State of Ohio
Environmental Protection Agency

Division of Surface Water

Total Maximum Daily Loads for the Swan Creek Watershed

Swan Creek at Swan Creek Preserve Metropark

Final Report
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Ted Strickland, Governor
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EXECUTIVE SUMMARY

The Swan Creek watershed drains approximately 204 square miles in northwestern Ohio near the Ohio-Michigan border. In 2006, the Ohio Environmental Protection Agency (Ohio EPA) evaluated the biological health and water quality of Swan Creek. The results indicate that most segments are in partial or non-attainment of the Warm Water Habitat (WWH) designated aquatic life use. Additionally, several segments do not support the Primary Contact Recreation use. Physical habitat impairments were also determined using the Quality Habitat Evaluation Index (QHEI) scores, which measure the overall habitat and ecosystem health (Rankin, 1989).

The Clean Water Act and U.S. Environmental Protection Agency (U.S. EPA) regulations require that states develop Total Maximum Daily Loads (TMDLs) for waters on the Section 303(d) lists. The TMDL and water quality restoration planning process involves several steps including watershed characterization, target identification, source assessment, and allocation of loads. The pollutant load is allocated among all sources within the watershed and voluntary (for nonpoint sources) and regulatory (for point sources) control measures are identified for attaining the source allocations.

Allowable pollutant loads are identified and presented in the TMDL report and these loads are allocated to the various significant sources. Wasteload allocations (WLAs) are established for the seven facilities with individual National Pollutant Discharge Elimination System (NPDES) permits, the City of Toledo Phase I Municipal Separate Storm Sewer System (MS4), eight Phase II MS4s (Lucas County, Monclova Township, Spencer Township, Springfield Township, Waterville Township, Holland, Maumee, Waterville), and the City of Toledo CSOs in the Swan Creek watershed. Potentially significant nonpoint sources in the watershed include runoff from agricultural areas, failing home sewage treatment systems, non-regulated urban stormwater, golf courses, contaminated sediments, and wildlife. Load Allocations are established in the TMDL for the nonpoint sources.

Degraded habitat and sedimentation are high concerns relative to biological impairments in the Swan Creek watershed. TMDL targets for total suspended solids have been identified, based on information in Ohio EPA guidance documents that are derived from HELP ecoregion statistics (Ohio EPA, 1999). These targets are used in conjunction with a hydrology-based framework (i.e., duration curves) to express loading capacities and allocations for individual segments. Because of the relationship between sediment, channel morphology, and hydrology, water flow should be considered in guiding TMDL implementation efforts, such as development of storm water management plans.

An evaluation of the bacteria data for the Swan Creek watershed indicates that unit area loads for tributaries sites are noticeably higher under mid-range and dry conditions. In addition, the variability when looking at these sites collectively is also greater. This suggests that these headwater areas are easily influenced by bacteria loads from failing home sewage treatment systems, poorly operated package plants, livestock with unrestricted access to streams, and riparian areas affected by livestock use under stable flow conditions. Under high flow conditions, surface runoff and storm water have a major effect on both tributary drainages as well as the mainstem Swan Creek. The effect on the mainstem would likely be more pronounced with more high flow event sampling given the presence of urban storm water sources and CSOs.

Ohio EPA has established a relationship between biological community performance in streams and elevated nutrient concentrations. Based on this work, TMDL targets for total phosphorus have been identified that are derived from ecoregion reference site statistics (Ohio EPA, 1999). These targets are used in conjunction with a hydrology-based framework (i.e., duration curves) to express loading capacities and allocations for individual segments.

The Swanton Wastewater Treatment Plant has a significant effect on mid-range and dry condition phosphorus concentrations in the mainstem Swan Creek. However, because of the relationship between total phosphorus, sediment, and hydrology, the role of storm water should also be considered in guiding TMDL implementation efforts. Storm water runoff from developed areas typically contains many pollutants including phosphorus. An example is elevated phosphorus loads in the Wolf Creek drainage under high flow conditions. Pollutants accumulate on impervious surfaces and are washed off during rain events and snow melt. Paved surfaces and piped drainage systems efficiently transport these pollutants from the watershed to the stream. As such, implementation to address the phosphorus TMDLs should also focus on storm water runoff reductions.

1 INTRODUCTION

The Swan Creek watershed drains approximately 204 square miles and consists of two 11-digit assessment units (AUs):

- Swan Creek upstream Blue Creek to the mouth (04100009 080)
- Swan Creek headwaters to upstream Blue Creek (04100009 070)

Swan Creek lies in northwestern Ohio near the Ohio-Michigan border and consists of a wide variety of land cover types. In 2006, the Ohio Environmental Protection Agency (Ohio EPA) evaluated the biological health and water quality of Swan Creek. The results indicate that most segments are in partial or non-attainment of the Warm Water Habitat (WWH) designated aquatic life use. Additionally, several segments do not support the Primary Contact Recreation use. Physical habitat impairments were also determined using the Quality Habitat Evaluation Index (QHEI) scores, which measure the overall habitat and ecosystem health (Rankin, 1989). Table 1-1 summarizes the impairment causes and sources reported on Ohio's most recent Section 303(d) *Integrated Water Quality Monitoring and Assessment Report* (Ohio EPA, 2008).

The Clean Water Act and U.S. Environmental Protection Agency (U.S. EPA) regulations require that states develop Total Maximum Daily Loads (TMDLs) for waters on the Section 303(d) lists. The TMDL and water quality restoration planning process involves several steps including watershed characterization, target identification, source assessment, and allocation of loads. The pollutant load is allocated among all sources within the watershed and voluntary (for nonpoint sources) and regulatory (for point sources) control measures are identified for attaining the source allocations. An implementation plan is also typically established to ensure that the control measures are effective at restoring water quality and all designated water uses.

The overall goals and objectives in developing the Swan Creek TMDLs were to:

- Assess the water quality within the Swan Creek watershed and identify key issues associated with the impairments and potential pollutant sources.

- Use the best available science and available data to determine water quality conditions that will result in all streams fully supporting their designated uses.

- Prepare a final TMDL report that meets the requirements of the Clean Water Act and provides information to the key stakeholders that can be used to facilitate implementation activities to improve water quality.

The results of the TMDL process for the Swan Creek watershed are documented in this report. Section 2 briefly describes the applicable water quality standards, Section 3 summarizes the available water quality data, and Section 4 provides an inventory of the potential pollutant sources. The linkage between the pollutant sources and observed water quality is described in Section 5 and the allowable loads and allocations are presented in Section 6. Appendix A presents the detailed load duration curve results for each station and Appendix B presents the load duration curve results for alternative TSS targets (see Section 2.3 for more details).

Table 1-1 Summary of Section 303(d) listings in the Swan Creek watershed.

Assessment Unit (HUC 11)	Designated Uses	Cause of Impairments	Sources of Impairments
Swan Creek-Headwaters to Upstream Blue Creek (04100009 070)	**Aquatic Life Use- WWH** Water Supply[1]- AWS, IWS Recreation- PCR	■ Sedimentation/Siltation ■ Direct Habitat Alterations ■ Nitrate/Nitrite (Nitrite+Nitrate as N) ■ Physical Substrate Habitat Alterations ■ Phosphorus (Total) ■ *E. coli* ■ Copper	■ Crop Production with Subsurface Drainage ■ Channelization ■ Home sewage treatment systems and Similar De-centralized Systems ■ Historic Bottom Deposits (Not Sediment) ■ Municipal Point Source Discharges ■ Sewage Discharges in Unsewered Areas ■ Golf Courses
Swan Creek-Upstream Blue Creek to Mouth (04100009 080)	**Aquatic Life Use- WWH[2]** Water Supply- AWS, IWS Recreation- PCR[3]	■ Sedimentation/Siltation ■ Direct Habitat Alterations ■ Nitrate/Nitrite (Nitrite+Nitrate as N) ■ Priority Organics ■ Sediment Screening Value (Exceedance) ■ Aluminum ■ Polycyclic Aromatic Hydrocarbons (PAHs) ■ Phosphorus (Total) ■ *E. coli* ■ Dieldrin ■ Ammonia ■ Total Dissolved Solids ■ Strontium	■ Crop Production with Subsurface Drainage ■ Sewage Discharges in Unsewered Areas ■ Dam or Impoundment ■ Upstream Impoundments ■ Combined Sewer Overflows ■ Sand/Gravel/Rock Mining or Quarries ■ Impervious Surface/Parking Lot Runoff

[1]-Swan Creek at RM 30.84 is listed as a public water supply as it is the location of the Swanton intake.
[2]-All segments in this AU are designated WWH with the exception of Heilman Ditch which is listed as a Limited Resource Water (small drainageway maintenance).
[3]-All segments in this AU are designated PCR with the exception of Heilman Ditch which is designated Secondary Contact Recreation.

1.1 Description of the Swan Creek Watershed

The purpose of this section of the report is to provide a brief background of the Swan Creek watershed. Extensive descriptions of the watershed are also available in the *Swan Creek Watershed Plan of Action* (TMACOG, 2001) and the *Draft Maumee Area of Concern Stage 2 Watershed Restoration Plan* (Maumee RAP, 2006).

Swan Creek drains a 204 square mile watershed in northeastern Ohio (Figure 1-1). The watershed lies within the glaciated Huron/Erie Lake Plains (HELP) ecoregion, which is nearly flat and very fertile land. The HELP ecoregion is characterized by mostly cleared and artificially drained lands providing productive farm land for corn, soybeans, vegetables, and livestock. Concentrated urban and industrial areas are also prevalent. Its underlying geology primarily consists of lake deposits and wave-planed ground moraine.

Flowing from west to east, Swan Creek is divided among three counties and eventually meets the Maumee River in Toledo. A majority of the watershed lies within northwestern Lucas County. Swan Creek, Blue Creek, and Ai Creek headwaters all originate in Fulton County. A small portion of the drainage lies in Henry County to the south. Cities that are either partially or completely within the watershed include Toledo, Maumee, and the Villages of Holland, Swanton, Delta, Whitehouse, and Waterville.

The Swan Creek mainstem is fed by several large tributaries–Wolf Creek, Cairl Creek, and Ai Creek flow from the north and Heilman Ditch, Blystone Ditch, Blue Creek, and Fewless Creek from the south. The watershed is divided into two 11-digit assessment units (AUs):

- Swan Creek upstream Blue Creek to the mouth (04100009 080)
- Swan Creek headwaters to upstream Blue Creek (04100009 070)

Each of the 11-digit AUs are further subdivided into a total of eight 14-digit hydrologic unit code (HUC) sub-watersheds as presented in Table 1-2.

Table 1-2 Assessment unit and 14-digit HUC designations for the Swan Creek watershed.

11-Digit AU	14-Digit HUC	Description	Drainage Area (acres)	Drainage Area (mi^2)
04100009 070	010	Swan Creek headwaters to above Ai Creek	17,997	28.12
	020	Ai Creek	32,373	50.58
	030	Swan Creek below Ai Creek to above Blue Creek	10,815	16.90
04100009 080	010	Blue Creek headwaters to above Harris Ditch	13,545	21.16
	020	Blue Creek above Harris Ditch to Swan Creek	15,127	23.64
	030	Swan Creek below Blue Creek to above Wolf Creek	14,254	22.27
	040	Wolf Creek	17,432	27.24
	050	Swan Creek below Wolf Creek to Maumee River	8,897	13.90
		Total	**130,406**	**203.81**

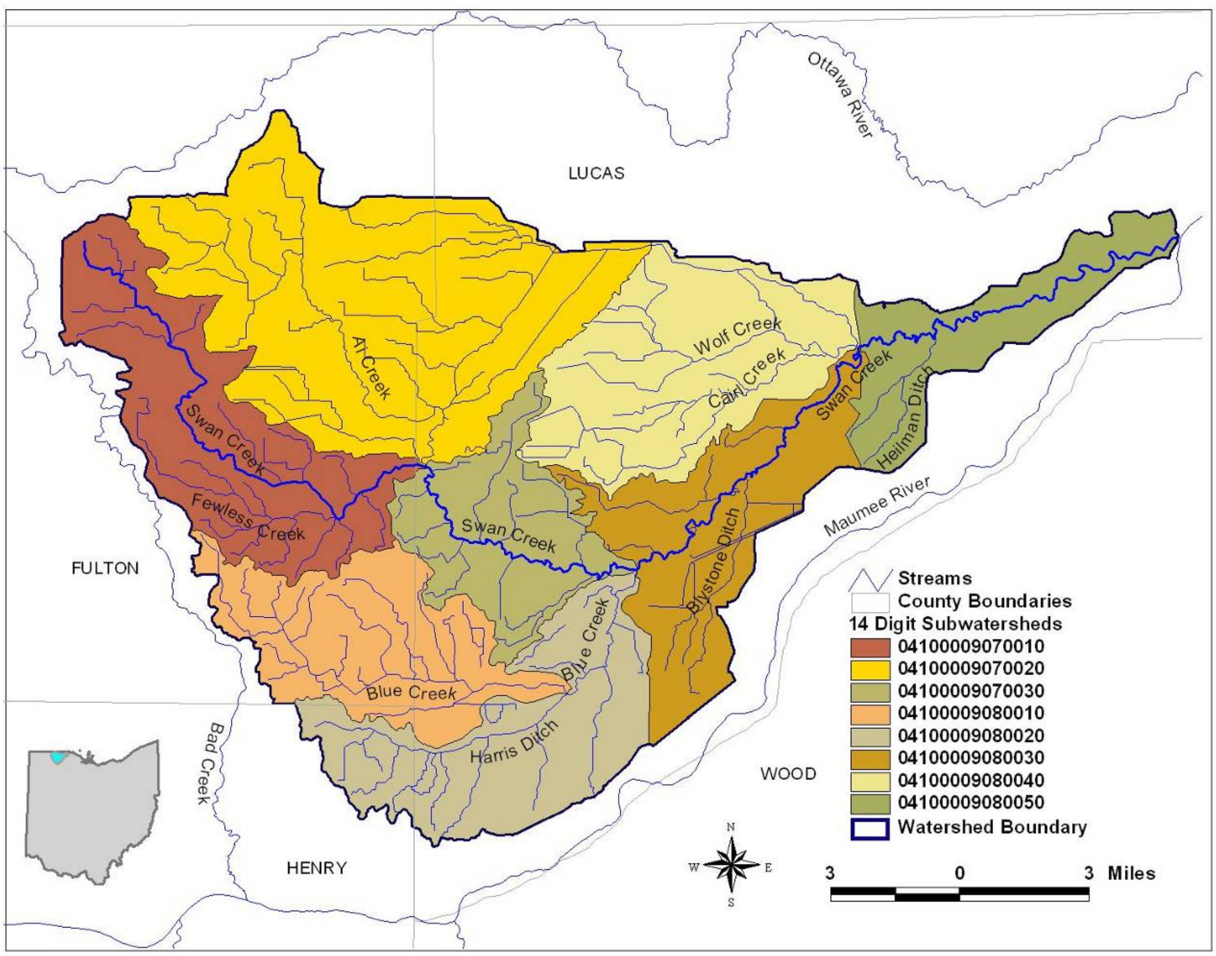


Figure 1-1 The Swan Creek watershed.

1.2 Land Cover within the Swan Creek Watershed

The land cover for the Swan Creek watershed was extracted from the Multi-Resolution Land Characteristics Consortium (MRLC) 2001 National Land Cover Database (Table 1-3). Figure 1-2 shows that land cover in each 14-digit HUC subwatershed varies significantly. The mouth and lower segments of Swan Creek are heavily influenced by developed land cover (open space and low, medium, and high intensity). Moving from the mouth to the headwaters along the mainstem of Swan Creek (away from the City of Toledo), the percent of developed land cover drops dramatically from 91 percent in the Swan Creek mouth subwatershed, to 27, 13, and 9 percent in the lower, middle, and upper Swan Creek subwatersheds, respectively. As developed land cover decreases moving towards the headwaters, the percent agricultural land cover (pasture/hay and row crops) increases. The only exception is the middle Swan Creek subwatershed, where the dominant land cover is forest (55 percent), followed by agricultural land cover (25 percent).

Table 1-3 Land cover characteristics of the Swan Creek watershed.

Land Cover	Area (acres)	Area (Sq. Miles)	Percent of Watershed
Open Water	582.38	0.91	0.45%
Developed, Open Space	13,048.70	20.39	10.01%
Developed, Low Intensity	9,761.29	15.25	7.49%
Developed, Medium Intensity	4,027.16	6.29	3.09%
Developed, High Intensity	2,136.07	3.34	1.64%
Barren Land (Rock/Sand/Clay)	182.03	0.28	0.14%
Deciduous Forest	22,279.54	34.81	17.08%
Evergreen Forest	1,981.82	3.10	1.52%
Mixed Forest	2.30	0.00	0.00%
Grasslands/Herbaceous	2,621.00	4.10	2.01%
Pasture/Hay	5,908.66	9.23	4.53%
Cultivated Crops	66,821.39	104.41	51.24%
Woody Wetlands	914.23	1.43	0.70%
Emergent Herbaceous Wetlands	139.61	0.22	0.11%
Total	**130,406.18**	**203.76**	**100.00%**

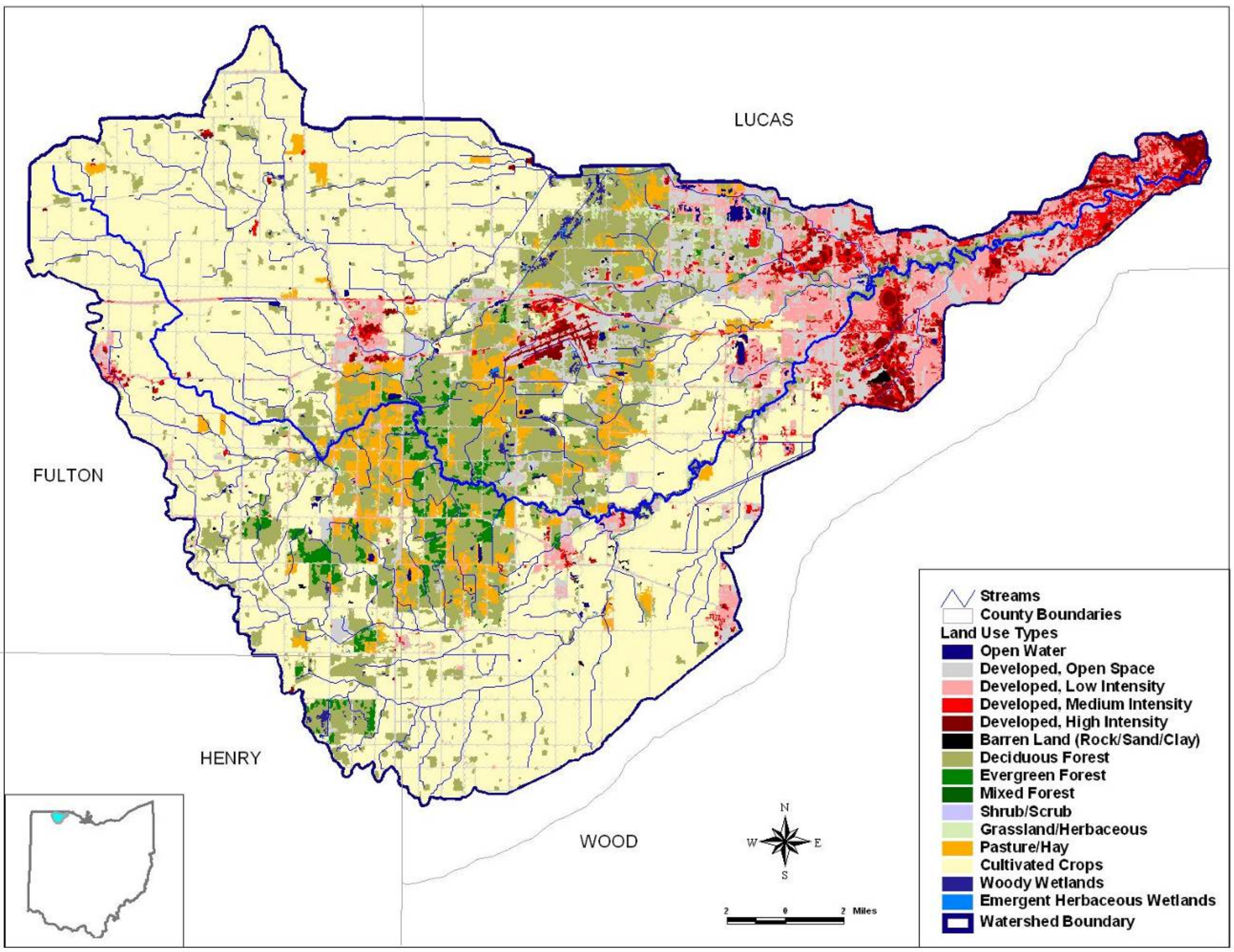


Figure 1-2 Land cover within the Swan Creek watershed.

The major tributaries to Swan Creek include Wolf Creek, Blue Creek, and Ai Creek. Wolf Creek has a very diverse land cover distribution. It has 43 percent developed land cover, 26 percent forested, and 20 percent agricultural land cover. The lower portion of Blue Creek is dominated by row crop agriculture (79 percent), while the headwaters contain a smaller proportion of row crops (49 percent) and a greater percentage of forested land cover (31 percent). Ai Creek land cover is primarily agricultural with over 73 percent being a combination of row crops and pasture/hay.

Table 1-4 2001 Land cover by subwatershed (square miles).

Land Cover (Square Miles)	Swan Mouth (080050)	Wolf Creek (080040)	Lower Swan Creek (080030)	Blue Creek Mouth (080020)	Blue Creek Headwaters (080010)	Middle Swan Creek (070030)	Ai Creek (070020)	Upper Swan Creek (070010)
Open Water	0.02	0.42	0.02	0.04	0.06	0.15	0.11	0.08
Developed, Open Space	2.11	6.49	2.54	1.47	1.51	1.44	3.25	1.56
Developed, Low Intensity	**5.25***	3.93	2.51	0.46	0.45	0.55	1.40	0.66
Developed, Medium Intensity	3.38	1.56	0.68	0.07	0.02	0.11	0.33	0.13
Developed, High Intensity	1.88	0.87	0.17	0.02	0.00	0.12	0.21	0.05
Barren Land (Rock/Sand/Clay)	0.09	0.04	0.02	0.04	0.02	0.02	0.02	0.03
Deciduous Forest	0.83	**7.01**	2.03	2.01	5.60	**7.85**	6.60	2.87
Evergreen Forest	0.01	0.09	0.02	0.26	1.08	1.36	0.16	0.12
Mixed Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grasslands/Herbaceous	0.00	1.11	0.34	0.30	0.35	0.62	1.01	0.36
Pasture/Hay	0.00	1.51	0.40	0.18	1.66	2.64	1.39	1.44
Cultivated Crops	0.00	4.05	**13.24**	**18.61**	**10.32**	1.72	**35.59**	**20.74**
Woody Wetlands	0.17	0.10	0.25	0.13	0.06	0.28	0.38	0.05
Emergent Herbaceous Wetlands	0.09	0.02	0.02	0.00	0.02	0.02	0.04	0.01
Total	13.83	27.21	22.26	23.62	21.15	16.90	50.48	28.09

*The largest land cover categories are indicated in bold font.

Table 1-5 2001 Land cover by subwatershed (percent of total area).

Land Cover (Percentage)	Swan Mouth (080050)	Wolf Creek (080040)	Lower Swan Creek (080030)	Blue Creek Mouth (080020)	Blue Creek Headwaters (080010)	Middle Swan Creek (070030)	Ai Creek (070020)	Upper Swan Creek (070010)
Open Water	0.16%	1.56%	0.11%	0.18%	0.28%	0.91%	0.22%	0.27%
Developed, Open Space	15.24%	23.84%	11.41%	6.24%	7.14%	8.52%	6.44%	5.54%
Developed, Low Intensity	**37.96%**	14.43%	11.28%	1.97%	2.14%	3.27%	2.76%	2.36%
Developed, Medium Intensity	24.42%	5.72%	3.07%	0.30%	0.09%	0.63%	0.66%	0.46%
Developed, High Intensity	13.62%	3.21%	0.78%	0.09%	0.01%	0.68%	0.41%	0.16%
Barren Land (Rock/Sand/Clay)	0.68%	0.14%	0.09%	0.16%	0.09%	0.15%	0.04%	0.11%
Deciduous Forest	5.98%	**25.76%**	9.14%	8.52%	26.48%	**46.47%**	13.07%	10.22%
Evergreen Forest	0.05%	0.33%	0.10%	1.11%	5.09%	8.03%	0.32%	0.43%
Mixed Forest	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%
Grasslands/Herbaceous	0.00%	4.09%	1.52%	1.28%	1.65%	3.67%	2.00%	1.29%
Pasture/Hay	0.00%	5.55%	1.79%	0.77%	7.87%	15.65%	2.75%	5.14%
Cultivated Crops	0.00%	14.89%	**59.49%**	**78.80%**	**48.81%**	10.20%	**70.50%**	**73.83%**
Woody Wetlands	1.23%	0.38%	1.14%	0.55%	0.26%	1.67%	0.76%	0.18%
Emergent Herbaceous Wetlands	0.66%	0.09%	0.07%	0.02%	0.07%	0.15%	0.07%	0.02%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

*The largest land cover categories are indicated in bold font.

2 WATER QUALITY STANDARDS

The purpose of developing a TMDL is to identify the pollutant loading that a waterbody can receive and still achieve water quality standards. Water quality standards are therefore central to the TMDL development process. Under the Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the Clean Water Act's goal of "swimmable/fishable" waters. Water quality standards consist of three components: designated uses, numeric or narrative criteria, and an antidegradation policy. Ohio's water quality standards are summarized in Table 2-1 and explained in greater detail below.

Table 2-1 Ohio water quality standards.

Component	Description
Designated Use	Designated use reflects how the water can potentially be used by humans and how well it supports a biological community. Every water in Ohio has a designated use or uses; however, not all uses apply to all waters (i.e., they are waterbody specific).*
Numeric Criteria	Chemical criteria represent the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. Biological criteria indicate the health of the in-stream biological community by using one of three indices: • Index of Biotic Integrity (IBI) (measures fish health). • Modified Index of well being (MIwb) (measures fish health). • Invertebrate Community Index (ICI) (measures benthic macroinvertebrate health).
Narrative Criteria	These are the general water quality criteria that apply to all surface waters. These criteria state that all waters must be free from sludge; floating debris; oil and scum; color- and odor-producing materials; substances that are harmful to human, animal or aquatic life; and nutrients in concentrations that may cause algal blooms.
Antidegradation Policy	This policy establishes situations under which Ohio EPA may allow new or increased discharges of pollutants, and requires those seeking to discharge additional pollutants to demonstrate an important social or economic need. Refer to <http://epa.ohio.gov/dsw/wqs/index.aspx> for more information.

* According to OAC 3745-1-07(A)(1) each waterbody is assigned a designated use. Any streams in Ohio that are undesignated still must attain the chemical criteria associated with the Warm Water Habitat designation. There is no similar protection for recreational use.

2.1 Designated Uses

Most of Swan Creek and its tributaries are designated by Ohio EPA as warmwater habitat (WWH) and Primary Contact Recreation (OAC 3745-1-11). The only exception is Heilman Ditch which is designated as limited resource water (LRW) and Secondary Contact Recreation (SCR). Ohio EPA has also noted that Heilman Ditch has small drainageway maintenance.

Water Supply Uses for all waterbodies in the watershed are designated as Agricultural Water Supply (AWS) and Industrial Water Supply (IWS). Swan Creek at RM 30.84 is also designated as a Public Water Supply (PWS) as it is the location of the Village of Swanton public water supply intake.

2.2 Numeric Criteria

Numeric criteria exist in Ohio to protect contact recreation designated uses. However, interpreting Ohio's water quality standards for fecal coliform and *E. coli* is somewhat complex. Standards have been established to protect three different designated uses:

Bathing waters: these are waters that, during the recreation season, are suitable for swimming where a lifeguard and/or bathhouse facilities are present, and include any additional such areas where the water quality is approved by the director.

Primary contact: these are waters that, during the recreation season, are suitable for full-body contact recreation such as, but not limited to, swimming, canoeing, and scuba diving with minimal threat to public health as a result of water quality.

Secondary contact: these are waters that, during the recreation season, are suitable for partial body contact recreation such as, but not limited to, wading with minimal threat to public health as a result of water quality.

Table 2-2 shows that the primary contact *E. coli* criterion of 126 colony-forming units (cfu)/100 mL is identical to the bathing water *E. coli* criterion as a geometric mean. However, this is not the case for fecal coliform. While the primary contact fecal coliform criterion is 1,000 cfu/100 mL, the bathing water fecal coliform criterion is 200/100 mL. For this reason, *E. coli* is not used by itself to determine if there is a violation of the primary contact recreation criteria because Ohio EPA's regulations state that:

> *"For each designation at least one of the two bacteriological standards (fecal coliform or E. coli) must be met (OAC 3745-1-07, Table 7-13)."*

Therefore, when both fecal coliform and *E. coli* data are available from the same sample, if at least one of the two standards is met, there is not a human health violation. However, no fecal coliform data are available for the Swan Creek watershed. Only *E. coli* data have been collected and for this reason, the TMDLs for the Swan Creek watershed are based on meeting the primary contact, instantaneous *E. coli* standard of 298/100 mL (with the exception of Heilman Ditch which will be based on the 576/100 mL *E. coli* standard as it is designated as secondary contact recreation). Note that the standard only applies during the recreation season (May 1 to October 15).

Table 2-2 Fecal coliform and *E. coli* standards for Ohio (May 1 through October 15).

Parameter	Bathing Waters		Primary Contact		Secondary Contact
	Geometric Mean[1]	Instantaneous[2]	Geometric Mean[1]	Instantaneous[2]	Instantaneous[2]
Fecal Coliform	200/100 mL	400/100 mL	1,000/100 mL	2,000/100 mL	5,000/100 mL
E. coli	126/100 mL	235/100 mL	126/100 mL	298/100 mL	576/100 mL

[1] Geometric mean should not exceed this standard based on not less than five samples within a thirty-day period.
[2] Fecal coliform or *E. coli* content should not exceed this standard in more than ten percent of the samples taken in any thirty-day period.

Ohio EPA (Ohio EPA, 1999) also has established water quality targets for the following causes of impairment in the Swan Creek watershed: TDS, dieldrin, benzo[a]pyrene, strontium, and ammonia (Table 2-3).

Table 2-3 TMDL target values for the Swan Creek watershed.

Water Quality Parameter	Source of TMDL Target	Target Value
TDS	Statewide Protection of Aquatic Life	1,500 mg/L
Dieldrin	Tier I Human Health value	0.0000065 µg/l
Benzo[a]pyrene	Tier II Human Health value	0.00002 µg/l[1]
Strontium	Tier I Aquatic Life value	5,300 µg/l
Ammonia	Statewide Protection of Aquatic Life	10.7 mg/l[2]

[1]The benzo[a]pyrene target of 0.00002 µg/l has been pulled from an exceedance table provided by the Ohio EPA and will be used for TMDL analysis unless an alternative target is recommended.
[2]The value shown is the lowest possible criterion for all samples obtained at the impaired site (P11K20 in Heilman Ditch). See Table 7-2 in OAC 3745-1-07 for WWH and LRW criteria values based on pH and hardness collected at the time of sampling (**http://www.epa.ohio.gov/portals/35/rules/01_all.pdf**).

2.3 Narrative Water Quality Criteria

Only narrative criteria are available for nutrient-related causes of impairment. TMDL numeric targets are therefore needed to compare existing water quality conditions to desired water quality conditions and to derive "maximum daily loads". Ohio EPA (Ohio EPA, 1999) has established proposed water quality targets for nutrients that were applied for TMDL development purposes in the Swan Creek watershed (Table 2-4).

Table 2-4 Nutrient TMDL target values for the Swan Creek watershed.

Water Quality Parameter	Drainage Area	Target Value (mg/L)
Total Phosphorus	Headwaters (< 20 square miles)	0.08
	Wadeable (20 ≥ to < 200 square miles)	0.10
	Small Rivers (200 ≥ to < 1000 square miles)	0.17
Nitrate Nitrogen	Headwaters (< 20 square miles)	1.0
	Wadeable (20 ≥ to < 200 square miles)	1.0
	Small Rivers (200 ≥ to < 1000 square miles)	1.5

The metal concentrations of concern in the Swan Creek watershed include aluminum and copper (Ohio EPA, 2008). Ohio EPA does not have numeric criteria for aluminum, therefore the U.S. EPA criterion of 970 µg/l was selected for the aluminum target.

Ohio EPA has a copper standard that coincides with the National Recommended Criteria by the U.S. EPA. The total copper criteria for outside the mixing zone maximum (OMZM) are based on hardness measured at the time of sample collection, and are calculated using the following shown below:

$$e^{(0.9422\ [\ln \text{Hardness (mg/L CaCO3)}] - 1.700)}$$

For the site impaired by total copper (TMDL site P11K14- Ai Creek at County Road L), the range of applicable criteria were calculated based on the available hardness data and the most restrictive criterion was 32.6 µg/l. Because attaining the lowest criterion value would result in the attainment of all other calculated total copper standards, 32.6 µg/l will be used as the target concentration for TMDL analyses at this station.

TMDL targets for total suspended solids (TSS) are not specifically addressed in Ohio's water quality standards and therefore were derived from HELP ecoregion reference site statistics (Ohio EPA, 1999). The medians of the reference site statistics were used as the TMDL targets and are shown in Table 2-5.

Table 2-5 Suggested TSS targets for Swan Creek derived from HELP reference site statistics.

Water Quality Parameter	Reference Site Statistic	Drainage Area	Target Value (mg/L)
Total Suspended Solids	Median	Headwaters (< 20 square miles)	13.5
		Wadeable (20 ≥ to < 200 square miles)	12.5
		Small Rivers (200 ≥ to < 1000 square miles)	34.0

Using TSS as an indicator of sediment in streams is fairly common and has been used in numerous TMDL reports. However, TSS concentrations may be an underestimation of sediment loads as they only account for particles small enough to be suspended in the water column. Larger particles, such as sand and coarser particles that may have the most influence on aquatic life and stream substrates, are often not included in TSS concentrations. These larger particles typically settle out of the water column and are transported as bed load sediments. Due to the lack of bed load and other sediment data throughout the Swan Creek watershed, TSS has been selected as a surrogate for the sediment impairment. Qualitative Habitat Evaluation Index (QHEI) and metric scores (the substrate metric in particular) are also used to supplement the sediment analyses. Future monitoring should focus on the QHEI substrate metric scores and other comparable measures to better evaluate the full extent of sediment issues in the Swan Creek watershed.

2.4 QHEI Narrative Ranges

Physical habitat was assessed in the Swan Creek watershed using the QHEI. A total of 28 sites (13 QHEI scores were calculated at headwater sites with less than 20 mi^2 of drainage area, and 15 at larger stream sites over 20 mi^2) were sampled. Table 2-6 presents the narrative ranges for total QHEI scores. No ratings have been developed for the individual QHEI metrics (substrate, cover, channel, etc.).

Table 2-6 General narrative ranges assigned to QHEI scores.

Narrative Rating	QHEI Range	
	Headwaters*	Larger Streams
Excellent	≥ 70	≥ 75
Good	55 to 69	60 to 74
Fair	43 to 54	45 to 59
Poor	30 to 42	30 to 44
Very Poor	< 30	< 30

*QHEI sampling sites with drainage areas of < 20 mi^2 are considered headwater sites.

3 WATER QUALITY DATA

An important step in the TMDL development process is the review of water quality conditions, particularly data and information used to list segments. Examination of water quality monitoring data is a key part of defining the problem that the TMDL is intended to address. This section provides a brief review of available water quality information including a summary of the spatial distribution for several parameters (e.g., longitudinal profile along Swan Creek, data clustered by contributing drainage area). The discussion also helps identify potential analytical methods that can strengthen the TMDL development process for Swan Creek.

3.1 Available Information

Ohio EPA employs an organized, sequential approach to monitoring and assessment (the "Five-Year Basin Approach") to better coordinate the collection of ambient monitoring data. Fish and aquatic insects are used as the primary indicators to assess the health of flowing waters. In addition to biological information, physical and chemical data are collected to further characterize water quality conditions. These biological and water quality surveys, or biosurveys, are routinely conducted on a systematic basis throughout the state. One of the major goals of the biosurveys is to provide a current and thorough assessment of water quality conditions in watersheds that are scheduled for TMDLs. The *Biological and Water Quality Study of Swan Creek and Selected Tributaries 2006* (Ohio EPA, 2009) is available at the following web site: **http://www.epa.ohio.gov/dsw/document_index/psdindx.aspx**.

An intensive ambient assessment of Swan Creek and all tributaries with a drainage area greater than five square miles was conducted by Ohio EPA in 2006. The assessment was designed to satisfy a number of objectives described in *"2006 Final Study Plan for the Swan Creek Watershed and Lower Maumee River Tributaries"*. Information from this assessment was intended to support TMDL development for Swan Creek. The sites sampled in the 2006 survey are shown in Figure 3-1, while Table 3-1 summarizes location information.

Water quality sampling by Ohio EPA occurred between June 12 and August 22, 2006. Table 3-2 summarizes specific dates and key parameters associated with each sampling event. Flow conditions are an important aspect of water quality assessment. Although flow measurements on Swan Creek were not included in the survey, there was an active USGS gage operated on the Ottawa River in Toledo. Average daily flows reported from the Ottawa River for each sampling event are also included in Table 3-2.

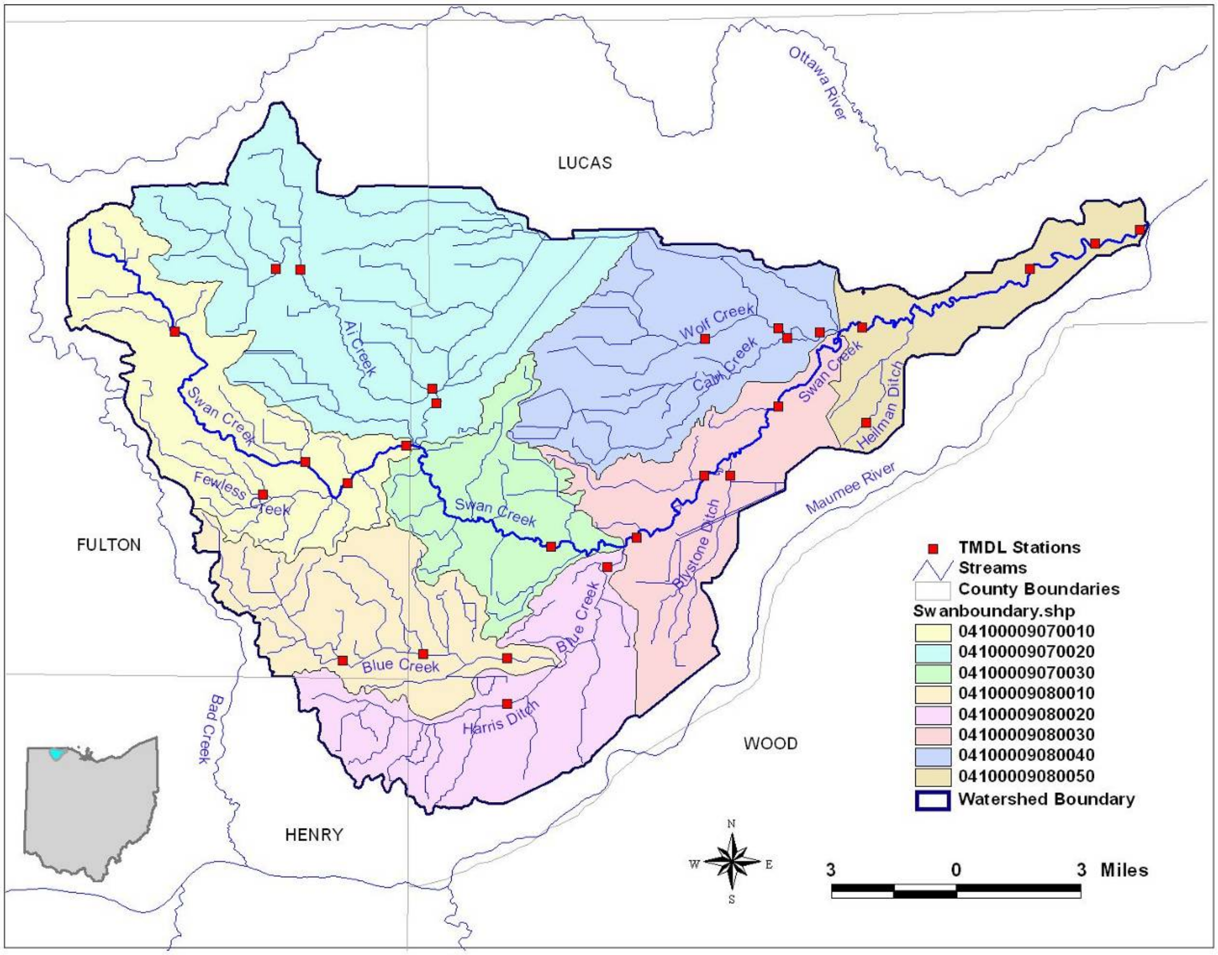


Figure 3-1 Location of 2006 Ohio EPA water quality sampling sites.

Table 3-1 Swan Creek watershed Ohio EPA survey sites.

11-Digit AU	14-Digit HUC	Stream Name	Station ID	River Mile	Drainage Area (Sq. mi.)	Location
04100009 -070	010	Swan Creek	P11K01	40.68	7.5	Fulton County Road 6-1
			P11K02	34.41	14.6	Fulton County Road 3
			P11K03	32.82	25.7	Fulton Township Road 2
			P11K04	30.90	28.2	above State Route 64
		Fewless Creek	P11K08	1.80	5.9	Fulton County Rod 4
	020	Ai Creek	P11K14	10.44	6.8	County Road L (in Ai)
			P11K15	8.29	12.5	County Road L (east of Ai)
			P11K17	2.10	19.5	Scott Road
			P11W15	1.66	49.3	State Route 2
	030	Swan Creek	P11K21	24.70	89	Spencer Road
04100009 -080	010	Blue Creek	P11K11	9.97	7.4	Fulton County Road 3
			P11P39	7.81	12.9	Manore Road
			P11K12	5.57	27.0	State Route 295
	020	Blue Creek	P11P13	0.73	44.5	Finzel Road
		Harris Ditch	P11K13	1.55	7.7	State Route 295
	030	Swan Creek	P11S11	21.64	140	Stitt Road
			P11K05	18.46	146	Monclova Road
			P11P09	15.24	160	Salisbury Road
		Blystone Ditch	P11A03	0.54	6.5	Monclova Road
	040	Wolf Creek	P11K09	4.06	7.9	Albon Road
			P11S66	1.96	12.9	Perrysburg-Holland Road
			P11P18	0.48	26.1	Holland-Sylvania Road
		Cairl Creek	P11K10	1.32	10.6	Pilliad Road
	050	Swan Creek	P11P08	10.84	192	Reynolds Road (SR-20)
			P11P05	4.31	200	South Avenue
			P11P03	1.58	203	City Park Avenue
			P11K07	0.19	204	OC Bridge
		Heilman Ditch	P11K20	3.01	10.8	Conant Road (SR-20)

Table 3-2 Swan Creek watershed Ohio EPA survey dates.

Dates	Ottawa River Flow *(cfs)*			Key Parameters Sampled		
	Day 1		***Day 2***	**E. Coli**	**Total Suspended Solids**	**Nutrients**
June 12-13, 2006	34	=>	29	X	X	X
June 19-20, 2006	27	=>	22	X		
June 26-27, 2006	319	=>	213	X	X	X
July 5-6, 2006	648	=>	284	X		
July 10-11, 2006	53	=>	56	X	X	X
July 24-25, 2006	54	=>	46	X	X	X
August 7-8, 2006	38	=>	35	X	X	X
August 21-22, 2006	19	=>	18	X	X	X

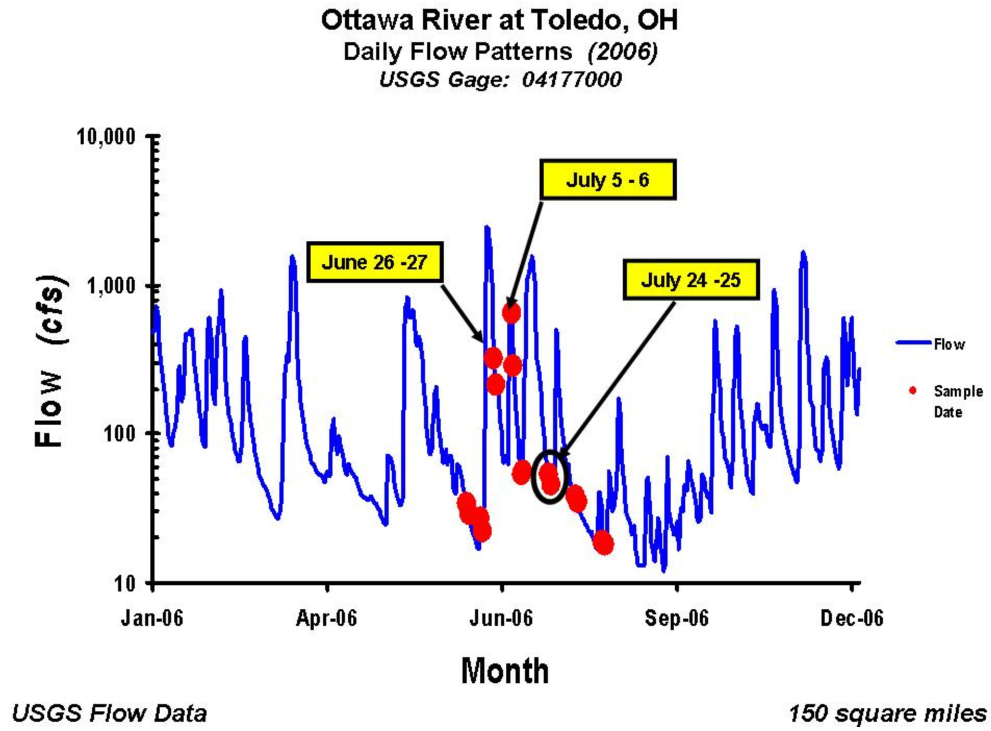


Figure 3-2 Average daily streamflow in the Ottawa River at Toledo during 2006.

Hydrology plays an important role in evaluating water quality. For this reason, flows associated with sample events are depicted relative to all 2006 daily average flows reported for the Ottawa River (Figure 3-2). The chart is useful by providing a context for sampling events relative to storms prior to data collection. The July 24-25 sample event is noted as one example. In addition, streams were undergoing rapid changes in flow during two sampling events as noted for June 26-27 and July 5-6.

In developing the TMDL for Swan Creek, it is useful to first look at some broad patterns for key water quality indicators, notably total suspended solids, nutrients, and *E. coli* bacteria. This provides an overall context for concerns that relate to individual parameters and locations within the Swan Creek watershed. Details regarding specific subwatersheds are discussed in Section 5.

3.1.1 Total Suspended Solids

A longitudinal profile for total suspended solids concentrations measured along the mainstem of Swan Creek during the Ohio EPA 2006 survey is shown in Figure 3-3. Another approach towards viewing the information is through a display of the data by drainage area in a way that includes the tributary sites (Figure 3-4). Several patterns are worth noting. Both graphs indicate a wide range of variability at each site. Reasons for the variability are likely linked to differences in flow conditions (Figure 3-2). The effect of flow conditions can be examined using a duration curve analysis, a method that will be described in a subsequent section.

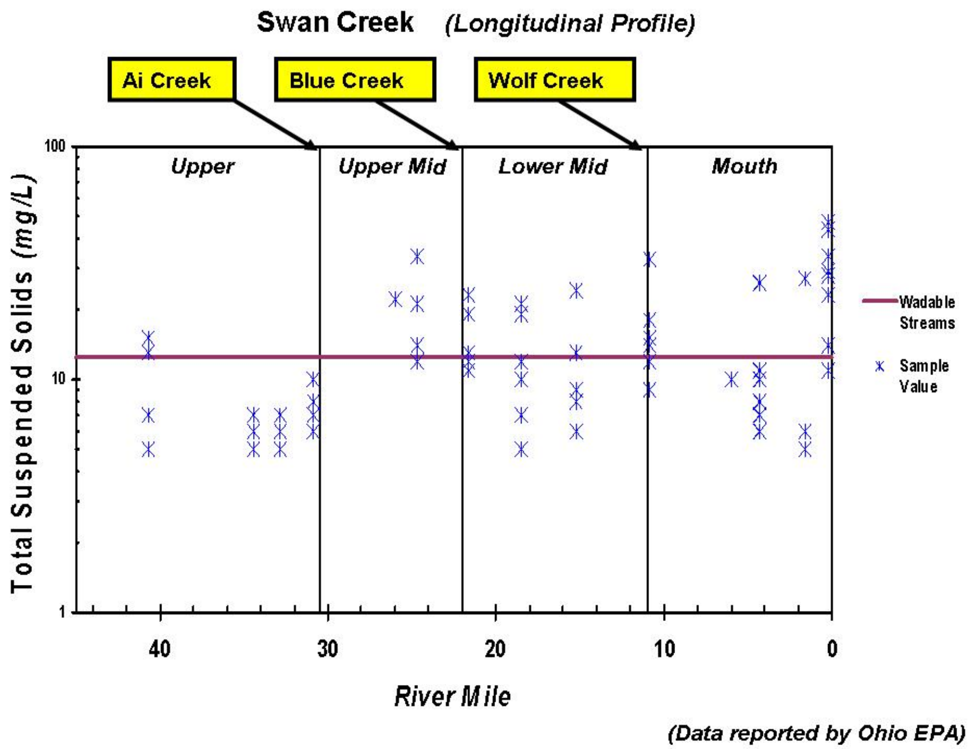


Figure 3-3 Longitudinal profile of Swan Creek TSS concentrations.

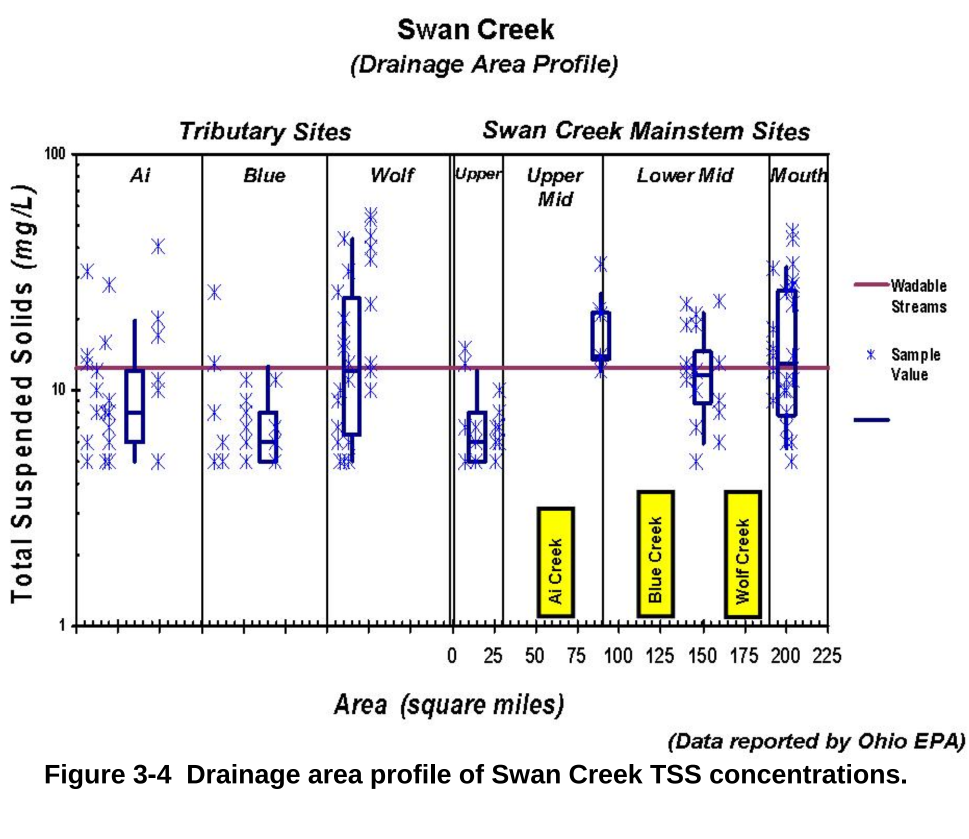


Figure 3-4 Drainage area profile of Swan Creek TSS concentrations.

Another pattern worth noting is the general increase in TSS concentrations on the mainstem between the upper Swan sites and stations sampled in the middle and lower reaches. The same pattern exists in the tributary sites when comparing Blue Creek to Wolf Creek. This could reflect the change in land use. Upper Swan and Blue Creeks tend to be more rural, while Wolf Creek has a higher percentage of developed land due to its proximity to the Toledo area. TSS patterns in Ai Creek tend to be mixed. Portions of the Ai Creek subwatershed are developed, particularly around Swanton. Factors, such as channel changes resulting from altered hydrology (e.g., increasing impervious cover), MS4 storm water, and site construction, could also explain the increase in TSS and are discussed in more detail in Section 5.

3.1.2 Nutrients

A longitudinal profile for total phosphorus concentrations measured along the mainstem of Swan Creek is shown in Figure 3-5, while the drainage area profile is shown in Figure 3-6. General patterns worth noting are the variability associated with flow conditions and the high levels in Ai Creek. There is also a noticeable increase in the mainstem Swan Creek concentrations below Ai Creek. The increase is likely associated with discharges from the Swanton Wastewater Treatment facility, which will be discussed in Section 4.

There also appear to be noticeable differences in phosphorus concentrations between Blue Creek and Wolf Creek. Differences in phosphorus concentrations were also measured on the mainstem between the lower middle reaches and those closer to the mouth. This may reflect the change in land use patterns between rural and urbanized areas within the watershed.

The profile information for nitrate plus nitrite (NO2+NO3) is shown in Figure 3-7 and Figure 3-8. Again, variability associated with flow conditions appears to be a major factor to be considered in the technical assessment. Also, there are noticeable differences in nitrate concentrations that may be related to land use, another factor to consider in both the source assessment and technical analysis.

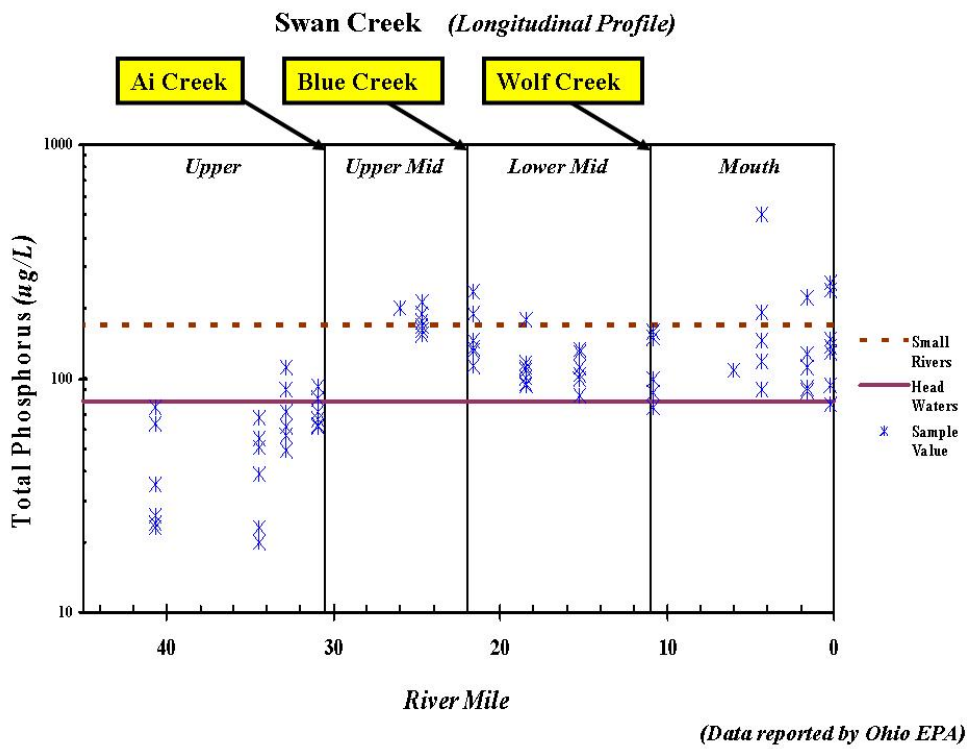


Figure 3-5 Longitudinal profile of Swan Creek total phosphorus concentrations.

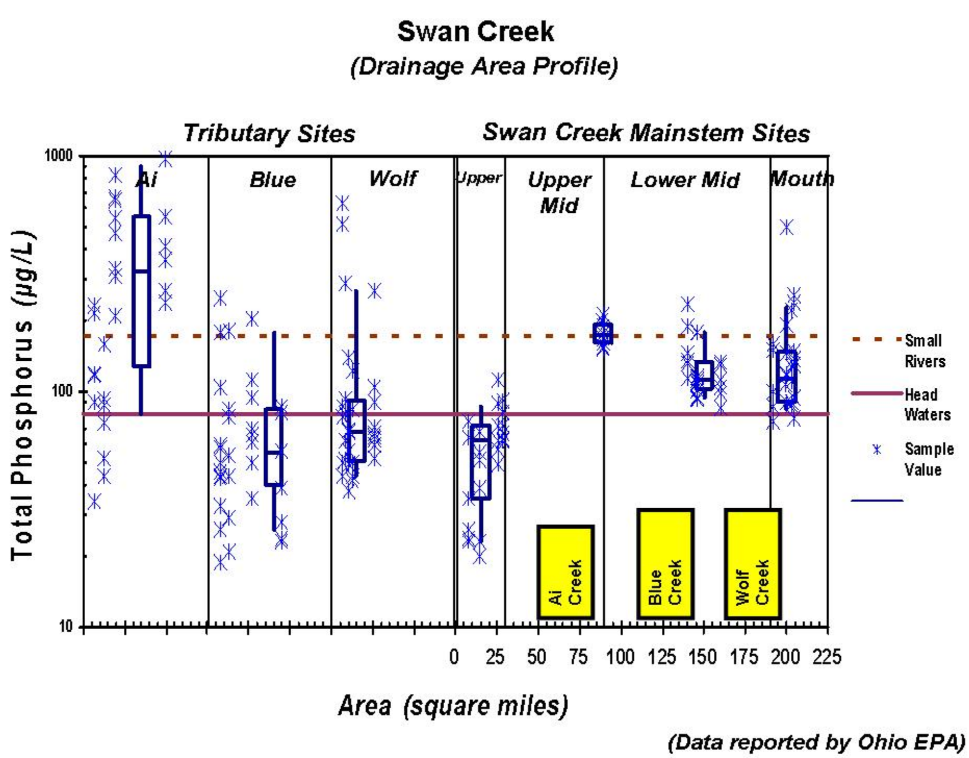


Figure 3-6 Drainage area profile of Swan Creek total phosphorus concentrations.

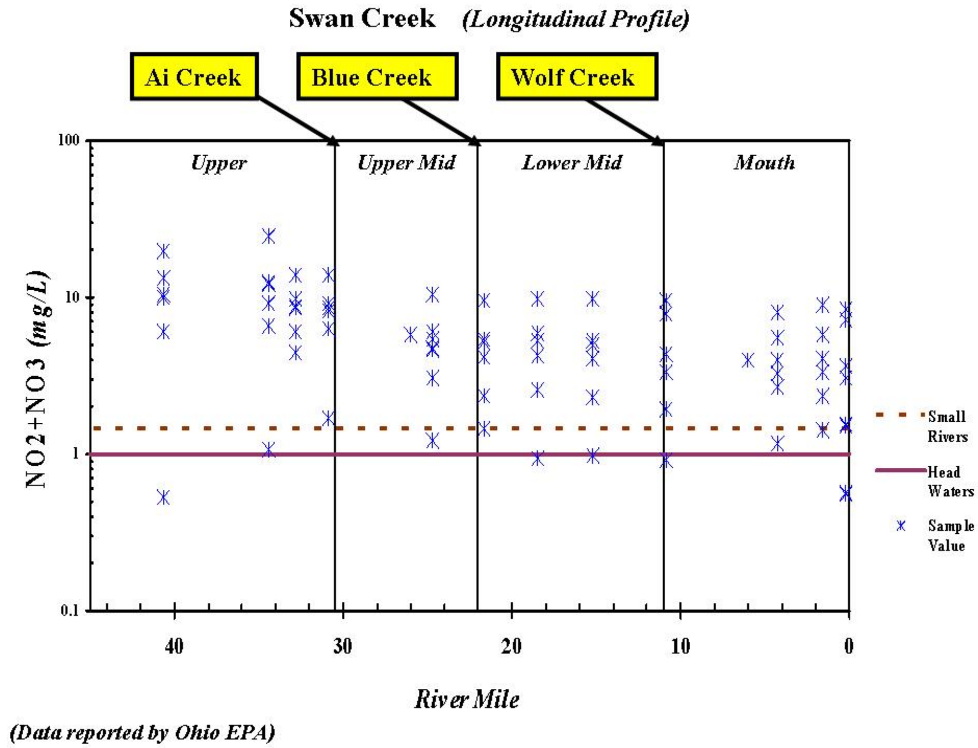


Figure 3-7 Longitudinal profile of Swan Creek NO2+NO3 concentrations.

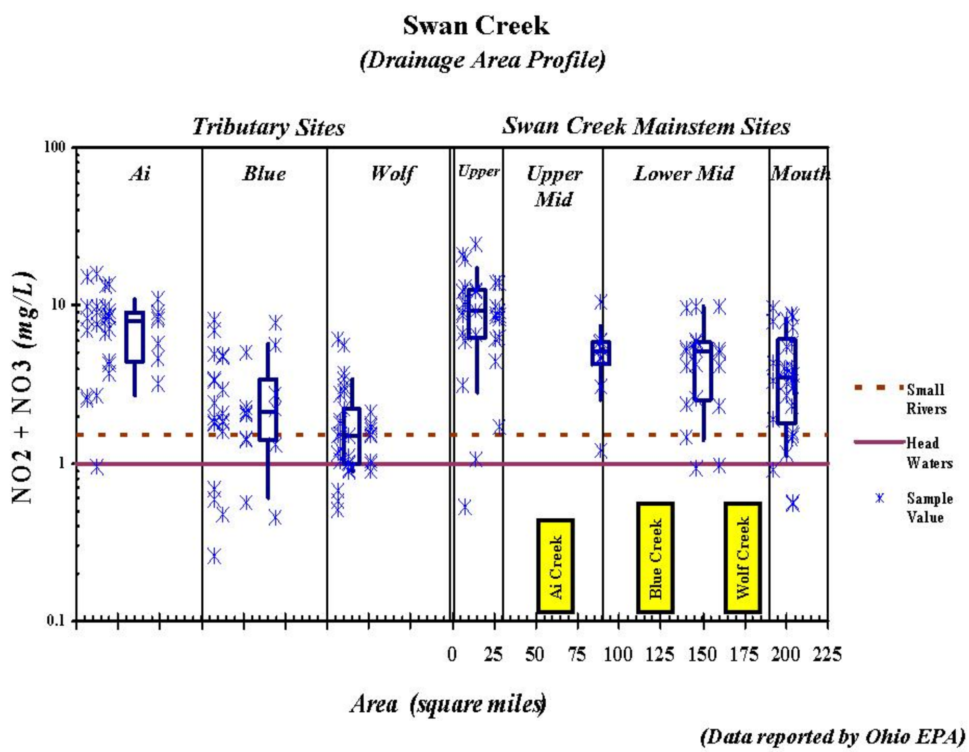


Figure 3-8 Drainage area profile of Swan Creek NO2+NO3 concentrations.

3.1.3 *E. coli* Bacteria

The profile information for *E. coli* bacteria is shown in Figure 3-9 and Figure 3-10. With very few exceptions, Ohio's water quality criteria for contact recreation were exceeded at all locations. Like TSS and nutrients, variability associated with flow conditions appears to be a major factor. An interesting pattern to be investigated in the source assessment and technical analysis is the difference in *E. coli* concentrations between the tributary headwater areas of the watershed and the lower reaches.

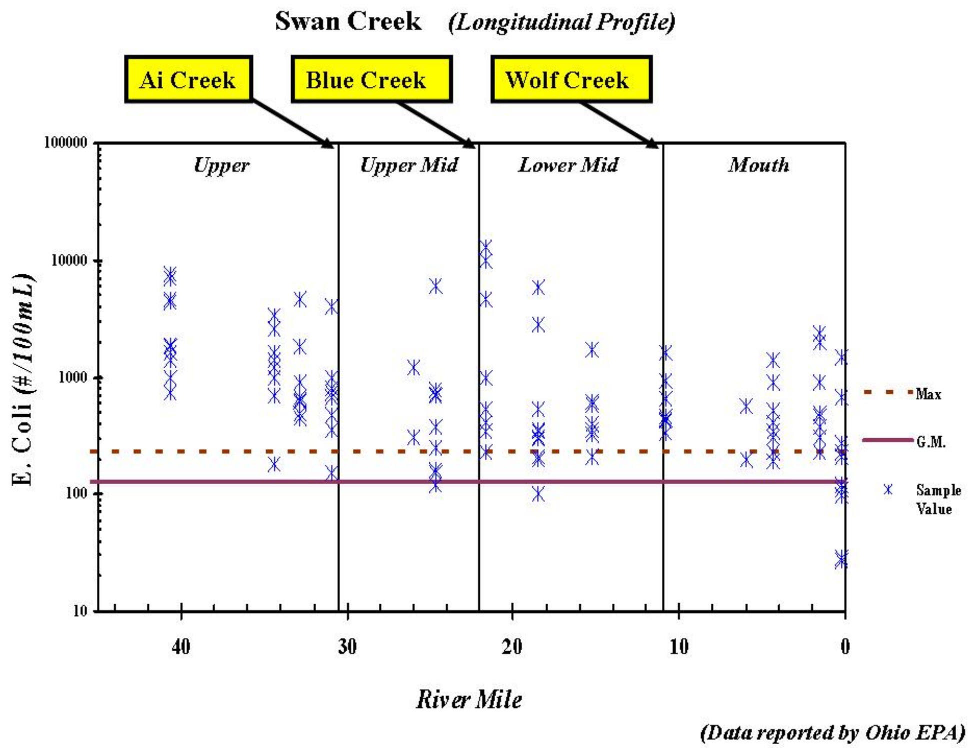


Figure 3-9 Longitudinal profile of Swan Creek *E. coli* concentrations.

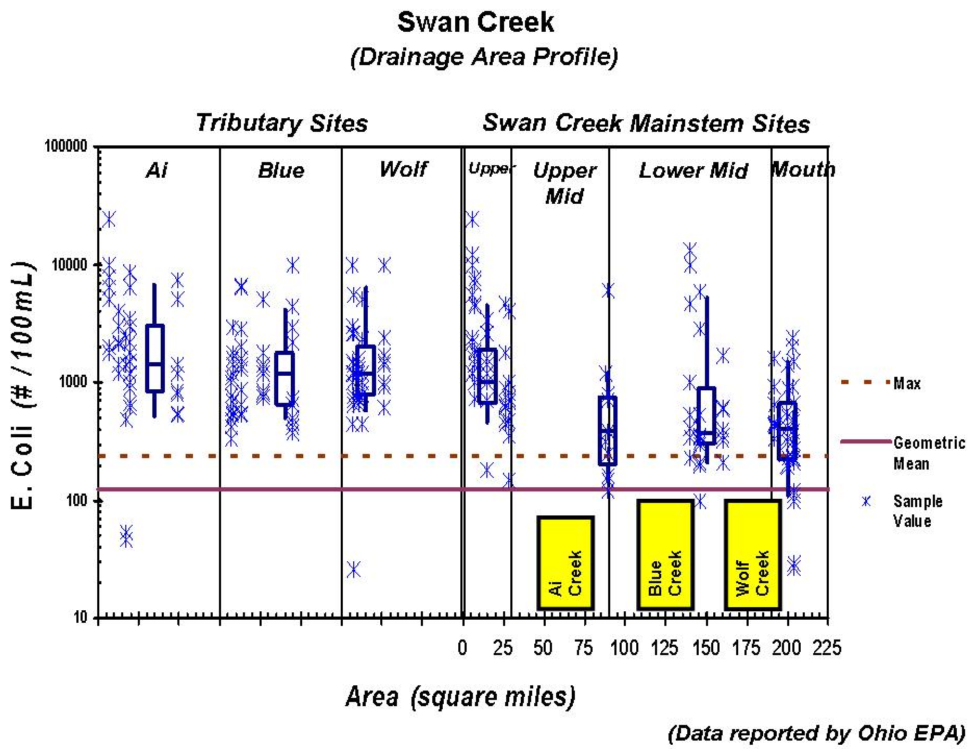


Figure 3-10 Drainage area profile of Swan Creek *E. coli* concentrations.

3.2 Duration Curve Analysis

This document describes an assessment approach that employs a hydrology-based framework using flow duration curves. The method is particularly helpful in examining water quality information where there are observed patterns associated with flow conditions. In addition to data analysis, the approach helps build a foundation for meaningful connections of the TMDL to implementation efforts (for example, water quality improvements that will result from erosion control or storm water management) by identifying patterns associated with hydrologic conditions (i.e., wet versus dry and to what degree). This section provides background material on available flow information in the Swan Creek watershed, briefly discusses the seasonal variation of flows observed in the Toledo area, and describes the duration curve approach including its use in assessing water quality data.

3.2.1 Stream Flow Estimates

There are no current/active USGS stream gages within the Swan Creek watershed, and therefore flow data are not available for the listed §303(d) segments. A flow estimation technique is needed for these segments to be able to estimate observed and allowable pollutant loads.

The drainage area weighting method was selected to determine continuous flow estimates for the Swan Creek TMDL sample stations. Drainage area weighting is a widely used technique in many cases where limited streamflow monitoring data are available. This method is most valid in situations where watersheds are of similar size, land cover, soil types, and experience similar precipitation patterns. Because there are no USGS gages in the Swan Creek watershed, a surrogate gage in the nearby Ottawa

River watershed was used to calculate estimates of daily flows. These flows were estimated using the following equation:

$$Q_{ungaged} = \frac{A_{ungaged}}{A_{gaged}} \times Q_{gaged}$$

Where,

$Q_{ungaged}$: Flow at the ungaged location
Q_{gaged}: Flow at surrogate USGS gage station
$A_{ungaged}$: Drainage area of the ungaged location
A_{gaged}: Drainage area at surrogate USGS gage station

Table 3-3 provides information for the USGS gage on the Ottawa River.

Table 3-3 USGS information for the Ottawa River gage at University of Toledo.

Gage ID	Drainage Area (sq. mi.)	Period of Record	Ecoregion	8-Digit HUC	Active (y/n)	Site Name
04177000	150	1945-2007	HELP	04100001	No	Ottawa River at University of Toledo, Toledo, Ohio

Table 3-4 presents the drainage area ratios used to estimate stream flow for all sites included in this TMDL.

Table 3-4 Drainage area ratios used to estimate stream flow for sites in the Swan Creek watershed.

11-Digit AU	14-Digit HUC	Station ID	Stream Name	Location	River Mile	Drainage Area (Sq. mi.)	Drainage Area Ratio
04100009 -070	010	P11K01	Swan Creek	At Fulton County Rd 6-1	40.68	7.5	0.0500
		P11K02	Swan Creek	At Fulton County Rd 3	34.41	14.6	0.0973
		P11K03	Swan Creek	At Township Rd 3	32.82	25.7	0.1713
		P11K04	Swan Creek	Upstream State Route 64	30.90	28.2	0.1880
		P11K08	Fewless Creek	At Fulton County Rd 4	1.80	5.9	0.0393
	020	P11K14	Ai Creek	At County Rd L (in Ai)	10.44	6.8	0.0453
		P11K15	Ai Creek	At County Rd L (east of Ai)	8.29	12.5	0.0833
		P11K17	Ai Creek	At Scott Rd	2.10	19.5	0.1300
		P11W15	Ai Creek	At State Route 2	1.66	49.3	0.3287
	030	P11K21	Swan Creek	At Spencer Rd	24.70	89	0.5933
04100009 -080	010	P11K11	Blue Creek	At Fulton County Rd 3	9.97	7.4	0.0493
		P11P39	Blue Creek	At Manore Rd	7.81	12.9	0.0860
		P11K12	Blue Creek	At State Route 295	5.57	27.0	0.1800
	020	P11P13	Blue Creek	At Finzel Rd	0.73	44.5	0.2967
		P11K13	Harris Ditch	At State Route 295	1.55	7.7	0.0513
	030	P11S11	Swan Creek	At Stitt Rd	21.64	140	0.9333
		P11K05	Swan Creek	At Monclova Rd	18.46	146	0.9733
		P11P09	Swan Creek	At Salisbury Rd	15.24	160	1.0667
		P11A03	Blystone Ditch	At Monclova Rd	0.54	6.5	0.0433
	040	P11K09	Wolf Creek	At Albon Rd	4.06	7.9	0.0527
		P11S66	Wolf Creek	At Perrysburg-Holland Rd	1.96	12.9	0.0860
		P11P18	Wolf Creek	At Holland-Sylvania Rd	0.48	26.1	0.1740
		P11K10	Cairl Creek	At Pilliad Rd	1.32	10.6	0.0707
	050	P11P08	Swan Creek	At Reynolds Rd (SR-20)	10.84	192	1.2800
		P11P05	Swan Creek	At South Ave	4.31	200	1.3333
		P11P03	Swan Creek	At City Park Ave	1.58	203	1.3533
		P11K07	Swan Creek	At OC Bridge	0.19	204	1.3600
		P11K20	Heilman Ditch	At Conant Rd (SR-20)	3.01	10.8	0.0720

3.2.2 Seasonal Variation

Seasonal variation must be considered in TMDL development. Seasonal variation in flow is a key part of the overall assessment because water quality parameters are often related to stream flow rates. This is a particularly important component of the linkage analysis described later in this report, where the timing of source loads is connected to seasonal water quality patterns. Figure 3-11 illustrates the seasonal variation in flow for the Ottawa River gage, based on USGS data reported in the National Water Information System (NWIS).

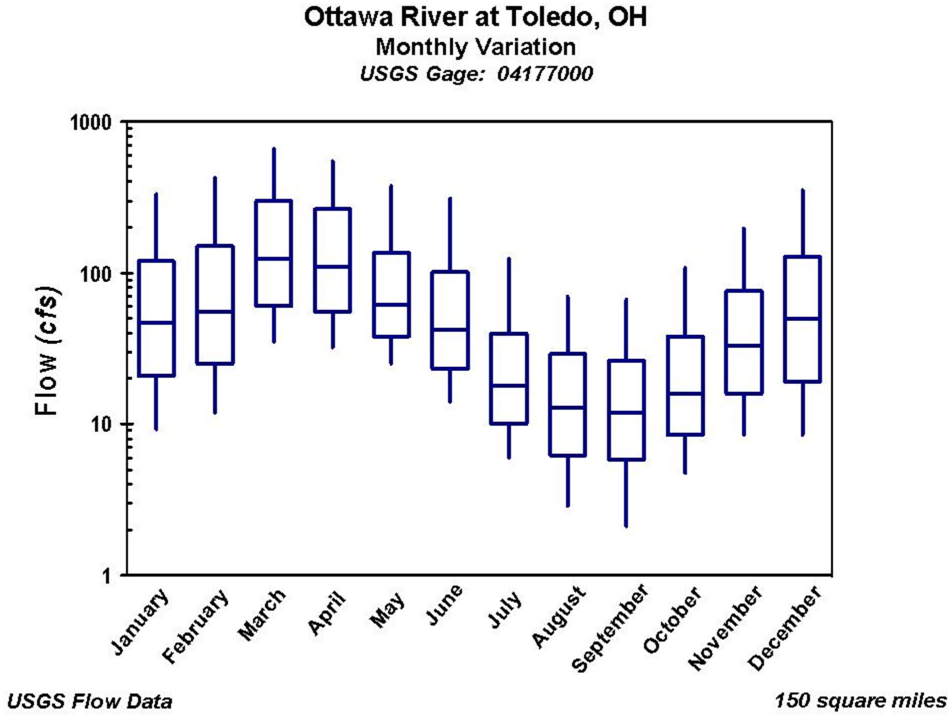


Figure 3-11 Monthly streamflow patterns observed in the Ottawa River at Toledo.

3.2.3 Flow Duration Curves

The daily average and monthly flow information shown for the Ottawa River (Figure 3-2 and Figure 3-11) illustrates the inherent variability associated with hydrologic information. Flow duration curves provide a way to address that variability. Duration curves describe the percentage of time during which specified flows are equaled or exceeded (Leopold, 1994). Flow duration analysis looks at the cumulative frequency of historic flow data over a specified period. Duration analysis results in a curve that relates flow values to the percent of time those values have been met or exceeded. Low flows are exceeded a majority of the time, whereas floods are exceeded infrequently.

Duration curves provide the benefit of considering the full range of flow conditions. Development of a flow duration curve is based on daily average stream discharge data. A typical curve runs from high flows to low flows along the x-axis, as illustrated in Figure 3-12 for the Ottawa River gage data. Note the flow duration interval of sixty associated with a stream discharge of 27 cfs (i.e., sixty percent of all observed stream discharge values equal or exceed 27 cfs).

Flow duration curve intervals can be grouped into several broad categories or zones. These zones provide additional insight about conditions and patterns associated with the impairment. A common way to look at the duration curve is by dividing it into five zones, as illustrated in Figure 3-12: one representing *high flows (0-10%)*, another for *moist conditions (10-40%)*, one covering *mid-range flows (40-60%)*, another for *dry conditions (60-90%)*, and one representing *low flows (90-100%)*. This particular approach places the midpoints of the moist, mid-range, and dry zones at the 25th, 50th, and 75th percentiles respectively (i.e., the quartiles). The high zone is centered at the 5th percentile, while the low zone is centered at the 95th percentile.

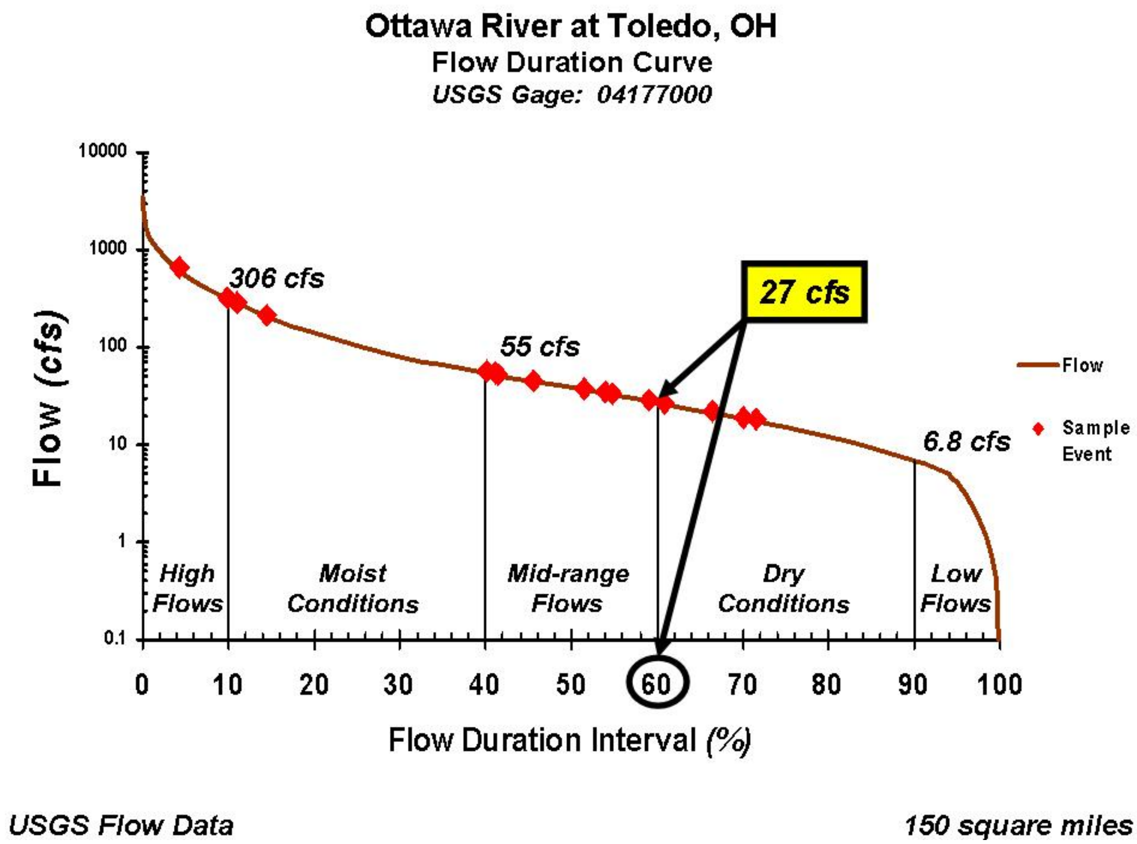


Figure 3-12 Flow duration curve for Ottawa River.

3.2.4 Water Quality Duration Curves

Ambient monitoring data, taken with some measure or estimate of flow at the time of sampling, can be used to develop water quality duration curves. Using the relative percent exceedance from the flow duration curve that corresponds to the stream discharge at the time the sample was taken, the water quality value can be plotted in a duration curve format. Figure 3-12 identifies the flow duration interval associated with the Ohio EPA 2006 survey sample events.

By displaying ambient water quality data and the daily average flow on the date of the sample (expressed as a flow duration curve interval), a pattern develops. This pattern describes the characteristics of the water quality impairment. Values that plot above the criterion or numeric target indicate an exceedance of the water quality criterion, while those below the load duration curve show compliance.

The pattern of impairment can be examined to see if it occurs across all flow conditions, corresponds strictly to high flow events, or conversely, only to low flows. Impairments observed in the low flow zone typically indicate the influence of point sources, while those further left generally reflect potential nonpoint source contributions. This concept is illustrated in Figure 3-13. Data may also be separated by season (e.g., summer versus winter). For example, Figure 3-13 uses a "+" to identify those samples collected during the summer season (June – September).

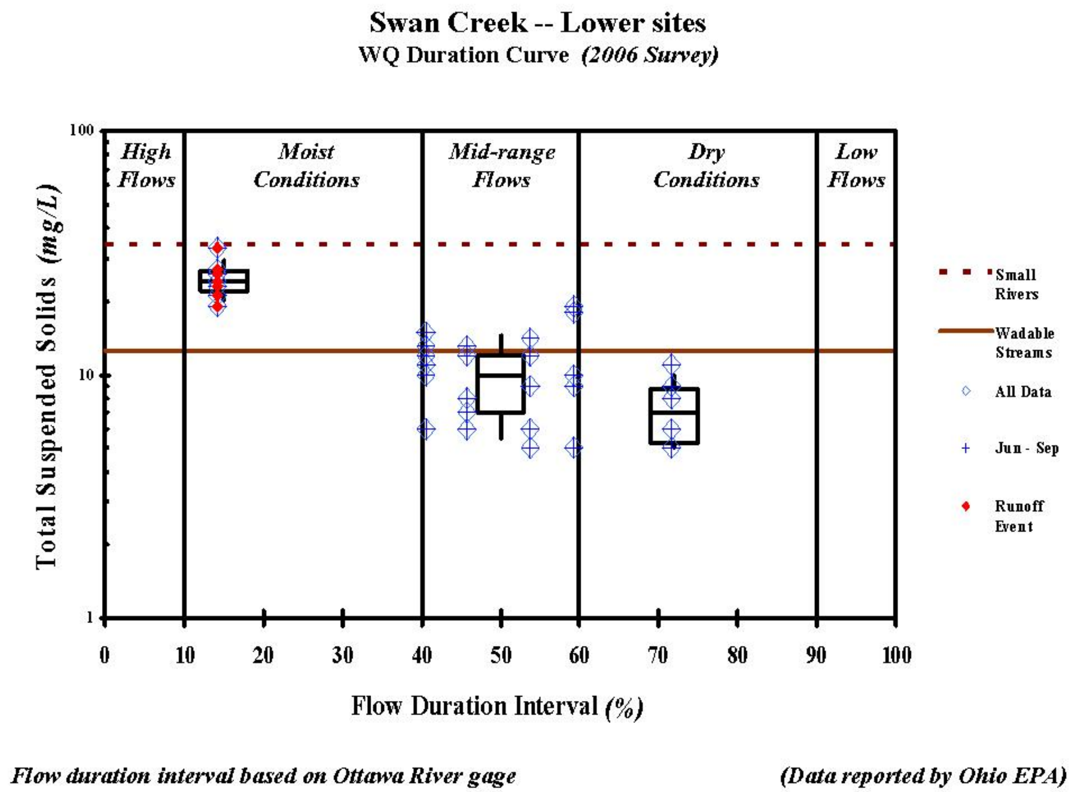


Figure 3-13 Water quality duration curve for TSS at lower mainstem Swan sites.

The utility of duration curve zones for pattern analysis can be further enhanced to characterize wet-weather concerns. Some measure or estimate of flow is available to develop the duration curves. As a result, stream discharge measurements on days preceding collection of the ambient water quality sample may also be examined. This concept is illustrated in Figure 3-13 by comparing the flow on the day the sample was collected with the flow on the preceding day. Any one-day increase in flow (above some designated minimum threshold) is assumed to be the result of a surface runoff event. In Figure 3-13, these samples are identified with a shaded diamond.

Figure 3-13 illustrates the utility of water quality duration curves in assessing the 2006 survey data in terms of flow conditions. A definite pattern exists between TSS measurements at the lower mainstem sites and flow conditions associated with the Ottawa River gage. For example, the highest TSS levels are generally associated with storm events (indicated by the shaded diamonds) and high flow conditions.

When coupled with water quality data, the flow duration approach helps to identify the issues surrounding the impairment and to roughly differentiate between sources. In addition, a major advantage of the duration curve framework in TMDL development is the ability to provide meaningful connections between allocations and implementation efforts. This is because the flow duration curve interval can be linked to source areas, delivery mechanisms, and the appropriate set of management practices.

3.3 Other Data

Water quality information from other sources has been collected in the Swan Creek watershed. Two of the more intensive efforts have been coordinated by the Maumee RAP Swan Creek Action Group and the City of Toledo. Though the data are not accepted as Level 3 credible data (Chapter 3745-4 of the Ohio Administrative Code), they do provide a valuable screening tool for determining bacterial "hotspots" throughout the watershed. Both efforts have also been conducted over a longer period of time, which allows an evaluation beyond the Ohio EPA 2006 survey that may provide indications of other factors to be considered, such as seasonal variation.

3.3.1 Streamkeeper Data

The City of Toledo and the Maumee RAP Swan Creek Action Group collaborated to create the Streamkeeper bacterial testing program in 1998. This program tested numerous sites throughout the Swan Creek watershed for bacterial contamination. Sampling was done on a monthly basis for two years and results are summarized in Figure 3-14, Figure 3-15, and Figure 3-16. This visual analysis of the data indicates several areas of the watershed exceeding Ohio EPA standards for primary and secondary contact recreation designated uses (TMACOG, 2001).

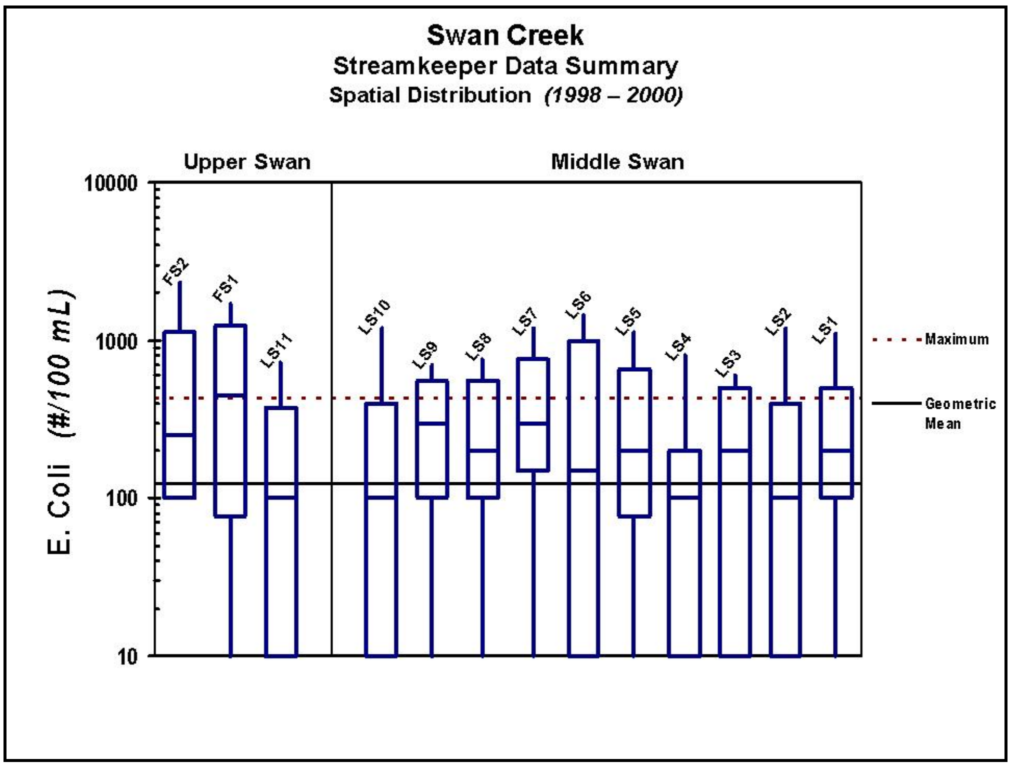


Figure 3-14 Swan Creek *E. coli* concentrations from Streamkeeper survey.

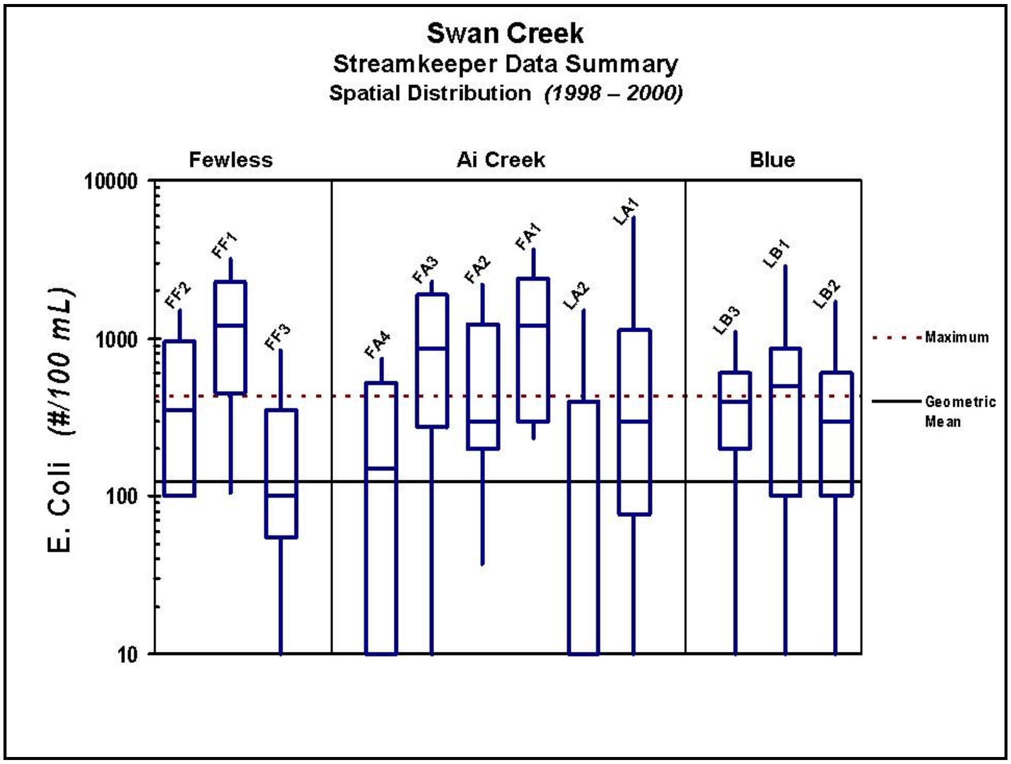


Figure 3-15 Fewless, Ai, and Blue Creek *E. coli* concentrations from Streamkeeper survey.

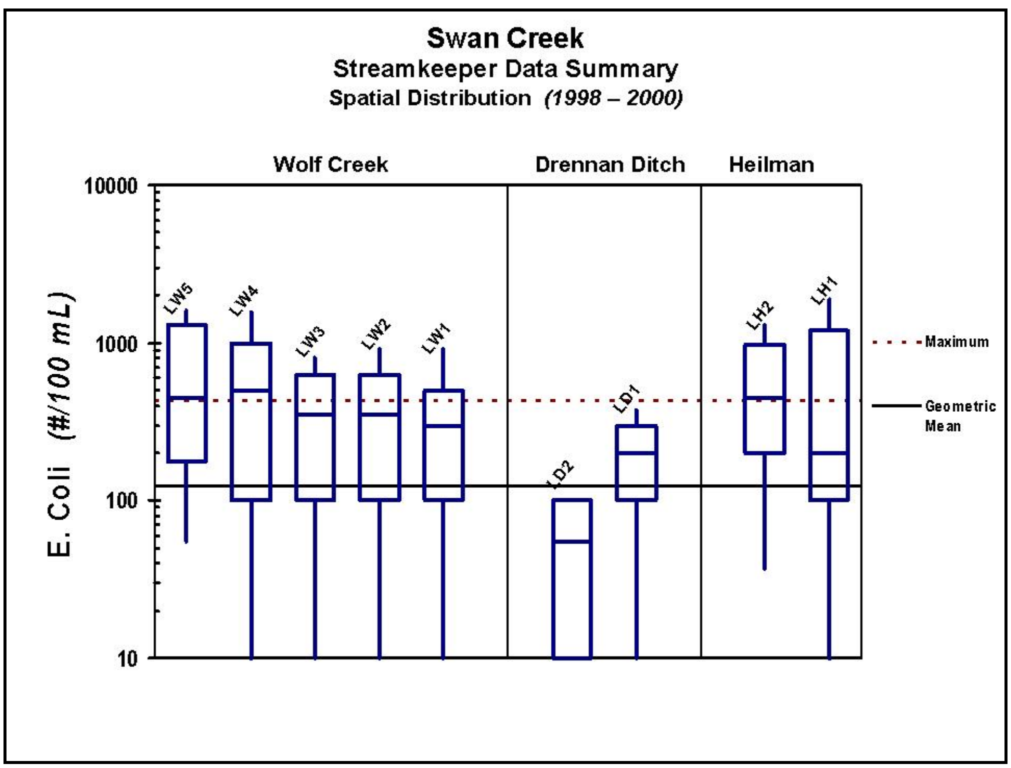


Figure 3-16 Swan Creek *E. coli* concentrations from Streamkeeper survey.

3.3.2 City of Toledo Water Quality Monitoring

The City of Toledo has been engaged in efforts to improve water quality in Swan Creek for a number of years. The Toledo Waterways Initiative and implementation of their CSO Long Term Control Plan are several examples. A part of their overall program includes water quality monitoring activities in the Maumee River, the Ottawa River, and Swan Creek. Although these data are not accepted as Level 3 credible data, the information has been collected over a long period covering the range of flow conditions. For this reason, the data can be used to provide insights on general water quality patterns.

Figure 3-17 provides a longitudinal profile of *E. coli* data from three Swan Creek sites sampled by the City of Toledo. Figure 3-18 and Figure 3-19 display the same information for the Eastgate and Hawley sites using a water quality duration curve that can be used to view the data by flow conditions.

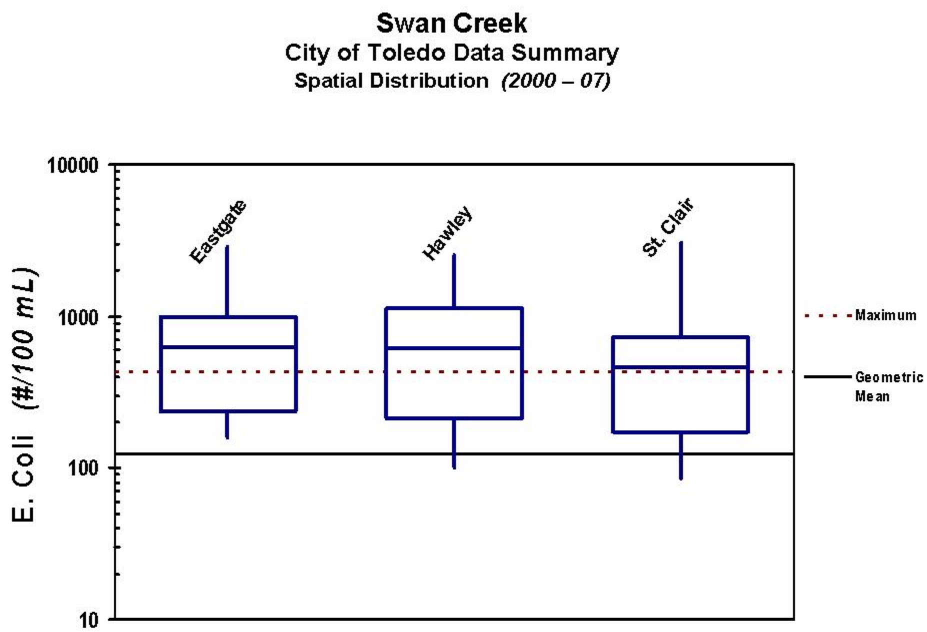
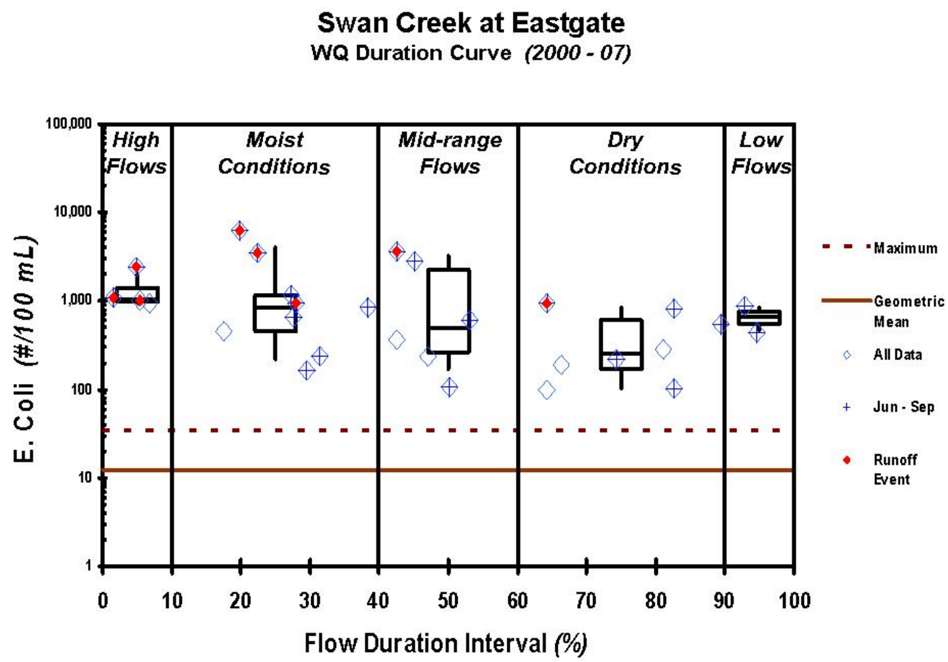
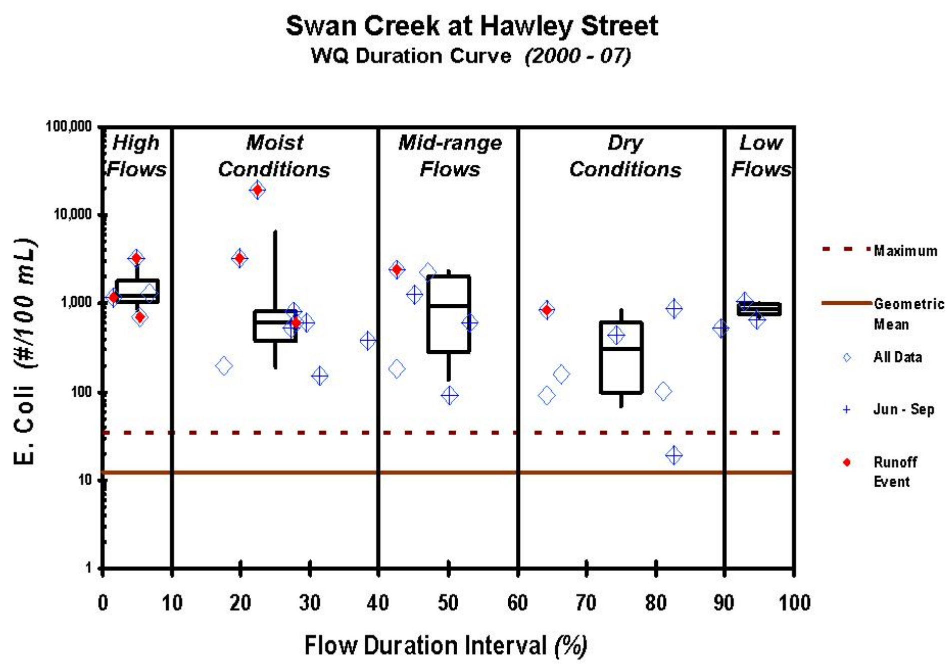


Figure 3-17 Swan Creek *E. coli* concentrations from City of Toledo data.



Flow duration interval based on Ottawa River gage *(Data reported by City of Toledo)*

Figure 3-18 Water quality duration curve for *E. coli* -- Swan Creek at Eastgate.



Flow duration interval based on Ottawa River gage *(Data reported by City of Toledo)*

Figure 3-19 Water quality duration curve for *E. coli* -- Swan Creek at Hawley Street.

4 SOURCE ASSESSMENT

This section of the report provides an inventory of the potential point and nonpoint sources of the pollutants of concern in the Swan Creek watershed. The significance of each of these potential point and nonpoint sources is more fully explored in the "linkage analysis" presented in Section 5.

4.1 Point Sources

This section of the report presents information on the sources within the Swan Creek watershed that are regulated through the National Pollutant Discharge Elimination System (NPDES) Program. These sources are commonly called "point sources".

4.1.1 Wastewater Treatment Plants and Industrial Dischargers

There are seven active facilities that are permitted to discharge within the Swan Creek watershed (Figure 4-1). All seven facilities are minor dischargers, or facilities with a design flow of less than 1 million gallons per day (MGD). Six of these facilities (all but the Stoneco Maumee Quarry) are permitted to discharge wastewater containing bacteria and nutrients to Swan Creek. These facilities include one larger municipal wastewater treatment plant (Swanton WWTP) and five smaller wastewater treatment plants associated with mobile home parks (Forest Park MHP, Swanton Meadows MHP, Peaceful Acres MHP, Arrowhead MHP and the Country Court MHP). As discussed in Section 5, the Swanton WWTP has a significant impact on downstream nutrient concentrations because its flow averages approximately 0.94 million gallons per day (MGD), the average TP effluent concentration is 1.3 mg/L, and the average NN effluent concentration is 8.7 mg/L. The WLAs developed for these facilities are presented in Section 6.

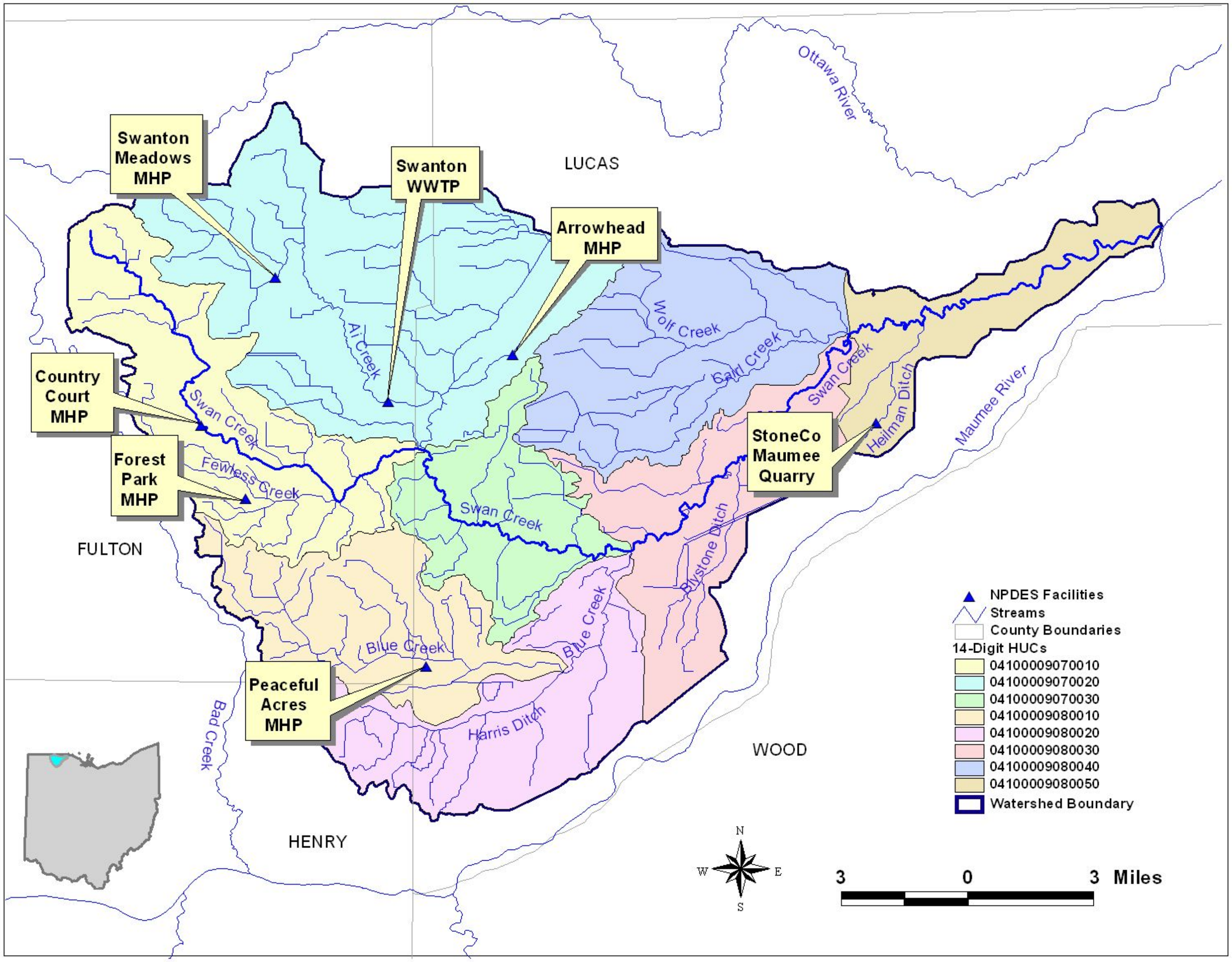


Figure 4-1 NPDES facilities in the Swan Creek watershed.

4.1.2 Combined Sewer Overflows (CSO)

Combined sewer system discharges typically occur in response to rainfall events during which urban runoff enters the sewer systems and mixes with untreated sewage. This can cause a significant increase in flow volumes in the sewer systems and, if the volume exceeds the system capacity, an overflow occurs. A CSO is a discharge of storm water and untreated sewage into nearby waterways that occurs prior to treatment at a municipal treatment plant. CSOs are considered point sources and are subjected to NPDES permit requirements including both technology-based and water quality-based requirements of the Clean Water Act. CSOs can be sources of elevated levels of suspended solids, bacteria, and nutrients that cause water quality standard exceedances and pose risks to human health, threaten aquatic habitat, and lower the aesthetic value of a waterbody.

There is one combined sewer service system covering portions of the Swan Creek watershed and it is located in the City of Toledo. The City of Toledo system has 33 permitted CSO discharge locations and eight of these outfalls discharge into Swan Creek. The City of Toledo Bayview Park Wastewater Treatment Plant has been issued NPDES Permit # 2PF00000 with distinct outfall locations, numbers and monitoring requirements for wet weather overflow events.

The Swan Creek CSO area is controlled by three main tunnel systems, and because of this the frequency, duration, and volume of CSO events are lower than those observed in the Maumee River and Ottawa River (LTCP, unpublished). The tunnels were constructed as part of CSO control phases 3 through 7 and have a total length of 12,915 feet. The total storage volume for the tunnel system is 13.83 million gallons (LTCP, unpublished).

Simulations of the Swan Creek system performance based on the 2003 collection system conditions and operations indicate that a total of 11 CSO discharge events occur per year. These events were simulated to last 126 hours/year producing an overflow volume of 86 million gallons/year (LTCP, unpublished). Based on the same simulated data, wet weather events produce a total combined sewer volume of 938 million gallons/year in the Swan Creek watershed, 90.8 percent of which is sent to the Bay View WWTP for treatment (LTCP, unpublished). Table 4-1 and Figure 4-2 present additional information and outfall locations for the CSOs present in the Swan Creek watershed.

Table 4-1 CSO outfalls in the Swan Creek Watershed.

City of Toledo CSO Outfall #	Outfall Name	Outfall Location	Downstream TMDL Stations
050	Highland[1]	Fearing St. in Highland Park	P11P05, P11P03, P11K07
069	Swan Creek South Tunnel[2]	Northeast of Champion and Walbridge	P11P03, P11K07
048	Hillside[1]	Hillside and Chester St.	P11P03, P11K07
047	Junction[1]	Pere West, East of Gibbons St.	P11P03, P11K07
046	Hawley[1]	Hawley St., South of Bridge	P11P03, P11K07
045	Ewing[1]	Ewing St. and Hamilton	P11P03, P11K07
043	Hamilton/Swan Creek North Tunnel[3]	Hamilton and Anthony Wayne Trail	P11K07
042	Erie[1]	Erie St., South of Hamilton	P11K07

[1]Denotes an outfall that is a CSO overflow or regulator discharge point.
[2]Denotes an outfall that is a tunnel overflow.
[3]Denotes an outfall that is both a CSO overflow and a tunnel overflow.

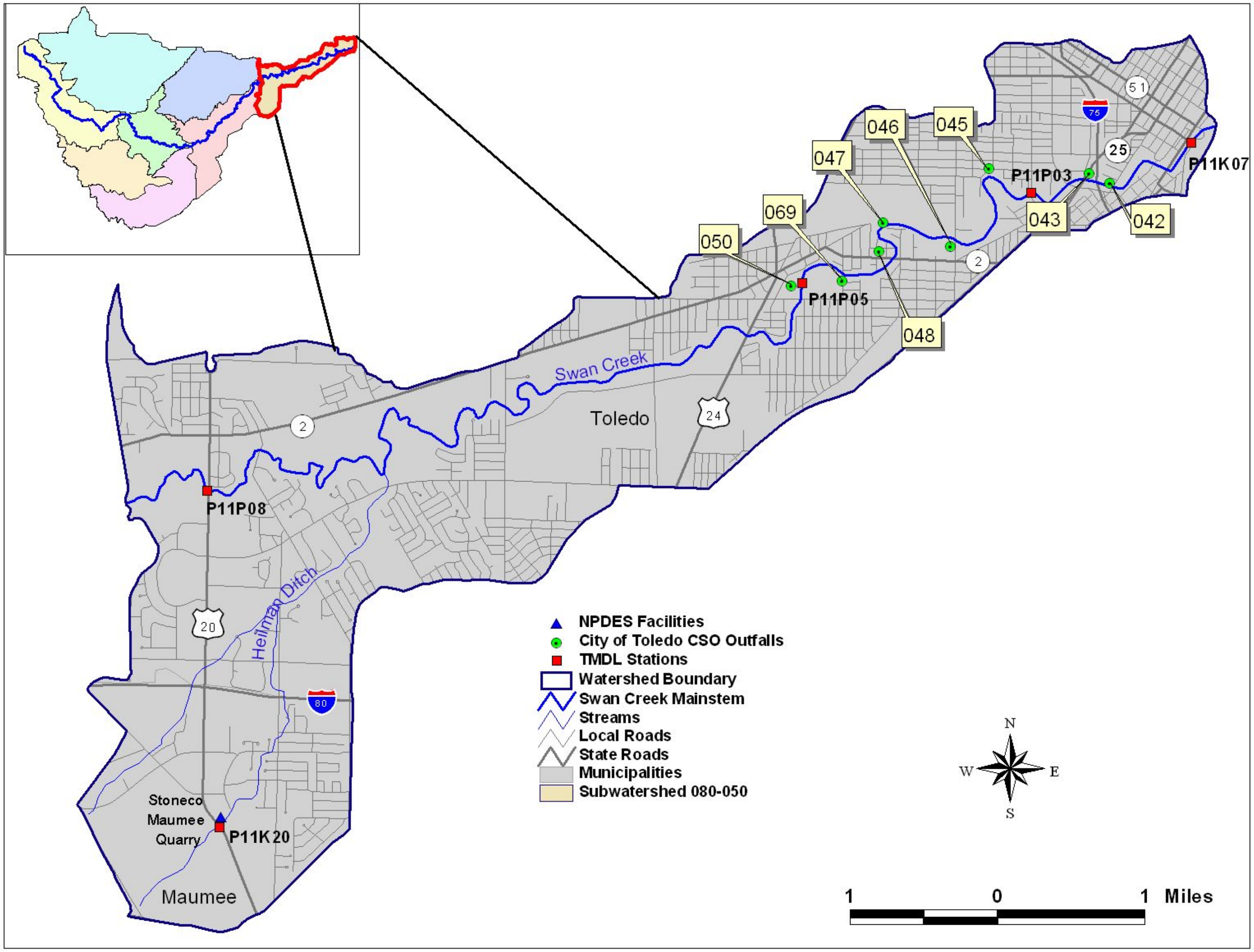


Figure 4-2 City of Toledo CSO outfall locations.

4.1.3 Municipal Separate Storm Sewer System (MS4)

MS4s carry storm water from "separate storm sewer systems" directly to bodies of water. Separate storm sewer systems include ditches, curbs, gutters, storm sewers, and other conveyances of runoff. These systems do not connect to wastewater collection systems or treatment plants. Storm water can transport oil, grease, pesticides, herbicides, dirt and grit that have the potential to reduce water quality.

EPA's storm water program requires municipalities to obtain storm water permits and addressed storm water in two phases: Phase I covered large (serving populations > 250,000) and medium (100,000 to 250,000) MS4s and Phase II addressed small (< 100,000) MS4s. There is one Phase I MS4 and ten Phase II MS4s located partially or completely within the Swan Creek watershed. Seven of the Phase II MS4s (Lucas County, Monclova Township, Spencer Township, Springfield Township, Waterville Township, the Village of Holland, and the Village of Waterville) are on one permit, and the other three Phase II MS4s have individual permits. Table 4-2 lists all of the Phase I and Phase II MS4s in the Swan Creek watershed. All Phase II MS4s are regulated under the Small MS4 general permit.

Table 4-2 MS4s in the Swan Creek watershed.

MS4 Type	MS4	Permit #
Phase I	City of Toledo	2PI00003*BD
Phase II	Lucas County*	OHQ000001
	Monclova Township*	
	Spencer Township*	
	Springfield Township*	
	Waterville Township*	
	Village of Holland*	
	Village of Waterville*	
	City of Maumee	OHQ000001
	Ohio Department of Transportation	OHQ000001
	Ohio Turnpike	OHQ000001

*All 7 of these MS4s are co-permittees and are regulated under the same permit.

There are no maps currently developed showing specific MS4 area delineation or outfall locations. However, MS4 drainage areas usually are contained within urbanized areas as delineated by the U.S. Census Bureau. Figure 4-3 shows the urbanized areas as well as municipalities within the Swan Creek watershed. MS4 drainage areas are contained within the urbanized areas shown below.

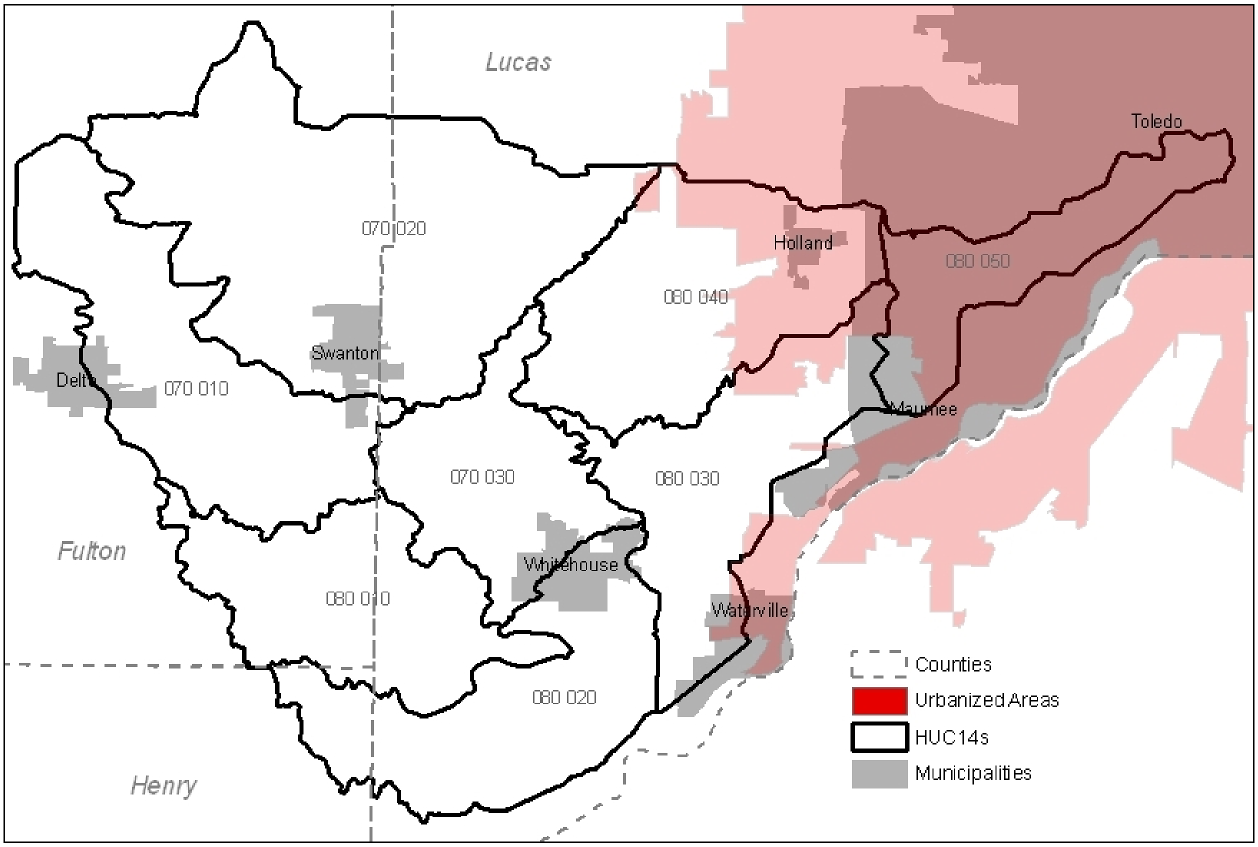


Figure 4-3 Urbanized areas and municipalities in the Swan Creek watershed.

4.1.4 Concentrated Animal Feeding Operations (CAFOs)

The removal and disposal of the manure, litter, or processed wastewater that is generated as the result of concentrated animal feeding operations falls under the regulations for concentrated animal feeding operations (CAFOs). Ohio EPA issues both general and individual NPDES permits to CAFOs. U.S. EPA regulations require that these facilities receive a WLA as part of the TMDL development process. The WLA is set at zero for all pollutants based on Ohio EPA regulations requiring that CAFOs not add or contribute to a violation of water quality standards. However, there are no CAFOs located within the Swan Creek watershed and therefore no WLAs for CAFOs will be included in TMDL development.

4.2 Nonpoint Sources

This section of the report presents information on the sources within the Swan Creek watershed that are not regulated through the NPDES Program. These sources are commonly called "nonpoint sources".

4.2.1 Home Sewage Treatment Systems

Another source of bacteria and nutrient impairment in the Swan Creek watershed comes from human waste. Unsewered areas with failing or poorly maintained home sewage treatment systems are of concern as untreated sanitary wastewater from rural residential areas and/or small businesses is discharged directly or indirectly into streams. There are several small rural areas outside of the City of Toledo limits that do not have a centralized wastewater collection and treatment facility (TMACOG, 2001). These areas rely on septic tanks, leaching fields, or sub-surface sand filters for sewage treatment. If these systems are not properly designed, installed, and maintained they have the potential to significantly impact local water quality with excessive nutrient and bacteria loads causing algal blooms, strong odors, and/or aquatic life impairments. Furthermore, home sewage treatment system malfunctions can pose a danger to human health when they contaminate drinking water supplies, wells and fishing and swimming areas.

Table 4-3 below provides estimates for home sewage treatment systems in the counties surrounding the Swan Creek watershed and also for the Lower Maumee River 8-digit HUC unit (04100009). Henry County is not included because it makes up a relatively small portion of the watershed (less than 3 percent of the total watershed area is covered by Henry County).

Table 4-3 Home sewage treatment system (HSTS) data for counties within the Swan Creek watershed.

County	Total Number of HSTS in County	# of HSTS in 04100009 8-Digit HUC	# of People Served by Each System	Estimated Population Served by HSTS
Fulton	6,814	3,125	2.73	8,531
Lucas	13,635	6,738	2.42	16, 305

4.2.2 Livestock Population

Though they are not listed as a high magnitude source of impairment in Swan Creek, livestock populations are also potential sources of bacteria and nutrients. Watershed specific data are not available for livestock populations in Swan Creek. However, county wide statistics are available from the National Agricultural Statistic Service (NASS, 2008). Table 4-4 details the county statistics for all available cattle and hogs/pigs data from 2005 to 2008 and Table 4-5 displays the proportion of each county that the Swan Creek watershed covers.

Table 4-4 Livestock data for Fulton, Henry, and Lucas Counties.

County	Commodity (values in head)						
	All Cattle (2005)	All Cattle (2006)	All Cattle (2007)	All Cattle (2008)	Hogs & Pigs (2005)	Hogs & Pigs (2006)	Hogs & Pigs (2007)
Fulton	19,700	20,300	20,500	20,000	55,600	57,600	62,500
Henry	5,100	5,600	5,600	5,800	9,800	9,300	10,200
Lucas	1,100	1,000	1,000	1,000	9,500	8,000	8,500

Table 4-5 Proportion of each county area within the Swan Creek watershed.

County	Total County Area (acres)	Area of Swan Creek Within County (acres)	Percentage of:	
			County Covered by Watershed	Watershed Area Within County
Fulton	260,213	48,441	18.6%	37.1%
Henry	276,875	3,293	1.2%	2.5%
Lucas	218,051	78,700	36.1%	60.4%

4.2.3 Wildlife

Wildlife such as deer, geese, and ducks can also be sources of bacteria and nutrients. Deer population data are sometimes used as surrogates for estimating wildlife populations but no Ohio county deer population data are available. The 2006 Ohio Department of Natural Resources white-tail deer status report indicates that the 2006 state-wide population was expected to be around 600,000 deer (ODNR, 2007). While white-tail deer are found in all 88 Ohio counties, population abundance is low to intermediate in the glaciated counties of northwest Ohio (ODNR, 2007).

4.2.4 Agricultural Runoff

The Swan Creek watershed land cover consists of over 104 square miles of cultivated crops, or nearly 67,000 acres (Section 1.2). During wet weather events (snowmelt and rainfall), pollutants are incorporated into runoff and can be delivered directly to adjacent water bodies. If proper best management practices are not in place to prevent this from happening, these agricultural areas can have significant impacts on water quality. The main pollutants of concern associated with agricultural runoff include sediment, nutrients, pathogens, and pesticides.

These agricultural areas are concentrated in particular subwatersheds throughout Swan Creek, and practically absent in others (Table 1-4 and Table 1-5). The water bodies most likely to be affected by agricultural runoff include Blystone Ditch, Harris Ditch, Cairl Creek, portions of Wolf Creek, Blue Creek, Fewless Creek, and the Swan Creek mainstem in HUC 14 subwatersheds -080-030 and -070-010.

4.2.5 Contaminated Sediments

Stream sediment contamination is thought to be caused by legacy pollutants in Swan Creek. Historic (and unregulated) discharges from industrial facilities and other pollutants from historic CSO discharges are noted sources (TMACOG, 2001). Recent sampling indicates that stream sediment contamination may be improving as a result of the elimination or reduction of numerous pollutant sources throughout the watershed such as CSOs, dumps, landfills, and uncontrolled waste sites (TMACOG, 2001). Additional detailed information on contaminated sediments in the Swan Creek watershed can be found in the Maumee RAP's *Swan Creek Watershed Plan of Action* (TMACOG, 2001).

4.2.6 Golf Courses

Five golf courses were identified within the Swan Creek watershed. The location and additional details for each golf course are provided below.

Valleywood Golf Club, 13502 Airport Hwy, Swanton, OH: This golf course is adjacent to Ai Creek just north of SR-2 at intersection with SR-64 in HUC 14 subwatershed -070-020. The Scott Rd. bridge site for P11K17 is on the outer edge of the golf course after Ai Creek flows directly through most of the golf course. Sample site P11W15 is a little further downstream of the golf course, just upstream of the confluence with Swan Creek.

White Pines Golf Course, County Road 2, Swanton, OH: This golf course is directly adjacent to the northern bank of Blue Creek in HUC 14 subwatershed -080-010. Sample station P11K11 is just upstream of the golf course and sample station P11P39 is further downstream of the facility.

Fallen Timbers Fairways Golf, 7711 Timbers Blvd, Waterville, OH: This golf course lies partially in the southern portion of HUC 14 subwatershed -080-030. Blystone Ditch flows just to the north and west of this housing development/golf course, located upstream of sample site P11A03.

Heather Downs Country Club, 3910 Heatherdowns Blvd, Toledo, OH: Portions of the course are within HUC 14 subwatershed -080-050, just south of the confluence of Heilman Ditch and Swan Creek. Sample station P11K20 on Heilman Ditch is upstream of this course and the nearest downstream station is well downstream on Swan Creek at P11P05.

Brandywine Country Club, 6904 Salisbury Road, Maumee, OH: The country club lies in the northeast corner of HUC 14 subwatershed -080 030. Swan Creek flows through the eastern 9 holes of this 18 hole golf course/housing community, immediately downstream of the Salisbury Road sample site P11P09.

5 TECHNICAL APPROACH AND LINKAGE ANALYSIS

An essential component of developing a TMDL is establishing a relationship between the source loadings and the resulting water quality. Key parameters have been discussed in Section 3 and potential point and nonpoint sources have been inventoried in Section 4. The purpose of this section is to evaluate which of the various potential sources is contributing to the observed water quality impairments.

Because portions of the Swan Creek watershed are in the Maumee River Area of Concern (AOC), efforts related to water quality in the Maumee Remedial Action Plan (RAP) were also considered in the linkage analysis. For example, the Swan Creek Plan of Action was created to guide restoration and preservation efforts in Swan Creek and its tributaries. The Plan of Action identifies priority concerns throughout the watershed that include:

Highest Priority
- Wetlands & Floodplains
- Home Sewage Disposal
- Land Use and Zoning
- Agricultural Runoff

High Priority
- Contaminated Stream Sediments
- Package Plants

Moderate Priority
- Atmospheric Deposition
- Combined Sewer Overflows
- Dumps, Landfills, & Uncontrolled Waste Sites
- Wastewater Treatment Plant Sludge

A matrix connecting major pollutant groups to corresponding sources of interest is provided in Table 5-1. Source types are divided between point and nonpoint as a logical place to start the linkage analysis discussion.

Table 5-1 Swan Creek sources and corresponding pollutants of interest.

Source Type or Concern		TSS	Nutrients	Bacteria	Other
Point	Wastewater Treatment Plants		XX	XX	XX
	Package Plants		XX	XX	
	Industrial Discharges				XX
	Combined Sewer Overflows		XX	XX	XX
	MS4 Storm Water	XX	XX	XX	XX
Non-Point	On-site Wastewater Systems / Home Sewage Disposal		XX	XX	
	Agricultural Runoff *(cropland)*	XX	XX		
	Livestock		XX	XX	
	Background & Wildlife			XX	
	Wetlands & Floodplains	XX			
	Land Use	XX	XX	XX	XX
	Dumps, Landfills, & Uncontrolled Waste sites				XX
	Wastewater Treatment Plant Sludge				XX

Each group of pollutants listed in Table 5-1 exhibits a different set of characteristics. Sediment, for instance, is closely connected to hydrology and erosion processes. Bacteria, on the other hand, are microorganisms largely the result of wastes from warm-blooded animals. Nutrients bring in yet another set of factors to be considered. When different source categories are incorporated into the overall assessment, timing and delivery mechanisms become an important part of the linkage analysis.

The linkage analysis is structured so that the range of factors uniquely affecting each pollutant group is acknowledged. In the case of sediment, for example, the water quality assessment highlights the importance of land use and hydrology. Thus, the portion of the linkage analysis addressing TSS concerns starts with a review of concentration patterns by subwatershed. Information is presented using the drainage area profile format shown in the water quality assessment section (Figure 3-4). The discussion transitions into the role of erosion processes, channel morphology, floodplain management, and riparian management relative to siltation concerns. Technical analyses are presented for TSS in Swan Creek and other northwest Ohio information in a way that emphasizes the connection between sediment and hydrology.

The linkage analysis for bacteria, like TSS, builds on patterns identified in the water quality assessment section. Watershed size appears to be an important consideration in the observed patterns of bacteria conditions. The linkage analysis looks at in-stream loads using the drainage area profile format, both in the tributaries and along the mainstem. Because of the range of bacteria sources (failing home sewage treatment systems, package plants, urban storm water, CSOs, livestock), the role of hydrology as a delivery mechanism is assessed. In particular, unit area duration curves are utilized. This enables a comparison of loading patterns from sites that represent different drainage areas in terms of dry weather problems and storm water related concerns.

The linkage analysis for other pollutants takes advantage of information and techniques presented for TSS and bacteria. In some instances, the pollutants are closely tied to sediment. Heavy metals, priority organics, and phosphorus from certain types of sources are examples. In such situations, control of sediment and runoff volume will also reduce loads delivered to Swan Creek associated with these pollutants. In other cases, linkage patterns are identified using the duration curve framework. This approach highlights important connections that can help guide post-TMDL implementation efforts.

5.1 Total Suspended Solids

Biological assessments in the Swan Creek watershed conducted as part of the Ohio EPA survey highlight sedimentation and siltation concerns at many sites. Water column indicators used to assess potential siltation issues typically focus on either suspended sediment concentration (SSC) or TSS. The data summarized in the water quality assessment section depict general TSS patterns based on the Ohio EPA survey information. Figure 5-1 provides another longitudinal profile of the TSS data, similar to Figure 3-4 except that Ai Creek is displayed as the headwater area.

This approach is taken for several reasons. First, the drainage area of the Ai subwatershed is actually greater than upper Swan Creek above Ai Creek. Second, as noted in the water quality assessment section, the proportion of developed land within each subwatershed may affect TSS concentrations. This perspective appears to indicate that Ai Creek has a major influence on the TSS profile of the Middle Swan mainstem. TSS patterns in Wolf Creek (closer to Toledo) are also higher than the more rural tributaries (e.g., upper Swan and Blue Creeks).

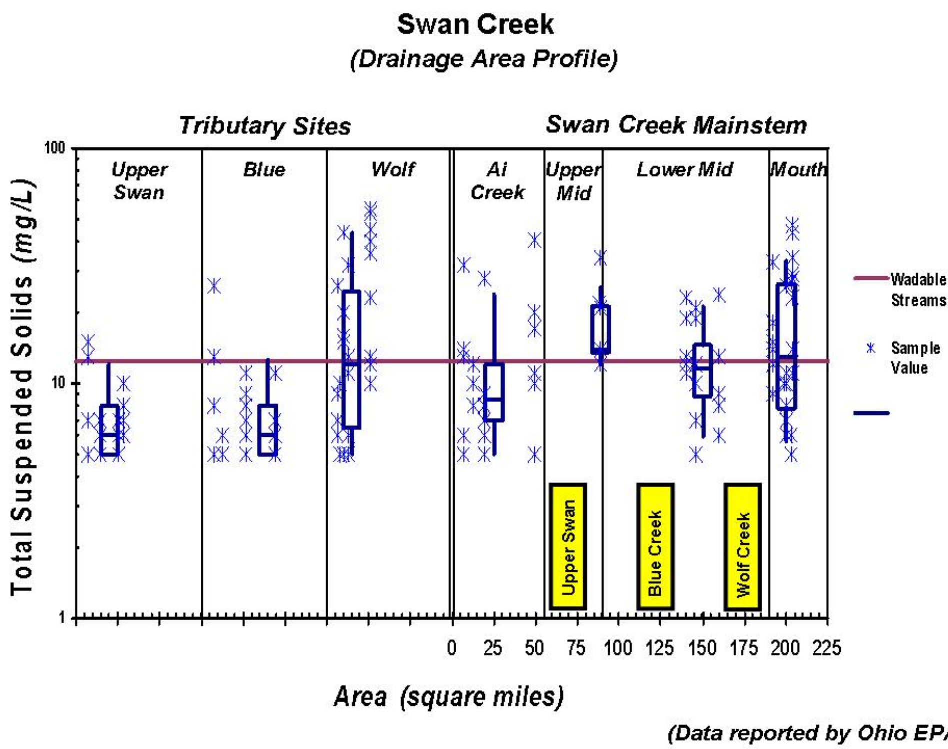


Figure 5-1 Drainage area profile of Swan Creek TSS concentrations.

Developing a linkage analysis to address the connection between siltation and its effect on aquatic life uses often involves an evaluation of multiple factors. The interaction between erosion processes and hydrology is an important part of the assessment. Land use, riparian areas, and channel condition are key considerations. Each can play a potential role in both creating and solving sediment problems. As pointed out in other Ohio TMDL work, a stream becomes impaired when its capacity to handle stressors is exceeded. This occurs when external inputs (e.g., sediment, runoff volume) to the stream become excessive, or when stream characteristics are altered so that it can no longer assimilate these stresses, or a combination of both occur.

5.1.1 QHEI Scores

Ohio's Qualitative Habitat Evaluation Index (QHEI) is a tool used to assess stream habitat quality. QHEI is composed of six principal habitat categories, or metrics. Several of these metrics relate directly to factors considered in a siltation linkage analysis that include:

- ✓ Substrate type and quality
- ✓ Stream channel morphology and condition
- ✓ Riparian zone quality and bank erosion

QHEI scores reported from the 2006 survey (Figure 5-2) can help inform development of a meaningful linkage analysis that addresses sedimentation concerns. Physical observations provide strong evidence that habitat degradation is a significant source of multiple stressors to biological communities in the Swan Creek watershed. Physical habitat data collected indicate high levels of sediment, silt, and embeddedness are evident at many sites. Channelization is also a problem in certain areas, as is bank erosion.

Based on the Ohio EPA's general narrative values (Table 2-6) the headwater sites rated very poor to good and the larger stream sites also rated very poor to good. The total QHEI scores for all headwater sites ranged from 23.0 to 41.5 with an average score of 38 points (Table 5-2). Samples taken at sites with larger drainage areas ranged from 24.0 to 74.5 points and averaged 44 points.

The individual QHEI metric scores reflect the severity of specific habitat impairments and provide additional insight into the nature of the impairment. At all QHEI sites in the Swan Creek watershed, 21 of the 28 substrate metric scores were 1.0 point or lower (out of a possible 20 points) and only 3 sites scored above 10 points. All headwater channel metric scores were less than 12.5 points out of 20 possible points and all headwater sites but one received riffle/run metric scores of zero (out of 8). Larger stream sites received slightly higher channel scores of 5.0 to 16.0 points, though only three larger stream sites scored above 0 points for the riffle/run metric.

These low metric scores indicate homogenized stream substrates dominated by sand and finer sized particles, channelized streams with low/no sinuosity, shallow/embedded riffles, and overall system instability. With such severe and widespread habitat impairments, Swan Creek is unlikely to support healthy and diverse aquatic communities, as was demonstrated by the 2006 biological sampling data. Only four of the 26 biological sampling sites (with fish and macroinvertebrate samples) fully attained their designated uses.

These observations support high priority concerns identified in the Swan Creek Plan of Action that relate to potential sediment problems, notably land use, floodplains, and wetlands. The role of floodplains and land use in contributing to potential water quality problems was also highlighted in two other recent Ohio EPA TMDLs in the Columbus area: Big Darby Creek and the Olentangy watershed (Ohio EPA, 2007; 2008).

Table 5-2 2006 QHEI and metric score summary for Swan Creek.

Stream Location	RM	Drainage Area	QHEI Total (100 max)	QHEI Metrics (Maximum Score)						
				Substrate (20)	Cover (20)	Channel (20)	Riparian (10)	Pool/Current (12)	Riffle/Run (8)	Gradient (10)
Ai Creek	1.7	49.3	26.5	1.0	6.0	5.0	4.5	4.0	0.0	6.0
Ai Creek	2.1	19.5	30.0	1.0	4.0	8.0	3.0	8.0	0.0	6.0
Ai Creek	8.3	12.5	49.0	1.0	10.0	12.0	3.5	10.0	2.5	10.0
Ai Creek	10.5	6.8	26.5	1.0	3.0	8.5	4.0	6.0	0.0	4.0
Fewless Creek	1.8	5.9	24.0	1.5	5.0	5.5	2.0	4.0	0.0	6.0
Swan Creek	24.7	89.0	40.0	1.0	8.0	11.0	6.0	8.0	0.0	6.0
Swan Creek	30.9	28.2	43.5	1.0	8.0	9.0	6.0	11.0	2.5	6.0
Swan Creek	32.9	25.7	44.5	1.0	9.0	12.5	7.0	9.0	0.0	6.0
Swan Creek	34.4	14.6	44.5	1.0	8.0	10.0	4.5	11.0	0.0	10.0
Swan Creek	40.7	6.5	48.0	6.0	8.0	11.0	7.0	8.0	0.0	8.0
Blue Creek	0.8	44.5	29.0	1.0	4.0	10.5	3.5	4.0	0.0	6.0
Blue Creek	5.5	27.0	24.0	1.0	3.0	6.0	4.0	4.0	0.0	6.0
Blue Creek	7.8	12.7	37.5	1.0	11.0	7.5	4.0	10.0	0.0	4.0
Blue Creek	10.0	6.7	29.5	1.0	8.0	5.0	3.5	8.0	0.0	4.0
Blystone Ditch	0.6	6.5	46.0	1.0	11.0	11.0	7.0	8.0	0.0	8.0
Cairl Creek	1.3	10.3	35.5	1.0	4.0	12.5	4.0	4.0	0.0	10.0
Harris Ditch	1.6	7.5	28.5	1.0	8.0	5.5	4.0	6.0	0.0	4.0
Swan Creek	1.4	202.0	34.0	1.0	7.0	11.0	3.0	8.0	0.0	4.0
Swan Creek	4.2	200.0	74.5	16.0	15.0	12.5	4.0	12.0	7.0	8.0
Swan Creek	4.4	200.0	43.5	7.0	14.0	6.0	4.5	8.0	0.0	4.0
Swan Creek	10.8	192.0	63.0	11.0	14.0	13.5	6.5	10.0	0.0	8.0
Swan Creek	15.3	160.0	38.0	-1.5	8.0	13.5	3.0	9.0	0.0	6.0
Swan Creek	18.5	146.0	66.5	14.5	10.0	16.0	6.0	8.0	6.0	6.0
Swan Creek	21.6	140.0	41.0	1.0	6.0	13.5	5.5	9.0	0.0	6.0
Wolf Creek	0.5	26.1	45.0	1.0	8.0	12.5	4.5	9.0	0.0	10.0
Wolf Creek	0.5	26.1	43.5	0.5	13.0	8.0	4.0	8.0	0.0	10.0
Wolf Creek	2.0	12.9	40.0	1.0	13.0	6.0	6.0	8.0	0.0	6.0
Wolf Creek	4.1	7.9	45.0	5.0	13.0	11.0	4.0	6.0	0.0	6.0

*QHEI headwater sampling sites with drainage areas of < 20 mi^2.

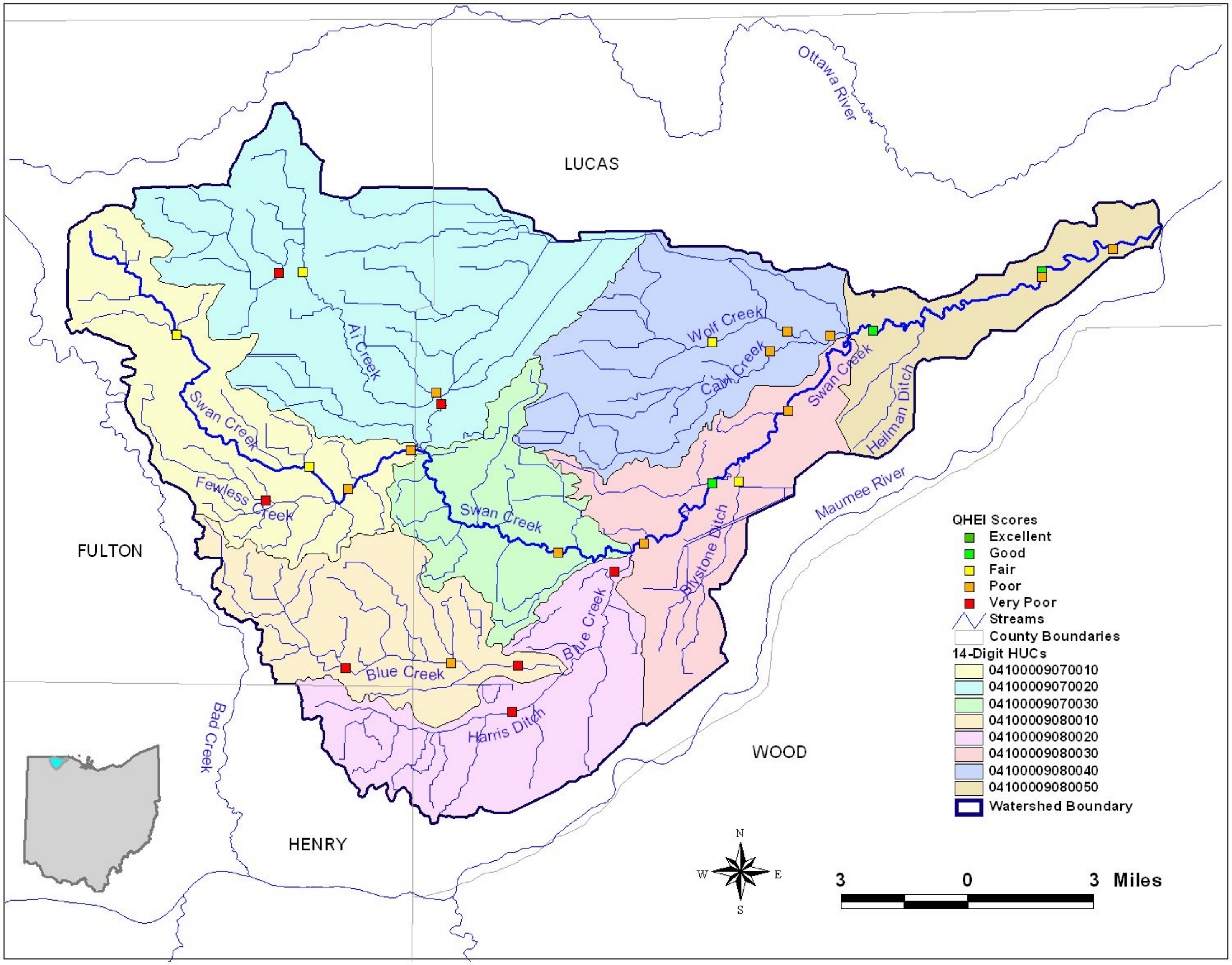


Figure 5-2 QHEI sample locations in the Swan Creek watershed.

5.1.2 Sediment and Hydrology

Degraded habitat can often be associated with water flow and sediment dynamics being out of balance. This may result from land use activities that either alter flow regimes, adversely affect the floodplain and streamside riparian areas, or a combination of both. Hydrology is a major driver for both upland and stream channel erosion. Consequently, the role of high water flows should be examined as it relates to the delivery and transport of sediment in the Swan Creek watershed (Figure 5-3).

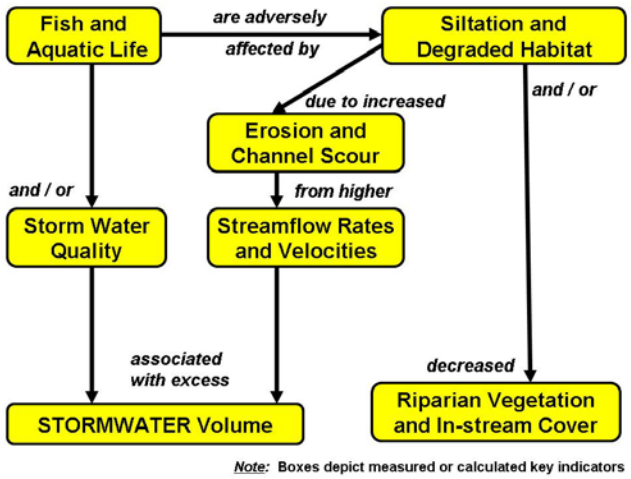


Figure 5-3 Relationship of biological impairments to habitat and hydrology.

The potential influence of hydrology on TSS concentrations and loads in the Swan Creek watershed can be examined in several ways. Figure 5-4 is a longitudinal profile of TSS loads along the mainstem of Swan Creek for the June 12-13 sample event (using Ai Creek as the headwater area). The solid line represents the TSS loading capacity using the 12.5 mg/L target for wadeable streams. The stream flow for the Ottawa River corresponding to the sample event was between 29 and 34 cfs; basically stable, dry conditions. Figure 5-5 is a longitudinal profile of TSS loads along the mainstem for the same stations that corresponds with the June 26-27 sample event. The Ottawa River stream flow on these days was between 213 and 319 cfs; high flow and moist conditions.

The effect of flow conditions can be seen by comparing these two graphs. Under stable, dry flow conditions, TSS loads were very close to the loading capacity. However, under high flow and moist conditions, observed TSS loads in Swan Creek were above the loading capacity. The increased loads occur below Swanton. This supports the need to examine the effect of land use on observed TSS concentrations in Swan Creek.

Figure 5-6 and Figure 5-7 provide another view that highlights the potential role that hydrology and land use play in observed TSS concentrations. Both use the duration curve framework to show TSS patterns according to flow conditions. Figure 5-6 displays observed values for sites in the Upper Swan and Blue Creek subwatersheds. Land use affecting water quality at these sites is more rural in nature, predominantly cropland. TSS concentrations measured under moist and high flow conditions during the Ohio EPA survey were not significantly greater than those under stable, dry conditions. Most observations were below the TSS target for wadeable streams. Conversely, TSS concentrations in the Wolf Creek watershed were noticeably greater than those at the more rural sites. The greatest values seem to occur during high flow conditions. Again, land use that affects hydrology appears to also exert an influence on TSS concentrations in the Swan Creek watershed.

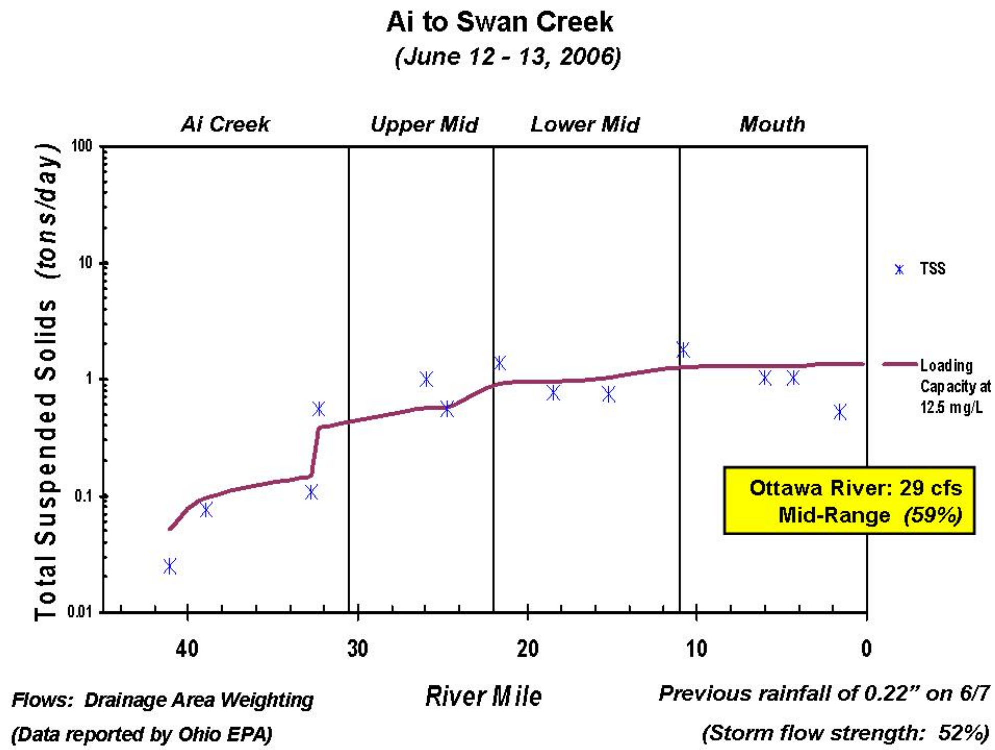


Figure 5-4 TSS loads along Swan Creek (June 12-13, 2006).

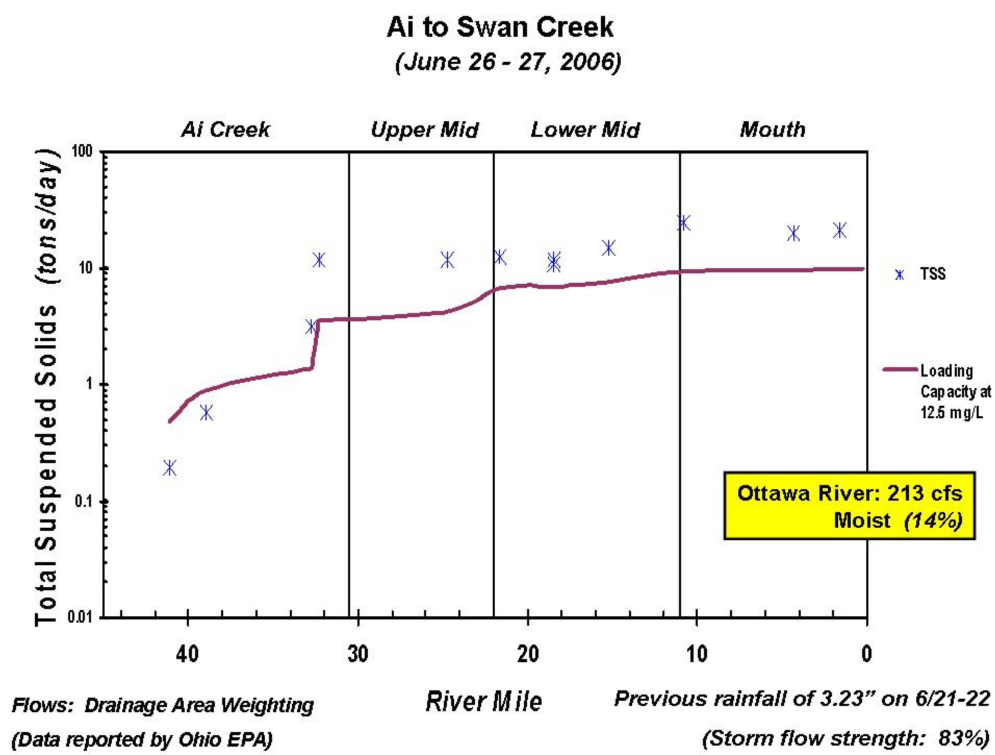


Figure 5-5 TSS loads along Swan Creek (June 26-27, 2006).

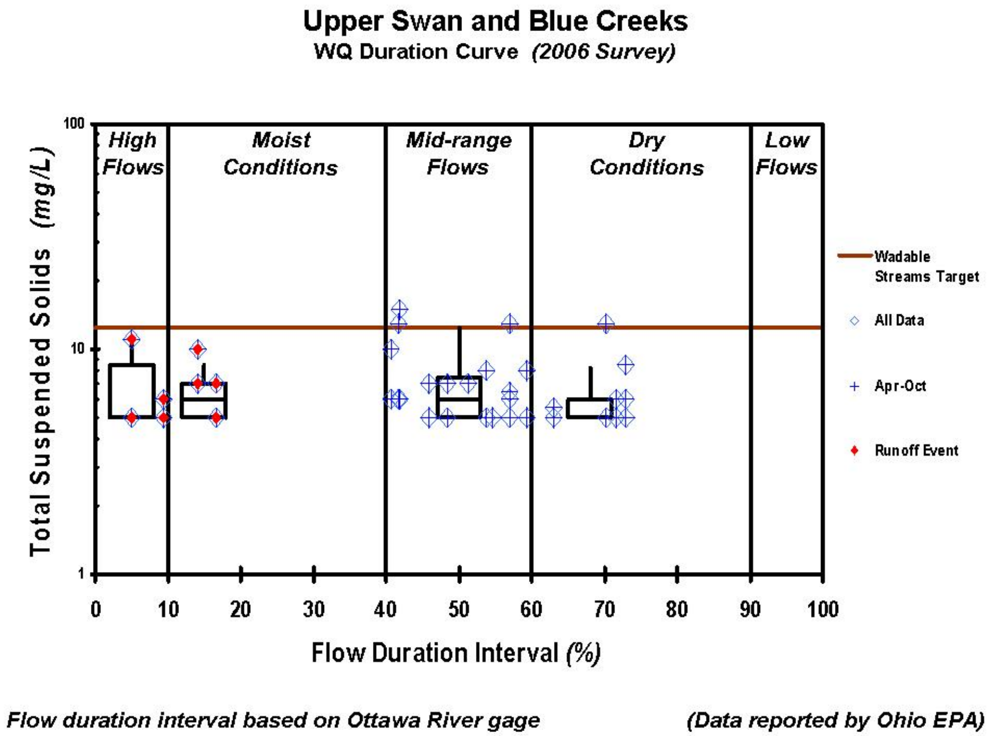


Figure 5-6 TSS concentrations by flow conditions in Upper Swan and Blue Creeks.

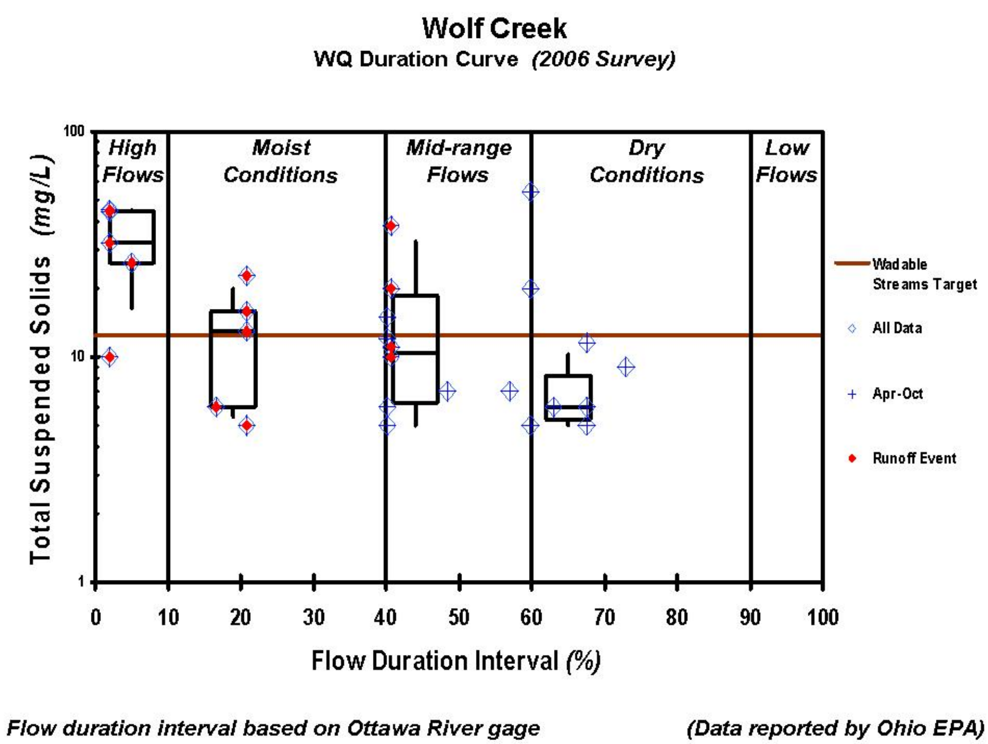


Figure 5-7 TSS concentrations by flow conditions in Wolf Creek.

5.1.3 Channel Morphology, Sediment, and Hydrology

Stream geomorphology pertains to the shape of stream channels and their associated floodplains. Other Ohio TMDLs have incorporated channel morphology into the technical analysis. For example, stream geomorphology and floodplain targets were incorporated into the Olentangy TMDL because they have a significant effect on habitat, water quality, and aquatic biological communities. As pointed out in the Olentangy TMDL, the capacity of a stream system to assimilate pollutants such as sediment, nutrients, and organic matter depends on features related to its geomorphology. This is especially the case for floodplains which, if connected to the channel, can store large quantities of sediment.

Several TMDLs developed in other states also recognize the importance of stream geomorphology and channel condition in addressing sediment concerns. A TMDL developed for Shades Creek near Birmingham, Alabama provides some logic that supports the importance channel dynamics. In this particular example, altered hydrology was a critical factor. Biological assessments and habitat studies concluded that increased water volumes and velocities within the channel adversely affected biological communities. Increased flows were attributable to nonpoint source runoff from existing development in the watershed. The role of channel processes and the effect of instability on physical habitat was a key part of the Shades Creek TMDL.

A conceptual model of channel evolution was used to characterize varying stages of channel modification through time, as illustrated in Figure 5-8 (Simon and Hupp, 1986). Stage I, undisturbed conditions, is followed by the construction phase *(Stage II)* where vegetation is removed and / or the channel is modified significantly (through altered hydrology, for example). Degradation *(Stage III)* follows and is characterized by channel incision.

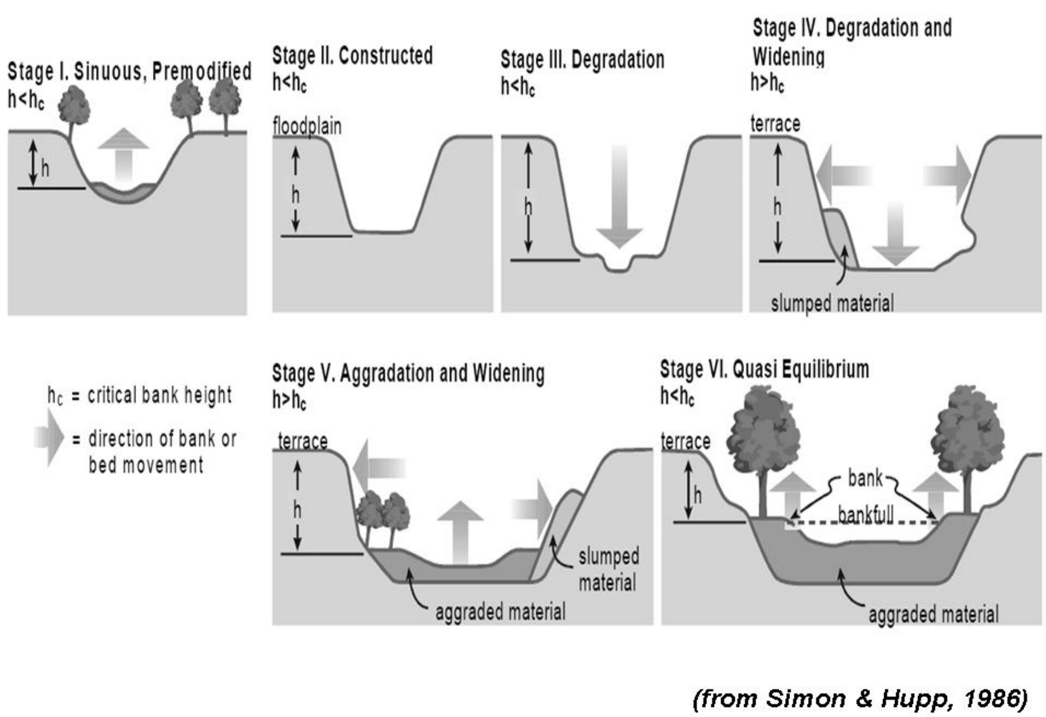


Figure 5-8 Channel evolution model.

Channel degradation leads to an increase in bank heights and angles, until critical conditions of the bank material are exceeded. Eventually, stream banks fail by mass wasting processes *(Stage IV)*. Sediments eroded from upstream degrading reaches and tributary streams are deposited along low gradient downstream segments. This process reflects channel aggradation and begins in Stage V. Aggradation continues until stability is achieved through a reduction in bank heights and bank angles. Stage VI (restabilization) is characterized by the relative migration of bank stability upslope, point-bar development, and incipient meandering. Stages I and VI represent two true *"reference"* or attainment conditions.

Physical habitat degradation is often indicated by stream reaches showing signs of channel instability. Increased levels of sand / silt often reflect channel evolution model stages IV and V (Figure 5-8). The Plan of Action provides information confirming this as a major concern in Swan Creek. It states: *"The middle reach is the area that lies between river miles 19 and 6. Here the creek is actively eroding its channel. The banks are high (35 to 45 feet or more) and unstable and are intermixed with detached floodplains. ... The major problems are urbanization with the filling in of the floodplains and destruction of wetland areas"*. Newer research (Grabarkiewicz and Crail, 2008) found that the stream channel between RM 19 and 15.3 maintained stable streambed substrates, low banks, and supported a diverse freshwater mussel community found nowhere else in the watershed.

Activities intended to address degraded habitat conditions should consider erosion processes that contribute to increased levels of measured sediment, as well as channel scour that transports it through the stream system. Efforts to address degraded habitat should also consider the role of riparian management, as well as the role that increased storm water runoff volumes and altered hydrology contribute to the problem.

5.1.4 Erosion Processes and Channel Scour

Most of the sediment supply that enters streams affected by siltation and degraded habitat is generated through erosion processes including:

- Bank erosion
- Surface erosion
- Gully erosion

Bank erosion is driven by channel stability, discharge volumes, and stream velocities, while surface and gully erosion result from excess watershed runoff. The selection of strategies to reduce sedimentation and siltation to streams should consider: 1) whether the channel condition is natural or modified, and 2) whether the major source of sediment is from bank erosion, upland sources, or a combination of both. Implementation of BMPs to reduce upland erosion without consideration of channel condition or other habitat limitations may not be sufficient to restore waterbodies (Ohio EPA, 1999). Reductions in upland erosion rates may be beneficial. However, this alone will be insufficient if bank erosion, riparian interactions, and hydrology are not concurrently addressed.

Because erosion and hydrology are connected, the timing of delivery and transport mechanisms is an extremely important consideration. The following sections briefly discuss each of the major erosion processes, as well as a framework for identifying potential measures to address water quality concerns for biologically impaired streams.

Bank Erosion & Channel Movement: Bank erosion is a natural process. Acceleration of this process, however, leads to a disproportionate sediment supply, channel instability, and aquatic habitat loss (Rosgen, 2006). Bank erosion processes are driven by two major components: streambank characteristics (e.g., erodibility) and hydraulic forces. Many land use activities affect both these components, which can lead to increased bank erosion. Riparian vegetation and floodplain protection provide internal bank strength. Bank strength can protect banks from fluvial entrainment and subsequent collapse. For instance, when riparian vegetation is changed from woody species to annual grasses, the internal strength is weakened, thus accelerating bank erosion processes.

Confronted by more frequent and severe floods that increase hydraulic forces, stream channels must respond. They typically increase their cross-sectional area to accommodate the higher flows. As described in Figure 5-8, this is done either through widening of the stream banks, down cutting of the stream bed, or frequently both. This phase of channel instability, in turn, triggers a cycle of stream bank erosion and habitat degradation, as seen in Figure 5-9.

Discharge flow rate is a major factor that affects sediment transport in stream systems. Higher discharge volumes lead to increased flow velocities, thus raising shear stress and stream power exerted on the channel bed and banks. This effect, combined with channel stability, determines the amount of sediment that is mobilized, which in turn influences habitat and aquatic biota. In Swan Creek, the Plan of Action has identified storm runoff and the erosive force of the stream itself as factors contributing to water quality problems. Streambed aggradation or degradation is often a response to channel instability. Because bank erosion is often a symptom of larger, more complex problems, long-term solutions often involve much more than bank stabilization.

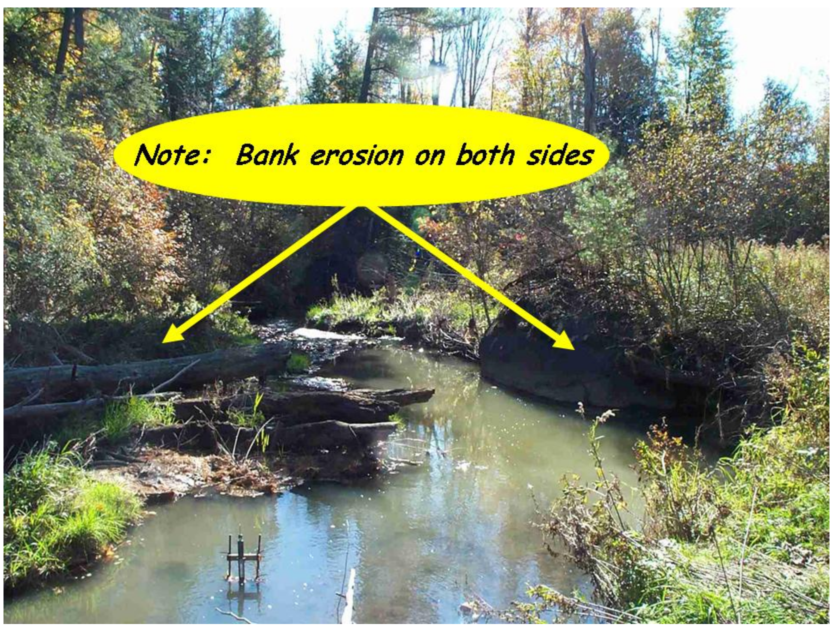


Figure 5-9 Example of Bank Erosion.

<u>Surface Erosion</u>: Excessive water runoff across a watershed can lead to detachment of soil particles. If the runoff volume is high enough and soils are exposed, surface erosion occurs. Surface erosion rates are affected by several factors including:

- soil type
- hill slope
- vegetative condition
- rainfall intensity

Surface runoff following rain events can be one of the most significant transport mechanisms of sediment, nutrients, bacteria, and other pollutants. Precipitation is the primary driving mechanism responsible for storm flows and associated surface runoff.

The use of basic hydrology and duration curves can help provide a method to examine general watershed response patterns regarding surface runoff and storm water. Streamflow hydrographs can be separated into base flow and surface runoff components (Sloto and Crouse, 1996). The base-flow component is traditionally associated with ground water. The surface-runoff component is associated with precipitation that enters the stream as overland flow; the primary driver of sediment delivered through surface erosion. Information from hydrograph separation can be used in a duration curve framework to evaluate effects of either the base flow or surface runoff components.

Figure 5-10 provides an example *"storm flow"* duration curve for the Ottawa River gage using hydrograph separation. The information is derived by subtracting the base flow estimate (which reflects the effect of ground water) from the total recorded flow. The resultant value represents an estimate of surface runoff. This duration curve can be used as an initial estimate to describe the frequency and magnitude of tributary storm flows and surface erosion to Swan Creek.

In this case, information from hydrograph separation is displayed as a fraction analysis using duration curve intervals to examine the percentage (or fraction) of total flow that consists of storm flow. Figure 5-10 illustrates the potential effect that storm flows may exert across the range of flow conditions, grouped by duration curve zone using data for the Ottawa River. In the case of Figure 5-10, surface runoff has its greatest effect on the Ottawa River during high flow conditions (median value of 69 percent). Correspondingly, sediment delivered to stream systems as a result of surface erosion will also be greatest during high flows.

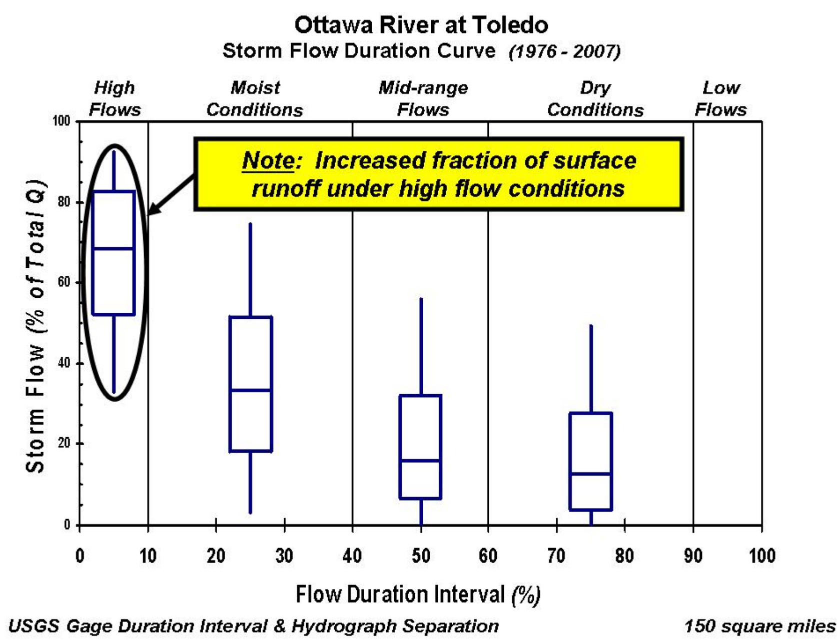


Figure 5-10 *"Storm flow"* duration curve for Ottawa River.

Gully Erosion: Gullies are relatively steep-sided watercourses, which experience ephemeral flows during heavy or extended rainfall. Gully erosion is caused when runoff concentrates and flows at a velocity sufficient to detach and transport soil particles. Widening of gully sides subsequently occurs by slumping and mass movement. Runoff may also enter a gully from the sides, causing secondary gullies or branching. Gully development associated with concentrated flow is evident in numerous streams around the country. Like surface erosion, sediment from gullied areas is delivered to stream systems during high flow conditions.

Gully formation may be triggered by land use changes, such as vegetation removal or by construction of new commercial / residential areas. Gully erosion is an important factor when considering upland sources, particularly where the delivery path is connected to small tributary streams or ditches. Riparian conditions adjacent to larger streams and in floodplains are also important. The development of rills and gullies can create direct paths, which *"short circuit"* the sediment and nutrient interception function of riparian zones.

5.1.5 Timing

An important aspect in the development of a framework to address the control of sediment sources is the timing of delivery and transport mechanisms. Duration curve analysis is a useful way to look at storm water and its effects on water quality. As discussed earlier, the analysis provides a hydrology-based context for examining and interpreting water quality data, allowing consideration of the full range of flows. Duration curves present water quality data in a way that characterizes concerns and describes patterns associated with impairments.

Several figures have already been presented that display the 2006 Ohio EPA survey data in a duration curve framework (Figure 3-13, Figure 5-6, and Figure 5-7). Another 2006 survey on Berger Ditch, also in the Toledo area, collected suspended sediment (SSC) data. This effort, conducted by the USGS, benefited from the presence of a flow gage. Samples were collected at frequent intervals, both during stable flow conditions and storm events, and the data confirm that sediment concentrations are significantly higher during high flow periods (Figure 5-11). This supports the strong connection between hydrology, sediment, and the importance of storm water.

A duration curve analysis (Figure 5-12) was developed using data from the Portage River watershed using a much longer period of record. Again, the intent is to look at patterns between in-stream sediment and flow conditions. This is a moderately larger drainage using historic data in the vicinity of the greater Toledo area. Figure 5-12 shows that SSC concentrations increase significantly in the high flow zone (i.e. the upper ten percent of all daily average flows).

When looking at the water quality monitoring data in terms of loads, the increase of sediment is even more dramatic in the high flow zone (Figure 5-13). This is consistent with the discussion on sediment supply (i.e., erosion processes exert the greatest effect on these waters under high flow conditions). Thus, the relationship between stream flow and sediment in northwest Ohio streams can be significant. Although the information was collected years ago, it provides an indication of basic flow and sediment patterns in northwest Ohio that continue to be relevant. Efforts to reduce peak flows will decrease sediment loads, in turn improving QHEI and bioassessment scores.

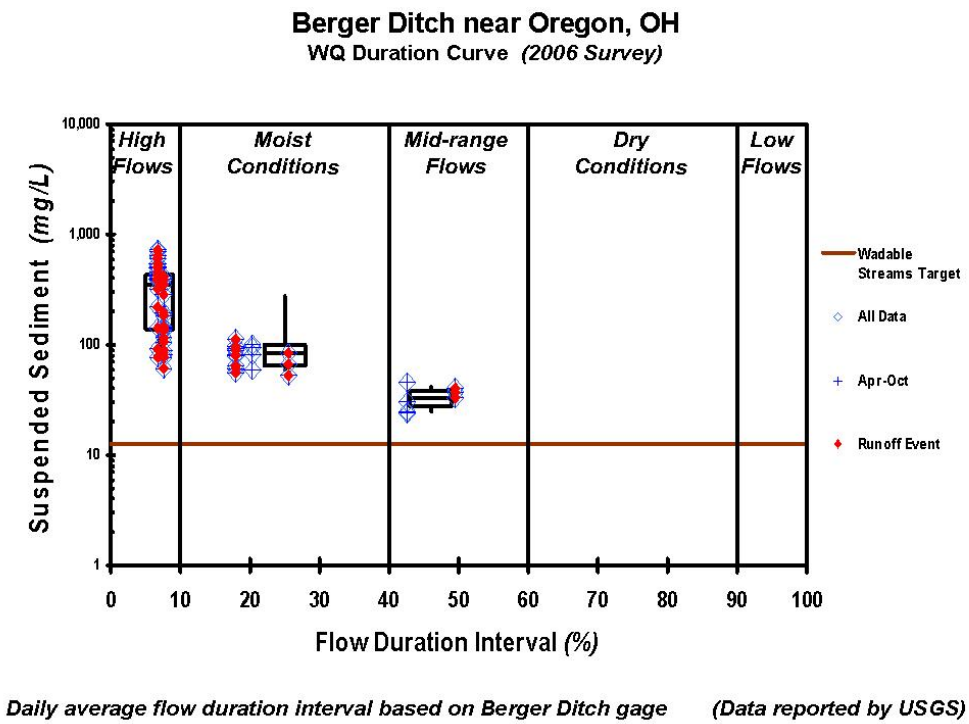


Figure 5-11 Water Quality Duration Curve Analysis -- Berger Ditch.

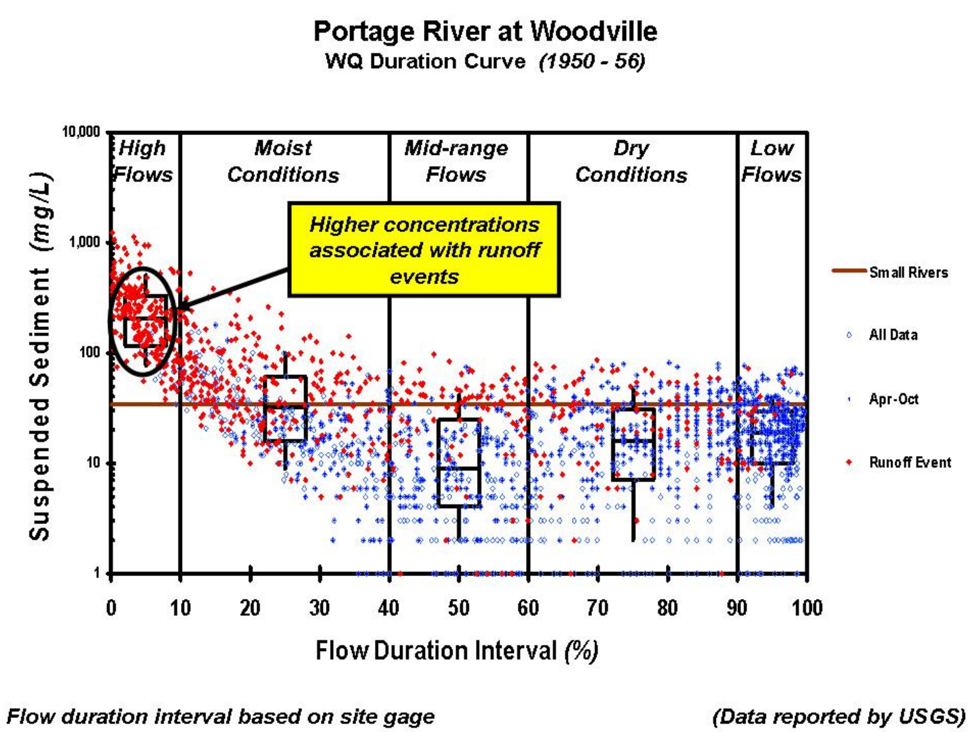


Figure 5-12 Water Quality Duration Curve Analysis -- Portage River.

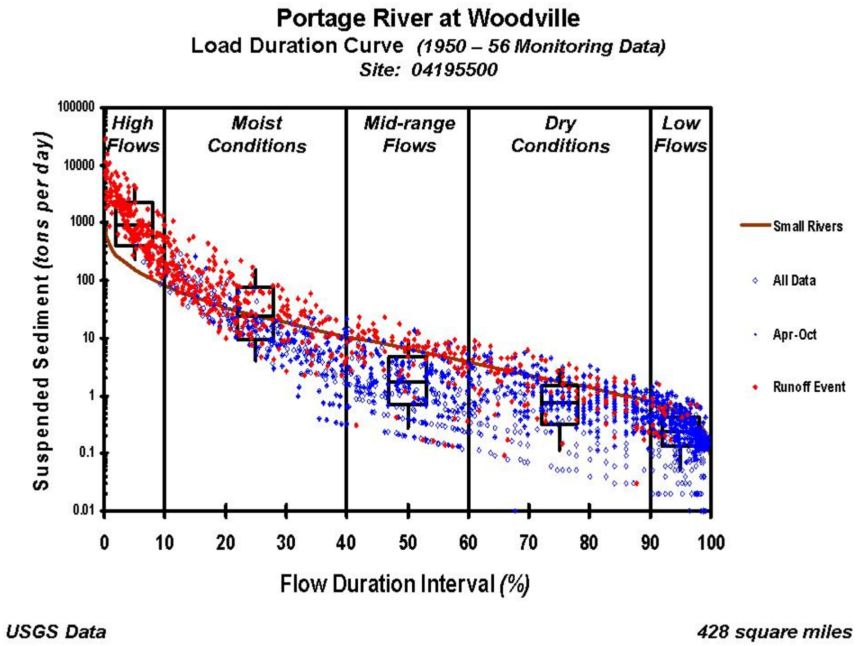


Figure 5-13 Load Duration Curve Analysis -- Portage River.

5.1.6 Relationship Between Flow and Sediment

The *"Protocol for Developing Sediment TMDLs"* (U.S. EPA, 1999a) indicates the appropriateness of using empirical relationships between stream flow and sediment, known as rating curves. Figure 5-14 illustrates development of a rating curve based on Portage River suspended sediment data. As indicated, there is a direct correlation between flow and suspended sediment load. This relationship supports the use of stream flow as a major factor to consider when developing sediment TMDLs and implementation plans to address biological and habitat impairments.

The importance of hydrology in addressing sediment concerns in the Swan Creek watershed is further supported based on relationships between flow, velocity, shear stress, and stream power. Increased sediment transport occurs from elevated velocities associated with higher stream flow. Impaired streams, such as Swan Creek, will mobilize more sediment even if flows are held constant, due to decreased resistance associated with the greater silt fraction in the channel substrate. This is illustrated with the sediment rating curve shown in Figure 5-15. The net effect of a decrease in average particle size and lower resistance to sediment transport is an increase in both the slope and intercept of the sediment rating curve.

The combined effect of these factors highlights the need to consider not only direct sediment loads to the stream, but also the importance of hydrology, channel substrate, and bank conditions. These relationships also point out the role that the floodplain and riparian zones play in providing bank and channel stability. Finally, land use and / or floodplain management changes that alter hydrology in the watershed can further exacerbate sediment problems through the resultant effect on stream habitat.

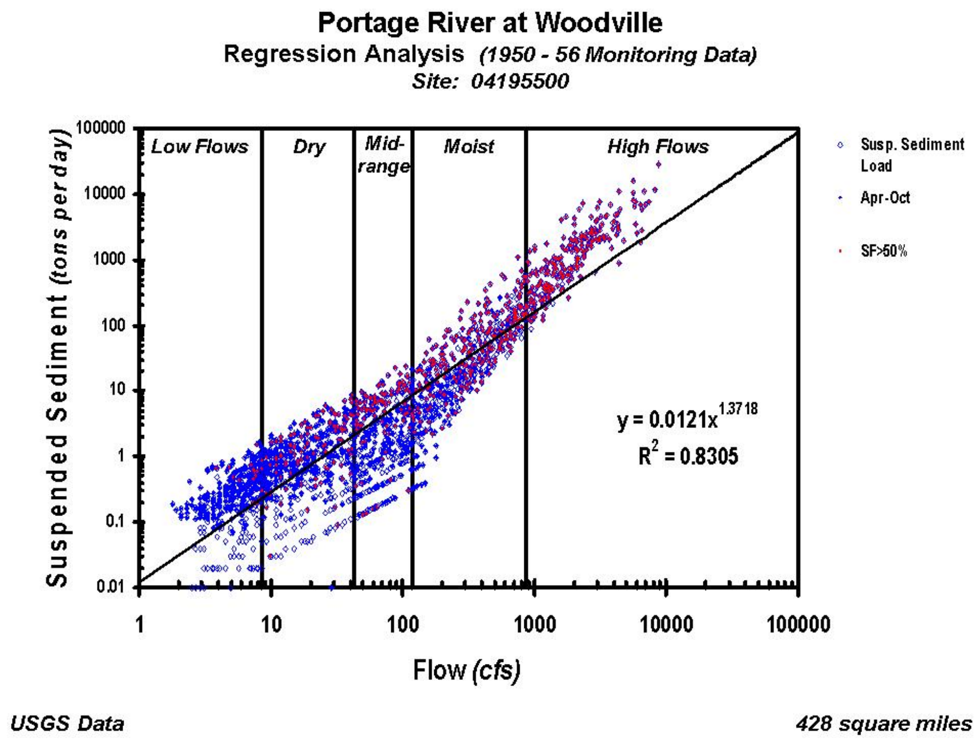


Figure 5-14 Suspended Sediment Rating Curve -- Portage River.

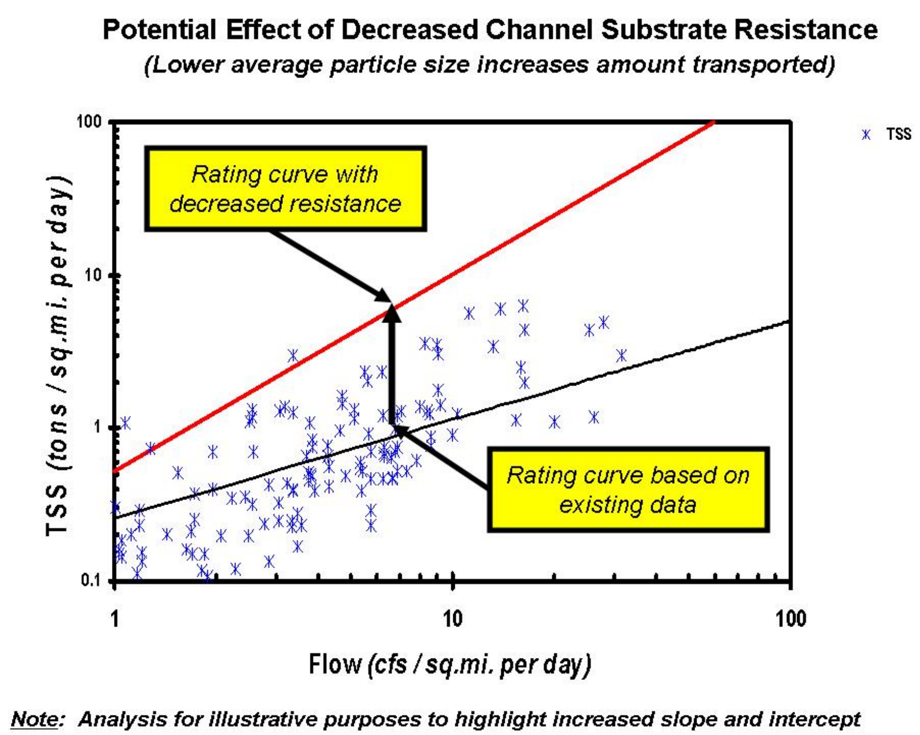


Figure 5-15 Cumulative Effect on TSS Rating Curve.

5.1.7 Summary

Degraded habitat and sedimentation are high concerns relative to biological impairments in the Swan Creek watershed. TMDL targets for total suspended solids have been identified, based on information in Ohio EPA guidance documents that are derived from HELP ecoregion statistics (Ohio EPA, 1999). These targets are used in conjunction with a hydrology-based framework (i.e., duration curves) to express loading capacities and allocations for individual segments (see Section 6). Because of the relationship between sediment, channel morphology, and hydrology, water flow should be considered in guiding TMDL implementation efforts, such as development of storm water management plans.

TMDLs for storm water impaired streams using water (i.e., discharge) as a surrogate measure have been developed in some states, based on its relationship to erosion processes, sediment, and channel stability. For example, work in Vermont, combined with basic hydrology / sediment dynamics principles, has demonstrated the appropriateness of stream flow as a surrogate measure to address biological impairments. In an approach using surrogate measures, stream flow and sediment characteristics of watersheds that are in compliance with the water quality standards provide estimates of *"assimilative capacity"*. Appropriate levels of discharge and sediment loading become the storm water management targets.

Within Ohio, the Big Darby TMDL identified numeric targets associated with flow quantity and hydrology (Ohio EPA, 2008). The rationale was based on the relationship of base flow and runoff to total streamflow and the amount of ground water recharge from a stable hydrologic regime. Targets were determined from historic USGS flow data in the watershed and hydrologic model results per sub-watershed based on land use prior to de-stabilization of stream patterns.

In summary, hydrology is a major driver for erosion processes, both from the watershed and from the channel. Control of high water flows should also achieve reductions in channel sediment movement. If sediment does not respond as desired over time, the TSS objectives and the need for hydrology-based targets might be revisited. This strategy is based on the assumption that there is a relationship between healthy in-stream geomorphology/habitats and storm water management. The precise nature of this relationship is uncertain. It is reasonable, however, to expect that as hydrology and sediment dynamics are restored, habitats will improve, and the biological community will recover.

5.2 Bacteria

Exceedances of Ohio's water quality standards for bacteria are widespread throughout the Swan Creek watershed. The Swan Creek Plan of Action indicates that the lower reach is not swimmable according to public health standards. The Ohio EPA 2006 survey confirmed the presence of *E. coli* problems at most sites sampled. Potential sources that contribute bacteria to receiving waters in the Swan Creek watershed include failing home sewage treatment systems, package plants, CSOs, urban storm water, livestock, and wildlife.

The data summarized in the water quality assessment section depicts general *E. coli* patterns based on the Ohio EPA survey information. Figure 5-16 provides another longitudinal profile of the *E. coli* data, similar to Figure 3-10 except that Ai Creek is displayed as the headwater area. Reasons for this perspective were discussed previously in the TSS section.

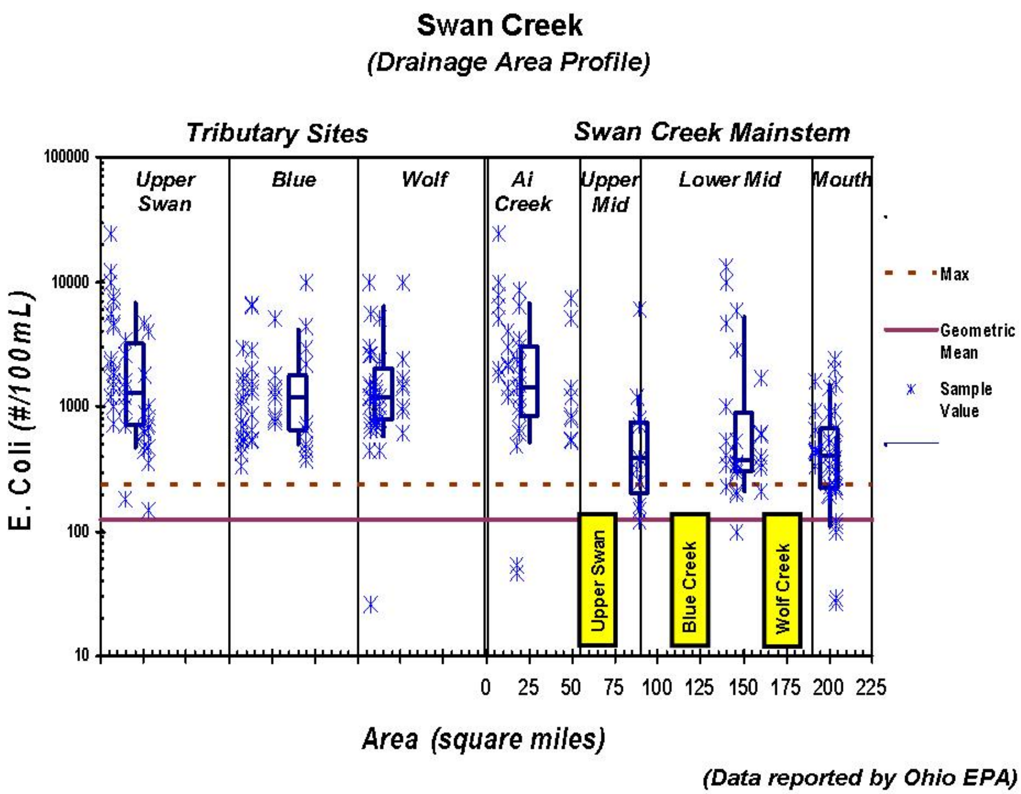


Figure 5-16 Drainage area profile of Swan Creek E. Coli concentrations.

As noted in the water quality assessment section, there is a difference in *E. coli* concentrations between the tributary headwater areas and the lower reaches of Swan Creek. Tributary headwater streams, particularly those in unsewered subwatersheds, are more prone to the influence of failing home sewage treatment systems that deliver bacteria to creeks and ditches. In addition, headwater streams in more rural subwatersheds can also be affected by livestock with access to streams. This includes potential runoff from areas used by livestock that are adjacent to receiving waters.

In more developed subwatersheds, elevated bacteria concentrations can reflect the effect of municipal storm water systems. Potential bacteria contributions in these areas include urban runoff (e.g., pet waste), leaky sewer systems, and illicit connections. Finally, the lower reaches of Swan Creek are affected by upstream sources of bacteria, as well as urban runoff, leaky sewer systems, illicit connections, and CSOs.

Because of the array of different source areas and delivery mechanisms, developing a linkage analysis to address elevated *E. coli* concentrations involves an evaluation of multiple factors. An important component of the analysis is to describe, as best as possible, the relationship between source loadings and observed values. Connections can be established through a range of techniques, from the use of qualitative assumptions backed up by sound scientific justification to the use of sophisticated models. Ideally, linkages might be based on a long-term set of monitoring data that enables one to associate waterbody responses to flow and loading conditions. However, the *"Protocol for Developing Pathogen TMDLs"* (U.S. EPA, 2001) recognizes that more often the links must be established by using a combination of monitoring data, statistical or analytical tools (including models), and best professional judgment.

5.2.1 Ambient Bacteria Loads

One way to examine bacteria concerns is to express the 2006 Ohio EPA data as loads. This enables a view of the potential magnitude of source contributions throughout the Swan Creek watershed in terms of in-stream response. Figure 5-17 displays bacteria loads along a drainage area profile using the same format as the concentration data in Figure 5-16. Loads were calculated from the 2006 Ohio EPA survey data and flow estimates based on drainage area weighting using the Ottawa River gage.

As a quick refresher, loads are calculated by multiplying the stream flow by the numeric water quality target (e.g., the bacteria criterion) and a conversion factor. Bacteria are measured in colony-forming units (cfu) per 100 milliliters. Thus, the appropriate expression of loads for bacteria TMDLs is organisms per day. Table 5-3 describes an approach used to calculate bacteria loads, which includes the needed conversion factors. Loads calculated in this manner result in extremely large numbers (i.e., numbers of organisms in the billions, trillions, or quadrillions per day). To avoid difficulties of communicating information associated with large counts (e.g., macro numbers of microorganisms), bacteria loads are expressed as billion organisms per day (giga- or G-org/day), similar to computer abbreviations of GB for gigabytes.

Table 5-3 Calculation of bacteria loads.

Load *(org/day)* = Concentration *(org/100mL)* × Flow *(cfs)* × Factor			
multiply by **3,785.2** *to convert*	mL per gallon	➔	org / 100 gallon
divide by **100** *to convert*	org / 100 gallon	➔	org / gallon
multiply by **7.48** *to convert*	gallon per ft^3	➔	org / ft^3
multiply by **86,400** *to convert*	seconds per day	➔	ft^3 / day
divide by **1,000,000,000**	billion	➔	G-org
multiply by **0.02446** *to convert*	**(org/100mL) × ft^3 / sec**	➔	**G-org/day**

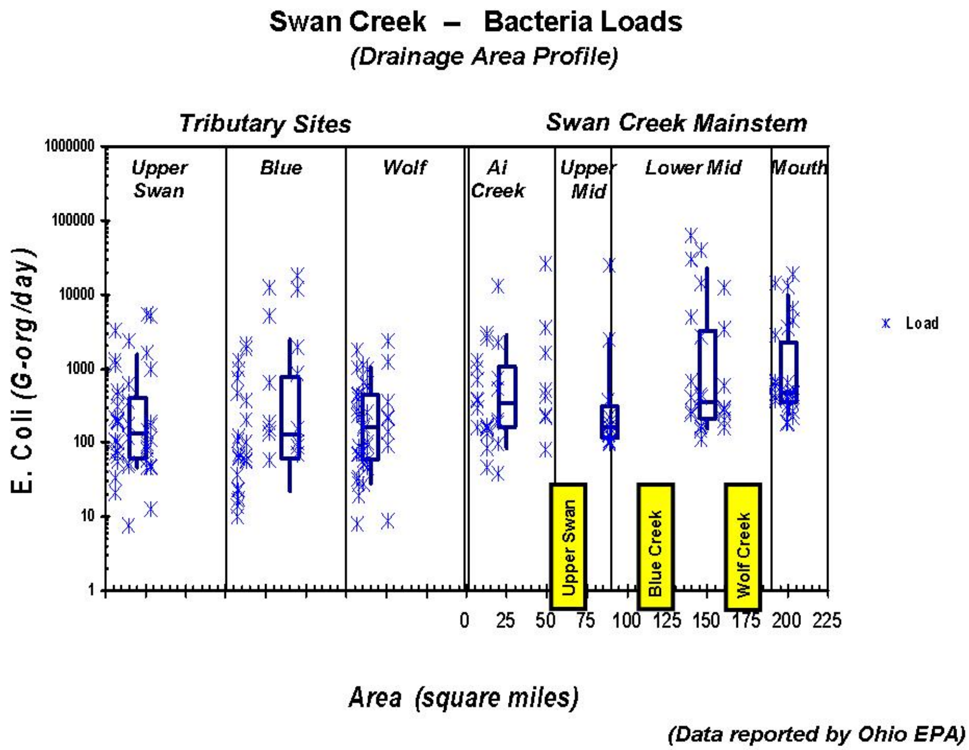


Figure 5-17 Drainage area profile of Swan Creek E. Coli loads.

Although some general patterns are evident, Figure 5-17 also reflects the variability of bacteria loads, both on the mainstem of Swan Creek and in the major tributary subwatersheds. Part of that variability is the result of different flow conditions during sampling events over the survey period. To help understand the effect of flow conditions, the loading information can also be displayed by showing high flow samples as one graph. Stable, mid-range to dry flow conditions can be shown as another.

Figure 5-18 is a drainage area profile of bacteria loads across the Swan Creek watershed based on samples taken during high flow conditions (the June 26-27 and the July 5-6 sample events). The solid and dashed lines represent the loading capacities associated with the geometric mean and maximum criteria values respectively (based on 250 cfs at the Ottawa River gage). Figure 5-18 is a drainage area profile of bacteria loads under more stable conditions. Specifically, these include mid-range to dry flows that are less than the median based on the Ottawa River gage (the June 12-13, June 19-20, August 7-8, and August 21 sample events). To provide a frame of reference, the loading capacities associated with the geometric mean and maximum criteria values are included in Figure 5-19 using 25 cfs at the Ottawa River gage.

The effect of flow conditions can be seen by comparing these two graphs. As discussed earlier, the *E. coli* criteria is exceeded across the Swan Creek watershed. Figure 5-18 and Figure 5-19 show that exceedances occur both under high flows and under stable, dry conditions. The effect of different source areas and delivery mechanisms tends to vary with flow conditions. As shown earlier in Table 5-1, there is a wide range of source categories in the Swan Creek watershed that contribute observed bacteria problems. The benefit of showing loads under both flow conditions is that it provides a starting point to examine the potential effect of various source categories on receiving water conditions.

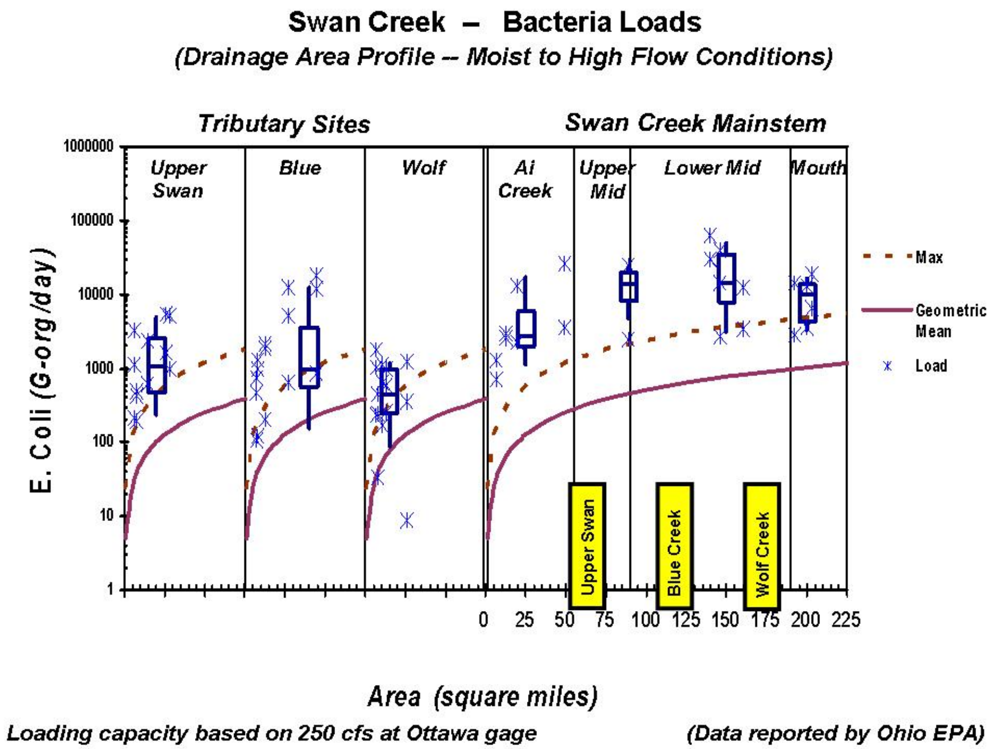


Figure 5-18 Drainage area profile of Swan Creek *E. coli* loads during high flow conditions.

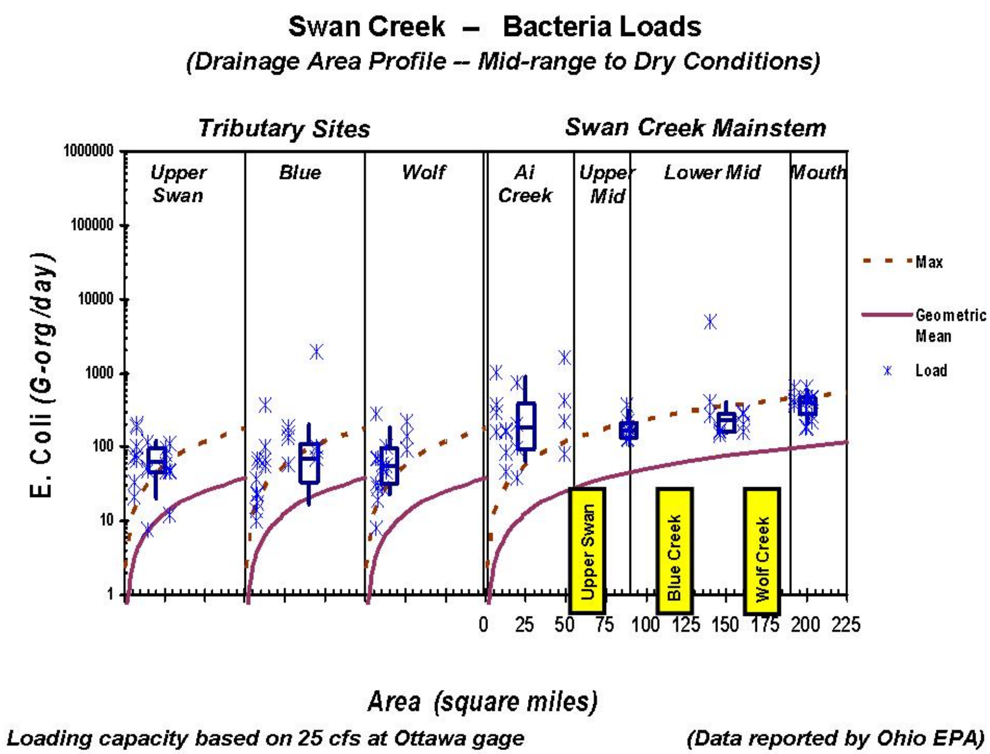


Figure 5-19 Drainage area profile of Swan Creek *E. coli* loads during stable dry flows.

Bacteria loads in several tributary headwater areas appear to exceed the loading capacity by a much greater degree than sites further downstream during stable, dry flows. Potential sources that contribute bacteria loads in the headwater areas under these flow conditions include failing home sewage treatment systems, poorly operated package plants, livestock with unrestricted access to streams, and riparian areas affected by livestock use.

Conversely, bacteria loads noticeably increase at mainstem Swan Creek sites further downstream under high flow conditions. Potential sources that contribute bacteria loads associated with these conditions include urban storm water and CSOs. Bacteria loads in rural areas also show an increase. This is likely the result of a greater portion of the watershed that contributes runoff to Swan Creek and its major tributaries. An example is failing home sewage treatment systems adjacent to roadside ditches. These sources would not necessarily deliver bacteria to Swan Creek under dry conditions. However, under high flow conditions, these ditches could deliver water and bacteria from failing home sewage treatment systems to Swan Creek, including bacteria that may have accumulated in ditches and intermittent tributaries.

An example of this concern in Lucas County is the Berger Ditch situation. Beach closures at Maumee Bay State Park prompted a cooperative effort between the County, TMACOG, USGS, and the University of Toledo to examine causes. Studies identified the Berger Ditch drainage as source area of concern. Land use in the Berger Ditch drainage is primarily farmland and single family residences (Brady, 2007). Overland runoff and discharges from home sewage treatment systems are likely sources of bacterial contamination to the ditch.

Figure 5-20 depicts data from this study in the form of a unit area load duration curve. Unit area loads enable a comparison of loads in watersheds of different sizes. As can be seen, the highest loads are transported under high flow conditions. Figure 5-21 uses the Ohio EPA survey information to display unit area loads for Swan Creek tributary sites draining less than 30 square miles, while Figure 5-22 shows the same information for the mainstem.

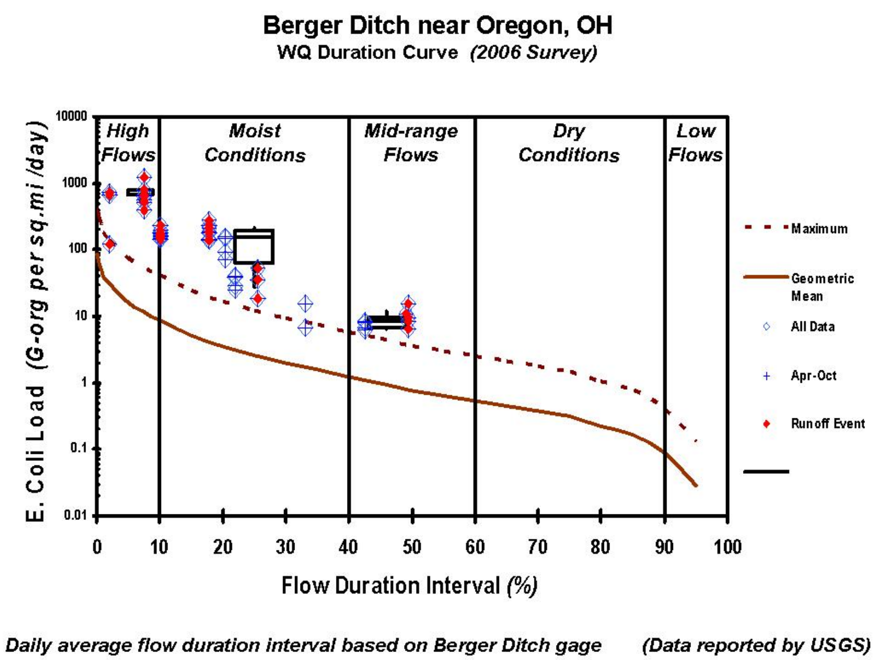


Figure 5-20 Unit area load duration curve for *E. coli* in Berger Ditch.

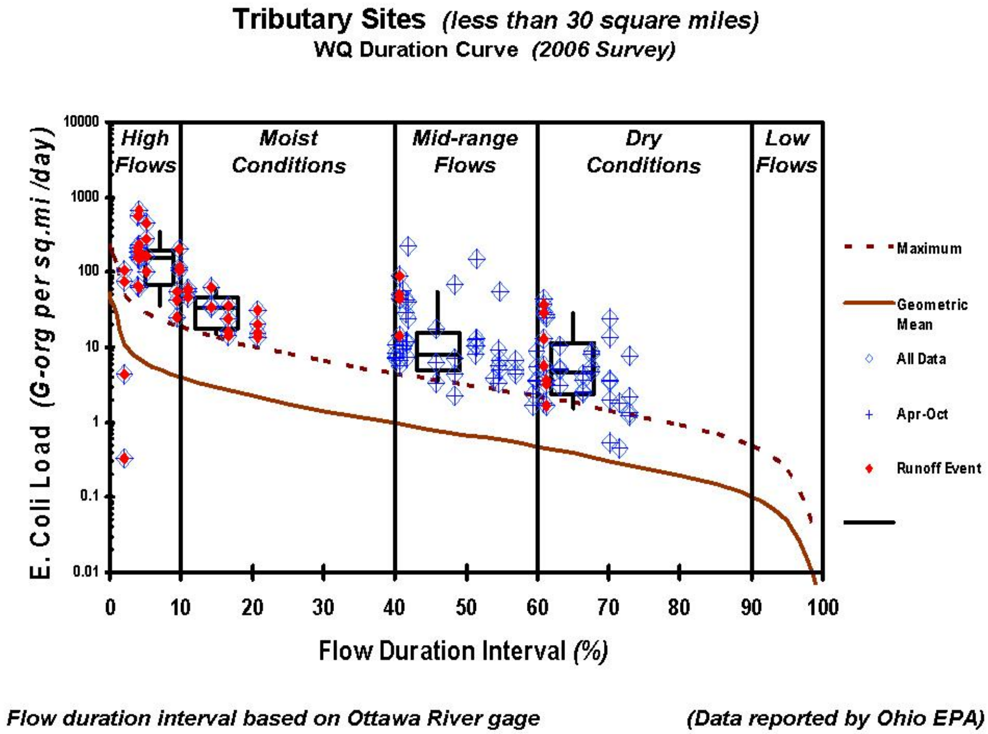


Figure 5-21 Unit area load duration curve for *E. coli* at tributary sites.

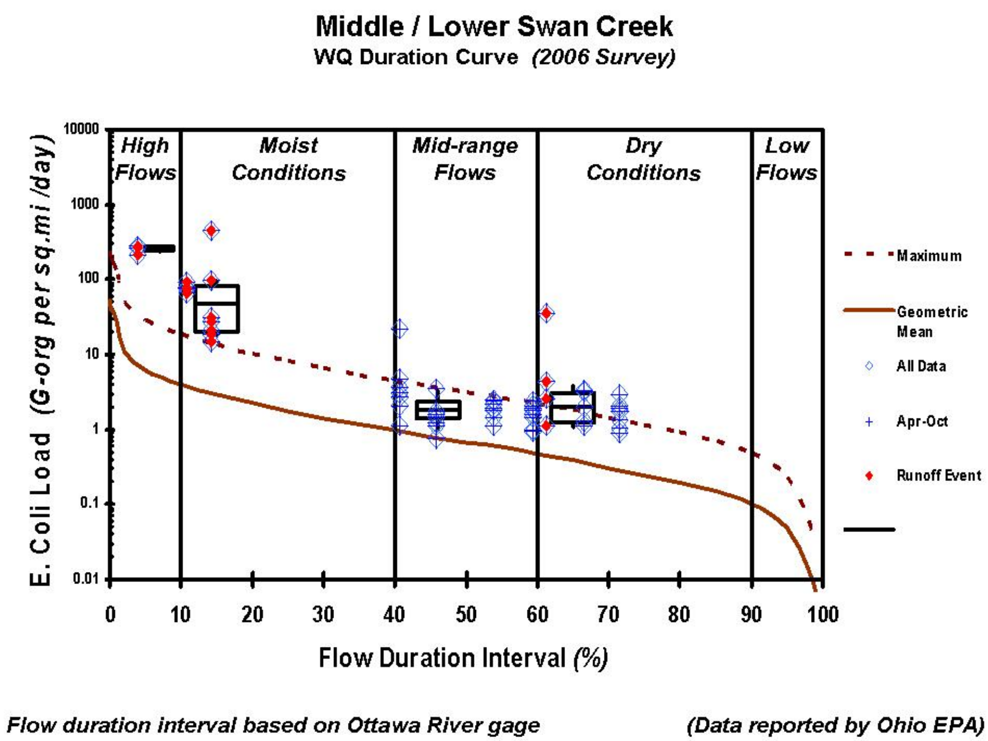


Figure 5-22 Unit area load duration curve for *E. coli* on the mainstem Swan Creek.

5.2.2 Summary

The timing of delivery and transport mechanisms is an important aspect in developing a framework for solving documented bacteria problems. Duration curve analysis is a useful way to examine bacteria loads, particularly given the wide range of source categories. Figure 5-21 shows that for the tributary sites, unit area loads are noticeably higher under mid-range and dry conditions. In addition, the variability when looking at these sites collectively is also greater. This highlights the point made earlier; specifically these headwater areas are easily influenced by bacteria loads from failing home sewage treatment systems, poorly operated package plants, livestock with unrestricted access to streams, and riparian areas affected by livestock use under stable flow conditions.

Under high flow conditions, surface runoff and storm water have a major effect on both tributary drainages, as well as the mainstem Swan Creek. The effect on the mainstem would likely be more pronounced with more high flow event sampling given the presence of urban storm water sources and CSOs.

5.3 Total Phosphorus

Information presented in the water quality assessment section describes phosphorus conditions in the Swan Creek watershed based on the Ohio EPA 2006 survey data. Elevated total phosphorus was noted throughout the basin, but was only identified as a cause of aquatic life use impairment at four sampling locations (three in Ai Creek, one in Heilman Ditch). Therefore, TMDLs were calculated at only those four locations. Suggested reductions in total phosphorus are made at the other sampling locations where elevated levels were noted; those reductions are presented in Appendix C.

Two general patterns were noted: the high levels in Ai Creek below Swanton including the subsequent effect on mainstem Swan Creek concentrations; and the high variability associated with flow conditions. Figure 5-23 provides another longitudinal profile of the total phosphorus data, similar to Figure 3-6 except that Ai Creek is displayed as the headwater area.

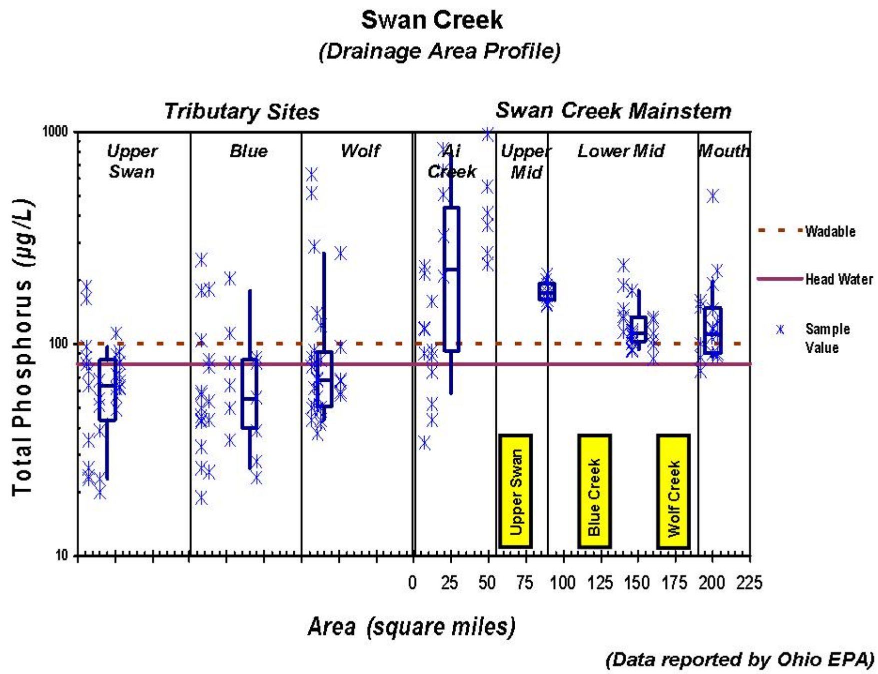


Figure 5-23 Drainage area profile of Swan Creek phosphorus concentrations.

As with TSS and bacteria, phosphorus is affected by an array of source areas and delivery mechanisms. Besides timing and flow conditions, another complicating factor is the form of phosphorus. Municipal wastewater treatment plants tend to have a greater effect on receiving waters under dry and low flow conditions. In addition, phosphorus in wastewater treatment plant effluents tends to be largely in the dissolved form. On the other hand, phosphorus in receiving streams that is the result of surface runoff tends to be associated with soil particulates. Thus, in these situations the linkage analysis described for TSS would also apply to phosphorus.

5.3.1 Ambient Phosphorus Loads

The Ohio EPA 2006 phosphorus data can be viewed as loads, similar to the analysis developed for TSS and bacteria. This provides a look at the survey information relative to the potential magnitude of source contributions. Figure 5-24 displays phosphorus loads using the drainage area profile format. Like TSS and bacteria, loads were calculated with the 2006 Ohio EPA survey data and flow estimates based on drainage area weighting using the Ottawa River gage. Several general patterns are quite evident. The most noticeable is the increased phosphorus loads in Ai Creek below the Swanton Wastewater Treatment Plant. The variability of phosphorus loads in the major tributaries is also quite apparent. Much of this variability is associated with flow conditions, as discussed earlier with respect to TSS and bacteria. The effect of flow conditions can be displayed in several ways using phosphorus load information.

Figure 5-25 is a drainage area profile of phosphorus loads across the Swan Creek watershed based on samples taken during high flow conditions (the June 26-27 sample event). The line represents the loading capacity associated with the phosphorus target described in Section 2.3 with flow at 210 cfs at the Ottawa River gage. Figure 5-26 is a drainage area profile of phosphorus loads under more stable conditions, specifically those that are less than the median flow based on the Ottawa River gage. To provide a frame of reference, the loading capacity is included in Figure 5-26 using 25 cfs at the Ottawa River gage.

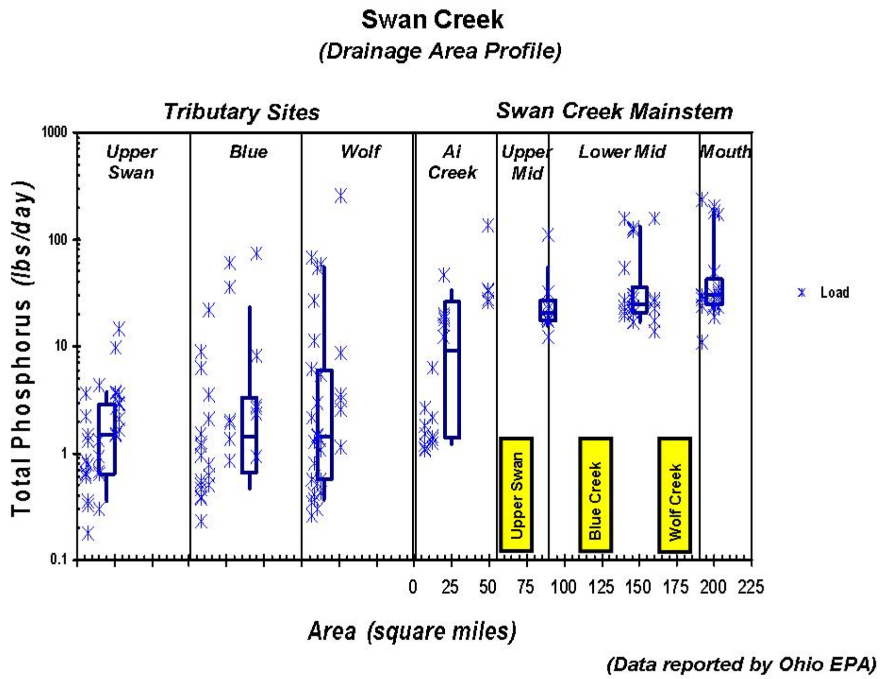


Figure 5-24 Drainage area profile of Swan Creek phosphorus loads.

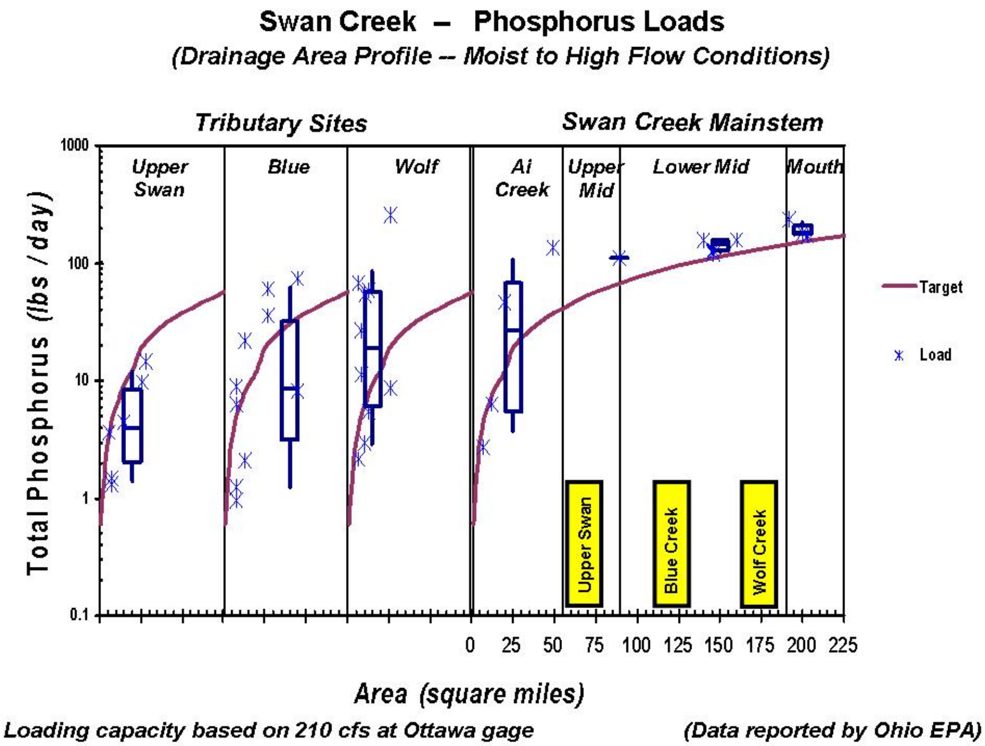


Figure 5-25 Drainage area profile of Swan Creek phosphorus loads during high flow conditions.

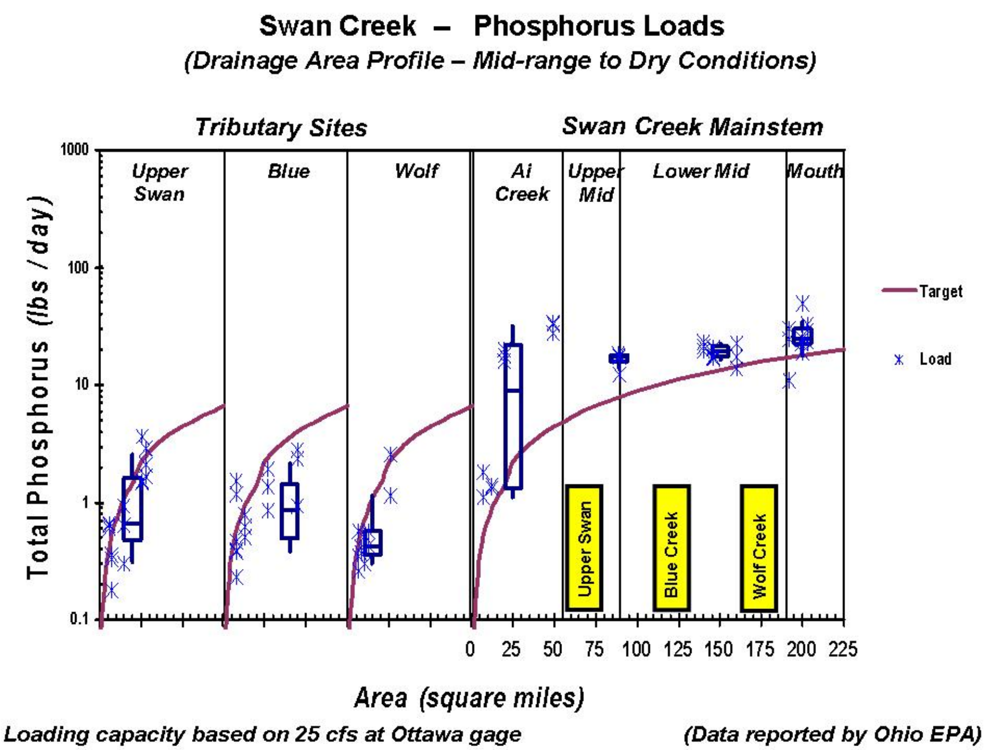


Figure 5-26 Drainage area profile of Swan Creek phosphorus loads during dry flow conditions.

5.3.2 Summary

Ohio EPA has established a relationship between biological community performance in streams and elevated nutrient concentrations. Based on this work, TMDL targets for total phosphorus have been identified that are derived from HELP ecoregion reference site statistics (Ohio EPA, 1999). These targets are used in conjunction with a hydrology-based framework (i.e., duration curves) to express loading capacities and allocations for individual segments.

The Swanton Wastewater Treatment Plant has a significant effect on mid-range and dry condition phosphorus concentrations in the mainstem Swan Creek. However, because of the relationship between total phosphorus, sediment, and hydrology, the role of storm water should also be considered in guiding TMDL implementation efforts. Storm water runoff from developed areas typically contains many pollutants including phosphorus. An example is elevated phosphorus loads in the Wolf Creek drainage under high flow conditions. Pollutants accumulate on impervious surfaces and are washed off during rain events and snow melt. Paved surfaces and piped drainage systems efficiently transport these pollutants from the watershed to the stream.

The benefit of a focus on hydrology in meeting TSS targets was discussed earlier in this document. Storm water runoff reductions are expected to increase infiltration which will lead to increases in base flow. The increased base flow will also lower the concentrations and effects of other pollutants (e.g., total phosphorus) during low flow conditions. In addition, phosphorous loading will be decreased both by the reductions in runoff volume (which will directly address the nonpoint source dissolved phosphorous component) and the resulting sediment reductions (which will address the particulate phosphorous component associated with sediment).

5.4 Other Pollutants

A detailed linkage analysis for other pollutants would basically follow the information and techniques presented for TSS, bacteria, and phosphorus. For example, a number of the other listed pollutants are closely tied to sediment. Listed metals (e.g. copper, aluminum, strontium) and priority organics (e.g., dieldrin, PAHs) are examples. In such situations, the linkage analysis for sediment addresses the pollutants. In addition, control of sediment and runoff volume will also reduce loads delivered to Swan Creek associated with these pollutants. In other cases, linkage patterns can be identified using the hydrology-based framework. TMDL results are presented for these pollutants using duration curves. This approach highlights important connections that can help guide post-TMDL implementation efforts.

6 TMDL RESULTS

A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs can be expressed in terms of mass per time or by other appropriate measures. TMDLs are composed of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this is defined by the equation:

$$TMDL = WLA + LA + MOS$$

A summary of the observed and allowable loads are presented in this section of the report. The allocations by each of the various sources and parameters are shown in the following tables. WLAs were established for the seven facilities with individual NPDES permits, the City of Toledo Phase I MS4, eight Phase II MS4s (Lucas County, Monclova Township, Spencer Township, Springfield Township, Waterville Township, Holland, Maumee, Waterville), and the City of Toledo CSOs in the Swan Creek watershed. Explanations for the calculation of each WLA are presented below.

WLAs for NPDES Permitted Facilities: There are seven NPDES permitted facilities within the Swan Creek watershed. For each facility, a WLA was calculated for all downstream TMDL parameters by multiplying the permitted design flow by either: a.) the permitted discharge concentration, b.) typical permit limit concentrations, or c.) concentrations required to meet the in-stream targets. In some cases the facility WLAs had to be set equal to the in-stream targets because of the lack of dilution capacity in the stream. Table 6-1 displays the design flows used to calculate the NPDES facility WLAs.

Table 6-1 NPDES facility WLA calculation table.

NPDES Facility	StateID	Design Flow (MGD)
Swanton WWTP	2PB00025	0.9200
Forest Park MHP	2PY00019	0.0090
Swanton Meadows MHP	2PY00022	0.0540
Peaceful Acres MHP	2PY00064	0.0125
Arrowhead MHP	2PY00067	0.0180
Country Court MHP	2PY00060	0.0050
Stoneco Maumee Quarry	2IJ00048	1.7280

MS4s: Allocations for the one Phase I MS4 and eight Phase II MS4s in the Swan Creek watershed (with the exception of the Ohio Department of Transportation and the Ohio Turnpike, discussed below) were determined based on the area of each MS4 draining to each assessment location. Townships, municipalities, and urbanized areas as documented in geographic information system (GIS) files within the Swan Creek watershed were used to determine the total regulated area for each MS4. These areas were then used to estimate WLAs based on the proportion of the upstream drainage area located within the MS4 boundaries. Storm water runoff was only assumed to occur during high flows, moist conditions, and mid-range flows.

The Ohio Department of Transportation (ODOT) and the Ohio Turnpike are also regulated under the Phase II program and are both located within the Swan Creek watershed. The ODOT Phase II Permit encompasses state routes and U.S. routes that are within urbanized areas but not incorporated areas. In addition, the permit includes any interstates within urbanized areas. The WLAs for these permittees are not separately identified but are instead included in the individual WLAs for each city/township based on the following:

- the loads were based on area, which would include the area of these MS4s;
- the loads are likely to be very small (less than one percent of the total load for each MS4); and
- the loads are difficult to quantify because separating the loads originating from the road areas compared to the other MS4 areas would be a very complex task.

The urbanized areas regulated within the Lucas County MS4 all overlap with the other, smaller MS4 areas (e.g. Township MS4s, city MS4s, and village MS4s) in the Swan Creek watershed. Due to the overlapping nature of local and county governments and the difficulty in separating their respective MS4 areas, the MS4 allocations noted for each township, city, and village applies jointly to those portions of the MS4 that Lucas County operates within each.

Similarly, the MS4 area of the Village of Waterville lies completely within that of Waterville Township. One joint allocation is provided for the two MS4s in each TMDL table for both entities.

City of Toledo CSOs: The City of Toledo combined sewer system has 33 permitted CSO discharge locations and eight of these outfalls discharge into Swan Creek. The Swan Creek CSO area is controlled by three main tunnel systems and simulations of the Swan Creek system performance based on the 2003 collection system conditions and operations indicate that a total of 11 CSO discharge events occur per year. These events were simulated to last 126 hours/year producing an overflow volume of 86 million gallons/year (LTCP, unpublished), which equates to 11.45 hours per event at an average flow of 25.35 cfs. A 25.35 flow rate and the concentrations shown below were therefore used to establish the Toledo CSO WLAs. The WLAs are assigned only to the high flow zone and will only apply to the number of events allowed per year in the final, approved Long-Term Control Plan.

- TSS: 127 mg/L (U.S. EPA, 2004b)
- TP: 0.7 mg/L (U.S. EPA, 2004b)
- Nitrate: 1 mg/L (SEWRPC, 2005)
- *E. coli:* Consistent with allowable loads
- Dieldrin: 0.0000065 µg/L (no data available; set equal to water quality standards)
- Total Aluminum: 970 µg/L (no data available; set equal to water quality standards)

Load duration analyses have been conducted for all sites with a sufficient number of samples (in most cases 8 or more samples) within each of the two 11-digit assessment units. The Ohio EPA Northwest District Office provided water quality data from intensive survey sampling that took place during the 2006 field season. Appendix A contains the detailed load duration results for all stations.

The following section provides the TMDL results for each 14-digit subwatershed and is organized by 11-digit assessment units: 04100009-070 (Upper Swan Creek), and 04100009-080 (Lower Swan Creek).

6.1 Assessment Unit 04100009-070: Upper Swan Creek (Headwaters to Upstream Blue Creek)

The load duration approach was applied to ten sampling stations within the Upper Swan Creek assessment unit (Figure 6-1). For each load duration site, all appropriate and available water quality and flow data were used. The load duration analyses for *E. coli* were based on flows and samples collected during the recreation season (May 1 to October 15) to be consistent with Ohio's water quality standards.

Table 6-2 summarizes the data used for the load duration analyses in the upper Swan Creek assessment unit. This assessment unit is divided into three 14-digit subwatersheds that will be further discussed in the following subsections.

Table 6-2 Summary of available data for the upper Swan Creek assessment unit.

Stream (River Mile)	Sample Site ID (STORET #)	Location	14-Digit Subwatershed	TMDL Parameters*	Count	Average	Minimum	Maximum	Period of Record
Swan Creek (40.68)	P11K01	At Fulton CR-6-1	04100009-070-010	NN	6	9.99	0.53	19.70	6/12/2006-8/21/2006
				E. coli	8	2945	1000	7300	
				TSS	5	10.6	5.0	15.0	
Swan Creek (34.41)	P11K02	At Fulton CR-3	04100009-070-010	NN	6	11.00	1.06	24.50	6/12/2006-8/21/2006
				E. coli	8	1510	180	3400	
				TSS	6	5.8	5.0	7.0	
Fewless Creek (1.80)	P11K08	At Fulton CR-4 (Utah Road)	04100009-070-010	TP	6	0.12	0.08	0.19	6/12/2006-8/21/2006
				NN	6	10.15	3.15	21.20	
				E. coli	8	7312	1200	24000	
				TSS	6	28.0	18.0	44.0	
Swan Creek (32.82)	P11K03	At Swanton Road	04100009-070-010	TP	6	0.07	0.05	0.11	6/13/2006-8/22/2006
				NN	6	8.60	4.43	13.90	
				E. coli	8	1267	450	4600	
				TSS	6	5.5	5.0	7.0	
Swan Creek (30.90)	P11K04	Upstream of SR-64	04100009-070-010	NN	6	8.01	1.71	14.00	6/13/2006-8/22/2006
				E. coli	8	1023	150	4000	
				TSS	6	8.2	6.0	10.0	
Ai Creek (10.44)	P11K14	At CR-L, in town of Ai	04100009-070-020	TP	6	0.14	0.03	0.23	6/12/2006-8/21/2006
				NN	6	7.58	2.50	15.20	
				TSS	6	12.7	5.0	32.0	
				Copper	6	26.0	5.0	106.0	
Ai Creek (8.29)	P11K15	At CR-L, east of the town of Ai	04100009-070-020	TP	6	0.09	0.04	0.16	6/12/2006-8/21/2006
				NN	6	7.70	0.95	16.00	
				E. coli	8	2037	1200	4000	
				TSS	6	9.7	8.0	12.0	
Ai Creek (2.10)	P11K17	At Scott Road	04100009-070-020	TP	6	0.62	0.21	1.20	6/12/2006-8/21/2006
				NN	6	7.85	3.99	13.70	
				E. coli	8	3080	640	8600	
				TSS	6	10.42	5.0	28.0	
Ai Creek (1.66)	P11W15	At SR-2	04100009-070-020	TP	6	0.47	0.24	0.97	6/12/2006-8/21/2006
				NN	6	6.91	3.17	11.10	
				E. coli	8	2285	530	7400	
				TSS	6	16.1	5.0	41.0	
Swan Creek (24.70)	P11K21	At Spencer Road	04100009-070-030	TP	6	0.18	0.15	0.21	6/13/2006-8/22/2006
				NN	6	5.14	1.21	10.50	
				E. coli	8	1150	120	6100	
				TSS	6	17.8	12.0	34.0	

*TP, NN, and TSS are in mg/l; *E. coli* is in #/100ml; Copper is in ug/l

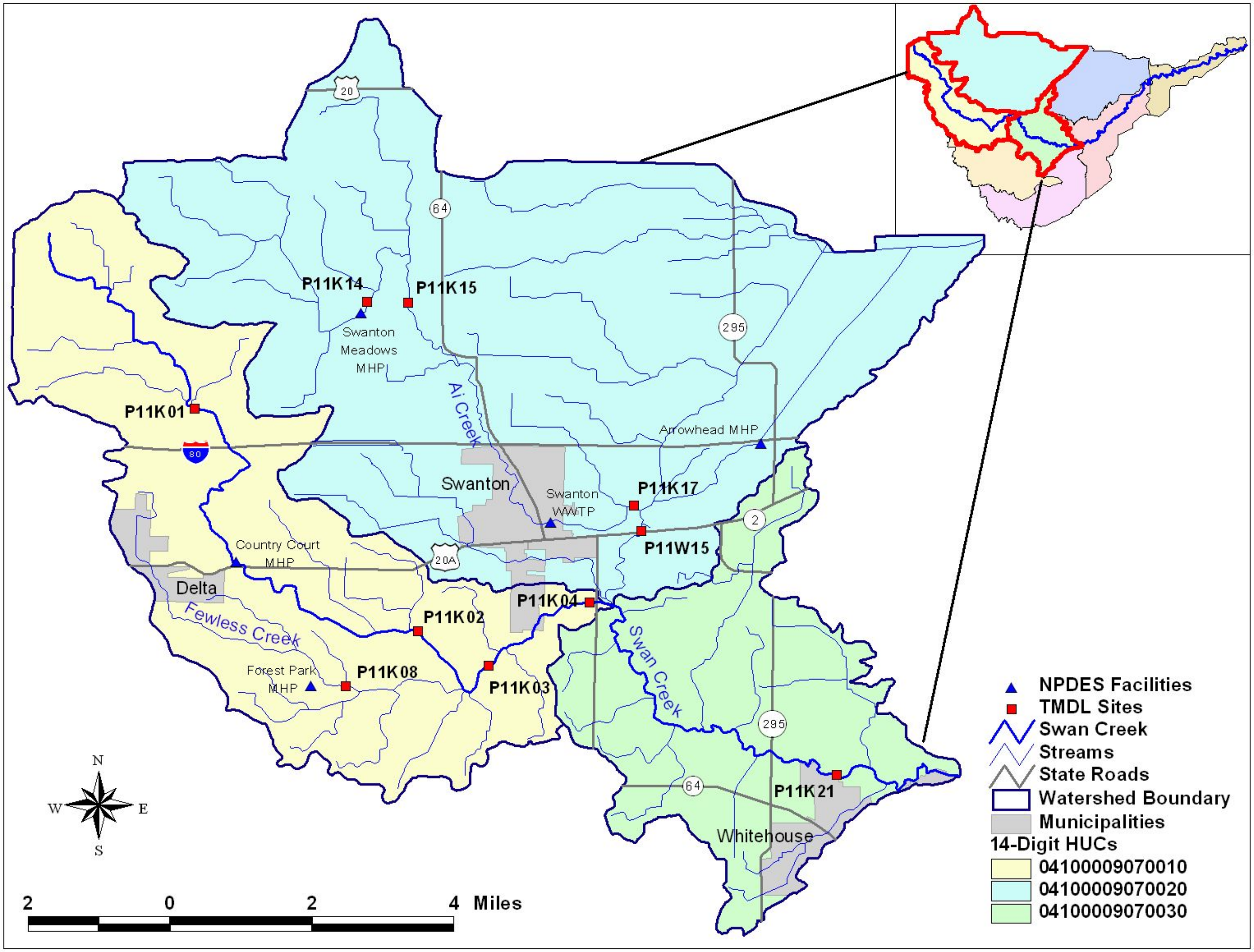


Figure 6-1 Load duration sites within the upper Swan Creek assessment unit.

6.1.1 Subwatershed 070-010: Swan Creek headwaters to above Ai Creek

The Swan Creek headwaters above Ai Creek were sampled at five locations by the Ohio EPA in 2006: four Swan Creek mainstem sites and one site on the Fewless Creek tributary. This subwatershed drains 28.12 square miles and the land cover (Table 1-5 and Figure 1-2) consists primarily of cultivated crops (74%), forest (11%), developed areas (8%), and pasture/hay (5%). A detailed map of the 070-010 subwatershed and its TMDL station locations is provided in Figure 6-2 below.

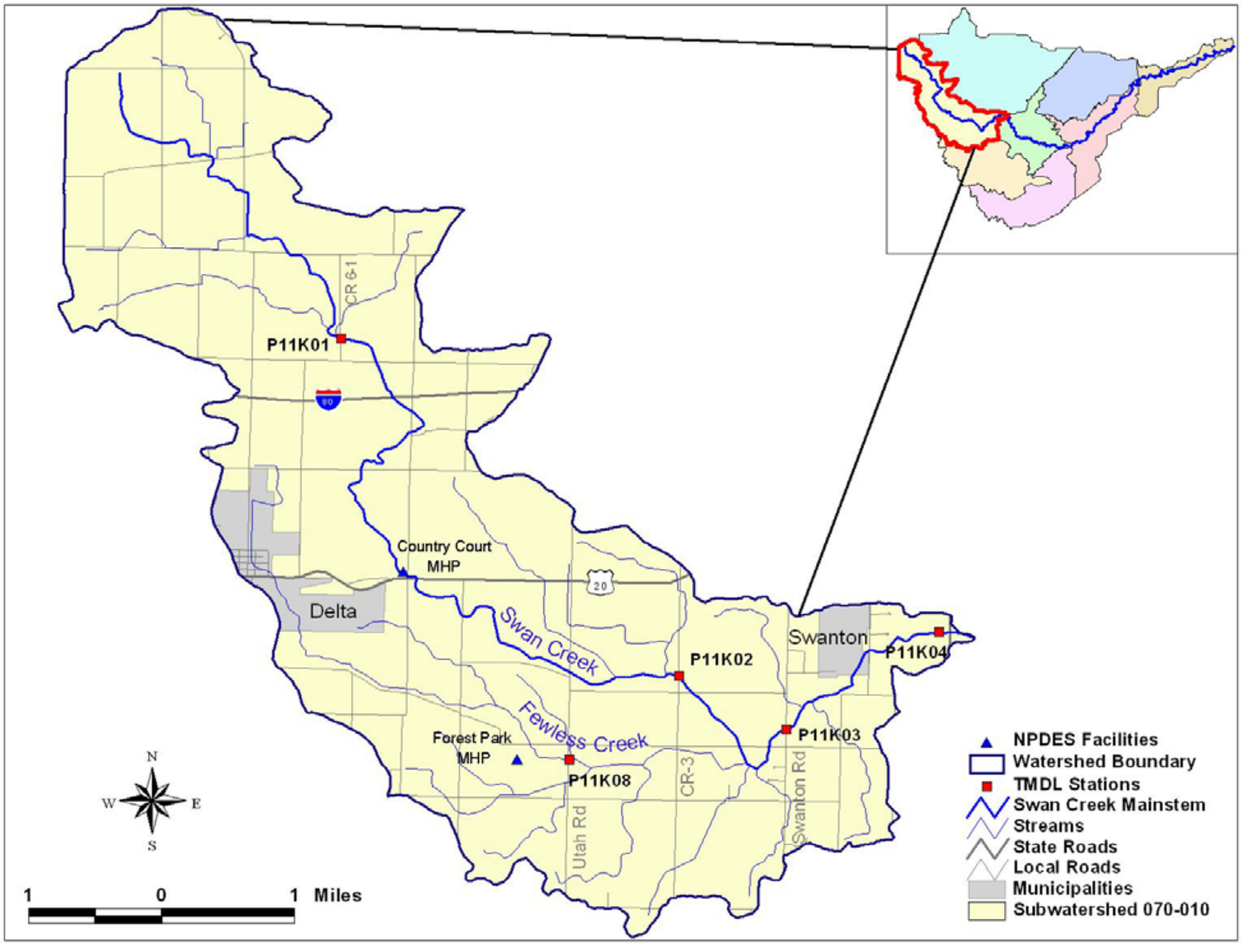


Figure 6-2 Subwatershed 070-010.

6.1.1.1 Swan Creek at RM 40.68 (P11K01)

Existing and allowable nitrate-nitrite (NN), TSS, and *E. coli* loads were calculated for Swan Creek at Fulton County Road 6-1 (P11K01). A total of 6 NN samples, 5 TSS samples, and 8 *E. coli* samples were available for the load duration analysis at site P11K01 (Table 6-2). There are no point sources upstream of this sampling station.

Table 6-3 presents the TMDL summary for site P11K01. Nearly all of the NN and *E. coli* observations were found to exceed the loading limit, resulting in observed loads well above allowable loads (see Appendix A for details). During high and mid-range flows, both NN and *E. coli* display needed reductions of 86 percent or greater. *E. coli* loads also display a 76 percent needed reduction during moist conditions. TSS did not display any needed reductions based on the 90th percentile reference site targets (see Appendix B for alternative TSS TMDLs).

Table 6-3 Loading Statistics for Swan Creek at RM 40.68 (P11K01).

P11K01- Swan Creek at RM 40.68 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	768.75	No Data	60.48	1.23	No Data
	TMDL= LA+WLA+MOS	**68.50**	**12.97**	**5.02**	**1.96**	**0.64**
	LA	61.65	11.67	4.52	1.76	0.58
	Future Growth Reserve (5%)	3.425	0.65	0.25	0.10	0.03
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	3.425	0.65	0.25	0.10	0.03
	TMDL Reduction (%)	**92%**	No Data	**93%**	**0%**	No Data
TSS (kg/day)	Current Load (Median)	195	No Data	86	30	No Data
	TMDL= LA+WLA+MOS	**3,357**	**635**	**246**	**96**	**31**
	LA	3,021	571	221	86	28
	Future Growth Reserve (5%)	168	32	12.5	5	1.5
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	168	32	12.5	5	1.5
	TMDL Reduction (%)	**0%**	No Data	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	782,192	83,674	106,917	No Data	No Data
	TMDL= LA+WLA+MOS	**121,756**	**21,872**	**9,478**	**4,010**	**1,385**
	LA	109,580	19,685	8,530	3,609	1,246
	Future Growth Reserve (5%)	6,088	1,093.5	474	200.5	69.5
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	6,088	1,093.5	474	200.5	69.5
	TMDL Reduction (%)	**86%**	**76%**	**92%**	No Data	No Data

6.1.1.2 Swan Creek at RM 34.41 (P11K02)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Swan Creek at Fulton County Road 3 (P11K02). A total of 6 NN samples, 6 TSS samples, and 8 *E. coli* samples were available for the load duration analysis at site P11K02 (Table 6-2).

Table 6-4 presents the TMDL summary for site P11K02. NN displays 29 percent needed reductions at dry flow conditions and much larger reductions of more than 90 percent at mid-range and high flow conditions. During all flow categories with available data, *E. coli* displays 71 percent or greater needed reductions that increase with increasing flow conditions. No observed TSS loads exceeded the allowable limits at this station based on the 90th percentile reference site targets.

Table 6-4 Loading Statistics for Swan Creek at RM 34.41 (P11K02).

P11K02- Swan Creek at RM 34.41 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	1,861.13	No Data	109.74	4.80	No Data
	TMDL= LA+WLA+MOS	**133.35**	**25.24**	**9.76**	**3.81**	**1.24**
	LA	119.82	22.53	8.59	3.24	0.93
	Future Growth Reserve (5%)	6.67	1.26	0.49	0.19	0.06
	WLA: Country Court MHP	0.19	0.19	0.19	0.19	0.19
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	6.67	1.26	0.49	0.19	0.06
	TMDL Reduction (%)	**94%**	No Data	**92%**	**29%**	No Data
TSS (kg/day)	Current Load (Median)	456	No Data	70	11	No Data
	TMDL= LA+WLA+MOS	**6,534**	**1,237**	**478**	**187**	**61**
	LA	5,880	1,112	429	167	54
	Future Growth Reserve (5%)	326.5	62	24	9.5	3
	WLA: Country Court MHP	1	1	1	1	1
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	326.5	62	24	9.5	3
	TMDL Reduction (%)	**0%**	No Data	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	3,079,066	205,749	56,676	No Data	No Data
	TMDL= LA+WLA+MOS	**237,019**	**42,578**	**18,451**	**7,806**	**2,697**
	LA	213,293	38,296	16,582	7,001	2,403
	Future Growth Reserve (5%)	11,851	2,129	922.5	390.5	135
	WLA: Country Court MHP	24	24	24	24	24
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	11,851	2,129	922.5	390.5	135
	TMDL Reduction (%)	**93%**	**81%**	**71%**	No Data	No Data

6.1.1.3 Fewless Creek at RM 1.80 (P11K08)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Fewless Creek at Fulton County Road 4 (P11K08). A total of 6 NN samples, 6 TSS, and 8 *E. coli* samples were available for the load duration analysis at site P11K08 (Table 6-2).

Table 6-5 presents the TMDL summary for site P11K08. For all TMDL parameters at this site, there is at least one needed reduction. All flow categories with available NN and *E. coli* data display 76 percent or greater needed reductions and in both cases, the values increase with increasing flow conditions. TSS issues occur at this station during dry flow conditions, but display no needed reductions at high and mid-range flows.

Table 6-5 Loading Statistics for Fewless Creek at RM 1.80 (P11K08).

P11K08- Fewless Creek at RM 1.80 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	650.80	No Data	42.08	5.76	No Data
	TMDL= LA+WLA+MOS	**53.89**	**10.20**	**3.95**	**1.54**	**0.50**
	LA	48.16	8.84	3.21	1.05	0.11
	Future Growth Reserve (5%)	2.695	0.51	0.195	0.075	0.025
	WLA: Forest Park MHP	0.34	0.34	0.34	0.34	0.34
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	2.695	0.51	0.195	0.075	0.025
	TMDL Reduction (%)	**93%**	No Data	**92%**	**76%**	No Data
TSS (kg/day)	Current Load (Median)	553	No Data	100	80	No Data
	TMDL= LA+WLA+MOS	**2,641**	**500**	**193**	**75**	**25**
	LA	2,376	449	173	66	22
	Future Growth Reserve (5%)	132	25	9.5	4	1
	WLA: Forest Park MHP	1	1	1	1	1
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	132	25	9.5	4	1
	TMDL Reduction (%)	**0%**	No Data	**0%**	**16%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	4,585,697	124,717	39,263	No Data	No Data
	TMDL= LA+WLA+MOS	**95,782**	**17,206**	**7,456**	**3,155**	**1,090**
	LA	86,161	15,442	6,667	2,797	938
	Future Growth Reserve (5%)	4,789	860.5	373	157.5	54.5
	WLA: Forest Park MHP	43	43	43	43	43
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	4,789	860.5	373	157.5	54.5
	TMDL Reduction (%)	**98%**	**88%**	**83%**	No Data	No Data

6.1.1.4 Swan Creek at RM 32.82 (P11K03)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Swan Creek at Township Road 3 (P11K03). A total of 6 NN samples, 6 TSS, and 8 *E. coli* samples were available for the load duration analysis at this site (Table 6-2).

Table 6-6 presents the TMDL summary for site P11K03. All NN loads display needed reductions of 82 percent or greater and all *E. coli* loads require 43 percent or higher reductions to meet the allowable loads. No needed reductions are noted for TSS at this site based on the 90th percentile reference site targets.

Table 6-6 Loading Statistics for Swan Creek at RM 32.82 (P11K03).

P11K03- Swan Creek at RM 32.82 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	No Data	1,241.07	141.83	33.43	No Data
	TMDL= LA+WLA+MOS	**234.74**	**44.43**	**17.19**	**6.71**	**2.18**
	LA	210.74	39.46	14.94	5.51	1.43
	Future Growth Reserve (5%)	11.735	2.22	0.86	0.335	0.11
	WLA: Country Court MHP	0.19	0.19	0.19	0.19	0.19
	WLA: Forest Park MHP	0.34	0.34	0.34	0.34	0.34
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	11.735	2.22	0.86	0.335	0.11
	TMDL Reduction (%)	No Data	**97%**	**89%**	**82%**	No Data
TSS (kg/day)	Current Load (Median)	No Data	625	67	38	No Data
	TMDL= LA+WLA+MOS	**15,587**	**2,950**	**1,141**	**445**	**145**
	LA	14,026	2,653	1,025	398	129
	Future Growth Reserve (5%)	779.5	147.5	57	22.5	7
	WLA: Country Court MHP	1	1	1	1	1
	WLA: Forest Park MHP	1	1	1	1	1
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	779.5	147.5	57	22.5	7
	TMDL Reduction (%)	No Data	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	7,051,031	117,329	98,299	46,027	No Data
	TMDL= LA+WLA+MOS	**417,219**	**74,950**	**32,478**	**13,741**	**4,747**
	LA	375,430	67,388	29,163	12,300	4,205
	Future Growth Reserve (5%)	20,861	3,747.5	1,624	687	237.5
	WLA: Country Court MHP	24	24	24	24	24
	WLA: Forest Park MHP	43	43	43	43	43
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	20,861	3,747.5	1,624	687	237.5
	TMDL Reduction (%)	**95%**	**43%**	**70%**	**73%**	No Data

6.1.1.5 Swan Creek at RM 30.90 (P11K04)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Swan Creek upstream of State Route 64 (P11K04). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for the load duration analysis at this site (Table 6-2).

Table 6-7 presents the TMDL summary for site P11K04. NN loads need reductions of 53 percent or greater at all flow categories with available data. *E. coli* loads display 94 percent needed reductions at high flows, but the needed reductions gradually decrease as flows decrease down to no necessary reductions at dry flow conditions. No TSS reductions are displayed at this site based on the 90th percentile reference site targets.

Table 6-7 Loading Statistics for Swan Creek at RM 30.90 (P11K04).

P11K04- Swan Creek at RM 30.90 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	No Data	1,371.59	148.97	14.16	No Data
	TMDL= LA+WLA+MOS	**257.58**	**48.76**	**18.86**	**7.36**	**2.39**
	LA	231.29	43.35	16.44	6.09	1.62
	Future Growth Reserve (5%)	12.88	2.44	0.945	0.37	0.12
	WLA: Country Court MHP	0.19	0.19	0.19	0.19	0.19
	WLA: Forest Park MHP	0.34	0.34	0.34	0.34	0.34
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	12.88	2.44	0.945	0.37	0.12
	TMDL Reduction (%)	No Data	**97%**	**89%**	**53%**	No Data
TSS (kg/day)	Current Load (Median)	No Data	980	138	50	No Data
	TMDL= LA+WLA+MOS	**17,103**	**3,237**	**1,252**	**489**	**159**
	LA	15,391	2,911	1,125	438	141
	Future Growth Reserve (5%)	855	162	62.5	24.5	8
	WLA: Country Court MHP	0.34	0.34	0.34	0.34	0.34
	WLA: Forest Park MHP	0.61	0.61	0.61	0.61	0.61
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	855	162	62.5	24.5	8
	TMDL Reduction (%)	No Data	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	6,450,890	179,706	58,369	12,419	No Data
	TMDL= LA+WLA+MOS	**457,804**	**82,240**	**35,638**	**15,078**	**5,209**
	LA	411,957	73,949	32,007	13,503	4,621
	Future Growth Reserve (5%)	22,890	4,112	1,782	754	260.5
	WLA: Country Court MHP	24	24	24	24	24
	WLA: Forest Park MHP	43	43	43	43	43
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	22,890	4,112	1,782	754	260.5
	TMDL Reduction (%)	**94%**	**59%**	**45%**	**0%**	No Data

6.1.2 Subwatershed 070-020: Ai Creek

The Ai Creek subwatershed was sampled at four locations by the Ohio EPA in 2006. All four sites were on the Ai Creek mainstem at river miles 10.44, 8.29, 2.10, and 1.66. This subwatershed drains 50.58 square miles and the land cover (Table 1-5 and Figure 1-2) consists primarily of cultivated crops (71%), forest (13%), developed areas (10%), and pasture/hay (3%). A detailed map of the Ai Creek subwatershed and its TMDL station locations is provided in Figure 6-3 below.

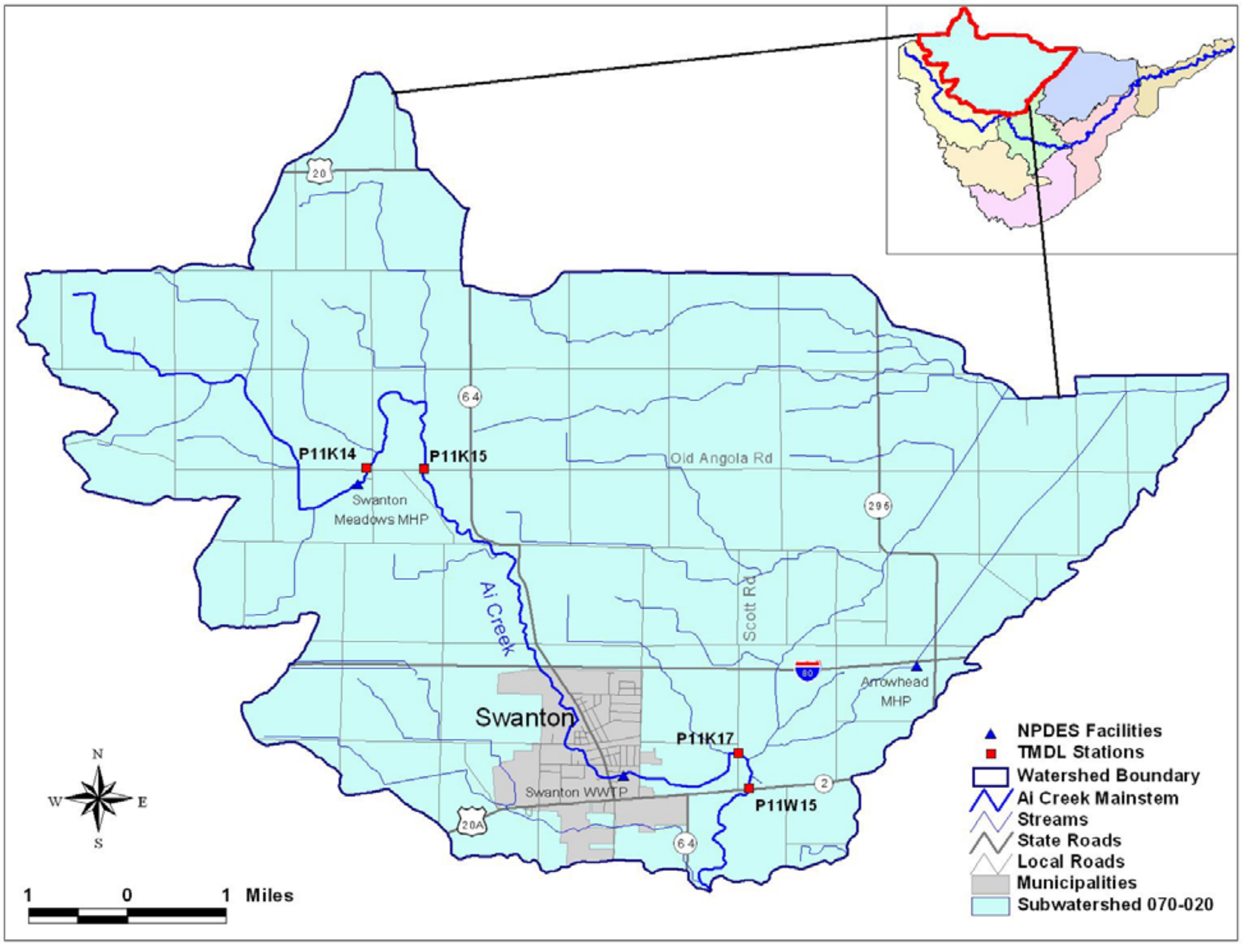


Figure 6-3 Subwatershed 070-020.

6.1.2.1 Ai Creek at RM 10.44 (P11K14)

Existing and allowable TP, NN, TSS, *E. coli*, and total copper loads were calculated for Ai Creek at County Road L in the town of Ai (P11K14). A total of 6 TP, 6 NN, 6 TSS, 8 *E. coli*, and 6 total copper samples were available for the load duration analysis at this site (Table 6-2).

Table 6-8 presents the TMDL summary for site P11K14. TP loads display increasing needed reductions with decreasing flows, from no reductions at high flows to 67 percent at dry conditions. All needed NN reductions are 64 percent or greater and all *E. coli* loads need to be reduced 89 percent or more. Total copper displays one needed reduction at dry flow conditions of 70 percent. No needed TSS reductions are displayed based on the 90th percentile reference site targets.

Table 6-8 Loading Statistics for Ai Creek at RM 10.44 (P11K14).

P11K14- Ai Creek at RM 10.44 TMD		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Total Phosphorus (kg/day)	Current Load (Median)	1.20	No Data	0.62	0.49	No Data
	TMDL= LA+WLA+MOS	**4.99**	**0.96**	**0.38**	**0.16**	**0.070**
	LA	4.54	0.71	0.16	0.084	0
	Future Growth Reserve (0%)	0	0	0	0	0
	WLA: Swanton Meadows MHP	0.20	0.20	0.20	0.066	0.066
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	0.25	0.05	0.02	0.01	0.004
	TMDL Reduction (%)	**0%**	No Data	**39%**	**67%**	No Data
Nitrate-Nitrite (kg/day)	Current Load (Median)	537.79	No Data	39.33	5.58	No Data
	TMDL= LA+WLA+MOS	**62.33**	**11.98**	**4.77**	**1.99**	**0.80**
	LA	57.17	9.34	2.49	1.09	0
	Future Growth Reserve (0%)	0.00	0.00	0.00	0.00	0
	WLA: Swanton Meadows MHP	2.04	2.04	2.04	0.80	0.76
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	3.12	0.60	0.24	0.10	0.04
	TMDL Reduction (%)	**88%**	No Data	**88%**	**64%**	No Data
TSS (kg/day)	Current Load (Median)	88	No Data	45	67	No Data
	TMDL= LA+WLA+MOS	**3,047**	**580**	**227**	**91**	**32**
	LA	2,738	518	200	78	25
	Future Growth Reserve (5%)	152.5	29	11.5	4.5	1.5
	WLA: Swanton Meadows MHP	4	4	4	4	4
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	152.5	29	11.5	4.5	1.5
	TMDL Reduction (%)	**0%**	No Data	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	1,000,644	383,312	299,465	No Data	No Data
	TMDL= LA+WLA+MOS	**110,676**	**20,115**	**8,877**	**3,920**	**1,540**
	LA	99,350	17,845	7,731	3,270	1,128
	Future Growth Reserve (5%)	5,534	1,006	444	196	77
	WLA: Swanton Meadows MHP	258	258	258	258	258
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	5,534	1,006	444	196	77
	TMDL Reduction (%)	**89%**	**95%**	**97%**	No Data	No Data
Total Copper (kg/day)	Current Load (Median)	0.177	No Data	0.025	0.223	No Data
	TMDL= LA+WLA+MOS	**2.033**	**0.391**	**0.156**	**0.066**	**0.027**
	LA	1.823	0.345	0.133	0.052	0.017
	Future Growth Reserve (5%)	0.1015	0.0195	0.008	0.0035	0.0015
	WLA: Swanton Meadows MHP	0.007	0.007	0.007	0.007	0.007
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	0.1015	0.0195	0.008	0.0035	0.0015
	TMDL Reduction (%)	**0%**	No Data	**0%**	**70%**	No Data

6.1.2.2 Ai Creek at RM 8.29 (P11K15)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Ai Creek at County Road L, east of the town of Ai (P11K15). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for the load duration analysis at this site (Table 6-2).

Table 6-9 presents the TMDL summary for site P11K15. NN loads displays 89 percent needed reductions at both high and mid-range flow conditions with a smaller reduction of 5 percent needed at dry conditions. All *E. coli* loads need to be reduced by 76 percent or more. No TSS reductions are needed at this site based on the 90th percentile reference site targets.

Table 6-9 Loading Statistics for Ai Creek at RM 8.29 (P11K15).

P11K15- Ai Creek at RM 8.29 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	1040.61	No Data	76.33	3.68	No Data
	TMDL= LA+WLA+MOS	**114.39**	**21.83**	**8.58**	**3.48**	**1.28**
	LA	100.91	17.61	5.68	2.33	0.35
	Future Growth Reserve (5%)	5.72	1.09	0.43	0.175	0.065
	WLA: Swanton Meadows MHP	2.04	2.04	2.04	0.80	0.80
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	5.72	1.09	0.43	0.175	0.065
	TMDL Reduction (%)	**89%**	No Data	**89%**	**5%**	No Data
TSS (kg/day)	Current Load (Median)	520	No Data	87	46	No Data
	TMDL= LA+WLA+MOS	**5,599**	**1,063**	**414**	**164**	**56**
	LA	5,035	953	369	144	46
	Future Growth Reserve (5%)	280	53	20.5	8	3
	WLA: Swanton Meadows MHP	4	4	4	4	4
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	280	53	20.5	8	3
	TMDL Reduction (%)	**0%**	No Data	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	2,754,031	151,281	83,184	No Data	No Data
	TMDL= LA+WLA+MOS	**203,211**	**36,738**	**16,081**	**6,967**	**2,593**
	LA	182,632	32,806	14,215	6,012	2,076
	Future Growth Reserve (5%)	10,160.5	1,837	804	348.5	129.5
	WLA: Swanton Meadows MHP	258	258	258	258	258
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	10,160.5	1,837	804	348.5	129.5
	TMDL Reduction (%)	**93%**	**76%**	**81%**	No Data	No Data

6.1.2.3 Ai Creek at RM 2.10 (P11K17)

Existing and allowable loads were calculated for Ai Creek at Scott Road (P11K17). A total of 6 TP, 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at site P11K17 (Table 6-2).

Table 6-10 presents the TMDL summary for this site. TP displays increasing needed reductions with decreasing flows and the NN and *E. coli* loads display consistently high needed reductions of 66 percent or greater. There are no needed TSS reductions at this site based on the 90th percentile reference site targets.

Table 6-10 Loading Statistics for Ai Creek at RM 2.10 (P11K17).

P11K17- Ai Creek at RM 2.10 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Total Phosphorus (kg/day)	Current Load (Median)	21.10	No Data	8.27	7.22	No Data
	TMDL= LA+WLA+MOS	**14.66**	**3.11**	**1.45**	**0.82**	**0.54**
	LA	10.25	2.28	0.71	0.11	0
	Future Growth Reserve (0%)	0	0	0	0	0
	WLA: Swanton WWTP	3.48	0.47	0.47	0.47	0.47
	WLA: Swanton Meadows MHP	0.20	0.20	0.20	0.20	0.04
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	0.73	0.16	0.07	0.04	0.03
	TMDL Reduction (%)	**31%**	No Data	**82%**	**89%**	No Data
Nitrate-Nitrite (kg/day)	Current Load (Median)	1390.00	No Data	111.25	26.83	No Data
	TMDL= LA+WLA+MOS	**182.16**	**37.76**	**17.09**	**9.14**	**5.70**
	LA	136.19	28.93	9.30	2.98	0
	Future Growth Reserve (0%)	0	0	0	0	0
	WLA: Swanton WWTP	34.82	4.90	4.90	4.90	4.90
	WLA: Swanton Meadows MHP	2.04	2.04	2.04	0.80	0.51
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	9.11	1.89	0.85	0.46	0.29
	TMDL Reduction (%)	**87%**	No Data	**85%**	**66%**	No Data
TSS (kg/day)	Current Load (Median)	2,841	No Data	108	30	No Data
	TMDL= LA+WLA+MOS	**8,801**	**1,726**	**713**	**323**	**155**
	LA	7,854	1,486	575	224	72
	Future Growth Reserve (5%)	440	86.5	35.5	16	8
	WLA: Swanton WWTP	63	63	63	63	63
	WLA: Swanton Meadows MHP	4	4	4	4	4
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	440	86.5	35.5	16	8
	TMDL Reduction (%)	**0%**	No Data	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	7,608,194	199,422	97,326	No Data	No Data
	TMDL= LA+WLA+MOS	**321,394**	**61,695**	**29,470**	**15,253**	**8,429**
	LA	284,867	51,137	22,135	9,340	3,198
	Future Growth Reserve (5%)	16,069.5	3,085	1,473.5	762.5	421.5
	WLA: Swanton WWTP	4,388	4,388	4,388	4,388	4,388
	WLA: Swanton Meadows MHP	258	258	258	258	258
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	16,069.5	3,085	1,473.5	762.5	421.5
	TMDL Reduction (%)	**96%**	**69%**	**70%**	No Data	No Data

6.1.2.4 Ai Creek at RM 1.66 (P11W15)

Existing and allowable TP, NN, TSS, and *E. coli* loads were calculated for Ai Creek at State Route 2 (P11W15). A total of 6 TP, 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at this site (Table 6-2).

Table 6-11 presents the TMDL summary for site P11W15. The needed TP reductions increase from 19 to 88 percent as flows decrease from high to dry conditions. Both NN and *E. coli* display needed reductions of 65 percent or greater at all flow conditions with available data. No TSS reductions are needed at this station based on the 90th percentile reference site targets.

Table 6-11 Loading Statistics for Ai Creek at RM 1.66 (P11W15).

P11W15- Ai Creek at RM 1.66 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Total Phosphorus (kg/day)	Current Load (Median)	60.79	No Data	13.86	14.79	No Data
	TMDL= LA+WLA+MOS	**49.16**	**9.20**	**3.72**	**1.71**	**0.84**
	LA	40.34	7.51	2.60	0.93	0.15
	Future Growth Reserve (5%)	2.46	0.46	0.185	0.085	0.04
	WLA: Swanton WWTP	3.48	0.47	0.47	0.47	0.47
	WLA: Swanton Meadows MHP	0.20	0.20	0.20	0.07	0.07
	WLA: Arrowhead Lake MHP	0.07	0.07	0.07	0.07	0.07
	WLA: Spencer Twp/Lucas Co MS4	0.15	0.03	0.01	0.00	0.00
	MOS (5%)	2.46	0.46	0.185	0.085	0.04
	TMDL Reduction (%)	**19%**	No Data	**73%**	**88%**	No Data
Nitrate-Nitrite (kg/day)	Current Load (Median)	2847.27	No Data	244.46	69.82	No Data
	TMDL= LA+WLA+MOS	**491.59**	**92.06**	**37.10**	**17.00**	**8.31**
	LA	403.44	74.96	25.68	8.92	1.10
	Future Growth Reserve (5%)	24.58	4.605	1.855	0.85	0.415
	WLA: Swanton WWTP	34.82	4.90	4.90	4.90	4.90
	WLA: Swanton Meadows MHP	2.04	2.04	2.04	0.80	0.80
	WLA: Arrowhead Lake MHP	0.68	0.68	0.68	0.68	0.68
	WLA: Spencer Twp/Lucas Co MS4	1.45	0.27	0.09	0.00	0.00
	MOS (5%)	24.58	4.605	1.855	0.85	0.415
	TMDL Reduction (%)	**83%**	No Data	**85%**	**76%**	No Data
TSS (kg/day)	Current Load (Median)	10,517	No Data	452	76	No Data
	TMDL= LA+WLA+MOS	**29,976**	**5,736**	**2,265**	**930**	**354**
	LA	26,812	5,075	1,962	768	250
	Future Growth Reserve (5%)	1,499	287	113.5	46.5	17.5
	WLA: Swanton WWTP	63	63	63	63	63
	WLA: Swanton Meadows MHP	4	4	4	4	4
	WLA: Arrowhead Lake MHP	2	2	2	2	2
	WLA: Spencer Twp/Lucas Co MS4	97	18	7	0	0
	MOS (5%)	1,499	287	113.5	46.5	17.5
	TMDL Reduction (%)	**0%**	No Data	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	14,822,129	427,789	221,454	No Data	No Data
	TMDL= LA+WLA+MOS	**805,550**	**148,980**	**67,508**	**31,564**	**14,311**
	LA	717,679	128,886	55,824	23,676	8,148
	Future Growth Reserve (5%)	40,277.5	7,449	3,375.5	1,578	715.5
	WLA: Swanton WWTP	4,388	4,388	4,388	4,388	4,388
	WLA: Swanton Meadows MHP	258	258	258	258	258
	WLA: Arrowhead Lake MHP	86	86	86	86	86
	WLA: Spencer Twp/Lucas Co MS4	2584	464	201	0	0
	MOS (5%)	40,277.5	7,449	3,375.5	1,578	715.5
	TMDL Reduction (%)	**95%**	**65%**	**70%**	No Data	No Data

6.1.3 Subwatershed 070-030: Swan Creek below Ai Creek to above Blue Creek

The 070-030 subwatershed was sampled at one location on the Swan Creek mainstem (RM 24.70) by the Ohio EPA in 2006. This subwatershed drains 16.90 square miles and the land cover (Table 1-5 and Figure 1-2) consists primarily of forest (55%), pasture/hay (16%), developed areas (13%), and cultivated crops (10%). A detailed map of the 070-030 subwatershed and its TMDL station location is provided in Figure 6-4 below.

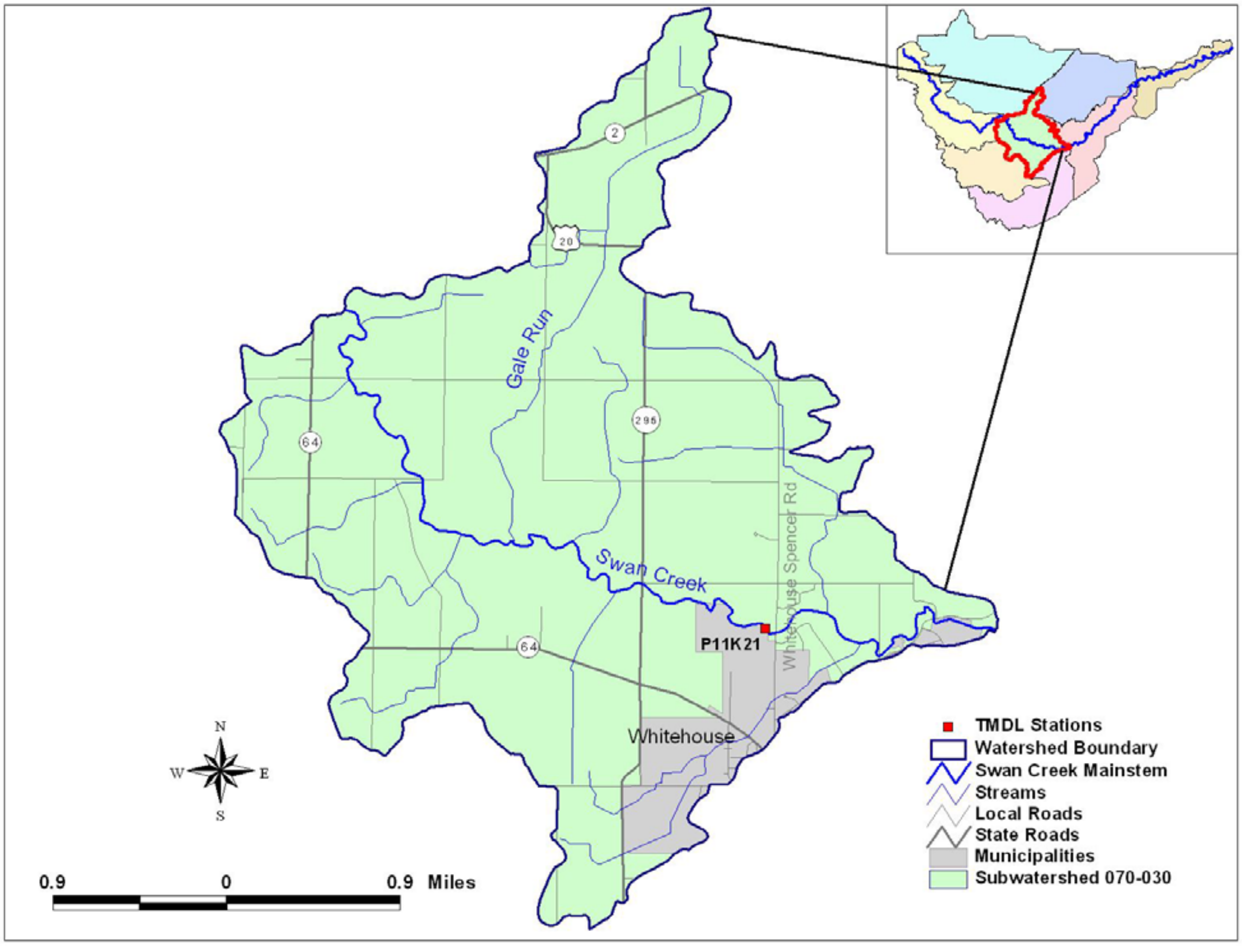


Figure 6-4 Subwatershed 070-030.

6.1.3.1 Swan Creek at RM 24.70 (P11K21)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Swan Creek at Spencer Road (P11K21). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at this site (Table 6-2).

Table 6-12 presents the TMDL summary for site P11K21. The needed NN load reductions increase with increasing flow conditions, and are all above 12 percent. *E. coli* needed reductions range from zero (moist conditions) to 95 percent (high flows) and TSS loads display a 2 percent needed reduction at moist flow conditions based on the 90th percentile reference site targets.

Table 6-12 Loading Statistics for Swan Creek at RM 24.70 (P11K21).

P11K21- Swan Creek at RM 24.70 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	No Data	3246.59	269.79	31.62	No Data
	TMDL= LA+WLA+MOS	**854.80**	**161.27**	**64.23**	**27.94**	**12.26**
	LA	729.80	136.72	49.56	18.24	4.12
	Future Growth Reserve (5%)	42.74	8.065	3.21	1.395	0.615
	WLA: Swanton WWTP	34.82	4.90	4.90	4.90	4.90
	WLA: Swanton Meadows MHP	2.04	2.04	2.04	0.80	0.80
	WLA: Arrowhead Lake MHP	0.68	0.68	0.68	0.68	0.68
	WLA: Country Court MHP	0.19	0.19	0.19	0.19	0.19
	WLA: Forest Park MHP	0.34	0.34	0.34	0.34	0.34
	WLA: Spencer Twp/Lucas Co MS4	1.45	0.27	0.10	0.00	0.00
	MOS (5%)	42.74	8.065	3.21	1.395	0.615
	TMDL Reduction (%)	No Data	**95%**	**76%**	**12%**	No Data
TSS (kg/day)	Current Load (Median)	No Data	10,513	823	314	No Data
	TMDL= LA+WLA+MOS	**54,056**	**10,295**	**4,030**	**1,620**	**579**
	LA	48,482	9,176	3,549	1,387	450
	Future Growth Reserve (5%)	2,703	515	201.5	81	29
	WLA: Swanton WWTP	63	63	63	63	63
	WLA: Swanton Meadows MHP	4	4	4	4	4
	WLA: Arrowhead Lake MHP	2	2	2	2	2
	WLA: Country Court MHP	1	1	1	1	1
	WLA: Forest Park MHP	1	1	1	1	1
	WLA: Spencer Twp/Lucas Co MS4	97	18	7	0	0
	MOS (5%)	2,703	515	201.5	81	29
	TMDL Reduction (%)	No Data	**2%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	29,911,462	100,526	159,972	182,910	No Data
	TMDL= LA+WLA+MOS	**1,450,121**	**264,832**	**117,753**	**52,865**	**21,718**
	LA	1,297,726	233,086	100,978	42,779	14,747
	Future Growth Reserve (5%)	72,506	13,241.5	5,887.5	2,643.5	1,086
	WLA: Swanton WWTP	4,388	4,388	4,388	4,388	4,388
	WLA: Swanton Meadows MHP	258	258	258	258	258
	WLA: Arrowhead Lake MHP	86	86	86	86	86
	WLA: Country Court MHP	24	24	24	24	24
	WLA: Forest Park MHP	43	43	43	43	43
	WLA: Spencer Twp/Lucas Co MS4	2584	464	201	0	0
	MOS (5%)	72,506	13,241.5	5,887.5	2,643.5	1,086
	TMDL Reduction (%)	**95%**	**0%**	**26%**	**71%**	No Data

6.2 Assessment Unit 04100009-080: Lower Swan Creek (upstream Blue Creek to mouth)

The load duration approach was applied to eighteen sampling stations located within the lower Swan Creek assessment unit (Figure 6-5). For each load duration site, all appropriate and available water quality and flow data were used. Table 6-13 summarizes all data used for the load duration analyses in the lower Swan Creek assessment unit. This assessment unit is divided into five 14-digit subwatersheds that are further discussed in the following subsections. Detailed reports for each TMDL can be found in Appendix A, and the alternative TSS TMDLs are presented in Appendix B.

Table 6-13 Summary of available data for the lower Swan Creek assessment unit.

Stream (River Mile)	Sample Site ID (STORET #)	Location	14-Digit Subwatershed	TMDL Parameters*	Count	Average	Minimum	Maximum	Period of Record
Blue Creek (9.97)	P11K11	At Fulton CR-3	04100009-080-010	TP	6	0.05	0.03	0.10	6/14/2006-8/23/2006
				E. coli	8	646	330	1100	
				TSS	6	6.3	5.0	13.0	
Blue Creek (7.80)	P11P39	At Manore Road	04100009-080-010	TP	6	0.08	0.03	0.18	6/14/2006-8/23/2006
				NN	6	2.29	0.48	4.80	
				E. coli	8	1981	540	6500	
				TSS	6	5.2	5.0	6.0	
Blue Creek (5.57)	P11K12	At SR-295	04100009-080-010	TP	6	0.09	0.04	0.20	6/14/2006-8/23/2006
				NN	6	2.25	0.57	5.06	
				E. coli	8	1656	785	5000	
				TSS	6	7.2	5.0	11.0	
Harris Ditch (1.55)	P11K13	At SR-295	04100009-080-020	TP	6	0.10	0.02	0.25	6/14/2006-8/23/2006
				NN	6	3.55	0.26	8.14	
				E. coli	8	1333	530	2900	
				Aluminum	6	1184	200	3030	
				TSS	6	55.3	5.0	145.0	
Blue Creek (0.73)	P11P13	At Finzel Road	04100009-080-020	NN	6	3.35	0.46	7.76	6/14/2006-8/23/2006
				E. coli	8	2459	395	10000	
				TSS	6	6.6	5.0	11.0	
Swan Creek (21.60)	P11S11	NE of Whitehouse, at Stitt Road	04100009-080-030	TP	6	0.16	0.11	0.24	6/13/2006-8/22/2006
				NN	6	4.70	1.46	9.65	
				E. coli	8	3776	230	13000	
				TSS	6	15.0	11.0	23.0	
Swan Creek (18.50)	P11K05	Monclova Road at Albon Road	04100009-080-030	TP	6	0.12	0.10	0.18	6/13/2006-8/22/2006
				NN	6	4.80	0.94	9.86	
				E. coli	8	1119	100	5800	
				TSS	6	9.7	5.0	20.0	
Blystone Ditch (0.54)	P11A03	At Monclova Road	04100009-080-030	TP	6	0.23	0.04	0.63	6/14/2006-8/23/2006
				NN	6	1.76	0.51	6.12	
				E. coli	8	3716	440	10000	
				TSS	6	10.2	6.0	26.0	
Swan Creek (15.30)	P11P09	Upstream of Salisbury Road	04100009-080-030	TP	6	0.11	0.09	0.13	6/13/2006-8/22/2006
				NN	6	4.59	0.97	9.88	
				E. coli	8	548	210	1700	
				TSS	6	11.5	6.0	24.0	

Stream (River Mile)	Sample Site ID (STORET #)	Location	14-Digit Subwatershed	TMDL Parameters*	Count	Average	Minimum	Maximum	Period of Record
Wolf Creek (4.06)	P11K09	At Albon Road	04100009-080-040	NN	6	1.70	1.03	2.72	6/15/2006-8/24/2006
				E. coli	8	1671	26	5500	
				TSS	6	6.7	5.0	10.0	
Wolf Creek (1.96)	P11S66	At Perrysburg-Holland Road	04100009-080-040	TP	6	0.06	0.04	0.12	6/15/2006-8/24/2006
				NN	6	1.07	0.89	1.49	
				E. coli	8	1552	450	5000	
				Aluminum	6	354	200	1050	
				TSS	6	12.2	5.0	32.0	
Cairl Creek (1.32)	P11K10	At Pilliad Road	041900009-080-040	TP	6	0.07	0.04	0.14	6/15/2006-8/24/2006
				NN	6	3.48	2.21	5.64	
				E. coli	8	1043	640	1600	
				TSS	6	20.0	5.0	44.0	
Wolf Creek (0.48)	P11P18	At Hollan-Sylvania Road	04100009-080-040	TP	6	0.10	0.06	0.27	6/15/2006-8/24/2006
				NN	6	1.55	0.94	2.12	
				E. coli	8	2127	2	10000	
				Aluminum	6	581	200	1135	
				Benzo[a]pyrene	2	0.93	0.53	1.32	
				TSS	6	30.6	11.5	55.0	
Swan Creek (10.84)	P11P08	At US-20	04100009-080-050	NN	6	4.66	0.92	9.56	6/13/2006-8/22/2006
				E. coli	8	656	330	1600	
				TSS	6	16.8	9.0	33.0	
Heilman Ditch (3.01)	P11K20	At US-20	04100009-080-050	TP	6	1.03	0.31	2.11	6/15/2006-8/24/2006
				NN	6	7.79	3.31	16.40	
				E. coli	8	5640	170	12000	
				Ammonia	6	7.12	3.65	19.10	
				Dissolved Solids	6	1597	914	1890	
				Strontium	6	15195	1670	19900	
				TSS	6	7.5	5.0	9.0	
Swan Creek (4.20)	P11P05	Downstream of South Avenue	04100009-080-050	TP	6	0.19	0.09	0.50	6/13/2006-8/22/2006
				NN	6	4.13	1.16	8.09	
				E. coli	8	537	190	1400	
				Dieldrin	2	0.0033	0.0021	0.0045	
				TSS	6	11.3	6.0	26.0	
Swan Creek (1.60)	P11P03	At City Park Avenue	04100009-080-050	TP	6	0.13	0.09	0.22	6/13/2006-8/22/2006
				NN	6	4.32	1.43	8.94	
				E. coli	8	897	230	2400	
				TSS	6	9.0	5.0	27.0	

Stream (River Mile)	Sample Site ID (STORET #)	Location	14-Digit Subwatershed	TMDL Parameters*	Count	Average	Minimum	Maximum	Period of Record
Swan Creek (0.19)	P11K07	At OC Bridge	04100009-080-050	TP	6	0.13	0.08	0.25	6/13/2006-8/22/2006
				NN	6	4.09	0.56	8.46	
				E. coli	8	377	28	1500	
				Aluminum	6	701	307	1080	
				Dieldrin	2	0.0039	0.0022	0.0057	
				TSS	6	26.0	11.0	45.5	

*UNITS: TP, NN, TSS, dissolved solids, and ammonia are in mg/l; *E. coli* is in #/100ml; aluminum, benzo[a]pyrene, strontium, and dieldrin are in µg/l

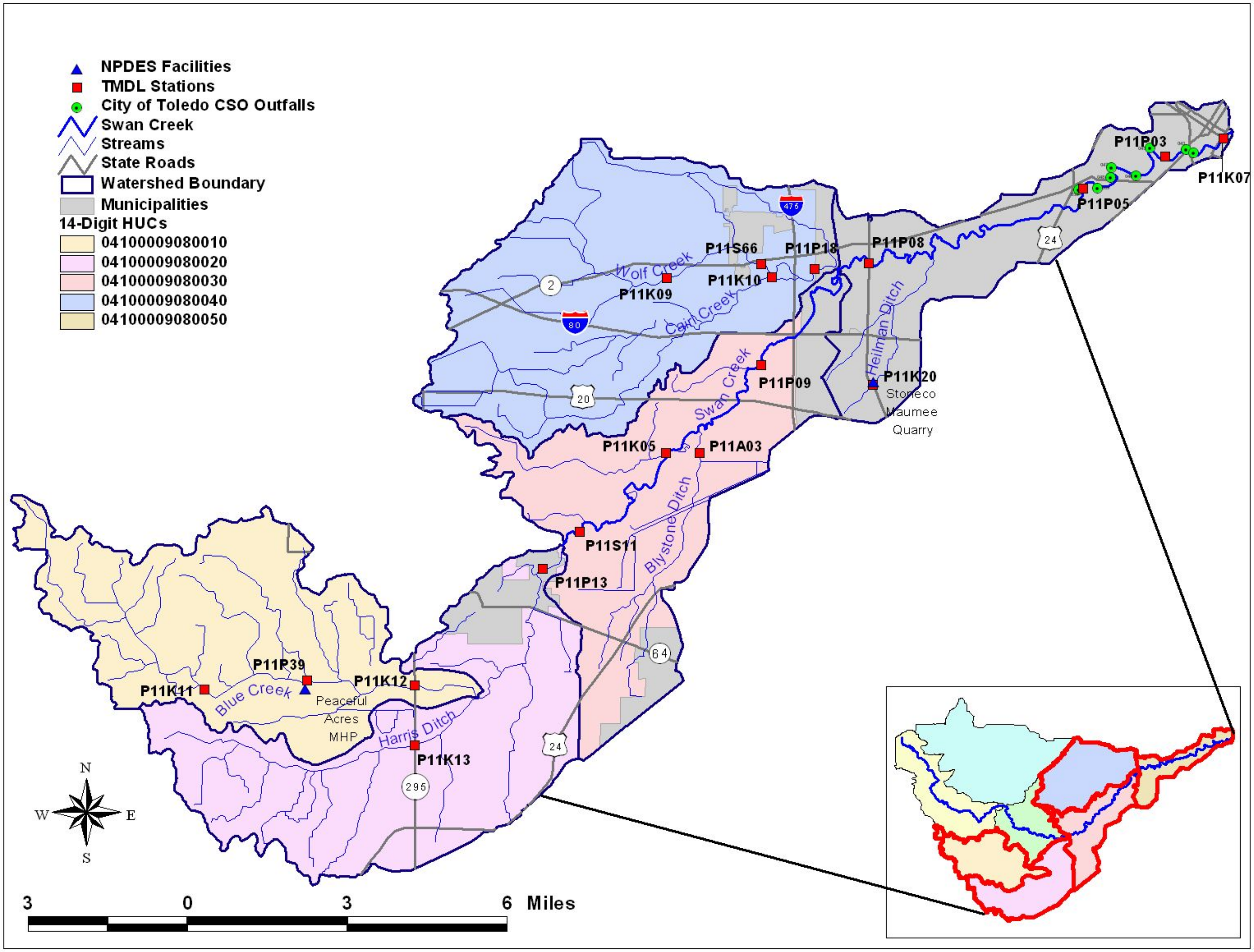


Figure 6-5 Load duration sites within the lower Swan Creek assessment unit.

6.2.1 Subwatershed 080-010: Blue Creek headwaters to above Harris Ditch

The Blue Creek headwaters subwatershed was sampled at three locations by the Ohio EPA in 2006. All three sites are on the Blue Creek mainstem at river miles 9.97, 7.80, and 5.57. This subwatershed drains 26.16 square miles and the land cover (Table 1-5 and Figure 1-2) consists primarily of cultivated crops (49%), forest (32%), developed areas (9%), and pasture/hay (8%). A detailed map of the 080-010 subwatershed and its TMDL station locations is provided in Figure 6-6 below.

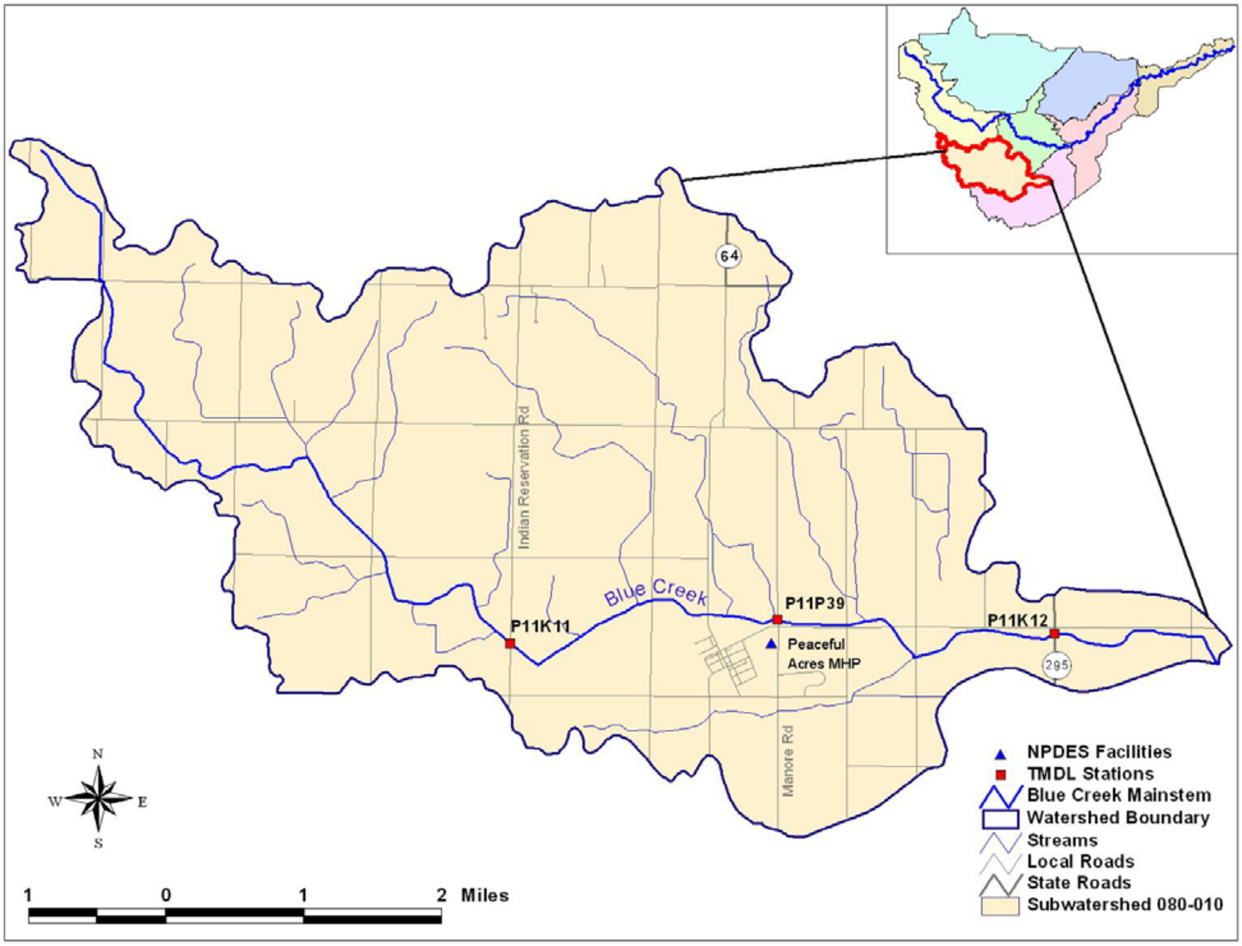


Figure 6-6 Subwatershed 080-010.

6.2.1.1 Blue Creek at RM 9.97 (P11K11)

Existing and allowable TSS and *E. coli* loads were calculated for Blue Creek at Fulton County Road 3 (P11K11). A total of 6 TSS and 8 *E. coli* samples were available for load duration analysis at this site (Table 6-13).

Table 6-14 presents the TMDL summary for site P11K11. Needed *E. coli* reductions range from zero percent at moist conditions to 77 percent at high flows. No TSS reductions are needed at this site based on the 90th percentile reference site targets. There are no NPDES permitted facilities or MS4 discharges upstream of this TMDL station.

Table 6-14 Loading Statistics for Blue Creek at RM 9.97 (P11K11).

P11K11- Blue Creek at RM 9.97 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
TSS (kg/day)	Current Load (Median)	168	55	31	9	No Data
	TMDL= LA+WLA+MOS	**3,312**	**627**	**242**	**95**	**31**
	LA	2,981	564	218	86	28
	Future Growth Reserve (5%)	165.5	31.5	12	4.5	1.5
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	165.5	31.5	12	4.5	1.5
	TMDL Reduction (%)	**0%**	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	461,452	16,729	22,933	10,054	No Data
	TMDL= LA+WLA+MOS	**120,133**	**21,581**	**9,352**	**3,957**	**1,367**
	LA	108,120	19,423	8,417	3,561	1,230
	Future Growth Reserve (5%)	6,006.5	1,079	467.5	198	68.5
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	6,006.5	1,079	467.5	198	68.5
	TMDL Reduction (%)	**77%**	**0%**	**63%**	**65%**	No Data

6.2.1.2 Blue Creek at RM 7.81 (P11P39)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Blue Creek at Manore Road (P11P39). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at site (Table 6-13).

Table 6-15 presents the TMDL summary for site P11P39. NN and *E. coli* loads need 34 percent or greater reductions across high to dry flow conditions, and no TSS loads display needed reductions at this site based on the 90th percentile reference site targets.

Table 6-15 Loading Statistics for Blue Creek at RM 7.81 (P11P39).

P11P39- Blue Creek at RM 7.81 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	215.84	183.62	14.44	8.54	No Data
	TMDL= LA+WLA+MOS	**118.35**	**22.82**	**9.15**	**3.89**	**1.15**
	LA	106.04	20.07	7.76	3.03	0.56
	Future Growth Reserve (5%)	5.92	1.14	0.46	0.195	0.06
	WLA: Peaceful Acres MHP	0.47	0.47	0.47	0.47	0.47
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	5.92	1.14	0.46	0.195	0.06
	TMDL Reduction (%)	**45%**	**88%**	**37%**	**54%**	No Data
TSS (kg/day)	Current Load (Median)	585	191	19	17	No Data
	TMDL= LA+WLA+MOS	**5,775**	**1,094**	**424**	**166**	**55**
	LA	5,196	984	381	148	48
	Future Growth Reserve (5%)	289	54.5	21	8.5	3
	WLA: Peaceful Acres MHP	1	1	1	1	1
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	289	54.5	21	8.5	3
	TMDL Reduction (%)	**0%**	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	1,908,800	57,441	68,383	100,155	No Data
	TMDL= LA+WLA+MOS	**209,487**	**37,687**	**16,368**	**6,963**	**2,449**
	LA	188,478	33,858	14,671	6,207	2,144
	Future Growth Reserve (5%)	10,474.5	1,884.5	818.5	348	122.5
	WLA: Peaceful Acres MHP	60	60	60	60	60
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	10,474.5	1,884.5	818.5	348	122.5
	TMDL Reduction (%)	**89%**	**34%**	**76%**	**93%**	No Data

6.2.1.3 Blue Creek at RM 5.57 (P11K12)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Blue Creek at State Route 295 (P11K12). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at this site (Table 6-13).

Table 6-16 presents the TMDL summary for site P11K12. NN and *E. coli* loads display needed reductions of at least 35 percent across all flow conditions with available data. TSS loads display no needed reductions at this site based on the 90th percentile reference site targets.

Table 6-16 Loading Statistics for Blue Creek at RM 5.57 (P11K12).

P11K12- Blue Creek at RM 5.57 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	553.37	405.56	28.73	13.80	No Data
	TMDL= LA+WLA+MOS	**247.13**	**47.20**	**18.58**	**7.57**	**2.35**
	LA	221.95	42.01	16.25	6.34	1.64
	Future Growth Reserve (5%)	12.355	2.36	0.93	0.38	0.12
	WLA: Peaceful Acres MHP	0.47	0.47	0.47	0.47	0.47
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	12.355	2.36	0.93	0.38	0.12
	TMDL Reduction (%)	**55%**	**88%**	**35%**	**45%**	No Data
TSS (kg/day)	Current Load (Median)	2,693	200	109	46	No Data
	TMDL= LA+WLA+MOS	16,376	3,101	1,200	469	153
	LA	**14,737**	**2,790**	**1,079**	**421**	**137**
	Future Growth Reserve (5%)	819	155	60	23.5	7.5
	WLA: Peaceful Acres MHP	1	1	1	1	1
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	819	155	60	23.5	7.5
	TMDL Reduction (%)	**0%**	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	5,136,637	188,662	154,577	58,770	No Data
	TMDL= LA+WLA+MOS	**438,389**	**78,807**	**34,187**	**14,502**	**5,053**
	LA	394,490	70,866	30,708	12,992	4,488
	Future Growth Reserve (5%)	21,919.5	3,940.5	1,709.5	725	252.5
	WLA: Peaceful Acres MHP	60	60	60	60	60
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	21,919.5	3,940.5	1,709.5	725	252.5
	TMDL Reduction (%)	**91%**	**58%**	**78%**	**75%**	No Data

6.2.2 Subwatershed 080-020: Blue Creek above Harris Ditch to Swan Creek

The 080-020 subwatershed includes the lower segments of Blue Creek and Harris Ditch. Two sites were sampled by the Ohio EPA in 2006: one Blue Creek site and one site on Harris ditch. This subwatershed drains 23.64 square miles and the land cover (Table 1-5 and Figure 1-2) consists primarily of cultivated crops (79%), forest (10%), and developed areas (9%). A detailed map of the 080-020 subwatershed and its TMDL station locations is provided in Figure 6-7 below.

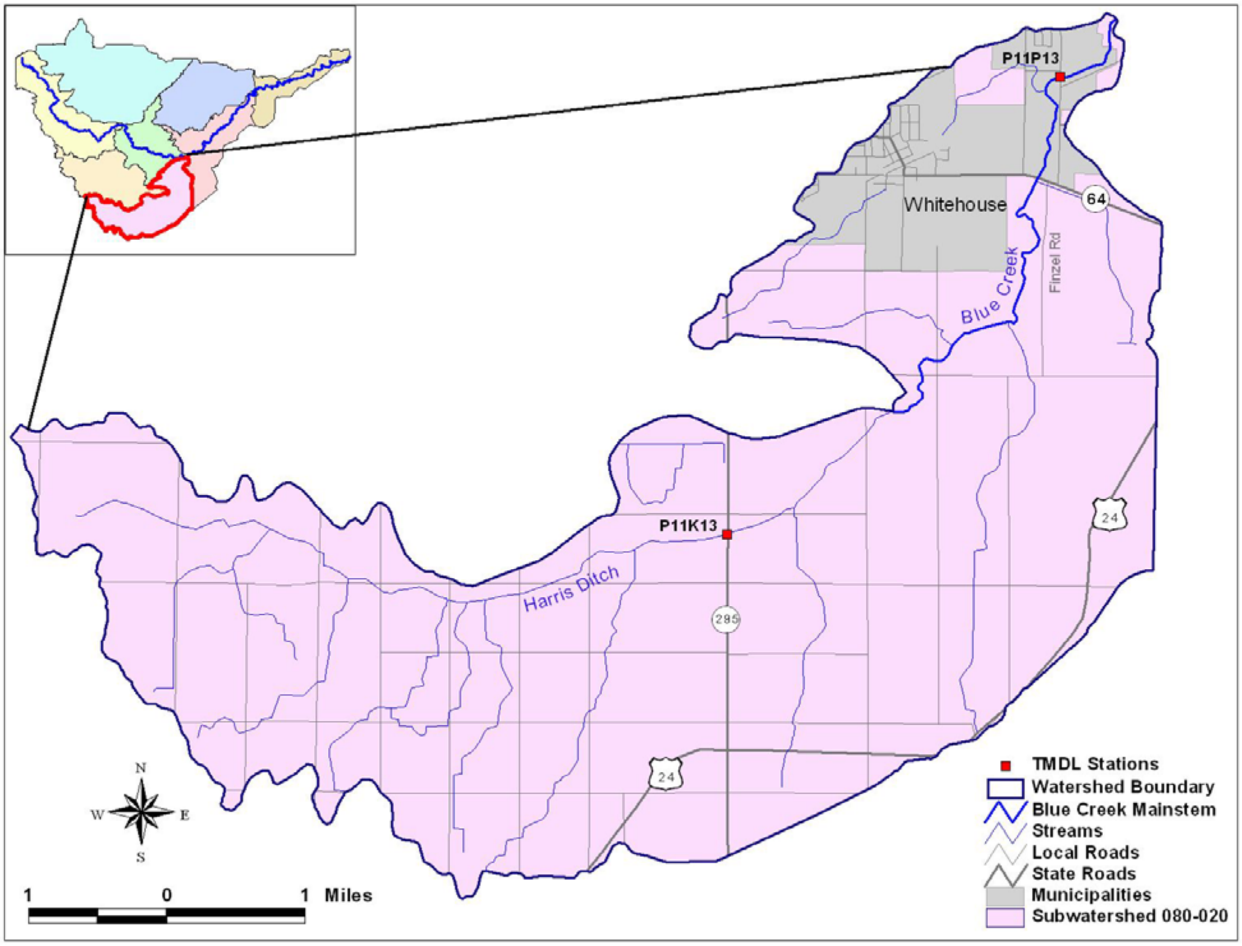


Figure 6-7 Subwatershed 080-020.

6.2.2.1 Harris Ditch at RM 1.55 (P11K13)

Existing and allowable NN, TSS, *E. coli*, and total aluminum loads were calculated for Harris Ditch at State Route 295 (P11K13). A total of 6 NN, 6 TSS, 8 *E. coli*, and 6 total aluminum samples were available for load duration analysis at this tributary site (Table 6-13).

Table 6-17 presents the TMDL summary for site P11K13. NN loads need to be reduced by 26 percent or greater and *E. coli* loads are all well over the allowable limit with 63 percent or greater reductions shown. TSS and total aluminum loads display similar needed reductions with around 35 percent at mid-range flows and 45 percent at dry conditions. There are no NPDES permitted facilities or MS4s upstream of this sampling station.

Table 6-17 Loading Statistics for Harris Ditch at RM 1.55 (P11K13).

P11K13- Harris Ditch at RM 1.55 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	238.81	186.06	6.29	11.14	No Data
	TMDL= LA+WLA+MOS	**70.33**	**13.31**	**5.15**	**2.01**	**0.65**
	LA	63.30	11.98	4.64	1.81	0.58
	Future Growth Reserve (5%)	3.515	0.665	0.255	0.1	0.035
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	3.515	0.665	0.255	0.1	0.035
	TMDL Reduction (%)	**73%**	**94%**	**26%**	**84%**	No Data
TSS (kg/day)	Current Load (Median)	559	57	347	159	No Data
	TMDL= LA+WLA+MOS	**3,446**	**652**	**252**	**98**	**32**
	LA	3,101	587	227	88	29
	Future Growth Reserve (5%)	172.5	32.5	12.5	5	1.5
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	172.5	32.5	12.5	5	1.5
	TMDL Reduction (%)	**0%**	**0%**	**35%**	**44%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	977,600	63,298	23,398	61,918	No Data
	TMDL= LA+WLA+MOS	**125,003**	**22,456**	**9,731**	**4,117**	**1,422**
	LA	112,503	20,210	8,758	3,705	1,280
	Future Growth Reserve (5%)	6,250	1,123	486.5	206	71
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	6,250	1,123	486.5	206	71
	TMDL Reduction (%)	**88%**	**68%**	**63%**	**94%**	No Data
Total Aluminum (kg/day)	Current Load (Median)	6.98	2.29	7.15	3.39	No Data
	TMDL= LA+WLA+MOS	**68.22**	**12.91**	**4.99**	**1.95**	**0.63**
	LA	61.40	11.62	4.49	1.76	0.57
	Future Growth Reserve (5%)	3.41	0.645	0.25	0.095	0.03
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	3.41	0.645	0.25	0.095	0.03
	TMDL Reduction (%)	**0%**	**0%**	**37%**	**48%**	No Data

6.2.2.2 Blue Creek at RM 0.73 (P11P13)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Blue Creek at Finzel Road (P11P13). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at site (Table 6-13).

Table 6-18 presents the TMDL summary for site P11P13. *E. coli* loads are consistently above the allowable limit resulting in 15 percent or greater needed reductions. No TSS reductions are needed at this site based on the 90th percentile reference site targets.

Table 6-18 Loading Statistics for Blue Creek at RM 0.73 (P11P13).

P11P13- Blue Creek at RM 0.73 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	1105.74	1025.09	48.42	53.92	No Data
	TMDL= LA+WLA+MOS	**406.98**	**77.46**	**30.28**	**12.13**	**3.83**
	LA	365.81	69.24	26.78	10.45	2.98
	Future Growth Reserve (5%)	20.35	3.875	1.515	0.605	0.19
	WLA: Peaceful Acres MHP	0.47	0.47	0.47	0.47	0.47
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	20.35	3.875	1.515	0.605	0.19
	TMDL Reduction (%)	**63%**	**92%**	**37%**	**78%**	No Data
TSS (kg/day)	Current Load (Median)	4,439	925	144	81	No Data
	TMDL= LA+WLA+MOS	**26,990**	**5,110**	**1,977**	**772**	**252**
	LA	24,290	4,598	1,778	694	226
	Future Growth Reserve (5%)	1,349.5	255.5	99	38.5	12.5
	WLA: Peaceful Acres MHP	1	1	1	1	1
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	1,349.5	255.5	99	38.5	12.5
	TMDL Reduction (%)	**0%**	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	11,993,414	152,423	103,503	88,842	No Data
	TMDL= LA+WLA+MOS	**722,487**	**129,843**	**56,303**	**23,859**	**8,286**
	LA	650,178	116,799	50,613	21,413	7,397
	Future Growth Reserve (5%)	36,124.5	6,492	2,815	1,193	414.5
	WLA: Peaceful Acres MHP	60	60	60	60	60
	WLA: MS4	n/a	n/a	n/a	n/a	n/a
	MOS (5%)	36,124.5	6,492	2,815	1,193	414.5
	TMDL Reduction (%)	**94%**	**15%**	**46%**	**73%**	No Data

6.2.3 Subwatershed 080-030: Swan Creek below Blue Creek to above Wolf Creek

This Swan Creek subwatershed was sampled at four locations by the Ohio EPA in 2006: three Swan Creek mainstem sites and one site on Blystone Ditch. This subwatershed drains 22.27 square miles and the land cover (Table 1-5 and Figure 1-2) consists primarily of cultivated crops (60%), developed areas (27%), and forest (9%). A detailed map of the 080-030 subwatershed and its TMDL station locations is provided in Figure 6-8 below.

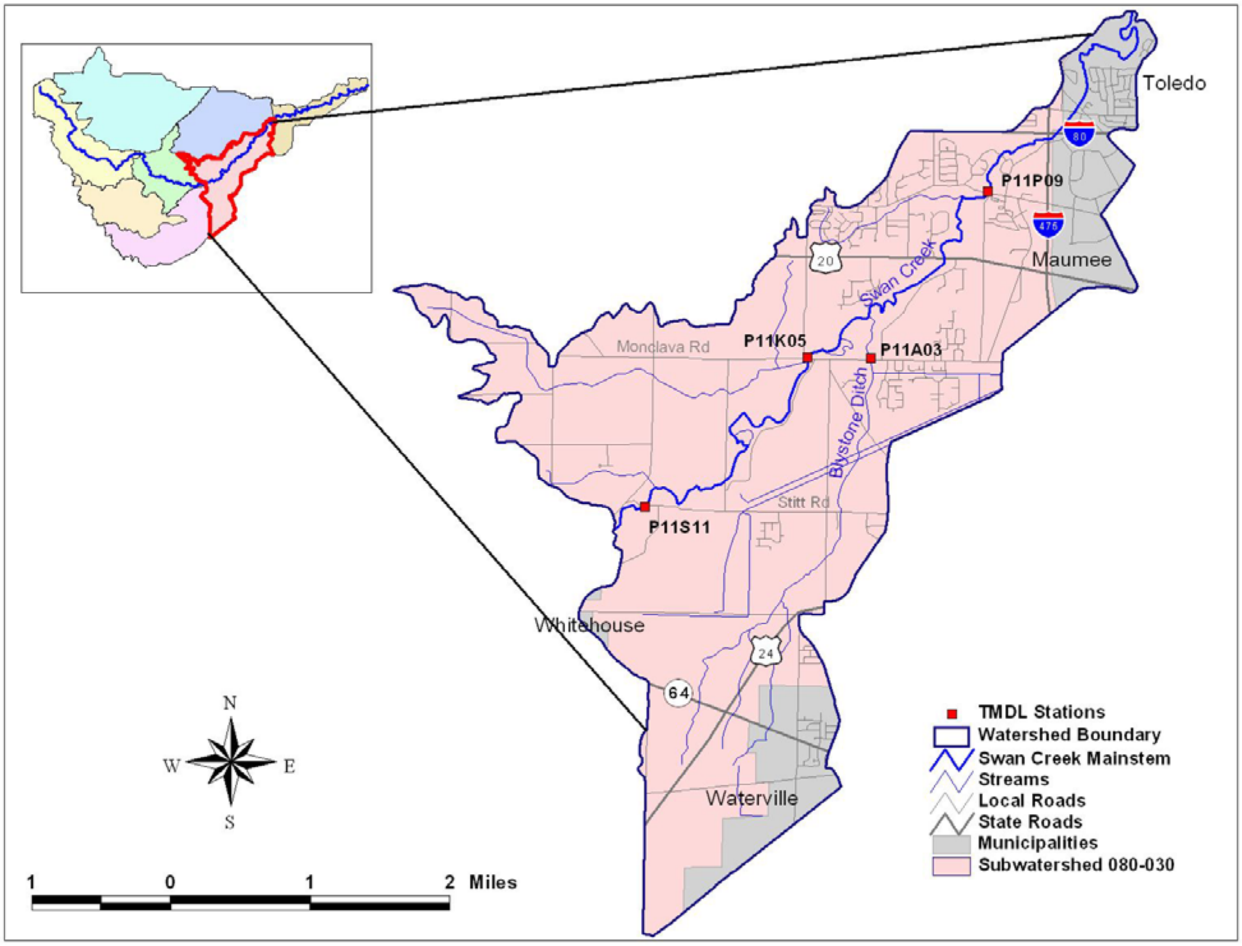


Figure 6-8 Subwatershed 080-030.

6.2.3.1 Swan Creek at RM 21.60 (P11S11)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Swan Creek at Stitt Road (P11S11). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at this mainstem site (Table 6-13).

Table 6-19 displays the TMDL summary for site P11S11. Needed NN load reductions appear to increase with increasing flow conditions at this site from 45 to 95 percent. *E. coli* loads display needed reductions of 20 to 97 percent and based on the 90th percentile reference site statistics, no TSS load reductions are needed at site P11S11.

Table 6-19 Loading Statistics for Swan Creek at RM 21.60 (P11S11).

P11S11- Swan Creek at RM 21.60 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	No Data	4693.57	398.86	60.01	No Data
	TMDL= LA+WLA+MOS	**1321.13**	**249.97**	**98.85**	**41.77**	**16.63**
	LA	1149.03	216.08	80.24	30.21	7.59
	Future Growth Reserve (5%)	66.055	12.5	4.945	2.09	0.83
	WLA: Swanton WWTP	34.82	4.90	4.90	4.90	4.90
	WLA: Swanton Meadows MHP	2.04	2.04	2.04	0.80	0.80
	WLA: Arrowhead Lake MHP	0.68	0.68	0.68	0.68	0.68
	WLA: Country Court MHP	0.19	0.19	0.19	0.19	0.19
	WLA: Forest Park MHP	0.34	0.34	0.34	0.34	0.34
	WLA: Peaceful Acres MHP	0.47	0.47	0.47	0.47	0.47
	WLA: Spencer Twp/Lucas Co MS4	1.45	0.27	0.10	0.00	0.00
	MOS (5%)	66.055	12.5	4.945	2.09	0.83
	TMDL Reduction (%)	No Data	**95%**	**75%**	**30%**	No Data
TSS (kg/day)	Current Load (Median)	No Data	11,187	1,312	452	No Data
	TMDL= LA+WLA+MOS	**84,988**	**16,151**	**6,296**	**2,505**	**867**
	LA	76,320	14,446	5,587	2,182	708
	Future Growth Reserve (5%)	4,249.5	807.5	315	125.5	43.5
	WLA: Swanton WWTP	63	63	63	63	63
	WLA: Swanton Meadows MHP	4	4	4	4	4
	WLA: Arrowhead Lake MHP	2	2	2	2	2
	WLA: Country Court MHP	1	1	1	1	1
	WLA: Forest Park MHP	1	1	1	1	1
	WLA: Peaceful Acres MHP	1	1	1	1	1
	WLA: Spencer Twp/Lucas Co MS4	97	18	7	0	0
	MOS (5%)	4,249.5	807.5	315	125.5	43.5
	TMDL Reduction (%)	No Data	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	66,387,410	459,666	271,736	411,033	No Data
	TMDL= LA+WLA+MOS	**2,278,131**	**413,631**	**182,270**	**80,199**	**31,205**
	LA	2,042,875	366,945	158,983	67,320	23,225
	Future Growth Reserve (5%)	113,906.5	20,681.5	9,113.5	4,010	1,560.5
	WLA: Swanton WWTP	4,388	4,388	4,388	4,388	4,388
	WLA: Swanton Meadows MHP	258	258	258	258	258
	WLA: Arrowhead Lake MHP	86	86	86	86	86
	WLA: Country Court MHP	24	24	24	24	24
	WLA: Forest Park MHP	43	43	43	43	43
	WLA: Peaceful Acres MHP	60	60	60	60	60
	WLA: Spencer Twp/Lucas Co MS4	2584	464	201	0	0
	MOS (5%)	113,906.5	20,681.5	9,113.5	4,010	1,560.5
	TMDL Reduction (%)	**97%**	**10%**	**33%**	**80%**	No Data

6.2.3.2 Swan Creek at RM 18.50 (P11K05)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Swan Creek at Monclova Road (P11K05). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at this mainstem site (Table 6-13).

Table 6-20 displays the TMDL summary for site P11K05. NN loads need 75 percent or greater reductions across flow conditions with available data, with the exception of dry conditions during which there are no needed reductions. *E. coli* displays needed reductions at high flows (95 percent) and dry conditions (44 percent), but no *E. coli* reductions are needed at moist conditions and mid-range flows. Based on the 90th percentile reference site statistics, no TSS reductions are needed at this site.

Table 6-20 Loading Statistics for Swan Creek at RM 18.50 (P11K05).

P11K05- Swan Creek at RM 18.46 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	No Data	4998.70	413.59	40.29	No Data
	TMDL= LA+WLA+MOS	**1375.94**	**260.34**	**102.87**	**43.33**	**17.14**
	LA	1198.36	225.42	83.86	31.62	8.05
	Future Growth Reserve (5%)	68.795	13.015	5.145	2.165	0.855
	WLA: Swanton WWTP	34.82	4.90	4.90	4.90	4.90
	WLA: Swanton Meadows MHP	2.04	2.04	2.04	0.80	0.80
	WLA: Arrowhead Lake MHP	0.68	0.68	0.68	0.68	0.68
	WLA: Country Court MHP	0.19	0.19	0.19	0.19	0.19
	WLA: Forest Park MHP	0.34	0.34	0.34	0.34	0.34
	WLA: Peaceful Acres MHP	0.47	0.47	0.47	0.47	0.47
	WLA: Spencer Twp/Lucas Co MS4	1.45	0.27	0.10	0.00	0.00
	MOS (5%)	68.795	13.015	5.145	2.165	0.855
	TMDL Reduction (%)	No Data	**95%**	**75%**	**0%**	No Data
TSS (kg/day)	Current Load (Median)	No Data	10,144	729	107	No Data
	TMDL= LA+WLA+MOS	**88,627**	**16,840**	**6,562**	**2,609**	**901**
	LA	79,595	15,066	5,827	2,276	739
	Future Growth Reserve (5%)	4,431.5	842	328	130.5	45
	WLA: Swanton WWTP	63	63	63	63	63
	WLA: Swanton Meadows MHP	4	4	4	4	4
	WLA: Arrowhead Lake MHP	2	2	2	2	2
	WLA: Country Court MHP	1	1	1	1	1
	WLA: Forest Park MHP	1	1	1	1	1
	WLA: Peaceful Acres MHP	1	1	1	1	1
	WLA: Spencer Twp/Lucas Co MS4	97	18	7	0	0
	MOS (5%)	4,431.5	842	328	130.5	45
	TMDL Reduction (%)	No Data	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	48,972,691	268,140	166,695	150,027	No Data
	TMDL= LA+WLA+MOS	**2,375,536**	**431,129**	**189,852**	**83,407**	**32,313**
	LA	2,130,539	382,693	165,807	70,207	24,223
	Future Growth Reserve (5%)	118,777	21,556.5	9,492.5	4,170.5	1,615.5
	WLA: Swanton WWTP	4,388	4,388	4,388	4,388	4,388
	WLA: Swanton Meadows MHP	258	258	258	258	258
	WLA: Arrowhead Lake MHP	86	86	86	86	86
	WLA: Country Court MHP	24	24	24	24	24
	WLA: Forest Park MHP	43	43	43	43	43
	WLA: Peaceful Acres MHP	60	60	60	60	60
	WLA: Spencer Twp/Lucas Co MS4	2584	464	201	0	0
	MOS (5%)	118,777	21,556.5	9,492.5	4,170.5	1,615.5
	TMDL Reduction (%)	**95%**	**0%**	**0%**	**44%**	No Data

6.2.3.3 Blystone Ditch at RM 0.54 (P11A03)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Blystone Ditch at Monclova Road (P11A03). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at this tributary site (Table 6-13).

Table 6-21 displays the TMDL summary for site P11A03. Needed NN reductions vary considerably, ranging from zero to 91 percent at mid-range and moist flow conditions, respectively. TSS displays no needed reductions at this site based on the 90th percentile reference site targets used. *E. coli* loads are consistently over the allowable limit at this station, as displayed by the 61 percent or greater needed *E. coli* load reductions.

Table 6-21 Loading Statistics for Blystone Ditch at RM 0.54 (P11A03).

P11A03- Blystone Ditch at RM 0.54 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	88.42	118.09	2.09	2.13	No Data
	TMDL= LA+WLA+MOS	**59.37**	**11.24**	**4.35**	**1.70**	**0.55**
	LA	43.03	8.15	3.16	1.53	0.49
	Future Growth Reserve (5%)	2.97	0.56	0.215	0.085	0.03
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Monclova Twp/Lucas Co MS4	5.07	0.96	0.37	0.00	0.00
	WLA: Waterville Twp and Village/Lucas Co MS4	5.33	1.01	0.39	0.00	0.00
	MOS (5%)	2.97	0.56	0.215	0.085	0.03
	TMDL Reduction (%)	**40%**	**91%**	**0%**	**28%**	No Data
TSS (kg/day)	Current Load (Median)	1,533	116	27	16	No Data
	TMDL= LA+WLA+MOS	**2,909**	**551**	**213**	**83**	**27**
	LA	2,108	399	155	75	24
	Future Growth Reserve (5%)	145.5	27.5	10.5	4	1.5
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Monclova Twp/Lucas Co MS4	249	47	18	0	0
	WLA: Waterville Twp and Village/Lucas Co MS4	261	50	19	0	0
	MOS (5%)	145.5	27.5	10.5	4	1.5
	TMDL Reduction (%)	**0%**	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	1,030,498	445,281	68,913	7,930	No Data
	TMDL= LA+WLA+MOS	**105,522**	**18,956**	**8,214**	**3,475**	**1,201**
	LA	76,470	13,737	5,935	3,127	1,081
	Future Growth Reserve (5%)	5,276	948	410.5	174	60
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Monclova Twp/Lucas Co MS4	9020	1620	720	0	0
	WLA: Waterville Twp and Village/Lucas Co MS4	9480	1703	738	0	0
	MOS (5%)	5,276	948	410.5	174	60
	TMDL Reduction (%)	**91%**	**96%**	**89%**	**61%**	No Data

6.2.3.4 Swan Creek at RM 15.30 (P11P09)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Swan Creek at Salisbury Road (P11P09). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at this mainstem site (Table 6-13). Table 6-22 displays the TMDL summary for site P11P09. NN reductions range from zero percent to 95 percent, increasing with from dry to moist flow zones. *E. coli* reductions also vary with flow condition, and range from zero percent to 67 percent. No TSS load reductions are noted at this site based on the 90th percentile reference site statistics.

Table 6-22 Loading Statistics for Swan Creek at RM 15.30 (P11P09).

P11P09- Swan Creek at RM 15.30 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	No Data	5491.93	435.90	45.57	No Data
	TMDL= LA+WLA+MOS	**1503.81**	**284.55**	**112.23**	**46.99**	**18.33**
	LA	1300.50	244.77	91.39	34.91	9.12
	Future Growth Reserve (5%)	75.19	14.23	5.61	2.35	0.915
	WLA: Swanton WWTP	34.82	4.90	4.90	4.90	4.90
	WLA: Swanton Meadows MHP	2.04	2.04	2.04	0.80	0.80
	WLA: Arrowhead Lake MHP	0.68	0.68	0.68	0.68	0.68
	WLA: Country Court MHP	0.19	0.19	0.19	0.19	0.19
	WLA: Forest Park MHP	0.34	0.34	0.34	0.34	0.34
	WLA: Peaceful Acres MHP	0.47	0.47	0.47	0.47	0.47
	WLA: Monclova Twp/Lucas Co MS4	7.61	1.43	0.53	0.00	0.00
	WLA: Waterville Twp and Village/Lucas Co MS4	5.33	1.00	0.37	0.00	0.00
	WLA: Spencer Twp MS4	1.45	0.27	0.10	0.00	0.00
	MOS (5%)	75.19	14.23	5.61	2.35	0.915
	TMDL Reduction (%)	No Data	**95%**	**74%**	**0%**	No Data
TSS (kg/day)	Current Load (Median)	No Data	13,341	891	282	No Data
	TMDL= LA+WLA+MOS	**97,117**	**18,447**	**7,184**	**2,852**	**980**
	LA	86,377	16,349	6,324	2,495	810
	Future Growth Reserve (5%)	4,856	922.5	359	142.5	49
	WLA: Swanton WWTP	63	63	63	63	63
	WLA: Swanton Meadows MHP	4	4	4	4	4
	WLA: Arrowhead Lake MHP	2	2	2	2	2
	WLA: Country Court MHP	1	1	1	1	1
	WLA: Forest Park MHP	1	1	1	1	1
	WLA: Peaceful Acres MHP	1	1	1	1	1
	WLA: Monclova Twp/Lucas Co MS4	505	96	37	0	0
	WLA: Waterville Twp and Village/Lucas Co MS4	354	67	26	0	0
	WLA: Spencer Twp MS4	97	18	7	0	0
	MOS (5%)	4,856	922.5	359	142.5	49
	TMDL Reduction (%)	No Data	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	7,995,159	418,335	200,949	277,154	No Data
	TMDL= LA+WLA+MOS	**2,602,814**	**471,957**	**207,545**	**90,893**	**34,899**
	LA	2,312,080	415,305	179,939	76,945	26,550
	Future Growth Reserve (5%)	130,140.5	23,598	10,377.5	4,544.5	1,745
	WLA: Swanton WWTP	4,388	4,388	4,388	4,388	4,388
	WLA: Swanton Meadows MHP	258	258	258	258	258
	WLA: Arrowhead Lake MHP	86	86	86	86	86
	WLA: Country Court MHP	24	24	24	24	24
	WLA: Forest Park MHP	43	43	43	43	43
	WLA: Peaceful Acres MHP	60	60	60	60	60
	WLA: Monclova Twp/Lucas Co MS4	13,529	2,430	1,053	0	0
	WLA: Waterville Twp and Village/Lucas Co MS4	9,480	1,703	738	0	0
	WLA: Spencer Twp MS4	2,585	464	201	0	0
	MOS (5%)	130,140.5	23,598	10,377.5	4,544.5	1,745
	TMDL Reduction (%)	**67%**	**0%**	**0%**	**67%**	No Data

6.2.4 Subwatershed 080-040: Wolf Creek

The Wolf Creek subwatershed was sampled at four locations by the Ohio EPA in 2006: three Wolf Creek mainstem sites and one site on the Cairl Creek tributary. This subwatershed drains 27.24 square miles and the land cover (Table 1-5 and Figure 1-2) consists primarily of developed areas (47%), forest (26%), cultivated crops (15%), and pasture/hay (6%). A detailed map of the Wolf Creek subwatershed and its TMDL station locations is provided in Figure 6-9 below.

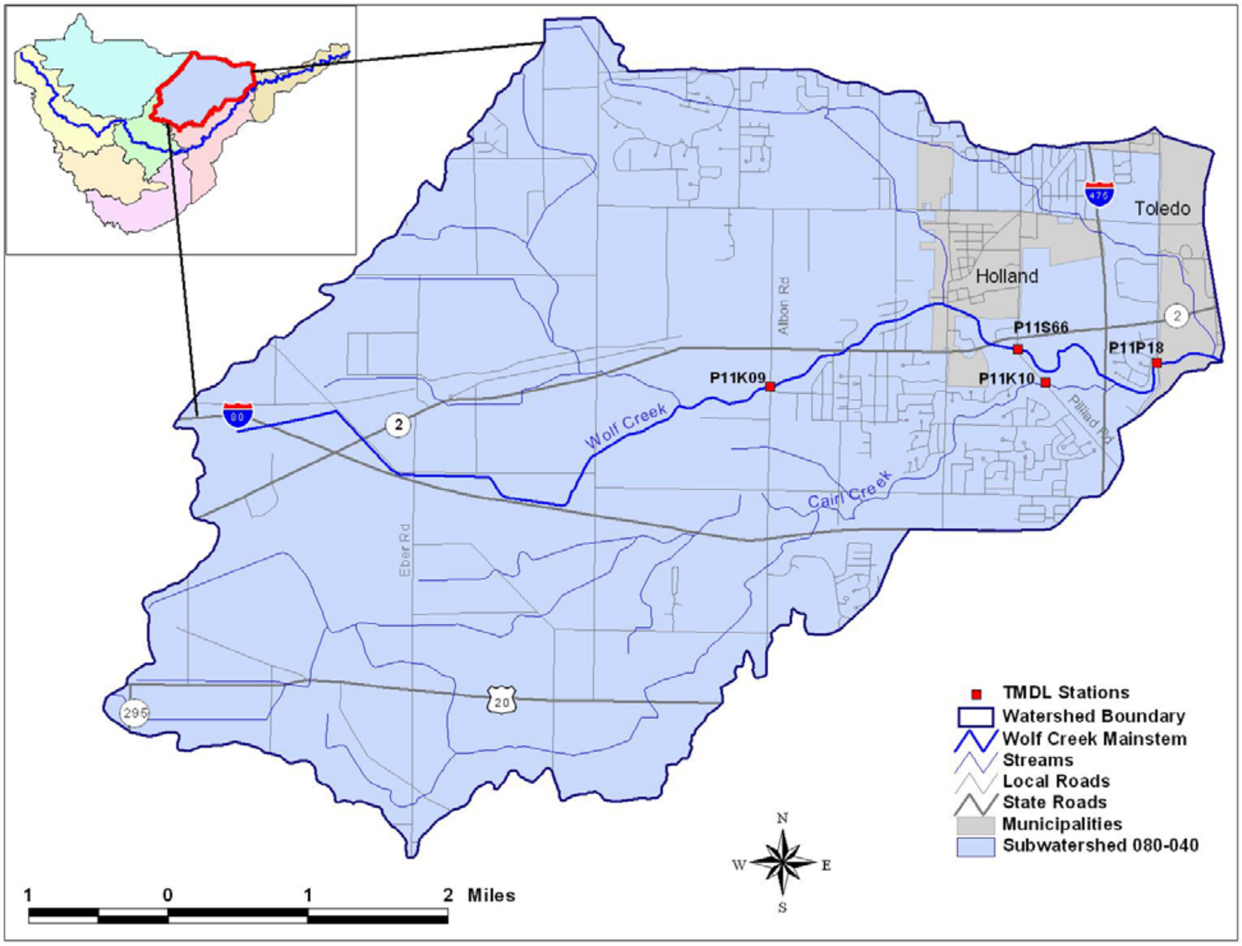


Figure 6-9 Subwatershed 080-040.

6.2.4.1 Wolf Creek at RM 4.06 (P11K09)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Wolf Creek at Albon Road (P11K09). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at this tributary site (Table 6-13).

Table 6-23 displays the TMDL summary for site P11K09. TP and *E. coli* loads display needed reductions of 51 percent or greater. No TSS reductions are needed at this site based on the 90th percentile targets used in TMDL development. There are no NPDES permitted facilities upstream of this sampling station.

Table 6-23 Loading Statistics for Wolf Creek at RM 4.06 (P11K09).

P11K09- Wolf Creek at RM 4.06 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	135.37	33.25	11.88	6.58	No Data
	TMDL= LA+WLA+MOS	**72.16**	**13.66**	**5.28**	**2.06**	**0.67**
	LA	53.29	10.08	3.90	1.85	0.60
	Future Growth Reserve (5%)	3.61	0.685	0.265	0.105	0.035
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Springfield Twp/Lucas Co MS4	9.08	1.72	0.66	0.00	0.00
	WLA: Spencer Twp/Lucas Co MS4	2.57	0.49	0.19	0.00	0.00
	MOS (5%)	3.61	0.685	0.265	0.105	0.035
	TMDL Reduction (%)	**52%**	**63%**	**60%**	**72%**	No Data
TSS (kg/day)	Current Load (Median)	1,314	89	44	8	No Data
	TMDL= LA+WLA+MOS	**3,536**	**669**	**259**	**101**	**33**
	LA	2,611	494	191	91	30
	Future Growth Reserve (5%)	177	33.5	13	5	1.5
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Springfield Twp/Lucas Co MS4	445	84	33	0	0
	WLA: Spencer Twp/Lucas Co MS4	126	24	9	0	0
	MOS (5%)	177	33.5	13	5	1.5
	TMDL Reduction (%)	**0%**	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	236,652	248,945	27,781	No Data	No Data
	TMDL= LA+WLA+MOS	**128,250**	**23,039**	**9,984**	**4,224**	**1,459**
	LA	94,720	17,015	7,374	3,802	1,313
	Future Growth Reserve (5%)	6,412.5	1,152	499	211	73
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Springfield Twp/Lucas Co MS4	16,136	2,899	1,256	0	0
	WLA: Spencer Twp/Lucas Co MS4	4,569	821	356	0	0
	MOS (5%)	6,412.5	1,152	499	211	73
	TMDL Reduction (%)	**51%**	**92%**	**68%**	No Data	No Data

6.2.4.2 Wolf Creek at RM 1.96 (P11S66)

Existing and allowable NN, TSS, *E. coli*, and total aluminum loads were calculated for Wolf Creek at Perrysburg-Holland Road (P11S66). A total of 6 NN, 6 TSS, 8 *E. coli*, and 6 total aluminum samples were available for load duration analysis at this tributary site (Table 6-13).

Table 6-24 displays the TMDL summary for site P11S66. NN loads are consistently above the allowable loading limit, resulting in all flow conditions requiring 35 percent or greater reductions. This station displays TSS issues at high flows and a 24 percent needed TSS load reduction. Similarly, the total aluminum load at high flows needs reduced by 54 percent to meet its allowable load. Needed *E. coli* reductions are consistently above 74 percent at this station. There are no NPDES permitted facilities upstream of this sampling station.

Table 6-24 Loading Statistics for Wolf Creek at RM 1.96 (P11S66).

P11S66- Wolf Creek at RM 1.96 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	218.91	43.26	12.33	4.65	No Data
	TMDL= LA+WLA+MOS	**117.83**	**22.30**	**8.63**	**3.37**	**1.09**
	LA	50.96	9.64	3.73	3.03	0.98
	Future Growth Reserve (5%)	5.89	1.115	0.43	0.17	0.055
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Springfield Twp/Lucas Co MS4	45.40	8.59	3.33	0.00	0.00
	WLA: Spencer Twp/Lucas Co MS4	2.57	0.49	0.19	0.00	0.00
	WLA: Holland/Lucas Co MS4	7.12	1.35	0.52	0.00	0.00
	MOS (5%)	5.89	1.115	0.43	0.17	0.055
	TMDL Reduction (%)	**52%**	**54%**	**37%**	**35%**	No Data
TSS (kg/day)	Current Load (Median)	6,868	377	99	28	No Data
	TMDL= LA+WLA+MOS	**5,774**	**1,093**	**423**	**165**	**54**
	LA	2,497	473	183	149	49
	Future Growth Reserve (5%)	288.5	54.5	21	8	2.5
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Springfield Twp/Lucas Co MS4	2,225	421	163	0	0
	WLA: Spencer Twp/Lucas Co MS4	126	24	9	0	0
	WLA: Holland/Lucas Co MS4	349	66	26	0	0
	MOS (5%)	288.5	54.5	21	8	2.5
	TMDL Reduction (%)	**24%**	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	781,657	255,517	55,548	No Data	No Data
	TMDL= LA+WLA+MOS	**209,421**	**37,621**	**16,302**	**6,897**	**2,383**
	LA	185,779	33,348	14,474	6,207	2,145
	Future Growth Reserve (5%)	10,471	1,881	815	345	119
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Springfield Twp/Lucas Co MS4	2,225	421	163	0	0
	WLA: Spencer Twp/Lucas Co MS4	126	24	9	0	0
	WLA: Holland/Lucas Co MS4	349	66	26	0	0
	MOS (5%)	10,471	1,881	815	345	119
	TMDL Reduction (%)	**76%**	**87%**	**74%**	No Data	No Data
Total Aluminum (kg/day)	Current Load (Median)	225.3	7.7	1.8	0.5	No Data
	TMDL= LA+WLA+MOS	**114.3**	**21.6**	**8.4**	**3.3**	**1.1**
	LA	49.5	9.3	3.7	3.0	1.0
	Future Growth Reserve (5%)	5.7	1.1	0.4	0.15	0.05
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Springfield Twp/Lucas Co MS4	44.0	8.3	3.3	0.0	0.0
	WLA: Spencer Twp/Lucas Co MS4	2.5	0.5	0.2	0.0	0.0
	WLA: Holland/Lucas Co MS4	6.9	1.3	0.5	0.0	0.0
	MOS (5%)	5.7	1.1	0.4	0.15	0.05
	TMDL Reduction (%)	**54%**	**0%**	**0%**	**0%**	No Data

6.2.4.3 Cairl Creek at RM 1.32 (P11K10)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Cairl Creek at Pilliad Road (P11K10). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at this tributary site (Table 6-13).

Table 6-25 displays the TMDL summary for site P11K10. Needed NN and *E. coli* reductions are all 75 percent or greater and TSS displays one needed reduction of 45 percent at high flows. There are no NPDES permitted facilities upstream of this sample station.

Table 6-25 Loading Statistics for Cairl Creek at RM 1.32 (P11K10).

P11K10- Cairl Creek at RM 1.32 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	365.51	82.52	15.59	8.38	No Data
	TMDL= LA+WLA+MOS	**59.37**	**11.24**	**4.35**	**1.70**	**0.55**
	LA	31.16	5.90	2.29	1.53	0.49
	Future Growth Reserve (5%)	2.97	0.56	0.215	0.085	0.03
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Springfield Twp/Lucas Co MS4	22.27	4.22	1.63	0.00	0.00
	MOS (5%)	2.97	0.56	0.215	0.085	0.03
	TMDL Reduction (%)	**85%**	**88%**	**75%**	**82%**	No Data
TSS (kg/day)	Current Load (Median)	4,758	234	103	35	No Data
	TMDL= LA+WLA+MOS	**2,909**	**551**	**213**	**83**	**27**
	LA	1,527	289	112	75	24
	Future Growth Reserve (5%)	145.5	27.5	10.5	4	1.5
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Springfield Twp/Lucas Co MS4	1,091	207	80	0	0
	MOS (5%)	145.5	27.5	10.5	4	1.5
	TMDL Reduction (%)	**45%**	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	541,754	93,297	31,170	No Data	No Data
	TMDL= LA+WLA+MOS	**105,522**	**18,956**	**8,214**	**3,475**	**1,201**
	LA	55,391	9,950	4,312	3,127	1,081
	Future Growth Reserve (5%)	5,276	948	410.5	174	60
	WLA: Facilities	n/a	n/a	n/a	n/a	n/a
	WLA: Springfield Twp/Lucas Co MS4	39,579	7,110	3,081	0	0
	MOS (5%)	5,276	948	410.5	174	60
	TMDL Reduction (%)	**82%**	**82%**	**76%**	No Data	No Data

6.2.4.4 Wolf Creek at RM 0.48 (P11P18)

Existing and allowable NN, TSS, *E. coli*, total aluminum, and benzo[a]pyrene loads were calculated for Wolf Creek at Holland-Sylvania Road (P11P18). A total of 6 NN, 6 TSS, 8 *E. coli*, 6 total aluminum, and 2 benzo[a]pyrene samples were available for load duration analysis at this tributary site (Table 6-13).

Table 6-26 displays the TMDL summary for site P11P18. Needed NN and *E. coli* loads are consistently high at this site, resulting in needed reductions of 37 percent or greater. TSS loads need to be reduced 27 percent during high flows, though no reductions are needed at any other flow conditions. Total aluminum reductions range from zero to 53 percent and benzo[a]pyrene loads are well above the allowable limit, resulting in a near 100 percent needed reduction.

Table 6-26 Loading Statistics for Wolf Creek at RM 0.48 (P11P18).

P11P18- Wolf Creek at RM 0.48 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	781.59	124.54	32.81	13.07	No Data
	TMDL= LA+WLA+MOS	**238.39**	**45.12**	**17.45**	**6.81**	**2.21**
	LA	141.31	26.74	10.34	6.13	1.99
	Future Growth Reserve (5%)	11.92	2.255	0.875	0.34	0.11
	WLA: Facilities	0.00	0.00	0.00	0.00	0.00
	WLA: Springfield Twp/Lucas Co MS4	63.55	12.03	4.65	0.00	0.00
	WLA: Spencer Twp/Lucas Co MS4	2.57	0.49	0.19	0.00	0.00
	WLA: Holland/Lucas Co MS4	7.12	1.35	0.52	0.00	0.00
	MOS (5%)	11.92	2.255	0.875	0.34	0.11
	TMDL Reduction (%)	**73%**	**67%**	**52%**	**53%**	No Data
TSS (kg/day)	Current Load (Median)	19,540	1,351	588	373	No Data
	TMDL= LA+WLA+MOS	**15,829**	**2,996**	**1,159**	**452**	**147**
	LA	9,382	1,775	686	407	132
	Future Growth Reserve (5%)	791.5	150	58	22.5	7.5
	WLA: Facilities	0	0	0	0	0
	WLA: Springfield Twp/Lucas Co MS4	4,220	799	309	0	0
	WLA: Spencer Twp/Lucas Co MS4	171	32	13	0	0
	WLA: Holland/Lucas Co MS4	473	90	35	0	0
	MOS (5%)	791.5	150	58	22.5	7.5
	TMDL Reduction (%)	**27%**	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	606,672	358,359	143,039	No Data	No Data
	TMDL= LA+WLA+MOS	**423,712**	**76,116**	**32,984**	**13,955**	**4,821**
	LA	251,160	45,119	19,551	12,559	4,339
	Future Growth Reserve (5%)	21,185.5	3,806	1,649	698	241
	WLA: Facilities	0	0	0	0	0
	WLA: Springfield Twp/Lucas Co MS4	112,951	20,290	8,793	0	0
	WLA: Spencer Twp/Lucas Co MS4	4,569	821	356	0	0
	WLA: Holland/Lucas Co MS4	12,661	2,274	986	0	0
	MOS (5%)	21,185.5	3,806	1,649	698	241
	TMDL Reduction (%)	**37%**	**81%**	**79%**	No Data	No Data
Total Aluminum (kg/day)	Current Load (Median)	438.6	18.1	8.3	7.8	No Data
	TMDL= LA+WLA+MOS	**231.2**	**43.8**	**16.9**	**6.6**	**2.1**
	LA	137.1	25.9	10.0	5.9	1.9
	Future Growth Reserve (5%)	11.55	2.2	0.85	0.35	0.1
	WLA: Facilities	0.0	0.0	0.0	0.0	0.0
	WLA: Springfield Twp/Lucas Co MS4	61.6	11.7	4.5	0.0	0.0
	WLA: Spencer Twp/Lucas Co MS4	2.5	0.5	0.2	0.0	0.0
	WLA: Holland/Lucas Co MS4	6.9	1.3	0.5	0.0	0.0
	MOS (5%)	11.55	2.2	0.85	0.35	0.1
	TMDL Reduction (%)	**53%**	**0%**	**0%**	**24%**	No Data

Table 6-26 Loading Statistics for Wolf Creek at RM 0.48 (P11P18) (continued).

P11P18- Wolf Creek at RM 0.48 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Benzo[a] pyrene (μg/day)	Current Load (Median)	No Data	15,040,000	No Data	15,730,000	No Data
	TMDL= LA+WLA+MOS	**4768.0**	**902.5**	**349.1**	**136.2**	**44.3**
	LA	2826.3	534.9	206.9	122.6	39.9
	Future Growth Reserve (5%)	238.4	45.15	17.45	6.8	2.2
	WLA: Facilities	0.0	0.0	0.0	0.0	0.0
	WLA: Springfield Twp/Lucas Co MS4	1271.0	240.6	93.1	0.0	0.0
	WLA: Spencer Twp/Lucas Co MS4	51.4	9.7	3.8	0.0	0.0
	WLA: Holland/Lucas Co MS4	142.5	27.0	10.4	0.0	0.0
	MOS (5%)	238.4	45.15	17.45	6.8	2.2
	TMDL Reduction (%)	No Data	**>99%**	No Data	**>99%**	No Data

6.2.5 Subwatershed 080-050: Swan Creek below Wolf Creek to Maumee River

The most downstream subwatershed in Swan Creek was sampled at five locations by the Ohio EPA in 2006. Four Swan Creek mainstem sites at river miles 10.84, 4.20, 1.60, and 0.19 and one site on Heilman Ditch were sampled. This subwatershed drains 13.90 square miles and lies entirely within the Toledo and Maumee municipal boundaries. The land cover (Table 1-5 and Figure 1-2) consists primarily of developed areas (91%), forest (6%), and woody wetlands (1%). A detailed map of the 080-050 subwatershed and its TMDL station locations is provided in Figure 6-10 below.

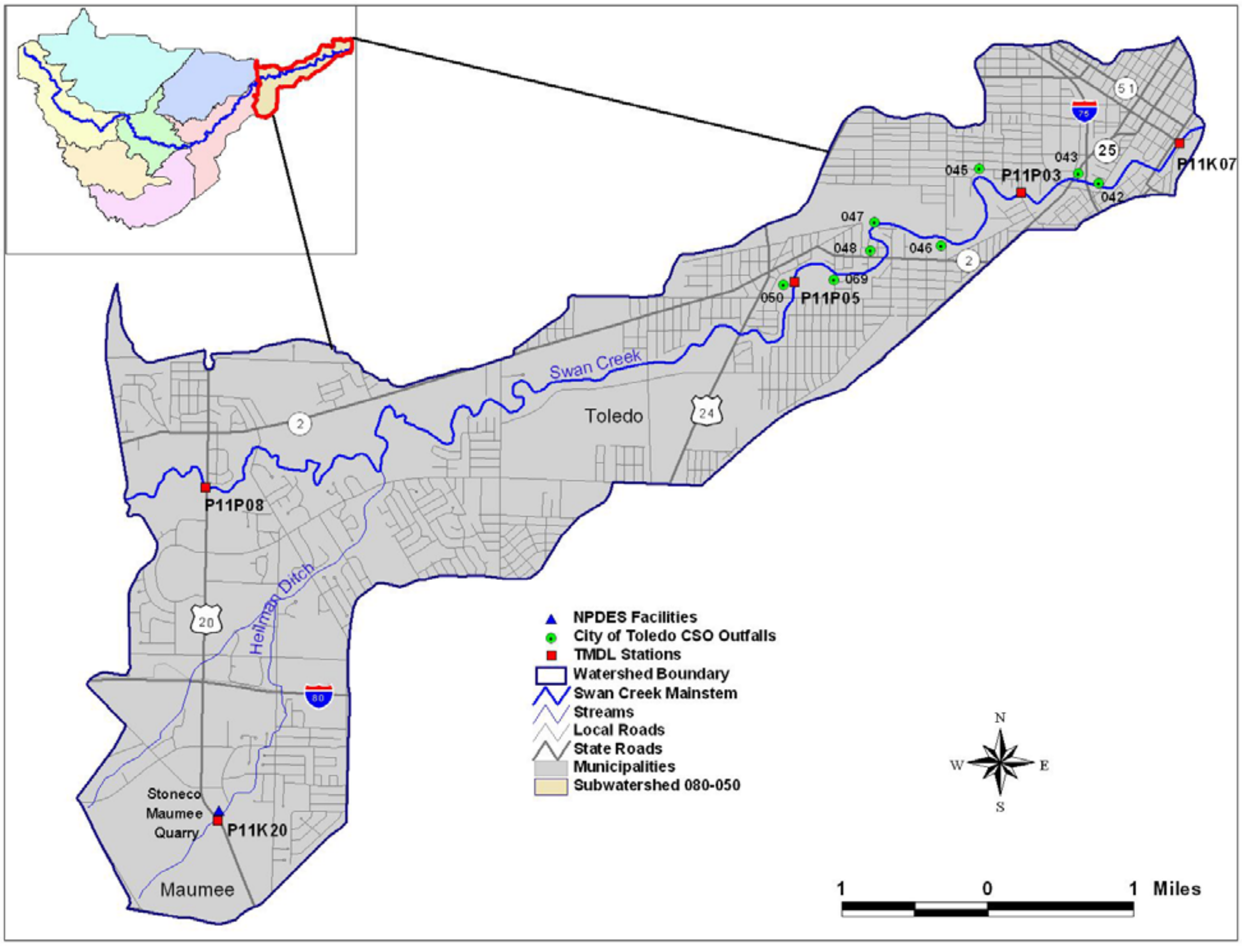


Figure 6-10 Subwatershed 080-050.

6.2.5.1 Swan Creek at RM 10.84 (P11P08)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Swan Creek at Reynolds Road/State Route 20 (P11P08). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at this mainstem site (Table 6-13).

Table 6-27 displays the TMDL summary for site P11P08. NN and *E. coli* loads consistently exceed the allowable limit at this station and display needed reductions of 9 percent or greater across all flow conditions with available data.

Table 6-27 Loading Statistics for Swan Creek at RM 10.84 (P11P08).

P11P08- Swan Creek at RM 10.84 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	No Data	5296.26	434.39	51.86	No Data
	TMDL= LA+WLA+MOS	**1796.10**	**339.87**	**133.63**	**55.34**	**21.05**
	LA	1445.88	272.38	102.31	42.43	11.56
	Future Growth Reserve (5%)	89.805	16.995	6.68	2.765	1.055
	WLA: Swanton WWTP	34.82	4.90	4.90	4.90	4.90
	WLA: Swanton Meadows MHP	2.04	2.04	2.04	0.80	0.80
	WLA: Arrowhead Lake MHP	0.68	0.68	0.68	0.68	0.68
	WLA: Country Court MHP	0.19	0.19	0.19	0.19	0.19
	WLA: Forest Park MHP	0.34	0.34	0.34	0.34	0.34
	WLA: Peaceful Acres MHP	0.47	0.47	0.47	0.47	0.47
	WLA: Monclova Twp/Lucas Co MS4	17.76	3.35	1.26	0.00	0.00
	WLA: Waterville Twp and Village/Lucas Co MS4	5.33	1.00	0.38	0.00	0.00
	WLA: Spencer Twp/Lucas Co MS4	4.02	0.76	0.28	0.00	0.00
	WLA: Springfield Twp/Lucas Co MS4	90.76	17.10	6.42	0.00	0.00
	WLA: Holland/Lucas Co MS4	7.12	1.34	0.50	0.00	0.00
	WLA: Toledo/Lucas Co MS4	7.08	1.33	0.50	0	0
	MOS (5%)	89.805	16.995	6.68	2.765	1.055
	TMDL Reduction (%)	No Data	**94%**	**69%**	**0%**	No Data
TSS (kg/day)	Current Load (Median)	No Data	22,012	1,682	507	No Data
	TMDL= LA+WLA+MOS	**116,525**	**22,121**	**8,605**	**3,406**	**1,160**
	LA	96,029	18,176	7,030	2,993	972
	Future Growth Reserve (5%)	5,826.5	1,106	430.5	170.5	58
	WLA: Swanton WWTP	63	63	63	63	63
	WLA: Swanton Meadows MHP	4	4	4	4	4
	WLA: Arrowhead Lake MHP	2	2	2	2	2
	WLA: Country Court MHP	1	1	1	1	1
	WLA: Forest Park MHP	1	1	1	1	1
	WLA: Peaceful Acres MHP	1	1	1	1	1
	WLA: Monclova Twp/Lucas Co MS4	1,179	223	86	0	0
	WLA: Waterville Twp and Village/Lucas Co MS4	354	67	26	0	0
	WLA: Spencer Twp/Lucas Co MS4	267	51	20	0	0
	WLA: Springfield Twp/Lucas Co MS4	6,028	1,141	441	0	0
	WLA: Holland/Lucas Co MS4	473	90	35	0	0
	WLA: Toledo/Lucas Co MS4	470	89	34	0	0
	MOS (5%)	5,826.5	1,106	430.5	170.5	58
	TMDL Reduction (%)	No Data	**0%**	**0%**	**0%**	No Data

Table 6-27 Loading Statistics for Swan Creek at RM 10.84 (P11P08) (continued).

P11P08- Swan Creek at RM 10.84 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
***E. coli* (Million/day)**	Current Load (Median)	8,515,816	620,691	471,313	366,406	No Data
	TMDL= LA+WLA+MOS	**3,122,308**	**565,280**	**247,985**	**108,003**	**40,810**
	LA	2,570,408	461,714	200,052	92,344	31,870
	Future Growth Reserve (5%)	156,115.5	28,264	12,399.5	5,400	2,040.5
	WLA: Swanton WWTP	4,388	4,388	4,388	4,388	4,388
	WLA: Swanton Meadows MHP	258	258	258	258	258
	WLA: Arrowhead Lake MHP	86	86	86	86	86
	WLA: Country Court MHP	24	24	24	24	24
	WLA: Forest Park MHP	43	43	43	43	43
	WLA: Peaceful Acres MHP	60	60	60	60	60
	WLA: Monclova Twp/Lucas Co MS4	31,569	5,671	2,457	0	0
	WLA: Waterville Twp and Village/Lucas Co MS4	9,480	1,703	738	0	0
	WLA: Spencer Twp/Lucas Co MS4	7,153	1,285	557	0	0
	WLA: Springfield Twp/Lucas Co MS4	161,356	28,984	12,558	0	0
	WLA: Holland/Lucas Co MS4	12,661	2,274	985	0	0
	WLA: Toledo/Lucas Co MS4	12,591	2,262	980	0	0
	MOS (5%)	156,115.5	28,264	12,399.5	5,400	2,040.5
	TMDL Reduction (%)	**63%**	**9%**	**47%**	**71%**	No Data

6.2.5.2 Heilman Ditch at RM 3.01 (P11K20)

Existing and allowable TP, NN, TSS, *E. coli*, ammonia, total dissolved solids, and strontium loads were calculated for Heilman Ditch at Conant Road (P11K20). A total of 6 TP, 6 NN, 6 TSS, 8 *E. coli*, 6 ammonia, 6 total dissolved solids, and 6 strontium samples were available for load duration analysis at this tributary site (Table 6-13).

Table 6-28 displays the TMDL summary for site P11K20. TP, NN, and *E. coli* loads are all well above the allowable limit at this station resulting in needed reductions of 41 percent or greater across all flow conditions with available data. Ammonia loads exceed the allowable limit during mid-range flows, as noted by the 38 percent needed reduction. Needed reductions range from zero to 45 percent for total dissolved solids, and strontium consistently exceeds the allowable load at this station resulting in needed reductions of 60 percent or greater. Based on the 90th percentile targets, no TSS reductions are displayed at this site.

Table 6-28 Loading Statistics for Heilman Ditch at RM 3.01 (P11K20).

P11K20- Heilman Ditch at RM 3.01 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Total Phosphorus (kg/day)	Current Load (Median)	379.12	14.59	11.52	2.57	No Data
	TMDL= LA+WLA+MOS	**15.08**	**8.68**	**0.58**	**0.23**	**0.07**
	LA	6.76	1.22	0.50	0.21	0.06
	Future Growth Reserve (5%)	0.755	0.435	0.03	0.01	0.005
	WLA: Stoneco Maumee Quarry	6.54	6.54	0.00	0.00	0.00
	WLA: Monclova Twp/Lucas Co MS4	0.20	0.04	0.01	0.00	0.00
	WLA: Maumee/Lucas Co MS4	0.07	0.01	0.01	0.00	0.00
	MOS (5%)	0.755	0.435	0.03	0.01	0.005
	TMDL Reduction (%)	**96%**	**41%**	**95%**	**91%**	No Data
Nitrate-Nitrite (kg/day)	Current Load (Median)	1087.04	165.30	130.25	15.36	No Data
	TMDL= LA+WLA+MOS	**170.59**	**90.61**	**7.22**	**2.82**	**0.92**
	LA	84.71	15.53	6.24	2.54	0.83
	Future Growth Reserve (5%)	8.53	4.53	0.36	0.14	0.045
	WLA: Stoneco Maumee Quarry	65.40	65.40	0.00	0.00	0.00
	WLA: Monclova Twp/Lucas Co MS4	2.52	0.46	0.19	0.00	0.00
	WLA: Maumee/Lucas Co MS4	0.90	0.16	0.07	0.00	0.00
	MOS (5%)	8.53	4.53	0.36	0.14	0.045
	TMDL Reduction (%)	**84%**	**45%**	**94%**	**82%**	No Data
TSS (kg/day)	Current Load (Median)	1,258	219	73	27	No Data
	TMDL= LA+WLA+MOS	**5,108**	**1,189**	**354**	**138**	**45**
	LA	4,180	790	307	124	40
	Future Growth Reserve (5%)	255.5	59.5	17.5	7	2.5
	WLA: Stoneco Maumee Quarry	249	249	0	0	0
	WLA: Monclova Twp/Lucas Co MS4	124	23	9	0	0
	WLA: Maumee/Lucas Co MS4	44	8	3	0	0
	MOS (5%)	255.5	59.5	17.5	7	2.5
	TMDL Reduction (%)	**0%**	**0%**	**0%**	**0%**	No Data
***E. coli* (Million/day)**	Current Load (Median)	11,330,898	804,146	177,565	No Data	No Data
	TMDL= LA+WLA+MOS	**184,395**	**40,562**	**13,648**	**5,774**	**1,995**
	LA	151,602	27,169	11,807	5,197	1,795
	Future Growth Reserve (5%)	9,220	2,028	682.5	288.5	100
	WLA: Stoneco Maumee Quarry	8,242	8,242	0	0	0
	WLA: Monclova Twp/Lucas Co MS4	4,508	808	351	0	0
	WLA: Maumee/Lucas Co MS4	1,603	287	125	0	0
	MOS (5%)	9,220	2,028	682.5	288.5	100
	TMDL Reduction (%)	**98%**	**95%**	**92%**	No Data	No Data

Table 6-28 Loading Statistics for Heilman Ditch at RM 3.01 (P11K20) (continued).

P11K20- Heilman Ditch at RM 3.01 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Ammonia (kg/day)	Current Load (Median)	846	89	124	19	No Data
	TMDL= LA+WLA+MOS	**1,133**	**277**	**77**	**30**	**10**
	LA	913	172	66	27	9
	Future Growth Reserve (5%)	56.5	14	4	1.5	0.5
	WLA: Stoneco Maumee Quarry	70	70	0	0	0
	WLA: Monclova Twp/Lucas Co MS4	27	5	2	0	0
	WLA: Maumee/Lucas Co MS4	10	2	1	0	0
	MOS (5%)	56.5	14	4	1.5	0.5
	TMDL Reduction (%)	**0%**	**0%**	**38%**	**0%**	No Data
Dissolved Solids (kg/day)	Current Load (Median)	244,360	44,729	8,855	7,707	No Data
	TMDL= LA+WLA+MOS	**158,761**	**38,800**	**10,833**	**4,228**	**1,374**
	LA	127,919	24,136	9,372	3,805	1,237
	Future Growth Reserve (5%)	7,938	1,940	541.5	211.5	68.5
	WLA: Stoneco Maumee Quarry	9,811	9,811	0	0	0
	WLA: Monclova Twp/Lucas Co MS4	3,803	718	279	0	0
	WLA: Maumee/Lucas Co MS4	1,352	255	99	0	0
	MOS (5%)	7,938	1,940	541.5	211.5	68.5
	TMDL Reduction (%)	**35%**	**13%**	**0%**	**45%**	No Data
Strontium (kg/day)	Current Load (Median)	2,659	484	96	79	No Data
	TMDL= LA+WLA+MOS	**562**	**138**	**38**	**15**	**5**
	LA	453	85	32.5	13	4
	Future Growth Reserve (5%)	28	7	2	1	0.5
	WLA: Stoneco Maumee Quarry	35	35	0	0	0
	WLA: Monclova Twp/Lucas Co MS4	13	3	1	0	0
	WLA: Maumee/Lucas Co MS4	5	1	0.5	0	0
	MOS (5%)	28	7	2	1	0.5
	TMDL Reduction (%)	**79%**	**71%**	**60%**	**81%**	No Data

6.2.5.3 Swan Creek at RM 4.20 (P11P05)

Existing and allowable NN, TSS, *E. coli*, and dieldrin loads were calculated for Swan Creek at South Avenue (P11P05). A total of 6 NN, 6 TSS, 8 *E. coli*, and 2 dieldrin samples were available for load duration analysis at this mainstem site (Table 6-13).

Table 6-29 displays the TMDL summary for site P11P05. NN loads are well above the allowable loads at moist conditions, but are within the loading limits at dry conditions. *E. coli* reductions are all above 47 percent, with the exception of moist conditions where the *E. coli* load is within the loading capacity of the stream. Dieldrin loads are well above the allowable load at this station, and require nearly 100 percent reductions. There are no TSS reductions noted at this site based on the 90th percentile reference site targets.

Table 6-29 Loading Statistics for Swan Creek at RM 4.20 (P11P05).

P11P05- Swan Creek at RM 4.20 TMDL		**High Flows**	**Moist Conditions**	**Mid-Range Flows**	**Dry Conditions**	**Low Flows**
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	No Data	5621.16	435.10	68.11	No Data
	TMDL= LA+WLA+MOS	**2,854.49**	**598.53**	**205.85**	**83.52**	**30.21**
	LA	2,138.85	404.62	153.82	67.79	19.81
	Future Growth Reserve (5%)	142.725	29.925	10.295	4.175	1.51
	WLA: Swanton WWTP	34.82	4.90	4.90	4.90	4.90
	WLA: Swanton Meadows MHP	2.04	2.04	2.04	0.80	0.80
	WLA: Arrowhead Lake MHP	0.68	0.68	0.68	0.68	0.68
	WLA: Country Court MHP	0.19	0.19	0.19	0.19	0.19
	WLA: Forest Park MHP	0.34	0.34	0.34	0.34	0.34
	WLA: Peaceful Acres MHP	0.47	0.47	0.47	0.47	0.47
	WLA: Stoneco Maumee Quarry	65.40	65.40	0.00	0.00	0.00
	WLA: Monclova Twp/Lucas Co MS4	38.05	7.17	2.73	0.00	0.00
	WLA: Waterville Twp and Village/Lucas Co MS4	8.00	1.51	0.57	0.00	0.00
	WLA: Spencer Twp/Lucas Co MS4	6.03	1.14	0.43	0.00	0.00
	WLA: Springfield Twp/Lucas Co MS4	136.12	25.66	9.75	0.00	0.00
	WLA: Holland/Lucas Co MS4	10.68	2.01	0.77	0.00	0.00
	WLA: Maumee/Lucas Co MS4	13.53	2.55	0.97	0.00	0.00
	WLA: Toledo/Lucas Co MS4	106.09	20.00	7.60	0.00	0.00
	WLA: Toledo CSO (050)	7.75	0.00	0.00	0.00	0.00
	MOS (5%)	142.725	29.925	10.295	4.175	1.51
	TMDL Reduction (%)	No Data	**89%**	**53%**	**0%**	No Data

Table 6-29 Loading Statistics for Swan Creek at RM 4.20 (P11P05) (continued).

P11P05- Swan Creek at RM 4.20 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
TSS (kg/day)	Current Load (Median)	No Data	18,066	998	470	No Data
	TMDL= LA+WLA+MOS	**137,777**	**26,406**	**10,137**	**4,004**	**1,355**
	LA	106,675	20,377	7,881	3,532	1,147
	Future Growth Reserve (5%)	6,889	1,320.5	507	200	68
	WLA: Swanton WWTP	63	63	63	63	63
	WLA: Swanton Meadows MHP	4	4	4	4	4
	WLA: Arrowhead Lake MHP	2	2	2	2	2
	WLA: Country Court MHP	1	1	1	1	1
	WLA: Forest Park MHP	1	1	1	1	1
	WLA: Peaceful Acres MHP	1	1	1	1	1
	WLA: Stoneco Maumee Quarry	294	294	0	0	0
	WLA: Monclova Twp/Lucas Co MS4	1,908	361	140	0	0
	WLA: Waterville Twp and Village/Lucas Co MS4	401	76	29	0	0
	WLA: Spencer Twp/Lucas Co MS4	303	57	22	0	0
	WLA: Springfield Twp/Lucas Co MS4	6,827	1,292	500	0	0
	WLA: Holland/Lucas Co MS4	536	101	39	0	0
	WLA: Maumee/Lucas Co MS4	678	128	50	0	0
	WLA: Toledo/Lucas Co MS4	5,321	1,007	390	0	0
	WLA: Toledo CSO (050)	984	0	0	0	0
	MOS (5%)	6,889	1,320.5	507	200	68
	TMDL Reduction (%)	No Data	**0%**	**0%**	**0%**	No Data

Table 6-29 Loading Statistics for Swan Creek at RM 4.20 (P11P05) (continued).

P11P05- Swan Creek at RM 4.20 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
***E. coli* (Million/day)**	Current Load (Median)	8,291,619	352,636	468,116	182,029	No Data
	TMDL= LA+WLA+MOS	**3,261,248**	**597,677**	**258,095**	**112,280**	**42,287**
	LA	2,540,032	457,001	198,042	96,193	33,199
	Future Growth Reserve (5%)	163,062.5	29,884	12,905	5,614	2,114.5
	WLA: Swanton WWTP	4,388	4,388	4,388	4,388	4,388
	WLA: Swanton Meadows MHP	258	258	258	258	258
	WLA: Arrowhead Lake MHP	86	86	86	86	86
	WLA: Country Court MHP	24	24	24	24	24
	WLA: Forest Park MHP	43	43	43	43	43
	WLA: Peaceful Acres MHP	60	60	60	60	60
	WLA: Stoneco Maumee Quarry	8,242	8,242	0	0	0
	WLA: Monclova Twp/Lucas Co MS4	45,097	8,100	3,510	0	0
	WLA: Waterville Twp and Village/Lucas Co MS4	9,479	1,703	738	0	0
	WLA: Spencer Twp/Lucas Co MS4	7,153	1,285	557	0	0
	WLA: Springfield Twp/Lucas Co MS4	161,351	28,979	12,558	0	0
	WLA: Holland/Lucas Co MS4	12,661	2,274	985	0	0
	WLA: Maumee/Lucas Co MS4	16,034	2,880	1,248	0	0
	WLA: Toledo/Lucas Co MS4	125,753	22,586	9,788	0	0
	WLA: Toledo CSO (050)	4,462	0	0	0	0
	MOS (5%)	163,062.5	29,884	12,905	5,614	2,114.5
	TMDL Reduction (%)	**61%**	**0%**	**45%**	**38%**	No Data

Table 6-29 Loading Statistics for Swan Creek at RM 4.20 (P11P05) (continued).

P11P05- Swan Creek at RM 4.20 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Dieldrin (μg/day)	Current Load (Median)	No Data	3,127,000	119,900	No Data	No Data
	TMDL= LA+WLA+MOS	**11,944**	**2,322**	**896.9**	**366.8**	**137.8**
	LA	9,251.596	1,760.994	681.123	305.075	98.975
	Future Growth Reserve (5%)	597.2	116.1	44.85	18.35	6.9
	WLA: Swanton WWTP	22.600	22.600	22.600	22.600	22.600
	WLA: Swanton Meadows MHP	1.330	1.330	1.330	1.330	1.330
	WLA: Arrowhead Lake MHP	0.443	0.443	0.443	0.443	0.443
	WLA: Country Court MHP	0.123	0.123	0.123	0.123	0.123
	WLA: Forest Park MHP	0.221	0.221	0.221	0.221	0.221
	WLA: Peaceful Acres MHP	0.308	0.308	0.308	0.308	0.308
	WLA: Stoneco Maumee Quarry	42.500	42.500	0.000	0.000	0.000
	WLA: Monclova Twp/Lucas Co MS4	164.860	31.210	12.070	0.000	0.000
	WLA: Waterville Twp and Village/Lucas Co MS4	34.650	6.560	2.540	0.000	0.000
	WLA: Spencer Twp/Lucas Co MS4	26.150	4.950	1.910	0.000	0.000
	WLA: Springfield Twp/Lucas Co MS4	589.850	111.670	43.190	0.000	0.000
	WLA: Holland/Lucas Co MS4	46.280	8.760	3.390	0.000	0.000
	WLA: Maumee/Lucas Co MS4	58.620	11.100	4.290	0.000	0.000
	WLA: Toledo/Lucas Co MS4	459.717	87.031	33.662	0.000	0.000
	WLA: Toledo CSO (050)	50.352	0.000	0.000	0.000	0.000
	MOS (5%)	597.2	116.1	44.85	18.35	6.9
	TMDL Reduction (%)	No Data	**>99%**	**99%**	No Data	No Data

6.2.5.4 Swan Creek at RM 1.60 (P11P03)

Existing and allowable NN, TSS, and *E. coli* loads were calculated for Swan Creek at City Park Avenue (P11P03). A total of 6 NN, 6 TSS, and 8 *E. coli* samples were available for load duration analysis at this tributary site (Table 6-13).

Table 6-30 displays the TMDL summary for site P11P03. NN loads decrease with decreasing flows, and show a decreasing pattern with the needed reductions as flows decrease. *E. coli* loads are well above the loading limit at this site and the needed reductions are all 41 percent or greater. No TSS reductions are needed based on the 90th percentile reference site statistics.

Table 6-30 Loading Statistics for Swan Creek at RM 1.60 (P11P03).

P11P03- Swan Creek at RM 1.60 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	No Data	6304.94	452.24	85.23	No Data
	TMDL= LA+WLA+MOS	**2895.60**	**606.32**	**208.86**	**84.70**	**30.59**
	LA	2121.07	408.60	155.36	68.85	20.15
	Future Growth Reserve (5%)	144.78	30.315	10.445	4.235	1.53
	WLA: Swanton WWTP	34.82	4.90	4.90	4.90	4.90
	WLA: Swanton Meadows MHP	2.04	2.04	2.04	0.80	0.80
	WLA: Arrowhead Lake MHP	0.68	0.68	0.68	0.68	0.68
	WLA: Country Court MHP	0.19	0.19	0.19	0.19	0.19
	WLA: Forest Park MHP	0.34	0.34	0.34	0.34	0.34
	WLA: Peaceful Acres MHP	0.47	0.47	0.47	0.47	0.47
	WLA: Stoneco Maumee Quarry	65.40	65.40	0.00	0.00	0.00
	WLA: Monclova Twp/Lucas Co MS4	38.05	7.17	2.73	0.00	0.00
	WLA: Waterville Twp and Village/Lucas Co MS4	8.00	1.51	0.57	0.00	0.00
	WLA: Spencer Twp/Lucas Co MS4	6.03	1.14	0.43	0.00	0.00
	WLA: Springfield Twp/Lucas Co MS4	136.12	25.66	9.76	0.00	0.00
	WLA: Holland/Lucas Co MS4	10.68	2.01	0.77	0.00	0.00
	WLA: Maumee/Lucas Co MS4	13.53	2.55	0.97	0.00	0.00
	WLA: Toledo/Lucas Co MS4	122.14	23.03	8.76	0.00	0.00
	WLA: Toledo CSOs (050, 069, 048, 047, 046, 045)	46.48	0.00	0.00	0.00	0.00
	MOS (5%)	144.78	30.315	10.445	4.235	1.53
	TMDL Reduction (%)	No Data	**90%**	**54%**	**1%**	No Data

Table 6-30 Loading Statistics for Swan Creek at RM 1.60 (P11P03) (continued).

P11P03- Swan Creek at RM 1.60 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
TSS (kg/day)	Current Load (Median)	No Data	19,042	747	298	No Data
	TMDL= LA+WLA+MOS	**139,837**	**26,796**	**10,288**	**4,063**	**1,374**
	LA	102,805	20,576	7,958	3,585	1,165
	Future Growth Reserve (5%)	6,992	1,340	514.5	203	68.5
	WLA: Swanton WWTP	63	63	63	63	63
	WLA: Swanton Meadows MHP	4	4	4	4	4
	WLA: Arrowhead Lake MHP	2	2	2	2	2
	WLA: Country Court MHP	1	1	1	1	1
	WLA: Forest Park MHP	1	1	1	1	1
	WLA: Peaceful Acres MHP	1	1	1	1	1
	WLA: Stoneco Maumee Quarry	294	294	0	0	0
	WLA: Monclova Twp/Lucas Co MS4	1,908	361	140	0	0
	WLA: Waterville Twp and Village/Lucas Co MS4	401	76	29	0	0
	WLA: Spencer Twp/Lucas Co MS4	303	57	22	0	0
	WLA: Springfield Twp/Lucas Co MS4	6,827	1,292	500	0	0
	WLA: Holland/Lucas Co MS4	536	101	39	0	0
	WLA: Maumee/Lucas Co MS4	678	128	50	0	0
	WLA: Toledo/Lucas Co MS4	6,126	1,159	449	0	0
	WLA: Toledo CSOs (050, 069, 048, 047, 046, 045)	5,903	0	0	0	0
	MOS (5%)	6,992	1,340	514.5	203	68.5
	TMDL Reduction (%)	No Data	**0%**	**0%**	**0%**	No Data

Table 6-30 Loading Statistics for Swan Creek at RM 1.60 (P11P03) (continued).

P11P03- Swan Creek at RM 1.60 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
***E. coli* (Million/day)**	Current Load (Median)	12,612,235	2,400,183	440,372	274,159	No Data
	TMDL= LA+WLA+MOS	**3,309,950**	**606,426**	**261,886**	**113,884**	**42,841**
	LA	2,542,525	461,456	199,973	97,637	33,698
	Future Growth Reserve (5%)	165,497.5	30,321.5	13,094.5	5,694	2,142
	WLA: Swanton WWTP	4,388	4,388	4,388	4,388	4,388
	WLA: Swanton Meadows MHP	258	258	258	258	258
	WLA: Arrowhead Lake MHP	86	86	86	86	86
	WLA: Country Court MHP	24	24	24	24	24
	WLA: Forest Park MHP	43	43	43	43	43
	WLA: Peaceful Acres MHP	60	60	60	60	60
	WLA: Stoneco Maumee Quarry	8,242	8,242	0	0	0
	WLA: Monclova Twp/Lucas Co MS4	45,097	8,100	3,510	0	0
	WLA: Waterville Twp and Village/Lucas Co MS4	9,479	1,703	738	0	0
	WLA: Spencer Twp/Lucas Co MS4	7,153	1,285	557	0	0
	WLA: Springfield Twp/Lucas Co MS4	161,351	28,980	12,558	0	0
	WLA: Holland/Lucas Co MS4	12,661	2,274	985	0	0
	WLA: Maumee/Lucas Co MS4	16,034	2,880	1,248	0	0
	WLA: Toledo/Lucas Co MS4	144,782	26,004	11,269	0	0
	WLA: Toledo CSOs (050, 069, 048, 047, 046, 045)	26,772	0	0	0	0
	MOS (5%)	165,497.5	30,321.5	13,094.5	5,694	2,142
	TMDL Reduction (%)	**74%**	**75%**	**41%**	**58%**	No Data

6.2.5.5 Swan Creek at RM 0.19 (P11K07)

Existing and allowable NN, TSS, *E. coli*, total aluminum, and dieldrin loads were calculated for Swan Creek at the OC Bridge (P11K07). A total of 6 NN, 6 TSS, 8 *E. coli*, 6 total aluminum, and 2 dieldrin samples were available for load duration analysis at this tributary site (Table 6-13).

Table 6-31 displays the TMDL summary for site P11K07. This site is similar to upstream mainstem sites as NN loads appear to decrease with decreasing flows. The biggest difference is that the *E. coli* loads at this site only exceed the allowable limit during high flow conditions, and are well within the limits during other flow conditions. Aluminum loads require a 9 percent reduction at dry flow conditions and dieldrin loads are well above the allowable limit, resulting in nearly 100 percent needed reductions in both flow conditions with available data.

Table 6-31 Loading Statistics for Swan Creek at RM 0.19 (P11K07).

P11K07- Swan Creek at RM 0.19 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Nitrate-Nitrite (kg/day)	Current Load (Median)	No Data	5995.82	575.60	33.54	No Data
	TMDL= LA+WLA+MOS	**2909.30**	**608.91**	**209.86**	**85.09**	**30.72**
	LA	2099.64	407.49	154.95	69.20	20.27
	Future Growth Reserve (5%)	145.465	30.445	10.495	4.255	1.535
	WLA: Swanton WWTP	34.82	4.90	4.90	4.90	4.90
	WLA: Swanton Meadows MHP	2.04	2.04	2.04	0.80	0.80
	WLA: Arrowhead Lake MHP	0.68	0.68	0.68	0.68	0.68
	WLA: Country Court MHP	0.19	0.19	0.19	0.19	0.19
	WLA: Forest Park MHP	0.34	0.34	0.34	0.34	0.34
	WLA: Peaceful Acres MHP	0.47	0.47	0.47	0.47	0.47
	WLA: Stoneco Maumee Quarry	65.40	65.40	0.00	0.00	0.00
	WLA: Monclova Twp/Lucas Co MS4	38.05	7.17	2.73	0.00	0.00
	WLA: Waterville Twp and Village/Lucas Co MS4	8.00	1.51	0.57	0.00	0.00
	WLA: Spencer Twp/Lucas Co MS4	6.03	1.14	0.43	0.00	0.00
	WLA: Springfield Twp/Lucas Co MS4	136.12	25.66	9.76	0.00	0.00
	WLA: Holland/Lucas Co MS4	10.68	2.01	0.77	0.00	0.00
	WLA: Maumee/Lucas Co MS4	13.53	2.55	0.97	0.00	0.00
	WLA: Toledo/Lucas Co MS4	140.41	26.47	10.07	0.00	0.00
	WLA: Toledo CSOs (All 8 outfalls)	61.97	0.00	0.00	0.00	0.00
	MOS (5%)	145.465	30.445	10.495	4.255	1.535
	TMDL Reduction (%)	No Data	**90%**	**64%**	**0%**	No Data

Table 6-31 Loading Statistics for Swan Creek at RM 0.19 (P11K07) (continued).

P11K07- Swan Creek at RM 0.19 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
TSS (kg/day)	Current Load (Median)	No Data	7,796	3,518	2,725	No Data
	TMDL= LA+WLA+MOS	**140,524**	**26,926**	**10,338**	**4,083**	**1,380**
	LA	100,541	20,519	7,936	3,603	1,170
	Future Growth Reserve (5%)	7,026	1,346.5	517	204	69
	WLA: Swanton WWTP	63	63	63	63	63
	WLA: Swanton Meadows MHP	4	4	4	4	4
	WLA: Arrowhead Lake MHP	2	2	2	2	2
	WLA: Country Court MHP	1	1	1	1	1
	WLA: Forest Park MHP	1	1	1	1	1
	WLA: Peaceful Acres MHP	1	1	1	1	1
	WLA: Stoneco Maumee Quarry	294	294	0	0	0
	WLA: Monclova Twp/Lucas Co MS4	1,908	361	140	0	0
	WLA: Waterville Twp and Village/Lucas Co MS4	401	76	29	0	0
	WLA: Spencer Twp/Lucas Co MS4	303	57	22	0	0
	WLA: Springfield Twp/Lucas Co MS4	6,827	1,292	500	0	0
	WLA: Holland/Lucas Co MS4	536	101	39	0	0
	WLA: Maumee/Lucas Co MS4	678	128	50	0	0
	WLA: Toledo/Lucas Co MS4	7,042	1,333	516	0	0
	WLA: Toledo CSOs (All 8 outfalls)	7,870	0	0	0	0
	MOS (5%)	7,026	1,346.5	517	204	69
	TMDL Reduction (%)	No Data	**0%**	**0%**	**0%**	No Data

Table 6-31 Loading Statistics for Swan Creek at RM 0.19 (P11K07) (continued).

P11K07- Swan Creek at RM 0.19 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
***E. coli* (Million/day)**	Current Load (Median)	9,461,478	335,731	84,183	65,284	No Data
	TMDL= LA+WLA+MOS	**3,326,184**	**609,342**	**263,150**	**114,419**	**43,026**
	LA	2,526,562	460,193	199,426	98,118	33,864
	Future Growth Reserve (5%)	166,309	30,467	13,157.5	5,721	2,151.5
	WLA: Swanton WWTP	4,388	4,388	4,388	4,388	4,388
	WLA: Swanton Meadows MHP	258	258	258	258	258
	WLA: Arrowhead Lake MHP	86	86	86	86	86
	WLA: Country Court MHP	24	24	24	24	24
	WLA: Forest Park MHP	43	43	43	43	43
	WLA: Peaceful Acres MHP	60	60	60	60	60
	WLA: Stoneco Maumee Quarry	8,242	8,242	0	0	0
	WLA: Monclova Twp/Lucas Co MS4	45,097	8,100	3,510	0	0
	WLA: Waterville Twp and Village/Lucas Co MS4	9,479	1,703	738	0	0
	WLA: Spencer Twp/Lucas Co MS4	7,153	1,285	557	0	0
	WLA: Springfield Twp/Lucas Co MS4	161,352	28,980	12,558	0	0
	WLA: Holland/Lucas Co MS4	12,661	2,274	985	0	0
	WLA: Maumee/Lucas Co MS4	16,034	2,880	1,248	0	0
	WLA: Toledo/Lucas Co MS4	166,431	29,892	12,954	0	0
	WLA: Toledo CSOs (All 8 outfalls)	35,696	0	0	0	0
	MOS (5%)	166,309	30,467	13,157.5	5,721	2,151.5
	TMDL Reduction (%)	**68%**	**0%**	**0%**	**0%**	No Data

Table 6-31 Loading Statistics for Swan Creek at RM 0.19 (P11K07) (continued).

P11K07- Swan Creek at RM 0.19 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Total Aluminum (kg/day)	Current Load (Median)	No Data	243.1	91.1	61.2	No Data
	TMDL= LA+WLA+MOS	**1,818.50**	**353.20**	**136.43**	**55.73**	**20.93**
	LA	1,338.22	264.59	102.33	46.41	15.09
	Future Growth Reserve (5%)	90.925	17.66	6.82	2.785	1.045
	WLA: Swanton WWTP	3.38	3.38	3.38	3.38	3.38
	WLA: Swanton Meadows MHP	0.20	0.20	0.20	0.20	0.20
	WLA: Arrowhead Lake MHP	0.07	0.07	0.07	0.07	0.07
	WLA: Country Court MHP	0.02	0.02	0.02	0.02	0.02
	WLA: Forest Park MHP	0.03	0.03	0.03	0.03	0.03
	WLA: Peaceful Acres MHP	0.05	0.05	0.05	0.05	0.05
	WLA: Stoneco Maumee Quarry	6.34	6.34	0.00	0.00	0.00
	WLA: Monclova Twp/Lucas Co MS4	24.61	4.66	1.80	0.00	0.00
	WLA: Waterville Twp and Village/Lucas Co MS4	5.17	0.98	0.38	0.00	0.00
	WLA: Spencer Twp/Lucas Co MS4	3.90	0.74	0.29	0.00	0.00
	WLA: Springfield Twp/Lucas Co MS4	88.06	16.66	6.44	0.00	0.00
	WLA: Holland/Lucas Co MS4	6.91	1.31	0.51	0.00	0.00
	WLA: Maumee/Lucas Co MS4	8.75	1.66	0.64	0.00	0.00
	WLA: Toledo/Lucas Co MS4	90.83	17.19	6.65	0.00	0.00
	WLA: Toledo CSOs (All 8 outfalls)	60.11	0.00	0.00	0.00	0.00
	MOS (5%)	90.925	17.66	6.82	2.785	1.045
	TMDL Reduction (%)	No Data	**0%**	**0%**	**9%**	No Data

Table 6-31 Loading Statistics for Swan Creek at RM 0.19 (P11K07) (continued).

P11K07- Swan Creek at RM 0.19 TMDL		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
Pollutant	**TMDL Component**	**0-10**	**10-40**	**40-60**	**60-90**	**90-100**
Dieldrin (µg/day)	Current Load (Median)	No Data	4,040,000	256,200	No Data	No Data
	TMDL= LA+WLA+MOS	**12,184.00**	**2,367.00**	**914.00**	**374.00**	**140.00**
	LA	8,966.44	1,773.08	686.01	311.98	100.98
	Future Growth Reserve (5%)	609	118.5	45.5	18.5	7
	WLA: Swanton WWTP	22.60	22.60	22.60	22.60	22.60
	WLA: Swanton Meadows MHP	1.33	1.33	1.33	1.33	1.33
	WLA: Arrowhead Lake MHP	0.44	0.44	0.44	0.44	0.44
	WLA: Country Court MHP	0.12	0.12	0.12	0.12	0.12
	WLA: Forest Park MHP	0.22	0.22	0.22	0.22	0.22
	WLA: Peaceful Acres MHP	0.31	0.31	0.31	0.31	0.31
	WLA: Stoneco Maumee Quarry	42.50	42.50	0.00	0.00	0.00
	WLA: Monclova Twp/Lucas Co MS4	164.90	31.21	12.07	0.00	0.00
	WLA: Waterville Twp and Village/Lucas Co MS4	34.66	6.56	2.54	0.00	0.00
	WLA: Spencer Twp/Lucas Co MS4	26.16	4.95	1.92	0.00	0.00
	WLA: Springfield Twp/Lucas Co MS4	590.00	111.65	43.20	0.00	0.00
	WLA: Holland/Lucas Co MS4	46.29	8.76	3.39	0.00	0.00
	WLA: Maumee/Lucas Co MS4	58.63	11.10	4.29	0.00	0.00
	WLA: Toledo/Lucas Co MS4	608.58	115.17	44.56	0.00	0.00
	WLA: Toledo CSOs (All 8 outfalls)	402.82	0.00	0.00	0.00	0.00
	MOS (5%)	609	118.5	45.5	18.5	7
	TMDL Reduction (%)	No Data	**100%**	**100%**	No Data	No Data

6.3 Margin of Safety and Future Growth

The Clean Water Act requires that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality. U.S. EPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS). An explicit MOS has been applied as part of all of the Swan Creek TMDLs by reserving five percent of the allowable load (see TMDL allocation tables throughout Section 6). A relatively low five percent MOS was selected based on the use of load duration curves, which minimize potential uncertainties associated with calculating the allowable loads (i.e., the allowable loads are based on observed data rather than modeling simulations).

Additionally, five percent of the allowable load has been reserved for future growth due to the fact that the Swan Creek watershed is rapidly developing and has complex and diverse pollutant sources. The future growth reserve also adds to the margin of safety in those parts of the watershed that are less likely to experience future growth.

6.4 Critical Conditions and Seasonality

The Clean Water Act requires that TMDLs take into account critical conditions for stream flow, loading, and water quality parameters as part of the analysis of loading capacity. Through the load duration curve approach it has been determined that load reductions are needed for specific flow conditions; however, the critical conditions (the periods when the greatest reductions are required) vary by location and are inherently addressed by specifying different levels of reduction according to flow. The critical conditions for each location and for each pollutant can be determined by evaluating the flow zones for which the largest load reductions are needed. For example, the critical condition for nitrate+nitrite at Swan Creek river mile 40.68 is the mid-range flow zone (Table 6-3).

The allocation of point source loads (i.e., the WLA) will also take into account critical conditions by assuming the facilities will always discharge at their maximum design flows. In reality, many facilities discharge at below their design flows.

The Clean Water Act also requires that TMDLs be established with consideration of seasonal variations. Seasonal variations are addressed in this TMDL by only assessing conditions during the season when the water quality standard applies (May through October) for *E. coli*. The load duration approach also accounts for seasonality by evaluating allowable loads on a daily basis over the entire range of observed flows, and by presenting daily allowable loads that vary by flow.

7 PUBLIC INVOLVEMENT

Public involvement is key to the success of any TMDL project. From the beginning, Ohio EPA has invited participation in all aspects of the TMDL program. Ohio EPA advanced public involvement in this TMDL project by including non-agency experts in the early stages of sampling site selection as well as referencing the locally developed *Maumee AOC Stage 2 Watershed Restoration Plan*. The TMDL team approach provided a setting for: sharing the Agency's progress in the project, soliciting input and feedback, hearing concerns and receiving information and data relevant to the project work, and planning for implementation of projects as identified by TMDL.

During the three-year project period, Ohio EPA gave TMDL project updates and presentations at several public venues, some hosted by Ohio EPA and others by TMDL team partners:

- A fish shocking and field sampling demonstration was conducted for the public at Highland Park on September 28, 2006.
- The Partners for Clean Streams hosted a Dam Mitigation and Stream restoration Workshop August 25-28, 2008 that included a hands-on field work in the Swan Creek watershed and a case study of the Highland Park Dam Mitigation Project.
- Two public meetings were held on September 30, 2008 to explain TMDL findings and gather public input on water quality problems. They were at the Highland Park Library at 2:00 pm and the Monclova Township Hall at 6:30 pm.
- A public information/input meeting was held with external technical representatives from the watershed on November 20, 2008 to discuss potential solutions for agricultural and urban sources of water quality impairment.
- A Maumee AOC Summit was sponsored by Partners for Clean Streams on February 24, 2009 where data collection and general TMDL information was presented for all the watersheds within the Maumee Area of Concern, including Swan Creek.

Ohio EPA acknowledges local volunteers' efforts to lead community involvement, to initiate development of a watershed action plan and to educate the public on water resource issues. Partners for Clean Streams and other local organizations, including American Rivers, Lucas County, the City of Toledo, the Lake Erie Commission, Soil and Water Conservation Districts, the National Resource Conservation Service, and the Toledo Metropolitan Area Council of Governments, are working together to accomplish many of these tasks. Ohio EPA encourages local leadership to promote watershed based planning to solve both water quantity and water quality problems.

Consistent with Ohio's current Continuous Planning Process (CPP), the draft TMDL report was available for public comment in June 2009 and a copy of the draft report was made available on Ohio EPA's Division of Surface Water web page at **http://epa.ohio.gov/Default.aspx?alias=epa.ohio.gov/dsw**. General information on TMDLs, water quality standards, 208 planning, permitting, and other Ohio EPA programs are also available on this site. A summary of the comments received and the associated responses is included in Appendix E.

Public involvement is vital to the success of any TMDL project. Ohio EPA will continue to support the implementation process and will facilitate, to the fullest extent possible, restoration actions that are acceptable to the communities and stakeholders in the study area and to the Agency. Ohio EPA is reluctant to rely solely on regulatory actions and strongly advocates voluntary actions facilitated by the local stakeholders, watershed organization, and Agency partners to bring the Swan Creek watershed into water quality attainment.

The Partners for Clean Streams and its many collaborators in the Maumee Area of Concern are serving as community advocates for the watershed, and have become an important force to maintain momentum and sponsor improvement efforts. Partners for Clean Streams is striving for abundant open space and a high quality natural environment; adequate floodwater storage capacities and flourishing wildlife; stakeholders who take local ownership in their resources; and rivers, streams, and lakes that are clean, clear and safe.

In 2005, the Maumee RAP (now Partners for Clean Streams) undertook an intensive and ambitious effort to create the *Maumee AOC Stage 2 Watershed Restoration Plan* (Stage 2 Restoration Plan). The *Stage 2 Restoration Plan* is a comprehensive regional water quality improvement plan intended to provide a one-stop-shop resource for all jurisdictions, agencies, organizations, and individuals who are working to restore this area's waterways.

The *Stage 2 Restoration Plan* has received "Full Endorsement Pending" status from the State of Ohio and will be fully endorsed with the completion of a Coastal Nonpoint Source Pollution Management Measures section. With late 2006 and most of 2007 spent focusing on the merger with PCS and 2008 working on the three Joyce Foundation projects, this report was not finalized. Partners for Clean Streams intends to spend much of 2009 working with its partners to make the changes requested by Ohio EPA and ODNR for completing the *Stage 2 Restoration Plan*. Projects recommended in this TMDL Report will also be incorporated.

The Western Lake Erie Basin (WLEB) Partnership is a tri-state partnership dedicated to enhancing multi-purpose projects that improve land and water resource management in the basin and promote a healthy, productive watershed. The WLEB Partnership is committed to sharing resources and knowledge to link land use to water quality, support ongoing efforts and identify new opportunities to enhance and improve the watershed. The WLEB is currently working with Partners for Clean Streams and has provided them with a small grant to help further project development and implementation in the Maumee Area of Concern, including Swan Creek. Visit their web site to learn more about implementation projects and funding opportunities at **http://www.wleb.org/**.

8 RECOMMENDED STRATEGIES FOR ACHIEVING WATER QUALITY GOALS

This section provides a strategy for improving water resources in the Swan Creek watershed to the full attainment of applicable water quality standards (WQS). The actions recommended are aimed at reaching the water quality goals and load reductions discussed in this report and address the documented sources of impairment (Ohio EPA, 2009). Additionally, protections are recommended for sustaining water quality in areas currently meeting the applicable WQS. Some recommendations would carry regulatory authority, while others are based on voluntarily action.

In 2007, the U.S. EPA began a project to redraw all hydrologic unit boundaries for Ohio according to a new coding method. This project was part of a nationwide initiative to develop a nationally consistent dataset (the Watershed Boundary Dataset). The project was initiated by the Advisory Committee on Water Information (run by USGS) and the Federal Geographic Data Committee. The former coding method uses 11 digits and 14 digits, respectively, to describe larger and smaller watersheds. In the new method, 11-digit codes have been converted to 10-digit codes and 14-digit codes have been converted to 12-digit codes. In addition, to make the size of smaller watersheds more consistent across the state, some of the small hydrologic units were combined or split. To do this, each hydrologic unit boundary was meticulously examined and redrawn, if necessary, to follow ridge lines more closely.

Near the borders of the state of Ohio, the old codes were not consistent with neighboring states. Therefore, those hydrologic units were renumbered in some cases to better line up with neighboring states' hydrologic unit codes. Many hydrologic units were also renamed to standardize naming across the state. The final set of hydrologic unit codes was published in 2008.

Work on the Swan Creek TMDL began before the new coding was completed, and restoration will continue after the new coding is adopted. The Swan Creek loading analysis uses 11- and 14-digit codes while this implementation chapter uses 10- and 12-digit codes. Thus, a way to bridge the conversion is needed. Table 8-1 shows the old 11- and 14-digit codes and names as well as the new 10- and 12-digit codes and names. Figure 8-1 shows the differences between the two sets of hydrologic units.

Table 8-1 Crosswalk listing old HUC11 and HUC14 numbers and new HUC10 and HUC12 numbers for the Swan Creek watershed.

HUC11/14	Name	HUC10/12	Name
04100009 070	Swan Creek (headwaters to above Blue Cr.)	04100009 07	Upper Swan Creek
04100009 070 010	Swan Creek headwaters to above Ai Cr.	04100009 07 02	Fewless Creek-Swan Creek
04100009 070 020	Ai Creek	04100009 07 01	Ai Creek
04100009 070 030	Swan Creek below Ai Cr. to above Blue Cr.	04100009 07 03	Gale Run-Swan Creek
04100009 080	Swan Creek (above Blue Cr. to Maumee R.)	04100009 08	Lower Swan Creek
04100009 080 010	Blue Creek headwaters to above Harris Ditch	04100009 08 01	Upper Blue Creek
04100009 080 020	Blue Creek above Harris Ditch to Swan Cr.	04100009 08 02	Lower Blue Creek
04100009 080 030	Swan Creek below Blue Cr. to above Wolf Cr.	04100009 08 04	Heilman Ditch-Swan Creek
04100009 080 040	Wolf Creek	04100009 08 03	Wolf Creek
04100009 080 050	Swan Creek below Wolf Cr. to Maumee R.	04100009 08 04	Heilman Ditch-Swan Creek

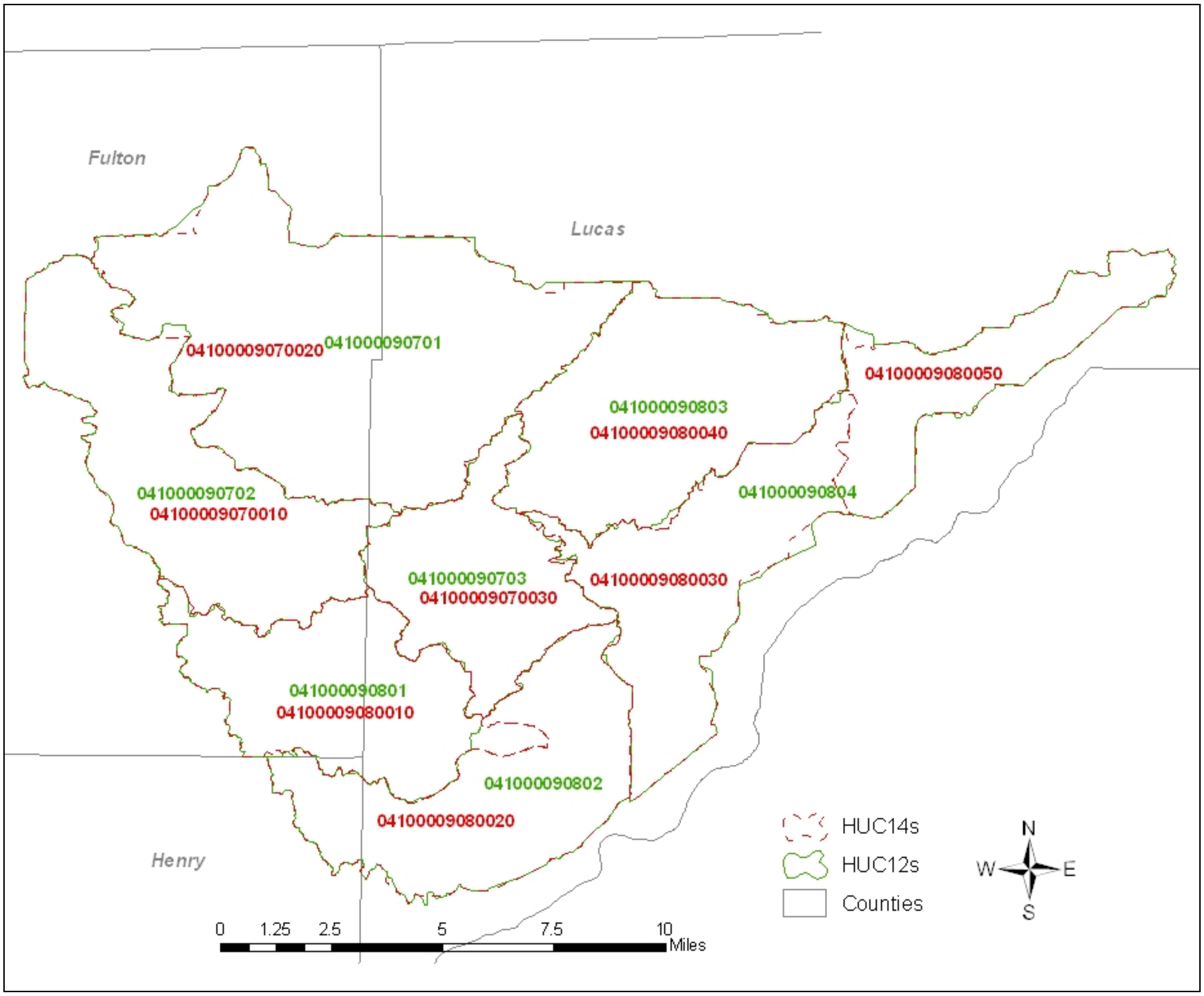


Figure 8-1 Map of the watershed showing 14-digit and 12-digit hydrologic unit boundaries.

8.1 Regulatory Measures

While nitrate/nitrite is a widespread cause of concern in the Swan Creek watershed, and some sources are permitted dischargers, Ohio EPA does not regulate effluent concentrations of nitrate/nitrite in NPDES discharge permits at this time, nor is monitoring typically required. In many situations where both phosphorus and nitrate/nitrite are present in the water column, phosphorus is the driving factor in nutrient enrichment. If phosphorus is addressed first, biological impairments from nutrients will often be reduced sufficiently to meet water quality standards. Also, there is an ongoing effort (via traditional toxicological studies and empirical evidence from field data) to reassess the toxicity of nitrate and nitrite. It may be that nitrate concentrations greater than 3.0 mg/l are toxic to some aquatic organisms.

Management options for nitrogen control should be re-considered when stream conditions are re-assessed. Therefore, phosphorus reductions may be addressed in the near term through wastewater discharge permits. Permit recommendations are discussed below.

8.1.1 Phosphorus

An NPDES permit limit for phosphorus at the Swanton WWTP will be set at 1.0 mg/l when the permit is renewed. The moderate impact from Swanton will be addressed by more intense management of wet weather flows and CSO elimination. Increasing the assimilative capacity of Ai Creek through habitat restoration and protection will also aid in reducing impacts from phosphorus inputs. Ohio EPA is in the process of developing nutrient criteria, including a criterion for total phosphorus that is planned to be incorporated into Ohio Administrative Code in the future. When that criterion becomes law, any discharger downstream of where there is biological impairment caused by total phosphorus will have to reduce effluent concentrations sufficiently to allow the in-stream concentrations to meet the criterion. However, if the Swanton WWTP reduces its effluent to 1.0 mg/l, works with land owners to improve assimilative capacity and biological performance moves from non-attainment to full attainment, the proposed total phosphorus criterion will not trigger further reduction requirements at the WWTP.

Table 8-2 displays the regulated facilities that discharge wastewater in this watershed with the current and proposed NPDES permit conditions.

Table 8-2 Summary of NPDES permit recommendations for total phosphorus in the Swan Creek watershed.

Entity (Ohio EPA permit no.)	Receiving Stream (RM of discharge)	Current Permit Condition	Proposed Average Permit Limit/Condition
Fewless Creek-Swan Creek Watershed Assessment Unit (04100009 07 02)			
Country Court MHP 2PY00060	Swan Creek	None	None
Forest Park MHP 2PY00019	Fewless Creek	None	None
Ai Creek Watershed Assessment Unit (04100009 07 01)			
Swanton WWTP 2PB00025	Ai Creek	Monitoring (1x/month)	1.0 mg/l
Swanton Meadows MHP 2PY00022	Ai Creek	None	None
Arrowhead Lake MHP 2PY00067	Wiregrass Ditch	None	None
Upper Blue Creek Watershed Assessment Unit (04100009 08 01)			
Peaceful Acres MHP 2PY00064	Blue Creek	None	None
Swan Creek Watershed Assessment Unit (04100009 08 04)			
StoneCo Inc. Maumee Quarry 2IJ00048	Heilman Ditch	None	None

8.1.2 Nitrate-Nitrite

As mentioned before, nitrogen is not currently regulated in point source discharges. It is, however, a nutrient that is found in the environment caused by the natural process of plant decay and the use of synthetic fertilizer for production of crops and turf grass. Nitrogen is also a component of human and animal waste. The land application of manure and sewage sludge is a beneficial use of organic nutrients that can be used alone or in combination with synthetic fertilizers to promote plant growth.

The mechanism and rate of delivery of nitrate-nitrite depends on two variables: the hydrology of a stream, including the interaction of field tiles; and the volume and intensity of a storm event. Nitrogen becomes a pollutant of concern when it washes off the land and contributes to nuisance algae blooms in rivers and lakes. It is a beneficial nutrient as long as it is applied according to applicable guidelines. Paths for nitrogen to migrate to waterways include runoff from lawns or agricultural fields during rain or snow melt events and leaching through the soil into drain tiles. Many farm fields have artificial systematic tiling to suppress the water table and enhance surface drainage of soils used for crop production. Depending on soil types and conditions of saturation, these tiles may become a conveyance for soluble nitrate/nitrite to leave the fields and pollute ditches and streams.

Excess nitrate-nitrite in the water column causes algal growth that depletes dissolved oxygen in the water. High nitrate (above 10 mg/l) is a potential human health threat and a violation of drinking water standards and is monitored closely by public drinking water supplies. The Village of Swanton pumps drinking water from Swan Creek and is currently on a "watch list" for high nitrate levels. Waters on the "watch list" are waters in full support of the public drinking water supply use designation or with insufficient data to determine support, but that exhibit elevated levels of contaminants and will be targeted for additional sampling (Ohio EPA 2008). Recommended reductions in nitrate runoff from agricultural land use above Swanton, particularly in the Upper Swan Creek and Ai Creek subwatersheds, are found in this report in Section 8.2.1.

8.1.3 Sediment

Understanding and managing erosion processes is critical to reducing sediment loading to the streams in the Swan Creek watershed. Three types of erosion are the result of both natural and man-induced processes. Before implementing management practices or installing control structures to reduce siltation, it is necessary to know that erosion and hydrology are connected, and the timing of delivery and transport mechanism is an important consideration.

Gully erosion was observed at exposed construction sites in the Swan Creek and Wolf Creek subwatersheds that are experiencing rapid development, and surface runoff is prevalent on farm fields above Swanton in the Blue Creek and Ai Creek subwatersheds. Streams in the lower Swan Creek and Heilman Ditch watersheds are impacted by bank erosion and "flashiness" caused by increased runoff from urban and developing areas upstream of Toledo.

While precipitation is ultimately responsible for the volume of storm flow, it is the land use characteristics and human activities that determine the outcome of a runoff event. Surface and gully erosion may be minimized by leaving riparian corridors intact along streams that flow through or beside agricultural fields and developing areas with new construction. Additional farm and storm water management practices can further control erosion from exposed soils and descriptions may be found in Appendix D.

Bank erosion is a response to channel stability, discharge volume and stream velocity. Actions to reduce upland runoff rates may be effective, but if water flows through a modified channel with little or no riparian vegetation, the overall improvement may be less than desired. In urban areas with larger than 10% impervious surfaces (e.g., roofs or road parking), practices that increase the water retention capacity of landscapes will help to slow down and reduce volume of storm flows. Post-construction storm water practices such as bio-retention areas, alternative pavement and low impact development could help to reduce peak flows, which will in turn decrease sediment loads and improve the habitat and biological performance in the watershed. More information on sediment and erosion control practices may be found in Appendix D.

8.2 Implementation Approach and Rationale

TMDLs are developed for ***pathogens (E. coli)*** to address impairment of the recreational use and also for ***total suspended solids, total phosphorus,*** and ***nitrate/nitrite*** to address impairment of aquatic life uses. In addition, TMDLs are developed in a few select locations for ***ammonia, strontium, aluminum, dieldrin, benzo[a]pyrene*** and ***dissolved solids***. Recreational use impairment is pervasive throughout most of the basin while aquatic life use impairment occurs more discretely on a segment by segment basis. The recommendations that follow provide a basic approach for addressing each of these causes of impairment and their respective sources. Also included are recommendations regarding ***stream geomorphology, floodplain connectivity, land use management and storm water management*** that are intended to provide further enhancement and protection of aquatic life uses**.**

It is possible that some stream segments not surveyed are impaired by sources that have been identified in surveyed segments. A broad application across the watershed of some of the recommendations is likely to abate those sources as well.

Table 8-3 shows an overview of all of the 12-digit watersheds that contained sites with partial attainment of aquatic life us. Causes (e.g., nutrients or sediment) are shown within parentheses following each source that may contribute to that cause of impairment. Tables 8-4 and 8-5 each represent a separate 10-digit assessment unit. For each 12-digit watershed, specific actions are recommended. Recommendations were developed after consultation with local technical stakeholders and agency staff. In each case, these actions are intended to be inclusive of possible methods to improve water quality in the watershed based on identified causes and sources of impairment. Because Ohio EPA recognizes that actions taken in any individual subwatershed may depend on a number of factors (including socioeconomic, political and ecological factors), these recommendations are not intended to be prescriptive of actions to be taken, and any number or combination might contribute to improvement, whether applied at sites where actual impairment was noted or other locations where sources contribute indirectly to water quality impairment. Further details about individual practices can be found in Appendix D.

Table 8-3 Summary of restoration recommendations for the Swan Creek watershed.

10-Digit HUC (Location Description) 12-Digit HUC (Location Description) Sources (Causes)	Restoration Categories: Streambank and Riparian Restoration	Stream Restoration	Wetland Restoration	Conservation Easements	Dam Modification or Removal	Levee or Dike Modification or Removal	Abandoned Mine Land Reclamation	Home Sewage Planning and Implementation	Education and Outreach	Agricultural Best Management Practices	Storm Water Best Management Practices	Regulatory Point Source Controls
04100009 07: Upper Swan Creek (Headwaters to Upstream Blue Creek)												
07 01: Ai Creek												
Channelization (habitat alteration, sediment)*	x	x	x								x	x
HSTS (nutrients, bacteria)								x	x			x
Row crop (nutrients, sediment)									x	x		
Village of Ai (nutrients, bacteria)												x
Swanton WWTP (phosphorus, nitrates)												x
07 02: Fewless Creek-Swan Creek												
Channelization (habitat alteration, sediment)*	x	x	x								x	x
HSTS (nutrients, bacteria)								x	x			x
Row crop (nutrients, sediment)									x	x		
07 03: Gale Run-Swan Creek												
HSTS (nutrients, bacteria)								x	x			x
Row crop (nutrients, sediment)				x					x	x		
04100009 08: Lower Swan Creek (upstream Blue Creek to mouth)												
08 01: Upper Blue Creek												
Channelization (habitat alteration, sediment)*	x	x	x								x	x
HSTS (nutrients, bacteria)								x	x			x
Row crop (nutrients, sediment)				x					x	x		
Village of Neapolis (nutrients, bacteria)												x

* The "Regulatory Point Source Controls" restoration category was checked for the channelization source of impairment to include situations in which ditch maintenance or drainage improvements may require construction storm water permit coverage.

Table 8-3 Summary of restoration recommendations for the Swan Creek watershed (continued).

10-Digit HUC (Location Description) 12-Digit HUC (Location Description) Sources (Causes)	Restoration Categories											
	Streambank and Riparian Restoration	Stream Restoration	Wetland Restoration	Conservation Easements	Dam Modification or Removal	Levee or Dike Modification or Removal	Abandoned Mine Land Reclamation	Home Sewage Planning and Implementation	Education and Outreach	Agricultural Best Management Practices	Storm Water Best Management Practices	Regulatory Point Source Controls
04100009 08: Lower Swan Creek (upstream Blue Creek to mouth) (continued)												
08 02: Lower Blue Creek												
Channelization (habitat alteration, sediment)*	x	x	x								x	x
HSTS (nutrients, bacteria)								x	x			x
Row crop (nutrients, sediment)				x					x	x		
08 03: Wolf Creek												
Channelization (habitat alteration, sediment)*	x	x	x								x	x
Dam/impoundment (habitat alterations)	x	x			x							
HSTS (nutrients, bacteria)								x	x			x
Sand quarry (sediment)												x
Row crop (nutrients, sediment)				x					x	x		
Urban runoff/storm sewers (metals, organics, aluminum, sediment)									x		x	x
08 04: Heilman Ditch-Swan Creek												
Channelization (habitat alteration, sediment)*	x	x	x								x	x
CSOs (nutrients, bacteria)												x
Culverted channel (habitat alterations)	x	x									x	x
Dam/impoundment (habitat alterations)	x	x			x							
HSTS (nutrients, bacteria)								x	x			x
Industrial runoff (chemicals, nutrients)									x		x	x
Row crop (nutrients, sediment)				x					x	x		
Stone quarry (sediment, strontium)												x
Urban runoff/storm sewers (metals, organics)									x		x	x

* The "Regulatory Point Source Controls" restoration category was checked for the channelization source of impairment to include situations in which ditch maintenance or drainage improvements may require construction storm water permit coverage.

Table 8-4 Specific restoration actions recommended for the upper Swan Creek watershed.

Restoration Categories		Specific Restoration Actions	Upper Swan Creek (04100009 07)		
			Ai Creek (07 01)	Fewless Creek-Swan Creek (07 02)	Gale Run-Swan Creek (07 03)
Streambank & Riparian Restoration	constructed	Restore streambank using bio-engineering	x	x	
		Restore streambank by recontouring or regrading	x	x	
	planted	Plant grasses in riparian areas	x	x	
		Plant prairie grasses in riparian areas			
		Remove/treat invasive species			
		Plant trees or shrubs in riparian areas	x	x	
Stream Restoration		Restore flood plain	x		
		Restore stream channel	x	x	
		Install in-stream habitat structures	x	x	
		Install grade structures			
		Construct 2-stage channel	x	x	
		Restore natural flow	x	x	
Wetland Restoration		Reconnect wetland to stream	x	x	
		Reconstruct & restore wetlands			
		Plant wetland species			
Conservation Easements		Acquire conservation easements			x
Dam Modification or Removal		Remove dams			
		Modify dams			
		Remove associated dam support structures			
		Install fish passage and/or habitat structures			
		Restore natural flow			
Levee or Dike Modification or Removal		Remove levees			
		Breach or modify levees			
		Remove dikes			
		Modify dikes			
		Restore natural flood plain function			

Table 8-4 Specific restoration actions recommended for the upper Swan Creek watershed (continued).

Restoration Categories		Specific Restoration Actions	Upper Swan Creek (04100009 07) Ai Creek (07 01)	Fewless Creek-Swan Creek (07 02)	Gale Run-Swan Creek (07 03)
Abandoned Mine Land Reclamation	treatment	Construct lime dosers			
		Install slag leach beds			
		Install limestone leach beds			
		Install limestone channels			
		Install successive alkalinity-producing systems			
		Install settling ponds			
		Construct acid mine drainage wetland			
	flow diversion	Repair subsidence sites			
		Reclaim pit impoundments			
		Reclaim abandoned mine land			
		Eliminate stream captures			
		Restore positive drainage			
		Cover toxic mine spoils			
Home Sewage Planning and Improvement		Develop HSTS plan	x	x	x
		Inspect HSTS	x	x	x
		Repair or replace traditional HSTS	x	x	x
		Repair or replace alternative HSTS	x	x	x
Education and Outreach		Host meetings, workshops, and/or other events	x	x	x
		Distribute educational materials	x	x	x
Agricultural Best Management Practices	farmland	Plant cover/manure crops	x	x	x
		Implement conservation tillage practices	x	x	x
		Implement grass/legume rotations	x	x	x
		Convert to permanent hayland			
		Install grassed waterways	x	x	x
		Install vegetated buffer areas/strips	x	x	x
		Install location-specific conservation buffers	x	x	x
		Install / restore wetlands	x	x	x
	nutrients / agro-chemicals	Conduct soil testing	x	x	x
		Install nitrogen reduction practices	x	x	x
		Develop nutrient management plans	x	x	x
	drainage	Install sinkhole stabilization structures			
		Install controlled drainage system	x	x	x
		Implement drainage water management	x	x	x
		Construct overwide ditch	x	x	x
		Construct 2-stage channel	x	x	x

Table 8-4 Specific restoration actions recommended for the upper Swan Creek watershed (continued).

Restoration Categories		Specific Restoration Actions	Upper Swan Creek (04100009 07) Ai Creek (07 01)	Fewless Creek-Swan Creek (07 02)	Gale Run-Swan Creek (07 03)
Agricultural Best Management Practices (cont.)	livestock	Implement prescribed grazing practices			
		Install livestock exclusion fencing			
		Install livestock crossings			
		Install alternative water supplies			
		Install livestock access lanes			
	manure	Implement manure management practices	x	x	
		Construct animal waste storage structures	x	x	
		Implement manure transfer practices			
		Install grass manure spreading strips			
	misc. infrastructure and mgt	Install chemical mixing pads	x		
		Install heavy use feeding pads			x
		Install erosion & sediment control structures	x	x	x
		Install roof water management practices			
		Install milkhouse waste treatment practices			
		Develop whole farm management plans	x	x	x
Storm Water Best Management Practices	planning	Develop/Implement local ordinances/resolutions	x	x	x
		Develop local comprehensive land use plans	x	x	x
	construction practices	Implement erosion controls	x	x	x
		Implement sediment controls	x	x	x
		Implement non-sediment controls	x	x	x
	post construction practices	Reduce pollutant(s) through treatment	x	x	x
		Reduce pollutant(s) through flow/volume management	x	x	x
	post development/ storm water retrofit	Implement erosion controls	x	x	x
		Implement sediment controls	x	x	x
		Implement non-sediment controls	x	x	x
		Reduce pollutant(s) through treatment	x	x	x
		Reduce pollutant(s) through flow/volume management	x	x	x

Table 8-4 Specific restoration actions recommended for the upper Swan Creek watershed (continued).

Restoration Categories		Specific Restoration Actions	Upper Swan Creek (04100009 07)		
			Ai Creek (07 01)	Fewless Creek-Swan Creek (07 02)	Gale Run-Swan Creek (07 03)
Regulatory Point Source Controls (includes Storm Water, Sanitary, and Industrial)	planning	Develop long-term control plan	x		
		Develop/Implement local ordinances/resolutions			
		Develop water quality management/208 plans	x	x	x
	collection and new treatment	Install sewer systems in communities	x		x
		Implement long-term control plan (CSOs)	x	x	
		Eliminate SSOs/CSOs/by-passes		x	x
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)	x		
		Improve quality of effluent	x		
	monitoring	Establish ambient monitoring program			
		Increase effluent monitoring	x		
	alternatives	Establish water quality trading	x		
	construction practices	Issue permit(s) and/or modify permit limit(s)	x	x	
		Implement erosion controls	x	x	x
		Implement sediment controls	x	x	x
		Implement non-sediment controls	x	x	x
	post construction practices	Issue permit(s) and/or modify permit limit(s)	x	x	x
		Reduce pollutant(s) through treatment	x	x	x
		Reduce pollutant(s) through flow/volume management	x	x	x
	post development/ storm water retrofit	Issue permit(s) and/or modify permit limit(s)	x	x	x
		Implement erosion controls	x	x	x
		Implement sediment controls	x	x	x
		Implement non-sediment controls	x	x	x
		Reduce pollutant(s) through treatment	x	x	x
		Reduce pollutant(s) through flow/volume management	x	x	x
		Reduce volume to CSOs	x	x	

Table 8-5 Specific restoration actions recommended for the lower Swan Creek watershed.

Restoration Categories		Specific Restoration Actions	Lower Swan Creek (04100009 08)			
			Upper Blue Creek (08 01)	Lower Blue Creek (08 02)	Wolf Creek (08 03)	Heilman-Swan Creek (08 04)
Streambank & Riparian Restoration	constructed	Restore streambank using bio-engineering	x	x	x	x
		Restore streambank by recontouring or regrading	x	x	x	x
	planted	Plant grasses in riparian areas	x	x	x	x
		Plant prairie grasses in riparian areas	x	x	x	x
		Remove/treat invasive species	x	x	x	x
		Plant trees or shrubs in riparian areas	x	x	x	x
Stream Restoration		Restore flood plain	x	x	x	x
		Restore stream channel	x	x	x	x
		Install in-stream habitat structures	x	x	x	x
		Install grade structures				x
		Construct 2-stage channel	x	x	x	x
		Restore natural flow	x	x	x	x
Wetland Restoration		Reconnect wetland to stream	x	x	x	x
		Reconstruct & restore wetlands	x	x	x	x
		Plant wetland species	x	x	x	x
Conservation Easements		Acquire conservation easements	x	x	x	x
Dam Modification or Removal		Remove dams			x	
		Modify dams				x
		Remove associated dam support structures			x	
		Install fish passage and/or habitat structures				x
		Restore natural flow			x	
Levee or Dike Modification or Removal		Remove levees				
		Breach or modify levees				
		Remove dikes				
		Modify dikes				
		Restore natural flood plain function				

Table 8-5 Specific restoration actions recommended for the lower Swan Creek watershed (continued).

Restoration Categories		Specific Restoration Actions	Lower Swan Creek (04100009 08)			
			Upper Blue Creek (08 01)	Lower Blue Creek (08 02)	Wolf Creek (08 03)	Heilman-Swan Creek (08 04)
Abandoned Mine Land Reclamation	treatment	Construct lime dosers				
		Install slag leach beds				
		Install limestone leach beds				
		Install limestone channels				
		Install successive alkalinity-producing systems				
		Install settling ponds				
		Construct acid mine drainage wetland				
	flow diversion	Repair subsidence sites				
		Reclaim pit impoundments				
		Reclaim abandoned mine land				
		Eliminate stream captures				
		Restore positive drainage				
		Cover toxic mine spoils				
Home Sewage Planning and Improvement		Develop HSTS plan	x	x	x	x
		Inspect HSTS	x	x	x	x
		Repair or replace traditional HSTS	x	x	x	x
		Repair or replace alternative HSTS	x	x	x	x
Education and Outreach		Host meetings, workshops, and/or other events	x	x	x	x
		Distribute educational materials	x	x	x	x
Agricultural Best Management Practices	farmland	Plant cover/manure crops	x	x	x	x
		Implement conservation tillage practices	x	x	x	x
		Implement grass/legume rotations	x	x	x	x
		Convert to permanent hayland				
		Install grassed waterways	x	x	x	x
		Install vegetated buffer areas/strips	x	x	x	x
		Install location-specific conservation buffers	x	x	x	x
		Install / restore wetlands	x	x	x	x
	nutrients / agro-chemicals	Conduct soil testing	x	x	x	x
		Install nitrogen reduction practices	x	x	x	x
		Develop nutrient management plans	x	x	x	x

Table 8-5 Specific restoration actions recommended for the lower Swan Creek watershed (continued).

Restoration Categories		Specific Restoration Actions	Lower Swan Creek (04100009 08) Upper Blue Creek (08 01)	Lower Blue Creek (08 02)	Wolf Creek (08 03)	Heilman-Swan Creek (08 04)
Agricultural Best Management Practices (cont.)	drainage	Install sinkhole stabilization structures				
		Install controlled drainage system	x	x	x	x
		Implement drainage water management	x	x	x	x
		Construct overwide ditch	x	x	x	x
		Construct 2-stage channel	x	x	x	x
	livestock	Implement prescribed & conservation grazing practices				
		Install livestock exclusion fencing				
		Install livestock crossings				
		Install alternative water supplies				
		Install livestock access lanes				
	manure	Implement manure management practices				
		Construct animal waste storage structures				
		Implement manure transfer practices				
		Install grass manure spreading strips				
	misc. infrastructure and mgt	Install chemical mixing pads				
		Install heavy use feeding pads				
		Install erosion & sediment control structures	x	x	x	x
		Install roof water management practices				
		Install milkhouse waste treatment practices				
		Develop whole farm management plans	x	x	x	x
Storm Water Best Management Practices	planning	Develop/implement local ordinances/ resolutions	x	x	x	x
		Develop local comprehensive land use plans	x	x	x	x
	construction practices	Implement erosion controls	x	x	x	x
		Implement sediment controls	x	x	x	x
		Implement non-sediment controls	x	x	x	x
	post construction practices	Reduce pollutant(s) through treatment	x	x	x	x
		Reduce pollutant(s) through flow/volume management	x	x	x	x

Table 8-5 Specific restoration actions recommended for the lower Swan Creek watershed (continued).

Restoration Categories		Specific Restoration Actions	Lower Swan Creek (04100009 08)			
			Upper Blue Creek (08 01)	Lower Blue Creek (08 02)	Wolf Creek (08 03)	Heilman-Swan Creek (08 04)
Storm Water Best Management Practices (cont.)	post development/ storm water retrofit	Implement erosion controls	x	x	x	x
		Implement sediment controls	x	x	x	x
		Implement non-sediment controls	x	x	x	x
		Reduce pollutant(s) through treatment	x	x	x	x
		Reduce pollutant(s) through flow/volume mgt	x	x	x	x
Regulatory Point Source Controls (includes Storm Water, Sanitary, and Industrial)	planning	Develop long-term control plan				
		Develop/implement local ordinances/ resolutions			x	x
		Develop water quality management/208 plans	x	x	x	x
	collection and new treatment	Install sewer systems in communities	x	x	x	x
		Implement long-term control plan (CSOs)				x
		Eliminate SSOs/CSOs/by-passes				x
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)				
		Improve quality of effluent	x	x	x	x
	monitoring	Establish ambient monitoring program				
		Increase effluent monitoring				
	alternatives	Establish water quality trading				
	construction practices	Issue permit(s) and/or modify permit limit(s)	x	x	x	x
		Implement erosion controls	x	x	x	x
		Implement sediment controls	x	x	x	x
		Implement non-sediment controls	x	x	x	x
	post construction practices	Issue permit(s) and/or modify permit limit(s)	x	x	x	x
		Reduce pollutant(s) through treatment	x	x	x	x
		Reduce pollutant(s) through flow/volume mgt	x	x	x	x
	post development/ storm water retrofit	Issue permit(s) and/or modify permit limit(s)	x	x	x	x
		Implement erosion controls	x	x	x	x
		Implement sediment controls	x	x	x	x
		Implement non-sediment controls	x	x	x	x
		Reduce pollutant(s) through treatment	x	x	x	x
		Reduce pollutant(s) through flow/volume mgt	x	x	x	x
		Reduce volume to CSOs				x

8.2.1 Source Water Protection

The Village of Swanton withdraws drinking water from Swan Creek's mainstem just upstream of the confluence with Ai Creek. While this public drinking water supply was not listed as impaired on the 2008 303(d) list of impaired waters (Ohio EPA, 2008), it was listed on the "watch list" for nitrate impairment, meaning that some data indicate elevated levels. Upstream sources from agriculture and small wastewater treatment plants are likely. Source water protection efforts should focus on controlling agricultural runoff, use of controlled drainage structures and fixing failing home sewage treatment systems (HSTS; often sources of nutrients), with particular attention to sources of pesticides, nitrates, phosphorus, and microorganisms such as *E. coli* bacteria. This can be accomplished via educational efforts and grants or other cost share programs focused to the Upper Swan Creek watershed. County extension agents are an excellent resource for assisting the agricultural community with controlling agricultural runoff, and staff from local and county health offices can instruct homeowners in proper maintenance of their septic systems.

More details on protective strategies are presented in the Source Water Assessment for the Village of Swanton. This report is available by linking to a secure web page off of the following web page: **http://epa.ohio.gov/ddagw/swap_assessments.aspx**.

Ohio EPA is offering Source Water Protection Planning workshops across the state to assist public water supply operators and their team in developing their source water protection plan. In a series of five workshops, Ohio EPA outlines the guidance for developing a source water protection plan and facilitates the development of portions of the plan at each workshop. Water supply operators may receive up to five contact hours for participating in the five workshops. Operators interested in participating in a workshop can contact Linda Merchant-Masonbrink at **linda.merchant-masonbrink@epa.state.oh.us**. The guidance for developing a source water protection plan for systems using inland surface waters can be found at: **http://epa.ohio.gov/ddagw/swap.aspx**.

8.2.2 Municipal Separate Storm Sewers

Ohio EPA issued as final the Small MS4 permit on January 30, 2009. It is a statewide permit and includes the MS4s in the Swan Creek watershed. The permit requires the MS4 to only address those TMDLs in their Storm Water Management Program (SWMP) that are final at the time the MS4 applies for permit coverage. Therefore, the MS4 permittees in the Swan Creek watershed will not be required to comply with the TMDL wasteload allocations contained in this report until the next statewide general permit is issued. However, it should be noted that the permits for both Toledo and the Phase II MS4 permittees require an adaptive management process. This means that the MS4 permittee routinely evaluates the success and performance of their SWMP, and then proposes appropriate alterations to their SWMP based on the objectives of: reducing their discharge of pollutants; protecting water quality; and satisfying the water quality requirements of ORC 6111 and the Clean Water Act. Ohio EPA will recommend, while giving technical assistance and during MS4 audits, that permittees begin to incorporate BMPs consistent with final TMDLs in their SWMPs.

The permittee must list measurable goals in the SWMP that they will use to evaluate the success of their BMPs and their progress at minimizing and reducing the discharge of pollutants from the MS4. The Phase II MS4s have some freedom to choose those BMPs and the respective measurable goals; monitoring is one option. The MS4 must implement BMPs to address each of the six Minimum Control Measures (Public Education, Public Participation, Illicit Discharges, Construction Sites, Post Construction Storm Water Management, and Pollution Prevention for Municipal Operations). These six areas address common sources of storm water pollution.

During the next permit cycle, MS4 permittees will likely need to review and possibly modify their SWMPs to achieve consistency with the TMDLs contained in this report. Co-permittees that are on one permit may choose how to apportion wasteloads among the various partners on the permit. Ohio EPA may use the wasteload allocations to identify a suite of BMPs that is appropriate for addressing the impairments. Ohio EPA should provide permit requirements that fill data gaps for potential future TMDL revisions, demonstrate SWMP progress toward implementing the WLA, and/or support adaptive management activities. Future chemical and biological monitoring by Ohio EPA will ultimately determine if water quality attainment has been achieved.

8.2.3 Summary

The diverse sources of impairment in the Swan Creek watershed require various implementation actions. The basic principles of providing floodplain connectivity, stable stream morphology and watershed hydrology that approximates natural conditions (i.e., there is adequate infiltration) are applicable to the agricultural, developing, and urban areas of the watershed. Likewise, stream buffers are appropriate for all land use types in the watershed.

Point source permit modifications for phosphorus reductions are needed at the Swanton Wastewater Treatment Plant. Home sewage treatment systems, a source of nutrients and bacteria, must be addressed in rural, urban, and developing areas. Overland sediment loading is primarily a concern in the agricultural areas and where residential and commercial development is rapid. Nutrient loading from agro-chemicals, residential sewage and a couple of manure sources is pervasive throughout all of the subwatersheds, with high nitrate-nitrite levels being especially problematic upstream of the Village of Swanton. Conservation and management practices promoted by NRCS are recommended to abate these sources. Residential, commercial and otherwise urban areas can reduce overland loading by reducing the application rate of fertilizers and improving timing. Cover crops and controlled drainage practices that uptake or intercept the release of nitrates from farm fields will benefit both aquatic organisms and the public drinking water supply. Reduction in runoff volume through on-site storm water management will also reduce loading from urban areas and improve watershed hydrology and subsequently stream stability.

In addition to decreasing the input load of nutrients and sediment, efforts to improve the habitat quality will increase the assimilative capacity of the stream to treat nonpoint source and surface runoff pollution entering the system. Providing more floodplain connections with wetland areas and exploring the concept of two-stage or over-wide drainage ditches may also reduce damaging flows throughout the watershed. These latter practices might be particularly applicable in areas of active ditch maintenance.

8.3 Reasonable Assurances

The recommendations made in this TMDL report will be carried out if the appropriate entities work to implement them. In particular, activities that do not fall under regulatory authority require that there be a committed effort by state and local agencies, governments, and private groups to carry out and/or facilitate such actions. The availability of adequate resources is also imperative for successful implementation.

When a TMDL is developed for waters impaired by point sources only, the issuance of a NPDES permit(s) provides the reasonable assurance that the wasteload allocations contained in the TMDL will be achieved. This is because 40 C.F.R. 122.44(d)(1)(vii)(B) requires that effluent limits in permits be consistent with the assumptions and requirements of any available wasteload allocation in an approved TMDL.

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, U.S. EPA's 1991 TMDL Guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions. The following text discusses local organizations and programs that have an important role or can provide assistance for meeting the goals and recommendations of this TMDL. In addition, Appendix D discusses state-level organizations and programs to establish in greater detail why it is reasonable to be assured of successful implementation.

8.3.1 Local Zoning and Regional Planning

The Toledo-Lucas County Plan Commission is a department of the City of Toledo that has responsibility for coordinating planning for the city and eleven townships of Lucas County. A current initiative of the Commission is the *Toledo 20/20 Future Land Use Plan Update.*

The 20/20 Implementation Committee is updating the land use plan for the Toledo 20/20 Comprehensive Plan. The Toledo 20/20 Plan establishes the overall character, extent and location of various land uses and serves as a guide to communicate the policies of the Toledo 20/20 Comprehensive Plan to citizens, the business community, developers and others involved in the development of the City of Toledo (**http://www.toledo.oh.gov**).

American Rivers has been working with the City of Toledo, Lucas County and area township representatives to revise local codes, ordinances and subdivision regulations to allow and incentivize green infrastructure techniques such as rain gardens and green roofs. The Rain Garden Initiative conducts workshops and has supported several public and private rain gardens and maintains a website (**www.raingardeninitiative.org**) containing educational material.

The Lucas County Engineer's Office has a planning section whose primary responsibility is to review engineering site plans for various proposed residential, commercial and industrial developments in the unincorporated areas of Lucas County. All subdivisions in Lucas County must follow the requirements of the Lucas County Subdivision Rules and Regulations. These regulations are periodically updated and maintained by the staff of the Lucas County Plan Commission. The planning section works closely with the Plan Commission staff and the eleven township zoning departments to assist in providing engineering reviews of proposed Site Plans (**http://www.co.lucas.oh.us**).

The Lucas County Soil and Water Conservation District works with engineers and the development community throughout the unincorporated areas of Lucas County. They designed one of the first bioretention cell systems in 2006 for the Deer Valley subdivision in Monclova Township. It was designed to adequately treat the Construction General Permit water quality volume. The District also reviews plans for erosion and sediment controls as well as post-construction water quality plans as requested, and they have worked with developers and the Planning Commission to preserve riparian areas along Swan Creek in the planning phase of new subdivisions (**http://www.co.lucas.oh.us/index.aspx?nid=458**).

8.3.2 Easements and Land Preservation

The preservation and protection of high quality riparian acres is advanced by multiple private and public entities throughout the watershed. Toledo Metroparks (**www.metroparkstoledo.com**) and The Nature Conservancy (**www.nature.org**) are active in preservation and enhancement of natural and recreational areas in the watershed. In particular, The Nature Conservancy owns a large tract of land in the Oak Openings region called the Kitty Todd Nature Preserve. For information on the Preserve see The Nature Conservancy's web site (**www.nature.org**). For information on the unique Oak Openings region, please see **www.oakopen.org**. Another local land trust, Black Swamp Conservancy, has been active with preserving farmland through the Clean Ohio Agricultural Easement Purchase Program (**www.blackswamp.org**).

The Lucas Soil and Water conservation District also holds several conservation easements in the Swan Creek watershed and is willing to manage smaller streamside easements that typically don't interest other land protection organizations.

8.3.3 Education and Outreach

Educational materials can be updated to include information on causes, sources and solutions to nonpoint pollution in the Swan Creek watershed. The primary focus would be building public awareness about the value of a healthy watershed and the importance of reducing/eliminating these sources of pollution.

The Lucas SWCD employs an education specialist who visits area schools to provide environmental programs ranging from storm water runoff to nonpoint pollution and general water quality. **http://www.co.lucas.oh.us/index.aspx?NID=458**.

Toledo Metropolitan Area Council Of Governments (TMACOG) employs the Maumee River watershed coordinator who organizes and supports the annual Student Watershed Watch that involves middle and high school students from area schools in the Maumee and Swan Creek watersheds to do stream monitoring. The project culminates in a summit where the students present their data and discuss local and global environmental issues. **http://www.tmacog.org/Environment/SWW_08/SWW_08.htm**.

Ohio's Source Water Environmental Education Teams (SWEET) program provides Ohioans with education and guidance on protecting their sources of drinking water. There are SWEETs in Fulton and Lucas County. SWEETs can attend public meetings or other events to help educate the community about the importance of protecting its drinking water supply. Schools can invite SWEETs to their classrooms to demonstrate ground water flow, contaminant transport and source water protection by using the ground water flow model. Public water systems can utilize SWEETs when developing and implementing their community's Drinking Water Source Protection Plan. A link to this program is: **http://wwwapp.epa.ohio.gov/ddagw/SWEET/**.

The Toledo-Lucas County Rain Garden Initiative has worked with local landowners and public organizations to install rain gardens and bioretention cells, throughout Lucas County since 2006. Examples are found at Springfield Twp Hall, Deer Valley Subdivision, Blue Creek Conservation Area, Metroparks, and numerous homesites. The City of Toledo and Rain Garden Initiative has partnered with the Highland Park Association to promote watershed protection projects in the neighborhood.

Funding for nonpoint source education is available through competitive grants from ODNR Division of Soil and Water Conservation and the Ohio Environmental Education Fund. Links to these two program web sites are: **http://www.dnr.state.oh.us/soilandwater/education.htm** and **http://www.epa.ohio.gov/oeef/oeefoverview.aspx**.

8.3.4 Other Sources of Funding and Special Projects

There are numerous other grant funding sources available for sediment control, habitat restoration and water quality improvement projects, including Great Lakes Commission Lake Erie Protection Fund, ODNR Coastal Management Program and Ohio EPA Section 319 Nonpoint Source Program.

There are private foundations found nationally, regionally and locally. Depending on the mission of the organization, funds might be available to help improve the Swan Creek watershed. Some local foundations include the Toledo Community Foundation, the Stranahan Foundation and the 577 Foundation.

The Joyce Foundation is a large national foundation that made a $5 million investment toward restoring water quality in the Maumee River Basin, of which the Swan Creek is a part. The Partners for Clean Streams received a grant to conduct several projects, including a dam mitigation project and an inventory/restoration plan.

- **Wetland and Riparian Inventory and Restoration Plans for Swan Creek & Ottawa River**: This project was to identify and prioritize potential wetland and/or riparian mitigation sites in both the Swan Creek and Ottawa River watersheds. The lists could be used to capture mitigation or penalty funds as they become available or to seek grant.

- **Highland Park Dam Decommissioning and Riparian Enhancement Project for Swan Creek**: This low-head dam prevented fish from spawning, trapped sediments and degraded water quality, but could not be removed. This project demonstrated dam mitigation without dam removal by decreasing its impact with the construction of structures to restore natural water movement, allow spawning fish to swim past the dam, and creating an overall more natural environment.

Other projects conducted by the Partners for Clean Streams can be found at **http://www.PartnersForCleanStreams.org**.

The Toledo Metropolitan Area Council of Governments (TMACOG) received a grant from the Ohio Lake Erie Commission in 2005 for a pilot project to test the use of incentives as a tool to promote balanced regional planning through their Balanced Growth Initiative. Balanced Growth is a strategy to protect and restore Lake Erie and its watersheds to assure long-term economic competitiveness, ecological health and quality of life. The recommendations focus on reducing urban sprawl, protecting natural resources and encouraging redevelopment in urban areas.

TMACOG's project included the Swan Creek watershed. In 2009, when the plan describing regional preferences is complete, and if 75 percent of the jurisdictions in the watershed agree with the plan, incentives will be available for communities to implement elements of the plan. The Ohio Lake Erie Commission is working with state agencies to develop the incentives that will support the plan's goals. For more information, see **http://balancedgrowth.ohio.gov/**.

The City of Toledo began constructing the Reynolds Road Enhancement Project in 2009. The project includes substitution of permeable pavement, bioswales, rain gardens, underdrainage systems and landscaping to ameliorate the affects of storm water runoff from Glendale Avenue to the Ohio Turnpike interchange on Reynolds Road.

8.3.5 Past and Ongoing Water Resource Evaluation

Ohio EPA assessed the Swan Creek watershed for attainment of designated beneficial uses in 2006. According to the *2008 Ohio Integrated Water Quality Monitoring and Assessment Report* (Ohio EPA, 2008), Ohio EPA will return to reassess the condition of the watershed in 2022. In addition, should substantial implementation occur prior to that date, Ohio EPA may return to assess the effects of implementation projects on water quality in applicable areas.

Under Toledo's NPDES permit for their Municipal Separate Storm Sewer System, three types of monitoring have been required: 1) seasonal wet weather outfall monitoring of representative land uses to characterize discharges from the MS4. Two of the outfalls are on Heilman Ditch; 2) quarterly in-stream monitoring at three locations on the mainstem of Swan Creek; and 3) dry weather screening once every five years of all major outfalls to locate illicit discharges and connections. During 2006, in lieu of the wet weather sampling as outlined in the permit, Toledo sampled one outfall each quarter in the Swan Creek watershed, along with an upstream and downstream point, during wet weather. The NPDES permit is currently in the process of being renewed.

Toledo has an Illicit Discharge, Detection and Elimination Program focusing on the Swan Creek watershed. As part of the Phase 1 MS4 permit, City of Toledo has conducted 53 IDDE inspections near Swan Creek.

The City of Toledo Bayview Park Wastewater Treatment Plant NPDES permit (permit number 2PF00000) requires monitoring and reporting of all plant bypass and combined sewer overflow (CSO) discharges to the Maumee River, Ottawa River and Swan Creek. There are a total of 33 CSOs, eight of which discharge to the Swan Creek watershed. The permit requires that CSO occurrence, flow rate and duration be reported for all outfalls that discharge during wet weather events. In addition, five-day carbonaceous biochemical oxygen demand and total suspended solids are to be monitored on a rotating schedule for at least five outfalls per storm event. The permit also requires that the collection system be operated and maintained in accordance with the CSO Nine Minimum Control Strategies.

The Long Term Control Plan (LTCP) for Toledo is under review at U.S. EPA. For Swan Creek, and specifically outfalls 042, 043, 045, 046, 047, 048, 050, and 069, the LTCP specifies a performance criterion of three overflow events per year from the Swan Creek North Tunnel and one event per year from the Swan Creek South Tunnel. This will be accomplished by optimizing the operation and maintenance of the two existing storage tunnels. Another project will separate some combined sewer areas to reduce volume to the South tunnel, thereby eliminating several outfalls. Disinfection facilities will be added to both tunnels, to minimize the impact of remaining discharges. Construction of these improvements (broken into four separate projects) is scheduled to begin in 2013 and be fully operational between 2015 and 2020.

The Toledo Waterways Initiative is the City of Toledo’s 15-year program designed to improve its aging sewer system. The initiative was formed as a result of the settlement of an 11-year-old lawsuit between the City of Toledo and the U.S. and Ohio EPAs that requires the City to update its sewer and wastewater treatment facilities to stop the release of raw sewage into Swan Creek and the Ottawa and Maumee Rivers. The series of improvements to upgrade the City’s sewer system is expected to cost more than $450 million. Funding for the program will come from an incremental increase of sanitary sewer rates over the next 15 years. In an effort to minimize the impact on ratepayers, the City is also pursuing federal and state funding and grants.

Other independent monitoring has also occurred in the Swan Creek watershed, as the stream has provided opportunities for other habitat, geomorphology, and ecology studies by area university classes and researchers. A freshwater mussel survey was performed from 2006-2008 by Ecological Survey and Design, LLC (J. Grabarkiewicz) and the University of Toledo. The study revealed a diverse community of freshwater mussels from RM 19 – 15.3, including a state endangered species and several species of concern in Ohio.

8.3.6 Potential and Future Evaluation

The Partners for Clean Streams utilizes a cooperative community partnership approach to water quality improvements. They are the umbrella organization that has taken the lead in the Swan Creek watershed to develop a watershed restoration plan. A draft of this report was published in 2006, and will be updated and completed for state endorsement in 2009. The *Maumee Area of Concern Stage 2 Watershed*

Restoration Plan provides a list of projects that can address many of the issues highlighted in this TMDL Report. This report can be found at **http://www.PartnersForCleanStreams.org**.

Another plan that was developed to facilitate restoration in the Swan Creek watershed is the *Wetland and Riparian Inventory and Restoration Plans for Swan Creek & Ottawa River*. This report will be completed in early 2009 and will include sites in the Swan Creek watershed that can potentially be restored and/or enhanced to improve water quality. This report will include concept site descriptions, field observations, concept plans and estimated costs, and will be available at **http://www.PartnersForCleanStreams.org**.

8.3.7 Revision to the Implementation Approach

An adaptive management approach will be taken in the watershed. Adaptive management is recognized as a viable strategy for managing natural resources (Baydack et al., 1999) and this approach is applied on federally-owned lands. An adaptive management approach allows for changes in the management strategy if environmental indicators suggest that the current strategy is inadequate or ineffective. The recommendations put forth for the watershed are discussed in the last chapter of the main report. If chemical water quality does not show improvement and/or water bodies are still not attaining water quality standards after the implementation plan has been carried out, then a TMDL revision would be initiated. The Ohio EPA would initiate the revision if no other parties wish to do so.

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