir

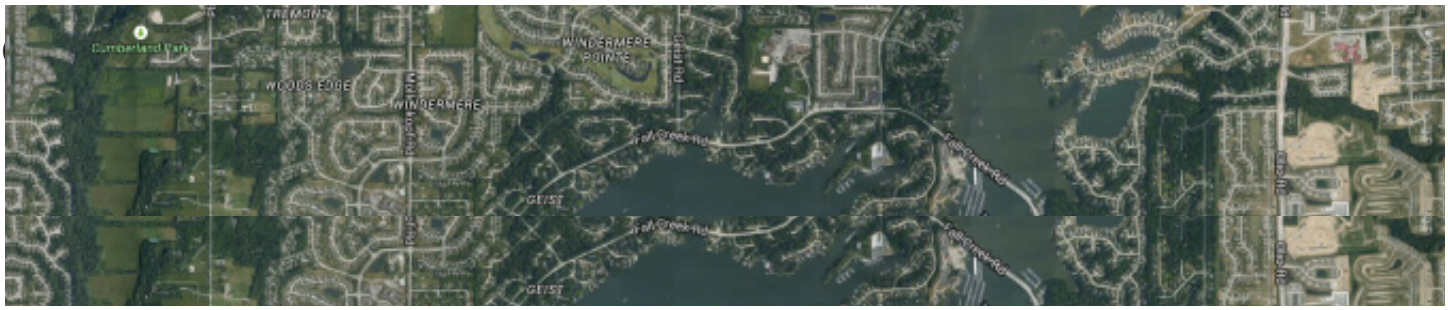


TABLE T.6 | Water Quality Data for Fall Creek			
Fall Creek at Southeastern Parkway	EPA STORET	Mean[2]	Units
Ammonia-nitrogen	0.14		mg/l
Chlorophyll a - Phytoplankton (suspended)	1.12		
Dissolved oxygen (DO)	9.37		mg/l
Escherichia coli	344.32	2,101	cfu/100ml
Inorganic nitrogen (nitrate and nitrite)	2.52	2.35	mg/l
Kjeldahl nitrogen	0.50		mg/l
pH	8.05		
Phosphorus	0.08	0.27	mg/l
Total suspended solids	22.82	53	mg/l
Turbidity	21.47		NTU

A wide variety of conditions, including geography, morphometry (lake depth, area, shoreline length, etc.), time of year, and watershed characteristics, can influence the water quality of lakes. -Interpreting Lake Data | Indiana Clean Lakes Program

TABLE T.7 | Parameter	Value
Contributing drainage area in square miles.	218
Percent of area covered by water and wetland	2.27
Percent of area covered by urban land cover	5.8

Geist Reservoir Management Plan
1. Nutrient Concerns (Algea)
2. Greater Sedimentation Issues
3. *E. coli* levels greater concern

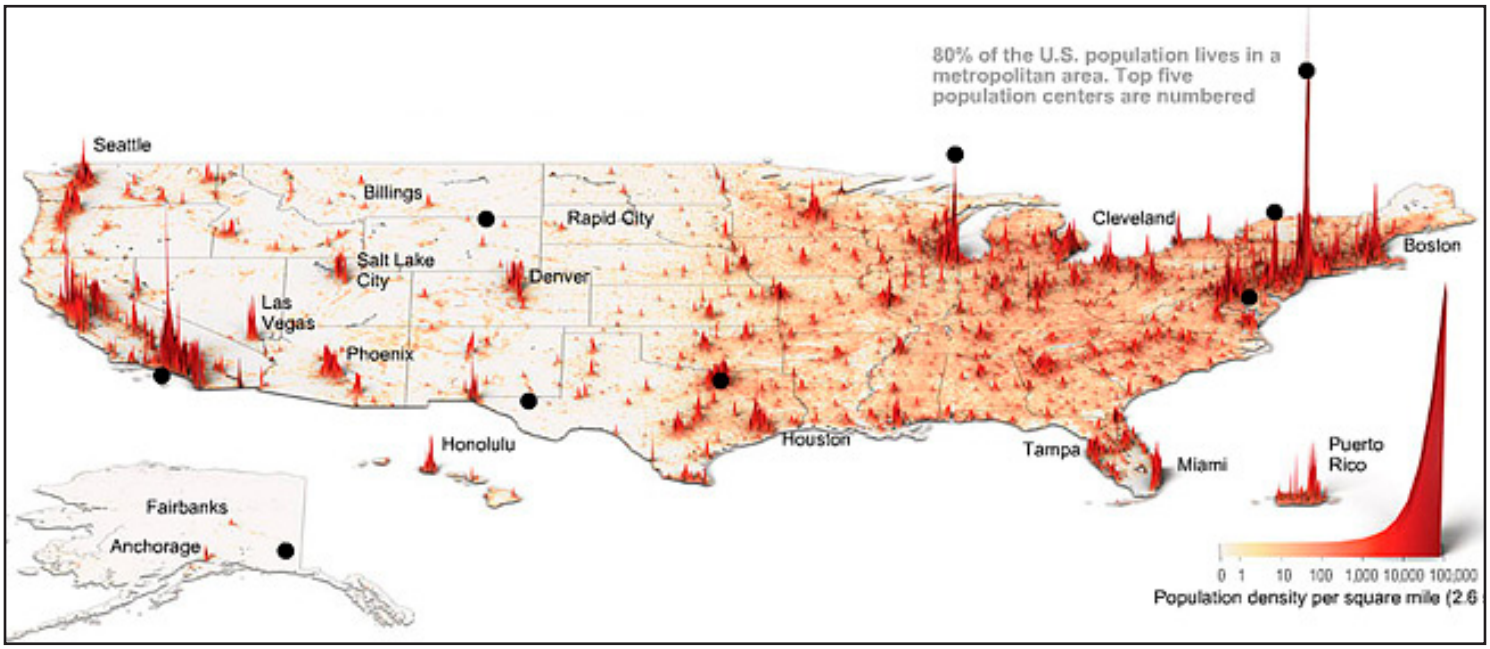


FIG. T.2 | Population Decentralization in Eastern United States

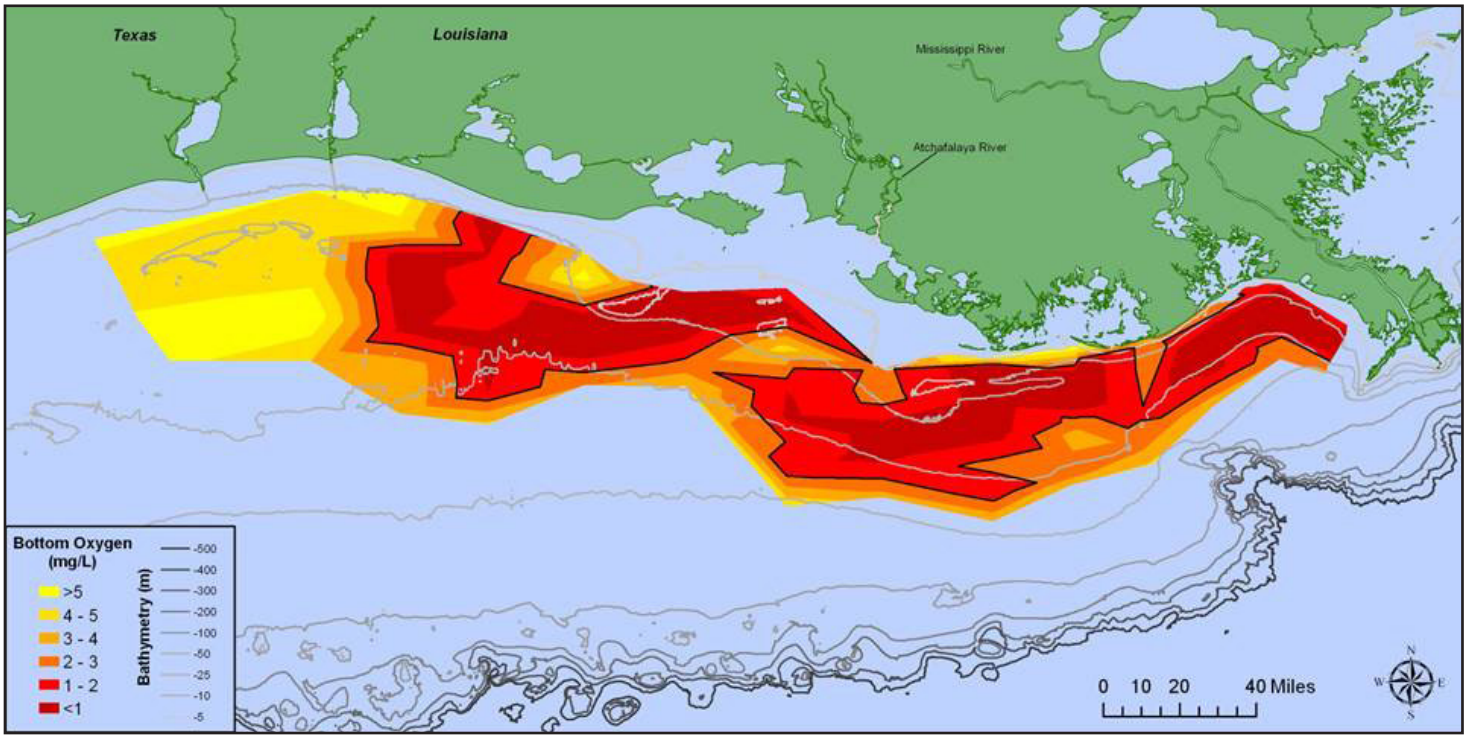


FIG. T.3 | Dead Zone

Map showeing distribution of bottom-water dissolved oxygen from July 28 to August 3, west of the Mississippi River delta. Black lined areas — areas in red to deep red — have very little dissolved oxygen. (Data: Nancy Rabalais, LUMCON; R Eugene Turner, LSU. Credit: NOAA) http://www.noaanews.noaa.gov/stories2015/080415-gulf-of-mexico-dead-zone-above-average.html

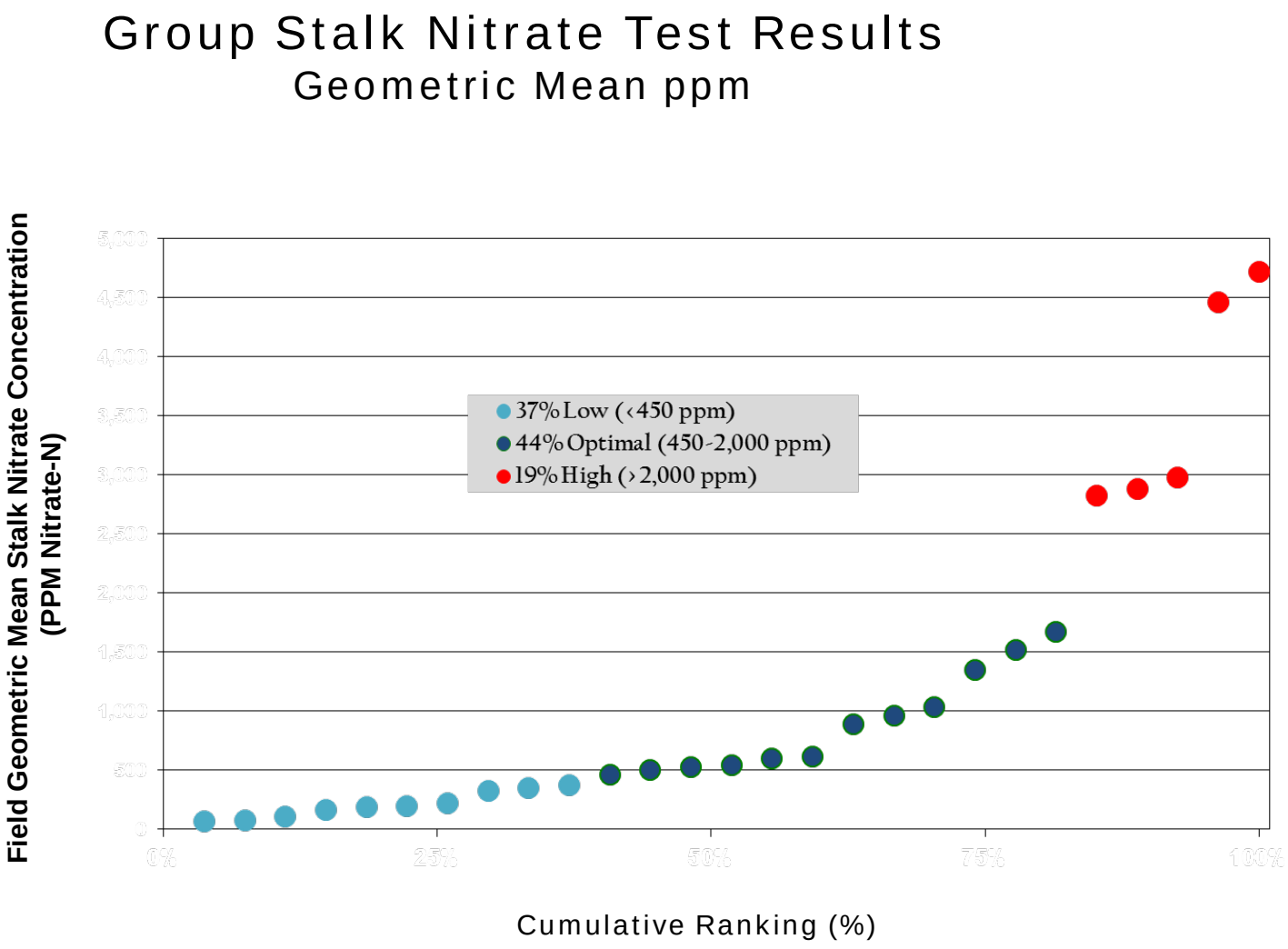


FIG. T.4 | Sample On-farm Network Data

TABLE T.8 | Load Reduction Cost-estimates (Appendix S)										
	Gray Branch (nitrate)	Deer Creek (nitrate)	Little Mis-sissinewa (nitrate)	Halfway Creek (phosphorus)	Little Lick Creek (phosphorus)	Campbell Creek (TSS)	Lugar Creek (TSS)	Halfway Creek (nitrate)	Pike Creek (nitrate)	Little Lick Creek (nitrate)
Wetland Restoration	$338,626	$194,920	$218,100	$-	$-	$-	$-	$76,230	$239,500	$461,020
Prairie Restoration	$154,075	$88,689	$99,236	$-	$-	$-	$-	$-	$-	$-
Extended Rotations	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Fertilizer Reduction Practices (MRTN, side-dress, no fall application)	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Cover Crops and Filter Strips*	$723,312	$291,444	$465,862	$-	$-	$-	$-	$502,813	$505,824	$995,803
Drainage Water Man-agement**	$365,716	$208,175	$738,050	$-	$-	$-	$-	$228,690	$252,912	$547,692
Saturated Buffer***	$84,657	$123,604	$51,254	$-	$-	$-	$-	$63,525	$52,690	$103,730
Bioreactors	$753,443	$-	$8,048	$-	$-	$-	$-	$-	$126,456	$145,221
Cover Crops	$-	$-	$-	$127,050		$19,520	$35,280	$-	$-	$-
Conservation Tillage	$-	$-	$-	$72,419	$43,797	$1,900	$5,700	$-	$-	$-
Filter Strips****	$-	$-	$-	$11,088	$16,632	$5,544	$8,316	$-	$-	$-
Total Cost	$2,419,828	$906,831	$1,580,549	$210,557	$60,429	$26,964	$49,296	$871,258	$1,395,327	$2,253,466

TABLE T.9 | Alternative Scenario Cost-estimate	
	Gray Branch (nitrate)
Wetland Restoration	$1,000
Prairie Restoration	$-
Extended Rotations	$-
Fertilizer Reduction Practic-es (MRTN, sidedress, no fall application)	$-
Cover Crops and Filter Strips*	$406,231
Drainage Water Management**	$162,492
Saturated Buffer***	$38,084
Total Cost	$607,808

U. BEST MANAGEMENT PRACTICES

COMPREHENSIVE NUTRIENT MANAGEMENT PLAN (NUTRIENTS & PATHOGENS) INDIANA NRCS FOTG NUTRIENT MANAGEMENT (590)
A nutrient management plan aids in applying the correct amount and form of plant nutrients for optimum yield and minimum impact on water quality. Soil tests are performed, yield goals are determined, past applications are considered, and short and long-term goals are set for nutrient application. This process can be applied in a variety of methods. Whether they are broadcast, starter, surface band, or injection, they aid in providing the proper application of the nutrient in spring or fall to the fields. In the spring, nitrogen testing is appropriate for corn when it is 6-12 inches tall. In the fall, refrain from applying commercial Nitrogen except when associated with Phosphorus application. Avoid applying manure on frozen or snow-covered ground as this causes extreme nutrient run-off. Applying the proper nutrient at the proper time through the proper method prevents over application of commercial fertilizers and animal manure that could infiltrate the water supply. Retesting soils, monitoring fields, and analyzing nutrient applications along with establishing a maintenance program provides quality care of the land, water supply, and ensures quality yield.

FILTER STRIPS (SEDIMENT & NUTRIENTS) INDIANA NRCS FOTG FILTER STRIP (393)
Strips of grass, trees and/or shrubs or filter strips, filter and slow runoff and remove contaminants before they reach water bodies or sources. The vegetation collects sediment, chemicals, and nutrients. These sources are absorbed so they cannot enter the water bodies. In addition, these strips provide habitat for a variety of birds and animals, remove row crop operations further from the water body to reduce added risk, and reduce soil erosion. Filter strips are most effective on slopes of 5% or less. If the strip is steeper, it should also be wider. A minimum of 15 foot wide strips should be used for cropland and minimum 50 foot wide for forestland. These strips become less effective during frozen conditions. Controlled grazing can occur as long as it is monitored.

GRADE STABILIZATION STRUCTURE (SEDIMENT & NUTRIENTS) GRADE STABILIZATION STRUCTURE (410)
An earthen, wooden, concrete, or other structure built across a drainageway aides in grade stabilization to prevent gully erosion and reducing water flow. These structures drop water from one stabilized grade to another by providing a water outlet and improving water quality. This prevents nutrients and sediment from contaminating a potential water source created by an embankment or field. Ensure that all permits are obtained and construction specifications considered before construction. Remove all trees and shrubs within 30 feet of the structure and any debris approximately 50 feet downstream from the outlet during construction.

CHECK DAMS- NATURAL IMPLEMENTATION (NUTRIENTS & PATHOGENS)
There are many different techniques to make check dams using natural materials. These techniques are fast, and given local supplies, relatively inexpensive. Some of the natural methods are coir fascines, wattle fences, straw bale, Sediment STOP, and Nilex GeoRidge. Coir fascines are formed by taking willow branches and laying them in a long pile that is generally the length of the channel. The pile should be 18-30” in height. Tie the bundle along its entire length, compacting the bundle as you go. Place this in a pre-dug channel approximately 3-6” deep. Stake the fascines using twine or wire to prevent them from floating away. Place soil or sphagnum moss on top of the bundles to allow the willow branches to grow. Wattle fences are formed by pounding the stems of dogwood or some other wood approximately 8” apart. Take long branches of dogwood or willow and weave them through the stakes like a basket. Make sure to push the branches into a tight bundle. A second technique is to make two rows of stakes and weave a basket with an opening in the middle. This can be filled with more sticks, creating thicker check dam. Wattle fences are an effective and economical alternative to silt fence or straw bales. Fertile topsoil, organic matter, and native seeds are then trapped behind the wattle to provide a stable medium for germination and increase stability. Straw bale check dams are simply created by placing straw bales in a row in the channel. Stake them down using hardwood stakes. This is a fast but effective method if stabilization is required in a short period of time. Sediment STOP is a specially designed straw mat that is rolled and staked in place. Sediment STOP is composed of a straw and coconut fiber matrix reinforced with 100% biodegradable netting. It is water permeable and has greater filtration capabilities than other check dam techniques. This creates a highly effective, temporary, three-dimensional, sediment-filtration structure. Nilex GeoRidge is a permeable ditch berm designed for erosion and sediment control. By acting as an energy dissipater, GeoRidge reduces flow velocities and provides a smoother, less damaging release of water. All of these natural techniques and others are effective in creating check dams and other erosion controls for storm water.

NO-TILL EQUIPMENT MODIFICATIONS (SEDIMENT & NUTRIENTS)
Indiana NRCS FOTG Residue and Tillage Management- No Till/Strip Till/Direct Seed (329) Modifications to farm equipment can be added to aid in no-till practices. Leaving last year’s crop residue on the surface before planting operations provides cover for the soil at a critical time of the year. Equipment modifications can vary and include no-till, mulch till and ridge till. These techniques prevent soil erosion, protect water quality, improve soil tilth, add organic matter to the soil, and reduce compaction with fewer tillage trips.

COVER CROPS
By planting cover crops, producers protect their topsoil during the winter months, see an increase in soil nutrient levels—and a decrease in fertilizer needs—and protect their fields from weeds and insects. The economic incentive of cover crops can be calculated by weighing their cost against the nutrients and herbicides a landowner would typically apply.

GRASSED WATERWAY (SEDIMENT & NUTRIENTS) INDIANA NRCS FOTG GRASSES WATERWAY (412)
A grassed waterway is a natural way to prevent gullies from forming. By analyzing the existing natural drainageways, the waterway should be graded and shaped to form a smooth, bowl-shaped channel that is deep and wide enough to carry the peek runoff from a 10-year frequency, 24-hour storm. The NRCS design charts can aid in determining these measurements. After the channel is complete, plant sod-forming grass ¼ to ½ inches deep in a figure eight pattern to avoid erosion. An outlet can then be installed at the base of the drainageway to prevent a new gully from forming. This grass covered strip provides stabilization to prevent erosion, may act as a filter for runoff, and could provide cover for small animals. To maintain this waterway, avoid using it as a roadway for machinery, and fertilize and mow as needed (wait until after July 15 to mow so birds have had a chance to leave nests).

LIVESTOCK EXCLUSION (NUTRIENTS & PATHOGENS) INDIANA NRCS FOTG FENCE (382)
Providing fencing and other natural barriers around water bodies ensures that animal contamination does not run-off into these sources or fields. If livestock need to cross streams, provide a controlled stream crossing. The stream bottom should be covered with coarse gravel to provide animals with firm footing, while discouraging them from congregating or wallowing in the stream. In high sensitive areas, high tensile fence, solar-powered electric fences, or woven fence can be inexpensive alternatives to keep livestock from streams or to allow them a limited number of access points.

STRIP CROPPING (SEDIMENT & NUTRIENTS) INDIANA NRCS FOTG STRIPCROPPING (585)
Crops are arranged so that a strip of meadow or small grain such as oats, grass or legumes, is alternated with a strip of row crop such as corn or soybeans to create strip cropping. These strips should be nearly the same width. These alternative strips slow runoff, increase infiltration, trap sediment and provide surface cover. Ridges formed by contoured rows slow water flow which reduces erosion. Rotating these crops allows nutrients to be recharged by other legumes or grains and can reduce fertilizer costs. In addition, grass and legumes should serve as the field borders to help establish waterways. Slopes must be considered to accommodate equipment width and to maintain proper stripcropping width.

VEGETATED STREAM BANK STABILIZATION (BIOENGINEERING) (SEDIMENT & NUTRIENTS) INDIANA NRCS FOTG STREAM BANK AND SHORELINE PROTECTION (580)
Grass, riprap, gabions, and other methods are installed along the edges of a stream to buffer the banks from heavy streamflow and reduce erosion. A buffer zone of at least 15-25 feet of vegetation along the stream bank filters runoff and may also absorb excess nutrients and chemicals. Remove brush that adversely affects the desired vegetation of the bank. Fencing may be added to prevent cattle from trampling banks, destroying vegetation and stirring up sediment.

WATER AND SEDIMENT CONTROL BASINS (SEDIMENT & NUTRIENTS) INDIANA NRCS FOTG WATER AND SEDIMENT CONTROL BASINS (638)
A short earthen dam built across a drainageway (where a terrace is impractical), though it usually is part of a terrace system that directs runoff into a control basin. This basin traps sediment and water running off farmland above the structure, preventing it from reaching farmland below to reduce erosion and improve water quality. The area draining into the basin should not exceed 50 acres. The basin should be large enough to control a 10-year storm and ensure there is a tile or infiltration outlet for potential overflow. Fill material should contain little to no debris and contain the correct moisture content for adequate compaction. Seeding the embankment to maintain vegetative cover, reduce erosion, and provide cover for wildlife provides for a strong control basin.

2-STAGE DITCHES (SEDIMENT & NUTRIENTS) NRCS' STREAM RESTORATION DESIGN MANUAL, CHAPTER 1- & JOURNAL OF SOIL AND WATER CONSERVATION 62(4) 277-296
When a ditch is modified to a two-stage design, benches are added to both sides of the stream. These benches create room for water to collect during high flows and the stream to more naturally meander. As water flows onto the benches and slows down, pollutants drop out, scouring decreases, and the soils and vegetation on the benches cleanse the water. Benefits to the landowner include a more stable stream with less undercutting of trees (due to reduced scouring during high flow) and increased wildlife habitat (due to reduced sedimentation). Two-Stage Ditches may also significantly decrease the need to dredge the ditches. Information on Two-Stage Ditches can be found at: NRCS' Stream Restoration Design Manual, Chapter 10 and G. E. Powell, et. al. "Two stage channel systems: Part 1, a practical approach to sizing agricultural ditches" Journal of Soil and Water Conservation. Volume 62, Number 4, pgs. 277-296.

CONSERVATION EASEMENTS/PROPERTY PURCHASE
Conservation easements provide lasting protection to land and can be a valuable watershed management tool. While Section 319 cannot reimburse property owners for property value lost due to an easement, certain administrative costs associated with creating the easement are eligible. Likewise, certain administrative costs associated with purchasing land so it can be permanently protected are eligible. See IDEM's Urban BMP Guidance for details and more information.

CONSERVATION PLAN DEVELOPMENT (SEDIMENT & NUTRIENTS) INDIANA NRCS CPA-52 CONSERVATION PLANNING FORM
Conservation Plan Development is a process that outlines management decisions and conservation practices that are currently in use or planned for an area. This plan discusses long and short-term goals and objectives; collects information and data regarding nutrient and pest management, soil, water, and other resources; identifies problems and potential solutions; and develops an implementation and maintenance plan. A Conservation Plan creates the best decisions and actions for the land and the landowner.

V. SSO OVERFLOWS

TABLE V.1 | SSO Overflows in Headwaters Mississinewa HUC 10 from 2014-2015

Source	NPDES Pemit #	Begin Date	End Date		Units	Location	Receiving Waterbody
UNION CITY MUNICIPAL SEWAGE TREATMENT PLANT	IN0020982	2/20/2014 19:30	2/21/2014 8:52	50,000	gal-lons	Jackson Lift Station	
UNION CITY MUNICIPAL SEWAGE TREATMENT PLANT	IN0020982	4/4/2014 15:30	4/4/2014 18:00	150	gal-lons	Walnut St	
UNION CITY MUNICIPAL SEWAGE TREATMENT PLANT	IN0020982	4/4/2014 15:30	4/4/2014 18:00	750	gal-lons	Debolt Ave.	
UNION CITY MUNICIPAL SEWAGE TREATMENT PLANT	IN0020982	6/27/2015 19:06	6/28/2015 16:20	44,100	gal-lons	Overflow Pipe	
UNION CITY MUNICIPAL SEWAGE TREATMENT PLANT	IN0020982	7/13/2015 23:00	7/14/2015 12:00		gal-lons	Overflow weir	
UNION CITY MUNICIPAL SEWAGE TREATMENT PLANT	IN0020982	7/14/2015 0:00	7/14/2015 12:00		gal-lons	Overflow Weir	

TABLE V.2 | SSO Overflows in Massey Creek HUC 10 from 2014-2015

Source	NPDES Permit #	Begin Date	End Date	Quantity	Units	Location	Receiving Waterbody
Upland Municipal Waste Water Treatment Plant	IN0036978	2/20/2014 0:00	2/21/2014 0:00	360	gallons	West Lift Station	
Upland Municipal Waste Water Treatment Plant	IN0036978	2/20/2014 21:00	2/21/2014 0:00	360	gallons	North Lift Station	
Upland Municipal Waste Water Treatment Plant	IN0036978	2/20/2014 21:00	2/21/2014 0:00	360	gallons	North Lift Station	
Upland Municipal Waste Water Treatment Plant	IN0036978	2/20/2014 23:00	2/21/2014 0:00	120	gallons	Manhole at Plant Site	
Upland Municipal Waste Water Treatment Plant	IN0036978	2/24/2014 4:00	2/24/2014 8:00	480	gallons	North Lift Station	
Upland Municipal Waste Water Treatment Plant	IN0036978	3/12/2014 7:00	3/12/2014 8:00	120	gallons	North Lift Station	
Upland Municipal Waste Water Treatment Plant	IN0036978	4/3/2014 10:00	4/3/2014 19:00	1,080	gallons	North Lift Station	
Upland Municipal Waste Water Treatment Plant	IN0036978	4/3/2014 10:00	4/3/2014 15:00	600	gallons	West Lift Station	
Upland Municipal Waste Water Treatment Plant	IN0036978	4/9/2015 12:30	4/9/2015 14:00	180	gallons	North Lift Station	
Upland Municipal Waste Water Treatment Plant	IN0036978	6/17/2015 7:00	6/17/2015 10:00	360	gallons	North Lift Station	
Upland Municipal Waste Water Treatment Plant	IN0036978	6/27/2015 5:00	6/27/2015 10:30	56,000	gallons	WWTP front manhole	
Upland Municipal Waste Water Treatment Plant	IN0036978	7/13/2015 11:30	7/13/2015 14:30	21,600	gallons	North Lift Station	
Upland Municipal Waste Water Treatment Plant	IN0036978	7/13/2015 12:30	7/15/2015 18:30	150,000	gallons	West Lift Station	
Upland Municipal Waste Water Treatment Plant	IN0036978	12/28/2015 21:00	12/29/2015 2:00	10,200	gallons	NORTH LIFT STATION WEST LIFT STATION	

TABLE V.3 | SSO Overflows in Big Lick Creek HUC 10 from 2014-2015

Source	NPDES Permit #	Begin Date	End Date	Quan-tity	Units	Location	Receiving Waterbody
HARTFORD CITY WASTE WATER TREATMENT PLANT	IN0021628	1/31/2014 0:00	1/31/2014 20:00	212500	gallons	Jefferson St overflow	
HARTFORD CITY WASTE WATER TREATMENT PLANT	IN0021628	1/31/2014 10:00	1/31/2017 20:00	212500	gallons	Old Plant Lift Station	
HARTFORD CITY WASTE WATER TREATMENT PLANT	IN0021628	1/31/2014 16:00	1/31/2014 20:00	50000	gallons	3M LS	
HARTFORD CITY WASTE WATER TREATMENT PLANT	IN0021628	2/4/2014 0:00	2/4/2014 0:00	275000	gallons	Old Plant LS @ S Monroe St	
HARTFORD CITY WASTE WATER TREATMENT PLANT	IN0021628	2/14/2014 0:00	2/14/2014 0:00	275000	gallons	Old Plant RR @ S Monroe St	
HARTFORD IRON & METAL	INP000612	7/7/2015 10:45	7/7/2015 19:00	490	gallons	Storm drain at W. Chestnut Street & Division Street Inter-section	
HARTFORD IRON & METAL	INP000612	7/8/2015 14:00	7/8/2015 20:00	360	gallons	Storm Drain at W. Chestnut St. & Divi-sion St. Intersection	
HARTFORD CITY WASTE WATER TREATMENT PLANT	IN0021628	8/17/2015 9:00	8/18/2015 8:00	1	gallons	3m railroad CSO#5 S.spring -man-hole-divbox	
HARTFORD CITY WASTE WATER TREATMENT PLANT	IN0021628	8/18/2015 9:00	8/18/2015 14:00	190000	gallons	3mls at crossroad & St.Rd 26	
HARTFORD CITY WASTE WATER TREATMENT PLANT	IN0021628	8/18/2015 9:00	8/18/2015 14:00	19000	gallons	3 mls at Cross Road and State Rd. 26	

TABLE V.4 | SSO Overflows in Halfway Creek HUC 10 from 2014-2015

Source	NPDES Permit #	Begin Date	End Date	Quantity	Units	Location	Receiving Waterbody
Redkey Waste Water Treatment Plant	IN0024406	7/7/2015 16:00	7/7/2015 22:30	136500	gallons	#8 location of release Manholes #: 12 14 15 19 22 26 27 33A 33B and 52	

TABLE V.5 | SSO Overflows in Pike Creek HUC 10 from 2014-2015

Source	NPDES Permit #	Begin Date	End Date	Quantity	Units	Location	Receiving Waterbody
Albany Municipal Waste Water Treatment Plant	IN0022136	3/18/2014 19:45	3/18/2014 22:00	30	gallons	SR67 & SR 167 Wastewater manhole overflow.	