Maidencreek Township, Berks County
MS4 TMDL Plan
Lake Ontelaunee TMDL

Prepared for

MAIDENCREEK TOWNSHIP
BOARD OF SUPERVISORS

1 Quarry Road
Blandon, PA 19510
Maidencreek Township, Berks County, PA

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SYSTEMS DESIGN
ENGINEERING, INC
Project 18-0019-0191
"A Passion for Engineering Excellence"
sdei.net

Maidencreek Township, Berks County
MS4 TMDL Plan
Lake Ontelaunee Watershed

1.0 Introduction

This MS4 TMDL Plan has been prepared by Systems Design Engineering, Inc. (SDE), for Maidencreek Township, Berks County, Pennsylvania (the Township), as part of the Township's obligations under its NPDES PAG-13 MS4 permit (Permit Number PAG-13-3521).

This TMDL Plan is required due to a small portion of the Township's MS4 being located within the watershed of Lake Ontelaunee, which has a TMDL specified for nutrients and suspended solids. The MS4 contributing to Lake Ontelaunee in Maidencreek Township consists of three (3) outfalls.

This plan will provide background wasteloads and propose a strategy for implementation of best management practice (BMP) control measures, with the intention of demonstrating a reduction in applicable pollutant loads as specified in the Lake Ontelaunee TMDL document.

2.0 TMDL Summary

A Total Maximum Daily Load (TMDL) report was prepared by Tetra Tech, Inc., for the U.S. Environmental Protection Agency (EPA) for the Lake Ontelaunee watershed, Berks and Lehigh Counties, Pennsylvania, on August 9, 2004. The report, referred herein as "TMDL report" is entitled "*Total Maximum Daily Load For Nutrients and Suspended Sediment Lake Ontelaunee, Berks and Lehigh County, Pennsylvania*".

The TMDL report indicates that the lake is impaired due to nutrients and suspended solids. Contributing to the impairment are agriculture, municipal point sources, on-site wastewater treatment systems, and urban runoff. Table 1-1 is reprinted from the TMDL report:

Table 1-1. 303(d) Listing for Lake Ontelaunee

Assessment ID	Causes	Listing Date	TMDL Date	Size	Use Assessed
Lake Ontelaunee 19910001-0004-LAK	Agriculture/Nutrients Agriculture/Suspended Solids Municipal Point Source/Nutrients Municipal Point Source/Suspended Solids On site Wastewater/Nutrients On site Wastewater/Suspended Solids Urban Runoff/Storm Sewers/Nutrients Urban Runoff/Storm Sewers/Suspended Solids	1996	2005	1080 acres	Aquatic Life

2.1 Nutrient Impairments

Nutrient impairments in water bodies tend to lead to excessive algal biomass which in turn reduces content of dissolved oxygen, potentially causing death of aquatic organisms. The TMDL report indicates that phosphorus is the limiting nutrient for algae control. The two largest nonpoint sources of the phosphorus nutrient are croplands and transitional areas, with point sources accounting for around 4.5 percent of Total Phosphorus. Nitrate is another nutrient that is often present with phosphorus contamination, and is of particular concern in this case, since Lake Ontelaunee is a public water supply. However, the report indicates that water quality data do not indicate nitrate concentrations in excess of EPA established maximum contaminant levels, leading to a determination that a nitrate TMDL was not necessary.

2.2 Sediment Loading

Sediment loading is a concern as it reduces storage capacity in the lake and impairs fish food sources and spawning areas. Excess sediment in drinking water supplies can lead to odor and taste issues, and can interfere with proper water treatment facilities. The TMDL report indicates that, as with nutrients, croplands and transitional areas are the largest sources of sediment. Pasturelands and unpaved roads are also significant sediment contributors. Point sources are responsible for less than one percent of the sediment load.

2.3 Affected Municipalities

Table 2 lists municipalities and counties subject to the TMDL within the same Hydrologic Unit Code (HUC) 02040203.

Table 1. Municipalities Subject to the Lake Ontelaunee TMDL for HUC 02040203

Municipality	County	Municipality	County
Albany Township	Berks	Maxatawny Township	Berks
Greenwich Township	Berks	Perry Township	Berks
Kutztown Borough	Berks	Richmond Township	Berks
Lenhartsville Borough	Berks	Rockland Township	Berks
Lynn Township	Lehigh	Windsor Township	Berks
Lyons Borough	Berks	Weisenberg Township	Lehigh
Maidencreek Township	Berks		

3.0 Watershed Characteristics

According to the TMDL report, the Lake Ontelaunee watershed consists of approximately 123,104 acres of land in Berks and Lehigh Counties. The lake itself has a surface area of approximately 1,100 acres. The watershed is within the Schuylkill River basin, Hydrologic Unit Code (HUC) 02040203. All discharges to the lake from the Maidencreek Township MS4 are from within this HUC area. Figure 1 is a graphical depiction of the watershed, from the TMDL report.

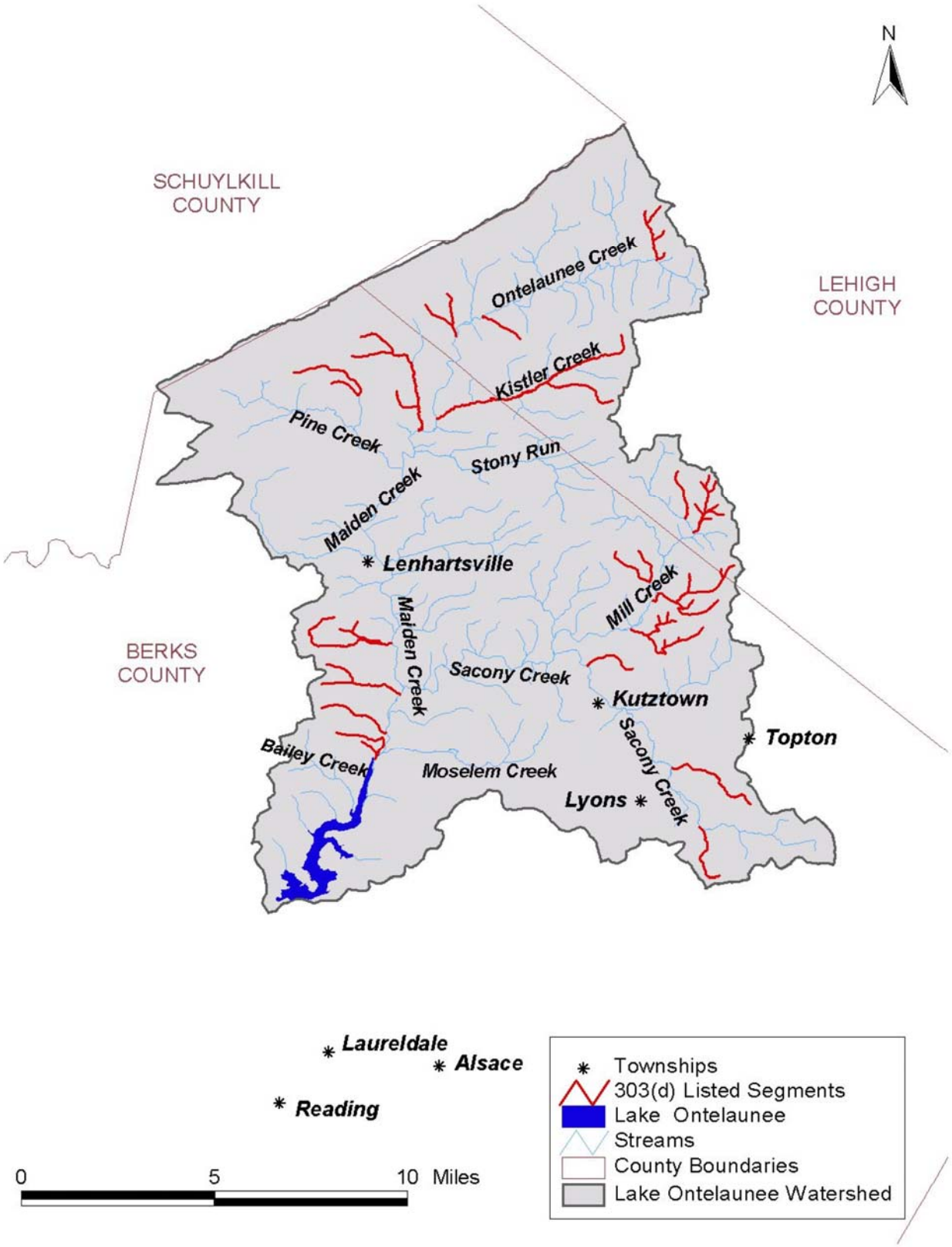


Figure 1. Lake Ontelaunee Watershed (*from USEPA Total Maximum Daily Load For Nutrients and Suspended Sediment Lake Ontelaunee Berks and Lehigh County, Pennsylvania, 8/9/04)*

Lake Ontelaunee supplies drinking water for the City of Reading and several surrounding municipalities. Fishing and hunting are primary recreational uses on and around the lake. The majority of the watershed is rural, dominated by agriculture.

The Maidencreek Township MS4 storm sewersheds within the Lake Ontelaunee watershed are depicted in Figure 2. Of the 123,104-acre watershed to the lake, a total of approximately 98 acres, or 0.08 percent, contribute from the storm sewersheds, and only about 57 acres (0.05 percent) contribute from the Urbanized Area within Maidencreek Township. Figure 3 depicts the areal breakdown to the three outfalls, and areas to the outfalls are tabulated in Table 2.

Table 2. Storm Sewersheds Tributary to Lake Ontelaunee from Maidencreek Township UA

Stormshed/Outfall	**Area, Ac.**
O-049	11.1
O-050	62.9
O-051	23.6
Total	**97.6**

Figure 4 superimposes Figure 2 onto Figure 1, to depict a relative comparison of drainage area size. The intent is to demonstrate the relative insignificance of Maidencreek Township's MS4 contribution to the lake's watershed.

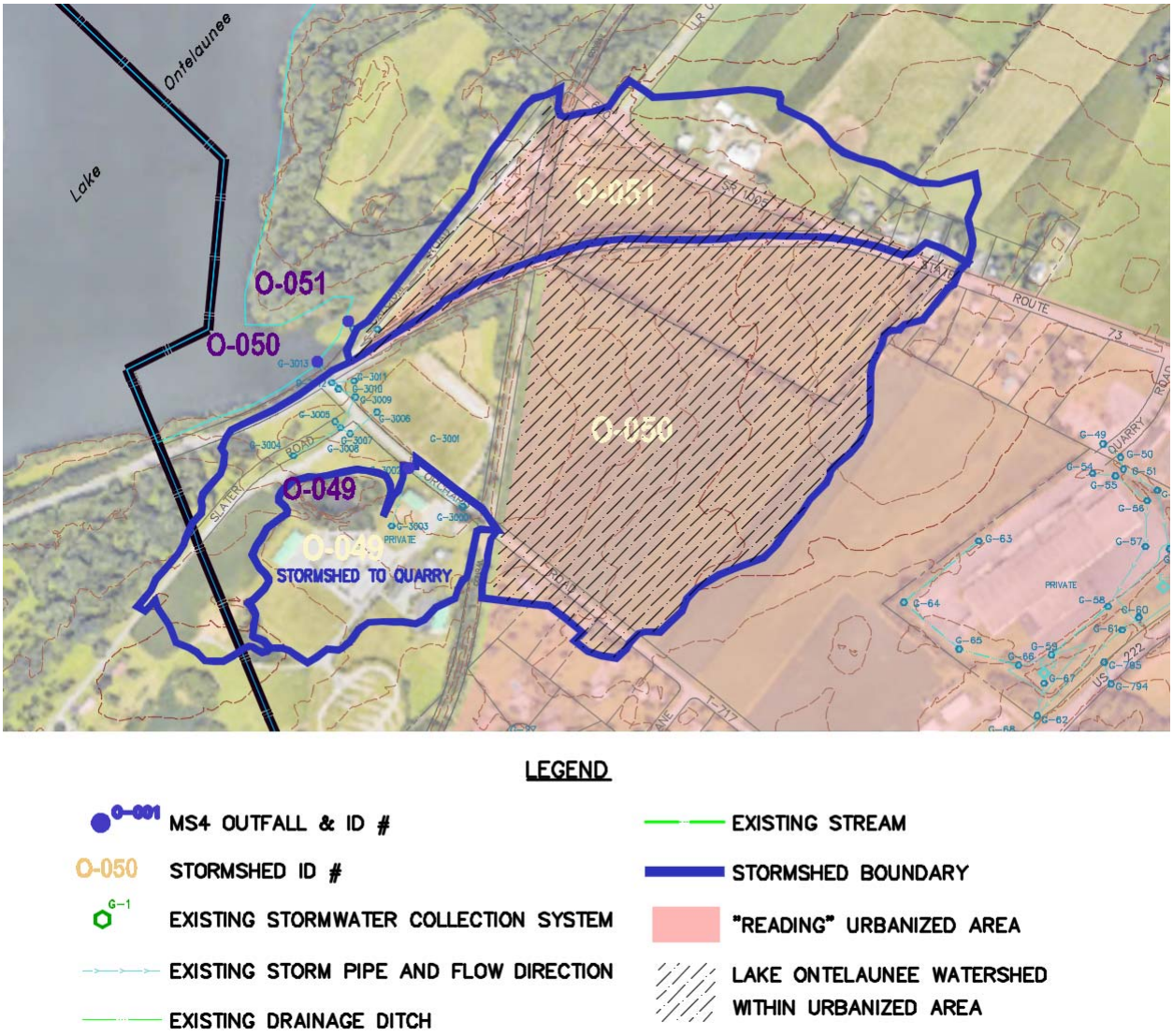


Figure 2. Maidencreek Township MS4 Area within Lake Ontelaunee Watershed

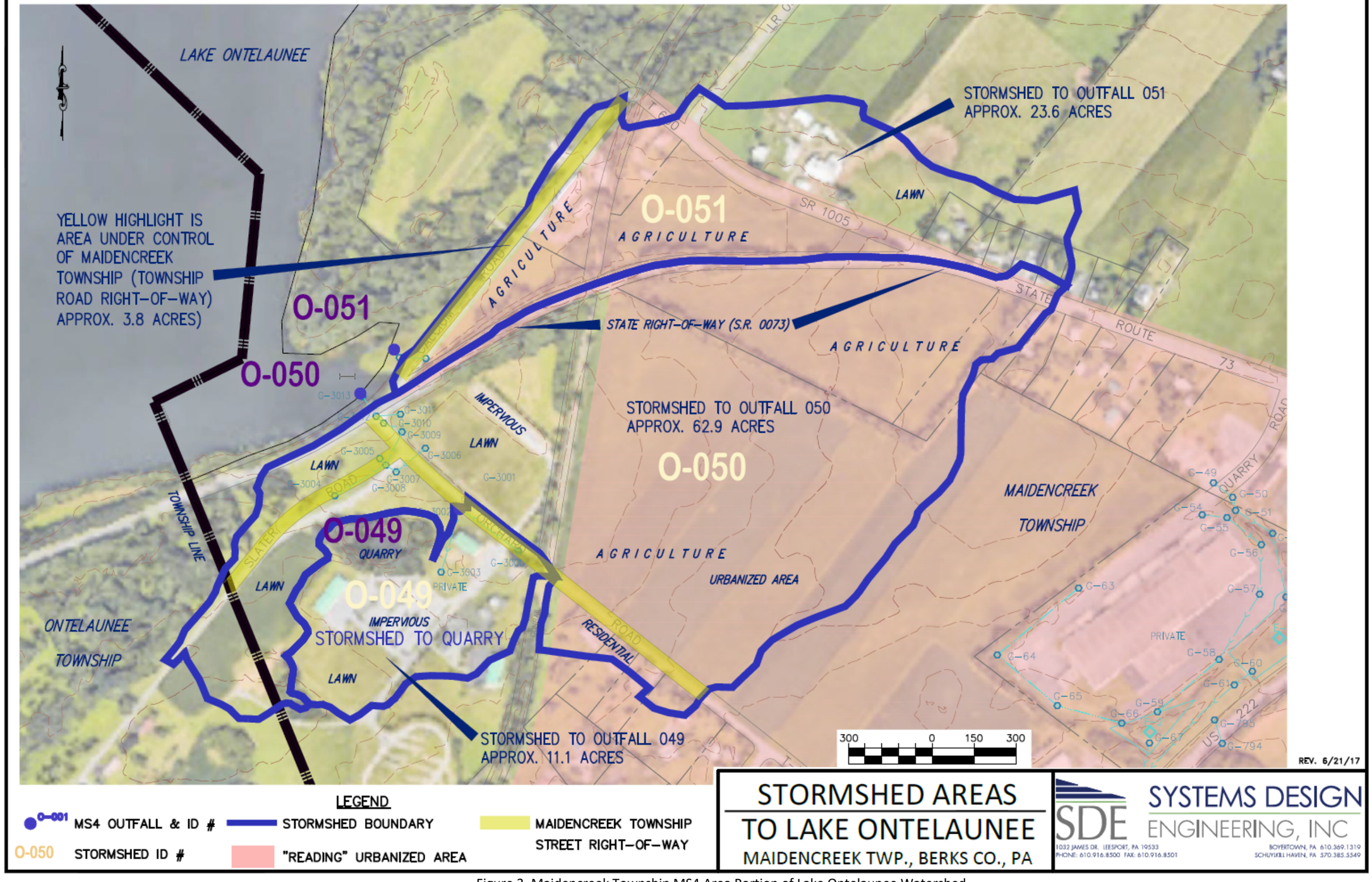


Figure 3. Maidencreek Township MS4 Area Portion of Lake Ontelaunee Watershed

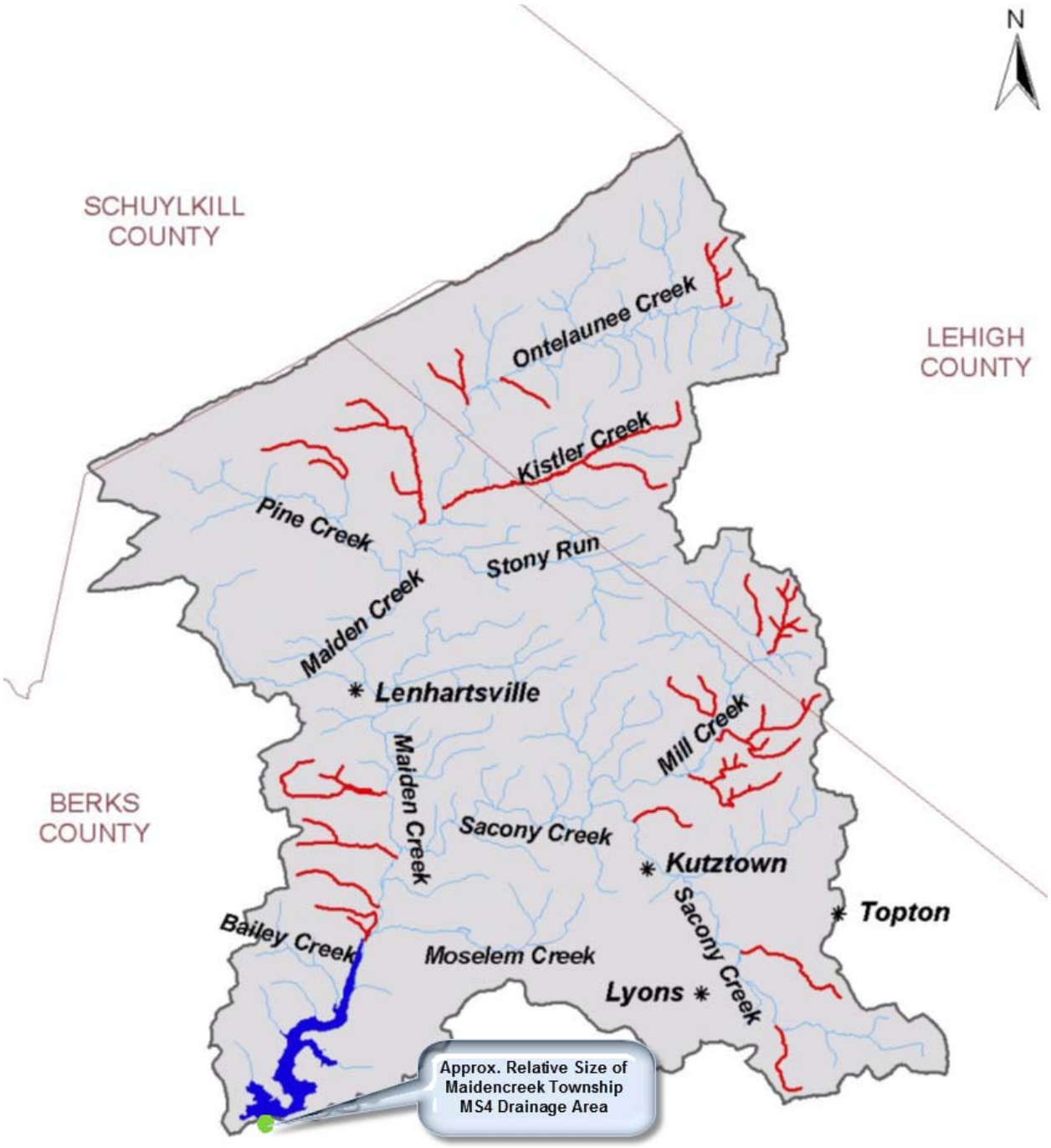


Figure 4. Maidencreek Township MS4 Area Relative to Lake Ontelaunee Watershed

4.0 Waste Load Allocations

The following tables are reprinted from the Lake Ontelaunee TMDL report, and depict various load and waste load allocations by pollutant. Recall that phosphorus was determined as the controlling nutrient in the nutrient loading component of the TMDL – nitrates were determined to be within acceptable levels.

Table ES-1. Lake Ontelaunee Phosphorus TMDL Table (metric tons per year)

TMDL (t/yr)	LA (t/yr)	WLA (t/yr)	MOS (t/yr)
10.65	7.36	2.77	0.52

Table ES-2. Lake Ontelaunee Phosphorus TMDL, Source Allocation Summary (metric tons/year)

Source	Area (ha)	Existing Load (t/yr)	% of Total Existing Load	Existing UAL (t/yr*ha)	Allocated Load (t/yr)	% of Total Allocated Load	Allocated UAL (t/yr*ha)	Percent reduction (%)
Hay/Pasture	9,061	3.95	4.8	0.00044	1.00	9.9	0.00011	75
Cropland	19,994	46.93	57.0	0.00235	2.35	23.2	0.00012	95
Coniferous	1,135	0.02	0.0	0.00002	0.02	0.2	0.00002	0
Mixed Forest	948	0.09	0.1	0.00009	0.09	0.9	0.00010	0
Deciduous Forest	14,481	1.34	1.6	0.00009	1.34	13.2	0.00009	0
Unpaved Roads	44	0.37	0.4	0.00841	0.02	0.2	0.00042	95
Quarry	16	0.06	0.1	0.00375	0.00	0.0	0.00022	93
Transitional	1,490	16.27	19.8	0.01092	0.81	8.0	0.00054	95
Low Intensity	646	0.07	0.1	0.00011	0.07	0.7	0.00011	0
High Intensity	242	0.35	0.4	0.00145	0.05	0.5	0.00022	85
MS4	54	0.13	0.2	0.00232	0.01	0.1	0.00015	94
Point Source	--	3.65	4.4	--	2.76	27.2	--	24
Groundwater	--	6.06	7.4	--	1.52	15.0	--	75
Septic Systems	--	3.03	3.7	--	0.09	0.9	--	97
Total	48,111	82.31	100.0	0.00171	10.13	100.0	0.00021	88

Table ES-3. WLA for Total Phosphorus, MS4s

Township	Permit ID	WLA, TP kg/yr	% Reduction
Maiden Creek	PAG133521	5.98	94
Ontelaunee	PAG133512	1.96	93

Table ES-6. Lake Ontelaunee Sediment Loading Characteristics, Existing and TMDL Conditions

	Existing Conditions	TMDL Conditions
Years until 30 percent full	43	92
Sedimentation Rate (cm/yr)	0.91	0.44
Annual Load (kg/m3)	10,772	5,149

Table ES-7. Lake Ontelaunee Sediment TMDL Table (metric tons)

TMDL tons/yr	LA tons/yr	WLA tons/yr
19,587	19,444	143

Table ES-8. Lake Ontelaunee Sediment TMDL, Source Allocation Summary

Source	Area (ha)	Existing Load (t/yr)	Existing UAL (t/ha-yr)	% of Existing Load	Allocated Load (t/yr)	Reduced UAL (t/yr-ha)	% of Allocated Load	% Reduction
Hay/Pasture	9,061	2,146.8	0.24	3.13	1,629.7	0.18	8.32	24
Cropland	19,994	44,973.1	2.25	65.53	11,243.3	0.56	57.40	75
Coniferous	1,135	24.2	0.02	0.04	24.2	0.02	0.12	0
Mixed Forest	948	104.6	0.11	0.15	104.6	0.11	0.53	0
Deciduous Forest	14,481	1,467.3	0.10	2.14	1,467.3	0.10	7.49	0
Unpaved Roads	44	416.7	9.47	0.61	104.2	2.37	0.53	75
Quarry	16	56.7	3.55	0.08	22.6	1.41	0.12	60
Transitional	1,490	19,244.2	12.92	28.04	4,811.0	3.23	24.56	75
Low Intensity Developed	646	19.8	0.03	0.03	19.8	0.03	0.10	0
High Intensity Developed	242	17.1	0.07	0.02	17.1	0.07	0.09	0
MS4	54	127.8632	2.37	0.19	33.494118	0.62	0.17	74
Point Sources	--	36.0	--	0.05	109.6	--	0.56	0
Total Existing Load (t/yr)	68,634							
Total Allocated Load (t/yr)	19,587							
Total % Reduction	71							
Existing Channel Deposition (t/yr)	53,071							
Reduced Channel Deposition (t/yr)	12,782							

Table ES-9. WLA for TSS, MS4s (metric tons)

Township	Permit ID	WLA, TSS t/yr	% Reduction
Maiden Creek	PAG133521	26.6	74
Ontelaunee	PAG133512	6.9	73

5.0 MS4 TMDL Strategy

5.1 MS4 Drainage Area

Lake Ontelaunee's watershed area is approximately 123,104 acres. Maidencreek Township's MS4 storm sewershed area to the lake is about 98 acres, or 0.08 percent. The 98 acres drain to a three outfalls (#s O-049, O-050 and O-051). See Figures 2, 3, and 4 for a graphical depiction of the MS4 drainage area.

The MS4 watershed consists predominantly of agricultural lands. The next largest land user is the Rajah Temple property, which consists of large areas of open grass (athletic fields and parking areas), as well as some significant paved areas for parking and access. Much of this area is tributary to a quarry on the Rajah property, which does not have an overland outlet, but is included in the contributing storm sewershed area nonetheless. Several detached residential homesites and roadways occupy the remaining portion of the watershed.

Figure 3 also depicts the extent of Township-owned land within the MS4 drainage area to the lake; approximately 3.8 acres, comprised solely of streets and adjoining rights-of-way – strips of land less than 50 feet wide. This severely limits the type and number of BMPs that can be implemented and directly controlled by the Township.

5.2 Prior TMDL Plans for Maidencreek Township's MS4

SDE, Inc. developed an initial TMDL Plan for the Maidencreek Township MS4 tributary to Lake Ontelaunee in September 2012. The strategy employed in that plan relied heavily on street sweeping as a means to reduce nutrient and sediment loading to the lake, because this was the only reasonable physical BMP that the Township had at its disposal on the limited areas of the MS4 under their ownership.

DEP subsequently deemed the street sweeping approach to be insufficient, and in December 2015, Great Valley Consultants (GVC) developed a supplement to the original plan. The supplement relies more on public education and outreach than on physical BMPs, and seeks voluntary cooperation with the implementation of conservation practices from private property owners, to achieve nutrient and sediment reductions. The GVC strategy is paraphrased in the following sections.

5.3 Waste Load Allocations and Sources

The Lake Ontelaunee TMDL waste load allocation (WLA) for sediment is 26.6 metric tons/year (58,643 pounds per year) and the WLA for phosphorous is 5.98 kg/year (13.18 pounds/year). The TMDL requires reductions in sediment and phosphorus loading of 74% and 94%, respectively. These reductions are applied MS4-wide; however, it should be abundantly clear that the 3.8 acres of Township-owned streets and rights-of-way are incapable of generating any significant quantities of sediment and nutrients. These reductions are the long-term (i.e., more than five years) goals of the TMDL strategy.

Principal land uses within the MS4 storm sewersheds tributary to the lake include privately-owned agricultural facilities and lawn areas. These uses are significantly more likely to contribute to the waste loads identified in the TMDL report. See Table 3 for an approximate distribution of land uses throughout the MS4 storm sewersheds tributary to Lake Ontelaunee, from Maidencreek Township.

Table 3. Contributing Land Uses to Lake Ontelaunee from Maidencreek Township MS4 Storm Sewersheds

Land Use Type	Approx. Area, ac	% of Total Area
Agriculture	**57.6**	**59.0**
Maintained Lawn	**14.3**	**14.7**
Woods/Quarry	**8.5**	**8.7**
Street ROW (State)	**5.2**	**5.3**
Impervious (Private)	**4.3**	**4.4**
Residential	**3.9**	**4.0**
Street ROW (Municipal)	**3.8**	**3.9**
Total	**97.6**	**100.0**

5.4 TMDL Strategy

It has been established that the Maidencreek Township MS4 has little, if any, impact to the wasteloads attributable to the Township in the Lake Ontelaunee TMDL. In addition, the Township owns very little property within the MS4 tributary to the lake, limited solely to the narrow strips of street rights-of-way depicted in Figure 3.

In consideration of these limitations, Maidencreek Township proposes public education and outreach as its principal BMP in the effort to reduce wasteloads to the lake. This approach will involve education of private landowners within the MS4 area about the effects of nutrient and sediment pollution on the lake, and encouragement of those landowners to voluntarily implement BMPs to reduce quantities of phosphorus and sediment in stormwater runoff from lands they control.

For agricultural lands, practices including contour cropping, no-till farming, cover crops and fertilizer reductions contribute greatly to sediment and nutrient reductions. In residential and commercial areas, landscaping practices can be altered to reduce the amounts of fertilizers and pesticides applied to "green" areas, and better housekeeping techniques can be implemented, such as refraining from disposal of grass clippings in or near waterways and dry cleanup of oils and debris from paved surfaces.

Education and outreach can be accomplished through the assistance of conservation agencies that specialize in agricultural education, including Berks Nature and Berks County Conservation District. These agencies often offer or have connections to agencies that offer funding opportunities and support for these efforts. Additional avenues for outreach are available to the Township via its membership in the Berks County MS4 Steering Committee, which provides continuous updates and opportunities for public education throughout Berks County.

5.4.1 Potential Loading Reductions

The TMDL strategy relies heavily upon cooperation of private property owners. The largest contiguous land block within the Maidencreek Township UA portion of the Lake Ontelaunee watershed consists of farmland. As farmland also happens to be the greatest potential contributor of sediment and nutrient loading within the planning area, WikiWatershed's "Model My Watershed" was utilized to gauge

effectiveness of applying several conservation measures to the agricultural lands. Results will help in the future discussions with the landowner(s).

The model was set up to cover the agricultural portion of the Maidencreek Township UA, an area of approximately 57.6 acres (233,277 sq. meters). Of this area, the model database characterized 9.9 acres (4.0 hectares) as "cropland." Based on Google Earth and other aerial imagery, the cropland acreage appears low, but the goal of the model runs are to gauge percentage loading reductions; therefore, the relative comparisons should be reflective of actual area.

The following scenarios were evaluated:

1. Current Condition
2. Add Cover Crop Only
3. Add Conservation Tillage Only
4. Add Nutrient Management Only
5. Add Cover Crop, Conservation Tillage and Nutrient Management ("All 3")
6. Add Cover Crop and Conservation Tillage
7. Add Cover Crop and Nutrient Management
8. Add Conservation Tillage and Nutrient Management

As would be expected, number 5 ("All 3" scenarios) achieved the highest wasteload reductions of 65% for sediment and 84% for phosphorus, which would meet the short term (permit term) reduction percentage requirements for sediment (10%) and phosphorus (5%). Long term reductions are those stipulated in the TMDL (74% for sediment and 94% for phosphorus). It is important to note that this evaluation assumes that none of the conservation measures are currently being used.

Table 4 summarizes the results of the model run for the different scenarios, and Appendix A contains the WikiWatershed screenshots with supporting documentation.

5.4.2 Plan Implementation

Maidencreek Township and/or its designee(s) will implement the TMDL Plan in the following manner ("Year x" designations refer to the end of the particular "Permit Year" by which foregoing activities will be completed):

Year 1 Collect and compile data regarding ownership and uses of properties within the storm sewersheds leading to Outfalls O-049, O-050 and O-051. Rank target audiences as to their pollutant potential, based on geographic locations within the sewersheds, and relative to public or private storm sewer systems.

Year 2 Model the agricultural portion of the planning area to gauge effectiveness of load reductions in response to various scenarios of conservation management measures and focus efforts on outreach accordingly. Contact local agricultural landowners to determine types and extents of conservation measures actually being utilized, as well as areal extent of application, and compare to model results. Contact local agencies including Berks County Conservation District and Berks Nature, and attend the quarterly meetings of the Berks County MS4 Steering Committee to gauge interest and ability for the agencies to reach out to and/or meet with

property owners, in conjunction with Maidencreek Township, in an order of timeliness based on severity of ranking in the Year 1 effort.

Year 3 Within the years leading up to and including Year 3, more detailed mapping of existing public and private stormwater conveyance and management facilities will be performed, to refine the concentration of private property owners to target with education and outreach, and seek voluntary cooperation with BMP implementation. BMP modeling will also be refined based on contact with landowners and evaluations of actual existing land use and/or conservation measures. Types of BMPs will be dictated by the type of property(ies) cooperating. Properties whose owners agree to participate in the plan will be mapped and a scheme will be devised to concentrate efforts based on topography and contributions of potential wasteloads to the outfalls. A baseline wasteload can then be computed for areas on and around the subject property(ies), to be used as a gauge to measure BMP effectiveness over time. The end of Year 3 will be the conclusion of efforts to solicit voluntary cooperation from private landowners.

Year 4 Properties whose owners do not wish to implement BMPs voluntarily will be mapped and any resulting "gaps" in potential BMP coverage will be evaluated. At this point, the Township will seek alternatives as needed for compliance with TMDL wasteload allocations. The Township will assess the "untreated" land uses and evaluate particular types of BMPs that could be effective in the given areas. Due to the need to establish an inventory of non-participating properties and a wasteload baseline in the preceding years, it will not be until this stage that the Township can begin the assessment of what actual BMPs will be effective in achieving the short term reductions of 10% sediment and 5% phosphorus, as well as the long term TMDL requirements of 74% reduction in sediment and a 94% reduction in phosphorous.

Year 5 By the end of Year 5, it is hoped that the Township will have succeeded in obtaining enough cooperation from private landowners that BMP implementation will have a positive effect on reducing sediment and phosphorus loadings to the short term goals of 10% and 5%, respectively. As needed and as available, the Township will also have established a BMP program to supplement reductions achieved by the private properties.

Long Term Beyond the permit term, the Township will continue to focus on any remaining pollutant sources and means to encourage private property cooperation to meet the TMDL waste load allocations.

5.4.3 Facilities Inventory

Several sources of data to refine the storm sewershed mapping are already available and include record plans for development of one of the larger private facilities. In addition, it is hoped that Agricultural Erosion and Sediment Control Plans and/or Conservation Plans are available at the Berks County Conservation District for the farms located within the sewersheds. Township and consultant staffs are also available for more detailed field investigations that will occur throughout the permit cycle.

5.4.4 Other MS4-Related Activities

The Township will also continue in its MS4 permit obligations, public education, outreach and participation, outfall inspections (IDD&E), erosion and sediment control and post-construction stormwater management inspections, and good housekeeping at all of its properties. Street-sweeping

of the two (2) Township roads within the delineated storm sewersheds will also be incorporated into the Township's sweeping program.

5.4.5 Ongoing Projects

A dredging project completed in 2017 removed approximately 50,000 cubic yards of sediment from Lake Ontelaunee. This equates to over 50,000 tons of dry sediment. Much of the sediment has been attributed to upstream farmland. This may have an impact on any future updates to the TMDL document.

5.4.6 Funding

Funding sources will be dependent upon the type and number of BMPs that will voluntarily be placed by private landowners on private property. Township-related efforts will be reimbursed via the general fund, unless any necessary alternative BMPs can be covered by grants.

6.0 Summary and Conclusions

The 2010 Census Urbanized Area (UA) within Maidencreek Township encompasses a small portion of the Lake Ontelaunee watershed; about 57 acres. The UA is part of three (3) MS4 storm sewersheds that include both UA and non-UA, totaling about 98 acres. The total Lake Ontelaunee watershed is approximately 123,104 acres, so it can be seen that Maidencreek Township's wasteload contribution is exceptionally slight. Couple this with the fact that the actual land owned by Maidencreek Township within the UA is less than 4 acres and it is evident that Maidencreek Township has very little opportunity to make an impact on wasteloads to the lake through traditional structural BMPs.

A strategy has been devised to adapt to this limitation and it involves public education and outreach to the approximately 96 percent of the tributary storm sewersheds that consist of private property. This audience will be targeted in hopes of obtaining voluntary cooperation and implementation of BMPs within their properties. Based on the results of the loading analyses, concentration will be focused on the agricultural landowners within the planning area. Short of succeeding in gaining cooperation and/or in conjunction with those properties who will participate, the Township will continue to investigate BMPs that it can implement, types and locations of which will be determined once it is know where and how many of the private landowners will participate.

In the interim, Maidencreek Township intends to continue to meet its Minimum Control Measure obligations under its current and anticipated renewed NPDES PAG-13 permit.

TABLE 4.
LAKE ONTELAUNEE TMDL STRATEGY- MAIDENCREEK TOWNSHIP
CROPLAND LOADING SCENARIOS
DECEMBER 2018

	CURRENT CROPLAND		ADD COVER CROP			ADD CONSERVATION TILLAGE			ADD NUTRIENT MANAGEMENT			ADD ALL (3) SCENARIOS		
POLLUTANT	ANNUAL LOAD (kg)	ANNUAL LOAD (lb)	ANNUAL LOAD (kg)	ANNUAL LOAD (lb)	PERCENT REDUCTION	ANNUAL LOAD (kg)	ANNUAL LOAD (lb)	PERCENT REDUCTION	ANNUAL LOAD (kg)	ANNUAL LOAD (lb)	PERCENT REDUCTION	ANNUAL LOAD (kg)	ANNUAL LOAD (lb)	PERCENT REDUCTION
SEDIMENT	13,197.0	29,094.4	8,580.8	18,917.4	**35.0%**	9,240.3	20,371.4	**30.0%**	13,197.0	29,094.4	0.0%	4,624.0	10,194.2	**65.0%**
PHOSPHORUS	34.7	76.5	17.4	38.4	**49.9%**	27.1	59.7	**21.9%**	19.4	42.8	**44.1%**	5.5	12.1	**84.1%**

	CURRENT CROPLAND		ADD COVER CROP & NUTRIENT MGMT.			ADD COVER CROP & CONSERVATION TILLAGE			ADD CONSERVATION TILLAGE & NUTRIENT MGMT.		
POLLUTANT	ANNUAL LOAD (kg)	ANNUAL LOAD (lb)	ANNUAL LOAD (kg)	ANNUAL LOAD (lb)	PERCENT REDUCTION	ANNUAL LOAD (kg)	ANNUAL LOAD (lb)	PERCENT REDUCTION	ANNUAL LOAD (kg)	ANNUAL LOAD (lb)	PERCENT REDUCTION
SEDIMENT	13,197.0	29,094.4	8,580.8	18,917.4	**35.0%**	4,624.0	10,194.2	**65.0%**	9,240.3	20,371.4	**30.0%**
PHOSPHORUS	34.7	76.5	9.7	21.4	**72.0%**	9.7	21.4	**72.0%**	15.2	33.5	**56.2%**

Notes:

1. **Bold** values indicate percent reductions meeting the short term (permit term) sediment and phosphorus reductions of 10% and 5%, respectively.
2. Lake Ontelaunee TMDL WLAs long term reductions are 74% for Sediment and 94% for Phosphorus.
3. Appendix A includes WikiWatershed screenshots supporting above data.

Sources

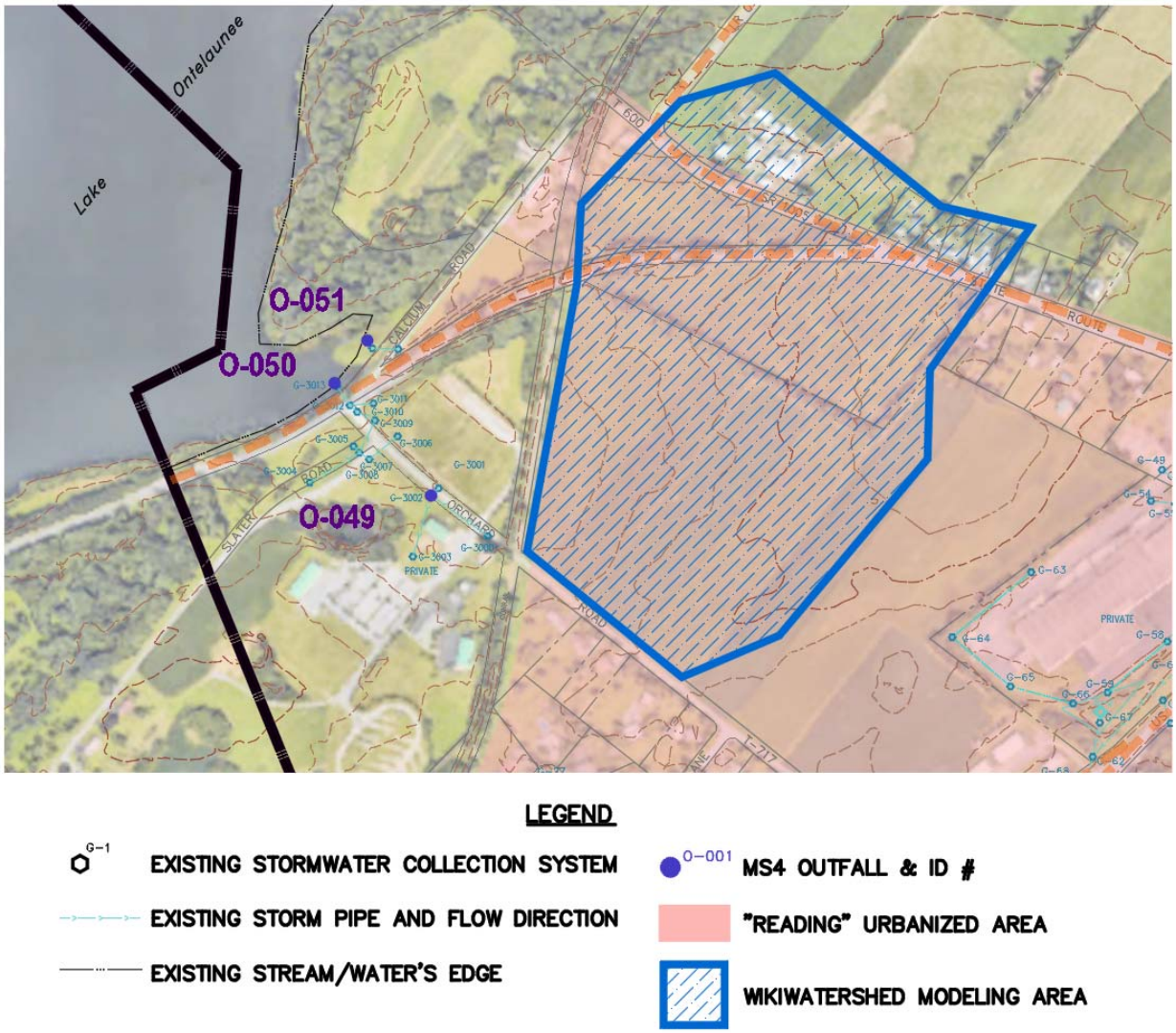
"Pennsylvania Stormwater Best Management Practices Manual", Pennsylvania Department of Environmental Protection, Bureau of Watershed Management, December 30, 2006.

"Total Maximum Daily Load For Nutrients and Suspended Sediment Lake Ontelaunee, Berks and Lehigh County, Pennsylvania", by Tetra Tech, Inc. for the U.S. Environmental Protection Agency, August 9, 2004.

"Model My Watershed," Version 1.23.1, WikiWatershed, by Stroud Water Research Center, https://wikiwatershed.org/model/

Appendix A

WikiWatershed Model My Watershed Documentation



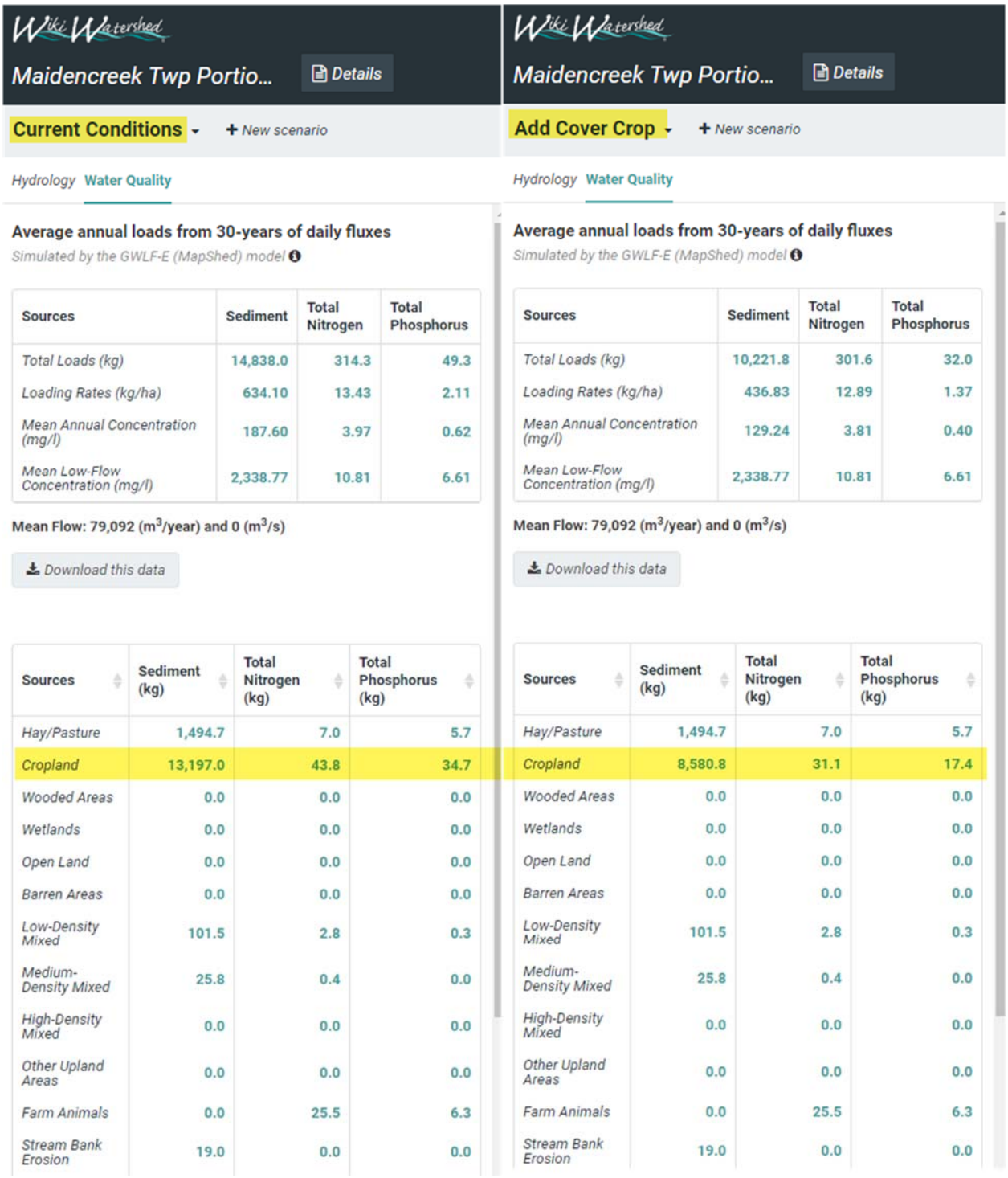
LEGEND

- G-1 — EXISTING STORMWATER COLLECTION SYSTEM
- EXISTING STORM PIPE AND FLOW DIRECTION
- EXISTING STREAM/WATER'S EDGE
- O-001 — MS4 OUTFALL & ID #
- "READING" URBANIZED AREA
- WIKIWATERSHED MODELING AREA

Figure A.1. WikiWatershed Modeling Area within Maidencreek Township's MS4 to Lake Ontelaunee

Figure A.2. WikiWatershed Model Area

Figure A.3. WikiWatershed Model Scenario Screenshots



WikiWatershed

Maidencreek Twp Portio... Details

Current Conditions + New scenario

Hydrology Water Quality

Average annual loads from 30-years of daily fluxes

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (kg)	14,838.0	314.3	49.3
Loading Rates (kg/ha)	634.10	13.43	2.11
Mean Annual Concentration (mg/l)	187.60	3.97	0.62
Mean Low-Flow Concentration (mg/l)	2,338.77	10.81	6.61

Mean Flow: 79,092 (m^3/year) and 0 (m^3/s)

Download this data

Sources	Sediment (kg)	Total Nitrogen (kg)	Total Phosphorus (kg)
Hay/Pasture	1,494.7	7.0	5.7
Cropland	13,197.0	43.8	34.7
Wooded Areas	0.0	0.0	0.0
Wetlands	0.0	0.0	0.0
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	101.5	2.8	0.3
Medium-Density Mixed	25.8	0.4	0.0
High-Density Mixed	0.0	0.0	0.0
Other Upland Areas	0.0	0.0	0.0
Farm Animals	0.0	25.5	6.3
Stream Bank Erosion	19.0	0.0	0.0

WikiWatershed

Maidencreek Twp Portio... Details

Add Cover Crop + New scenario

Hydrology Water Quality

Average annual loads from 30-years of daily fluxes

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (kg)	10,221.8	301.6	32.0
Loading Rates (kg/ha)	436.83	12.89	1.37
Mean Annual Concentration (mg/l)	129.24	3.81	0.40
Mean Low-Flow Concentration (mg/l)	2,338.77	10.81	6.61

Mean Flow: 79,092 (m^3/year) and 0 (m^3/s)

Download this data

Sources	Sediment (kg)	Total Nitrogen (kg)	Total Phosphorus (kg)
Hay/Pasture	1,494.7	7.0	5.7
Cropland	8,580.8	31.1	17.4
Wooded Areas	0.0	0.0	0.0
Wetlands	0.0	0.0	0.0
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	101.5	2.8	0.3
Medium-Density Mixed	25.8	0.4	0.0
High-Density Mixed	0.0	0.0	0.0
Other Upland Areas	0.0	0.0	0.0
Farm Animals	0.0	25.5	6.3
Stream Bank Erosion	19.0	0.0	0.0

Wiki Watershed

Maidencreek Twp Portio... Details

Add Conservation Tillage + New scenario

Hydrology Water Quality

Average annual loads from 30-years of daily fluxes

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (kg)	10,881.3	310.8	41.7
Loading Rates (kg/ha)	465.01	13.28	1.78
Mean Annual Concentration (mg/l)	137.58	3.93	0.53
Mean Low-Flow Concentration (mg/l)	2,338.77	10.81	6.61

Mean Flow: 79,092 (m^3/year) and 0 (m^3/s)

Download this data

Sources	Sediment (kg)	Total Nitrogen (kg)	Total Phosphorus (kg)
Hay/Pasture	1,494.7	7.0	5.7
Cropland	9,240.3	40.3	27.1
Wooded Areas	0.0	0.0	0.0
Wetlands	0.0	0.0	0.0
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	101.5	2.8	0.3
Medium-Density Mixed	25.8	0.4	0.0
High-Density Mixed	0.0	0.0	0.0
Other Upland Areas	0.0	0.0	0.0
Farm Animals	0.0	25.5	6.3
Stream Bank Erosion	19.0	0.0	0.0

Wiki Watershed

Maidencreek Twp Portio... Details

Add Nutrient Mgmt + New scenario

Hydrology Water Quality

Average annual loads from 30-years of daily fluxes

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (kg)	14,838.0	301.6	33.9
Loading Rates (kg/ha)	634.10	12.89	1.45
Mean Annual Concentration (mg/l)	187.60	3.81	0.43
Mean Low-Flow Concentration (mg/l)	2,338.77	10.81	6.61

Mean Flow: 79,092 (m^3/year) and 0 (m^3/s)

Download this data

Sources	Sediment (kg)	Total Nitrogen (kg)	Total Phosphorus (kg)
Hay/Pasture	1,494.7	7.0	5.7
Cropland	13,197.0	31.1	19.4
Wooded Areas	0.0	0.0	0.0
Wetlands	0.0	0.0	0.0
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	101.5	2.8	0.3
Medium-Density Mixed	25.8	0.4	0.0
High-Density Mixed	0.0	0.0	0.0
Other Upland Areas	0.0	0.0	0.0
Farm Animals	0.0	25.5	6.3
Stream Bank Erosion	19.0	0.0	0.0

Wiki Watershed

Maidencreek Twp Portio... Details

Add Cover Crop; Nutrient Mgt.; Conserv. Tillage + New scenario

Hydrology Water Quality

Average annual loads from 30-years of daily fluxes

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (kg)	6,265.0	290.1	19.9
Loading Rates (kg/ha)	267.74	12.40	0.85
Mean Annual Concentration (mg/l)	79.21	3.67	0.25
Mean Low-Flow Concentration (mg/l)	2,338.77	10.81	6.61

Mean Flow: 79,092 (m^3/year) and 0 (m^3/s)

Download this data

Sources	Sediment (kg)	Total Nitrogen (kg)	Total Phosphorus (kg)
Hay/Pasture	1,494.7	7.0	5.7
Cropland	4,624.0	19.6	5.5
Wooded Areas	0.0	0.0	0.0
Wetlands	0.0	0.0	0.0
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	101.5	2.8	0.3
Medium-Density Mixed	25.8	0.4	0.0
High-Density Mixed	0.0	0.0	0.0
Other Upland Areas	0.0	0.0	0.0
Farm Animals	0.0	25.5	6.3
Stream Bank	19.0	0.0	0.0

Wiki Watershed

Maidencreek Twp Portio... Details

Add Cover Crop & Nutrient Mgmt. + New scenario

Hydrology Water Quality

Average annual loads from 30-years of daily fluxes

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (kg)	10,221.8	292.6	24.2
Loading Rates (kg/ha)	436.83	12.50	1.03
Mean Annual Concentration (mg/l)	129.24	3.70	0.31
Mean Low-Flow Concentration (mg/l)	2,338.77	10.81	6.61

Mean Flow: 79,092 (m^3/year) and 0 (m^3/s)

Download this data

Sources	Sediment (kg)	Total Nitrogen (kg)	Total Phosphorus (kg)
Hay/Pasture	1,494.7	7.0	5.7
Cropland	8,580.8	22.1	9.7
Wooded Areas	0.0	0.0	0.0
Wetlands	0.0	0.0	0.0
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	101.5	2.8	0.3
Medium-Density Mixed	25.8	0.4	0.0
High-Density Mixed	0.0	0.0	0.0
Other Upland Areas	0.0	0.0	0.0
Farm Animals	0.0	25.5	6.3
Stream Bank Erosion	19.0	0.0	0.0

WikiWatershed

Maidencreek Twp Portio... Details

Add Cover Crop & Conserv Tillage + New scenario

Hydrology Water Quality

Average annual loads from 30-years of daily fluxes

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (kg)	6,265.0	298.1	24.4
Loading Rates (kg/ha)	267.74	12.74	1.04
Mean Annual Concentration (mg/l)	79.21	3.77	0.31
Mean Low-Flow Concentration (mg/l)	2,338.77	10.81	6.61

Mean Flow: 79,092 (m^3/year) and 0 (m^3/s)

Download this data

Sources	Sediment (kg)	Total Nitrogen (kg)	Total Phosphorus (kg)
Hay/Pasture	1,494.7	7.0	5.7
Cropland	4,624.0	27.6	9.7
Wooded Areas	0.0	0.0	0.0
Wetlands	0.0	0.0	0.0
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
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Farm Animals	0.0	25.5	6.3
Stream Bank Erosion	19.0	0.0	0.0

WikiWatershed

Maidencreek Twp Portio... Details

Add Conservation Tillage & Nutrient Mgmt. + New s

Hydrology Water Quality

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Wetlands	0.0	0.0	0.0
Open Land	0.0	0.0	0.0
Barren Areas	0.0	0.0	0.0
Low-Density Mixed	101.5	2.8	0.3
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High-Density Mixed	0.0	0.0	0.0
Other Upland Areas	0.0	0.0	0.0
Farm Animals	0.0	25.5	6.3
Stream Bank Erosion	19.0	0.0	0.0