# HUC – 0410009 LOWER MAUMEE SWAT MODEL SUMMARY

## Lower Maumee Watershed Background

The Lower Maumee Watershed Hydrologic Unit Code (HUC)-8 (04100009) is located in northwest Ohio in the counties of Defiance, Fulton, Hancock, Henry, Lucas, Putnam, and Wood. The Maumee River is the largest river in this 1,081 square mile (692,040 acre) watershed, flowing generally north-eastward from its headwaters in the city of Defiance into Lake Erie from Maumee Bay. The largest land use classifications in the watershed are cultivated crops (78%), developed land (15%), and undeveloped natural land (7%). Prior to the original settlement of the area, the watershed was part of the Great Black Swamp, a region dominated by wetlands. Agriculture quickly became a dominant land use throughout the region when the natural wetlands were drained to reveal fertile soils. The watershed is almost entirely flat-lying, with an average slope of 2% or less, featuring very poorly to poorly drained soils overlaying Silurian-Devonian lime- and dolostone bedrock. The major cities contained entirely or partially in the watershed include Toledo, Maumee, Perrysburg, Rossford, and Bowling Green, along with many small towns, villages, and townships. The main tributaries to the lower Maumee River include South Turkeyfoot Creek, Beaver Creek, and Swan Creek.

## SWAT Model

The Soil and Water Assessment Tool (SWAT) was developed by the United States Department of Agriculture - Agricultural Research Service (USDA-ARS) "to predict the impact of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land use and management conditions over a long period of time" (Neitsch et al., 2011). As a spatially distributed, physically-based, and continuous-event hydrologic model, the processes (e.g. precipitation, evaporation, nutrient loss, and plant growth) are implemented in the smallest spatial area possible to increase accuracy and minimize uncertainty. This smallest spatial unit is called the hydrologic response unit (HRU), a unique combination of land use/crop cover, soil properties, and slope. A geographic information system (GIS) interface is used to enter and designate land use, soil, weather, groundwater, water use, management, pond and stream water quality data, and the simulation period (DiLuzio et al., 2002). GIS input files include a digital elevation model (DEM), land use/land cover and soil properties layers, and a daily weather database.

SWAT is one of many tools available for assessing watersheds and is regarded as the most versatile and customizable tool available to best achieve real-world scenarios for evaluating best management practices (BMPs) employed within a watershed. It is the most appropriate model to test the effects of BMPs on crop yield and environmental outputs. Runoff movement, sediment, nutrient, and pesticide loadings to the main channel in each subbasin are simulated by considering realistic physical processes.

## Lower Maumee SWAT Model Methodology

In order to best represent actual conditions within the Lower Maumee HUC-8 watershed, USGS streamgages (which are active, continuously functioning measuring devices in streams that measure the height of water to calculate average daily streamflow), local weather data, point source nutrient contributors, knowledge of agricultural practices and land management procedures were used in conjunction with the USDA Cropland Data Layer (CDL) to isolate the HUC-8 and determine the actual contribution of its loading into Lake Erie.

## SWAT Model Input Data

### *Non-Point Sources*

The actual crop rotations and land management practices utilized across the watershed is estimated in some cases due to the lack of current data. The crop planted for a certain area (i.e., field, farm, or HRU) in a certain year was taken from the USDA CDL, which is the most accurate data set available. The crop rotation (2010 to 2015) for an area was then estimated by overlaying the CDLs from these years. Tillage practices were identified using the prevailing practice and published reports from the area (NRCS WLEB CEAP report). An example of tillage practices in the area include, mainly no tillage on wheat and soybeans and approximately 80% conventional tillage on corn. Fertilizer and manure rate applications were based on the Tri-State Fertility Guide developed by Michigan State University, The Ohio State University and Purdue University in 1995 and from the Nutrient Use Geographic Information System (NUGIS) nutrient balance report (IPNI, 2012).

### *Point Sources*

National Pollutant Discharge Elimination System (NPDES) permit locations represent point sources that discharge pollutants to waters of the United States. Created in 1972 by the Clean Water Act, the NPDES permit program is authorized to state governments by the US Environmental Protection Agency (EPA) to perform many permitting, administrative, and enforcement aspects of the program. There are 84 NPDES permits (77 Individual and seven General permits) located in the Lower Maumee watershed, at the time this model was prepared. Nutrient loading data from each of the permitted locations are included in the SWAT model with data provided from the Ohio EPA Mass Balance Study (Figure 1).

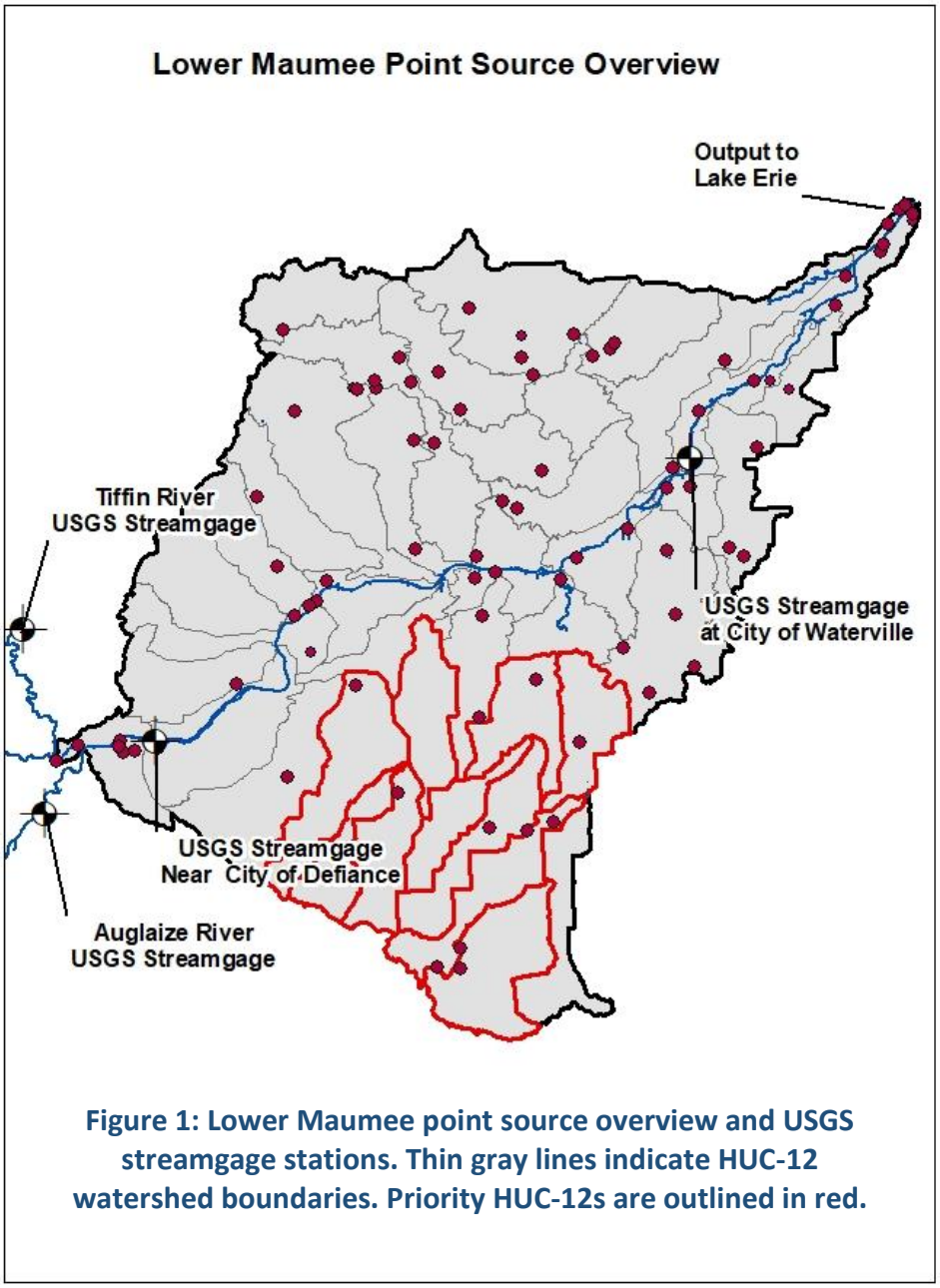


**Figure 1: Lower Maumee point source overview and USGS streamgage stations. Thin gray lines indicate HUC-12 watershed boundaries. Priority HUC-12s are outlined in red.**

Some entities also have Municipal Separate Storm Sewer Systems (MS4) NPDES permits, regulating stormwater runoff using six minimum control measures expected to reduce discharge of pollutants to the receiving waterbody. The Ohio EPA has grouped the MS4-permitted entities into two categories (Phase 1 or Phase 2) based upon population and amount of combined sewers within the community. The City of Toledo is the only Phase 1 MS4 community within the Lower Maumee watershed. The list of Phase 2 MS4 permittees in the Lower Maumee watershed is included in Table 1.

**Table 1. MS4 permittees in the Lower Maumee Watershed HUC-8**

| Applicant Name | Permit Number | County |
|---|---|---|
| City of Defiance* | 2GQ00036*BG | Defiance |
| City of Bowling Green* | 2GQ00042*BG | Wood |
| Wood County and Others* | 2GQ00028*CG | Wood |
| City of Perrysburg | 2GQ00018*CG | Wood |
| City of Rossford | 2GQ00017*CG | Wood |
| City of Northwood* | 2GQ00002*CG | Wood |
| Village of Swanton | 2GQ00047*AG | Lucas |
| Lucas County and Others* | 2CG00006*CG | Lucas |
| University of Toledo | 2GQ00046*AG | Lucas |

*Denotes applicant is located partially in the watershed.

Confined animal feeding operations (CAFOs) are considered point source pollutants due to their production of animal waste. There are four permitted CAFOs in the Lower Maumee Watershed. The watershed is home to over 400 confined livestock operations (NRCS, 2009). The waste generated by the confined livestock operations in the watershed is estimated to supply 16 percent of the total phosphorus needed to fertilize crops in the watershed (NRCS, 2009).

### *Nutrients, Sediments, and Flow Observed Data*

The SWAT model was calibrated for a two year period (2013-2015) with the observed nutrients (phosphorus and nitrogen) and total suspended solids from Heidelberg's Waterville water quality monitoring station and USGS streamgage data (Figure 1). Nutrient and sediment data upstream of the Lower Maumee watershed were provided by the Ohio EPA Mass Balance Study, and flow data was provided from USGS streamgages downstream of Defiance, just below the Lower Maumee-Upper Maumee watershed boundary.

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## Lower Maumee SWAT Model Findings

Table 2 lists the HUC-12 watersheds with the ten highest Total Phosphorus (Total P) and Dissolved Reactive Phosphorus (DRP) simulated yield from the Lower Maumee SWAT model. These priority watershed locations are outlined in Figure 1.

**Table 2. HUC-12 watersheds with highest simulated Total P and DRP yield**

| HUC-12 Number | HUC-12 Name | Area (hectare) | Total P yield (kg/hectare) | DRP yield (kg/hectare) |
|---|---|---|---|---|
| 041000090504 | Upper Yellow Creek | 8967.3 | 3.00 | 2.54 |
| 041000090505 | Brush Creek | 6502.1 | 2.34 | 2.05 |
| 041000090508 | Middle Beaver Creek | 6072.9 | 2.06 | 1.81 |
| 041000090502 | Hammer Creek | 6496.7 | 2.40 | 2.12 |
| 041000090102 | Upper South Turkeyfoot Creek | 5445.2 | 2.56 | 2.20 |
| 041000090105 | Little Turkeyfoot Creek | 5986.4 | 2.04 | 1.77 |
| 041000090104 | Middle South Turkeyfoot Creek | 9385.8 | 2.19 | 1.90 |
| 041000090507 | Cutoff Ditch | 5710.5 | 2.20 | 1.80 |
| 041000090503 | Upper Beaver Creek | 4326.2 | 2.23 | 1.98 |
| 041000090101 | West Creek | 4131.6 | 2.26 | 1.90 |

## Recommendations

As outlined in the previous section, the Lower Maumee SWAT Model shows the ten HUC-12 watersheds that have the highest potential to contribute the largest loading of Total P within the Lower Maumee watershed. In order to meet the goal of a 40% reduction in nutrient loadings coming from the Lower Maumee watershed, attention must be focused on implementing BMPs within these HUC-12 watersheds. In lieu of regulations that would require the implementation of nutrient reduction BMPs, a key “first step” to implementing BMPs is to identify land stakeholders within these HUC-12 watersheds. A list of organizational stakeholders working in and around these prioritized HUC-12s in the Lower Maumee watershed are listed in Table 3.

**Table 3. Stakeholders Located or Working in the HUC 12 Watersheds**

| Organization Name | Type of Organization |
|---|---|
| Toledo Metropolitan Area Council of Governments (TMACOG) | Government |
| Ohio Pheasants Forever | Non-government Organization |
| Black Swamp Conservancy | Non-government Organization |
| Soil and Water Conservation Districts (Hancock, Henry, Putnam, Wood) | Government |
| Boards of County Commissioners (Hancock, Henry, Putnam, Wood) | Government |
| Cities (Leipsic, Deshler, Hamler) | Government |
| Townships (Pleasant, Marion, Van Buren, Liberty) | Government |

An important next step toward implementing BMPs within the prioritized HUC-12s is to develop an approved watershed plan for these areas that includes projects that incorporate the recommended BMPs. An approved watershed plan follows the Nonpoint Source-Implementation Strategic (NPS-IS) planning document from Ohio EPA and meets the key nine elements identified by the US EPA. NPS-IS plans that have the required nine elements are strategic planning documents meant to identify critical areas that affect water quality impairment, outline goals and objectives to attain water quality standards and describe projects meant to reduce causes and sources of water quality impairment. The need for the preparation of approved NPS-IS plans in the Lower Maumee watershed is evident in the fact that of the 42 HUC-12s, only five have approved plans in place (Hielman Ditch-Swan Creek HUC-12, Wolf Creek HUC-12, Lower Blue Creek HUC-12, Grassy Creek Diversion HUC-12 and Preston Run-Maumee River HUC-12). Once the plans are approved, the projects detailed within each plan become eligible for nonpoint source funding opportunities through government agencies, potentially reducing costs of implementation.

The Lower Maumee SWAT model also includes scenarios of agricultural BMPs that would dramatically reduce the loading of Total P coming from the Lower Maumee watershed.

The scenarios consisted of subsurface application of fertilizer, no-till practices, fertilizer application at half the Baseline scenario rate and a combination of subsurface application of fertilizer and no-till practices. These scenarios assume 100% adoption of the BMPs across the entire HUC-8, which is likely unrealistic, but it snapshots the importance of changes in agricultural practices. In the future, the scenarios will be refined down to the priority HUC-12 level to once again demonstrate their effectiveness. Agricultural practitioners in those areas should be strongly encouraged to adopt the most effective BMPs for their respective farms.

## References

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