Michigan Department of Environmental Quality
Water Bureau
August 2009

Total Maximum Daily Load for Phosphorus for the Upper Maple River, Peet Creek, and Lost Creek Watersheds Shiawassee, Clinton, and Gratiot Counties

INTRODUCTION

Section 303(d) of the Federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations, Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting water quality standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide states with a basis for determining the pollutant reductions necessary from both point sources and nonpoint sources to restore and maintain the quality of their water resources.

The purpose of this TMDL is to identify the sources of phosphorus to the upper Maple River, Peet Creek, and Lost Creek and determine the maximum allowable phosphorus load that can be assimilated by the water bodies and meet applicable WQS.

PROBLEM STATEMENT

Six water bodies within the Maple River watershed appear on the 2008 Section 303(d) list as presented in Table 1 and Figure 1.

Table 1. List of impaired reaches within the Maple River watershed (4050005) that will be addressed in this total phosphorus TMDL.

2008 AUID*	2008 Location Description	Stream Miles	Impaired Use**	Cause(s)
040500050103-02	Alder Creek Drain	3.39	OIALW	Excess Algal Growth; Organic Enrichment (Sewage) Biological Indicators; Phosphorus (Total)
040500050202-02	Maple River	18.78	OIALW	Aquatic Plants – Native; Phosphorus (Total)
040500050204-02	Ferdon Creek and Maple River	30.89	OIALW	Excess Algal Growth; Phosphorus (Total)
040500050208-02	Collier Creek and Maple River	15.83	OIALW	Phosphorus (Total)
040500050406-02	Lost Creek	9.27	OIALW and WWF	Bacterial Slimes; Excess Algal Growth; Phosphorus (Total); Sedimentation/Siltation
040500050503-02	Peet Creek	23.06	OIALW	Excess Algal Growth; Organic Enrichment (Sewage) Biological Indicators; Phosphorus (Total)
	Total Stream Miles	**101.22**		

* AUID = Assessment Unit Identifier
** OIALW = Other Indigenous Aquatic Life and Wildlife; WWF = Warmwater Fishery

These six sections of river in the Maple River watershed were included on the 2008 Section 303(d) list due to excessive algal growths, elevated total phosphorus, organic enrichment biological indicators, aquatic plants, bacterial slimes, and/or sedimentation/siltation, a total of 15 impairments (LeSage and Smith, 2008). The pollutant causing or contributing to the impairments was determined to be total phosphorus for each water body. A total phosphorus TMDL for the upper Maple River (upstream of State Road in Gratiot County), Peet Creek, and Lost Creek will address all of these impairments. Note that throughout this document, AUIDs described as Alder Creek Drain, Maple River, Ferdon Creek and Maple River, and Collier Creek and Maple River, will jointly be referred to as the upper Maple River.

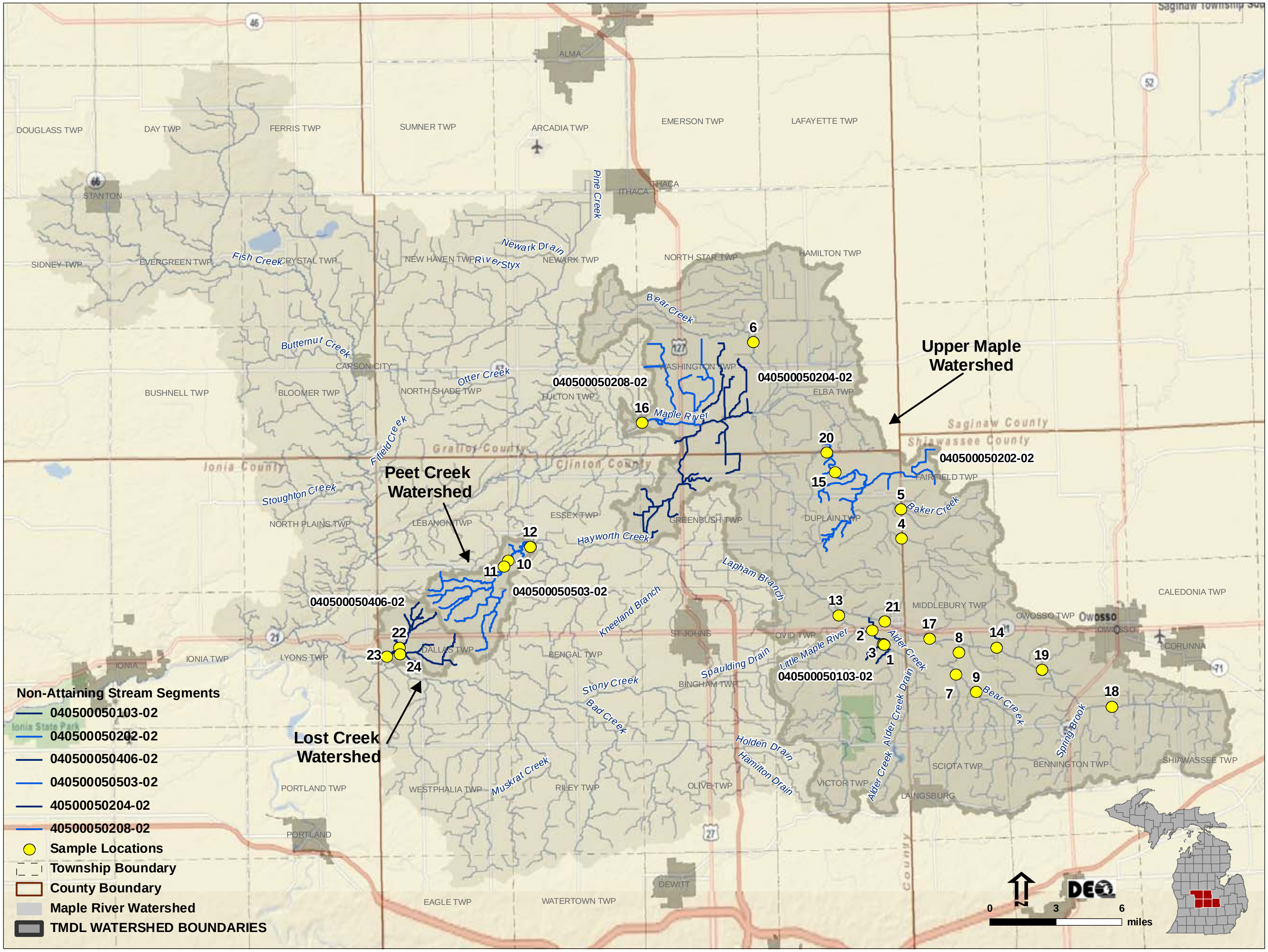


Figure 1. Maple River watershed, upper Maple River, Peet Creek, and Lost Creek TMDL watersheds, and water chemistry sample locations.

Many areas within the Maple River watershed are considered to be nutrient enriched or borderline nutrient enriched based on visual observations of plant growth and in-stream total phosphorus concentrations. This TMDL will address the water bodies currently listed as impaired due to excessive nutrient loadings, but will also include all of the water bodies upstream of the listed water body since these areas contribute nutrients to the impaired segments. This means that the entire upper Maple River watershed, upstream of State Road in Gratiot County, is included in this TMDL, along with the Peet Creek and Lost Creek subwatersheds.

NUMERIC TARGET

The overall objective of the TMDL is to reduce total phosphorus loads to the upper Maple River, Peet Creek, Lost Creek, and their tributaries to levels that are expected to result in the attainment of the WQS; specifically, to reduce excessive plant and algae growth, organic enrichment, and sedimentation. The period of time when it is most critical to reduce phosphorus loads is in the summer during the growing season. Between June 1 and October 15, environmental conditions such as higher temperatures, lower stream flows, and increased light intensity are most likely to result in nuisance plant growth if nutrient concentrations are elevated. All references to phosphorus in the document are assumed to mean “total phosphorus” unless otherwise specified.

Rule 100 (R 323.1100) (Designated Uses) of the Part 4 rules, WQS, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, requires that the Maple River be protected for warmwater fish, other indigenous aquatic life and wildlife, agriculture, navigation, industrial water supply, public water supply at the point of intake, partial body contact recreation, total body contact recreation from May 1 to October 31, and fish consumption. The impaired designated uses for the Maple River addressed by this TMDL are the *warmwater fishery* and *other indigenous aquatic life and wildlife* uses (R 323.1100(1)(d and e)), due to excessive algal growths, organic enrichment, and nuisance aquatic plants. Excess phosphorus can stimulate nuisance growths of algae and aquatic plants that indirectly reduce oxygen concentrations to levels that cannot support a balanced fish or aquatic macroinvertebrate community (e.g., extreme day/night time fluctuations in oxygen) and can shade out beneficial phytoplankton (algal) and aquatic macrophyte (vascular plant) communities that are important food sources and habitat areas for fish and wildlife.

R 323.1060(2) (Plant Nutrients) was developed to provide the authority to limit the addition of nutrients to surface waters of the state that are injurious to the designated uses listed above. Michigan does not have ambient numeric nutrient criteria for phosphorus within its WQS; however, the excessive growths of algae and aquatic plants are a violation of the narrative standard in subrule (2) of R 323.1060. Michigan’s plant nutrient rule is as follows:

R 323.1060 Plant Nutrients.

Rule 60. (1) Consistent with Great Lakes protection, phosphorus which is or may readily become available as a plant nutrient shall be controlled from point source discharges to achieve 1 milligram per liter (mg/L) of total phosphorus as a maximum monthly average effluent concentration unless other limits, either higher or lower, are deemed necessary and appropriate by the department.

(2) In addition to the protection provided under subrule (1) of this rule, nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended, and floating plants, fungi, or bacteria which are or may become injurious to the designated uses of the surface waters of the state.

The numeric load and concentration targets for phosphorus reductions in the upper Maple River and Peet and Lost Creeks were developed based on a weight-of-evidence approach that uses biological threshold information obtained from the scientific studies and data from streams throughout the Maple River watershed that do not have nuisance levels of plant growth. Changes in specific biological responses can be used as surrogates for how biological integrity may change along a nutrient gradient (Soranno et al., 2008). An average in-stream phosphorus concentration of 0.06 mg/L was determined to be protective of the *other indigenous aquatic life and wildlife* and *warmwater fisheries* designated uses.

One of the key factors in determining nuisance plant conditions in Michigan streams is excessive filamentous plant growth. Nuisance levels of filamentous algae may be reached in streams somewhere between 100 and 200 mg/m^2 of chlorophyll (Dodds and Welch, 2000). Stream phosphorus concentrations below 0.06 mg/L are expected to keep stream chlorophyll levels below 100 mg/m^2 most of the time (Dodds and Welch, 2000).

In Wisconsin wadeable streams it was determined that there was a significant change in macroinvertebrate communities (as evidenced by increasing Hilsenhoff Biotic Index scores, which indicate a more pollution tolerant macroinvertebrate community, and decreases in the percentage of Ephemeroptera, Plecoptera, and Tricoptera individuals and taxa, which are groups known to be sensitive to environmental stressors) at stream phosphorus concentrations above 0.09 mg/L (Robertson et al., 2006). The same study found significant changes in fish communities (as evidenced by decreases in Fish Index of Biotic Integrity scores, percentage of carnivorous fish, and percentage of intolerant fish) at stream phosphorus concentrations above 0.06 mg/L. Decreases in Fish Index of Biotic Integrity scores and decreases in percent carnivores and intolerant taxa are indicators that there is an environmental stress that is negatively impacting the fish community. In the same set of Wisconsin streams, chlorophyll *a* concentrations were unlikely to be low when stream phosphorus concentrations exceeded 0.07 mg/L.

An approach to derive nutrient criteria suggested by the USEPA is to take the 25th percentile phosphorus concentrations of all water bodies within a region (USEPA, 2000). A United States Geological Survey (USGS) study in the Great Lakes basin found that for watersheds similar to the Maple River watershed (similar environmental characteristics and 50 to 75% agricultural land use) the 25th percentile of in-stream phosphorus concentrations was 0.06 mg/L (Robertson et al., 2001). A numeric goal of 0.06 mg/L of phosphorus in the upper Maple River and Peet and Lost Creeks, as an average during the growing season of June 1-October 15, is expected to prevent nuisance plant growths, and will also protect the *warmwater fishery* and *other indigenous aquatic life and wildlife* designated uses.

DATA DISCUSSION

The Maple River and its tributaries have been sampled for phosphorus intermittently since the 1970s (Table 2 and Appendix A) (Goble, 1989; Hanshue, 2002; Rockafellow, 2003; and Holden, 2008). The data from the 1970s are very similar to the data from the 1990s and 2000s, so it does not appear that there have been significant increases or decreases in phosphorus in the Maple River and its tributaries for over 30 years. Throughout the watershed total phosphorus concentrations range from 0.01 to 2.45 mg/L, although most data are below 0.6 mg/L (Table 2). Two datapoints above 0.6 mg/L in the Hayworth Creek subwatershed, with values of 0.66 and 0.972 mg/L, are immediately downstream of a municipal wastewater treatment plant outfall, and the sample at 2.45 mg/L was collected in an area with an illicit discharge, which has since been removed. Additionally, in the Pine Creek subwatershed there is one sample with a value of 0.95 mg/L, which cannot be attributed to a particular source.

Table 2. Summary of phosphorus data, in mg/L, from 1975-2007, from the impaired reaches of the Maple River watershed. Note: Alder Creek is a tributary to the upper Maple River that is on the Section 303(d) list.

Watershed	Average	Median	Min	Max	# of Samples
Lost Creek	0.114	0.068	0.032	0.390	7
Peet Creek	0.331	0.340	0.105	0.510	7
Upper Maple River – TMDL Reaches	0.108	0.086	0.039	0.240	13
Alder Creek	0.059	0.041	0.021	0.220	9

The data from the TMDL reaches on the upper Maple River range from 0.039 to 0.24 mg/L, and average 0.108 mg/L (Table 2). The phosphorus concentrations in Alder Creek, a tributary to the upper Maple River, are relatively low (averaging 0.059 mg/L). The phosphorus concentrations in Lost Creek range between 0.032 and 0.39 mg/L; however, all but one data point are below 0.1 mg/L (Figure 2) indicating that high concentrations of phosphorus only occur intermittently. The phosphorus concentrations in Peet Creek are consistently high, averaging 0.331 mg/L, with a range from 0.105 to 0.51 mg/L.

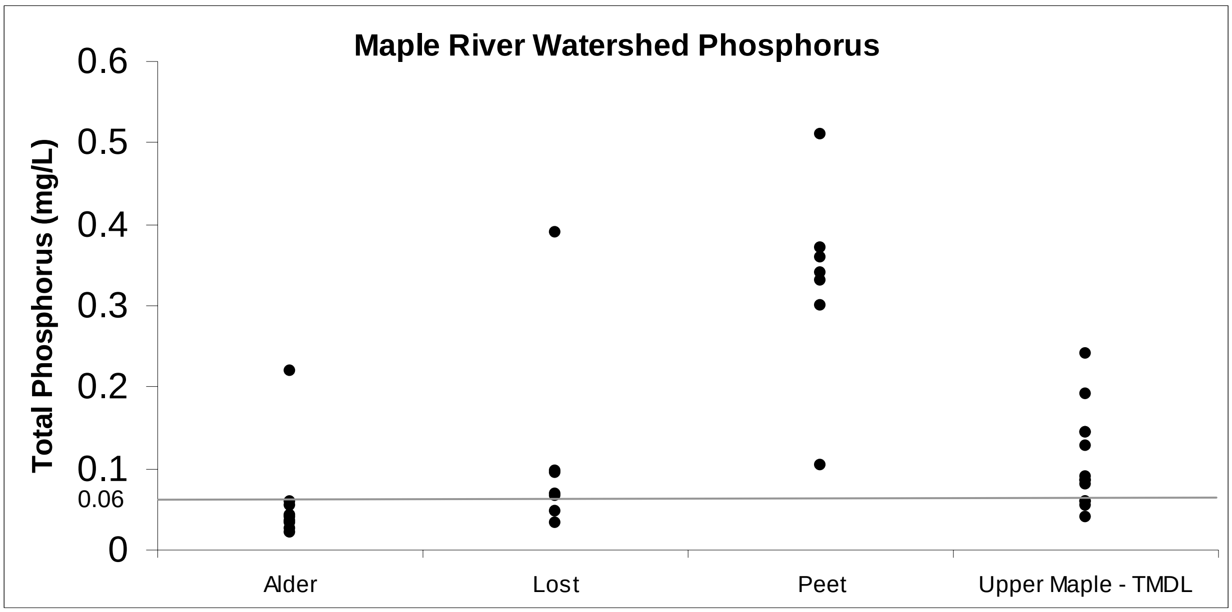


Figure 2. Phosphorus data from the Maple River watershed from 1975-2007. Impaired subwatersheds with phosphorus data from impaired river segments include Alder Creek, Lost Creek, Peet Creek, and upper Maple River-TMDL. The horizontal line at 0.06 mg/L is the phosphorus concentration goal for the TMDL.

Associated data on stream flow are not available for the water chemistry samples so phosphorus loads cannot be calculated. Most or all of the data were collected during non-wet weather flows. Sediment, with its attached phosphorus, moving from the land to the surface water during rain events generally increases stream total phosphorus concentrations. It is expected that the phosphorus concentrations in all of the Maple River streams are higher during wet weather flows than the data summarized in Table 2 and Figure 2 due to the agricultural nature of much of the watershed.

SOURCE ASSESSMENT

Watershed Description

The entire Maple River watershed encompasses approximately 960 square miles of predominantly agricultural land within five counties (Hanshue, 2002; Table 3.) in the center of the lower peninsula of Michigan. The river originates from a series of drainage ditches in the central portion of Shiawassee County. The majority of the watershed is characterized by flat to gently rolling moraine with an average mainstream slope of three feet per mile (USACE, 1968). The soils within the watershed are characterized as poorly to somewhat poorly drained. An extensive drainage network has been established to facilitate crop production in former wetlands resulting in highly modified stream channels. Comer (1996) estimates the total loss of wetlands in Clinton County and Shiawassee County to be 47% and 60%, respectively. These landscape modifications have resulted in less storage capacity within the watershed leading to unstable flow patterns that ultimately result in increased erosion, and therefore increased potential for excess land-use based contributions of pollutants such as phosphorus.

Land Use/Land Cover

Nutrient enrichment in the Maple River watershed due to agricultural land use has been an ongoing problem for many years (Evans, 1973; Goble, 1989; Hanshue, 2002; Holden, 2008). The Maple River watershed has been used intensively for agriculture for over a century (Figure 3). By 1900, approximately 70% of the watershed was in agricultural land uses (Waisanen and Bliss, 2002). Gratiot County has had the highest proportion of agricultural land use in the watershed since 1950 (Figure 3).

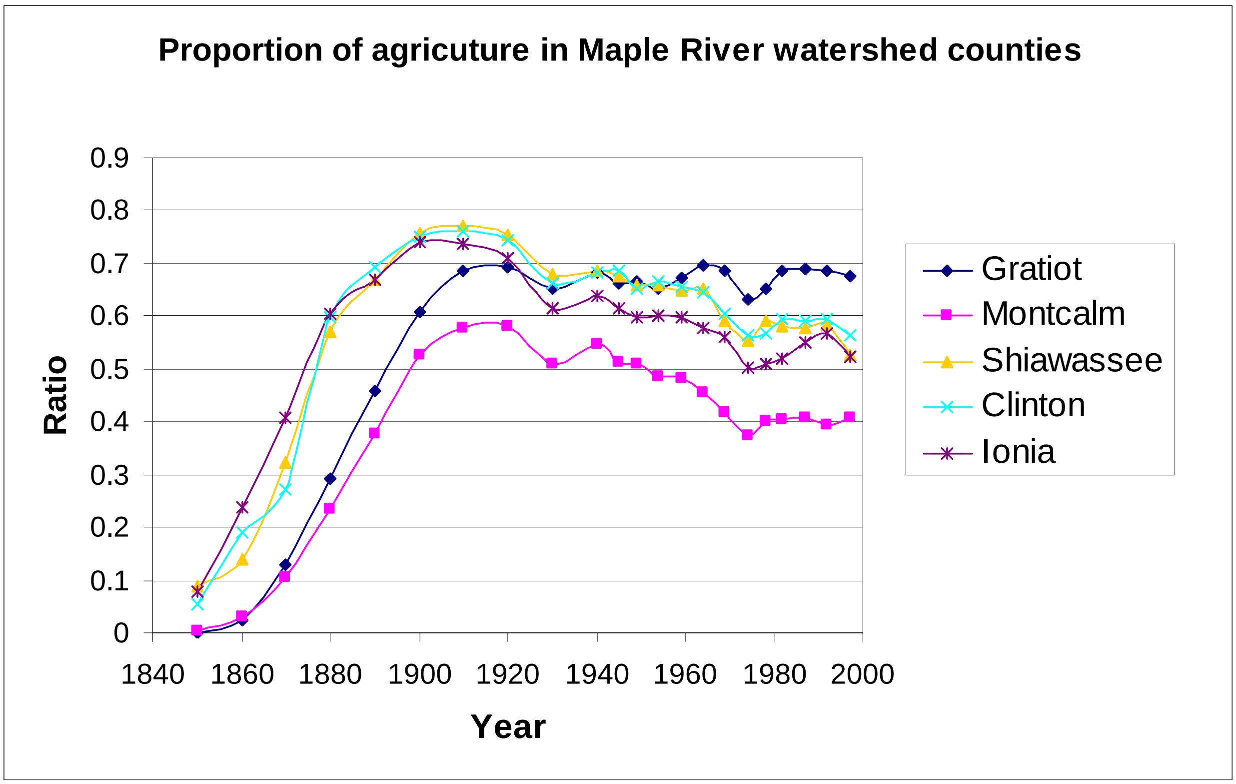


Figure 3. Ratio of improved farmland or cropland to total county area. Source: USGS data: http://landcover.usgs.gov/

Currently, the entire Maple River watershed is approximately 64% agricultural land use (Table 3). Corn and soybeans comprise the majority of crops produced in the watershed. The subwatersheds range from 54 to 77% agricultural land use. Other important land uses include urban (1%), grass/pasture (17%), and forest (17%). Most of the urban land use in the Maple River watershed is residential, with less than a quarter of the urban land use in commercial uses.

Table 3. Land use in the Maple River watershed and TMDL subwatersheds (Purdue and USEPA, 2001). For each watershed data are presented as the number of acres of each land use on the top row and percent of watershed in each land use category in the bottom row.

	Agriculture	Urban		Natural Cover			
Acres % of Watershed	Agriculture	Residential	Commercial	Grass/ Pasture	Forest	Water	Total Area
Upper Maple River	138408	2029	535	34330	28766	2955	207023
	66.9	1.0	0.3	16.6	13.9	1.4	
Peet Creek	5960	180	9	2694	551	18	9412
	63.3	1.9	0.1	28.6	5.8	0.2	
Lost Creek	3994	0	0	1224	425	0.2	5643
	70.8	0.0	0.0	21.7	7.5	0.0	

Land used for agricultural purposes can be a source of phosphorus. Croplands can accumulate phosphorus from decomposition of residual crop material, addition of chemical and manure fertilizers, atmospheric deposition, wildlife excrement, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. The majority of nutrient loading from cropland occurs from fertilization with commercial and manure fertilizers (USEPA, 2003; Hoorman and Shipitalo, 2006). Use of manure for nitrogen supplementation often results in excessive phosphorus loads relative to crop requirements (USEPA, 2003). Surface erosion from bare fields, streambank erosion associated with the loss of vegetation, and runoff from underdrains are three sources of phosphorus from agricultural lands.

Runoff from pastures and livestock operations can also be potential agricultural sources of phosphorus. Animals grazing in pasturelands deposit manure directly upon the land surface and the manure will often be concentrated near feeding and watering areas in the field or at stream access points. These areas can quickly become compacted and barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event. It is clear from the land use percentages in the watershed that the Maple River watershed is highly agricultural. Not only is the land used heavily for growing row crops, but there are many livestock (more than 93,000, which is 1.5 times the human population) in the watershed producing manure, which is often spread on fields.

The small amount of urban/residential land use in the watershed is also a potential source of phosphorus to the Maple River because on-site septic systems serve many of the homes. In Clinton County there are 15-30 septic systems per square mile and in Gratiot County there are 0-15 septic systems per square mile (*E. Coli* Work Group, 2009). When septic systems are not functioning properly, or are poorly designed, they can be a source of phosphorus to nearby streams. Across Michigan, the on-site septic system failure rate reportedly averages around 10% (*E. Coli* Work Group, 2009). The incidence of failure is variable depending on geology, age of the septic system, and stringency of local regulations. Another potential, but undocumented, source of total phosphorus to the Maple River is illicit discharge from residential units, which are reportedly common throughout some portions of the watershed. Local health departments have been notified in the past that illicit discharges may be present (Rockafellow, 2003).

Point Source Discharges

There are 3 groundwater permits and 29 National Pollutant Discharge Elimination System (NPDES) permits in the Maple River TMDL watersheds (Table 4 and Appendix B). Of the NPDES permits, there are 4 individual permits, 23 certificates of coverage (COCs) under 5 general permits, and 2 notices of coverage (NOCs) under permit-by-rule. One of the individual permits is a lagoon discharge. Of the general permit COCs, 6 are for Wastewater Stabilization Lagoons (WWSLs) and 12 are for Concentrated Animal Feeding Operations

(CAFOs) (Note: The T&H Dairy CAFO has land in both the Peet Creek and Lost Creek watersheds).

Table 4. Number of discharge permits, COCs, and NOCs, by category, in the upper Maple River, Peet Creek, and Lost Creek watersheds.

Permit Type	Upper Maple River	Peet Creek	Lost Creek
Groundwater Permits	3	--	--
NPDES Individual Permits			
Sanitary Wastewater	1	--	--
Industrial Wastewater	2	--	--
Municiple Storm Water	1*	1*	1*
NPDES General Permits			
WWSLs	5	1	--
New Large CAFOs	6	5**	2**
Noncontact Cooling Water	1	--	--
Sand and Gravel Mining Wastewater	1	--	--
Storm Water from Industrial Activity	3	--	--
Permits-by-Rule			
Storm Water Discharges from Construction Activity	2	--	--

* The MDOT MS4 permit is a single permit applied statewide and with land in all three TMDL watersheds.
** The T&H Dairy CAFO has land in both the Peet Creek and Lost Creek watersheds.

Phosphorus is limited in the individual permits for the sanitary wastewater facility (Elsie WWSL) and one of the industrial wastewater permits (MMPA-Ovid Plant). The general permit for WWSLs has a clause that can be invoked at the discretion of the Michigan Department of Environmental Quality (MDEQ) to limit effluent phosphorus concentration to 1.0 mg/L, but this requirement has not been invoked for any of the six lagoons operating under the general permit.

The Clean Water Act defines CAFOs as point source dischargers and requires NPDES permits for each operation. In general, CAFOs congregate animals, feed, and manure on a small land area and feed is brought to the animals rather than the animals grazing in pastures. As part of their NPDES permit, CAFOs are required to have a nutrient management plan which details: (1) an adequate storage of manure and process wastewater to prevent a direct discharge from the storage facility; and (2) the application of manure, litter, and process wastewater to agricultural lands in accordance with site-specific nutrient management practices to prevent the accumulation and potential runoff of excessive nutrients in the soil. The CAFO permits in the upper Maple River, Peet Creek, and Lost Creek watersheds apply manure to over 8594, 1906, and 228 acres of land, respectively, which is equivalent to approximately 6% of the agricultural land area in the upper Maple River and Lost Creek watersheds and 32% of the agricultural land area in the Peet Creek watershed (Table 5).

Permit-by-Rule (R 323.2190) coverage for a construction site requires the permittee to have regular inspections of the soil erosion control measures at a construction site and requires that the site have an active Sediment Erosion and Sediment Control (SESC) permit. SESC permits are required for any earth change that disturbs one or more acres, or is within 500 feet of a lake or stream. An NOC is required for sites greater than 5 acres. Sites between 1 and 5 acres are automatically deemed to have coverage with Permit-by-Rule if the site is in compliance with the SESC permit and the activities must comply with the requirements of Permit-by-Rule. Another core requirement of the Permit-by-Rule is that the permittee must inspect the soil erosion control measures at the site to ensure that they are working correctly. The inspections of the soil erosion control measures must be done once per week and within 24 hours of a precipitation event that results in a storm water discharge from the site.

Table 5. Acres of the upper Maple River, Peet Creek, and Lost Creek watersheds that are included in a CAFO Certified Nutrient Management Plan and thus included in the Waste Load Allocation (WLA).

CAFO	Upper Maple River	Peet Creek	Lost Creek
Dutch Meadows Dairy		104	
EB Ridge Dairy	881		
Green Meadow Farms 1	2008		
Green Meadow Farms 2&3	3306		
Kurncz Farms	1074		
Rich Ro Farms		252	
Rudat Farms		5	
Schneider Dairy		199	
Steenblik Dairy Inc			97
Stewart Farms	1185		
T&H Dairy		1346	131
Willow Creek Farms	140		
Total	8594	1906	228

LINKAGE ANALYSIS

Phosphorus can exist in dissolved and particulate forms. When dissolved, some of the phosphorus is available for use by aquatic plants and increased growth in rooted plants and floating algae can result. Phosphorus in the particulate form, such as that sorbed to eroding soil, can be released as dissolved phosphorus under certain conditions, contributing to increased plant growth. A reduction in phosphorus loadings to the TMDL watersheds is expected to directly address all of the causes of designated use nonattainment, including excess algal growth, nuisance levels of native aquatic plants, biological indicators of organic enrichment, and sedimentation caused by plant decomposition. In addition, a reduction in phosphorus loadings will contribute to a reduction in sedimentation/siltation by virtue of erosion control measures to control phosphorus-laden soil loss. The presence of phosphorus can also be critical to bacterial slime production, so reducing phosphorus concentrations is expected to also reduce the development of bacterial slimes (Amberg and Cormack, 1960).

LOADING CAPACITY (LC) DEVELOPMENT

The LC represents the maximum daily loading that can be assimilated by the water body while still achieving WQS. However, because the Maple River and its tributaries are flowing water bodies, the total phosphorus concentrations, versus the loads, are expected to be the predominant influence on nuisance aquatic plant growth in each stream and will be the goal for this TMDL. The total phosphorus seasonal average numeric target for the upper Maple River, Peet Creek, and Lost Creek is 0.06 mg/l. The current average concentration of total phosphorus is 0.108 mg/L in the upper Maple River, 0.331 mg/L in Peet Creek, and 0.117 mg/L in Lost Creek.

To reach the phosphorus target in the upper Maple River watershed, the proposed load reduction of total phosphorus is from 77.3 pounds per day to 21.3 pounds per day (Table 6). To reach the target in Peet Creek and its tributaries, the proposed load reduction of total phosphorus is from 11.9 pounds per day to 0.85 pounds per day (Table 6). To reach the target in Lost Creek and its tributaries, the proposed load reduction of total phosphorus is 4.4 pounds per day to 0.71 pounds per day (Table 6). The daily and seasonal TMDL goal loads were calculated using the concentration goal of 0.06 mg/L and the average 50% exceedance flows for the TMDL season (June 1 to October 15). WQS for most pollutants are determined using the stream 95% exceedance flows per R 323.1090(2); however, average 50% exceedance flows were used because the phosphorus concentration goal is a seasonal average. Wet weather phosphorus loads are a large proportion of the annual loading, which makes it appropriate to use an alternate design flow to apply the TMDL concentration goal, as allowed in R 323.1090(4) (Applicability of WQS).

The LC is the sum of individual WLAs for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the LC must include a margin of safety (MOS), either implicitly within the WLA or LA, or explicitly, that accounts for uncertainty in the relation between pollutant loads and the quality of the receiving water body. Conceptually, this definition is denoted by the equation:

$$LC = \sum LAs + \sum WLAs + MOS$$

Table 6. Current and targeted phosphorus loads to the upper Maple River, Peet Creek, and Lost Creek in pounds of phosphorus.

	Current Phosphorus Load		**TMDL Numeric Target Phosphorus Load**		**WLA**	**LA**
Water Body	TMDL Season June 1- Oct 15 (lbs)	Daily (lbs)	TMDL Season June 1- Oct 15 (lbs)	Daily (lbs)	Daily (lbs)	Daily (lbs)
UPPER MAPLE RIVER						
NPDES Loads	964.7	7.0	291	2.1	2.1	-
Nonpoint Sources and Groundwater Permits	9,632.3	70.3	2,623	19.2	-	19.2
Totals:	10,597	77.3	2,914			
Daily Loading Capacity:				**21.3**		
PEET CREEK						
NPDES Loads	500	3.6	30	0.22	0.22	-
Nonpoint Sources	1,132	8.3	86	0.63	-	0.63
Totals:	1,632	11.9	116			
Daily Loading Capacity:				**0.85**		
LOST CREEK						
NPDES Loads	46	0.3	7	0.05	0.05	-
Nonpoint Sources	558	4.1	90	0.66	-	0.66
Totals:	604	4.4	97			
Daily Loading Capacity:				**0.71**		

* Seasonal load = Phosphorus Load during the TMDL season of June 1-October 15.

Table 7. Annual, TMDL seasonal, and LC total phosphorus loads for the upper Maple River. The current TMDL season load and the LC load apply from June 1-October 15.

UPPER MAPLE TOTAL PHOSPHORUS Source	**Annual Current** Current TP Load lbs P/yr	**TMDL Season** Current TP Load lbs P/season	**Loading Capacity** TMDL Goal: 0.06 mg/L lbs P/season
Total	**84,602**	**10,597**	**2,914**
WLA			
NPDES Individual Permits			
Sanitary Wastewater	1,200	49	0 *
Elsie WWSL	1,200	49	0
Industrial Wastewater	761	107	94.5
MDOT Statewide MS4	190	24	12
Sunoco-Owosso Terminal	5	1	0.5
MMPA-Ovid Plant	566	82	82
NPDES General Permits			
Wastewater Stabilization Lagoons	1,217	151	0 *
Becks Development Co	4	1	0
Ashley WWSL	495	53	0
Ovid WWSL	626	95	0
Spring Vale Academy	4	1	0
MDNR-Sleepy Hollow SP WWSL	88	1	0
New Large Concentrated Animal Feeding Operations	5,001	631	170.3
Green Meadow Farms 2 & 3-CAFO	1,924	243	66
Stewart Farms-CAFO	689	87	23.1
EB Ridge Dairy-CAFO	513	65	17.1
Green Meadow Farms 1-CAFO	1,169	147	40
Willow Creek Farms-CAFO	81	10	3
Kurncz Farms - CAFO	625	79	21.1
Noncontact Cooling Water	0.5	0.1	0.1
EB Ridge Dairy	0.5	0.1	0.1
Sand and Gravel Mining Wastewater	66	25	25
Carl Schlegel-Harmon Rd Pit	66	25	25
Storm Water from Industrial Activity	12	1.6	0.8
Ovid Farmers Elevator-Ovid	--	--	--
Nero Plastics Inc-Owosso	--	--	--
Ovid Iron and Metal	--	--	--
Permits-by-Rule			
Storm Water Discharges from Construction	0	0.0	0
MDOT-US-127 Maple Riv Wetland	0	0.0	0
MDOT-US-127/Livingston Rd	0	0.0	0
Total Current NPDES Load	8,258	964.7	
WLA Subtotal			**290.7**
LA			
Current Nonpoint Source Load	76,317	9,629	
Agriculture	75,537	9,531	2,570
Residential	353	45	23
Commercial	357	45	23
Grass/Pasture	50	6	3
Forest	19	2	1
Water	0	0	0
Groundwater Permits	27	3.3	3.3
North Star Sewer System	24	3.0	3
Bellingar Packing	2	0.2	0.2
MDNR-Sleepy Hollow SP WWSL	1	0.1	0.1
LA Subtotal			**2,623.3**
MARGIN OF SAFETY			**IMPLICIT**

* WWSL discharges will be prohibited during the June 1-October 15 period.

Table 8. Annual, TMDL seasonal, and LC total phosphorus loads for Peet Creek. The current TMDL season load and the LC load apply from June 1-October 15.

PEET CREEK TOTAL PHOSPHORUS Source	Annual Current Current TP Load lbs P/yr	TMDL Season Current TP Load lbs P/season	Loading Capacity TMDL Goal: 0.06 mg/L lbs P/season
Total	**7,194**	**1,632**	**116**
WLA			
NPDES Individual Permits			
Industrial Wastewater	8	2	1
MDOT Statewide MS4	8	2	1
NPDES General Permits			
Wastewater Stabilization Lagoons	968	143	0 *
Fowler WWSL	968	143	0
New Large Concentrated Animal Feeding Operations	1,485	355	29
T & H Dairy-CAFO	1,049	251	20.5
Dutch Meadows Dairy-CAFO	81	19	1.6
Rudat Farms-CAFO	4	1	0.1
Rich Ro Farms-CAFO	196	47	3.8
Schneider Dairy-CAFO	155	37	3
Total Current NPDES Load	2,461	500	
WLA Subtotal			**30**
LA			
Current Nonpoint Source Load	4,733	1,132	
Agriculture	4,642	1109	73
Residential	78	19	10
Commercial	7	2	1
Grass/Pasture	5	1	1
Forest	1	1	1
Water	0	0	0
LA Subtotal			**86**
MARGIN OF SAFETY			**IMPLICIT**

* WWSL facility discharges will be prohibited during the June 1-October 15 period.

Table 9. Annual, TMDL seasonal, and LC total phosphorus loads for Lost Creek. The current TMDL season load and the LC load apply from June 1-October 15.

LOST CREEK TOTAL PHOSPHORUS Source	Annual Current Current TP Load lbs P/yr	TMDL Season Current TP Load lbs P/season	Loading Capacity TMDL Goal: 0.06 mg/L lbs P/season
Total	**2,858**	**604**	**97**
WLA			
NPDES Individual Permits			
Industrial Wastewater	15	3	1.5
MDOT Statewide MS4	15	3	1.5
NPDES General Permits			
New Large Concentrated Animal Feeding Operations	156	32	5.5
T & H Dairy-CAFO	90	18.5	3.2
Steenblik Dairy Inc-CAFO	66	13.5	2.3
Total Current NPDES Load	117	46	
WLA Subtotal			**7**
LA			
Current Nonpoint Source Load	2,741	558	
Agriculture	2737	556	88
Grass/Pasture	3	1	1
Forest	1	1	1
Water	0	0	0
LA Subtotal			**90**
MARGIN OF SAFETY			**IMPLICIT**

* WWSL facility discharges will be prohibited during the June 1-October 15 period.

LA

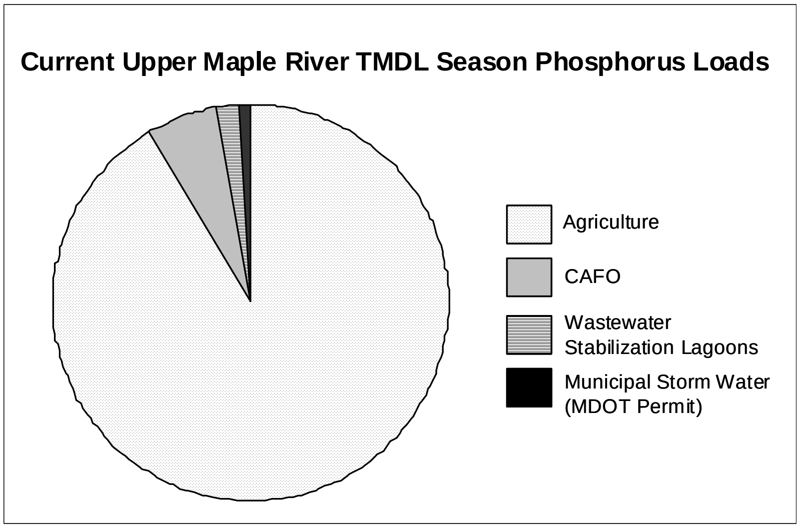
The LA component of the TMDL defines the fraction of the LC originating from nonpoint sources and from groundwater permits. Estimates of all land use-related loads of total phosphorus to the Maple River TMDL reaches were estimated using the Long-Term Hydrologic Impact Assessment (L-THIA) Web-based software created and maintained by Purdue University and the USEPA (Purdue University and USEPA, 2001). The L-THIA has been developed as a straightforward analysis tool that provides estimates of changes in runoff, recharge, and nonpoint source pollution resulting from past or proposed land use changes. It gives long-term average annual runoff for a land use configuration, based on actual long-term climate data for that area. By using many years of climate data in the analysis, L-THIA focuses on the average impact, rather than an extreme year or storm. L-THIA results do not predict what will happen in a specific year. As a quick and easy approach, L-THIA results are intended to provide insight into the relative hydrologic impacts of different land use scenarios. The results can be used to generate community awareness of potential long-term problems and to support physical planning aimed at minimizing disturbance of critical areas. It is an ideal tool to assist in the evaluation of potential effects of land use change and to identify the best location of a particular land use for minimum impact on the natural environment of the area. Concern over urban sprawl has focused on several land use change issues, including the failure to account for hydrologic aspects of land use change that can result in flooding, stream degradation, erosion, and loss of groundwater supply. The L-THIA was developed to provide a quick, accessible tool to use in assessing the long-term impacts of land use change. This site suitability analysis tool makes use only of information that is readily available from municipal databases (Purdue University and USEPA, 2001).

L-THIA annual phosphorus loads were calculated to be 76,317 pounds in the upper Maple River watershed, 4,642 pounds in the Peet Creek watershed, and 2,737 pounds in the Lost Creek watershed (Tables 7-9). Estimated TMDL season (June 1-October 15) nonpoint source loads of 9,629 pounds in the upper Maple River watershed, 1,132 pounds per season in Peet Creek, and 558 pounds in Lost Creek are based on a flow weighted proportion of the annual load, which was calculated taking the proportion of the annual flow, using monthly 50^{th} percentile flows, that occurs between June 1 and October 15 and multiplying that proportion by the annual load. For example, in the upper Maple River the current annual phosphorus load from agricultural land is 75,537 pounds and 12.6% of the annual discharge volume from the watershed occurs from June 1 to October 15, so the flow weighted load for the TMDL season is 9,629 pounds.

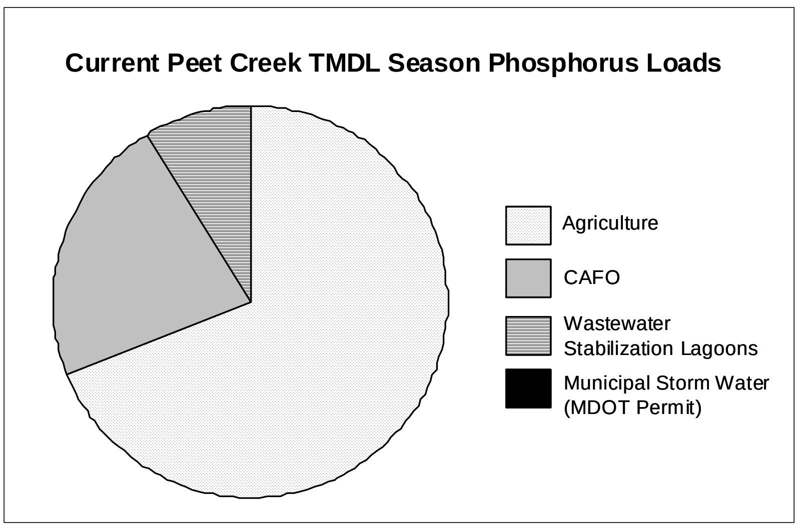
To calculate the LA, no reductions from the forest, grass/pasture, and water/wetland land uses are proposed because the expected concentrations of phosphorus are less than the 0.06 mg/L phosphorus target for the watershed. A 50% reduction in the TMDL season load is expected from residential and commercial land uses through the implementation of Best Management Practices.

The primary source of phosphorus in all of the TMDL watersheds is from nonpoint source runoff from agricultural land not included in CAFO permits (Figure 4). In the upper Maple River watershed the current load from agricultural land during the TMDL season is 9,531 pounds of phosphorus, which is 99% of the LA and 90% of the total load. In the Peet Creek watershed the current load from agricultural land during the TMDL season is 1,109 pounds of phosphorus, which is 98% of the LA and 68% of the total load. In the Lost Creek watershed the current load from agricultural land during the TMDL season is 556 pounds of phosphorus, which represents almost 100% of the LA and 92% of the total load. In all of the watersheds the CAFO component of the WLA is the second highest load in the watershed (Figure 4). Because agricultural land, under or not under the CAFO general permit, is the largest source of phosphorus, very large reductions are needed in order to achieve the TMDL. After all of the possible reductions were made to point sources and other LA categories, the remaining load was broken up between agricultural LA and CAFO WLA.

A.



B.



C.

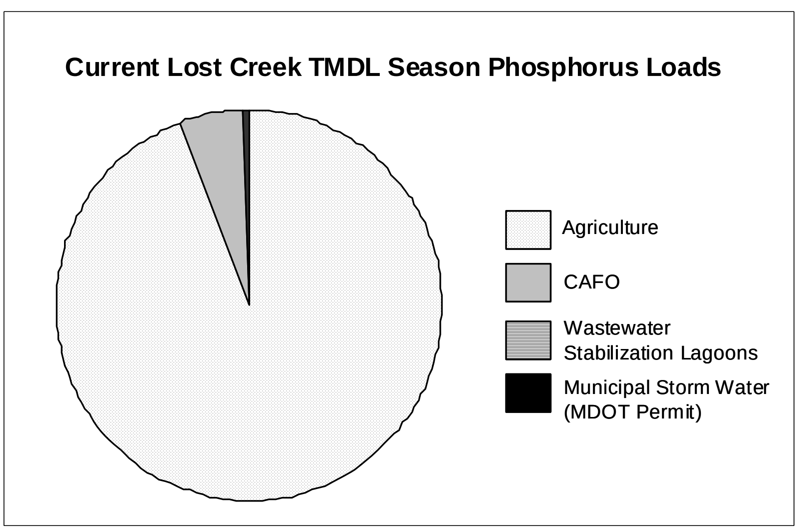


Figure 4. Current sources of phosphorus in the (A) upper Maple River, (B) Peet Creek, and (C) Lost Creek watersheds including both the LA and WLA. The total phosphorus loads (including L-THIA and permitted loads) are 10,597, 1,632, and 604 pounds of phosphorus per TMDL season (June 1-October 15).

In the upper Maple River watershed there were also three groundwater permits included in the LA, with a load of 6 pounds during the TMDL season of June 1-October 15. No reductions were made to the LA for the groundwater permits because they are such small components of the total phosphorus load.

WLA

Queries of the MDEQ, NPDES Management System database yielded 6 WWSL COCs, 12 CAFO COCs, 1 noncontact cooling water COC, 1 sand and gravel mining wastewater COC, 3 industrial storm water COCs, 4 individual point source permits (including the Michigan Department of Transportation (MDOT) statewide MS4 permit), and 2 construction site NOCs under permit-by-rule in the TMDL watersheds. To reach the final WLA for the TMDL, the current loads of many facilities were reduced, especially those discharging wet weather-related runoff likely to contain sediment (Tables 7-9).

The existing annual loads for all WWSL COCs covered under the general permit were determined based on the permitted flows and average phosphorus concentration the facility discharged from 2004 to 2008. The existing annual load for the one WWSL covered by an individual permit (Elsie WWSL) is the annual load limit included in the individual permit. The current TMDL season load for all of the WWSLs was determined as an average of representative loads reported during the TMDL season from 2004 to 2008. None of the WWSLs are given any load in the WLA because they will not be allowed to discharge during the TMDL season, from June 1-October 15.

The existing annual load from the 12 CAFO permits in the TMDL watersheds was estimated as a geographic proportion of the L-THIA estimated agricultural land load. For example, in the Peet Creek watershed 32% of the agricultural land in the watershed is included in a Certified Nutrient Management Plan from a CAFO, so 32% of the L-THIA estimated phosphorus load from agricultural land was allocated to the WLA. A flow weighted proportion of the annual load was taken to develop the existing load during the TMDL season. The flow weighted proportion was calculated taking the proportion of the annual flow, using monthly 50% exceedance flows, that occur between June 1 and October 15 and multiplying that value by the annual load. For example, in Peet Creek the current annual phosphorus load from CAFO COCs was calculated to be 1,485 pounds, which is 32% of the original L-THIA agricultural load. Just under 24% of the annual discharge volume from the watershed occurs from June 1 to October 15, so the flow weighted CAFO load for the TMDL season is 355 pounds, which is 23.9% of the annual CAFO load. The WLA for the CAFO COCs reduces the existing loads by the same proportion as the reductions taken from the agricultural land in the LA.

The COC for the noncontact cooling water and the COC for sand and gravel mining wastewater have existing TMDL season loads of phosphorus of 0.1 pounds and 25 pounds, respectively. These loads represent 37.5% (or the proportion of the days of the year the TMDL season represents) of their current load, which is calculated using their permitted discharge volumes and a groundwater phosphorus concentration of 0.01 mg/L (Cummings, 1989). The WLA for both facilities is the same amount as the current TMDL season load.

The current TMDL season load from the three industrial storm water COCs in the upper Maple River watershed is 1.6 pounds. The TMDL season load for the Sunoco-Owosso Terminal NPDES permit, which is very similar to an industrial storm water COC, is 1 pound. These calculations were made using a geographic proportion of the commercial land associated with these facilities compared to the total area of commercial land use in the upper Maple River watershed. A flow weighted proportion of the annual load, based on the monthly 50th percentile flows during the TMDL season compared to the rest of the year, was taken to develop the TMDL seasonal load. The WLA was determined to be one-half of the existing load during the TMDL season.

Runoff of precipitation from transportation areas is covered under the statewide MDOT MS4 permit. The MDOT owns and operates approximately 509 acres of transportation right-of-way in the upper Maple River watershed, 22 acres in the Peet Creek watershed, and 40 acres in the Lost Creek watershed. These areas include a 50-foot right-of-way on either side of the road's centerline. A conservative estimate of the phosphorus load from this source during the TMDL season (June 1 to October 15) is assumed to be 24, 2, and 3 pounds, respectively (Tables 7, 8, and 9; respectively). These loads are a flow weighted proportion (using the proportion of the 50% flows that occur during the TMDL season) of the estimated annual load. The annual load was estimated assuming that half of the volume of precipitation that falls on the land area under the jurisdiction of the MS4 permit will run off to an impaired water body at an average phosphorus concentration of 0.22 mg/L (Waschbusch et. al., 1999). The WLA was determined to be one-half of the existing TMDL season load. The two construction site NOC permits in the TMDL watersheds are short-term MDOT projects and no LA was given to these permits.

No reductions were made to the current TMDL season load from the MMPA-Ovid NPDES permit because they already have very strict phosphorus loading restrictions (monthly average limits of 0.6 pounds per day and 0.15 mg/L) from April 1 to October 31.

MOS

In a TMDL the MOS is used, in part, to account for variability in source inputs to the system, or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can be either implicit (i.e., incorporated into the TMDL analysis through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). In this TMDL an implicit MOS was used in developing the target loads for attaining WQS. This TMDL assumes that all of the phosphorus entering the streams during the TMDL season will stay there (treating the water bodies more like lakes instead of lotic systems). A large proportion of the phosphorus load in these watersheds enters the streams during wet weather events, and during these high flow conditions some proportion of that phosphorus load washes out of the watershed. Because it is difficult to accurately estimate the amount of phosphorus that leaves the TMDL streams before it can be taken up by plants, we did not explicitly account for this loss of phosphorus and are using it as an implicit MOS.

SEASONALITY AND CRITICAL CONDITIONS

The period of time when it is most critical to meet the 0.06 mg/L phosphorus goal in the upper Maple River, Peet Creek, and Lost Creek is the summer. Between mid-June and mid-October, environmental conditions, such as higher temperatures and lower flows, are most likely to result in nuisance plant growth if nutrient concentrations exceed the goal. In the non-summer months, cooler water temperature, higher flows, and reduced light intensity greatly limit the growth of aquatic plants to the point where nuisance conditions will not occur even if nutrient concentrations are elevated. Therefore, if nutrient loadings are reduced such that the 0.06 mg/l goal is met from June through mid-October, WQS are expected to be met the remainder of the year.

MONITORING

Future monitoring will be conducted to assess whether activities implemented under the TMDL result in water quality improvements. This monitoring will be conducted as resources allow. Typically, the MDEQ monitors watersheds in accordance with the five-year NPDES permit review process. Total phosphorus standard attainment will result in the water bodies being removed from the Section 303(d) list, while continued nonattainment will result in further evaluation under the TMDL process. The Maple River watershed is scheduled for monitoring in 2012 and 2017.

REASONABLE ASSURANCE ACTIVITIES

The Friends of the Maple River is a community group working in the Maple River watershed to "preserve, improve, and educate the public regarding the wise use of the Maple River and its watershed." The Friends of the Maple River are part of a group, which includes the Clinton Conservation District, Fishbeck Consulting, Michigan Department of Natural Resources, drain commissioners, and the MDEQ, that is developing a watershed management plan for the upper Maple River under a nonpoint source Section 319 grant. The extent of the "upper Maple" overseen in the Section 319 grant includes the upper Maple River described in this TMDL and Peet Creek, but does not include Lost Creek. As part of the watershed management plan, volunteers have done road stream surveys and consultants have conducted additional biological assessments, which have helped to identify high priority areas of the watershed. High priority areas of the watershed are walked to identify potential sources of pollution to the stream, with the goal of implementing Best Management Practices and reducing nonpoint sources of pollution to the upper Maple River and its tributaries. Land use practices in the Lost Creek watershed, including reducing cattle access to the creek, have been changing since the water body was initially listed on the Section 303(d) list and likely have already begun to help reduce the nonpoint source load of phosphorus to the creek.

Although this TMDL focuses on phosphorus loads during the TMDL season, reductions will also be made to phosphorus loading during the rest of the year. Facilities operating under the WWSL general permit will be required to limit the phosphorus concentration in their effluent to 1 mg/L when they discharge from October 16 to December 31 and March 1 to May 31. The phosphorus limitation clause already exists in the WWSL general permit and can be invoked at the MDEQ's discretion. Because phosphorus cycling in the TMDL streams is not fully understood, it is important to reduce phosphorus loads outside the TMDL season to reduce any lingering effects those loads may have on plant growth during the TMDL season. WWSLs will also be encouraged to complete their spring discharges as early as possible in May.

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Appendix A. Total phosphorus data from the Maple River watershed from 1975 to 2007. Data from Alder Creek, Lost Creek, Peet Creek, and Upper Maple River-TMDL are from the listed nonattaining reaches.

Watershed	Stream	Road Crossing	Date	TP mg/L
Alder	Alder Creek	Hollister Road	6/19/1997	0.054
Alder	Alder Creek	M21	9/6/2007	0.027
Alder	Alder Creek	M21	8/22/2007	0.060
Alder	Alder Creek	M21	7/27/2007	0.036
Alder	Alder Creek	M21	7/25/2007	0.021
Alder	Alder Creek	M21	06/28/2007	0.041
Alder	Alder Creek	M21	6/18/2007	0.032
Alder	Alder Creek	Woodworth Road	8/22/2007	0.043
Alder	Alder Creek	Woodworth Road	August, 2002	0.220
Peet	Peet Creek	Bauer Road	8/22/2007	0.340
Peet	Peet Creek	Bauer Road	7/27/2007	0.360
Peet	Peet Creek	Colony Road	06/28/2007	0.105
Peet	Peet Creek	Wacousta Road	8/22/2007	0.300
Peet	Peet Creek	Wacousta Road	7/27/2007	0.330
Peet	Peet Creek	Wacousta Road	06/28/2007	0.370
Peet	Peet Creek	Wacousta Road	6/19/1997	0.510
Lost	Lost Creek	Jones Road	8/22/2007	0.095
Lost	Lost Creek	Jones Road	7/27/2007	0.032
Lost	Lost Creek	Jones Road	8/16/1989	0.098
Lost	Lost Creek	Townsend Road	06/28/2007	0.048
Lost	Lost Creek	Townsend Road	6/19/1997	0.068
Lost	Wieber Creek	Jones Road	8/22/2007	0.390
Lost	Wieber Creek	Jones Road	7/27/2007	0.066
Upper Maple - TMDL	Maple River	S. County Line Road	August, 2002	0.059
Upper Maple - TMDL	Maple River	Shepardsville Road	9/5/2007	0.058
Upper Maple - TMDL	Maple River	Shepardsville Road	8/22/2007	0.086
Upper Maple - TMDL	Maple River	Shepardsville Road	7/27/2007	0.081
Upper Maple - TMDL	Maple River	Shepardsville Road	7/25/2007	0.055
Upper Maple - TMDL	Maple River	Shepardsville Road	06/28/2007	0.192
Upper Maple - TMDL	Maple River	Shepardsville Road	6/18/2007	0.090
Upper Maple - TMDL	Maple River	Shepardsville Road	6/19/1997	0.085
Upper Maple - TMDL	Maple River	Shepardsville Road	August, 2002	0.039
Upper Maple - TMDL	Maple River	State Road	8/22/2007	0.127
Upper Maple - TMDL	Maple River	State Road	7/27/2007	0.145
Upper Maple - TMDL	Maple River	State Road	06/28/2007	0.143
Upper Maple - TMDL	Maple River	State Road.	August, 2002	0.240
Fish	Butternut Creek	Miner Road	August, 2002	0.053
Fish	Butternut Creek	Miner Road	6/19/1997	0.035
Fish	Fish Creek	Blackmer Road	9/4/2007	0.029
Fish	Fish Creek	Blackmer Road	7/26/2007	0.031
Fish	Fish Creek	Blackmer Road	6/19/2007	0.031

Watershed	Stream	Road Crossing	Date	TP mg/L
Fish	Fish Creek	Blackmer Road	August, 2002	0.019
Fish	Fish Creek	Colby Road	August, 2002	0.018
Fish	Fish Creek	Condensery Road	6/19/1997	0.045
Fish	Fish Creek	Fenwick Road	6/19/1997	0.045
Fish	Fish Creek	M-57	August, 2002	0.026
Fish	Fish Creek	Mt. Hope Road	August, 2002	0.030
Fish	Fish Creek	Stoudt Road	August, 2002	0.035
Fish	Fish Creek	Town Hall Road	August, 2002	0.047
Fish	Fish Creek	Vickeiyville Road	6/19/1997	0.033
Hayworth	Cox Drain	Wacousta Road	6/19/1997	0.031
Hayworth	Cox Drain	Wacusta Road	August, 2002	0.027
Hayworth	Hayworth Creek	Bauer Road	6/19/1997	0.044
Hayworth	Hayworth Creek	Kinley & Lowell Roads	August, 2002	0.087
Hayworth	Hayworth Creek	u/s Peet Crk	August, 2002	0.056
Hayworth	Hayworth Creek	Wacousta Road	8/22/2007	0.167
Hayworth	Hayworth Creek	Walker Road	August, 2002	2.450
Hayworth	S. Fork Hayworth Creek	Colony Road	June or July, 1997	0.026
Hayworth	St Johns Ditch	d/s St Johns WWTP	August, 2002	0.972
Hayworth	St Johns Ditch	Livingston Road	8/22/2007	0.260
Hayworth	St Johns Ditch	Livingston Road	7/27/2007	0.230
Hayworth	St Johns Ditch	Walker Road	8/22/2007	0.180
Hayworth	St Johns Ditch	Walker Road	8/22/2007	0.560
Hayworth	St Johns Ditch	Walker Road	7/27/2007	0.320
Hayworth	St Johns Ditch	Walker Road	7/27/2007	0.470
Hayworth	St Johns Ditch	Walker Road	06/28/2007	0.390
Hayworth	St Johns Ditch	Walker Road	06/28/2007	0.660
Lower Maple	Maple River	Hubbardston Road	August, 2002	0.195
Lower Maple	Maple River	M21	9/28/1992	0.114
Lower Maple	Maple River	M21	8/25/1992	0.081
Lower Maple	Maple River	M21	7/28/1992	0.136
Lower Maple	Maple River	M21	6/16/1992	0.129
Lower Maple	Maple River	M21	5/20/1992	0.154
Lower Maple	Maple River	M21	4/29/1992	0.089
Lower Maple	Maple River	M21	2/13/1975	0.050
Lower Maple	Maple River	M21	1/28/1975	0.080
Lower Maple	Maple River	M21	11/5/1974	0.080
Lower Maple	Maple River	M21	10/14/1974	0.080
Lower Maple	Maple River	M21	9/12/1974	0.100
Lower Maple	Maple River	M21	8/7/1974	0.120
Lower Maple	Maple River	M21	7/2/1974	0.170
Lower Maple	Maple River	M21	6/13/1974	0.130
Lower Maple	Maple River	M21	5/16/1974	0.100
Lower Maple	Maple River	M21	4/17/1974	0.120
Lower Maple	Maple River	M21	3/12/1974	0.110
Lower Maple	Maple River	M21	2/19/1974	0.080
Lower Maple	Maple River	M21	1/8/1974	0.060
Lower Maple	Maple River	M21	12/6/1973	0.110
Lower Maple	Maple River	M21	11/6/1973	0.090
Lower Maple	Maple River	M21	10/1/1973	0.140
Lower Maple	Maple River	M21	9/10/1973	0.160

Watershed	Stream	Road Crossing	Date	TP mg/L
Lower Maple	Maple River	M21	7/10/1973	0.190
Lower Maple	Maple River	M21	6/7/1973	0.210
Lower Maple	Maple River	M21	5/15/1973	0.170
Lower Maple	Maple River	M21	4/17/1973	0.120
Lower Maple	Maple River	M21	8/30/1971	0.130
Lower Maple	Maple River	Maple Road	11/2/1977	0.128
Lower Maple	Maple River	Maple Road	10/5/1977	0.153
Lower Maple	Maple River	Maple Road	9/7/1977	0.290
Lower Maple	Maple River	Maple Road	8/9/1977	0.340
Lower Maple	Maple River	Maple Road	7/11/1977	0.300
Lower Maple	Maple River	Maple Road	6/22/1977	0.230
Lower Maple	Maple River	Maple Road	5/23/1977	0.198
Lower Maple	Maple River	Maple Road	4/5/1977	0.050
Lower Maple	Maple River	Maple Road	3/21/1977	0.050
Lower Maple	Maple River	Maple Road	2/8/1977	0.054
Lower Maple	Maple River	Maple Road	1/25/1977	0.037
Lower Maple	Maple River	Maple Road	12/1/1976	0.031
Lower Maple	Maple River	Maple Road	11/2/1976	0.068
Lower Maple	Maple River	Maple Road	10/11/1976	0.091
Lower Maple	Maple River	Maple Road	9/13/1976	0.181
Lower Maple	Maple River	Maple Road	8/19/1976	0.182
Lower Maple	Maple River	Maple Road	7/7/1976	0.113
Lower Maple	Maple River	Maple Road	6/29/1976	0.202
Lower Maple	Maple River	Maple Road	5/5/1976	0.079
Lower Maple	Maple River	Maple Road	4/6/1976	0.072
Lower Maple	Maple River	Maple Road	3/4/1976	0.069
Lower Maple	Maple River	Maple Road	2/5/1976	0.080
Lower Maple	Maple River	Maple Road	1/8/1976	0.067
Lower Maple	Maple River	Maple Road	12/16/1975	0.075
Lower Maple	Maple River	Maple Road	11/12/1975	0.131
Lower Maple	Maple River	Maple Road	10/29/1975	0.145
Lower Maple	Maple River	Maple Road	9/22/1975	0.122
Lower Maple	Maple River	Maple Road	8/27/1975	0.192
Pine	North Shade Drain	outlet to Pine Creek	9/5/2006	0.103
Pine	Pine Creek	below Rainbow Lake	6/19/1997	0.043
Pine	Pine Creek	Fillmore Road. d/s illicit disch.	August, 2002	0.360
Pine	Pine Creek	Fillmore Road. u/s illicit disch.	August, 2002	0.220
Pine	Pine Creek	Grant Road	9/5/2006	0.197
Pine	Pine Creek	Johnson Road	9/4/2007	0.330
Pine	Pine Creek	Johnson Road	7/26/2007	0.360
Pine	Pine Creek	Johnson Road	6/21/2007	0.113
Pine	Pine Creek	Johnson Road	9/5/2006	0.194
Pine	Pine Creek	Johnson Road	6/19/1997	0.200
Pine	Pine Creek	u/s Alger Road	9/5/2006	0.210
Pine	Pine Creek	u/s confluence with North Shade Drain	9/5/2006	0.270
Pine	River Styx	Ely Hwy	6/19/1997	0.192
Pine	River Styx	Johnson Road	9/5/2006	0.950
Pine	Unnamed Trib	Pierce Road	9/5/2006	0.066

Watershed	Stream	Road Crossing	Date	TP mg/L
Stoney	Bad Creek	Centerline Road	June or August 2002	0.030
Stoney	Kloeckner and Fuller Creek	Taft Road	June or August 2002	0.139
Stoney	Muskrat Creek	Dexter Road	June or August 2002	0.036
Stoney	Spaulding Creek	County Farm Road	9/10/2003	0.041
Stoney	Spaulding Creek	County Farm Road	8/12/2003	0.032
Stoney	Spaulding Creek	County Farm Road	7/14/2003	0.026
Stoney	Spaulding Creek	DeWitt Road	9/10/2003	0.027
Stoney	Spaulding Creek	DeWitt Road	8/12/2003	0.036
Stoney	Spaulding Creek	DeWitt Road	7/14/2003	0.024
Stoney	Spaulding Creek	Grove Road	June or August 2002	0.037
Stoney	Spaulding Creek	Grove Road	9/10/2003	0.023
Stoney	Spaulding Creek	Grove Road	8/12/2003	0.023
Stoney	Spaulding Creek	Grove Road	7/14/2003	0.020
Stoney	Spaulding Creek	Grove Road	9/19/2002	0.014
Stoney	Spaulding Creek	Grove Road	8/9/2002	0.024
Stoney	Spaulding Creek	Grove Road	6/20/2002	0.037
Stoney	Spaulding Creek	Grove Road	6/7/2002	0.079
Stoney	Spaulding Creek	Krepps Road	9/10/2003	0.049
Stoney	Spaulding Creek	Krepps Road	8/12/2003	0.040
Stoney	Spaulding Creek	Krepps Road	7/14/2003	0.027
Stoney	Spaulding Creek	Parks Road	9/10/2003	0.047
Stoney	Spaulding Creek	Parks Road	8/12/2003	0.037
Stoney	Spaulding Creek	Parks Road	7/14/2003	0.034
Stoney	Spaulding Creek	Parks Road	9/19/2002	0.068
Stoney	Spaulding Creek	Parks Road	8/9/2002	0.045
Stoney	Spaulding Creek	Parks Road	6/7/2002	0.042
Stoney	Spaulding Creek	Townsend Road	9/10/2003	0.027
Stoney	Spaulding Creek	Townsend Road	8/12/2003	0.015
Stoney	Spaulding Creek	Townsend Road	7/14/2003	0.034
Stoney	Stoney Creek	County Line Road	6/19/1997	0.047
Stoney	Stoney Creek	Grove Road	8/16/1989	0.141
Stoney	Stoney Creek	Jones Road	8/16/1989	0.094
Stoney	Stoney Creek	Lowell Road	9/5/2007	0.018
Stoney	Stoney Creek	Lowell Road	7/26/2007	0.034
Stoney	Stoney Creek	Lowell Road	6/21/2007	0.015
Stoney	Stoney Creek	M21	June or August 2002	0.053
Stoney	Stoney Creek	M21	6/19/1997	0.051
Stoney	Stoney Creek	M21	11/8/1977	0.047
Stoney	Stoney Creek	M21	10/4/1977	0.109
Stoney	Stoney Creek	M21	9/8/1977	0.051
Stoney	Stoney Creek	M21	8/2/1977	0.072
Stoney	Stoney Creek	M21	7/6/1977	0.090
Stoney	Stoney Creek	M21	6/1/1977	0.117
Stoney	Stoney Creek	M21	5/10/1977	0.047
Stoney	Stoney Creek	M21	4/13/1977	0.072
Stoney	Stoney Creek	M21	3/16/1977	0.076
Stoney	Stoney Creek	M21	2/23/1977	0.041
Stoney	Stoney Creek	M21	1/19/1977	0.019

Watershed	Stream	Road Crossing	Date	TP mg/L
Stoney	Stoney Creek	M21	12/15/1976	0.010
Stoney	Stoney Creek	M21	11/3/1976	0.016
Stoney	Stoney Creek	M21	10/20/1976	0.020
Stoney	Stoney Creek	M21	9/23/1976	0.020
Stoney	Stoney Creek	M21	8/25/1976	0.044
Stoney	Stoney Creek	M21	7/13/1976	0.037
Stoney	Stoney Creek	M21	6/29/1976	0.073
Stoney	Stoney Creek	M21	5/6/1976	0.093
Stoney	Stoney Creek	M21	4/14/1976	0.029
Stoney	Stoney Creek	M21	3/30/1976	0.088
Stoney	Stoney Creek	M21	2/25/1976	0.182
Stoney	Stoney Creek	M21	1/20/1976	0.047
Stoney	Stoney Creek	M21	12/2/1975	0.137
Stoney	Stoney Creek	M21	11/6/1975	0.072
Stoney	Stoney Creek	M21	10/30/1975	0.024
Stoney	Stoney Creek	M21	9/4/1975	0.280
Stoney	Stoney Creek	M21	8/7/1975	0.106
Stoney	Stoney Creek	Taft Road	8/16/1989	0.124
Stoney	Stoney Creek	Tallman Road	6/19/1997	0.035
Stoney	Stoney Creek	Tallman Road	8/16/1989	0.171
Stoney	Stoughton Creek	Cowman Road	August, 2002	0.100
Stoney	Stoughton Creek	Cowman Road	6/19/1997	0.087
Upper Maple	Baker Creek	French Road	6/19/1997	0.073
Upper Maple	Baker Creek	Meridian Road	6/19/1997	0.039
Upper Maple	Bear Creek	Dewey Road	6/19/1997	0.052
Upper Maple	Bear Creek	Garfield Road	6/19/1997	0.075
Upper Maple	Bear Creek	Krouse Road	August, 2002	0.064
Upper Maple	Bear Creek	Shaftsburg Road	6/19/1997	0.067
Upper Maple	Little Maple River	Shepardsville Road	August, 2002	0.077
Upper Maple	Maple River	Baldwin Road	June or July, 1997	0.076
Upper Maple	Maple River	Baldwin Road.	9/6/2007	0.036
Upper Maple	Maple River	Baldwin Road.	7/25/2007	0.041
Upper Maple	Maple River	Baldwin Road.	6/19/2007	0.068
Upper Maple	Maple River	Baldwin Road.	August, 2002	0.057
Upper Maple	Maple River	Front St	August, 2002	0.038
Upper Maple	Maple River	Morrice Road	6/19/1997	0.055
Upper Maple	Maple River	Ruess Road	August, 2002	0.065
Upper Maple	Maple River	Ruess Road	6/19/1997	0.053
Upper Maple	Maple River	Warren Road	August, 2002	0.020
Upper Maple	Maple River	Warren Road	6/19/1997	0.034

Appendix B. List of NPDES and groundwater permits in the upper Maple River, Peet Creek, and Lost Creek watersheds.

UPPER MAPLE PERMITS

Designated Name	Facility Type	Permit No.	County	Latitude	Longitude
Groundwater Permits					
North Star Sewer System	GW-Municipal, Sanitary Wastewater	GW1110263	Gratiot	43.23909	-84.54087
Bellingar Packing	GW-Commercial	GW1510052	Gratiot	43.14138	-84.57566
MDNR-Sleepy Hollow SP WWSL	Non-Industrial Sanitary Wastewater	GW1510069	Clinton	42.952222	-84.41667
Individual Permits					
Sanitary Wastewater					
Elsie WWSL	Non-Industrial Sanitary Wastewater	MI0056260	Clinton	43.098611	-84.39583
Industrial Wastewater					
MDOT Statewide MS4		MI0057364	All		
Sunoco-Owosso Terminal	Standard (All others)	MI0036498	Shiawassee	43	-84.24583
MMPA-Ovid Plant	Standard (All others)	MI0043427	Clinton	43.006111	-84.37889
General Permits					
General Permit MIG580000 - Wastewater Stabilization Lagoons					
Becks Development Co	Non-Industrial Sanitary Wastewater	MIG580052	Clinton	43.091666	-84.57
Ashley WWSL	Non-Industrial Sanitary Wastewater	MIG580059	Gratiot	43.181111	-84.46667
Ovid WWSL	Non-Industrial Sanitary Wastewater	MIG580064	Clinton	42.99957	-84.38385
Spring Vale Academy	Non-Industrial Sanitary Wastewater	MIG580228	Shiawassee	42.933611	-84.225
MDNR-Sleepy Hollow SP WWSL	Non-Industrial Sanitary Wastewater	MIG580290	Clinton	42.952222	-84.41667
General Permit MIG010000 - New Large Concentrated Animal Feeding Operations					
Green Meadow Farms 2 & 3-CAFO	Concentrated Animal Feeding Operati	MIG010019	Shiawassee	43.070563	-84.35272
Stewart Farms-CAFO	Concentrated Animal Feeding Operati	MIG010021	Gratiot	43.12528	-84.45389
EB Ridge Dairy-CAFO	Concentrated Animal Feeding Operati	MIG010100	Clinton	43.096154	-84.48177
Green Meadow Farms 1-CAFO	Concentrated Animal Feeding Operati	MIG010107	Clinton	43.07917	-84.38473
Willow Creek Farms-CAFO	Concentrated Animal Feeding Operati	MIG010114	Gratiot	43.16323	-84.59539
Kurncz Farms - CAFO	Concentrated Animal Feeding Operati	MIG010161	Clinton	43.046944	-84.49417
General Permit MIG250000 - Noncontact Cooling Water					
EB Ridge Dairy-CAFO	Standard (All others)	MIG250495	Clinton	43.096154	-84.48177
General Permit MIG490000 - Sand and Gravel Mining Wastewater					
Carl Schlegel-Harmon Rd Pit	Standard (All others)	MIG490294	Clinton	43.0362	-84.46389
General Permit MIS410000 - Storm Water from Industrial Activity and/or with Required Monitoring					
Ovid Farmers Elevator-Ovid	Industrial Storm Water Only	MIS410122	Clinton	43.010277	-84.36917
Nero Plastics Inc-Owosso	Industrial Storm Water Only	MIS410132	Shiawassee	42.992777	-84.20528
Ovid Iron and Metal	Industrial Storm Water Only	MIS410615	Clinton	43.01042	-84.38409
Notice of Coverage					
Storm Water Discharges from Construction Activity					
MDOT-US-127 BR/Old US-27	Construction Sites	MIR110439	Clinton	42.99967	-84.5601
MDOT-US-127/Livingston Rd	Construction Sites	MIR110919	Clinton	43.11623	-84.56079

PEET CREEK PERMITS

Designated Name	Facility Type	Permit No.	County	Latitude	Longitude
Individual Permits					
Industrial Wastewater					
MDOT Statewide MS4		MI0057364			
General Permits					
General Permit MIG580000 - Wastewater Stabilization Lagoons					
Fowler WWSL	Non-Industrial Sanitary Wastewater	MIG580061	Clinton	42.98913	-84.72726
General Permit MIG010000 - New Large Concentrated Animal Feeding Operations					
Schneider Dairy-CAFO	Concentrated Animal Feeding Operati	MIG010033	Clinton	42.98778	-84.70111
Rich Ro Farms-CAFO	Concentrated Animal Feeding Operati	MIG010118	Clinton	43.03747	-84.6933
T & H Dairy-CAFO	Concentrated Animal Feeding Operati	MIG010126	Clinton	43.032963	-84.73931
Rudat Farms-CAFO	Concentrated Animal Feeding Operati	MIG010152	Clinton	43.070833	-84.74583

LOST CREEK PERMITS

Designated Name	Facility Type	Permit No.	County	Latitude	Longitude
Individual Permits					
Sanitary Wastewater					
Industrial Wastewater					
MDOT Statewide MS4		MI0057364			
General Permits					
General Permit MIG010000 - New Large Concentrated Animal Feeding Operations					
Steenblik Dairy Inc-CAFO	Concentrated Animal Feeding Operati	MIG010080	Clinton	43.04351	-84.48274
T & H Dairy-CAFO	Concentrated Animal Feeding Operati	MIG010126	Clinton	43.032963	-84.73931
Rudat Farms-CAFO	Concentrated Animal Feeding Operati	MIG010152	Clinton	43.070833	-84.74583