Upper Maple River
Watershed Management Plan

June 2010
MDNRE Tracking Code #2007-0118

Appendix 5

Threatened & Endangered Species

APPENDIX 5 - Michigan Natural Features Inventory Watershed Element Data

Watershed Name: Maple - -0204 Ferdon Creek-Maple River

HUC ID: 04050005010150

Scientific Name	Common Name	Species	State Status
Alasmidonta marginata	Elktoe	Mussel	SC
Ammodramus henslowii	Henslow's Sparrow	Bird	T
Ammodramus savannarum	Grasshopper Sparrow	Bird	SC
Botaurus lentiginosus	American Bittern	Bird	SC
Cistothorus palustris	Marsh Wren	Bird	SC
Epioblasma triquetra	Snuffbox	Mussel	E
Haliaeetus leucocephalus	Bald Eagle	Bird	T
Pandion haliaetus	Osprey	Bird	T
Protonotaria citrea	Prothonotary Warbler	Bird	SC
Rallus elegans	King Rail	Bird	E
Schoenoplectus americanus	Olney's Bulrush	Plant	T
Venustaconcha ellipsiformis	Ellipse	Mussel	SC

Watershed Name: Maple - Stevens Drain - Maple River -0202

HUC ID: 04050005010100

Scientific Name	Common Name	Species	State Status
Alasmidonta marginata	Elktoe	Mussel	SC
Alasmidonta viridis	Slippershell Mussel	Mussel	SC
Villosa iris	Rainbow	Mussel	SC

Watershed Name: Maple - Little Maple River -0104

HUC ID: 04050005010050

Scientific Name	Common Name	Species	State Status
Hydrastic Canadensis	Goldenseal	Plant - forb	T
Oecanthus pini	Pinetree Cricket	Cricket	SC

Watershed Name: Maple - Collier Creek - Maple River - 0208

HUC ID: 04050005010160

Scientific Name	Common Name	Species	State Status
Gymnocladus dioicus	Kentucky Coffee-tree	Plant - tree	SC
Jeffersonia diphylla	Twinleaf	Plant - forb	SC

Watershed Name: Maple - Shiawassee Co (Ovid-Maple River - 0105)

HUC ID: 04050005010070

Scientific Name	Common Name	Species	State Status
Dennstaedtia punctilobula	Hay-scented Fern	Plant - fern	X
Galearis spectabilis	Showy Orchis	Plant - orchid	T
Plantago cordata	Heart-leaved Plantain	Plant - forb	E

Watershed Name: Maple - Shiawassee Co. Alder Creek - 0103

HUC ID: 04050005010040

Scientific Name	Common Name	Species	State Status
Ammodramus henslowii	Henslow's Sparrow	Bird	T
Galearis spectabilis	Showy Orchis	Plant - orchid	T

Watershed Name: Maple - Shiawassee Co. Springbrook - Maple River – 0101

HUC ID: 04050005010030

Scientific Name	Common Name	Species	State Status
Dennstaedtia punctilobula	Hay-scented Fern	Plant - fern	X
Galearis spectabilis	Showy Orchis	Plant - orchid	T

Scientific Name	Common Name	Species	State Status
Plantago cordata	Heart-leaved Plantain	Plant - forb	E

Watershed Name: Maple - Shiawassee Co. Coon Creek-Bear Creek – 0102
HUC ID: 04050005010020

Scientific Name	Common Name	Species	State Status
Dennstaedtia punctilobula	Hay-scented Fern	Plant - fern	X
Galearis spectabilis	Showy Orchis	Plant - orchid	T
Great Blue Heron Rookery	Great Blue Heron Rookery		
Plantago cordata	Heart-leaved Plantain	Plant - forb	E

T = Threatened, E = Endangered, SC = Special Concern, X = Probably Extirpated (all gone)

Upper Maple River
Watershed Management Plan

June 2010
MDNRE Tracking Code #2007-0118

Appendix 6

Regulated Dams

APPENDIX 6 - Regulated Dams in the Upper Maple River Watershed (Michigan Department of Natural Resources and Environment)

Dam ID	Dam Name	Location (County)	Type	Height	Hazard	Purpose	Public Acess	Owner
465	Cummings Lake Dam	Shiawassee	Earth	21	Significant	Recreation	No	Privately Owned
616	Rainbow Lake Dam	Gratiot	Earth	46	Significant	Recreation	No	Rainbow Lake Maintenance Corp.
717	Sleepy Hollow Dam	Clinton	Earth	30	Significant	Flood & Storm water Recreation	Yes	MDNR Parks & Recreation
46	Elsie Dam	Clinton	Concrete	10	Low	Recreation	No	Duplain Township
355	Milli-Ander Pond Dam	Gratiot	Earth	7	Low	Recreation Other	No	MDNR Wildlife
401	Lake Manitou Dam	Shiawassee	Earth Gravity	12	Low	Recreation	No	Lake Manitou Residents Association
440	Little Rainbow Lake Dam	Gratiot	Earth	33	Low	Recreation	No	Rainbow Lake Maintenance Corporation
618	Lake Victoria Dam	Clinton	Earth	24	Low	Recreation	No	Lake Victoria Association
675	Sadilek Dam	Gratiot	Earth	12	Low	Recreation Farm Pond	No	Privately Owned
1629	Perrington Dam	Gratiot	Earth	11	Low	Irrigation	No	Privately Owned
1630	Shook Dam	Gratiot	Earth	13	Low		No	Privately Owned
2052	Country Club Dam	Clinton	Earth Gravity	15	Low	Recreation	No	Sleepy Hollow Country Club
2054	Whitaker Dam	Clinton	Earth Gravity	7	Low	Recreation	No	Privately Owned
2055	Slamka Dam	Clinton	Earth Gravity	23	Low	Recreation	No	Privately Owned
2056	Markman Dam	Clinton	Earth Gravity	5	Low	Recreation	No	Privately Owned
2061	Phillips Dam	Clinton	Earth Gravity	6	Low	Recreation	No	Privately Owned
2062	Schlarf Dam #1	Clinton	Earth Gravity	15	Low	Recreation	No	Privately Owned
2063	Schlarf Dam #2	Clinton	Earth Gravity	11	Low	Recreation	No	Privately Owned
2469	Gratiot-Saginaw Impoundment 15 Dam	Gratiot	Earth	6	Low	Other	Yes	MDNR Wildlife
2588	Gratiot-Saginaw Impoundment 21 Dam	Gratiot	Earth	5	Low	Other	Yes	MDNR Wildlife

Upper Maple River
Watershed Management Plan

June 2010
MDNRE Tracking Code #2007-0118

Appendix 7

List of Fish

APPENDIX 7 - FISH SPECIES PREVIOUSLY DOCUMENTED IN THE MAPLE RIVER WATERSHED (1989 AND 2006 MDNR SURVEYS)

Common Name	Scientific Name
black bullhead	*Ictalarus melas*
black crappie	*Pomoxis nigromaculatus*
blacknose dace	*Rhinichthys atratulus*
blackside darter	*Percina maculata*
bluegill	*Lepomis macrochirus*
bluntnose minnow	*Pimephales notatus*
bowfin	*Amia calva*
brassy minnow	*Hybognathus hankinosoni*
brook stickleback	*Culaea inconstans*
burbot	*Lota lota*
central mudminnow	*Umbra limi*
central stoneroller	*Campostoma anomalum*
channel catfish	*Ictalarus punctatus*
chestnut lamprey	*Ichthyomyzon castaneus*
common carp	*Cyprinus carpio*
common shiner	*Luxilus cornutus*
creek chub	*Semotilus atromaculatus*
emerald shiner	*Notropis atherinoides*
flathead catfish	*Pylodictis olivaris*
gizzard shad	*Dorosoma cepedianum*
golden redhorse	*Moxostoma erythrurum*
golden shiner	*Notemigonus crysoleucas*
goldfish	*Carassius auratus*
grass pickerel	*Esox americanus vermiculatus*
greater redhorse	*Moxostoma valenciennesi*
green sunfish	*Lepomis cyanellus*
hornyhead chub	*Nocomis biguttatus*
johnny darter	*Etheostoma nigrum*
largemouth bass	*Micropterus salmoides*
log perch	*Percina caprodes*
longnose gar	*Lepisosteus osseus*
norther pike	*Esox lucius*
northern hog sucker	*Hypentelium nigricans*
pirate perch	*Aphredoderus sayanus*
pumpkinseed	*Lepomis gibbosus*
quillback	*Carpiodes cyprinus*
rainbow darter	*Etheostoma caeruleum*
redfin shiner	*Notropis umbratilis*
rock bass	*Ambloplites rupestris*
rosyface shiner	*Notropis rubellus*
sand shiner	*Notropis stramineus*
shorthead redhorse	*Moxostoma macrolepidotum*
silver lamprey	*Ichthyomyzon unicuspis*
silver redhorse	*Moxostoma anisurum*
smallmouth bass	*Micropterus dolomieu*
spotfin shiner	*Cyprinella spilopterus*
spotted sucker	*Minytrema melanops*
stonecat	*Noturus flavus*
striped shiner	*Notropis chrysocephalus*
tadpole madtom	*Noturus gyrinus*
walleye	*Stizostedium vitreum*
warmouth	*Lepomis gulosus*
white crappie	*Pomoxis annularis*
white sucker	*Catostomus commersoni*
yellow bullhead	*Ameiurus natalis*

Upper Maple River
Watershed Management Plan

June 2010
MDNRE Tracking Code #2007-0118

Appendix 8

Water Quality Standards by Designated Use

APPENDIX 8 - WATER QUALITY STANDARDS

		DESIGNATED USE					
Pollutant	**Water Quality Standard***	**Warmwater Fishery**	**Other Indigenous Aquatic Life & Wildlife**	**Total Body Contact Recreation**	**Partial Body Contact Recreation**	**Agricultural (Irrigation)**	**Navigation**
Temperature	(DFI-101.97) R 323.1069-1075	Heat load cannot cause exceedance of monthly limits (max. 77 °F in July and August [Creal and Wuycheck 2002])					
Dissolved Oxygen (DO)	R 323.1064 Rule 64. (1)	5 mg DO/liter					
Total Suspended Soilds (Turbidity)	MDEQ recognizes an informal TSS target of 80 mg/L under wet weather conditions.	80 mg/L	80 mg/L				
E. coli	R 323.1062 Microorganisms. Rule 62. (1)			130 organisms/100 mL 30-day geometric mean, (300 organisms/ 100 mL) single sample (May1 to October 1)	1,000 organisms/ 100 mL, 30-day geometric mean		
Phosphorus and Nitrogen (Plant Nutrients)	R 323.1060 Rule 60. (2)	Nutrients shall be limited to the extent necessary to prevent stimulation of growth 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.	Nutrients shall be limited to the extent necessary to prevent stimulation of growth 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. TMDL on Pine Creek has target of 0.08 mg/L; TMDL for Upper Maple River and Peet Creek has target of 0.06 mg/L				
Chlorides	R 323.1051 Rule 51. (1)						
pH (instream)	R 323.1053 Hydrogen ion concentration	6.5 to 9.0 S.U.	6.5 to 9.0 S.U.	6.5 to 9.0 S.U.	6.5 to 9.0 S.U.	6.5 to 9.0 S.U.	6.5 to 9.0 S.U.
Total Dissolved Solids (TDS)	R 323.1051 Rule 51. (1)	500 mg/L as a monthly average, 750 mg/L at any time	500 mg/L as a monthly average, 750 mg/L at any time				
Other Pollutants	Other Standards	Minimum fish ratings from -4 to acceptable (SWAS Procedure 51)	Minimum macroinvertebrate ratings from -4 to accceptable (SWAS Procedure 51)			No specific assessments. Assumed to be supported unless a targeted concern is found.	No specific assessments. Assumed to be supported unless a targeted concern is found.

*PART 4. WATER QUALITY STANDARDS (Promulgated pursuant to Part 31 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended). Effective: December 13, 1973. Latest revisions effective: January 13, 2006. MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY, WATER BUREAU
http://www.deq.state.mi.us/documents/deq-wb-intreport-appendixa.pdf

Appendix 9

TMDL Reports

Michigan Department of Environmental Quality
Water Bureau
August 2007

Total Maximum Daily Load for Phosphorus for Pine Creek Gratiot County

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 a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their water resources. The purpose of this TMDL is to identify the allowable total phosphorus loads that will enable WQS to be attained in Pine Creek, a tributary of the Maple River, located in Gratiot County, Michigan.

PROBLEM STATEMENT

The TMDL reach for Pine Creek appears on the 2006 Section 303(d) list as:

PINE CREEK WBID#: 082821L
County: Gratiot County Size: 9 M
Location: SW of Ithaca. Grant Road us/ to 0.8 miles u/s of St. Charles Road
NHD Reach Code: 04050005000219
Problem Summary: Nuisance plant growths, Phosphorus
TMDL YEAR(s): 2007

Pine Creek was placed on the Section 303(d) list due to documented nuisance plant conditions (Edly and Wuycheck, 2006). Monitoring data collected by the Michigan Department of Environmental Quality (MDEQ) in 1997 and 2002 documented nuisance plant growth and bacterial slimes. The presence of nuisance plant conditions indicates that the other indigenous aquatic life and wildlife designated use is not supported.

NUMERIC TARGET

The WQS that applies to total phosphorus is found in Rule 60 (R 323.1060) 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, and is defined as follows:

R 323.1060 Plant Nutrients
(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 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 goal of 0.08 milligrams per liter (mg/l) of total phosphorus is recommended for Pine Creek. This average in-stream concentration was chosen as a target based upon phosphorus concentrations in other streams in the Maple River watershed for which nuisance aquatic plant growths have not been observed. The MDEQ data show that many tributaries to the Maple River have total phosphorus concentrations between 0.03 and 0.08 mg/l. Data from a study done on Spaulding Drain, a tributary to the Maple River, show that total phosphorus ranged from 0.015 to 0.079 mg/l during summer monthly sampling in 2002 and 2003 (Roush, 2003), and was determined to be meeting WQS. Like Pine Creek, Spaulding Drain is a maintained drain without much relief and is surrounded by intensive agricultural land uses. Therefore, a target concentration of 0.08 mg/l is a realistic goal for Pine Creek, and will be used to develop the Pine Creek total phosphorus TMDL.

DATA DISCUSSION

Pine Creek was sampled for total phosphorus at four stations in September 2006 (Table 1 and Figure 1). The average total phosphorus concentration was 0.22 mg/l. The MDEQ staff also visited Pine Creek in 1997 and 2002 (Table 1). In 1997, the stream was noticeably impaired, with excessive rooted aquatic plant growth (Hanshue, 2002), and the total phosphorus concentration during this survey was 0.2 mg/l. In 2002, it was noted that the removal of streamside cover and nutrient enrichment had resulted in excessive rooted aquatic plant growth and floating algae (Rockafellow, 2003). Water chemistry data from 2002, were collected upstream and downstream of discharging tile drain where total phosphorus concentrations at both locations exceeded 0.2 mg/l.

SOURCE ASSESSMENT

Pine Creek primarily drains agricultural land and is located entirely in the Southern Michigan Northern Indiana Till Plain ecoregion (Omernik and Gallant, 1988). The drainage has little topographic relief and has been extensively channelized and tiled. Pine Creek is similar to most of the streams in southern Gratiot County, in that its entire length is actively maintained as an agricultural drain. Almost all of the riparian vegetation has been removed in the TMDL reach, manure is spread on fields throughout the watershed, and cattle access to the stream has been noted on multiple occasions. All of these changes to the watershed increase the phosphorus load to the Pine Creek TMDL reach and the potential for nutrient expression. Another potential, but undocumented, source of total phosphorus to Pine Creek is illicit discharges from residential units, which are reportedly common throughout Gratiot County. The local health department has been notified that illicit discharges may be present in the area.

Table 1. Water chemistry data from Pine Creek.

	Pine Creek at Johnson Road	Pine Creek at Fillmore Rd. u/s tile drain	Pine Creek at Fillmore Rd. d/s tile drain	Pine Creek at Alger Road	Pine Creek at Johnson Road	Pine Creek u/s confl. with North Shade Drain	Pine Creek at Grant Road
Date	6/19/1997	8/1/2002	8/1/2002	9/5/2006	9/5/2006	9/5/2006	9/5/2006
Total Phosphorus (mg/l)	0.2	0.22	0.36	0.21	0.194	0.27	0.197
Ortho-phosphate (mg/l)	0.159	0.14 DL	0.17 DL	0.131	0.098	0.143	0.139
pH	--	--	--	7.58	7.7	8.52	7.71
Conductivity (umho/cm)	--	--	--	888	811	778	763
Total Kjeldahl Nitrogen (mg/l)	1.46	2.8	2.9	1.13	2.1	1.18	0.89
Nitrate + Nitrite (mg/l)	1.53	5.2	8.8	0.2	1.44	1.94	1.16
Ammonia (mg/l)	0.4	0.8 DL	1.2	0.23	0.87	0.063	0.122
Nitrite (mg/l)	0.155	0.27	0.26	0.019	0.135	0.127	0.061
Solids – Suspended (mg/l)	--	45	410	13	6	27	7

All phosphorus loadings to Pine Creek are from land-based sources. Loadings from these sources were determined based on land uses in the drainage basin (Table 2). Land use proportions were derived using the Long-Term Hydrologic Impact Assessment (L-THIA) Web-based application created and maintained by Purdue University and the USEPA (Purdue University and USEPA, 2004; Choi et al., 2005). This geographic information system-based software uses the event mean concentration and curve number procedures to calculate daily pollutant loads based on site-specific land use, soil type, and meteorological data. The default site-specific data include 30 meter resolution land use data from National Land Cover Database and average annual precipitation data. The L-THIA application is supported by staff of the USEPA, Region 5.

Table 2. Calculated land use/cover in the Pine Creek watershed.

Land Use/Cover	Area (acres)	Percent
Water	671	2
Urban/Residential	64	< 1
Urban/Commercial	5	< 1
Agricultural	26594	78
Grass/Pasture	3483	10
Forest	3161	9
Total	33978	100

There are three National Pollutant Discharge Elimination System (NPDES) permits within the Pine Creek watershed (Table 3). There are two general permits for concentrated animal feeding operations (CAFOs) and one stormwater general permit.

Table 3. Permitted Discharges in the Pine Creek watershed.

Facility	Permit Number	Acres	Latitude	Longitude
MIS410000 Stormwater Permit	Storm Water from Industrial Activities			
Sparks Pickle Co-Ithaca	MIS410369	5	43.2775	-84.675833
MIG010000 General Permit	New Large Concentrated Animal Feeding Operations			
Nathan Duflo Farm-CAFO	MIG010006	570	43.21448	-84.8001
MIG440000 General Permit	Concentrated Animal Feeding Operations			
Vanderploeg Holsteins-CAFO	MIG440002	1032	43.27542	-84.63829

The daily load of total phosphorus to Pine Creek was estimated to be 40.7 pounds per day using basic input options in the L-THIA model. These include watershed specific land use and soil type proportions, default curve numbers, and average precipitation rates. This load

represents the pollutant load from all sources to the TMDL reach, including both land use (Table 2) and NPDES permits (Table 3).

LINKAGE ANALYSIS

The observed total phosphorus standard nonattainment in Pine Creek can be attributed to a number of factors. The growth of aquatic plants and algae in a stream is controlled, in part, by nutrients and light availability. Pine Creek is not shaded by riparian vegetation, which allows plant growth within the stream to increase as total phosphorus concentrations increase.

Phosphorus can exist in dissolved forms and particulate forms sorbed to solids. 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 can be released as dissolved phosphorus under certain conditions, contributing to increased plant growth. Solids that run off of the land into Pine Creek, or that are discharged directly to the stream, are a significant load of particulate phosphorus in agricultural watersheds.

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 Pine Creek is a flowing water body, the total phosphorus concentration, versus the load, is expected to be the predominant influence on nuisance aquatic plant growth and will be the goal for this TMDL. We have established the total phosphorus numeric target for Pine Creek at 0.08 mg/l. The current average concentration of total phosphorus in Pine Creek is 0.22 mg/l. The numeric target of 0.08 mg/l represents a 64 percent reduction from the current concentration. To reach the target, we propose to reduce the load of total phosphorus by 64 percent, from 40.7 pounds per day to 14.7 pounds per day (Table 4).

The LC is the sum of individual waste load allocations (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:

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

<u>WLAs</u>

There are three NPDES permitted point source discharges within the listed reach of Pine Creek; two general permits, Nathan Duflo Farm-CAFO (MIG010006) and Vanderploeg Holsteins-CAFO (MIG440002), and a stormwater general permit for Sparks Pickle Co-Ithaca (MIS410369). The wasteload for these permits was calculated based on the land under jurisdiction of each of these NPDES permits.

The five acres delineated in L-THIA as urban-commercial, were assumed to be the area of land associated with the Sparks Pickle Co-Ithaca stormwater permit. To determine the area of land

Table 4. Summary of the total phosphorus LC development for Pine Creek, Gratiot County, Michigan.

Source Category	Acres	Estimate Current TP (pounds/day)	TMDL TP Target Load TP (pounds/day)
WLA Components:			
Sparks Pickle Co-Ithaca	5	0.008	0.003
Nathan Duflo Farm - CAFO	570	0.870	0.278
Vanderploeg Holsteins - CAFO	1032	1.576	0.504
CAFO Subtotal:	1602	2.44	0.782
WLA Total:	1607	2.45	0.785
LA Components:			
Water	671	0	0
Urban/Residential	64	0.054	0.017
Agricultural	24992	38.2	12.2
Grass/Pasture	3483	0.014	0.014
Forest	3161	0.007	0.007
LA Subtotal:	32371	38.28	12.2
Totals:	33978	40.7	13
MOS			1.7
Daily TMDL Load Target			14.7

associated with the CAFO general permits, the area of the fields with a potential to receive CAFO manure applications was totaled. To determine the target phosphorus load, each estimated current phosphorus load was reduced by 68 percent, an additional 4 percent reduction over the targeted load to address the MOS. The calculated existing and target loads from these sources are 2.45 pounds per day and 0.785 pounds per day, respectively (Table 4).

LAs

The nonpoint source and natural background levels of phosphorus are combined to produce the LA. The primary sources of total phosphorus in the Pine Creek watershed are runoff from various land uses, including agricultural land, and potentially illicit discharges from septic systems. The current estimated loading of phosphorus is 38.28 pounds per day. The total LA is 12.2 pounds per day, which equates to a 68 percent reduction of total phosphorus (Table 4).

MOS

The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can be either implicit (i.e., incorporated into the WLA or LA through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an explicit MOS.

The total phosphorus goal for Pine Creek is 0.08 mg/l, which is a 64 percent reduction in phosphorus concentration from current conditions. The WLA and LA were calculated to achieve a phosphorus goal of 0.07 mg/L, a 68 percent reduction in the phosphorus load, and the difference assigned to the MOS. This results in a MOS of 1.7 pounds per day of phosphorus.

Although a TMDL must specify load reductions, the primary goal of this TMDL is to achieve the concentration target. A concentration target is more relevant than a load-based target for Pine Creek, and many headwater stream systems, because storm event-related sediment loadings, with the associated phosphorus, tend to pass quickly through to slower flow areas downstream. This rapid movement of loadings is further enhanced in an agriculture watershed, such as the Pine Creek watershed which has been altered to rapidly move rainwater and the associated sediment load downstream. Because the concentration goal of 0.08 mg/L is expected to attain WQS, the sediment loading target is secondary, and the MOS of 1.7 pounds per day phosphorus is considered appropriate.

SEASONALITY AND CRITICAL CONDITIONS

The period of time when it is most critical to meet the 0.08 mg/l phosphorus goal in Pine Creek is the summer. Between June and September, 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 the 0.08 mg/l goal is met during the summer period, WQS are expected to be attained 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. Pine Creek is scheduled for monitoring in 2007 and 2012.

REASONABLE ASSURANCE ACTIVITIES

The Friends of the Maple River is a community group working on the Maple River watershed, which includes Pine Creek. The mission of the Friends of the Maple River is to "preserve, improve, and educate the public regarding the wise use of the Maple River and its watershed." The Friends of the Maple River plan to develop a watershed management plan and have applied for state grants to work on the plan. The group will be helpful in finding locations in the Pine Creek watershed to implement Best Management Practices and communicating with landowners to increase the level of implementation.

Pine Creek is also scheduled for monitoring by the MDEQ, Water Bureau, during the summer of 2007. This monitoring will include both an investigation on the locations of cattle access sites and aquatic macroinvertebrate monitoring. Limiting cattle access sites and reducing any illicit discharges will also reduce the load of phosphorus to Pine Creek.

Prepared by: Sarah Holden, Aquatic Biologist
Surface Water Assessment Section
Water Bureau
Michigan Department of Environmental Quality
August 13, 2007

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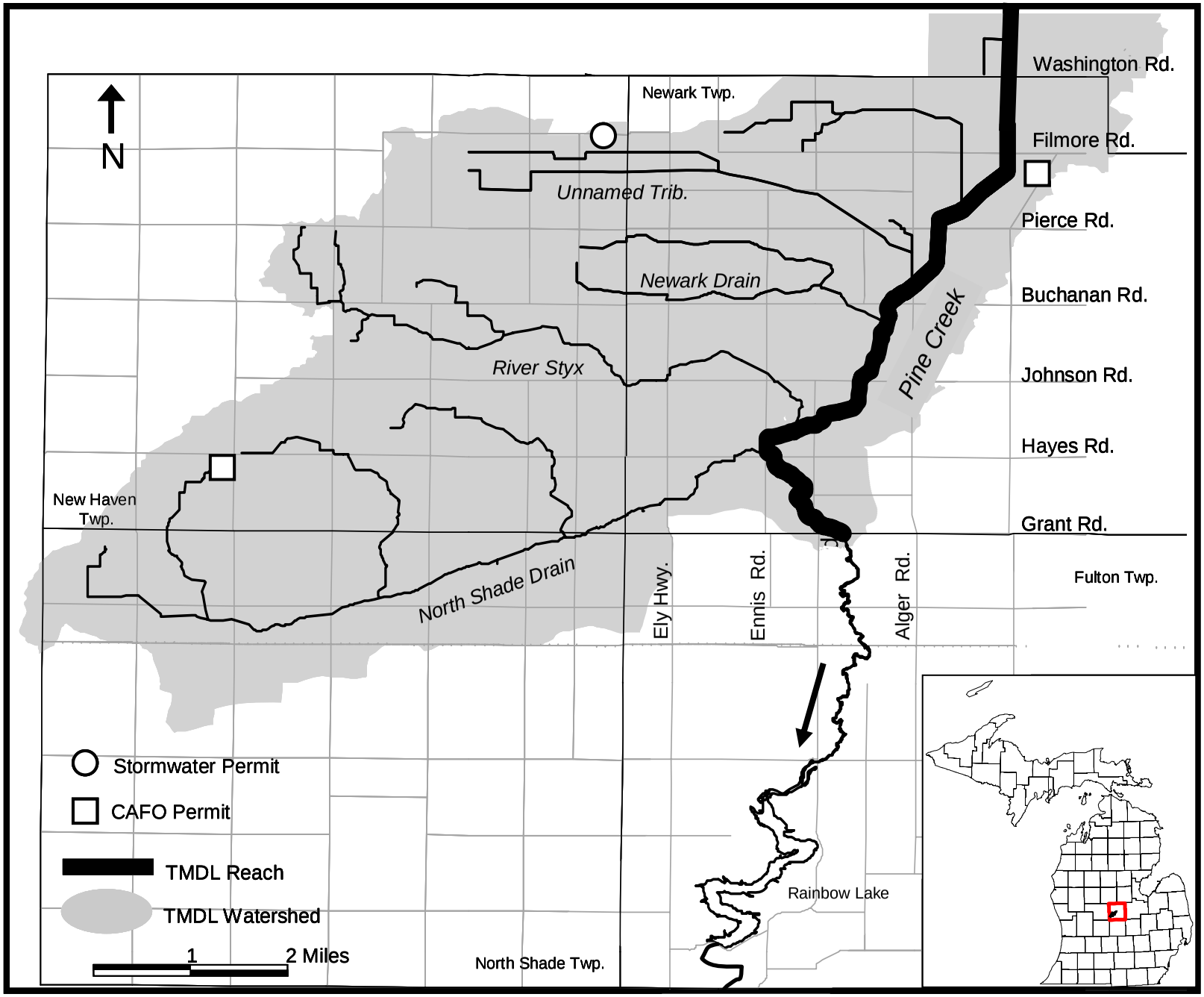


Figure 1. Pine Creek total phosphorus TMDL area, Gratiot County, MI.

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.

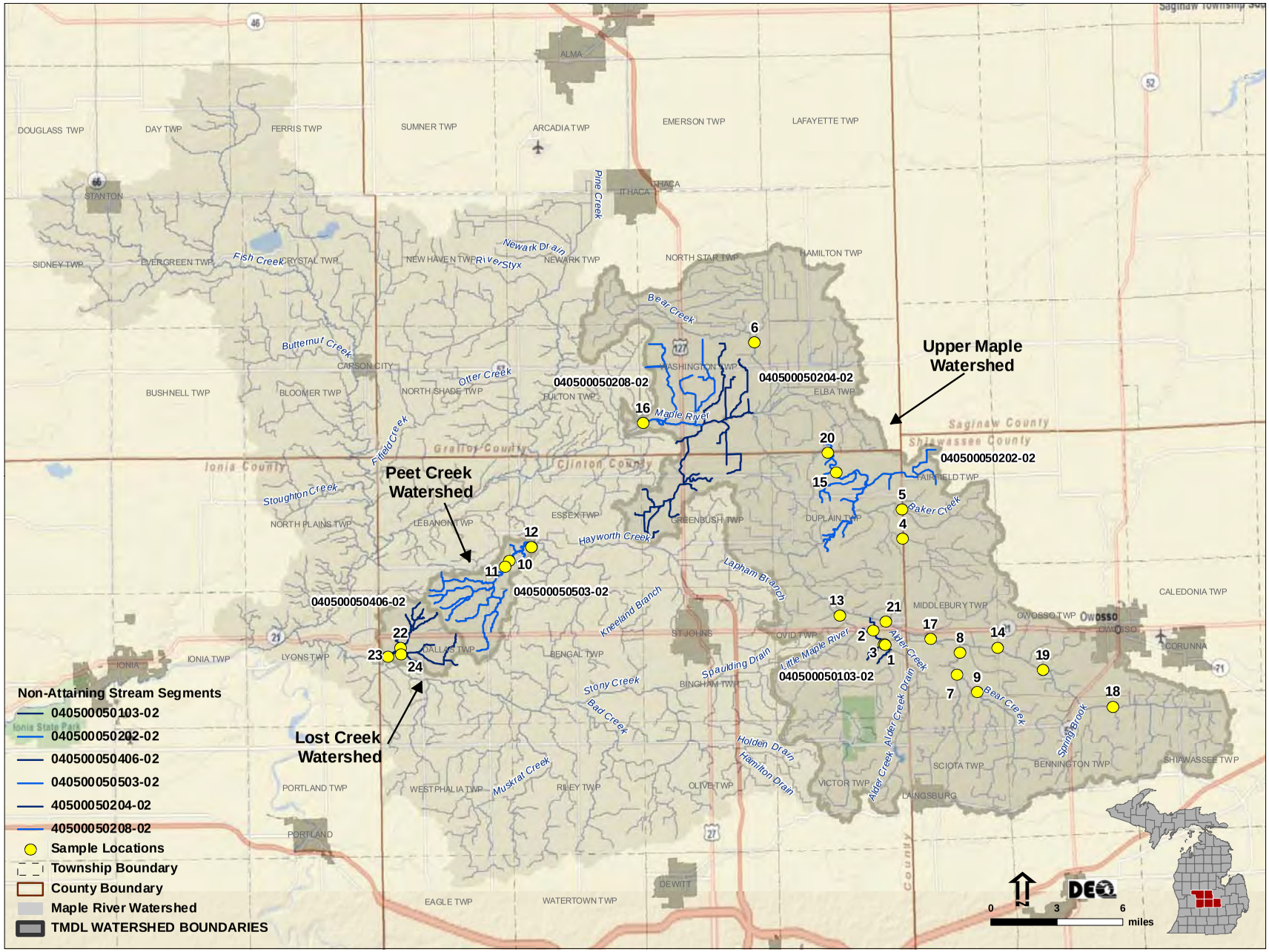


Figure 1. Maple River watershed, upper Maple River, Peet Creek, and Lost Creek TMDL watersheds, and water chemistry sample locations.

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.

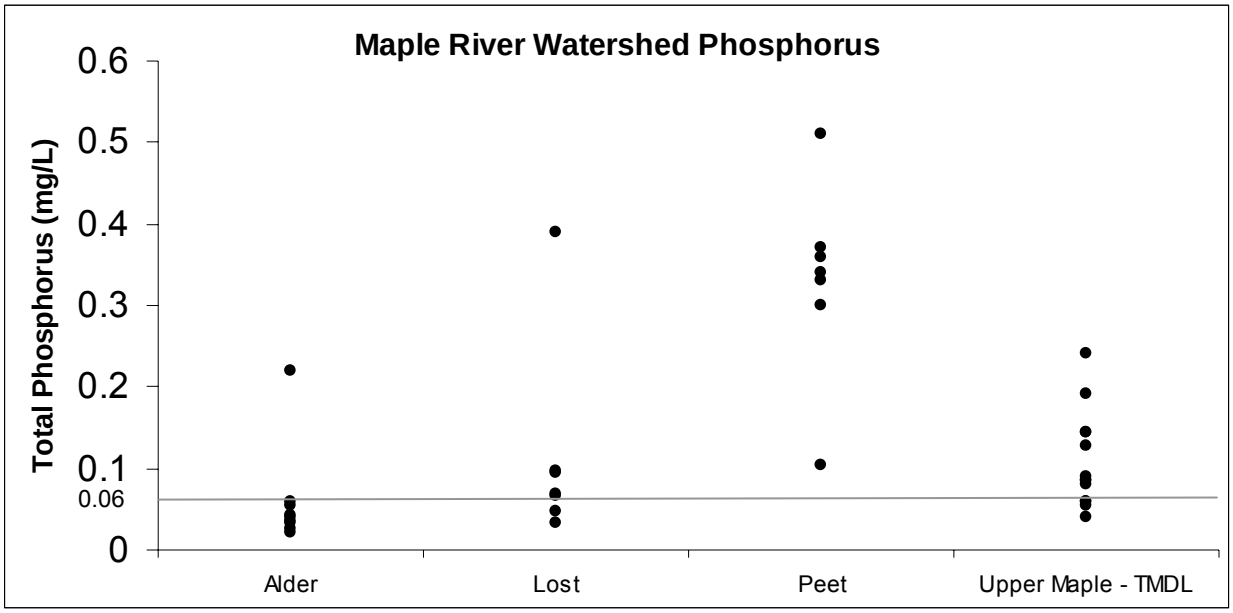


Figure 2. Phosphorus data from the Maple River watershed from 1975-2007. Impaired subwatersheds with phosphorus data from impaired river segments include Alder Creek, Lost Creek, Peet Creek, and upper Maple River-TMDL. The horizontal line at 0.06 mg/L is the phosphorus concentration goal for the TMDL.

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).

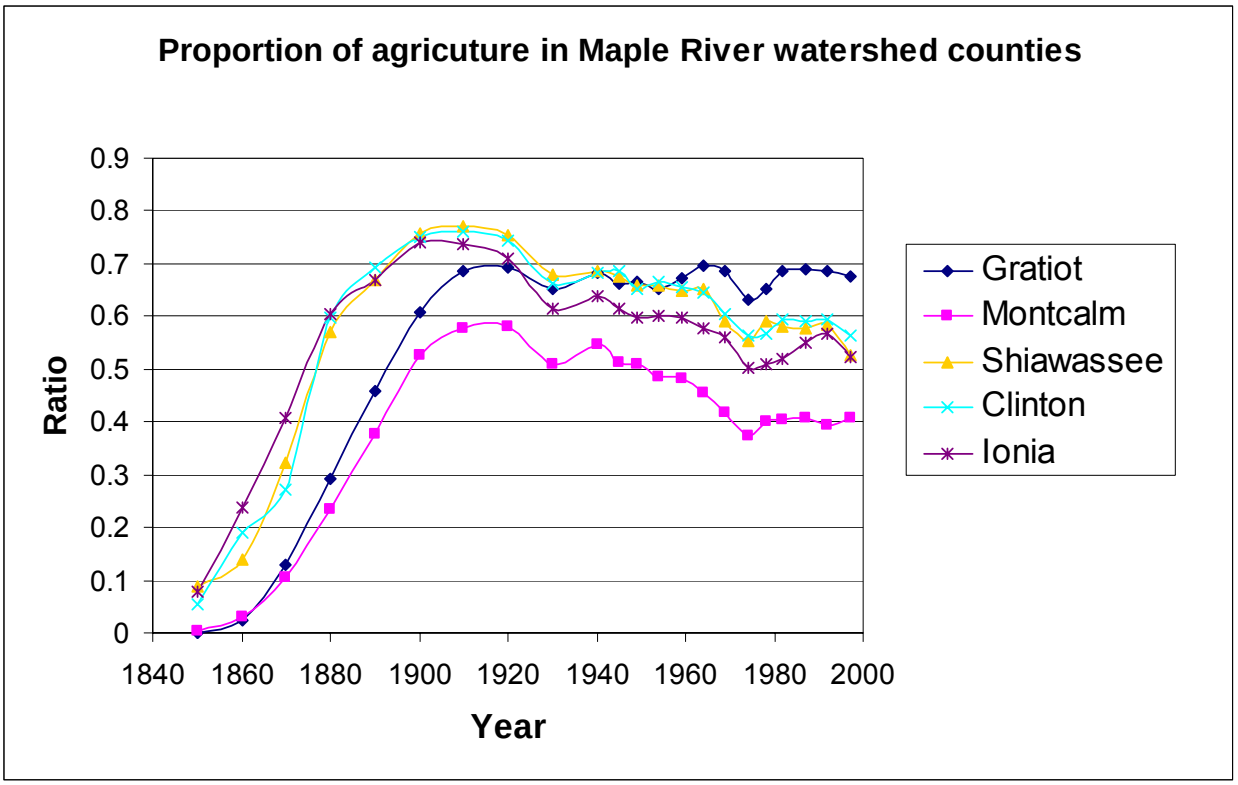


Figure 3. Ratio of improved farmland or cropland to total county area. Source: USGS data: http://landcover.usgs.gov/cropland/

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

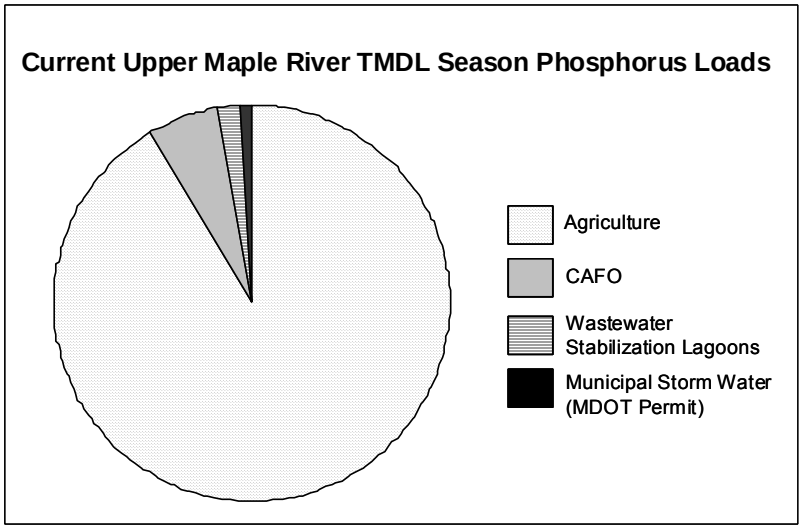
The LA component of the TMDL defines the fraction of the LC originating from nonpoint sources and from groundwater permits. Estimates of all land use-related loads of total phosphorus to the Maple River TMDL reaches were estimated using the Long-Term Hydrologic Impact Assessment (L-THIA) Web-based software 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 50th 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.

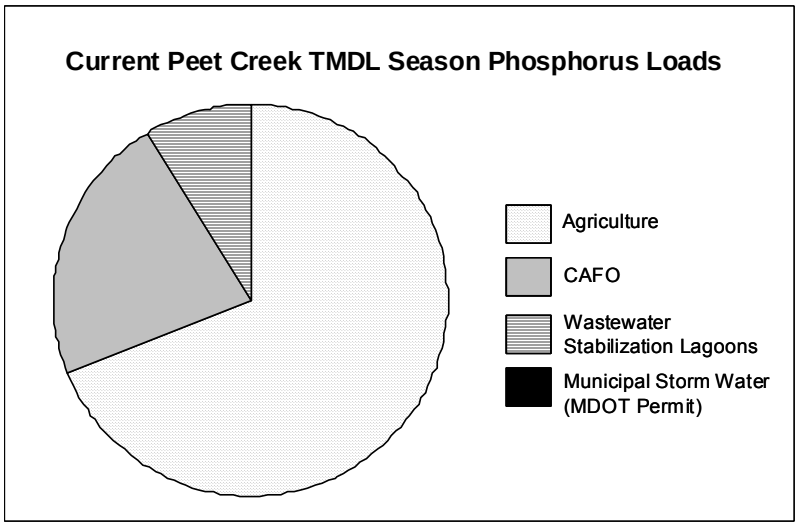
To calculate the LA, no reductions from the forest, grass/pasture, and water/wetland land uses are proposed because the expected concentrations of phosphorus are less than the 0.06 mg/L phosphorus target for the watershed. A 50% reduction in the TMDL season load is expected from residential and commercial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

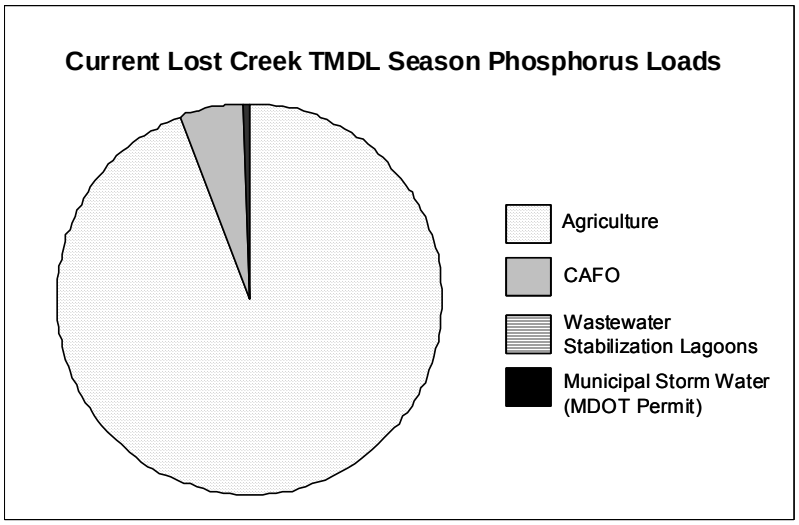


Figure 4. Current sources of phosphorus in the (A) upper Maple River, (B) Peet Creek, and (C) Lost Creek watersheds including both the LA and WLA. The total phosphorus loads (including L-THIA and permitted loads) are 10,597, 1,632, and 604 pounds of phosphorus per TMDL season (June 1-October 15).

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

Upper Maple River Watershed Management Plan

June 2010
MDNRE Tracking Code #2007-0118

Clinton Conservation District

Friends of the Maple River

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Appendix 10

P51 Report - Biological Assessment

Upper Maple River
Biological and Aquatic Habitat Assessments

Assessment of the physical habitat and biological community of the Upper Maple River and its tributaries was completed to characterize the quality of the watercourses and to provide information necessary for making recommendations for improvements. In addition to collecting physical and biological data, previous studies performed by state agencies and others were reviewed and their findings evaluated.

Physical habitat and biological community were rated at fifteen sites. The assessment was conducted over several days in September and October 2008 using protocols set forth in the Great Lakes Environmental Assessment Section, Procedure No. 51 (P51) (MDEQ 1997 and MDEQ 2002). P51 is a rapid assessment technique that is used by the Michigan Department of Environmental Quality to rate streams based upon their physical habitat and aquatic community.

Sites were selected based upon review of existing MDEQ data and results of volunteer stream crossing surveys. An effort was made to fill data gaps that had been left by previous studies, as well as to duplicate effort in at least one site to validate sampling results.

Relative to physical habitat, P51 considers such factors as the amount of woody debris and rock that organisms can hide amongst, the stability of the stream banks, the amount of vegetation growing along the stream margins, and the degree of impact to adjacent lands. These "metrics" are scored on an individual basis and then compiled, resulting in a final score of up to 200 points. Sites scoring less than 56 are considered to be "poor", those scoring between 56 and 104 are "marginal", between 105 and 154 points is "good", and sites scoring over 154 are "excellent".

The abundance and diversity of aquatic macroinvertebrates are commonly used as indicators of the overall quality of a stream. As such, assessment of the biological communities within the watershed was completed to characterize the quality of each watercourse, and to provide information necessary for making recommendations for improvements.

Dip nets with 1 mm mesh were used to sample aquatic macroinvertebrates. Sampling was conducted in an upstream direction and each station was sampled until no new taxa were found (approximately 20 minutes for each station). All available habitats were sampled, including fast and slow moving water areas, hard and soft substrates, vegetated areas, woody material and undercut banks. Kick sampling was used in most areas, except in slower moving water, where dip-netting methods were used. Large stones and logs were sampled by hand picking. All organisms collected were identified, counted, and recorded.

For macroinvertebrates, P51 uses a set of nine metrics to score the community based upon comparison to an excellent site within the same ecoregion. The P51 Microsoft

Excel spreadsheet was used to calculate the following nine (9) metrics for each station, to provide a qualitative rating of the macroinvertebrate community (taxa is plural for taxon, which refers to a taxonomic category, such as family, genus or species):

- Total number of taxa
- Total number of mayfly taxa
- Total number of caddisfly taxa
- Total number of stonefly taxa
- Percent mayfly composition
- Percent caddisfly composition
- Percent contribution of dominant taxon
- Percent isopods, snails, and leeches
- Percent surface dependant

The process results in a score based upon on a scale of -9 to 9; -9 to -5 is rated as poor, -4 to 4 is rated as acceptable, and anything greater than 4 is rated as excellent. Generally speaking, flowing waters which harbor a high diversity of macroinvertebrates, specifically different types of mayfly, caddisfly and stonefly, are of higher water quality than those waters that have few taxa. Water bodies with low diversity often have very high numbers of individuals due to their ability to thrive in degraded water with little competition or predation.

Macroinvertebrate and Aquatic Habitat Assessments
2008 Assessment

Station 1; Pine Creek @ Grant Road
Physical habitat at this station received a score of 64/200 with an adjective rating of marginal (moderately impaired), tending toward poor (Table 1). This is the lowest habitat score of all 15 stations sampled as part of this study. All habitat metrics scored quite low; streambanks were eroding, the bed had significant accumulations of fine sediment and the riparian area was heavily impacted by grazing.

The macroinvertebrate community was rated at the low end of acceptable, with a score of -4 (Table 1). Fourteen taxa were collected including two families of caddisfly. The sample was dominated by hydropsychidae, a relatively tolerant family of caddisfly. No mayflies or stoneflies were found at this site.

Station 2; Bradley Drain @ State Road
Station 2 rated good with a score of 111/200. While the riparian corridor is relatively natural and quality epifaunal substrate exists within the stream, the flow appears to be very flashy as evidenced by unstable banks and debris lines. A landowner reported that the water often has a smell of manure and is often off color, possibly due to a pig farm upstream.

The macroinvertebrate community rated poor, scoring -8, the lowest of all stations sampled. Fifteen taxa were collected, but the sample was dominated by isopods and other tolerant organisms. One family of caddisfly (Phryganeidae) was found, but no mayflies or stoneflies were captured.

Station 3; Peet Creek @ Kinley Road
Physical habitat was rated as marginal (moderately impaired), with a score of 69/200. The "creek" consists of a straight agricultural drain that contains a small low-flow channel. Substrate is poor and woody debris is absent; however, overhanging grasses do provide instream cover during the growing season. The riparian area on the right side of the drain is fallow and the left side contains a relatively wide buffer between the drain and an active corn field.

The macroinvertebrate community scored -4, with an adjective rating of acceptable, but tending toward poor. Seventeen taxa were collected, but included mostly pollution tolerant organisms. The relative distribution of families is quite diverse, but the sample was dominated by surface breathing insects, indicating a potential dissolved oxygen impairment.

Station 4; Cox Drain @ Wacousta Road
Overall, this is one of the highest scoring stations sampled. Physical habitat was rated as good (slightly impaired) with a score of 127/200, while the macroinvertebrate community scored 0 (acceptable).

The Cox Drain has a diversity of instream substrates, including coarse bed material, woody debris and overhanging trees, shrubs and grasses. With exception of a small livestock access area, the streambanks are stable and riparian vegetation is quite dense.

The macroinvertebrates found at the site represented 23 taxa and included two families of mayfly and three families of caddisfly. The dominant taxa represented only 17% of the sample, indicating equal distribution among families. However, the station does have a fairly high percentage of isopods, snails and leaches.

Station 5; Baker Creek @ Ovid Road – north crossing
Physical habitat scored 100/200, with an adjective rating of marginal (moderately impaired). The riparian areas are vegetated with shrubs, trees and grasses, but evidence of flashy flow exists and banks are moderately eroded. Epifaunal substrate is present, but sedimentation also exists. A CAFO is located on the south side of the channel.

The macroinvertebrate community found at this station scored -4, which is acceptable but tending toward poor. Only 70 organisms were collected despite intensive effort; however, these 70 organisms represented twenty different taxa. One family of mayfly (Baetidae) and three families of caddisfly were collected. The sample contained relatively large numbers of snails and damselflies.

Station 6; Baker Creek @ Ovid Road – south crossing
This station is quite similar to Station 5 in terms of physical habitat, with a score of 95/200 and an adjective rating of marginal, tending toward good. Banks are less stable and the channel is slightly more modified. The same CAFO exists adjacent the north side of this channel.

The macroinvertebrate community scored much higher (1) than Station 5, but has the same adjective rating of acceptable and the same number of taxa (20). This is the tied for the highest scoring macroinvertebrate community of all stations sampled. Three families of mayfly and one family of caddisfly were found, and mayflies were the dominant family in the sample, representing nearly 29% of all organisms. All families of mayflies and caddisflies collected at this station are, however, relatively tolerant of degraded conditions.

Station 7; Stonebrook Drain @ Rich Road
Physical habitat at this station rated marginal, tending toward good, with a score of 104/200. The riparian area is quite heavily impacted by adjacent land use. Sedimentation is impairing the instream habitat.

The macroinvertebrate community scored -3 with an adjective rating of acceptable, but tending toward poor. Only nine taxa and 88 individuals were collected despite intensive effort. The sample was heavily dominated by chironomids and amphipods. Two taxa of caddisfly were found, but no mayflies or stoneflies were collected.

Station 8; North Shade Drain @ Pingree Road
The North Shade Drain is a heavily modified agricultural drain. It is straight and farmed nearly to the top of bank on both sides. The station is rated as marginal (moderately impaired) with a score of 91/200. Epifaunal substrate and instream cover is obviously lacking, with exception of seasonal overhanging grasses. The drain banks are quite stable and vegetated with herbaceous vegetation and a few shrubs and trees.

The macroinvertebrate community of the North Shade Drain scored -7, with a rating of poor. Eighteen taxa were collected, but no mayflies, no stoneflies and only one individual caddisfly were collected. The sample was heavily dominated by surface air breathers and snails.

Station 9; Ferdon Creek @ Wilson Road
This station received the second lowest habitat rating (65) of all stations and rated as marginal, tending toward poor. All metrics were rated low, with the exception of bank stability, which is high.

As anticipated, the station received a poor macroinvertebrate score (-5). Nineteen taxa were collected but only included four individual mayflies. Stoneflies and caddisflies were absent from the sample. Over 65% of the sample consisted of surface air breathers and snails.

Station 10; Halterman Creek @ Wilson Road
The habitat of Halterman Creek received the minimum score (105/200) for a good rating, but all metrics were rated very low except for bank stability, vegetative cover and the condition of the riparian area on the right side. The banks are very well vegetated with grasses, shrubs and trees, but sedimentation is heavy and instream habitat is virtually non-existent.

Even though 27 taxa were collected and the numbers of individuals were very high, the macroinvertebrate community was rated as poor (-6). The sample contained high numbers of surface breathers, snails and clams, with Corixids being the most dominant taxa. Two individual caddisflies (Hydropsychidae) and two individual mayflies (Baetidae) were collected.

Station 11; Walker Drain @ Essex Center Road
While the physical habitat at this station was rated as marginal (78/200), instream habitat is poor; heavy sediment covers the bottom and few attachment sites exist for macroinvertebrates. However, the banks are stable and well vegetated.

The macroinvertebrate community scored (-7) for a rating of poor. Seventeen taxa were collected, but the sample included no caddisflies, mayflies or stoneflies. Clams and isopods made up over half of the sample.

Station 12; TRIB @ Hollister Road
This tributary offers exceptional habitat (168/200) for a stream of its size. While being only 4-5 feet wide and having a relatively narrow riparian buffer, instream habitat is diverse and includes coarse substrate, woody debris and overhanging vegetation. Current is swift and riffles and pools are present. Streambanks are stable and well vegetated.

Twenty-seven taxa were collected in this stream and included two families of both caddisflies and mayflies. The station scored -1 with an adjective rating of acceptable. The sample was dominated by Hydropsychid caddisflies. Percent mayfly composition was low and the number of surface dependant organisms was relatively high.

Station 13; TRIB @ Bennington Road
Station 13 has the highest quality habitat found within the Upper Maple River watershed during this assessment, with a score of 181/200. The only limiting factor appears to be the relatively small size of the stream, which averages approximately six feet in width.

The macroinvertebrate community tied for the highest score (1) of all stations sampled. Twenty-one taxa were found, including three families of caddisfly and three families of mayfly; similar to every other station, no stoneflies were collected. The mayfly family Leptophlebiidae is relatively intolerant of degraded water quality. Numbers of individual organisms were relatively even, which is representative of a diverse, healthy population. The percentage of surface dependant organisms, while receiving a negative score, is lower than at most other sampling stations.

Station 14; South Fork Hayworth Creek @ Lowell Road
The South Fork of Hayworth Creek has good, tending toward marginal, habitat at this location, with a score of 108/200. The riparian area is narrow and both the banks and bed of the stream appear to be eroding. A low-flow channel meanders through the bottom of the originally dredged channel. Substrate is course and undercut banks are prevalent. Steep slope through the reach has scoured pools and keeps the bed relatively free of excess sediment.

The macroinvertebrate community was rated as poor (-7), with the majority of organisms being surface breathers. No mayflies or stoneflies were collected. Only one individual caddisfly was found at this station.

Station 15; Baker Creek @ Vincent Road
This channel is significantly different on the upstream and downstream sides of this crossing. Upstream, the physical habitat scored 100/200 (marginal), while downstream it scored 146/200 (good). The upstream station was characterized by stagnant flow and accumulation of sediment and detritus. The banks were stable and well vegetated with relatively wide riparian area. Downstream, the riparian area is vegetated with grasses and a few shrubs and trees. Though historically dredged, a low flow meandering channel has developed in the bottom. Substrate is coarse, woody debris and overhanging vegetation is present and banks are undercut.

Despite the differences in habitat quality, the macroinvertebrate scores were the same (-6; poor) at both locations. No caddisflies, mayflies or stoneflies were found, and the samples were heavily dominated by amphipods.

Summary

Overall, the physical habitat of the Upper Maple River and its tributaries is marginal due to human impacts throughout the watershed. Agricultural land use has led to a dense network of drainage and sediment and nutrients are obvious pollutants on many of these drains. Evidence of "flashiness" was found in the majority of tributaries; however, erosion of the streambanks is not severe. It appears as though the physical attributes of the watershed and of the agricultural ditches prevent excessive water velocity. Water levels rise and fall within the ditches with little downstream velocity.

While macroinvertebrate communities were found to be acceptable at several stations, they are generally toward the low end of that rating and seem to be tending toward poor. Mayflies and caddisflies were collected at many stations, but overall, the families represented by the largest number of individuals are considered to be relatively tolerant of degraded water quality (Hilsenhoff 1988). Families of macroinvertebrate considered to be sensitive were rare throughout the watershed. Further, despite extensive sampling, stoneflies were not found at any of the sampling stations; generally, stoneflies are found in the highest quality waters.

Many of the lower scoring metrics in the P51 assessment could be improved through the implementation of habitat improvement projects, but there does not appear to be a direct correlation between the quality of physical habitat and the macroinvertebrate community. High scoring habitat values did not necessarily correspond to high macroinvertebrate scores. It appears that water quality and other confounding factors are limiting the potential for aquatic organisms to thrive.

Past Assessments

In addition to the assessments of fifteen stations conducted for inclusion in the watershed management plan, several past studies have documented results of fish, macroinvertebrate and habitat sampling on the Upper Maple River and its tributaries. These studies were completed by the Michigan Departments of Natural Resources (MDNR) and Environmental Quality (MDEQ).

MDEQ, Surface Water Quality Division, 2002. A Biological Assessment of the Maple River and Selected Tributaries. Shiawassee, Clinton, Gratiot, Montcalm and Ionia Counties, Michigan. June and July 1997.

Maple River – The macroinvertebrate community was rated as poor at Morrice Road, but acceptable at Ruess, Baldwin and Warren Roads. There was a lot of variability among the "acceptable" scores, and this variability was thought to be related to channel modifications. At Shepardsville Road, the macroinvertebrate community was rated as excellent, with a score of 7. The community was diverse, and approximately half the sample consisted of mayflies, caddisflies and stoneflies. Possible nutrient enrichment was reported at Shepardsville Road.

Bear Creek (Shiawassee County) – The physical habitat rated as good at this station, and the macroinvertebrate community was found to be acceptable, tending toward excellent. Caddisflies, mayflies and stoneflies were all collected.

Alder Creek – The macroinvertebrate community rated excellent, which was said to be similar to findings from a 1969 study. Bank instability and nutrient enrichment were reported as potential impairments.

Baker Creek – The macroinvertebrate community rated acceptable, but tending toward poor, and physical habitat was rated as good.

Bear Creek (Gratiot County) – Nearly the entire drainage area of Bear Creek had been modified and the physical habitat was rated as fair. The channel was straight, incised and lacked stable substrate. Unstable flows were noted as causing bank instability. Despite the impairments, the macroinvertebrate community rated acceptable, tending toward excellent.

Pine Creek – The macroinvertebrate community at this station rated acceptable, but tending toward poor. Physical habitat was impaired due to dredging and removal of streamside cover. Excessive plant growth was observed.

River Styx – Physical habitat and the macroinvertebrate community were impaired at this station. The macroinvertebrate community rated as poor and no intolerant taxa were collected.

Hayworth Creek – The macroinvertebrate community was rated as acceptable and the habitat rated as good. Caddisflies, mayflies and stoneflies were all found at this station. High quality substrate was reported, despite unstable bed and banks caused by flashy flow.

South Fork Hayworth Creek – High percentages of surface dependent and other tolerant taxa of organisms were found at this station, leading to a poor rating. Habitat was found to be fair, with sediment and nutrients mentioned as pollutants. A fish kill was reported to have happened in 1992 near this station.

Peet Creek – Peet Creek rated acceptable, tending toward poor, for macroinvertebrates and fair for physical habitat. Sedimentation and excess growth of algae were impairing the site.

MDEQ, Water Division, 2003. A Biological Survey of the Maple River Watershed and Selected Tributaries. Shiawassee, Clinton, Gratiot, Montcalm and Ionia Counties, Michigan. August 2002.

Maple River – Two stretches of the Maple River mainstream were identified as having elevated levels of nutrients and high levels of weed growth which impairs designated uses; between Shepardsville and Maple Rapids Roads and between State and Blair Roads. The remainder of the Maple River was meeting all designated uses. Macroinvertebrate communities were found to be acceptable to excellent at all stations sampled.

Total phosphorus levels increased substantially between South County Line and State Roads, as did the levels of total suspended solids. Dredging of Bear Creek was listed as a potential cause of this increase.

Bear Creek (Shiawassee County) – All water quality parameters were found to be below the average and below the range of values identified at reference reaches in the same ecoregion.

Alder Creek – While total phosphorus levels were excessive and extensive growths of plants and algae had been observed at this site in the past, the fish community rated acceptable and the macroinvertebrate community rated excellent.

Little Maple River – The Little Maple River was found to be acceptable.

Hayworth Creek – An illicit connection discharging untreated sanitary waste was discovered during the survey as a result of a complaint from a local property owner. The information was passed on the Mid-Michigan District Health Department. Water chemistry results indicated that the ammonia and total phosphorus levels were excessive near this discharge and for a considerable distance downstream.

Peet Creek – Peet Creek was found to contain nuisance growths of algae, which supports its inclusion on the list of waterbodies that does attain designated uses.

Cox Drain – Both the fish and macroinvertebrate communities were found to be acceptable and nutrient concentrations were found to be below average. The drain was attaining all of the designated uses based upon survey results.

Bear Creek (Gratiot County) – Recent dredging activities were observed and identified as a possible cause of excessive nutrient levels in the Maple River.

MDEQ, Water Bureau, 2008. Biological and Water Chemistry Surveys of Selected Stations in the Maple River Watershed, Shiawassee, Clinton, Gratiot, Montcalm and Ionia Counties, Michigan. June to September 2007.

The DEQ surveyed the physical habitat and macroinvertebrate community at several sites within the Upper Maple River watershed. In addition, water chemistry was sample at 11 of these sites. Results of these surveys are provided in Figure 13 and summarized below:

Maple River Headwaters at Vandekarr, M-52 and Baldwin Roads – Physical habitat rated as marginal at all three sites with the primary impairment being sedimentation. The macroinvertebrate community scored -1 (acceptable) at Vandekarr, -5 (poor) at M-52, and 3 (acceptable) at Baldwin.

Alder Creek at M-21 – The riffle/run habitat at this station rated excellent (156/200) and the macroinvertebrate community scored 8 (excellent).

Baker Creek at Maple River Road – Physical habitat rated as marginal (100) and the macroinvertebrate community rated as acceptable (-4), but tending toward poor. Historic dredging was mentioned as the likely cause of macroinvertebrate community impairment.

Maple River at Maple River, Shepardsville, Wilson and McClelland Roads – Overall, the mid-section of the Maple River has few physical modifications and better physical habitat than the headwaters. The physical habitat scored good at all stations, except for McClelland Road, which rated as marginal. Macroinvertebrate communities were found to be acceptable at all four stations, with Shepardsville and McClelland Roads tending toward excellent.

Bear Creek at Baldwin and Crapo Roads – Three stations were sampled on Bear Creek; one at Baldwin Road and two on Crapo Road. Physical habitat was marginal at all three stations due, in large part, to channel modification and flashy flows. Despite the degraded habitat, the macroinvertebrate communities were rated as acceptable at all three stations.

Halterman Creek at Wilson Road – Physical habitat was marginal at this stationed and impaired by sediment, lack of pools and lack of epifaunal substrate. The macroinvertebrate community rated as acceptable (-4), but tending toward poor.

Pine Creek and Tributaries (North Shade Drain, River Styx and Otter Creek) – Pine Creek was sampled at Johnson and Garfield Roads, while each tributary had one sampling station. Physical habitat rated as good and macroinvertebrate communities rated as acceptable on both Pine Creek stations. Nuisance plant growth was observed at Johnson Road. On the North Shade Drain, physical habitat was rated as marginal (80/200) and the macroinvertebrate community rated acceptable (-2). River Styx also had marginal habitat (67/200), but a poor (-6) macroinvertebrate community. This stream had recently been channelized and the lack of habitat was obvious. Vegetation and algae were widespread, indicating a high nutrient supply. Otter Creek had marginal habitat and an acceptable (0) macroinvertebrate community. Compared to all other Pine Creek tributaries sampled during this study, Otter Creek had a wider diversity and higher density of mayflies and caddisflies.

Hayworth Creek and Tributaries (South Fork Hayworth Creek and Peet Creek) –
Hayworth Creek had marginal habitat at Airport Road, but good habitat at Wacousta Road. At Airport Road, the channel had been dredged straight and stable habitat was lacking. The macroinvertebrate community rated acceptable at both Airport Road (-3) and Wacousta Road (4). The sample at Wacousta Road was of relatively high quality, tending toward excellent, and stoneflies were collected in the sample.

Physical habitat on the South Fork of Hayworth Creek was rated as marginal at Kinley Road. The majority of the stream bottom was affected by sediment deposition. The macroinvertebrate community rated as acceptable (-3), tending toward poor. The sample was dominated by isopods and snails.

Peet Creek was sample at Wacousta Road and had marginal (88) habitat and excessive growth of algae. The stream was reported to have smelled like sewage or animal waste. The macroinvertebrate community scored -2 (acceptable) and was dominated by flatworms and midges.

Fisheries Literature Review

The MDNR conducted fish sampling in 1989 and 2006 to complete a general survey of the fish community. Rotenone was used for fish collection in 1989, while a boom shocker was utilized for electrofishing in 2006. A total of 55 species were documented during these surveys (Table 2). The species collected are typical of a warmwater fish community.

Summary of Existing Data

Results of 1997 sampling are largely unchanged in comparison to the 2007 sampling results. The Maple River headwaters for example, which have been dredged, were reported as being either threatened or impaired in all studies, while the middle portion of the river near Shepardsville Road rated higher for both habitat and macroinvertebrates. Sediment, nutrients and habitat loss through channel modification were mentioned as the primary impairments in all previous studies.

Table 1. Procedure 51 Scores for Macroinvertebrates and Physical Habitat, Upper Maple River Watershed, 2008.

STATION	LOCATION	COUNTY	MACROINVERTEBRATES	HABITAT
1	Pine Creek @ Grant	Gratiot	-4	64
2	Bradley Drain @ State	Gratiot	-8	111
3	Peet Creek @ Kinley	Clinton	-4	69
4	Cox Drain @ Wacousta	Clinton	0	127
5	Baker Ck @ Ovid (north)	Clinton	-4	100
6	Baker Ck @ Ovid (south)	Clinton	1	95
7	Stonebrook Drain @ Rich	Gratiot	-3	104
8	N. Shade Drain @ Pingree	Gratiot	-7	91
9	Ferdon Ck @ Wilson	Gratiot	-5	65
10	Halterman Ck @ Wilson	Gratiot	-6	105
11	Walker Drain @ Essex Center	Clinton	-7	78
12	trib @ Hollister Rd	Clinton	-1	168
13	trib @ Bennington Rd	Shiawassee	1	181
14	S. Fork Hayworth @ Lowell Rd	Clinton	-7	108
15	Baker Creek u/s Vincent Rd	Shiawassee	-6	100

Poor = -9 to -5	Marginal = 56-104
Acceptable = -4 to 4	Good = 105-154
Excellent = 5 to 9	Excellent >154

Table 2. Cumulative list of fish species found in the Maple River during 1989 and 2006 MDNR surveys.

Common Name	Scientific Name
black bullhead	*Ictalarus melas*
black crappie	*Pomoxis nigromaculatus*
blacknose dace	*Rhinichthys atratulus*
blackside darter	*Percina maculata*
bluegill	*Lepomis macrochirus*
bluntnose minnow	*Pimephales notatus*
bowfin	*Amia calva*
brassy minnow	*Hybognathus hankinosoni*
brook stickleback	*Culaea inconstans*
burbot	*Lota lota*
central mudminnow	*Umbra limi*
central stoneroller	*Campostoma anomalum*
channel catfish	*Ictalarus punctatus*
chestnut lamprey	*Ichthyomyzon castaneus*
common carp	*Cyprinus carpio*
common shiner	*Luxilus cornutus*
creek chub	*Semotilus atromaculatus*

Common Name	Scientific Name
emerald shiner	*Notropis atherinoides*
flathead catfish	*Pylodictis olivaris*
gizzard shad	*Dorosoma cepedianum*
golden redhorse	*Moxostoma erythrurum*
golden shiner	*Notemigonus crysoleucas*
goldfish	*Carassius auratus*
grass pickerel	*Esox americanus vermiculatus*
greater redhorse	*Moxostoma valenciennesi*
green sunfish	*Lepomis cyanellus*
hornyhead chub	*Nocomis biguttatus*
johnny darter	*Etheostoma nigrum*
largemouth bass	*Micropterus salmoides*
log perch	*Percina caprodes*
longnose gar	*Lepisosteus osseus*
norther pike	*Esox lucius*
northern hog sucker	*Hypentelium nigricans*
pirate perch	*Aphredoderus sayanus*
pumpkinseed	*Lepomis gibbosus*
quillback	*Carpiodes cyprinus*
rainbow darter	*Etheostoma caeruleum*
redfin shiner	*Notropis umbratilis*
rock bass	*Ambloplites rupestris*
rosyface shiner	*Notropis rubellus*
sand shiner	*Notropis stramineus*
shorthead redhorse	*Moxostoma macrolepidotum*
silver lamprey	*Ichthyomyzon unicuspis*
silver redhorse	*Moxostoma anisurum*
smallmouth bass	*Micropterus dolomieu*
spotfin shiner	*Cyprinella spilopterus*
spotted sucker	*Minytrema melanops*
stonecat	*Noturus flavus*
striped shiner	*Notropis chrysocephalus*
tadpole madtom	*Noturus gyrinus*
walleye	*Stizostedium vitreum*
warmouth	*Lepomis gulosus*
white crappie	*Pomoxis annularis*
white sucker	*Catostomus commersoni*
yellow bullhead	*Ameiurus natalis*

P 51 HABITAT RATINGS (Scores for Physical Habitat, Upper Maple River Watershed, 2008)

	Pine Creek		Bradley Drain		Peet Creek		Cox Drain		Baker Creek
HABITAT METRIC									
Substrate and Instream Cover									
Epifaunal Substrate/ Avail Cover	4		12		7		13		10
Embeddedness*							12		10
Velocity/Depth Regime*							11		11
Pool Substrate Characterization**	7		9		7				
Pool Variability**	6		10		2				
Channel Morphology									
Sediment Deposition	3		12		2		11		7
Flow Status - Maint. Flow Volume	4		7		6		8		6
Flow Status - Flashiness	5		2		5		6		3
Channel Alteration	11		14		6		12		11
Frequency of Riffles/Bends*							8		11
Channel Sinuosity**	2		9		2				
Riparian and Bank Structure									
Bank Stability (L)	3		6		8		7		6
Bank Stability (R)	3		6		8		7		6
Vegetative Protection (L)	4		8		6		8		6
Vegetative Protection (R)	4		8		6		8		6
Riparian Veg. Zone Width (L)	4		3		2		8		3
Riparian Veg. Zone Width (R)	4		5		2		8		4
TOTAL SCORE (200):	64		111		69		127		100
HABITAT RATING:	MARGINAL		GOOD		MARGINAL		GOOD		MARGINAL
	(MODERATELY		(SLIGHTLY		(MODERATELY		(SLIGHTLY		(MODERATELY
	IMPAIRED)		IMPAIRED)		IMPAIRED)		IMPAIRED)		IMPAIRED)

	Baker Creek/south		Stonebrook Drain		North Shade Drain		Ferdon Creek		Halterman Creek
HABITAT METRIC									
Substrate and Instream Cover									
Epifaunal Substrate/ Avail Cover	11		12		8		3		6
Embeddedness*			13						
Velocity/Depth Regime*			6						
Pool Substrate Characterization**	7				11		7		7
Pool Variability**	7				4		5		6
Channel Morphology									
Sediment Deposition	7		6		13		2		10
Flow Status - Maint. Flow Volume	8		7		9		8		7
Flow Status - Flashiness	5		6		5		5		6
Channel Alteration	11		7		6		3		10
Frequency of Riffles/Bends*			8						
Channel Sinuosity**	3				2		4		4
Riparian and Bank Structure									
Bank Stability (L)	6		8		8		5		9
Bank Stability (R)	6		7		8		5		9
Vegetative Protection (L)	6		7		7		8		9
Vegetative Protection (R)	6		7		7		8		9
Riparian Veg. Zone Width (L)	6		5		1		1		4
Riparian Veg. Zone Width (R)	6		5		2		1		9
TOTAL SCORE (200):	95		104		91		65		105
HABITAT RATING:	MARGINAL		MARGINAL		MARGINAL		MARGINAL		GOOD
	(MODERATELY		(MODERATELY		(MODERATELY		(MODERATELY		(SLIGHTLY
	IMPAIRED)		IMPAIRED)		IMPAIRED)		IMPAIRED)		IMPAIRED)

	Walker Drain		Trib @ Hollister Road		Trib @ Bennington		S. Fork Hayworth		Baker @ Vincent
HABITAT METRIC									
Substrate and Instream Cover									
Epifaunal Substrate/ Avail Cover	2		18		18		14		5
Embeddedness*			16				14		
Velocity/Depth Regime*			14				14		
Pool Substrate Characterization**	9				17				7
Pool Variability**	3				16				5
Channel Morphology									
Sediment Deposition	8		18		18		10		3
Flow Status - Maint. Flow Volume	9		10		10		9		8
Flow Status - Flashiness	6		10		9		2		4
Channel Alteration	6		14		18		8		14
Frequency of Riffles/Bends*			16				11		
Channel Sinuosity**	1				15				2
Riparian and Bank Structure									
Bank Stability (L)	8		10		10		4		9
Bank Stability (R)	8		10		10		4		9
Vegetative Protection (L)	7		10		10		7		8
Vegetative Protection (R)	7		10		10		7		8
Riparian Veg. Zone Width (L)	2		7		10		2		9
Riparian Veg. Zone Width (R)	2		5		10		2		9
TOTAL SCORE (200):	78		168		181		108		100
HABITAT RATING:	MARGINAL		EXCELLENT		EXCELLENT		GOOD		MARGINAL
	(MODERATELY		(NON-		(NON-		(SLIGHTLY		(MODERATELY
	IMPAIRED)		IMPAIRED)		IMPAIRED)		IMPAIRED)		IMPAIRED)

P51 MACROINVERTEBRATE COLLECTION (Upper Maple River Watershed, 2008)

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PLATYHELMINTHES (flatworms)														7	
Turbellaria	4		18	2	2	2		5			2				
ANNELIDA (segmented worms)															
Hirudinea (leeches)		6	1	2	2			13		2	2		1	3	3
Oligochaeta (worms)	1				1			4	1	2	10			4	4
ARTHROPODA															
Crustacea															
Amphipoda (scuds)		15	2	9	2	2	18		1	44		12	29		46
Decapoda (crayfish)		1		2		1			3	8	1	5	6		
Isopoda (sowbugs)	6	67	1	3	2			1	11	20	30	9		44	6
Insecta															
Ephemeroptera (mayflies)															
Baetidae			8	7		19			3	2		1	1		
Caenidae					1	6			1						
Ephemeridae						6									
Heptageniidae				4								2	12		
Leptophlebiidae													7		
Odonata															
Anisoptera (dragonflies)															
Aeshnidae		1	4			3		3	1	5		7	8	1	
Libellulidae		1	8					11			2		1		4
Zygoptera (damselflies)															
Calopterygidae	11			13	14	17			21			6	22		
Coenagrionidae		2	3					22	2	2	2	4		1	1

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hemiptera (true bugs)															
Belostomatidae				1		2		4	1	1	5	1	4	1	2
Corixidae	24	8	14	3	2			38	32	95	8	16	19	43	1
Gerridae	3		3	2	4	1	1		1	2	1	9			2
Nepidae	1									2	1	2	4	3	7
Notonectidae		4	1	1	1			7	4		2	3		1	1
Pleidae										2					
Veliidae										7		2			1
Megaloptera	1														
Sialidae (alder flies)				6				1	1	2					
Trichoptera (caddisflies)															
Hydropsychidae	39			7	9	15	5			2		73	21		
Leptoceridae	1			1	1										
Limnephilidae				6	1		1						5		
Phryganeidae		3						1				1	2		
Coleoptera (beetles)															
Curculionidae (adults)										1					
Dytiscidae (total)		3						11		4		2		4	17
Gyrinidae (adults)												2		2	1
Haliplidae (adults)	1	12	25			2	1	20	24	33	10	24		18	17
Hydraenidae			5												
Hydrophilidae (total)						1			1	8	4	6	2	6	
Elmidae	2			4	1	2		1		1		1	2	2	
Noteridae	1														
Lampyridae								4							
Psephenidae				1			1								

SITE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Diptera (flies)															
Ceratopogonidae															2
Chironomidae	23	2	4	18	12	9	53	9	4	5	7	7	3	7	2
Culicidae			3		2	1							3		
Empididae										1		1			
Simuliidae				4	2	3						2			
Tabanidae		1		3	2	1							1	1	
Tipulidae										1		2			
MOLLUSCA															
Gastropoda (snails)															
Physidae	8	1	2	6	9	1	7	5	10	36	14	1		5	2
Planorbidae	1			1		7	1								
Viviparidae										4					
Pelecypoda (bivalves)															
Sphaeriidae (clams)					2	7		2	3	50	39	6	1	13	20
Unionidae			4												
TOTAL INDIVIDUALS	127	127	106	106	72	108	88	162	125	342	140	207	154	166	139

Upper Maple River
Watershed Management Plan

June 2010
MDNRE Tracking Code #2007-0118

Appendix 11

Field Data Sheet Templates and Inventory Results

ID	Longitude	Latitude	Bank_Heigh	Bank_Full_	Length__Fe	Bank_Angle	Root_Depth	Root_Densi	Surface_Pr	Stratifica	Bank_Mater	Accessibil	Erosion Rate	load (tons)	BEHI
P16	-84.700243	43.149573	18	4	180	80	18	15	15	0	0	Medium	0.32	52.4	32.0
P14	-84.701969	43.149186	20	3	70	90	3	2	2	0	4	Medium	0.55	38.5	49.0
P9	-84.703962	43.147912	25	3	50	75	0	0	5	0	0	Easy	0.50	31.5	45.5
P17	-84.698613	43.150120	14	4	120	90	14	10	30	0	0	Difficult	0.33	27.7	32.5
P6	-84.708716	43.146151	5	3	200	90	4	15	20	5	5	Easy	0.48	24.2	44.0
P3	-84.707326	43.146929	15	4	60	70	2	5	5	3	0	Easy	0.52	23.3	46.5
P1	-84.705341	43.146910	5	3	200	120	3	40	30	4	3	Easy	0.38	18.8	36.0
P2	-84.706289	43.146889	7	3	100	80	4	5	10	5	5	Easy	0.53	18.6	47.5
P28	-84.673137	43.201599	6	4	200	90	6	25	20	0	0	Medium	0.26	15.8	27.5
P26	-84.673300	43.203719	6	4	150	90	4	10	20	0	0	Easy	0.34	15.2	33.0
P12	-84.702648	43.148934	7	3	110	90	4	5	20	0	0	Medium	0.38	14.8	36.5
P5	-84.707752	43.146289	12	4	50	80	5	10	10	0	3	Easy	0.46	13.9	42.5
P25	-84.674184	43.204420	7	5	150	90	7	10	40	0	0	Easy	0.26	13.5	27.0
P7	-84.705052	43.147387	6	3	150	60	6	15	40	5	0	Easy	0.30	13.4	30.0
P8	-84.704142	43.147762	8	4	70	70	3	5	5	0	5	Easy	0.47	13.2	43.0
P18	-84.696562	43.150206	4	4	400	90	4	20	80	0	0	Difficult	0.14	11.5	18.5
P20	-84.695836	43.150810	6	4	200	80	6	30	55	0	0	Medium	0.19	11.4	22.0
P10	-84.703759	43.148149	6	3	110	90	5	20	65	0	0	Easy	0.28	9.1	28.5
P15	-84.701917	43.149507	5	3	120	80	3	10	40	0	0	Medium	0.30	8.9	30.0
P24	-84.694550	43.152706	4	3	140	90	4	20	55	0	0	Easy	0.22	6.3	24.5
P11	-84.703604	43.148732	7	3	50	50	5	5	5	0	0	Easy	0.35	6.1	34.0
P4	-84.707498	43.146717	4	3	80	120	4	10	10	0	0	Easy	0.35	5.6	34.0
P19	-84.695500	43.150296	3	3	170	90	3	10	45	0	0	Medium	0.21	5.4	23.5
P21	-84.695122	43.151407	3	3	150	90	3	15	40	0	0	Medium	0.19	4.3	22.0
P27	-84.673652	43.202910	4	4	200	100	4	70	70	0	0	Medium	0.10	4.1	15.5
P13	-84.702495	43.149008	4	3	40	90	3	20	20	0	0	Medium	0.31	2.5	31.0
P23	-84.694518	43.152538	4	3	40	90	3	10	50	0	0	Easy	0.28	2.3	29.0
P22	-84.694851	43.152388	4	3	55	90	4	45	70	0	0	Easy	0.18	1.9	21.0
F1	-84.494335	43.124426	4	4	100	90	3	15	25	0	0	Easy	0.25	5.1	26.5
F2	-84.494735	43.125273	5	4	130	90	5	25	50	0	0	Easy	0.23	7.4	24.5
F3	-84.494303	43.125691	4	4	60	50	4	15	85	0	0	Easy	0.10	1.2	15.0
F4	-84.494670	43.125921	4	4	80	90	0	0	10	0	0	Easy	0.43	6.9	40.0
F5	-84.494412	43.126293	5	4	100	90	5	20	80	0	0	Easy	0.20	5.0	22.5
F6	-84.493284	43.124139	5	4	60	75	5	20	60	0	0	Easy	0.19	2.8	21.5
F7	-84.492845	43.124007	5	4	90	75	5	25	60	0	0	Easy	0.18	4.1	21.0
F8	-84.492842	43.123698	4	4	40	80	4	10	40	0	0	Easy	0.19	1.5	21.5
F9	-84.492174	43.123397	4	4	40	90	4	50	20	0	0	Easy	0.17	1.2	20.5
F10	-84.491769	43.123217	5	4	100	90	5	60	90	0	0	Easy	0.14	3.5	18.0
F11	-84.491812	43.122997	5	4	50	100	5	50	85	0	0	Easy	0.16	1.8	19.5
F12	-84.491370	43.122746	4	4	60	80	4	50	70	0	0	Easy	0.11	1.3	15.5
F13	-84.491112	43.122485	4	4	80	70	4	30	75	0	0	Easy	0.1	1.7	15.5
F14	-84.490939	43.122281	4	4	50	90	4	40	80	0	0	Easy	0.1	1.1	16.0
F15	-84.490695	43.122124	6	4	80	45	6	20	50	0	0	Easy	0.17	4.2	20.5
F16	Gratiot to Dean		7	4	6450	90	7	30	40	0	0	Easy	0.25	571.9	26.5
F17	127 to Maple Rapids		6	4	6075	80	6	50	80	0	0	Easy	0.15	267.3	18.5
F18	Dean past Wilson		5	4	4800	45	5	35	70	0	0	Easy	0.12	144.0	16.5
F19	-84.552427	43.129950	5	4	200	90	1	2	2	0	0	Easy	0.45	22.7	41.5
C1	Roosevelt to Taft	grassy banks	5	3	3900	90	5	20	50	5	0	easy	0.32	312.0	31.5
C2	Roosevelt to Taft	woodland	4	3	3400	75	4	30	55	3	0	easy	0.21	140.5	23.0
C3	Roosevelt to Taft	wooded corridor	6	4	6100	80	6	40	60	5	0	Medium	0.25	451.4	26.0
C4	-84.619410	43.170356	4	3	100	45	3	25	80	0	0	easy	0.17	3.5	20.5
C5	-84.620544	43.170370	8	3	60	80	6	15	40	5	0	easy	0.38	9.1	36.0
C6	-84.644556	43.146863	5	4	1066	90	4	50	60	0	0	easy	0.21	55.1	23.0
C7	-84.651529	43.146908	6	5	1466	80	5	25	65	0	0	easy	0.21	93.8	23.5
H1	-84.720057	43.048773	5	3	30	60	2	15	25	0	0	Easy	0.31	2.4	31.0
H2	-84.720249	43.048525	5	4	14	45	5	15	50	0	0	Easy	0.21	0.7	23.0
H3	-84.719490	43.049448	6	4	45	60	1	15	60	0	0	Easy	0.31	4.1	30.5
H4	-84.701056	43.059491	4	3	22	120	4	20	80	2	0	Easy	0.25	1.0	26.5
H5	-84.701668	43.059801	5	4	70	90	1	15	20	0	0	Easy	0.40	7.0	37.5

ID	Longitude	Latitude	Bank_Heigh	Bank_Full_	Length__Fe	Bank_Angle	Root_Depth	Root_Densi	Surface_Pr	Stratifica	Bank_Mater	Accessibil	Erosion Rate	load (tons)	BEHI
H6	-84.702477	43.061444	5	4	80	45	5	10	15	0	0	Easy	0.27	5.3	27.5
H7	-84.702713	43.062046	4	4	160	45	4	10	30	0	0	Easy	0.16	5.1	19.5
H8	-84.703100	43.061852	5	4	65	60	5	10	50	1	0	Easy	0.21	3.1	23.5
H9	-84.703277	43.062001	5	4	80	85	5	20	50	0	0	Easy	0.22	4.4	24.0
H10	-84.703681	43.061918	4	4	45	45	3	10	10	0	0	Medium	0.25	2.3	26.5
H11	-84.703887	43.061547	5	4	150	90	5	10	25	0	0	Medium	0.28	10.5	28.5
H12	-84.706459	43.061194	4	4	50	90	4	40	60	0	0	Medium	0.15	1.5	18.5
H13	-84.706667	43.061071	6	6	20	45	2	10	10	0	0	Medium	0.30	1.8	30.0
H14	-84.706511	43.060602	3	3	50	95	3	10	0	0	0	Medium	0.31	2.4	31.0
H15	-84.705467	43.060322	40	4	80	75	3	10	15	0	0	Medium	0.33	52.3	32.0
H16	-84.706227	43.059335	3	3	50	50	3	15	65	0	0	Medium	0.10	0.8	15.0
H17	-84.706523	43.059567	5	4	30	60	5	15	50	0	0	Medium	0.19	1.5	22.0
H18	-84.706660	43.059205	4	4	50	90	4	15	65	0	0	Medium	0.18	1.8	21.0
H19	-84.707313	43.059401	4	4	30	120	4	15	20	0	0	Medium	0.26	1.6	27.0
H20	-84.708651	43.059295	4	3	50	90	4	15	30	0	0	Medium	0.22	1.9	24.0
H21	-84.708853	43.059301	4	3	45	75	4	15	50	0	0	Medium	0.18	1.4	21.0
H22	-84.709355	43.058924	4	4	45	90	4	40	75	0	0	Medium	0.12	0.9	16.5
H23	-84.708213	43.058287	3	3	200	90	3	25	70	0	0	Medium	0.15	3.7	18.5
H24	-84.706964	43.057828	35	3	50	45	25	10	10	0	0	Medium	0.31	27.4	31.0
H25	-84.707129	43.056812	4	4	40	90	4	15	60	0	0	Medium	0.17	1.4	20.5
H26	-84.707364	43.056790	4	4	200	85	4	15	50	0	0	Medium	0.21	8.5	23.5
H27	-84.699369	43.059645	6	5	15	50	6	35	35	0	0	Easy	0.16	0.7	19.5
H28	-84.699119	43.059882	15	4	30	70	15	35	45	0	0	Easy	0.24	5.4	25.5
H29	-84.697316	43.060827	10	4	160	75	4	50	75	0	0	Easy	0.27	21.9	28.0
H30	-84.697135	43.061080	5	4	50	85	2	15	25	0	0	Easy	0.33	4.2	32.5
H31	-84.697083	43.062757	6	5	200	75	6	50	65	0	0	Easy	0.13	8.0	17.5
H32	-84.697037	43.063152	8	5	100	45	8	35	45	0	0	Easy	0.19	7.5	21.5
H33	-84.718910	43.050617	6	5	130	90	6	45	50	0	0	Easy	0.20	7.8	22.5
H34	-84.717836	43.050563	4	4	90	75	1	10	15	0	0	Easy	0.31	5.5	30.5
H35	-84.717277	43.050271	12	4	250	75	7	20	20	0	0	Easy	0.36	54.0	34.5
H36	-84.717021	43.050641	4	4	100	90	4	10	15	0	0	Easy	0.24	4.8	25.5
H37	-84.716780	43.050887	15	4	15	75	0	0	5	0	0	Easy	0.50	5.6	45.0
H38	-84.676445	43.046698	5	4	50	90	5	20	70	0	0	Easy	0.2	2.6	23.0
H39	-84.676161	43.047119	5	4	150	90	5	10	20	0	0	Easy	0.3	10.5	28.5
H40	-84.676039	43.047425	7	4	50	85	3	10	10	0	0	Easy	0.4	7.2	38.5
H41	-84.675918	43.047678	5	4	75	90	5	40	85	0	0	Easy	0.2	3.0	19.5
H42	-84.676186	43.048646	7	5	150	50	7	15	60	0	0	Easy	0.2	9.1	20.5
N1	-84.731043	43.205046	8	4	40	45	8	30	85	0	0	easy	-0.1	-1.6	
N2	-84.730673	43.204648	8	4	30	45	8	30	85	0	0	easy	-0.1	-1.2	
N3	-84.731383	43.205784	8	4	20	45	8	30	85	0	0	easy	-0.1	-0.8	
SF1	-84.635906	43.046498	10	4	200	75	4	15	20	0	0	Easy	0.36	36.0	34.5
SF2	-84.637857	43.047496	8	4	80	85	4	15	15	0	0	Easy	0.35	11.1	33.5
SF3	-84.639578	43.047182	8	4	150	85	4	15	30	0	0	Easy	0.35	20.8	33.5
SF4	-84.635584	43.045651	10	5	60	80	4	15	20	0	0	Easy	0.36	10.8	34.5
SF5	-84.635452	43.045471	10	5	70	60	5	15	20	0	0	Easy	0.32	11.2	31.5
SF6	-84.635043	43.044598	6	5	60	80	5	15	20	0	0	Easy	0.29	5.2	29.0
SF7	-84.635029	43.043076	8	5	100	45	5	15	35	0	0	Easy	0.25	10.1	26.5
SF8	-84.636974	43.040368	10	5	100	75	5	15	25	0	0	Easy	0.35	17.7	34.0
SF9	-84.638503	43.038661	10	5	150	85	5	15	35	0	0	Easy	0.35	26.0	33.5
SF10	-84.638977	43.036430	8	5	60	75	5	15	30	0	0	Easy	0.30	7.2	30.0
SF11	-84.634821	43.043958	7	5	100	45	5	15	40	0	0	Easy	0.25	8.6	26.0
SF12	-84.661389	42.992487	9	3	45	80	1	5	10	0	0	Easy	0.48	9.7	43.5
SF13	-84.661179	43.045813	7	4	60	45	3	15	50	0	0	Easy	0.3	6.0	29.0
SF14	-84.661817	43.045927	8	4	80	45	3	15	60	0	0	Easy	0.3	9.0	28.5
SF15	-84.662163	43.046073	7	4	80	45	3	15	50	0	0	Easy	0.29	8.0	29.0

Stream: Reach: Cross Section:

Observers: Date:

BEHI Score (Fig. V-15)

Bank Height / Max Depth Bankfull (C)

Study Bank Height (ft) =	(A)	***Bankfull*** Height (ft) =	(B)	(A) / (B) =	(C)	

Root Depth / Bank Height (E)

Root Depth (ft) =	(D)	***Study Bank*** Height (ft) =	(A)	(D) / (A) =	(E)	

Weighted Root Density (G)

Root Density as **%** =	(F)	(F) x (E) =	(G)	

Bank Angle (H)

Bank **Angle** as *Degrees* =	(H)	

Surface Protection (I)

Surface **Protection** as **%** =	(I)	

Bank Material Adjustment:

Bedrock (Overall Very Low BEHI)

Boulders (Overall Low BEHI)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending percentage of bank material that is composed of sand)

Sand (Add 10 points) **Silt Clay** (no adjustment)

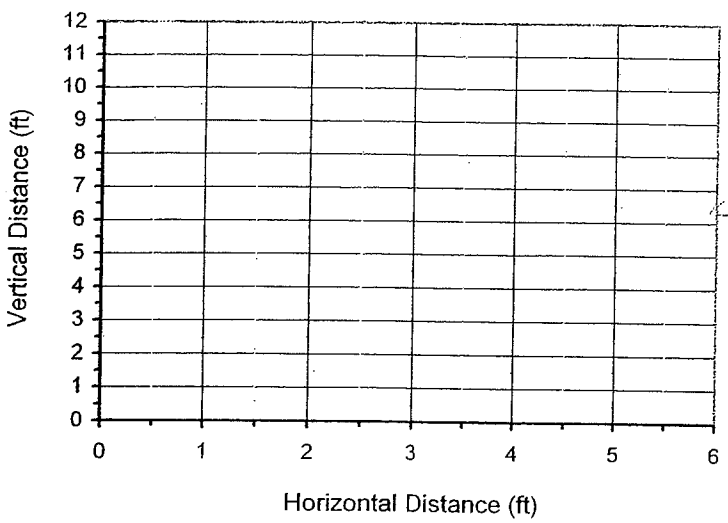
Bank Materials Adjustment

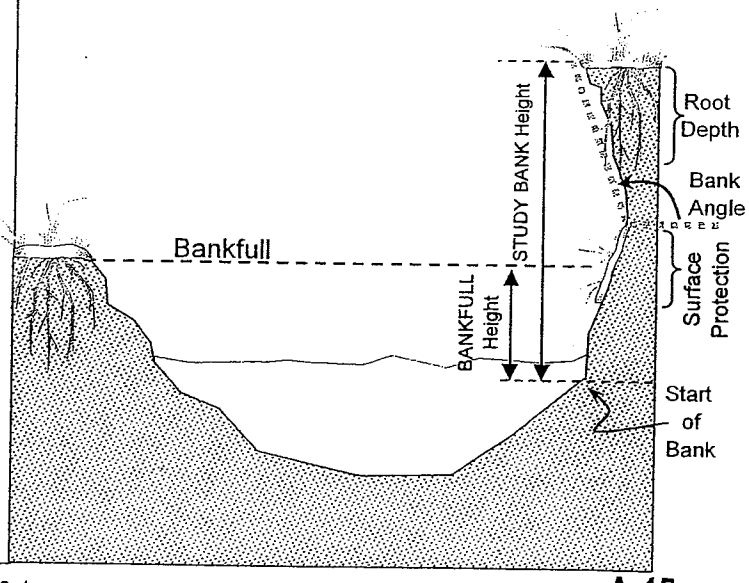
Stratification Adjustment

Add 5-10 points, depending on position of unstable layers in relation to bankfull stage

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME	*ADJECTIVE RATING* and **TOTAL SCORE**
5 - 9.5	10 - 19.5	20 - 29.5	30 - 39.5	40 - 45	46 - 50	

Bank Sketch





Upper Maple River
BEHI Survey Results

ID	Longitude	Latitude	Bank_Heigh	Bank_Full_	Length__Fe	Bank_Angle	Root_Depth	Root_Densi	Surface_Pr	Stratifica	Bank_Mater	Accessibil	Erosion Rate	load (tons)	BEHI	BEHI Rating
SF9	-84.638503	43.038661	10	5	150	85	5	15	35	0	0	Easy	0.35	26.0	33.5	High
SF8	-84.636974	43.040368	10	5	100	75	5	15	25	0	0	Easy	0.35	17.7	34.0	High
SF7	-84.635029	43.043076	8	5	100	45	5	15	35	0	0	Easy	0.25	10.1	26.5	Moderate
SF6	-84.635043	43.044598	6	5	60	80	5	15	20	0	0	Easy	0.29	5.2	29.0	Moderate
SF5	-84.635452	43.045471	10	5	70	60	5	15	20	0	0	Easy	0.32	11.2	31.5	High
SF4	-84.635584	43.045651	10	5	60	80	4	15	20	0	0	Easy	0.36	10.8	34.5	High
SF3	-84.639578	43.047182	8	4	150	85	4	15	30	0	0	Easy	0.35	20.8	33.5	High
SF2	-84.637857	43.047496	8	4	80	85	4	15	15	0	0	Easy	0.35	11.1	33.5	High
SF15	-84.662163	43.046073	7	4	80	45	3	15	50	0	0	Easy	0.29	8.0	29.0	Moderate
SF14	-84.661817	43.045927	8	4	80	45	3	15	60	0	0	Easy	0.3	9.0	28.5	Moderate
SF13	-84.661179	43.045813	7	4	60	45	3	15	50	0	0	Easy	0.3	6.0	29.0	Moderate
SF12	-84.661389	42.992487	9	3	45	80	1	5	10	0	0	Easy	0.48	9.7	43.5	Very High
SF11	-84.634821	43.043958	7	5	100	45	5	15	40	0	0	Easy	0.25	8.6	26.0	Moderate
SF10	-84.638977	43.036430	8	5	60	75	5	15	30	0	0	Easy	0.30	7.2	30.0	High
SF1	-84.635906	43.046498	10	4	200	75	4	15	20	0	0	Easy	0.36	36.0	34.5	High
P9	-84.703962	43.147912	25	3	50	75	0	0	5	0	0	Easy	0.50	31.5	45.5	Very High
P8	-84.704142	43.147762	8	4	70	70	3	5	5	0	5	Easy	0.47	13.2	43.0	Very High
P7	-84.705052	43.147387	6	3	150	60	6	15	40	5	0	Easy	0.30	13.4	30.0	High
P6	-84.708716	43.146151	5	3	200	90	4	15	20	5	5	Easy	0.48	24.2	44.0	Very High
P5	-84.707752	43.146289	12	4	50	80	5	10	10	0	3	Easy	0.46	13.9	42.5	Very High
P4	-84.707498	43.146717	4	3	80	120	4	10	10	0	0	Easy	0.35	5.6	34.0	High
P3	-84.707326	43.146929	15	4	60	70	2	5	5	3	0	Easy	0.52	23.3	46.5	Extreme
P28	-84.673137	43.201599	6	4	200	90	6	25	20	0	0	Medium	0.26	15.8	27.5	Moderate
P27	-84.673652	43.202910	4	4	200	100	4	70	70	0	0	Medium	0.10	4.1	15.5	Low
P26	-84.673300	43.203719	6	4	150	90	4	10	20	0	0	Easy	0.34	15.2	33.0	High
P25	-84.674184	43.204420	7	5	150	90	7	10	40	0	0	Easy	0.26	13.5	27.0	Moderate
P24	-84.694550	43.152706	4	3	140	90	4	20	55	0	0	Easy	0.22	6.3	24.5	Moderate
P23	-84.694518	43.152538	4	3	40	90	3	10	50	0	0	Easy	0.28	2.3	29.0	Moderate
P22	-84.694851	43.152388	4	3	55	90	4	45	70	0	0	Easy	0.18	1.9	21.0	Moderate
P21	-84.695122	43.151407	3	3	150	90	3	15	40	0	0	Medium	0.19	4.3	22.0	Moderate
P20	-84.695836	43.150810	6	4	200	80	6	30	55	0	0	Medium	0.19	11.4	22.0	Moderate
P2	-84.706289	43.146889	7	3	100	80	4	5	10	5	5	Easy	0.53	18.6	47.5	Extreme
P19	-84.695500	43.150296	3	3	170	90	3	10	45	0	0	Medium	0.21	5.4	23.5	Moderate
P18	-84.696562	43.150206	4	4	400	90	4	20	80	0	0	Difficult	0.14	11.5	18.5	Low
P17	-84.698613	43.150120	14	4	120	90	14	10	30	0	0	Difficult	0.33	27.7	32.5	High
P16	-84.700243	43.149573	18	4	180	80	18	15	15	0	0	Medium	0.32	52.4	32.0	High
P15	-84.701917	43.149507	5	3	120	80	3	10	40	0	0	Medium	0.30	8.9	30.0	High
P14	-84.701969	43.149186	20	3	70	90	3	2	2	0	4	Medium	0.55	38.5	49.0	Extreme
P13	-84.702495	43.149008	4	3	40	90	3	20	20	0	0	Medium	0.31	2.5	31.0	High
P12	-84.702648	43.148934	7	3	110	90	4	5	20	0	0	Medium	0.38	14.8	36.5	High
P11	-84.703604	43.148732	7	3	50	50	5	5	5	0	0	Easy	0.35	6.1	34.0	High
P10	-84.703759	43.148149	6	3	110	90	5	20	65	0	0	Easy	0.28	9.1	28.5	Moderate
P1	-84.705341	43.146910	5	3	200	120	3	40	30	4	3	Easy	0.38	18.8	36.0	High
N3	-84.731383	43.205784	8	4	20	45	8	30	85	0	0	easy	0.15	1.2	19	Low
N2	-84.730673	43.204648	8	4	30	45	8	30	85	0	0	easy	0.14	1.7	18	Low
N1	-84.731043	43.205046	8	4	40	45	8	30	85	0	0	easy	0.15	2.5	19	Low
H9	-84.703277	43.062001	5	4	80	85	5	20	50	0	0	Easy	0.22	4.4	24.0	Moderate
H8	-84.703100	43.061852	5	4	65	60	5	10	50	1	0	Easy	0.21	3.1	23.5	Moderate
H7	-84.702713	43.062046	4	4	160	45	4	10	30	0	0	Easy	0.16	5.1	19.5	Low
H6	-84.702477	43.061444	5	4	80	45	5	10	15	0	0	Easy	0.27	5.3	27.5	Moderate
H5	-84.701668	43.059801	5	4	70	90	1	15	20	0	0	Easy	0.40	7.0	37.5	High
H43	Maple River	d/s mouth of Peet Creek	7	6	3000	70	4	15	85	0	0	Easy	0.16	168.0	19.5	Low
H42	-84.676186	43.048646	7	5	150	50	7	15	60	0	0	Easy	0.2	9.1	20.5	Moderate
H41	-84.675918	43.047678	5	4	75	90	5	40	85	0	0	Easy	0.2	3.0	19.5	Low
H40	-84.676039	43.047425	7	4	50	85	3	10	10	0	0	Easy	0.4	7.2	38.5	High
H4	-84.701056	43.059491	4	3	22	120	4	20	80	2	0	Easy	0.25	1.0	26.5	Moderate
H39	-84.676161	43.047119	5	4	150	90	5	10	20	0	0	Easy	0.3	10.5	28.5	Moderate
H38	-84.676445	43.046698	5	4	50	90	5	20	70	0	0	Easy	0.2	2.6	23.0	Moderate
H37	-84.716780	43.050887	15	4	15	75	0	0	5	0	0	Easy	0.50	5.6	45.0	Very High
H36	-84.717021	43.050641	4	4	100	90	4	10	15	0	0	Easy	0.24	4.8	25.5	Moderate
H35	-84.717277	43.050271	12	4	250	75	7	20	20	0	0	Easy	0.36	54.0	34.5	High
H34	-84.717836	43.050563	4	4	90	75	1	10	15	0	0	Easy	0.31	5.5	30.5	High
H33	-84.718910	43.050617	6	5	130	90	6	45	50	0	0	Easy	0.20	7.8	22.5	Moderate
H32	-84.697037	43.063152	8	5	100	45	8	35	45	0	0	Easy	0.19	7.5	21.5	Moderate

Upper Maple River
BEHI Survey Results

ID	Longitude	Latitude	Bank_Heigh	Bank_Full_	Length__Fe	Bank_Angle	Root_Depth	Root_Densi	Surface_Pr	Stratifica	Bank_Mater	Accessibil	Erosion Rate	load (tons)	BEHI	BEHI Rating
H31	-84.697083	43.062757	6	5	200	75	6	50	65	0	0	Easy	0.13	8.0	17.5	Low
H30	-84.697135	43.061080	5	4	50	85	2	15	25	0	0	Easy	0.33	4.2	32.5	High
H3	-84.719490	43.049448	6	4	45	60	1	15	60	0	0	Easy	0.31	4.1	30.5	High
H29	-84.697316	43.060827	10	4	160	75	4	50	75	0	0	Easy	0.27	21.9	28.0	Moderate
H28	-84.699119	43.059882	15	4	30	70	15	35	45	0	0	Easy	0.24	5.4	25.5	Moderate
H27	-84.699369	43.059645	6	5	15	50	6	35	35	0	0	Easy	0.16	0.7	19.5	Low
H26	-84.707364	43.056790	4	4	200	85	4	15	50	0	0	Medium	0.21	8.5	23.5	Moderate
H25	-84.707129	43.056812	4	4	40	90	4	15	60	0	0	Medium	0.17	1.4	20.5	Moderate
H24	-84.706964	43.057828	35	3	50	45	25	10	10	0	0	Medium	0.31	27.4	31.0	High
H23	-84.708213	43.058287	3	3	200	90	3	25	70	0	0	Medium	0.15	3.7	18.5	Low
H22	-84.709355	43.058924	4	4	45	90	4	40	75	0	0	Medium	0.12	0.9	16.5	Low
H21	-84.708853	43.059301	4	3	45	75	4	15	50	0	0	Medium	0.18	1.4	21.0	Moderate
H20	-84.708651	43.059295	4	3	50	90	4	15	30	0	0	Medium	0.22	1.9	24.0	Moderate
H2	-84.720249	43.048525	5	4	14	45	5	15	50	0	0	Easy	0.21	0.7	23.0	Moderate
H19	-84.707313	43.059401	4	4	30	120	4	15	20	0	0	Medium	0.26	1.6	27.0	Moderate
H18	-84.706660	43.059205	4	4	50	90	4	15	65	0	0	Medium	0.18	1.8	21.0	Moderate
H17	-84.706523	43.059567	5	4	30	60	5	15	50	0	0	Medium	0.19	1.5	22.0	Moderate
H16	-84.706227	43.059335	3	3	50	50	3	15	65	0	0	Medium	0.10	0.8	15.0	Low
H15	-84.705467	43.060322	40	4	80	75	3	10	15	0	0	Medium	0.33	52.3	32.0	High
H14	-84.706511	43.060602	3	3	50	95	3	10	0	0	0	Medium	0.31	2.4	31.0	High
H13	-84.706667	43.061071	6	6	20	45	2	10	10	0	0	Medium	0.30	1.8	30.0	High
H12	-84.706459	43.061194	4	4	50	90	4	40	60	0	0	Medium	0.15	1.5	18.5	Low
H11	-84.703887	43.061547	5	4	150	90	5	10	25	0	0	Medium	0.28	10.5	28.5	Moderate
H10	-84.703681	43.061918	4	4	45	45	3	10	10	0	0	Medium	0.25	2.3	26.5	Moderate
H1	-84.720057	43.048773	5	3	30	60	2	15	25	0	0	Easy	0.31	2.4	31.0	High
F9	-84.492174	43.123397	4	4	40	90	4	50	20	0	0	Easy	0.17	1.2	20.5	Moderate
F8	-84.492842	43.123698	4	4	40	80	4	10	40	0	0	Easy	0.20	1.6	22.5	Moderate
F7	-84.492845	43.124007	5	4	90	75	5	25	60	0	0	Easy	0.18	4.1	21.0	Moderate
F6	-84.493284	43.124139	5	4	60	75	5	20	60	0	0	Easy	0.19	2.8	21.5	Moderate
F5	-84.494412	43.126293	5	4	100	90	5	20	80	0	0	Easy	0.20	5.0	22.5	Moderate
F4	-84.494670	43.125921	4	4	100	90	0	0	10	0	0	Easy	0.43	8.7	40.0	Very High
F3	-84.494303	43.125691	4	4	60	50	4	15	85	0	0	Easy	0.10	1.2	15.0	Low
F2	-84.494735	43.125273	5	4	200	90	5	25	50	0	0	Easy	0.23	11.3	24.5	Moderate
F19	-84.552427	43.129950	5	4	200	90	1	2	2	0	0	Easy	0.45	22.7	41.5	Very High
F18	Dean past Wilson		5	4	4800	45	5	35	70	0	0	Easy	0.16	192.0	19.5	Low
F17	127 to Maple Rapids		6	4	6100	80	6	50	80	0	0	Easy	0.16	292.8	19.5	Low
F16	Gratiot to Dean		7	4	6500	90	7	30	40	0	0	Easy	0.26	591.5	27.0	Moderate
F15	-84.490695	43.122124	6	4	80	45	6	20	50	0	0	Easy	0.17	4.2	20.5	Moderate
F14	-84.490939	43.122281	4	4	50	90	4	40	80	0	0	Easy	0.1	1.1	16.0	Low
F13	-84.491112	43.122485	4	4	80	70	4	30	75	0	0	Easy	0.1	1.7	15.5	Low
F12	-84.491370	43.122746	4	4	60	80	4	50	70	0	0	Easy	0.11	1.3	15.5	Low
F11	-84.491812	43.122997	5	4	50	100	5	50	85	0	0	Easy	0.16	1.8	19.5	Low
F10	-84.491769	43.123217	5	4	100	90	5	60	90	0	0	Easy	0.14	3.5	18.0	Low
F1	-84.494335	43.124426	4	4	100	90	3	15	25	0	0	Easy	0.25	5.1	26.5	Moderate
C7	-84.651529	43.146908	6	5	1466	80	5	25	65	0	0	easy	0.21	93.8	23.5	Moderate
C6	-84.644556	43.146863	5	4	1066	90	4	50	60	0	0	easy	0.21	55.1	23.0	Moderate
C5	-84.620544	43.170370	8	3	60	80	6	15	40	5	0	easy	0.38	9.1	36.0	High
C4	-84.619410	43.170356	4	3	100	45	3	25	80	0	0	easy	0.17	3.5	20.5	Moderate
C3	Roosevelt to Taft	wooded corridor	6	4	6100	80	6	40	60	5	0	Medium	0.25	451.4	26.0	Moderate
C2	Roosevelt to Taft	woodland	4	3	3400	75	4	30	55	3	0	easy	0.21	140.5	23.0	Moderate
C1	Roosevelt to Taft	grassy banks	5	3	3900	90	5	20	50	5	0	easy	0.32	312.0	31.5	High

Upper Maple River

Sub-watershed Prioritization

INTRODUCTION

In an effort to narrow the area of focus on a large watershed such as the Upper Maple, a systematic methodology was developed to prioritize sub-watersheds for further assessment.

Step 1. Compile and Map Existing Data
- GIS data sources included: Hydrology for the Upper Maple River and tributaries, SSURGO Soils, 1978 Land Use/Land Cover, 1992 Land Use/Land Cover, 1978 Aerial Photography, 2005 Aerial Photography, TMDL locations.
- The HIT tool combines the RUSLE and SEDMOD models, which incorporate land slope, land use, soil erodibility, rainfall, management practices, surface roughness, soil texture and proximity to streams.
- Michigan Department of Environmental Quality biological monitoring results from 2002 and 2007

Step 2. Review the Landscape History
- Using 1978 and 2001 LULC data and 1978 and 2006 aerial photography, an analysis of land use change was conducted. It was determined that very little change has occurred over the past few decades. Agricultural practices have dominated all areas that have been effectively drained. Much of the area not being farmed is wetland.

Step 3. Volunteer Stream Crossing Survey/Rapid Watershed Review
- An overview of the watershed was conducted by volunteers and survey results were digitized for inclusion in GIS

Step 4. Review and digitize MDEQ biological assessments for inclusion in GIS

Step 5. Conduct High-Impact Targeting Assessment and create GIS layer

Step 6. Summarize Activities that Potentially Affect Sediment Supply and Channel Stability
- An analysis of Steps 1-6 resulted in a list of considerations for the Upper Maple River watershed, including:
    - Livestock in the stream
    - Modified channels for agriculture
    - Significant population of livestock and abundance of CAFOs
    - Dense drainage network
    - Lack of stream buffers
    - Extensive and widespread agricultural land use including tiled fields and deep tillage practices
    - Limited, but locally significant streambank erosion

Step 7. Assess Hydrologic Processes
- Based upon analysis of land use data, field observation and historic personal accounts, the hydrology of the watershed has not changed significantly over the past several decades. Additionally, significant change is not expected in the near future.

Step 8. Identify Direct Impacts to Streambanks and Channels using GIS

- Nearly every channel within the watershed has been directly impacted to some extent. Most of the streams are maintained as agricultural drains. The main branch of the Maple is in a relatively natural state but direct impacts can be found, especially in the historic straightening of several headwater reaches. Despite the extensive modifications throughout the watershed, erosion and other evidence of channel "recovery" is not widespread. Overall, the agricultural tributaries are very stable and covered with herbaceous vegetation. Eroded banks are locally prevalent in forested and grazed portions of the watershed.

Step 9. Rank Sub-Watersheds

- Overlay TMDL reaches, impaired biological sampling stations, HIT results and "degraded" stream crossing using GIS shapefiles. Assign one point for each criteria located in each sub-watershed, for a total maximum score of four points per sub-watershed. For HIT, half the subwatersheds with the highest rates scored a one, the other half of the subwatersheds with the lowest rates were give a score of zero. Consider all other pertinent information in Steps 1-8 and complete ranking matrix.

Step 10. Based upon prioritization in Step 9, sub-watersheds were selected for further assessment

RESULTS

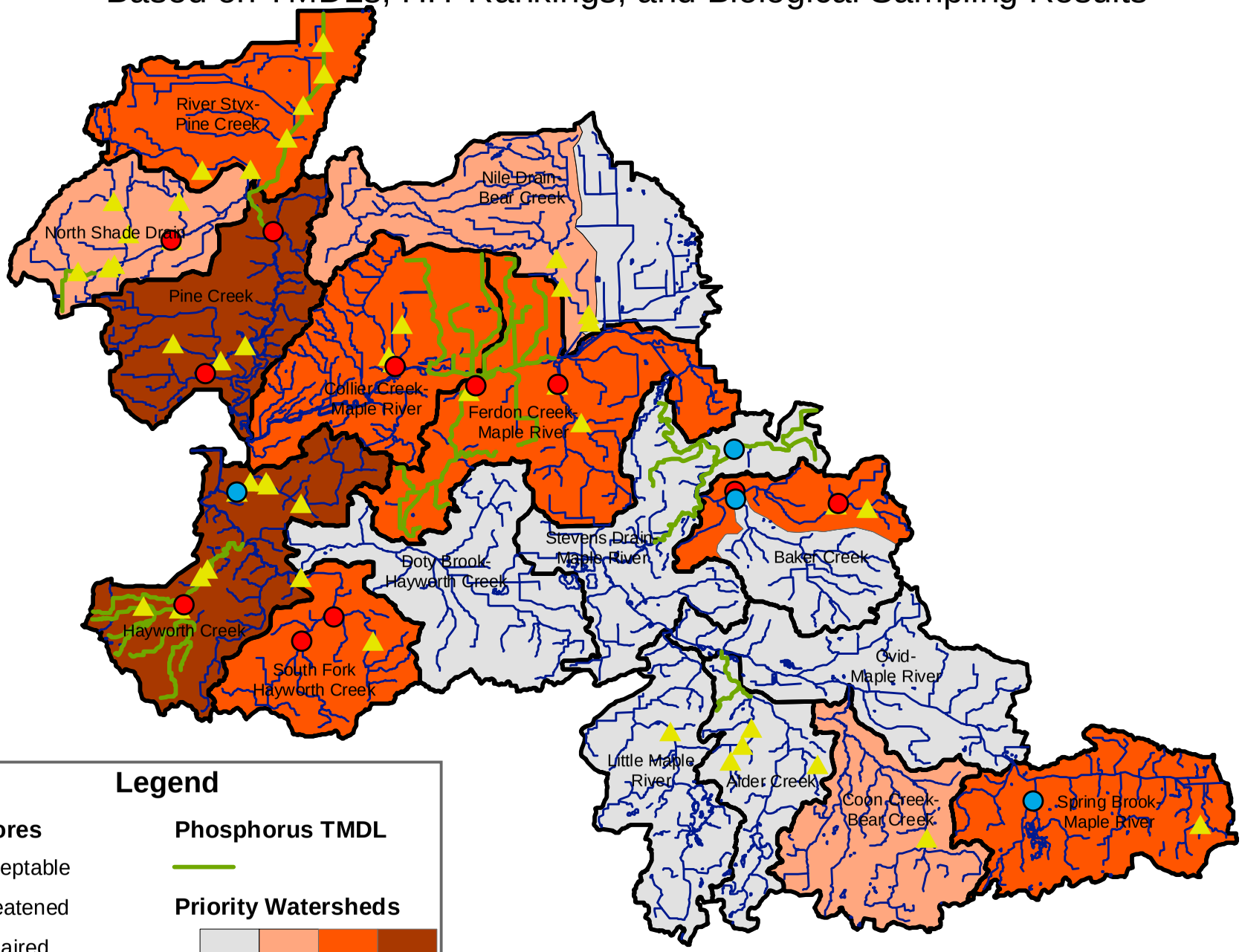
High Priority – Pine and Hayworth Creeks

Medium Priority – River Styx-Pine Creek, Collier Creek-Maple River, Ferdon Creek-Maple River, South Fork Hayworth Creek, north half of Baker Creek, Spring Brook-Maple River

Low Priority – North Shade Drain, Nile Drain-Bear Creek, Coon Creek-Bear Creek

Lowest Priority – Doty Brook-Hayworth Creek, Stevens Drain-Maple River, south portion of Baker Creek, Ovid-Maple River, Little Maple River, Alder Creek

Upper Maple River Priority Sub-Watersheds
Based on TMDLs, HIT Rankings, and Biological Sampling Results



Legend

Bugs Scores

- acceptable
- threatened
- impaired

Poor Stream Crossings

Phosphorus TMDL

Priority Watersheds

Lowest | Low | Medium | Highest

1/13/09

Detailed Sub-watershed Assessment

Based upon the results of the prioritization, subwatersheds were selected for more detailed assessment.

Step 1. Windshield Assessment

- The entire subwatershed was assessed via windshield survey. Due to the wide open nature of many subwatersheds, large sections of channel could be assessed from the roadway, thereby eliminating the need to traverse on foot.
- If impairments were identified during the windshield survey, the channel was assessed on foot. If no impairments were identified, the section of channel was eliminated from further assessment.

Step 2. Walking Assessment

- Those reaches determined to potentially be impaired during the windshield survey were assessed by foot. Each source of pollution was identified and the location was recorded using a handheld GPS. Potential sources of pollution included:
    - eroding streambanks
    - gully erosion on adjacent lands
    - livestock access points and pastures
    - animal holding facilities located adjacent the channel
    - highly maintained golf course properties
    - orchards
    - manure application
    - cropland
    - septic systems
    - maintained lawns adjacent lakes
    - open channel with no canopy
- Site-specific data was recorded at each point. At a minimum, enough data was collected to estimate the pollutant load at each site.

Step 3. The cause of pollution was identified for each source documented during Step 2.

- Potential causes of pollution included:
    - Indiscriminant access to the stream for livestock
    - Altered morphology
    - Altered hydrology
    - Over or improper application of manure
    - Over or improper application of lawn fertilizers and chemicals
    - Lack of riparian buffer adjacent channel
    - Lack of filter strips on erosion-prone cropland
    - Improper grading or drainage at livestock holding facilities
    - Improper maintenance of septic systems

EROSION ASSESSMENT

An erosion analysis was conducted on select reaches of the Maple River and its tributaries based on results of Step 1 in the Detailed Subwatershed Assessment section. Erosion sites were evaluated using a modified Bank Erosion Hazard Index (BEHI) model (Rosgen 2001). The BEHI model incorporates measurable field parameters into a relative predictive index. The BEHI values were modified for this study through the addition of a factor accounting for bank length. The resulting relative values were used to ascertain which sites are likely to produce the most sediment on an annual basis, and also to prioritize potential bank stabilization efforts.

The BEHI data was entered into a Trimble XT Global Positioning System (GPS) and associated with a GPS point for location of each eroded bank. In some instances, bank erosion was so widespread that it was not feasible to distinguish individual erosion sites; therefore, average BEHI values were used to determine sediment loading from an entire reach. Following data collection, results were downloaded from the GPS and processed via the BEHI model on a spreadsheet. Erosion results were then ranked and classified according to BEHI categories of "low," "moderate," "high," "very high," and "extreme". For purposes of this study, the BEHI model category of "very low" was assumed to correspond to relatively stable banks and was of little value. Thus "very low" ranking erosion sites were neither assessed in the field nor included in the BEHI modeling analysis.

The total length of channel traversed by foot was approximately 10 miles, or 20 miles including both left and right banks. Erosion sites were evaluated quantitatively, representing a total eroded bank length of approximately 8.2 miles (43,203 feet), or 41% of the total length assessed, as shown in Figure 13. Erosion sites appear to be distributed randomly in terms of location and severity.

A copy of the BEHI model spreadsheet is provided in Appendix 11.

SEDIMENT LOAD CALCULATIONS

Sediment load from each erosion site was calculated using a formula developed specifically for this project. The BEHI score (erosion potential of each site) was used to weight an erosion rate for each site. BEHI scores ranged from 15 to 49. Erosion rates ranged from 0.1 to 0.5 feet per year based upon field observation and MDEQ guidance (MDEQ - Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual). Therefore, a BEHI score of 15 was assumed to erode at 0.1 feet/year, and a BEHI score of 49 was assumed to erode at a rate of 0.5 feet per year. Erosion rates at each site were weighted using this method.

Using the BEHI-weighted erosion rate, load calculations were made based upon the formula: length x height x erosion rate x 0.05 = sediment load in tons/year.

GENERAL INSTRUCTION FOR STREAM CROSSING SURVEY

The survey information that you have volunteered to collect is critical for successful completion of the Upper Maple River Watershed Management Plan. The data will be used for a variety of purposes, but most importantly, they will be used to guide detailed sampling and assessment efforts aimed at identifying stream pollutants and their sources.

We ask that you take some time to review the enclosed information prior to setting out into the field. The binder includes a cover sheet with a list of sites that need to be assessed, a large map of the stream with survey sites, one set of data sheets for each site, spare data sheets in case of error, and supporting sheets to help identify riparian areas, land use and assist with the stream sketch.

In general, please:

- Do not enter private property or put yourself in danger of injury
- Record the site name and number on the data sheets
- Use the cover sheet to check off sites as you complete them
- Observe surrounding lands as you drive from one crossing to the next. If you see anything out of the ordinary or of possible concern, record the location on the large map and take notes of the site. Examples include pivot irrigation in farm fields, livestock operations and mining.
- Make sure you have at least two photographs of each crossing; one facing upstream and one facing downstream. Record photo numbers so they can be organized appropriately.
- Use your best judgment and remember that there is no "right" answer. If you are unsure of a question, take detailed notes.
- Remember that "right" and "left" are always your right or left regardless of the direction you are facing.
- Keep track of your time and mileage. They can be used as "match" for the grant.

If you have any questions, feel free to contact:

Aaron Snell: (517) 388-0678

John Switzer: (989) 640-2403

Thank you for your participation. Please have fun and we look forward to working with you.

Sincerely,

Aaron John Gary

Volunteer Stream Crossing Survey Summary

A survey of stream crossings was conducted by volunteers from the Friends of the Maple River, Clinton and Shiawassee Conservation Districts and the Clinton County Drain Commissioners Office. The purpose of the survey was to collect general information to aid in identifying critical areas in the watershed, be used to help identify sites for biological surveys and to provide photographic and written documentation of the watershed that could be used from the office.

A total of 19 tributaries were surveyed using data sheets that were developed by the Monitoring Committee and pre-approved by MDEQ staff. Binders were prepared for each of the 19 tributaries that included a cover sheet with instructions, a map of the watershed and data sheets. In addition to instruction provided in each binder, an instructive presentation was given to the Friends of the Maple River at their monthly meeting.

Upon completion, each binder was reviewed and analyzed. Every stream crossing that appeared to be relatively degraded was recorded in a GIS database. Similarly, streams appearing to be of high quality based on the crossing survey were compiled into a separate database to aid in identification of high-quality, or "priority", areas within the watershed. The final product was a GIS shapefile containing all of the "degraded" stream crossings that could be overlaid on the watershed to illustrate spatial distribution of the sites.

Overall, results of the volunteer surveys were of very high quality. The most common impairments identified during the surveys were sedimentation and nutrient enrichment issues. Based upon information collected, more rigorous assessment methods were employed to follow-up on sites that the volunteers identified as having possible impairments.

Watershed Survey Data Sheet

WATERSHED **HALTERMAN CREEK and NEWSOM DRAIN**

Sites to Inspect

_____	1. Wilson Rd
_____	2. Allen Rd
_____	3. County Line Rd
_____	4. Chandler Rd (north crossing)
_____	5. Willowbrook Rd
_____	6. Maple Rapids Rd
_____	7. Ridge Rd
_____	8. Chandler Rd (south crossing)
_____	9. Taft Rd (west crossing)
_____	10. McClelland Rd
_____	11. Taft Rd (east crossing)

Checklist

_____ Watershed Map
_____ Sharp Pencils
_____ County Map Book
_____ Camera
_____
_____
_____
_____

HOURS WORKED: _____

MILES DRIVEN: _____

Stream Crossing Survey Data Sheet

Date	_____			**u/s Photo Number**	_____		
Investigator (s)	_____			**d/s Photo Number**	_____		
Waterbody Name	_____			**other photos**	describe on notes page		
Road Name	_____			**Road Surface**	Paved	Gravel	
Type of Crossing	Bridge	Single Culvert	Double Culvert	Box		Other: _____	
Channel Type	natural	maintained					

Problems Present (circle all that apply)

	Debris/Trash/Obstructions	Farm Field	
	Livestock Access	Natural Vegetation Removal	
	Streambank Erosion	Other:	_____

Extent of Erosion	Minor	Moderate	Severe				
Sediment Islands?	Yes	No					
Current precipitation	None	Light	Moderate	Heavy			
Days since last rain	1 or less	2	3 or more	**How much?**	_____	inches	
Plants and Algae	None	<25% of channel	25-50% of channel	>50% of channel			
Stream flow type	Dry	Stagnant	Slow Flow	Moderate	Rapid Flow		
Stream bottom substrate	Clay	Sand	Gravel	Cobble	Organic		
Size:	Slippery	Smaller than ladybug	Ladybug to tennis ball	Tennis ball to basketball	Fine black particles		
Average Stream Wetted Width	_____	**feet**					
Average Stream Depth	_____	**feet/inches**					
Streambank Height (low bank)	_____	**feet**					
Highest Visible Water Mark (above water level)	_____	**feet**					

Riparian Habitat (facing u/s)	**Left Bank**	Trees (>10 ft tall)	Shrubs	Grass	Bare	Crops	
	Right Bank	Trees (>10 ft tall)	Shrubs	Grass	Bare	Crops	
Land Use (facing u/s)	**Left Bank**	Woodland	Wetland	Idle	Agricultural	Residential	Roadway
	Right Bank	Woodland	Wetland	Idle	Agricultural	Residential	Roadway
Riparian Habitat (facing d/s)	**Left Bank**	Trees (>10 ft tall)	Shrubs	Grass	Bare	Crops	
	Right Bank	Trees (>10 ft tall)	Shrubs	Grass	Bare	Crops	
Land Use (facing d/s)	**Left Bank**	Woodland	Wetland	Idle	Agricultural	Residential	Roadway
	Right Bank	Woodland	Wetland	Idle	Agricultural	Residential	Roadway

Watershed Survey Data Sheet **SITE ID#** _____

Additional Comments

Sketch of site

Tillage Survey Results

	Subwatershed				
	Doty Brook	**North Shade Drain**	**Hayworth Creek**	**Spring Brook**	**Pine Creek**
Total Acres in Survey Area	21,190	14,529	21,044	21,138	19,573
Actual Acres Surveyed	7,854	10,676	14,117	8,732	13,941
Percent of total area	37.1%	73.5%	67.1%	41.3%	71.2%
Percent of survey area with 0-10% residue	35.1%	65.2%	35.9%	20.6%	36.6%
Percent of survey area with 10-30% residue	9.4%	14.1%	10.2%	29.2%	21.8%
Percent of survey area with >30% residue; cropped	55.5%	20.7%	12.9%	21.6%	10.7%
Percent of survey area with >30% residue; pasture, wheat, hay	No Data	No Data	41.0%	28.6%	30.8%

Subwatersheds are in order of completion from earliest to latest ranging from 5/23/09 to 6/15/09-due to weather conditions tillage may have been delayed

North Shade Drain has a high level of 0-10% residue and a low level of >30% residue for being a lower priority subwat North Shade Drain is the northernmost subwatershed surveyed and may have received less rain allowing farmers to begin tillage earlier than other subwatersheds. Also there are 4 CAFOs in the North Shade Drain sub (more than any other subwatershed) that are likely spreading and incorporating manure.

North Shade Drain ranked 15th out of 16 subwatersheds by HIT for sediment in ton per acre per year.

Tillage Survey

Subwatershed Name: Pine Creek

Total Size: 19,573 Acres

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres		Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
13	0-10%	39		246	10-30%	19
141	0-10%	66		247	10-30%	27
325	0-10%	40		249	10-30%	76
326	0-10%	38		260	10-30%	36
30	0-10%	39		262	10-30%	35
420	0-10%	28		263	10-30%	54
452	0-10%	5		286	10-30%	19
457	0-10%	40		295	10-30%	32
458	0-10%	33		297	10-30%	30
459	0-10%	76		306	10-30%	13
461	0-10%	31		307	10-30%	3
465	0-10%	16		315	10-30%	21
466	0-10%	63		425	10-30%	20
156	0-10%	64		428	10-30%	18
157	0-10%	66		429	10-30%	40
158	0-10%	29		469	10-30%	84
160	0-10%	57		237	10-30%	17
161	0-10%	143		399	10-30%	58
165	0-10%	19		404	10-30%	82
166	0-10%	16		407	10-30%	150
186	0-10%	100		443	10-30%	49
210	0-10%	38		444	10-30%	60
230	0-10%	36		446	10-30%	65
233	0-10%	55		8	>30%	36
105	0-10%	74		12	>30%	74
173	0-10%	55		15	>30%	27
300	0-10%	20		51	>30%	14
357	0-10%	19		52	>30%	62
359	0-10%	22		54	>30%	41
477	0-10%	38		55	>30%	33
478	0-10%	18		56	>30%	36
479	0-10%	50		57	>30%	55
480	0-10%	31		146	>30%	16
481	0-10%	48		149	>30%	49
482	0-10%	35		151	>30%	20
490	0-10%	37		329	>30%	14
77	0-10%	21		29	>30%	15
115	0-10%	39		33	>30%	39
111	0-10%	38		35	>30%	29
126	0-10%	38		37	>30%	65
128	0-10%	31		38	>30%	33
129	0-10%	85		41	>30%	38
130	0-10%	45		212	>30%	59
192	0-10%	30		217	>30%	38
45	0-10%	42		252	>30%	68
99	0-10%	66		253	>30%	39
351	0-10%	11		255	>30%	100
383	0-10%	60		421	>30%	62
385	0-10%	40		422	>30%	65
5	0-10%	24		450	>30%	41
6	0-10%	39		453	>30%	5
58	0-10%	28		456	>30%	56
61	0-10%	29		460	>30%	65
64	0-10%	17		462	>30%	25
66	0-10%	24		152	>30%	56
21	0-10%	43		153	>30%	8
22	0-10%	58		154	>30%	15
24	0-10%	24		159	>30%	27
85	0-10%	15		162	>30%	20
86	0-10%	16		164	>30%	39
122	0-10%	55		185	>30%	38
124	0-10%	2		205	>30%	40
125	0-10%	17		206	>30%	34
310	0-10%	92		208	>30%	32
167	0-10%	52		209	>30%	14
168	0-10%	36		103	>30%	80
169	0-10%	75		360	>30%	42
170	0-10%	40		476	>30%	19
89	0-10%	33		491	>30%	40
90	0-10%	22		75	>30%	60
91	0-10%	13		112	>30%	37

Total Acres in Survey Area	19,573
Actual Acres Surveyed	7,139
Percent of total area	36.5%
Percent of survey area with 0-10% residue	71.5%
Percent of survey area with 10-30% residue	28.5%
Percent of survey area with <30% residue*	81.2%

*Included hay, pasture, wheat, and fallow fields

Tillage Survey

Subwatershed Name: Pine Creek

Total Size: 19,573 Acres

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres		Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
92	0-10%	48		113	>30%	104
189	0-10%	80		114	>30%	110
190	0-10%	32		116	>30%	40
278	0-10%	33		117	>30%	5
280	0-10%	18		118	>30%	7
199	0-10%	40		107	>30%	95
204	0-10%	79		109	>30%	38
266	0-10%	25		110	>30%	80
268	0-10%	38		127	>30%	35
272	0-10%	27		131	>30%	34
273	0-10%	78		132	>30%	12
275	0-10%	40		133	>30%	39
374	0-10%	11		135	>30%	35
435	0-10%	58		176	>30%	71
436	0-10%	36		193	>30%	14
437	0-10%	42		194	>30%	17
336	0-10%	18		222	>30%	39
413	0-10%	15		224	>30%	55
414	0-10%	19		46	>30%	26
415	0-10%	18		48	>30%	37
494	0-10%	34		78	>30%	66
177	0-10%	70		79	>30%	30
181	0-10%	12		94	>30%	41
184	0-10%	21		95	>30%	16
472	0-10%	26		350	>30%	45
473	0-10%	7		352	>30%	23
474	0-10%	27		390	>30%	32
475	0-10%	57		392	>30%	39
486	0-10%	53		395	>30%	39
487	0-10%	69		397	>30%	40
244	0-10%	18		1	>30%	38
248	0-10%	50		2	>30%	9
251	0-10%	39		4	>30%	73
302	0-10%	67		7	>30%	18
303	0-10%	53		63	>30%	25
304	0-10%	118		68	>30%	14
308	0-10%	29		69	>30%	46
424	0-10%	21		18	>30%	10
427	0-10%	26		26	>30%	20
431	0-10%	122		496	>30%	20
433	0-10%	128		81	>30%	8
468	0-10%	56		82	>30%	20
484	0-10%	17		83	>30%	47
485	0-10%	14		84	>30%	47
497	0-10%	46		119	>30%	6
239	0-10%	15		120	>30%	6
402	0-10%	36		309	>30%	38
370	0-10%	37		312	>30%	16
439	0-10%	30		341	>30%	24
442	0-10%	82		346	>30%	38
447	0-10%	57		171	>30%	38
449	0-10%	25		172	>30%	11
50	10-30%	23		87	>30%	21
53	10-30%	39		88	>30%	21
137	10-30%	11		187	>30%	33
139	10-30%	18		188	>30%	25
140	10-30%	10		277	>30%	35
214	10-30%	29		202	>30%	23
254	10-30%	46		267	>30%	11
256	10-30%	18		269	>30%	8
423	10-30%	40		274	>30%	17
451	10-30%	26		276	>30%	56
454	10-30%	43		377	>30%	16
455	10-30%	39		379	>30%	25
463	10-30%	29		434	>30%	45
464	10-30%	31		467	>30%	16
155	10-30%	10		334	>30%	26
163	10-30%	38		416	>30%	7
207	10-30%	29		417	>30%	39
228	10-30%	36		495	>30%	27
235	10-30%	19		178	>30%	37

Tillage Survey

Subwatershed Name: Pine Creek
Total Size: 19,573 Acres

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres		Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
101	10-30%	71		180	>30%	10
298	10-30%	63		183	>30%	13
299	10-30%	98		289	>30%	112
356	10-30%	21		290	>30%	35
106	10-30%	43		293	>30%	30
134	10-30%	14		488	>30%	32
220	10-30%	38		489	>30%	70
80	10-30%	23		250	>30%	38
93	10-30%	6		258	>30%	36
349	10-30%	19		259	>30%	96
382	10-30%	26		261	>30%	102
387	10-30%	40		287	>30%	61
3	10-30%	40		288	>30%	38
311	10-30%	28		296	>30%	32
343	10-30%	30		305	>30%	20
344	10-30%	30		319	>30%	18
279	10-30%	30		320	>30%	39
281	10-30%	35		321	>30%	21
282	10-30%	16		322	>30%	10
283	10-30%	32		316	>30%	27
284	10-30%	9		317	>30%	36
285	10-30%	16		318	>30%	17
198	10-30%	38		426	>30%	32
200	10-30%	17		430	>30%	78
201	10-30%	18		432	>30%	122
203	10-30%	129		470	>30%	22
264	10-30%	59		471	>30%	48
265	10-30%	74		483	>30%	3
271	10-30%	23		498	>30%	55
372	10-30%	83		238	>30%	17
418	10-30%	37		242	>30%	24
419	10-30%	38		109	>30%	75
493	10-30%	83		364	>30%	20
179	10-30%	37		366	>30%	64
182	10-30%	13		441	>30%	65
291	10-30%	54		445	>30%	9
292	10-30%	37		448	>30%	23
294	10-30%	36				

Tillage Survey Results

Subwatershed Name: Doty Brook
Total Size: 21,190 Acres

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
5	0-10%	115
6	0-10%	54
7	0-10%	116
14	0-10%	72
15	0-10%	48
17	0-10%	43
18	0-10%	30
22	0-10%	20
23	0-10%	20
25	0-10%	115
27	0-10%	46
29	0-10%	24
30	0-10%	126
32	0-10%	40
33	0-10%	18
38	0-10%	54
41	0-10%	141
44	0-10%	100
46	0-10%	43
49	0-10%	113
50	0-10%	142
51	0-10%	66
52	0-10%	85
53	0-10%	116
54	0-10%	70
55	0-10%	43
57	0-10%	58
63	0-10%	16
65	0-10%	8
66	0-10%	8
67	0-10%	16
70	0-10%	10
71	0-10%	29
74	0-10%	50
76	0-10%	24
80	0-10%	15
81	0-10%	12
86	0-10%	9
90	0-10%	52
91	0-10%	69
95	0-10%	9
98	0-10%	45
99	0-10%	42
100	0-10%	26
106	0-10%	118
108	0-10%	30
109	0-10%	10
110	0-10%	104
111	0-10%	62
114	0-10%	56
115	0-10%	20
3	10-30%	55
28	10-30%	17
31	10-30%	21
34	10-30%	13
36	10-30%	46
47	10-30%	72
87	10-30%	67
89	10-30%	120
105	10-30%	160

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
113	10-30%	94
116	10-30%	75
1	>30%	28
2	>30%	23
4	>30%	14
8	>30%	68
9	>30%	90
10	>30%	29
11	>30%	19
12	>30%	50
13	>30%	51
16	>30%	28
19	>30%	91
35	>30%	180
37	>30%	51
39	>30%	65
40	>30%	47
42	>30%	144
43	>30%	236
45	>30%	230
48	>30%	76
56	>30%	127
58	>30%	37
59	>30%	15
60	>30%	28
61	>30%	143
62	>30%	51
64	>30%	8
68	>30%	46
69	>30%	19
72	>30%	60
73	>30%	7
75	>30%	72
77	>30%	22
78	>30%	77
79	>30%	30
82	>30%	74
83	>30%	90
84	>30%	164
85	>30%	162
88	>30%	88
92	>30%	32
93	>30%	37
94	>30%	92
96	>30%	47
97	>30%	125
101	>30%	105
102	>30%	60
103	>30%	40
104	>30%	71
107	>30%	94
112	>30%	64
117	>30%	44
118	>30%	152
119	>30%	109
120	>30%	112
121	>30%	56
122	>30%	185
123	>30%	91

Total Acres in Survey Area	21,190
Actual Acres Surveyed	3,329
Percent of total area	15.7%
Percent of survey area with 0-10% residue	0.0%
Percent of survey area with 10-30% residue	0.0%
Percent of survey area with <30% residue	0.0%

Tillage Survey Results

Subwatershed Name: Hayworth Creek
Total Size: 21,044 Acres

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
1	0-10%	31
4	0-10%	56
7	0-10%	16
11	0-10%	27
13	0-10%	20
14	0-10%	122
17	0-10%	30
24	0-10%	17
26	0-10%	28
31	0-10%	29
35	0-10%	18
46	0-10%	222
54	0-10%	113
65	0-10%	14
66	0-10%	21
68	0-10%	30
71	0-10%	58
72	0-10%	21
79	0-10%	38
80	0-10%	21
82	0-10%	32
89	0-10%	19
92	0-10%	17
94	0-10%	78
95	0-10%	120
96	0-10%	40
101	0-10%	39
107	0-10%	33
108	0-10%	54
109	0-10%	40
110	0-10%	74
111	0-10%	138
114	0-10%	74
116	0-10%	87
117	0-10%	93
121	0-10%	1.5
122	0-10%	31
123	0-10%	22
125	0-10%	17
128	0-10%	35
130	0-10%	20
132	0-10%	8
133	0-10%	18
137	0-10%	188
138	0-10%	16
140	0-10%	39
141	0-10%	43
143	0-10%	12
147	0-10%	80
154	0-10%	24
157	0-10%	61
158	0-10%	60
164	0-10%	32
169	0-10%	5
171	0-10%	40
172	0-10%	110
173	0-10%	37
176	0-10%	32
178	0-10%	18
182	0-10%	35
183	0-10%	24
187	0-10%	25
203	0-10%	52
206	0-10%	7
212	0-10%	36
213	0-10%	36
216	0-10%	39
223	0-10%	37
226	0-10%	50
232	0-10%	64
235	0-10%	40
242	0-10%	25
243	0-10%	36
245	0-10%	20
247	0-10%	24
248	0-10%	11

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
40	>30%	34
41	>30%	39
42	>30%	17
43	>30%	102
44	>30%	18
45	>30%	13
47	>30%	65
48	>30%	8
49	>30%	108
50	>30%	25
52	>30%	116
53	>30%	15
55	>30%	19
57	>30%	71
58	>30%	34
59	>30%	38
60	>30%	10
62	>30%	37
63	>30%	76
64	>30%	19
67	>30%	51
69	>30%	128
70	>30%	30
73	>30%	48
74	>30%	56
76	>30%	56
77	>30%	79
81	>30%	19
83	>30%	14
84	>30%	51
85	>30%	16
86	>30%	2.5
87	>30%	16
88	>30%	49
90	>30%	51
91	>30%	61
93	>30%	48
97	>30%	143
98	>30%	95
99	>30%	93
105	>30%	17
106	>30%	72
112	>30%	26
113	>30%	131
115	>30%	68
118	>30%	69
119	>30%	20
120	>30%	44
124	>30%	74
127	>30%	12
129	>30%	21
131	>30%	15
134	>30%	23
136	>30%	13
142	>30%	50
144	>30%	65
145	>30%	10
146	>30%	30
149	>30%	40
151	>30%	42
152	>30%	35
156	>30%	43
159	>30%	7
161	>30%	24
162	>30%	26
163	>30%	45
165	>30%	5
166	>30%	40
167	>30%	35
168	>30%	20
170	>30%	70
175	>30%	33
177	>30%	170
179	>30%	22
181	>30%	30
184	>30%	14

Total Acres in Survey Area	21,044
Actual Acres Surveyed	7,395
Percent of total area	35.1%
Percent of survey area with 0-10% residue	35.9%
Percent of survey area with 10-30% residue	10.2%
Percent of survey area with <30% residue*	6.3%

*Included hay, pasture, wheat, and fallow fields

Subwatershed Name: Hayworth Creek
Total Size: 21,044 Acres

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
253	0-10%	74
255	0-10%	34
256	0-10%	77
258	0-10%	110
261	0-10%	13
262	0-10%	25
266	0-10%	42
269	0-10%	70
271	0-10%	45
276	0-10%	11
277	0-10%	33
279	0-10%	40
280	0-10%	85
281	0-10%	10
282	0-10%	32
288	0-10%	56
292	0-10%	176
293	0-10%	5
304	0-10%	63
313	0-10%	198
314	0-10%	15
316	0-10%	60
317	0-10%	38
319	0-10%	44
321	0-10%	39
325	0-10%	57
327	0-10%	30
328	0-10%	90
329	0-10%	66
333	0-10%	50
8	10-30%	45
10	10-30%	61
15	10-30%	118
19	10-30%	18
23	10-30%	10
27	10-30%	2
30	10-30%	28
51	10-30%	6
56	10-30%	10
61	10-30%	84
75	10-30%	28
78	10-30%	40
126	10-30%	33
135	10-30%	9
139	10-30%	39
160	10-30%	5
180	10-30%	102
189	10-30%	7
198	10-30%	19
199	10-30%	59
205	10-30%	60
210	10-30%	60
218	10-30%	39
219	10-30%	39
227	10-30%	24
231	10-30%	11
249	10-30%	5
264	10-30%	35
274	10-30%	83
285	10-30%	69
290	10-30%	54
294	10-30%	110
297	10-30%	14
298	10-30%	40
300	10-30%	9
307	10-30%	24
324	10-30%	42
2	>30%	41
3	>30%	42
6	>30%	45
9	>30%	12
12	>30%	27
16	>30%	13
18	>30%	74
20	>30%	76
21	>30%	79
22	>30%	146
25	>30%	69

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
185	>30%	93
188	>30%	38
190	>30%	9
191	>30%	40
192	>30%	36
193	>30%	32
194	>30%	6
195	>30%	35
196	>30%	44
197	>30%	40
200	>30%	50
201	>30%	66
202	>30%	1
204	>30%	8
207	>30%	32
208	>30%	12
209	>30%	30
211	>30%	26
214	>30%	94
215	>30%	38
217	>30%	124
220	>30%	22
221	>30%	11
222	>30%	7
224	>30%	37
225	>30%	39
228	>30%	39
229	>30%	20
230	>30%	15
233	>30%	30
234	>30%	66
236	>30%	14
237	>30%	9
238	>30%	20
239	>30%	42
240	>30%	23
241	>30%	8
244	>30%	30
250	>30%	16
251	>30%	32
252	>30%	75
257	>30%	62
259	>30%	17
260	>30%	29
263	>30%	24
265	>30%	38
267	>30%	50
268	>30%	43
270	>30%	65
272	>30%	90
273	>30%	21
275	>30%	33
278	>30%	55
283	>30%	18
284	>30%	65
286	>30%	56
287	>30%	64
289	>30%	73
291	>30%	6
295	>30%	8
296	>30%	34
299	>30%	40
301	>30%	21
302	>30%	32
303	>30%	35
305	>30%	118
306	>30%	36
308	>30%	107
309	>30%	78
310	>30%	40
311	>30%	40
312	>30%	40
315	>30%	69
318	>30%	34
320	>30%	48
323	>30%	42
326	>30%	10
330	>30%	72

Subwatershed Name: Hayworth Creek
Total Size: 21,044 Acres

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
28	>30%	170
33	>30%	35
36	>30%	17
38	>30%	16
39	>30%	23

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
331	>30%	30
332	>30%	48
334	>30%	91

Tillage Survey

Subwatershed Name: North Shade Drain

Total Size: 14,529 Acres

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres		Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
1	0-10%	155		179	0-10%	23
2	0-10%	39		180	0-10%	20
3	0-10%	36		181	0-10%	40
4	0-10%	32		182	0-10%	68
5	0-10%	22		185	0-10%	116
7	0-10%	20		186	0-10%	160
8	0-10%	40		187	0-10%	46
13	0-10%	20		188	0-10%	72
14	0-10%	20		191	0-10%	50
15	0-10%	38		193	0-10%	130
20	0-10%	10		194	0-10%	63
24	0-10%	32		198	0-10%	50
29	0-10%	18		199	0-10%	21
30	0-10%	8		200	0-10%	68
31	0-10%	32		201	0-10%	5
32	0-10%	31		204	0-10%	123
33	0-10%	76		205	0-10%	100
35	0-10%	78		206	0-10%	67
36	0-10%	25		207	0-10%	63
37	0-10%	45		208	0-10%	151
41	0-10%	38		210	0-10%	35
42	0-10%	67		211	0-10%	37
43	0-10%	57		212	0-10%	6
56	0-10%	78		213	0-10%	9
61	0-10%	103		215	0-10%	46
63	0-10%	50		9	10-30%	38
64	0-10%	48		10	10-30%	38
65	0-10%	18		12	10-30%	40
67	0-10%	17		16	10-30%	20
69	0-10%	20		18	10-30%	25
73	0-10%	32		19	10-30%	13
74	0-10%	78		22	10-30%	40
77	0-10%	5		28	10-30%	14
79	0-10%	57		50	10-30%	4
80	0-10%	35		53	10-30%	32
81	0-10%	100		54	10-30%	19
83	0-10%	15		57	10-30%	30
84	0-10%	18		59	10-30%	7
85	0-10%	74		70	10-30%	120
86	0-10%	5		75	10-30%	32
87	0-10%	72		115	10-30%	77
89	0-10%	23		120	10-30%	96
90	0-10%	15		123	10-30%	60
92	0-10%	32		137	10-30%	39
93	0-10%	55		139	10-30%	20
95	0-10%	43		140	10-30%	77
96	0-10%	68		145	10-30%	148
97	0-10%	5		149	10-30%	11
99	0-10%	76		154	10-30%	76
100	0-10%	31		161	10-30%	115
101	0-10%	43		167	10-30%	44
102	0-10%	94		169	10-30%	61
103	0-10%	49		170	10-30%	61
104	0-10%	35		183	10-30%	22.5
105	0-10%	20		203	10-30%	122
106	0-10%	32		6	>30%	10
107	0-10%	84		11	>30%	97
109	0-10%	50		17	>30%	80
110	0-10%	36		25	>30%	78
111	0-10%	35		26	>30%	31
116	0-10%	40		34	>30%	25
121	0-10%	75		38	>30%	49
122	0-10%	68		39	>30%	36
124	0-10%	83		40	>30%	30
125	0-10%	31		44	>30%	116
126	0-10%	128		47	>30%	32
128	0-10%	89		48	>30%	14
129	0-10%	140		51	>30%	15
130	0-10%	219		52	>30%	19
131	0-10%	46		55	>30%	49
132	0-10%	73		62	>30%	19
133	0-10%	70		66	>30%	19
136	0-10%	110		68	>30%	38
141	0-10%	70		71	>30%	20
142	0-10%	80		72	>30%	56

Total Acres in Survey Area	14,529
Actual Acres Surveyed	5,392
Percent of total area	37.1%
Percent of survey area with 0-10% residue	100.0%
Percent of survey area with 10-30% residue	27.8%
Percent of survey area with <30% residue*	41.0%

*Included hay, pasture, wheat, and fallow fields

Tillage Survey

Subwatershed Name: North Shade Drain

Total Size: 14,529 Acres

Field Number	**% Residue Cover** (0-10% 10-30% >30%)	**Acres**		**Field Number**	**% Residue Cover** (0-10% 10-30% >30%)	**Acres**
144	0-10%	40		78	>30%	32
146	0-10%	115		82	>30%	90
147	0-10%	92		88	>30%	30
148	0-10%	150		91	>30%	46
150	0-10%	30		94	>30%	13
151	0-10%	60		98	>30%	45
152	0-10%	150		108	>30%	32
153	0-10%	30		112	>30%	41
155	0-10%	80		113	>30%	83
156	0-10%	67		117	>30%	115
157	0-10%	106		118	>30%	68
159	0-10%	38		119	>30%	77
162	0-10%	61		134	>30%	63
164	0-10%	33		135	>30%	32
165	0-10%	57		138	>30%	47
166	0-10%	35		143	>30%	146
168	0-10%	68		158	>30%	68
171	0-10%	46		163	>30%	66
172	0-10%	77		173	>30%	35
175	0-10%	76		174	>30%	33
176	0-10%	33		192	>30%	17
177	0-10%	16		195	>30%	50
178	0-10%	20		196	>30%	30
				197	>30%	19
				202	>30%	75
				214	>30%	27

Tillage Survey

Subwatershed Name: Spring Brook
Total Size: 21,138 Acres

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres		Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
35	0-10%	25		33	>30%	19
43	0-10%	24		34	>30%	17
50	0-10%	17		36	>30%	16
51	0-10%	88		37	>30%	30
55	0-10%	50		38	>30%	22
56	0-10%	6		40	>30%	33
57	0-10%	29		41	>30%	60
59	0-10%	16		42	>30%	45
63	0-10%	113		46	>30%	80
146	0-10%	29		47	>30%	32
147	0-10%	45		49	>30%	35
174	0-10%	60		54	>30%	8
176	0-10%	64		58	>30%	24
179	0-10%	41		60	>30%	22
190	0-10%	23		61	>30%	18
18	0-10%	93		62	>30%	25
67	0-10%	60		192	>30%	33
102	0-10%	33		237	>30%	47
104	0-10%	50		238	>30%	38
155	0-10%	61		239	>30%	50
284	0-10%	11		240	>30%	25
173	0-10%	14		241	>30%	30
185	0-10%	50		264	>30%	24
253	0-10%	20		265	>30%	90
258	0-10%	19		267	>30%	3
209	0-10%	45		145	>30%	16
273	0-10%	73		150	>30%	34
293	0-10%	25		175	>30%	5
295	0-10%	15		181	>30%	77
296	0-10%	14		182	>30%	50
297	0-10%	36		163	>30%	22
90	0-10%	86		164	>30%	48
125	0-10%	70		165	>30%	22
128	0-10%	52		166	>30%	20
4	0-10%	51		167	>30%	19
74	0-10%	50		168	>30%	29
81	0-10%	136		169	>30%	34
107	0-10%	6		188	>30%	68
106	0-10%	103		189	>30%	33
29	10-30%	25		191	>30%	48
39	10-30%	178		243	>30%	10
44	10-30%	12		244	>30%	19
45	10-30%	85		14	>30%	11
48	10-30%	43		20	>30%	33
52	10-30%	40		66	>30%	79
53	10-30%	40		71	>30%	71
193	10-30%	155		72	>30%	60
263	10-30%	16		103	>30%	74
266	10-30%	12		153	>30%	75
149	10-30%	22		156	>30%	10
151	10-30%	32		157	>30%	20
152	10-30%	32		160	>30%	35
177	10-30%	58		161	>30%	16
178	10-30%	43		274	>30%	24
180	10-30%	27		275	>30%	28
162	10-30%	40		280	>30%	13
245	10-30%	35		282	>30%	28
246	10-30%	15		283	>30%	29
15	10-30%	37		285	>30%	26
24	10-30%	93		286	>30%	15
68	10-30%	13		86	>30%	30
69	10-30%	2		89	>30%	29
70	10-30%	35		186	>30%	37
101	10-30%	23		187	>30%	47
105	10-30%	24		251	>30%	25
154	10-30%	12		252	>30%	24
158	10-30%	16		118	>30%	26
159	10-30%	38		120	>30%	30
276	10-30%	18		131	>30%	105
279	10-30%	24		132	>30%	45
88	10-30%	172		134	>30%	35
247	10-30%	30		199	>30%	38

Total Acres in Survey Area	21,138
Actual Acres Surveyed	4,623
Percent of total area	21.9%
Percent of survey area with 0-10% residue	39.0%
Percent of survey area with 10-30% residue	55.2%
Percent of survey area with <30% residue*	5.8%

*Included hay, pasture, wheat, and fallow fields

Subwatershed Name: Spring Brook
Total Size: 21,138 Acres

Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres		Field Number	% Residue Cover (0-10% 10-30% >30%)	Acres
248	10-30%	22		206	>30%	66
255	10-30%	45		299	>30%	17
256	10-30%	66		300	>30%	54
112	10-30%	13		301	>30%	56
115	10-30%	81		303	>30%	21
121	10-30%	24		64	>30%	48
302	10-30%	23		135	>30%	5
78	10-30%	14		212	>30%	16
210	10-30%	10		215	>30%	15
211	10-30%	9		216	>30%	24
214	10-30%	19		217	>30%	19
219	10-30%	75		218	>30%	36
220	10-30%	22		221	>30%	39
259	10-30%	66		222	>30%	5
261	10-30%	35		223	>30%	6
269	10-30%	42		224	>30%	25
294	10-30%	12		225	>30%	27
91	10-30%	26		262	>30%	50
7	10-30%	66		268	>30%	20
26	10-30%	34		270	>30%	39
27	10-30%	27		271	>30%	23
287	10-30%	156		272	>30%	39
76	10-30%	54		290	>30%	68
94	10-30%	6		291	>30%	12
97	10-30%	15		292	>30%	22
98	10-30%	20		298	>30%	40
109	10-30%	24		92	>30%	10
110	10-30%	21		93	>30%	84
141	10-30%	11.5		122	>30%	67
142	10-30%	11		124	>30%	22
143	10-30%	27		2	>30%	41
194	10-30%	22		10	>30%	?
195	10-30%	5		25	>30%	63
12	>30%	73		229	>30%	23
28	>30%	35		234	>30%	9
30	>30%	52		236	>30%	28
31	>30%	14		73	>30%	14
32	>30%	95		75	>30%	204
				83	>30%	41
				95	>30%	20
				96	>30%	23
				99	>30%	7
				100	>30%	36
				111	>30%	47
				140	>30%	31
				278	>30%	10
				196	>30%	25
				197	>30%	14

Upper Maple River
Watershed Management Plan

June 2010
MDNRE Tracking Code #2007-0118

Appendix 12

NPDES Point Sources

POINT SOURCES - NPDES PERMITS (personal communication with Ms. Christe Alwin, MDNRE 12-10-2009; http://www.deq.state.mi.us/owis/Page/main/Home.aspx)

DESIGNATED	PERMIT_NO_	COUNTY	PERMIT TYPE	LOCATION	CITY
Becks Development Co	MIG580052	Clinton	COC	2121 West Hyde Road	Saint Johns
Carl Schlegel-Harmon Rd Pit	MIG490294	Clinton	COC	3250 North Watson Road	Saint Johns
EB Ridge Dairy-CAFO	MIG250495	Clinton	CAFO/COC	4100 East Ridge Road	Elsie
Elsie WWSL	MI0056260	Clinton	IP	7485 North Park Avenue	Elsie
Fowler WWSL	MIG580061	Clinton	COC	10723 North Drive	Fowler
MAHLE Inc-St Johns	MIG250395	Clinton	COC	916 West State Street	Saint Johns
Maple Rapids WWSL	MIG580260	Clinton	COC	at Garfield Road	Maple Rapids
MDNR-Sleepy Hollow SP WWSL	MIG580290	Clinton	COC	7835 East Price Road	Laingsburg
MMPA-Ovid Plant	MI0043427	Clinton	IP	431 West Williams Street	Ovid
Ovid WWSL	MIG580064	Clinton	COC	South Main Street	Ovid
Searles Construction Inc	MIG490288	Clinton	COC	4665 North Dewitt Road	Saint Johns
St Johns WWTP	MI0026468	Clinton	IP	1000 North US 27	Saint Johns
Carl Schlegel Inc-Martin Pit	GW1510266	Clinton	COC	3715 North Chandler Road	Saint Johns
Carl Schlegel-Harmon Rd Pit	GW1510234	Clinton	COC	3250 North Watson Road	Saint Johns
MDNR-Sleepy Hollow SP WWSL	GW1510069	Clinton	COC	7835 East Price Road	Laingsburg
Ashley WWSL	MIG580059	Gratiot	COC	114 West Oak Street	Ashley
Bellingar Packing	GW1510052	Gratiot	COC	1557 East Wilson Road	Ashley
Gratiot CRC	GW1510222	Gratiot	COC	200 Commerce Drive	Ithaca
North Star Sewer System	GW1110263	Gratiot	COC	3725 South Baldwin Road	Ithaca
Spring Vale Academy	MIG580228	Shiawassee	COC	4150 South M-52	Owosso
Sunoco-Owosso Terminal	MI0036498	Shiawassee	IP	4004 West Main Street	Owosso

COC = Certificate of Coverage
IP = Individual Permit
CAFO = Concentrated Animal Feeding Operation

NON-POINT SOURCES - CONCENTRATED AMINAL FEEDING OPERATIONS

DESIGNATED	PERMIT_NO_	COUNTY	PERMIT TYPE	FACILITY OWNERSHIP	LOCATION	CITY	TOTAL ANIMALS	PRIMARY SPECIES
Dutch Meadows Dairy-CAFO	MIG010096	Clinton	CAFO	Private	3427 North Wacousta Road	Saint Johns	0	
EB Ridge Dairy-CAFO	MIG010100	Clinton	CAFO	Private	4100 East Ridge Road	Elsie	1754	
Green Meadow Farms 1-CAFO	MIG010107	Clinton	CAFO	Private	6400 Hollister Road	Elsie	4186	DAIRY
Nobis Dairy Farms-CAFO	MIG010058	Clinton	CAFO	Private	5813 West Walker Road	Saint Johns	1777	DAIRY
Rich Ro Farms-CAFO	MIG010118	Clinton	CAFO	Private	8317 West Colony Road	Saint Johns	3248	
Schneider Dairy-CAFO	MIG010033	Clinton	CAFO	Private	1982 South Wacousta Road	Saint Johns	2312	DAIRY
Steenblik Dairy Inc-CAFO	MIG010080	Clinton	CAFO	Private	3844 North Hubbardston Road	Pewamo	3890	DAIRY
T & H Dairy-CAFO	MIG010126	Clinton	CAFO	Private	3024 North Wright Road	Fowler	1544	DAIRY
De Saegher Dairy-CAFO	MIG010097	Gratiot	CAFO	Private	8068 West Buchanan Road	Middleton	3761	DAIRY
Double Eagle Dairy - CAFO	MIG010110	Gratiot	CAFO	Private	5742 Pendell Road	Middleton	4974	DAIRY
Four D Farms-CAFO	MINPTD012	Gratiot	CAFO	Private	7920 Osborn Rd.	Carson City	1600	SWINE
Nathan Duflo Farm-CAFO	MIG010006	Gratiot	CAFO	Private	southwest corner of Osborne and Nelson Roads	Carson City	1600	SWINE
Regal Boehs Farm-CAFO	MIG010037	Gratiot	CAFO	Private	4862 West Hayes Road	Middleton	3456	
Stewart Farms-CAFO	MIG010021	Gratiot	CAFO	Private	11334 South Ransom Road	Bannister	1920	SWINE
Vanderploeg Holsteins-CAFO	MIG010092	Gratiot	CAFO	Private	1223 South Begole Road	Ithaca	2102	
Willow Creek Farms-CAFO	MIG010114	Gratiot	CAFO	Private	305 East Rossevelt Road	Ashley	2720	SWINE
Green Meadow Farms 2 & 3-CAFO	MIG010019	Shiawassee	CAFO	Private	5853 North Meridian Road	Elsie	4350	DAIRY

Upper Maple River
Watershed Management Plan

June 2010
MDNRE Tracking Code #2007-0118

Appendix 13

Pollutant, Source, Cause for Each Subwatershed

DESIGNATED USE	PRIORITIZED POLLUTANT	PRIORITIZED SOURCE	PRIORITIZED CAUSE	PRESENCE IN WATERSHED
Other Indigenous Aquatic Life and Wildlife (impaired)	1. sediment (k)	1. cropland (k)	1. tillage practices (k)	agriculture is dominant land use; the tillage survey indicated a percentage of the watersheds having (0%-10% tillage) as follows: Doty Brook (35.1%), North Shade Drain (65.2%), Hayworth Creek (35.9%), Spring Brook (20.6%), and Pine Creek (36.6%)
			2. lack of buffers (k)	365.5 miles of unbuffered channel
			3. dense drainage network (k)	observed during NPS survey
		2. streambanks (k)	1. altered morphology and hydrology (k)	over 43,000 feet of eroded streambanks
			2. uncontrolled livestock access (k)	13 sites identified; 11,000 feet of channel impacted
			3. removal of vegetation (k)	365.5 miles of unbuffered channel
		3. gravel roads (k)	1. runoff to roadside ditch or drain (k)	observed during NPS surveys
		4. rill and gully erosion (k)	1. concentrated flow from roadside ditch (s)	3 sites identified
		5. lakeshore erosion (k)	1. boat traffic/seawalls/wave action (k)	approximately 4,000 feet of Lake Riparian Areas shoreline
		6. streambed (k)	1. headcutting (culvert placement) (s)	observed during NPS survey
			2. headcutting (altered morphology/hydrology) (s)	observed during NPS survey
Other Indigenous Aquatic Life and Wildlife (impaired) Warmwater Fishery (impaired and threatened)	2. nutrients (s); Phosphorus (k) - TMDL	1. cropland (s)	1. over or improper application of manure/fertilizers (s)	row-crop agriculture is dominant land use; 94 animal agriculture facilities
		2. livestock (s)	1. lack of buffer or setback at holding facilities adjacent channel (s)	2 holding facilities adjacent channel
			2. uncontrolled livestock access (s)	13 sites identified; 11,000 feet of channel impacted
		3. dense areas of maintained landscapes (s)	1. over or improper application of fertilizers (s)	Lake Riparian Areas
			2. lack of riparian buffer on lakes (s)	Lake Riparian Areas
		4. septic tanks (s)	1. aging systems and/or improper maintenance (s)	health department records
		5. golf courses (s)	1. over or improper application of fertilizers (s)	reaches of Ferdon Creek bisect golf course lands
			2. lack of buffers (k)	observed during NPS survey
		6. ducks and geese (s)	1. maintained lawn to edge of water (s)	Lake Riparian Areas
			2. overpopulation of waterfowl (s)	Lake Riparian Areas
Other Indigenous Aquatic Life and Wildlife (impaired) Warmwater Fishery (impaired and threatened) Partial Body Contact Recreation (threatened)	3. pathogens and bacteria (p)	1. livestock (p)	1. over or improper application of manure (p)	row-crop agriculture is dominant land use; 94 animal agriculture facilities
			2. lack of buffer or setback at holding facilities adjacent channel (s)	2 holding facilities adjacent channel
		2. septic tanks (p)	1. aging and/or improper maintenance (p)	health department records
		3. ducks and geese (p)	1. maintained lawn to edge of water (p)	Lake Riparian Areas
			2. overpopulation of waterfowl (p)	Lake Riparian Areas
Other Indigenous Aquatic Life and Wildlife (impaired) Warmwater Fishery (impaired and threatened)	4. high temperature (p)	1. lack of riparian canopy (p)	1. removal of riparian vegetation (p)	365.5 miles of unbuffered channel
			2. dense drainage network (p)	observed during NPS survey
Other Indigenous Aquatic Life and Wildlife (impaired) Warmwater Fishery (impaired and threatened)	5. pesticides (p)	1. cropland (p)	1. over or improper application of pesticides (p)	agriculture is dominant land use; the tillage survey indicated a percentage of the watersheds having (0%-10% tillage) as follows: Doty Brook (35.1%), North Shade Drain (65.2%), Hayworth Creek (35.9%), Spring Brook (20.6%), and Pine Creek (36.6%)
		2. dense areas of maintained landscapes (p)	1. over or improper application of pesticides (p)	Lake Riparian Areas
			2. lack of riparian buffer on lakes (p)	Lake Riparian Areas
		3. golf courses (s)	1. over or improper application of pesticides(s)	reaches of Ferdon Creek bisect golf course lands
			2. lack of buffers (k)	observed during NPS survey
		4. orchards (p)	1. over or improper application of pesticides(s)	reaches of Ferdon Creek bisect orchards
			2. lack of riparian buffers (k)	observed during NPS survey
Navigation	6. navigation	1. log-jams and excessive sedimentation (k)	1. lack of maintenance (k)	observed during NPS survey

PINE CREEK SUBWATERSHED
POLLUTANT, SOURCES, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use; the tillage survey indicated 36.6% of the Pine Creek watershed had (0%-10% tillage)
				2	lack of buffers (k)	27.5 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	altered morphology and hydrology (k)	9,325 feet of eroded streambanks
				2	uncontrolled livestock access (k)	3 sites identified; 4,100 feet of channel impacted
				3	removal of vegetation (k)	27.5 miles of unbuffered channel
		3	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS surveys
		4	rill and gully erosion (k)	1	concentrated flow from roadside ditch (s)	1 site identified
		5	lakeshore erosion (k)	1	boat traffic/seawalls/wave action (k)	approximately 4,000 feet of Rainbow Lake shoreline
		6	streambed (k)	1	headcutting (culvert placement) (s)	Otter Creek is incised - two culverts with potential impact
				2	headcutting (altered morphology/hydrology) (s)	Otter Creek is incised - "headwaters" are maintained drain
2	nutrients (s) phosphorus known (TMDL)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	row-crop agriculture is dominant land use; 8 animal agriculture facilities
		2	livestock (s)	1	lack of buffer or setback at holding facilities adjacent channel (s)	1 holding facility adjacent channel
				2	Uncontrolled access (k)	3 sites identified; 4,100 feet of channel impacted
		3	dense areas of maintained landscapes (s)	1	over or improper application of fertilizers (s)	Rainbow Lake
				2	lack of riparian buffer on lakes (s)	Rainbow Lake
		4	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
		5	ducks and geese (s)	1	maintained lawn to edge of water (s)	Rainbow Lake
				2	overpopulation of waterfowl (p)	Rainbow Lake
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	row-crop agriculture is dominant land use; 8 animal agriculture facilities
				2	lack of buffer or setback at holding facilities adjacent channel (p)	1 holding facility adjacent channel
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
		3	ducks and geese (p)	1	maintained lawn to edge of water (p)	Rainbow Lake
				2	overpopulation of waterfowl (p)	Rainbow Lake
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	27.5 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use; results of tillage survey (0%-10% tillage)
		2	maintained landscapes (p)	1	over or improper application of pesticides (p)	Rainbow Lake
				2	lack of riparian buffer on lakes (p)	Rainbow Lake
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

HAYWORTH CREEK SUBWATERSHED
POLLUTANT, SOURCES, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use; the tillage survey indicated 35.9% of the Hayworth Creek watershed had (0%-10% tillage)
				2	lack of buffers (k)	28.8 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	Uncontrolled livestock access (k)	3 cattle access sites
				2	altered morphology and hydrology (k)	7,365 feet of eroded streambanks
				3	removal of vegetation (k)	28.8 miles of unbuffered channel
		3	gravel roads (s)	1	runoff to roadside ditch or drain (s)	observed during NPS surveys
2	nutrients (s) phosphorus known (TMDL)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	row-crop agriculture is dominant land use; 11 animal agriculture facilities, including 3 CAFOs
		2	livestock (s)	1	lack of buffer or setback at holding facilities adjacent channel (s)	1 dairy operation with suspected loading; 450 feet of channel
				2	Uncontrolled livestock access (s)	3 cattle access sites
		3	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	row-crop agriculture is dominant land use; 11 animal agriculture facilities, including 3 CAFOs
				2	lack of buffer or setback at holding facilities adjacent channel (p)	1 dairy operation with suspected loading; 450 feet of channel
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	28.8 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use; the tillage survey indicated 35.9% of the Hayworth Creek watershed had (0%-10% tillage)
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

NORTH SHADE SUBWATERSHED
POLLUTANT, SOURCES, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use; the tillage survey indicated 65.2% of the North Shade Drain watershed had (0%-10% tillage)
				2	lack of buffers (k)	26.9 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	gravel roads (s)	1	runoff to roadside ditch or drain (s)	observed during NPS surveys
		3	streambanks (k)	1	Uncontrolled livestock access (k)	1 cattle access site
				2	altered morphology and hydrology (k)	1 streambank erosion site
				3	removal of vegetation (k)	26.9 miles of unbuffered channel
2	nutrients (s) phosphorus known (TMDL)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	row-crop agriculture is dominant land use; 12 animal agriculture facilities, including 4 CAFOs
		2	livestock (s)	1	Uncontrolled livestock access (s)	1 cattle access site
				2	lack of buffer or setback at holding facilities adjacent channel (s)	1 holding facility sloped toward channel - 1,425 feet
		3	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	row-crop agriculture is dominant land use; 12 animal agriculture facilities, including 4 CAFOs
				2	lack of buffer or setback at holding facilities adjacent channel (p)	1 holding facility sloped toward channel - 1,425 feet
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	26.9 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use; the tillage survey indicated 65.2% of the North Shade Drain watershed had (0%-10% tillage)
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

RIVER STYX SUBWATERSHED
POLLUTANT, SOURCES, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use
				2	lack of buffers (k)	31 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS surveys
		3	streambanks (s)	1	altered morphology and hydrology (k)	observed during NPS survey
				2	removal of vegetation (k)	31 miles of unbuffered channel
2	nutrients (s) phosphorus known (TMDL)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	row-crop agriculture is dominant land use; 13 animal agriculture facilities, including 2 CAFOs
		2	livestock (s)	1	lack of buffer or setback at holding facilities adjacent channel (s)	3 dairy operations with suspected loading directly to channel; 1,700 feet
		3	septic tanks (s)	1	aging systems and/or aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	row-crop agriculture is dominant land use; 13 animal agriculture facilities, including 2 CAFOs
				2	lack of buffer or setback at holding facilities adjacent channel (p)	3 dairy operations with suspected loading directly to channel; 1,700 feet
		2	septic tanks (p)	1	aging systems and/or aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	31 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

SOUTH FORK HAYWORTH DRAIN SUBWATERSHED
POLLUTANT, SOURCES, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use
				2	lack of buffers (k)	23.6 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	altered morphology and hydrology (k)	15 streambank erosion sites; 1,395 feet of channel
				2	removal of vegetation (k)	23.6 miles of unbuffered channel
				3	Uncontrolled livestock access (k)	2 cattle access sites
		3	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS survey
2	nutrients (s)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	row-crop agriculture is dominant land use; 7 animal agriculture facilities, including 2 CAFOs; dairy population exceeds 4,050 animals
		2	livestock (s)	1	lack of buffer or setback at holding facilities adjacent channel (s)	1 dairy operation with suspected nutrient loading to channel
		3	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	row-crop agriculture is dominant land use; 7 animal agriculture facilities, including 2 CAFOs; dairy population exceeds 4,050 animals
				2	lack of buffer or setback at holding facilities adjacent channel (p)	1 dairy operation with suspected nutrient loading to channel
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	23.6 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

COLLIER CREEK SUBWATERSHED
POLLUTANT, SOURCES, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use
				2	lack of buffers (k)	24.2 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	cattle access (k)	1 cattle access site; 2,800 feet of access
				2	altered morphology and hydrology (k)	16,060 feet of streambank erosion
				3	removal of vegetation (k)	24.2 miles of unbuffered channel
		3	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS survey
2	nutrients (s) phosphorus known (TMDL)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	row-crop agriculture is dominant land use; 2 animal agriculture facilities, including 1 CAFO
		2	livestock (s)	1	Uncontrolled access to channel (s)	1 cattle access site; 2,800 feet of access
				2	lack of buffer or setback at holding facilities adjacent channel (s)	1 cattle access site; 2,800 feet of access
		3	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	row-crop agriculture is dominant land use; 2 animal agriculture facilities, including 1 CAFO
				2	lack of buffer or setback at holding facilities adjacent channel (p)	1 cattle access site; 2,800 feet of access
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	24.2 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

FERDON CREEK SUBWATERSHED
POLLUTANT, SOURCES, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use
				2	lack of buffers (k)	33.3 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	cattle access (k)	1 cattle access site, 2,500 feet of channel
				2	altered morphology and hydrology (k)	17,120 feet of streambank erosion
				3	removal of vegetation (k)	33.3 miles of unbuffered channel
		3	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS survey
2	nutrients (s) phosphorus known (TMDL)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	row-crop agriculture is dominant land use; 8 animal agriculture facilities, including 2 CAFOs
		2	livestock (s)	1	Uncontrolled access to channel (s)	1 cattle access site, 2,500 feet of channel
				2	lack of buffer or setback at holding facilities adjacent channel (s)	
		3	golf courses (s)	1	over or improper application of fertilizers (s)	two golf courses; 230 acres of land; 5,450 feet of channel
		4	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	row-crop agriculture is dominant land use; 8 animal agriculture facilities, including 2 CAFOs
				2	lack of buffer or setback at holding facilities adjacent channel (p)	
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	33.3 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use
		2	golf courses (p)	1	over or improper application of pesticides (p)	two golf courses; 230 acres of land; 5,450 feet of channel
		3	orchard (p)	1	over or improper application of pesticides (p)	25 acres of land; 1,420 feet of channel
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

SPRING BROOK SUBWATERSHED
POLLUTANT, SOURCES, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use; the tillage survey indicated 20.6% of the Spring Brook watershed had (0%-10% tillage)
				2	lack of buffers (k)	9.9 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	rill and gully erosion	1	tillage practices (k)	one site identified
		3	streambanks (s)	1	altered morphology (k)	none identified; not included in detailed assessment
				2	removal of vegetation (k)	9.9 miles of unbuffered channel
		4	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS survey
2	nutrients (s)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	agriculture is dominant land use; 1 animal agriculture facility
		2	maintained landscapes (s)	1	over or improper application of fertilizers (s)	observed in "Lakes" region
				2	lack of riparian buffer on lakes (s)	observed in "Lakes" region
		3	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
		4	ducks and geese (s)	1	maintained lawn to the edge of lake (s)	observed in "Lakes" region
				2	overpopulation of waterfowl (s)	observed in "Lakes" region
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	agriculture is dominant land use; 1 animal agriculture facility
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
		3	ducks and geese (p)	1	maintained lawn to the edge of lake (p)	observed in "Lakes" region
				2	overpopulation of waterfowl (p)	observed in "Lakes" region
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	9.9 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use; results of tillage survey
		2	maintained landscapes (p)	1	over or improper application of pesticides (p)	observed in "Lakes" region
				2	lack of riparian buffer on lakes (p)	observed in "Lakes" region
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

COON CREEK SUBWATERSHED
POLLUTANT, SOURCE, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use
				2	lack of buffers (k)	9 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	altered morphology and hydrology (k)	erosion site at mouth, not quantified; not included in detailed assessment
				2	removal of vegetation (k)	9 miles of unbuffered channel
		3	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS survey
2	nutrients (s)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	agriculture is dominant land use
		2	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	agriculture is dominant land use
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	9 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

BAKER CREEK SUBWATERSHED
POLLUTANT, SOURCE, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use
				2	lack of buffers (k)	13.8 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	altered morphology and hydrology (k)	3 streambank erosion areas not quantified; not included in detailed assessment
				2	removal of vegetation (k)	13.8 miles of unbuffered channel
		3	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS survey
2	nutrients (s)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	agriculture is dominant land use; 8 animal agriculture facilities, including 2 CAFOs
		2	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	agriculture is dominant land use; 8 animal agriculture facilities, including 2 CAFOs
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	13.8 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

ALDER CREEK SUBWATERSHED
POLLUTANT, SOURCE, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use
				2	lack of buffers (k)	18.4 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	altered morphology and hydrology (k)	ubiquitous but minor erosion observed, not quantified;
				2	livestock access (k)	1 site identified; 1,600 feet of erosion
				3	removal of vegetation (k)	18.4 miles of unbuffered channel
		3	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS survey
2	nutrients (s) phosphorus known (TMDL)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	agriculture is dominant land use
		2	livestock (s)	1	lack of buffer or setback at holding facilities adjacent channel (s)	many small farms with 2-12 animals; runoff observed
		3	dense area of maintained landscapes (s)	1	over or improper application of fertilizers (s)	Lake Victoria
				2	lack of riparian buffer on lakes (s)	Lake Victoria
		4	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	agriculture is dominant land use
				2	lack of buffer or setback at holding facilities adjacent channel (p)	many small farms with 2-12 animals; runoff observed
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	18.4 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use
		2	dense area of maintained landscapes (p)	1	over or improper application of pesticides (p)	Lake Victoria
				2	lack of riparian buffer on lakes (p)	Lake Victoria
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

NILES DRAIN SUBWATERSHED
POLLUTANT, SOURCE, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use
				2	lack of buffers (k)	61 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	altered morphology and hydrology (k)	numerous eroded banks identified on Bear Creek; not quantified or included in detailed assessmen
				2	removal of vegetation (k)	61 miles of unbuffered channel
		3	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS surveys
2	nutrients (s)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	agriculture is dominant land use
		2	livestock (s)	1	lack of buffer or setback at holding facilities adjacent channel (s)	3 small farms identified; one dairy, one horse, one bee!
		3	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	agriculture is dominant land use
				2	lack of buffer or setback at holding facilities adjacent channel (p)	3 small farms identified; one dairy, one horse, one bee!
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	61 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

STEVENS DRAIN SUBWATERSHED
POLLUTANT, SOURCE, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use
				2	lack of buffers (k)	15 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	altered morphology and hydrology (k)	3 eroded streambank areas identified, not quantified; not included in detailed assessment
				2	removal of vegetation (k)	15 miles of unbuffered channel
				3	livestock access (k)	1 site identified with animal in channel
		3	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS survey
2	nutrients (s) phosphorus known (TMDL)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	agriculture is dominant land use; 9 animal agriculture facilities
		2	livestock (s)	1	lack of buffer or setback at holding facilities adjacent channel (s)	1 feedlot adjacent drain
		3	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	agriculture is dominant land use; 9 animal agriculture facilities
				2	lack of buffer or setback at holding facilities adjacent channel (p)	9 animal agriculture facilities
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	15 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

DOTY BROOK SUBWATERSHED
POLLUTANT, SOURCE, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use; the tillage survey indicated 35.1% of the Doty Brook watershed had (0%-10% tillage)
				2	lack of buffers (k)	7.2 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	altered morphology and hydrology (k)	3 areas of streambank erosion identified, not quantified
				2	removal of vegetation (k)	7.2 miles of unbuffered channel
		3	rill and gully erosion	1	tillage practices (k)	1 site identified
		4	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS survey
2	nutrients (s)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	agriculture is dominant land use; the tillage survey indicated 35.1% of the Doty Brook watershed had (0%-10% tillage)
		2	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	agriculture is dominant land use; the tillage survey indicated 35.1% of the Doty Brook watershed had (0%-10% tillage)
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	7.2 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use; the tillage survey indicated 35.1% of the Doty Brook watershed had (0%-10% tillage)
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

LITTLE MAPLE RIVER SUBWATERSHED
POLLUTANT, SOURCE, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use
				2	lack of buffers (k)	12.7 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	altered morphology and hydrology (k)	1 area of streambank erosion identified, not quantified; not included in detailed assessment
				2	removal of vegetation (k)	12.7 miles of unbuffered channel
		3	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS survey
2	nutrients (s)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	agriculture is dominant land use; 5 animal agriculture facilities
		2	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
		3	ducks and geese (s)	1	overpopulation of waterfowl (s)	discussion with MDNR at Lake Ovid
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	agriculture is dominant land use; 5 animal agriculture facilities
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	12.7 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

OVID-MAPLE RIVER SUBWATERSHED
POLLUTANT, SOURCE, CAUSE TABLE

Pollutant Priority	POLLUTANT	Source Priority	SOURCE	Cause Priority	CAUSE	PRESENCE IN WATERSHED
1	sediment (k)	1	cropland (k)	1	tillage practices (k)	agriculture is dominant land use
				2	lack of buffers (k)	23.2 miles of unbuffered channel
				3	dense drainage network (k)	observed during NPS survey
		2	streambanks (k)	1	altered morphology and hydrology (k)	3 areas of streambank erosion identified, not quantified; not included in detailed assessment
				2	removal of vegetation (k)	23.2 miles of unbuffered channel
		3	gravel roads (k)	1	runoff to roadside ditch or drain (k)	observed during NPS survey
2	nutrients (s)	1	cropland (s)	1	over or improper application of manure/fertilizers (s)	agriculture is dominant land use; 7 animal agriculture facilities
		2	septic tanks (s)	1	aging systems and/or improper maintenance (s)	health department records
3	pathogens and bacteria (p)	1	livestock (p)	1	over or improper application of manure (p)	agriculture is dominant land use; 7 animal agriculture facilities
		2	septic tanks (p)	1	aging systems and/or improper maintenance (p)	health department records
4	high temperature (p)	1	lack of riparian canopy on cropland (p)	1	removal of riparian vegetation (p)	23.2 miles of unbuffered channel
				2	dense drainage network (p)	observed during NPS survey
5	pesticides (p)	1	cropland (p)	1	over or improper application of pesticides (p)	agriculture is dominant land use
		2	junkyard (p)	1	storage of junk vehicles near stream (p)	1 site identified
6	navigation (k)	1	log-jams and excessive sedimentation (k)	1	lack of maintenance (k)	observed during NPS surveys

(k) known
(s) suspected
(p) potential

Upper Maple River
Watershed Management Plan

June 2010
MDNRE Tracking Code #2007-0118

Appendix 14

BMP Master List

Best Managerial Practices	Description	Benefit	Pollutant Addressed	Potential Sources of Pollutants	Environmental Impacts and Special Concerns	Comparative Costs	MDEQ/NRCS Link
Agricultural							
Crop Residue Management (329A-C, 344), includes no till, mulch till, ridge till, and seasonal	Leaving last year's crop residue on the surface before and during planting operations, providing soil cover at a critical time of the year. The residue is left on the surface by reducing tillage operations and turning the soil less. Pieces of crop residue shield soil particles from rain and wind until plants can produce a protective canopy.	Ground cover prevents soil erosion and protects water quality. Residue improves soil tilth and adds organic matter to the soil as it decomposes. Fewer trips and less tillage reduce soil compaction.	Sediment and attached pollutants	Agricultural runoff, soil erosion	Consider if crop will produce enough residue. Planning for residue cover should begin at harvest. Time, energy, and labor savings are possible with fewer tillage trips. Equipment for specialized tillage techniques needed. Additional chemical treatments may be necessary to control pests. Assistance available from USDA office or Conservation District. No local government controls in place. Crop reside reduces the velocity of storm water runoff and improves infiltration	$28-36/acre (includes no-till and strip till, ridge till) (11). Maintenance costs are 100% of original cost (11). Environmental Quality Incentive Program (EQIP) (for mulch till, ridge till, and seasonal residue management). Equipment rental or purchase $40+ per acre. Consider costs for pest control.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/329a.pdf ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/329b.pdf ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/329c.pdf ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/344.pdf
Conservation Crop Rotation (328)	A sequence of crops designed to provide adequate organic residue for maintenance or improvement of soil tilth and fertility. Other BMPs to use include nutrient and pest management, buffer/filter strips, cover crops	Reduces sheet, rill, and wind erosion Maintains or improve soil organic matter content Manages the balance of plant nutrients Improves water use efficiency Manages saline seeps Manages plant pests (weeds, insects, and diseases) Provides food and cover for wildlife Reduces fertilizer needs and may reduce pesticide needs	Sediment and attached pollutants	Soil erosion, agricultural runoff	Rotations that include grains, such as corn, or meadow provide better erosion control. Where excess plant nutrients or soil contaminants are a concern, utilizing deep rooted crops or cover crops in the rotation can help recover or remove the nutrient or contaminant from the soil profile. Over application of fertilizer or pesticide is possible. Plants will reduce the velocity of storm water runoff and increase infiltration.	$4.00/acre (11) - EQIP	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/328.pdf
Planned Grazing System	Pasture is divided into two or more pastures or paddocks with fencing. Cattle are moved from paddock to paddock based on forage availability and livestock nutrition needs. Other BMPs to use include alternative water source, cattle exclusions, nutrient management, and soil testing	Improves vegetative cover, reduces erosion, and improves water quality by reducing sediment and nutrient runoff. Rotating also evenly distributes manure and nutrient resources.	Sediment and attached pollutants, nutrients, pathogens	Soil erosion, agricultural runoff	Keep fencing secure. Apply fertilizer and nutrients according to soil tests, mow or hay paddocks if needed and update rotation schedule if needed. Practice is widely applicable. Consider adequacy of the mix of grass and legumes to meet livestock needs. Sediment and nutrient runoff is not eliminated just reduced. This practice will increase harvest efficiently and help ensure adequate forage throughout the grazing season.	EQIP can fund establishment. $25/acre for maintenance (14)	
Irrigation Water Management (449)	Determining and controlling the rate, amount, and timing of irrigation water in a planned and efficient manner. Other BMPs to use include nutrient management, pest management, crop residue management, soil conservation measures	Management of the irrigation system should provide the control needed to minimize losses of water and discharge of sediment and sediment-attached and dissolved substances, such as plant nutrients and herbicides.	Sediment and attached pollutants, nutrients, hydrologic flow	Agricultural runoff	Poor management may allow the loss of dissolved substances from the irrigation system to surface or groundwater. There is an insignificant reduction in runoff/flooding and slight reduction in excess subsurface water. Consider the effects irrigation water has on wetlands, water related wildlife habitats, riparian areas, cultural resources, and recreation opportunities.	EQIP can fund establishment.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/449.pdf
Contour Strip Cropping (585)	Crop rotation and contouring combined in equal-width strips of corn or soybeans planted on the contour and alternated with strips of oats, grass, or legumes. Other BMPs to use include field border, fertilizer management, grassed waterways.	Meadow slows runoff, increases infiltration, traps sediment and provides surface cover. Ridges formed by contoured rows slow water flow which reduces erosion. May reduce fertilizer costs.	Sediment and attached pollutants, hydrologic flow	Agricultural runoff, soil erosion	Keep strip widths consistent from year to year. Make adjustments in rotation schedule if needed. Over application of fertilizer possible, if used. Will reduce the velocity of storm water runoff and increase infiltration. Strip cropping is not as effective if crop strips become too wide, especially on steep slopes.	$10/acre (9) - EQIP	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/585.pdf

Best Managerial Practices	Description	Benefit	Pollutant Addressed	Potential Sources of Pollutants	Environmental Impacts and Special Concerns	Comparative Costs	MDEQ/NRCS Link
Contour Farming (330)	Hillsides are cultivated and planted in rows along the hillside contour, not up and down the hill. Crop row ridges on the contour create hundreds of small berms. Other BMPs to use include field border, grassed waterways, and terraces or strip cropping if needed.	Reduces sheet and rill erosion and transport of sediment and other water-borne contaminants. Ridges built by tilling and planting on the contour, slow water flow and increase infiltration, which reduces erosion by as much as 50% from up and down hill farming.	Sediment and attached pollutants, hydrologic flow	Agricultural runoff, soil erosion	To avoid having to lay out new contour lines every year, establish a narrow permanent strip of grass along each key contour line. All tillage and planting operations should be performed parallel to the key contour line. Contour farming will reduce the velocity of storm water runoff, increase infiltration, moderately decrease runoff/ flooding, and slightly increase excess subsurface water. Contouring is less effective in preventing soil erosion on steeper or longer slopes.	$10/acre (9)	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/330.pdf
Pest Management (595)	Crops are scouted to determine type of pests and the stage of development. The potential damage of the pest is then weighed against the cost of control. Finally, if pest control is economical, all alternatives are evaluated based on cost, results, and environmental impact. Precaution is taken to keep any chemicals from leaving the field by leaching, runoff, or drift. Other BMPs include buffer/filter strips, crop rotation, and erosion control measures.	Treatments tailored for specific pests on identified areas of a field prevent over-treatment of pests. Using fewer chemicals improves water quality.	Chemicals (Pesticide)	Agricultural runoff	Continual scouting to best identify pests and control methods. Keep records to track costs and chemical application. Calibrate spray equipment. Consider which soils on farm are likely to leach pesticides. Consider pest control alternatives.	100% of cost/unit (11) - EQIP	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/595.pdf
Nutrient Management (590) CNMP	Crop nutrient needs are determined after a soil test, setting realistic yield goals, and taking credit for contributions from previous years' crops and manure applications, crop nutrient needs are determined. Nutrients are then applied at the proper time by the proper application method. Nutrient sources include animal manure, sludge, and commercial fertilizers. Other BMPs include manure testing, soil testing, soil conservation measures, waste management system, waste storage facility, and waste utilization.	This practice properly budgets and supplies nutrients for plant production. It also reduces the potential for nutrients to infiltrate into water supplies by preventing over application. Correct manure and sludge application on all fields can improve soil tilth and organic matter. It is very applicable on Concentrated Animal Feeding Operations (CAFOs).	Nutrients	Agricultural runoff, over application of fertilizers.	Maintenance requirements: - Perform a periodic plan review to determine necessary adjustments - Protect nutrient storage facilities from weather and accidental leakage/spillage - Calibrate application equipment and document application rates - Spread wastes away from waterbodies on an adequate land base and incorporate ASAP - Analyze manure and other organic waste for nutrient content before field application and determine appropriate application rate - Test soils once every three years according to Extension recommendations - Establish a winter cover crop if nitrogen leaching is possible due to poor crop yield * Consider the Michigan Agriculture Environmental Assurance Program (MAEAP). The CNMP must be developed by a trained technical person (service provided by NRCS or Conservation District). Consider potential groundwater contamination - proximity to waterbodies critical.	$5/acre (9) - EQIP (Costs associated with waste water collection, soil testing, integrated crop management are low but have a high start up.)	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/590.pdf

Best Managerial Practices	Description	Benefit	Pollutant Addressed	Potential Sources of Pollutants	Environmental Impacts and Special Concerns	Comparative Costs	MDEQ/NRCS Link
Organic Farming Practices	Organic farming differs from other farming systems in a number of ways. It favors renewable resources and recycling, returning to the soil the nutrients found in waste products. Where livestock is concerned, meat and poultry production is regulated with particular concern for animal welfare and by using natural foodstuffs. Organic farming respects the environment's own systems for controlling pests and disease in crops and livestock. Organic farmers use a range of techniques that help sustain ecosystems and reduce pollution. Other BMPs include filter/buffer strips, crop rotation, organic manuring, composting, limited chemical intervention, conservation of wildlife and natural habitats, management of livestock, recycling of organic materials.	Organic farming conserves biodiversity, provides a wide range of habitats, saves energy, improves soil fertility, and protects groundwater and surface waters from nitrates, phosphates, and pesticides. Organic food is grown without using any synthetic pesticides, herbicides, insecticides, fungicides, fertilizers, or hormones.	Nutrients, chemicals (pesticides)	Agricultural runoff	Organic farming methods are usually more labor intensive than conventional farming, so the cost of organic farming will usually be more.	EQIP funds supporting practices such as cover crops, conservation crop rotation, nutrient management, pest management.	
Soil Testing of Cropland	For proper management, a soil test for available nutrients should be made every 3-5 years. Use Integrated Crop Management (ICM)	Testing will help prevent over application of nutrients from fertilizers, manures and other sources.	Nutrients	Agricultural runoff.	Soil should be tested to determine nutrient levels. Care should be taken to not add nutrients already present in adequate levels. Soil testing should be undertaken by lab or local Michigan State University Extension (MSUE) office. Proper collection of a soil sample is important. Accuracy of analysis depends on the collection of a representative soil sample.	Costs associated with Integrated Crop Management (ICM). Typically a yearly expense. Low cost technique of monitoring soil. EQIP	
Agriculture Incentive Programs	Farm Bill programs that offer a rental payment to landowners that agree to take environmentally sensitive areas out of production. Continuous sign-ups for these programs are available to riparian and wetland areas. Rental rates are set by county boards.	Creates incentive for landowners to conserve riparian buffers, wetlands, and wildlife habitats.	Sediment, nutrients, hydrologic flow, pathogens, chemicals (pesticides)	Agricultural runoff	Property enrolled in Farm Bill programs are not protected in perpetuity. Fertilizer cannot be applied to areas under contract. In some cases, land values or crop yields may discourage landowners to use these incentive programs.	In some counties soil rental rates can be very high.	http://www.nrcs.usda.gov/programs
Zoning Ordinances/Land Use Policies							
Stronger County and State Regulatory Oversight of Over Application and Misapplication of Septage	Stronger regulatory oversight can ensure that septage is applied correctly and limited to those areas where it is appropriate. Septic system alternatives should be encouraged where such alternatives prove economical and technically sufficient in order to protect public health and the environment.	Stronger regulatory oversight will reduce the over application and misapplication of septage and help prevent nutrients and *E.coli* from entering waterbodies.	Nutrients, *E. coli*	Agricultural runoff	If existing and future regulations are not enforced, they will be useless in preventing over application and misapplication of septage		
Development/Enforcement of Storm Water Ordinance	An ordinance can provide for the regulation and control of storm water runoff; provide for storm water permits and the procedures and standards for the issuance; provide regulations for the inspection, sampling and monitoring of storm water and other discharges; establish performance and design standards for storm water management in specified zones of the township/municipality; and provide penalties for the violations of the ordinance.	Storm water runoff rates and volumes are controlled in order to protect floodways. Controls soil erosion and sedimentation; minimizes deterioration of existing watercourses, culverts, bridges, etc.; and encourages groundwater recharge.	Sediment and attached pollutants, hydrologic flow	Storm water runoff	Establishing storm water management control will minimize storm water runoff rates and volumes from identified new land development and encourage groundwater recharge. Proposed Model Storm Water Ordinance for Kent County recommends the following release rates: 0.05 cfs/acre for a 2-year storm event for Zone A; 0.13 cfs/acre per Kent County Drain Commission rules for Zone B	$8,000/ordinance development (Grand Valley Community Survey)	
Development/Enforcement of Stream Buffer Ordinance	Ordinance protects a given area of buffer adjacent to stream systems. Protected buffers can provide numerous environmental protection and resource management benefits.	Moderate to high. Reduces the risk of sediment and contaminants entering the stream. Provides long term solution to water quality concerns.	Sediment and attached pollutants, nutrients, thermal pollution	Storm water runoff from impervious surfaces (e.g. parking lots and roof tops) and outflow from ponds.	Lack of maintenance can increase erosion if trees fall into streams. At a minimum, keep south and west sides of streams wooded to provide shade. Trees in floodway can impede flow.	$8,000/ordinance development (Grand Valley Community Survey)	

Best Managerial Practices	Description	Benefit	Pollutant Addressed	Potential Sources of Pollutants	Environmental Impacts and Special Concerns	Comparative Costs	MDEQ/NRCS Link
Development/Enforcement of Wetland Ordinance	Ordinance promotes a policy to avoid or minimize damage to wetlands and coordinate the planning and zoning process with federal and state wetland programs.	Wetland benefits are preserved. Wetlands provide natural pollution control by removing pollutants, filtering and collecting sediment, reducing both soil erosion and downstream flooding, and recharging groundwater supplies.	Sediment and attached pollutants, hydrologic flow, nutrients, pathogens, chemicals (pesticides), salts	Storm water runoff	Part 303, section 324.30307 authorizes local units of government to adopt and administer their own wetland regulations that address wetlands not protected by the state, provided they are at least as restrictive as state regulations. The DEQ must be notified if a community adopts a wetland ordinance, but it has no review or approval authority.	$8,000/ordinance development (Grand Valley Community Survey)	
Green Space Protection Ordinance	Ordinance preserves environmentally sensitive and open areas. Can also use filter strips and tree planting to enhance protection.	High if properly executed. Provides protection of natural pollutant removal methods.	Thermal pollution, sediment, nutrients, hydrologic flow	Construction zones, developed parcels, agricultural land		$3/sq. ft. Land acquisition and management costs depend on site. Affected property may double as park/open space usage with related costs.	
Low Impact Design Practices	Land use planning to incorporate practices onsite. Examples include: bioretention, dry wells, filter strips, vegetated buffers, grass swales, rain barrels, cisterns, infiltration trenches. Involves careful site planning to reduce the impact to water resources by eliminating impervious surfaces and protecting infiltration areas.	Numerous water quality benefits. Long term solution to concerns.	Thermal pollution, solids, sediments, nutrients, metals	Rainfall, runoff, solar, fertilizers			http://www.lid-stormwater.net/
Illicit Discharge Ordinance (MDOT)	Program to seek out and prohibit illicit discharges and connections to municipal separate storm sewers	High if properly executed. Eliminate hazardous and harmful discharges	Hazardous wastes	Industrial, residential, commercial		$2/ac (assuming 1 system monitored every 5 sq. miles). Maintenance program. $0.83/acre/year, $50/ac/yr (with TV inspection)	
Pet Waste Disposal Ordinance	Ordinance to require pet owners to clean up after their pets. Can be enhanced by installing signs and pet waste collection facilities in high traffic areas	Moderate	Nutrients, bacteria	Animals, dogs or other household pets			
Development/Enforcement of Septic System Ordinance	Ordinance abates water pollution caused by failing onsite sewage disposal systems, minimizes infiltration of seepage from systems into the storm water drainage system, and establishes penalties for its violation.	Ordinance can be used to enforce regular maintenance of disposal systems, which will minimize threats to public health and combat the degradation of surface and subsurface waters.	Bacteria	Septic systems	Lack of ordinance enforcement (regular inspection) can introduce pollution into groundwater reserves.	$8,000/ordinance development (Grand Valley Community Survey)	
Development/Enforcement of Yard and Kitchen Waste Ordinance	Ordinance prohibits the disposal of yard and kitchen waste on streambanks and outlines acceptable disposal methods, such as composting or disposal at a permitted disposal facility.	Proper disposal of yard and kitchen waste ensures that nutrients from these materials are not released into surface and groundwater supplies.	Nutrients	Upland source (yard/kitchen waste)	If yard and kitchen waste are composted on landowner's premises, nutrient runoff should not reach nearby surface water bodies.	$8,000/ordinance development (Grand Valley Community Survey)	
Development/Enforcement of Watercraft Control Ordinance	Ordinance prohibits the operator of a recreational watercraft to exceed a "slow - no wake" speed when within x feet of the shoreline.	Enforcing "no wake" zones will reduce streambank erosion.	Sediment and attached pollutants	Recreational watercraft	Issues concerning trespass, disorderly conduct, or damage caused to private property by the wake of vessels are not valid safety considerations for establishing a local ordinance.	$8,000/ordinance development (Grand Valley Community Survey)	
Public Access Ordinance	Ordinance controls access to a designated waterbody by limiting hours of access, number of users, etc.	By controlling public access to a waterbody, sediment pollution is reduced.	Sediment and attached pollutants	Public access, boat wakes	Consider using porous/ modular pavement at boat launches locations.	$8,000/ordinance development (Grand Valley Community Survey)	
Development/Enforcement of Fertilizer Ordinance	Ordinance prohibits the use of fertilizers containing more than 1% by weight of anhydric phosphoric acid.	Moderate; other sources of phosphorus may be present in the watershed.	Phosphorus	Fertilizers	Sources of low phosphorus fertilizers are few.	$8,000/ordinance development (Grand Valley Community Survey)	
Recycling/Composting							
Household Hazardous Waste Management	Proper buying, using, storing and disposal of Hazardous materials such as automotive waste, household cleaners and paint.	Moderate: eliminates disincentives and discourages illegal dumping of products into storm sewers and onto the ground	Hazardous wastes	Residents: Used oil, paints, cleaning products, etc.	Proper credentials needed for management. Typically consultant based.	Recycling station expenses.	http://www.deq.state.mi.us/documents/deq-swq-nps-hhhw.pdf
Composting	Converting plant debris, grass, leaves, pruned branches, etc. to compost. Use with lawn maintenance, pesticide and fertilizer management, and diversions (if needed)	Keeping organic debris out of surface waters and away from floodplains. Will help prevent the depletion of oxygen in surface waters. Widely applicable to dense residential or riparian sites.	Nutrients, chemicals, and pesticides, low dissolved oxygen, trash and debris	neighborhoods, agricultural areas, yard, and kitchen waste	Compost piles placed near floodplains will contribute to the depletion of oxygen in surface waters. Composting requires proper aeration, watering, and mixing in order to result in a useable end-product. Soils, topography and climate will all affect the types of composting options available.	Recycling vs. garbage hauler costs. Establishment of large scale facility $190,000, land dependant. $70,000 annual maintenance.	

Best Managerial Practices	Description	Benefit	Pollutant Addressed	Potential Sources of Pollutants	Environmental Impacts and Special Concerns	Comparative Costs	MDEQ/NRCS Link
Yard Waste Collection and Disposal Program	Municipalities collect yard waste for compost.	Widely applicable to dense residential or riparian sites	Nutrients and organic sediment, trash and debris	Yard waste and leaf litter	Waste needs to be composted and correctly applied as fertilizer. Need large collection facility for compost operations.	Low	
Recycling Program (MDOT)	Collection of recyclable materials either by curb-side pick up or at drop off centers	Reduction in potential clogging and harmful discharge	Trash, used construction material reuse	Highways, travelers, vehicle debris	Some materials may require more energy to collect and recycle than using new products. However, recycling programs do build awareness	$200,000/year. $1.15/person/yr.	
Used Oil Recycling Program (MDOT)	Central collection facilities that allow residents to drop off used motor oil. Can be operated by local governments or businesses that recycle oil.	Reduces risk of surface water and groundwater contamination	Used oil and other transportation fluids reuse, hydrocarbons, metals, nutrients	Vehicle maintenance facilities. Vehicles or other equipment requiring lubrication.	Oil may easily become contaminated during collection making it a hazardous waste.	$79 - $179 recovery charge. Administrative costs to organize. Minimal personnel cost to collect and temporarily store oil. Opportunity to be paid by private business for waste material	
Turf Management							
Pesticide Management for Turf Grass and Ornamentals	Use of all available strategies (resistant turf, cultural controls, biological controls, mechanical controls and pesticides) to manage pests so that an acceptable yield and quality can be achieved economically with the least disruption to the environment. Used with lawn maintenance, fertilizer management, and soil management.	Moderate to High	Harmful chemicals, pesticides, insecticides	Landscaping, storm water runoff	Must have proper training and credentials to commercially apply pesticides and manage turf.	Pesticide management should reduce application rates and related costs.	http://www.deq.state.mi.us/documents/deq-swq-nps-pm.pdf
Lawn Maintenance	Includes mowing, irrigating, pesticide and fertilizer management, soil management and the disposal of organic debris such as lawn clippings and leaves.		Phosphorus, nutrients, and sediments	Landscaping, storm water runoff	Consider minimizing lawn with more native species	Lawn alternatives may reduce mowing but still require regular maintenance of weed control and pest management.	http://www.deq.state.mi.us/documents/deq-swq-nps-lm.pdf
Fertilizer Management	Includes the proper selection, use, application, storage and disposal of fertilizers. Used with pesticide management, lawn maintenance, and nutrient management	Moderate	Nutrients	Landscaping, storm water runoff	Consider consulting professional, such as Michigan State University Extension (MSUE)	Material cost reduction may conflict with traditional aesthetic values. Fertilizer management should reduce chemical costs but may impact maintenance and watering.	http://www.deq.state.mi.us/documents/deq-swq-nps-fm.pdf
Soil Testing of Lawns and Gardens			Nutrients	Lawn and garden fertilizer	Testing should be done at qualified lab	Typically yearly testing required, contact local MSUE office. Test results may result in operations and maintenance costs. Low cost tool in management of lawns and gardens. $9.50 per test.	
Operations and Maintenance							
Operation and Maintenance Programs			Sediment, hydrocarbons, metals, nutrients	Erosion of road footprint and related infrastructure, leaking equipment, etc.		Labor intensive. Equipment required.	
BMP Inspection and Maintenance Plan for Roads (MDOT)		A regular inspection and maintenance program will maintain the effectiveness and structural integrity of the BMPs.	Sediment, hydrocarbons, metals, nutrients, etc.	Road related sediments/pollutants	Materials needed for emergency structural repairs may not be easily obtainable and may require stockpiling (MDOT). Should be designed and implemented by trained professional.	$150-$9,000 depending on the BMP. Specialized BMP installation involves planning, design, construction and maintenance costs.	
Material Management Plan (MDOT)	Identified hazardous and non-hazardous materials in the facility. Assures that all containers have labels. Identifies hazardous chemicals that require special handling, storage, and disposal.		Chemicals and other potentially hazardous materials.	Varies depending on type of material usage at specific facilities. Oil, salt, degreasers, solvents, antifreeze, etc. Industrial sites where chemicals are used.	Extensive training typically required to prepare and administer plan.	Plan preparation and updates. Inspections mandated. Plan development typically needs consultant or knowledgeable employee. Operation typically employee dependant.	
Clean and Maintain Storm Drain Channels (MDOT)		Prevent erosion in channels. Improve capacity by removing sediment. Remove debris toxic to wildlife.	Sediment, trash, woody debris	Development, natural erosion, vehicle remnants, road winter safety operations.	Should be implemented by trained professional.	$21/acre/year, $45-60 per acre (rural). Channels are less expense to construct and easier to maintain than enclosed systems.	

Best Managerial Practices	Description	Benefit	Pollutant Addressed	Potential Sources of Pollutants	Environmental Impacts and Special Concerns	Comparative Costs	MDEQ/NRCS Link
Clean and Maintain Storm Inlets and Catch Basins (MDOT)	Catch basins are periodically inspected and cleaned out using a vacuum truck.	Moderate; reduces pollutant slugs during the first flush, prevents downstream clogging, and restores sediment trapping capacity of the catch basin.	Solids, sediments, metals, oils	Storm water runoff, automobiles	Requires continual maintenance every 1 - 3 years. General fund, KCRC road maintenance budget - $250,000	Moderate to High; Total annual cost per catch basin = ($8/catch basin) + ($40/catch basin) = $48/catch basin. (Grand Rapids (GR) BMP Study). $21/acre/year maintenance.	
Annual Road/Stream Crossing Inspections	Inspections of stream crossings for evidence of erosion, debris, etc.	Moderate	Sediment	Erosion of streambank		Moderate; regular inspection can prevent major expenditures for potential major points of erosion	
Municipal Operations							
Snow and Ice Control Operations	Removal of snow and ice from roadways, utilizing plows, salt, and sand.		Salts	Snow melt runoff	Moderate, all KCRC equipment operators are trained. Training of road maintenance crew required.	KCRC winter maintenance budget - $3.5 million. Maintenance costs $1,000/lane/mile, dependant on severity of winter.	
Calibrated Salt Delivery		Low	Salts	Over application of salt	Calibration does not guarantee efficient application of road salt. Annual training and calibration necessary.	Low upfront cost. Long term equipment maintenance vs. reduced salt. Equipment costs $1,500 per truck, minimal additional cost.	
Pre-wet Road Salt Application		High if also used with environmentally friendly alternatives to salt	Salts	Road salt		Low to Moderate; $25/lane/mile, equipment maintenance costs - $5,000 per truck.	
Snow Removal Storage on Grassy Areas		Low	Sediment, metals, hydrocarbons, salt	Snow melt runoff	Snow storage may damage vegetation and possibly cause soil erosion. Piled snow melts at a slower rate. Need Right of Way (ROW) for snow removal. Need large grassed area adjacent to buildings and parking areas and properly spaced from waterbody.	Dependant on amount of trucking, distance to site, etc. Cleanup after melt	
Minimizing Effects from Road Deicing (MDOT)			Salts & chemicals	Maintaining agency, Snow melt runoff, spring rains		Varies	
Street Sweeping	The use of specialized equipment to remove litter, loose gravel, soil, vehicle debris and pollutants, dust, de-icing chemicals, and industrial debris from road surfaces. There are generally 2 types of sweepers: mechanical broom street sweepers and vacuum-type street sweepers.	Moderate; 60% TSS removal rate. Reduction in potential clogging of storm drains. Some oil and grease control (MDOT). When done regularly, can remove 50 - 90% of street pollutants (1), makes road surfaces less slippery in light rains, improves aesthetics by removing litter, and controls pollutants.	Sediment, metals, hydrocarbons	Atmosphere, construction, vehicles	Sweeping may wash sediments into catch basins if wash is not vacuumed. Disposal of collected materials must be handled by the governing agency (MDEQ, Public Health, Transportation). Sweeping schedules and timing critical - sweep after snow melt and before spring rains. Vehicle maintenance required.	KCRC Road maintenance budget - $300,000/yr. Ottawa County: Mechanical - $119.40/curb mile. Vacuum Assisted - $87.95/curb mile (GR BMP Study)	http://www.deq.state.mi.us/documents/deq-swq-nps-sw.pdf
Emergency Spill Response and Prevention Plan	Plans detail emergency procedures to respond to a release of hazardous materials. Also plans that describe procedures for proper handling and storage of chemical materials.	Low to High, depending on preparedness. Can be highly effective at reducing the risk of surface and ground water contamination	Hazardous wastes	Equipment, poor training, accidents, Industrial, commercial, residential, and transportation related spills, chemical storage areas	Speed and containment are critical. Requires a well-planned and clearly defined plan, updated regularly. May require training, protective gear, containment and retrieval knowledge. Equipment must be readily available. (MDOT)	Management plan preparation with upgrades. Cost of simulations. In public sector, typically subcontracted to private contractor	
SESC Plans	Plans that specifies the actions that will be taken on a construction site to minimize erosion and sedimentation	High if properly executed. Reduce erosion and sedimentation during construction project. Increased removal using Floc Logs through construction.	Sediment	Unvegetated areas, land development	State training, SESC and/or certified operator.	Act 91 mandated, ongoing local administrative costs. Fee based to landowner option.	
Dust Control (MDEQ)	Using measures such as watering, fencing, mulching and vegetation to prevent soil and attached pollutants from leaving a site and/or entering nearby waterways.	High if properly executed.	Sediment	Lack of vegetation typically associated with dirt or gravel roads	Salt and other potential pollutants are used in the dust control mixture. Rural, urbanizing, and transportation sites subject to wind erosion. Air pollution issue if neglected.	$100 to $500 per treatment. Employee administrative expense. Maintenance of water truck (minimal) - Roads 50-55 cents/gal, 1,500 gal/mile for a single pass	http://www.deq.state.mi.us/documents/deq-swq-nps-dc.pdf
Urban Forestry	Management of woods and trees in an urban setting.	Moderate to high. Increases greenspace, reduces storm water runoff and thermal pollution. Long term solution to concerns.	Thermal pollution, solids, sediments	Rainfall, Solar	Woody debris and detritus may require annual maintenance. May eliminate original line of sight		

Best Managerial Practices	Description	Benefit	Pollutant Addressed	Potential Sources of Pollutants	Environmental Impacts and Special Concerns	Comparative Costs	MDEQ/NRCS Link
Other							
Invasive Plant Species Management	Invasive plant species are controlled using appropriate and effective removal methods for particular species.	Population and spread of invasive plant species is reduced or eliminated.	Invasive plant species	Accidental/purposeful introduction, natural dispersion	Invasive alien plants thrive in disturbed sites. Native plant communities fragmented by human disturbance are most vulnerable to invasion, but the most invasive species can infest even intact ecosystems. Invasive alien plants are free of natural controls such as insects and diseases that keep them in balance in their native habitats. Invasive species can also significantly reduce forest regeneration.		
Woody Debris Management							
Goose Management							
Information and Education							
Public Education Program (MDOT)		Can reduce improper disposal of hazardous waste	Potentially all			$200,000/year	
Grounds Maintenance Training		Moderate	Nutrients and organic sediment	Leaf litter, grass clippings, fertilizer, and pesticides		Low	
Employee Training (MDOT)		Low cost and easy to implement storm water management BMPs	Potentially all				
Storm Drain Stenciling	Painting Storm Drain Inlets with "No Dumping" signs and symbols.	Moderate; Educates the general public that the storm drain discharges into a natural waterbody. Can tie into hazardous waste collection, yard waste collection	Hazardous waste and nutrients	Household hazardous waste, motor oil, pet waste and yard waste	Volunteers need to take care with paint around storm drains. Permanent castings or decals may be more effective. Public education campaign is also needed for effective reduction in illegal dumping. Short term effectiveness.	$0.45/inch - Mylar stencils $5-$6 each - ceramic tiles $100 or more - metal stencils	

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Appendix 14 – Structural and Vegetative Best Management Practices

Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	MDEQ/NRCS Link
Pretreatment (e.g., sediment traps, drainage channels, water quality inlets)															
Catch basin inlet devices	Devices that are inserted into the storm drain inlets to filter or absorb sediment, pollutants, and sometimes oil and grease. The capture of hydrocarbons can be enhanced with the use of absorbents.	Solids, sediments	Moderate to high; 70% of total suspended solids (5); <20% of total phosphorous. Assume same as Hydrodynamic Separators.	Storm water runoff	Catch basin cleaning program	2 - 5 years	High; Remove and dispose of sediment, trash and debris, and change filters as needed (approximately every 6 months)	Low/moderate	Needs less than 5 acres of drainage area	Proper disposal of sediment		$50 - 1,500 (5)	$300/Catch Basin/year (5)	Useful for retrofit	
Permanent Sediment Basin (including forebays)	Man-made depression in the ground where runoff water is collected and stored to allow suspended solids to settle out. May have inlet and outlet structures to regulate flow.	Sediments, solids	Moderate to high; 50% of Total Suspended Solids(4); <20% of Total Phosphorous (4)	Storm water runoff	Detention/Infiltration	50+ years	Moderate; Remove and dispose of sediment, trash and debris, and repair erosion.	Low	Use for large drainage areas (≥ 1 acre), at storm sewer outfalls, may be included with detention pond, and to collect overland flow.			Low; Capital Cost: $0.60/cft of storage volume excluding land purchase. (1)	7% of capital cost/year. (1)	Not always aesthetically pleasing	http://www.deq.state.mi.us/documents/deq-swq-nps-sb.pdf
Combination curb with water spreader and vegetated swale	Curb with cut outs. Storm water is directed off the street at the cut out areas (not spillways).	Sediments, water volumes	High; 80% of total suspended solids. 50% of total phosphorous.	Storm water runoff	Vegetated swale, detention pond	30+ years (6)	Moderate; Remove and dispose of sediment, trash and debris, and repair erosion.	Low			Capacity must be equal to swale or channel	Moderate	Low	Need to stabilize cut out sections behind curb to prohibit soil erosion. Requires a vegetated swale behind the curb. Street sweeping.	
Check dams, Grade control structures (NRCS practice 410)	Stones, sandbags, or gravel generally used to stabilize grades in natural or artificial channels by carrying runoff from one grade to another. Designed to prevent banks from slumping, reduce runoff velocity, and prevent channel erosion from an excessive grade.	Sediment and attached pollutants, hydrologic flow	High (classic gully erosion) (12) Moderate (streambank erosion) (12) Low (runoff/ flooding) (12)	Streambank erosion, soil erosion, storm water runoff	Buffer/filter strips, grassed waterway, diversion, critical area planting	20+ years	Low. Periodic inspections. Repair/replace failing structures. Address any vegetation and erosion plems.	Moderate. Design and installation should be done by a registered professional engineer	Widely applicable to erosive areas with an excessive grade. Place in drainage channel.	Concentrated flows may cause erosion downstream - discharge point should be investigated.	Cause backwater effect; slows down water velocities; capacity equal to channel	Low to moderate. $4,650/structure or $800/vegetated chute (9) - EQIP, WHIP	Low. $60 structure (9)	Use native grasses when planting filter strip. Easements or permits may need to be obtained.	http://www.deq.state.mi.us/documents/deq-swq-nps-cd.pdf
Hydrodynamic Separator Units (Continuous Deflective Separation (CDS) Units, Stormceptors, Vortechnics, Downstream Defender)	Precast, flow-through, underground units that capture sediments, debris, and oils (in some units). The capture of oils can be enhanced with the use of absorbents. (CDS, Vortechs, Downstream Defender, Stormceptor)	Sediment, solids	Effective; 60% TSS Removal (1); <20% of total phosphorous (4)	Storm sewer system	Street sweeping, stream protection practices	50+	Moderate; Remove and dispose of sediment, trash and debris	Minimum	Use for small drainage areas (≤ 1 acre) with high pollutant loads, in line with storm sewer system, and to collect overland flow	Proper disposal of sediment	Catches first flush. High flows by-pass unit through pipe system	High. $15,000 per acre of impervious (2); 6,000/cfs capacity	$500 practice (2); $1,000/year (3)	Placed upstream of storm sewer discharge. Unit is below grade. Need to allow access for cleaning the chambers.	http://www.deq.state.mi.us/documents/deq-swq-nps-ogs.pdf

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Detention/Retention (e.g., extended detention basin)															
Ponded Type Detention Basin (wet pond)	Small, man-made basin to maintain a permanent pool of water with emergent wetland vegetation around the bank. Designed to capture and remove particulate matter, nonsoluble metals, organic matter and nutrients through settling. It generally has inlet and outlet structures to regulate flow.	Sediment; nutrients; hydrologic flow	Moderate; 80% of total suspended solids (4) 50% of total phosphorous (4). Of the detention/ retention basins, this practice may be the most effective in removing pollutants.	Storm water runoff	Sediment forebay or other form of pretreatment, riprap, sediment basin, filter	50+ years (1,6)	Low; remove and dispose of sediment, trash and debris; repair erosion; and plant replacement vegetation as needed.	Low; design and installation should be done by a professional	Use for large drainage areas (≥ 10 acre), at storm sewer outfalls, and to collect overland flow. Ponds generally will not work in soils with high infiltration rates.	Possible downstream warming; low bacteria removal; West Nile Virus (aerator can remove threat of West Nile Virus)	Provides full control of peak discharges for large design storms.	Low to moderate; $1/cft of storage volume, excluding land purchase (1)	5% of capital cost/year. (1)	Need available land area, can include sediment forebay, requires more planning, maintenance and land to construct.	http://www.deq.state.mi.us/documents/deq-swq-nps-wdb.pdf
Dry Detention Basin	Small, man-made basin designed to capture and remove particulate matter. It generally has inlet and outlet structures to regulate flow, but is dry for most of the year.	Sediment; hydrologic flow	Moderate; 80% of total suspended solids (4) 50% of total phosphorous (4)	Storm water runoff	Sediment forebay or other form of pretreatment	50+ years	Low; remove and dispose of sediment, trash and debris; repair erosion.	Minimum	Needs land that will allow inlet at a higher elevation than outlet	Low bacteria and nutrient removal. If vegetation is not maintained, erosion and resuspension will occur.	Reduced peak flows and no standing water	Low to moderate	Low to moderate	Basin grading very important to prevent pools of standing water.	
Extended Detention Basin	Extended detention basins are designed to receive and detain storm water runoff for a prolonged period of time, typically up to 48 hours. Benefits include: receives and detains storm water runoff, minimizes downstream erosion, reduces flooding, and provides enhanced pollutant removal.	Sediment and attached pollutants, nonsoluble metals, nutrients, hydrologic flow	Moderate to high	Storm water runoff	Riprap, grassed waterways, sediment basins		Moderate to high	Mow buffer/filter strip, remove debris and inspect basin regularly during wet weather, and remove sediment from basin every 5-10 years.	Depends on infiltration rates and soil permeability	Can significantly warm the water in the marsh area over a short period of time	Designed to receive and detain storm water runoff for a prolonged period of time. Outlet device regulates the flow from the basin.			Determine site location of BMP through a hydrologic analysis. Designed as either single stage or two-stage. Need spill response plan.	http://www.deq.state.mi.us/documents/deq-swq-nps-edb.pdf
Parking lot storage	Storage of storm water on parking lots is used primarily to reduce the peak discharge of storm water from the surrounding area during moderate storms. Will reduce peak runoff from small sites and provide some flood storage. This helps reduce stream bank erosion and flooding.	Sediment and attached pollutants, hydrologic flow		Storm water runoff, soil erosion	Grassed waterway, porous or modular pavement, infiltration trench, buffer/filter strip, street sweeping		Low to moderate - sweep and clear debris from the parking lot after storms. Regularly inspect and clean the release drain.	Design and installation should be done by a professional	This BMP will work best in areas that do not have a steep slope. Parking lot slope should be 1% or less.	Because detention time is small, only some large solids will settle. Solids must be removed often to prevent resuspension.	Reduces peak runoff from small sites, provides some flood storage, and reduces flooding.			A spill response plan must be developed. BMP is most effective when used with other BMPs that allow for infiltration or sediment trapping.	http://www.deq.state.mi.us/documents/deq-swq-nps-pls.pdf
Water and Sediment Control Basin (638)	An earth embankment or a combination ridge and channel generally constructed across the slope and minor watercourses to form a sediment trap and water detention basin. Improves water quality by trapping sediment on uplands and reducing gully erosion. Grass cover may provide wildlife habitat. Dissolved substances, such as nitrates, may be removed from discharge to downstream areas because of the increased infiltration.	Sediment and attached pollutants, nutrients, hydrologic flow	High (gully erosion) (12) Moderate (runoff/ flooding) (12) Low (streambank erosion) (12)	Soil erosion, agricultural runoff	Nutrient management, terraces, grassed waterways, contouring, conservation cropping system, conservation tillage, and crop residue management	10 years (9)	Reseed and fertilize as needed. Check basins after large storm events and make necessary repairs.	USDA Natural Resources Conservation Service (NRCS) available for assistance	Widely applicable.	Over application of fertilizer possible.	Traps storm water runoff and prevents it from reaching lowlands. Moderate decrease in runoff/flooding. Slight increase in excess subsurface water. (12)	$2,100 - 3,150/basin (11)	5% of original cost per unit (11)	Basin must be large enough to control the runoff from a 10-year storm without overtopping.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/638.pdf

Appendix 14 – Structural and Vegetative Best Management Practices

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Regional Detention	Large, man-made basin designed to capture and remove particulate matter. It generally has inlet and outlet structures to regulate flow from large drainage areas.	Sediment; nutrients; hydrologic flow	Moderate	Storm water runoff	Sediment forebay or other form of pretreatment	50+ years	Low; remove and dispose of sediment, trash and debris; repair erosion.	Minimum	Use for large drainage areas (≥ 1 acre), at storm sewer outfalls, and to collect overland flow.	Possible downstream warming; low bacteria removal; West Nile Virus	Reduced peak flows, storage	Moderate	Low to Moderate	Need available land area, can include sediment forebay.	
Vegetated Treatment (e.g., constructed wetland, grassed swale)															
Constructed Wetland	Excavated basin with irregular perimeters and undulating bottom contours into which wetland vegetation is placed to enhance pollutant removal from storm water runoff.	Sediment, nutrients, bacteria	Moderate to high depending on season; 80% of total suspended solids (4) 50% of total phosphorous (4)	Storm water runoff	Sediment forebay or other form of pretreatment	50+ years (1)	High; remove and dispose of sediment, trash and debris; repair erosion.	Moderate to High	Significant land use requirement; needs appropriate soils, slope, and hydrology	Potential for nutrient release in winter months	Slows flow and reduces peak flow	Moderate to High; $500 - $1000 excluding purchase of land (3)	2% of capital cost/year (1)	2% of drainage area needs to be wetland for efficient pollutant removal. Harvesting may be necessary if plants are taking up large amounts of toxics. Needs supplement water to maintain water level.	http://www.deq.state.mi.us/documents/deq-swq-nps-conw.pdf
Restored Wetland (NRCS practice 657)	Rehabilitation of a drained or degraded wetland where hydrology and the vegetative community are returned to their natural condition to the extent practicable. Provides natural pollution control by removing pollutants, filtering and collecting sediment, reducing both soil erosion and downstream flooding, and recharging groundwater supplies.	Sediment and attached pollutants, nutrients, hydrologic flow, bacteria, chemicals	Moderate to high (depending on season); 80% of total suspended solids from sheet, rill, wind, or ephemeral gully erosion (4) 50% of total phosphorous (4).	Storm water runoff, soil erosion	Sediment forebay or other form of pretreatment. In agricultural areas cattle exclusion fencing, buffer/filter strip, grassed waterway	50+ years (1)	High; remove and dispose of sediment, trash and debris, and repair eroded areas.	Moderate to High Design and installation should be done by a professional	Site must have previously been a wetland	Can increase water temperature. Potential for nutrient release in winter months	Stores storm water and may reduce downstream runoff and flooding. Slows flow and reduces peak flow.	Low: $200 cost to landowner if wildlife organization involved. Break tile and build berm. $2,350/acre (scwmp)	3% of original cost (11)	Many wetlands release water slowly into the ground which recharges groundwater supplies. One acre of wetland can store up to 1.5 million gallons of floodwater (enough to fill 30 Olympic size swimming pools) (EPA, 2002)	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/657.pdf
Rain Gardens and other "Landscaping for Water Quality" techniques	Small, vegetated depressions used to promote infiltration and evapo-transpiration of storm water runoff. A rain garden combines shrubs, grasses, and flowering perennials in depressions that allow water to pool for only a few days after a rain. Landscaping for water quality involves planting native gardens in place of turf grass using native grasses, sedges, and wildflowers. Protects water quality, captures rainwater, reduces flooding, eases soil erosion, increases infiltration, and requires less fertilizer and water to thrive.	Sediment and attached pollutants, nutrients, thermal pollution, solids, chemicals, oils, salt, hydrologic flow	High; 75% - 90% of total suspended solids. (3) (8) 75% of total phosphorous. (8)	Storm water runoff, fertilizers	Mulching	Assume 25 years, based on rain gardens installed in the early 1990s in Prince George County, MD which are still functioning. Depends on plant types and owner maintenance .	Low to Medium; remove and dispose of sediment, trash, and debris, repair erosion, re-vegetate, and weed, water, and mulch, annually. Soil replacement and additional preparation are sometimes needed for success. A mulch of shredded hardwood is an integral part of the rain garden to keep the soil moist and ready to soak up rain, and low maintenance.	Moderate, initial work to establish plant community. Aesthetic maintenance after initial establishment of rain garden. Center for Environmental Study, Master Gardeners Program, West Michigan Environmental Action Council available for assistance.	Site specific, depends on soils. Use for drainage areas ≤ 5 acres (8), at storm sewer outfalls, and to collect overland flow. Highly suitable for residential areas, not on steep slopes	Introduction of exotic/invasive plant species possible. Landowner may treat vegetation with herbicides or pesticides which could be carried via runoff to surface waters.	Will reduce the velocity of storm water runoff and increase infiltration	$1,075 - $12,355/ rain garden (dependent on surrounding land use)	Low. Assume $100/year; similar to yearly landscaping maintenance	Use native plant species. Soils adequate for infiltration are required. Cold climates may reduce evapotranspiration and infiltrative capacity. Practice not suitable for slopes greater than 20% (1). Pretreatment (sediment basin) needed in high sediment load areas. Not used in wellhead protection areas.	

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Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	MDEQ/NRCS Link
Vegetated Buffers or Filter Strips (NRCS Practice 393)	A buffer/filter strip is a vegetated area adjacent to a water body. The buffer/filter area may be natural, undeveloped land where the existing vegetation is left intact, or it may be land planted with vegetation. Practice protects water bodies from pollutants such as sediment, nutrients and organic matter, prevents erosion, provides shade, leaf litter, and woody debris. Buffer/filter strips often provide several benefits to wildlife, such as travel corridors, nesting sites and food sources.	Sediment and attached pollutants, nutrients, thermal pollution	High to Moderate (streambank erosion) (12) Insignificant (runoff/ flooding) (12)	Runoff from parking lots, roof tops, and outflow from ponds, soil erosion, agricultural runoff	Conservation tillage in agricultural areas	10-20 years (9)	Low. Perform periodic inspections to identify concentrated flows and to verify that vegetative cover is maintaining its effectiveness. Address stream bank erosion if identified. Damaged areas should be repaired.	Low. NRCS available for assistance	Widely applicable		Will reduce the velocity of storm water runoff and increase infiltration.	Low. $350/acre (10). $250/ herbaceous acre (11) – Conservation Reserve Program (CRP), Environmental Quality Management Program (EQIP)	Low. $10/acre (9)	Several researchers have measured >90% reductions in sediment and nitrate concentrations; buffer/filter strips do a reasonably good job of removing phosphorus attached to sediment, but are relatively ineffective in removing dissolved phosphorus (Gilliam, 1994).	http://www.deq.state.mi.us/documents/deq-swq-nps-bfs.pdf ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/393.pdf
Forested or Wooded Riparian Buffer (NRCS practice 390)	Forested or wooded areas adjacent to stream	Sediment and attached pollutants, nutrients, thermal pollution	High (sheet, rill, wind, streambank, soil mass movement, road bank/ construction erosion; organics, fertilizers, pesticides, runoff/ flooding) (12)	Runoff from parking lots, roof tops, and outflow from ponds, soil erosion, storm water runoff	Filter strip	15 years (9)	Low. Perform periodic inspections to identify concentrated flows and to verify that vegetative cover is maintaining its effectiveness. Address stream bank erosion if identified. Damaged areas should be repaired.	Moderate to High. NRCS/Michigan Department of Agriculture (MDA) available for assistance	Widely applicable	Poor or lack of maintenance may cause increased erosion if trees fall into stream	Trees in the floodplain may catch debris and impede flow.	Low. $475/forrested acre (11) - CRP, EQIP	1% of original cost (11)	Keep south and west sides of streams wooded to provide shade. Several researchers have measured >90% reductions in sediment and nitrate concentrations; buffer/filter strips do a reasonably good job of removing phosphorus attached to sediment, but are relatively ineffective in removing dissolved phosphorus (Gilliam, 1994).	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/390.pdf
Two-stage channel design	A practical procedure that can be used to correctly size the stream channel and minimum bench widths for stable, effective discharge in agricultural drainage ditches. The bench of a two-stage ditch acts as a floodplain within the ditch to dissipate energy, reduces the erosive potential of high flow volumes, and reduces the shear stress on the bank toe. Two-stage ditches will have improved conveyance capacity, will be more self sustaining, will create and maintain better habitat, and will improve water quality.	Sediment, hydrologic flow		Agricultural runoff	Filter/buffer strips		May require less maintenance then conventional ditches.	The Nature Conservancy has information available for assistance.	Widely applicable.		Two-stage ditches have improved conveyance capacity compared to conventional ditches and enhance drainage	In comparison to conventional ditches, additional costs are related to increased width and more initial earthwork.	May result in less annual Operation & Maintenance (O&M) costs then conventional ditches.	Evidence and theory both suggest that ditches prone to filling with accumulated sediment may require less frequent "dipping out" if constructed in a two-stage form.	

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Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	MDEQ/NRCS Link
Infiltration (e.g., infiltration basin)															
Infiltration Trench	An excavated trench (3 - 12 feet deep), backfilled with stone aggregate, and lined with filter fabric. Infiltration trenches remove fine sediment and the pollutants associated with them.	Nutrients, sediment, metals, hydrologic flow (soluble pollutants - dependent on holding time)	High; 100% of total suspended solids (4); 60% of total phosphorous.	Storm water runoff	Sediment basin, buffer/filter strips, oil/grit separators	Short; 10 years or less (1)	Low to Moderate - Annual; Remove and dispose of sediment, trash and debris. Eroding or barren areas must be re-vegetated.	Moderate. Design and installation should be done by a professional	Site specific; depends on soils. Soil infiltration rates must be greater than 0.52 inches per hour, with clay content less than 30%.	If storm water runoff contains high amounts of soluble contaminants, groundwater contamination can occur.	Provides full control of peak discharges for small sites, provides groundwater recharge, may augment base stream flow, and allow infiltration.	Moderate; average $8/cubic feet of storage (1)	9% of capital cost (1)	Avoid areas with potential hazardous material contamination. Soils with high infiltration rates required. Cold climates may hinder infiltrative capacity, fines will clog pore space in soil, and practice is not suitable for steep slopes. Use as part of a "treatment train," where soluble organic substances, oils, and coarse sediment are removed prior to storm water entering the trench. A very high failure rate occurs with infiltration trenches if they are not maintained.	http://www.deq.state.mi.us/documents/deq-swq-nps-it.pdf
Infiltration Pond	Water impoundment over permeable soils which receives storm water runoff and contains it until it infiltrates the soils.	Nutrients, sediment, metals	High	Storm water runoff	Sediment forebay or other form of pretreatment	25+ years	Annual	Moderate	Site specific depends on soils	Potential to contaminate groundwater	May recharge groundwater	Moderate	Moderate	Avoid areas with potential hazardous material contamination	http://www.deq.state.mi.us/documents/deq-swq-nps-ib.pdf
Porous or Modular Pavement	Permeable asphalt or interlocking paving blocks providing infiltration. When the brick or concrete is laid on a permeable base, water will be allowed to infiltrate. Benefits include: removal of fine particulates and soluble pollutants; attenuation of peak flows; reduction in the volume of runoff; reduction in soil erosion; and groundwater recharge.	Nutrients, sediment, metals, hydrologic flow	High; 95% TSS removal rate (2)	Storm water runoff	Vacuum sweeping, subsurface drains, extended detention basin, infiltration basin.	10+ years	Moderate; Bi annual sweeping required. Periodically inspect, especially after large storms. If severe clogging occurs, may have to replace filtering material.	Low. Design and installation should be done by a professional	This practice should only be used on sites with soils which are well or moderately well drained. Must use special materials for high traffic areas	Potential risk to groundwater due to oils, greases, and other substances that may leak onto the pavement and leach into the ground.	Provides soil infiltration, attenuation of peak flows, reduction in the volume of runoff leaving the site and entering storm sewers, and groundwater recharge.	Moderate	Low to Moderate	Pretreatment of storm water is recommended where oil and grease or other potential groundwater contaminants are expected. Avoid areas with potential hazardous material contamination	http://www.deq.state.mi.us/documents/deq-swq-nps-pap.pdf

Appendix 14 – Structural and Vegetative Best Management Practices

Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	MDEQ/NRCS Link
Filtration (e.g., sand filters)															
Vegetated Swale or Bio-filtration	A broad, shallow channel consisting of dense vegetation and designed to accommodate concentrated flows without erosion.	Sediment	High; 75% - 80% of total suspended solids (2)(4); 50% of total phosphorous (4)	Storm water runoff	Native vegetation	20-50 years	Moderate; remove and dispose of sediment, trash and debris, and repair erosion.	Moderate	Highly applicable to residential areas, not suited to steep slopes	Potential to contaminate groundwater	Slows flow	Low; $0.50/square foot of swale (7)	$0.03/square foot/year. (7)	Does not require a large land area. Should not be used in steep areas or well head areas. Soils adequate for infiltration required to discourage ponding on slopes less than 2%.	
Sand Filters	Area designed to hold and treat the first half inch of runoff discharging from an adjacent impervious area.	Sediment, bacteria, nutrients, metals	Moderate; 83% TSS removal rate (2)	Storm water runoff		Yet to be determined	Moderate to High depending on amount of sediment	Moderate	Suitable for individual developments; requires less land and can be placed underground.	Will not filter soluble nutrients and toxics		Low to moderate	5% of initial construction costs (1)	BMP performance is still experimental	
Agricultural BMPs															
Cattle Exclusion (NRCS practices: Use Exclusion (472), Fence (382))	Fencing to exclude cattle from waterbodies and protect streambanks. Fencing prevents cattle from trampling banks, destroying vegetation, depositing waste in the stream, and stirring up sediment in the streambed.	Sediment and attached pollutants, nutrients, pathogens	Moderate to High (12)	Livestock access, animal manure	Buffer/filter strip, alternative water sources for livestock, planned grazing system, stream crossing and livestock access	10 years (use exclusion) (15) 20 years (fence) (9)	Repair fence as needed. Remove off-stream watering systems in the winter, if needed.	NRCS available for assistance	Widely applicable	Increased grazing in confined areas may reduce vegetative cover	Fencing in floodplain may catch debris and restrict flow	$1.90/ft of fence (9) - EQIP (use exclusion) Wildlife Habitat Incentive Program (WHIP) (fence)	$0.05/ft of fence (9)	Additional BMPs (e.g. Buffer/Filter Strips) are needed to prevent animal waste runoff from entering the stream.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/472.pdf ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/382.pdf
Agricultural Waste Storage Facility (313)	A waste storage impoundment that protects water bodies from manure runoff by storing manure until conditions are appropriate for field application. Several options exist including an earthen storage pond, above or below ground tank, pit underneath a confinement facility, or a sheltered concrete slab area. Allows for field application when conditions are right. Field application cuts fertilizer costs and reduces nutrient losses.	Nutrients, pathogens	Moderate (organics (12), fertilizers (12), and polluted storm water runoff)	Animal manure	Cattle exclusion fencing, roof runoff management, diversion, Comprehensive Nutrient Management Plan (CNMP)	15 years (15)	Inspect storage structures for leaks or seepage periodically and make necessary repairs. Repair any damaged fences immediately. Empty storage structure twice a year.	NRCS available for assistance	Widely applicable	Leaks or seepage of the structure could add nutrients and bacteria to downstream water bodies via runoff. However, if building is according to specifications this would not occur.		Approximately $10,000 - 250,000 (14) - (12) - EQIP	$250 - 1,000 maximum (14)	Storage period should be 6 months unless winter applied risk index is completed	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/313.pdf
Alternative Water Sources (Watering Facility (614), Water Well (642))	A readily available source of clean drinking water for cattle located away from water bodies. Reduces the direct deposition of cattle waste into water bodies by changing animal behavior through providing alternate drinking water.	Sediment and attached pollutants, nutrients, pathogens		Livestock access, animal manure	Cattle exclusion fencing, buffer/filter strip, planned grazing system, stream crossing and livestock access	10 years / watering facility (15) 20 years / water well (15)	Watering facility: check for materials in the trough which may restrict the inflow or outflow system; check for leaks and repair immediately; check the automatic water level device to insure proper operation. Water well: create a maintenance plan including a log of identified problems, corrective actions taken, etc.	NRCS available for assistance	Widely applicable	Depending on the structure, it may not protect watercourse if contiguous with it	Diversion of water	$1,050 / water facility (11) - EQIP	2% original cost (watering facility) (11) 1% original cost (water well) (11)	Areas adjacent to source that will be trampled by livestock should be graveled, paved, or otherwise treated to provide firm footing and reduce erosion.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/614.pdf ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/642.pdf

Appendix 14 – Structural and Vegetative Best Management Practices

Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	MDEQ/NRCS Link
Cover Crop (340)	A crop of close-growing, grasses, legumes, or small grain grown primarily for seasonal protection and soil improvement. It usually is grown for 1 year or less, except where there is permanent cover as in orchards. Temporarily protects ground from wind / water erosion, adds organic matter to the soil, recycles or holds nutrients, improves soil tilth, reduces weed competition, retained soil moisture by acting as a mulch, and fixes atmospheric nitrogen (legumes).	Sediment and attached pollutants, nutrients, chemicals (pesticide), hydrologic flow, chloride (salt)	High (sheet, rill, wind, gully irrigation induced erosion, runoff/ flooding) (12) Moderate (salts, organics, fertilizers, pesticides) (12)	Soil erosion, agricultural runoff	Pest management, nutrient management, conservation crop rotation, crop residue management	1 year (9)	Plant cover crop annually, kill cover crop in the spring, restrict grazing if necessary	NRCS available for assistance	Widely applicable. Consider soil type, slopes, etc.	Requires pest management (IPM) to ensure that pesticide use is appropriate	Significant decrease in runoff/ flooding, moderate reduction in excess subsurface water	$30/acre (9) - EQIP	$0/acre (9)	Can be used for livestock feed or left alone to build soil organic matter.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/340.pdf
Windbreak/Shelterbelt Establishment (380)	Rows of trees and shrubs that protect areas from wind and provide food and cover for wildlife. Reduces wind erosion, conserves energy, provides food and cover for wildlife, and beautifies a farmstead.	Sediment and attached pollutants	High (wind erosion only) (12)	Soil erosion	Cattle exclusion fencing	15 years (9)	Control competing vegetation, inspect regularly	NRCS available for assistance	Widely applicable	Over application of herbicides or pesticides possible	Will reduce storm water runoff and increase infiltration	$150 - 1,000 seedlings (13) - EQIP, WHIP	10% of original cost (11)	Consider if the mature windbreak will cast a shadow over the driveway or nearby road, prolonging icy conditions.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/380.pdf
Conservation Cover (327)	Establishing and maintaining perennial vegetative cover to protect soil and water resource on land retired from agricultural production. Reduces erosion and increases soil tilth due to perennial cover establishment of species adapted to site. Improves water quality when nutrients and sediments are retained on the field. Reduces weed sources. Wildlife food, cover, and water needs will be met.	Sediment and attached pollutants, hydrologic flow, nutrients	High (sheet, rill, wind, gully erosion; runoff/ flooding) Moderate (streambank erosion) (12)	Soil erosion, agricultural runoff	Upland wildlife habitat management, wildlife food plot, tree/shrub establishment	10 years (15)	If necessary, mow during the establishment period to reduce competition from annual weeds. Annual mowing of the conservation cover stand for general weed control is not recommended. Control noxious weeds.	NRCS available for assistance	Widely applicable	Over application of herbicides or pesticides possible	Significant decrease in runoff/ flooding, moderate reduction in excess subsurface water	$260 - 460/acre (9) - CRP, EQIP	$35/acre (9)	Use of fertilizers, pesticides and other chemicals should not compromise the intended purpose. Maintenance practices and activities should not disturb cover during the primary nesting period for grassland species in each state.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/327.pdf
Pasture and Hayland Planting (512)	Planting grass and legumes to reduce soil erosion and improve production in a low-producing pasture, hayfield, or eroding crop field. Reduces soil erosion by wind and/or water, extends length of the grazing season, provides cover and habitat for wildlife, protects water quality by filtering runoff and increasing filtration, and adds organic matter to the soil	Sediment and attached pollutants, nutrients, chemicals (pesticides), hydrologic flow	High (sheet, rill, wind ephemeral gully, irrigation inducted erosion; fertilizers, pesticides, runoff/ flooding) (12)	Soil erosion, agricultural runoff	Nutrient management, pest management, prescribed grazing	10 years (9)	Mow weeds, apply fertilizer and herbicide as needed	NRCS available for assistance	Widely applicable. Consider soil type	Over application of herbicides or pesticides possible	Significant decrease in runoff/ flooding and excess subsurface water	$75/acre (11) - EQIP, CRP	5% of original cost per unit (11)	Do not mix warm and cool season grasses in the same pasture. Choose species that will help reduce the use of pesticides and herbicides.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/512.pdf

Appendix 14 – Structural and Vegetative Best Management Practices

Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	MDEQ/NRCS Link
Critical Area Planting (342)	Establishing permanent vegetation on sites that have or are expected to have high erosion rates, and on sites that have physical, chemical or biological conditions that prevent the establishment of vegetation with normal practices. Stabilizes areas with existing or expected high rates of soil erosion by water and wind. Restores degraded sites that cannot be stabilized through normal methods.	Sediment and attached pollutants, salts	High (sheet, rill, wind, gully, streambank, soil mass movement, road bank/construction erosion) (12) Moderate (salts) (12)	Soil erosion, agricultural runoff	Diversions, riprap, grade stabilization structures, filter/buffer strips, subsurface drains, grassed waterways, nutrient management	10 years (9)	Periodic burning (if needed), prohibit grazing until year 2, prevent overgrazing, inspect after severe storms	NRCS available for assistance	Widely applicable. Consider soil type, slopes, etc. Apply on any area which is difficult to stabilize.	Use of non-native or invasive species is not recommended. Use by recreational users may degrade area.	Will reduce the velocity of storm water runoff and increase infiltration.	$460 - $815/acre (2001 and 2004) EQIP, WHIP, WRP	1 % of original cost per unit (11)	Use native plants with low long term maintenance requirements. Soil tests should be done to determine the nutrient and pH content of the soil.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/342.pdf
Grassed Waterway (412)	The establishment and shaping of grass in a natural drainage way to prevent gullies from forming. Vegetation filters runoff and provides cover for wildlife.	Sediment and attached pollutants, hydrologic flow	High (ephemeral gully erosion) (12) Low (reduction in classic gully erosion, runoff/ flooding) (12)	Soil erosion, agricultural runoff	Grade stabilization structure	10 years (9)	Yearly re-grading, reseeding, and inspection of subsurface drain and related outfall may be needed. Fertilize as needed and mow periodically.	Design and installation should be done by a professional. NRCS available for assistance.	Widely applicable	Better conveyance enhances storm water runoff velocities and possible contamination to surface waters	Drainage way directs runoff to an outlet	$800/acre (without tile) (9) $4,500/acre (with tile) (9) CRP, EQIP	$105/acre (9)	A nurse crop, temporary cover or mulching may be necessary until permanent cover is established. Avoid planting end rows along the waterway.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/412.pdf
Diversion (362)	Earthen embankment that directs runoff water from a specific area. Reduces soil erosion on lowlands. Vegetation filters runoff water and provides cover. Allows better crop growth on bottomland soils.	Sediment, nutrients, chemicals (pesticide), hydrologic flow	High (ephemeral gully erosion, runoff/ flooding) (12) Moderate (classic gully, soil mass movement, road bank/construction erosion) (12) Low (sheet, rill, streambank erosion, organics, fertilizers, pesticides) (12)	Soil erosion, agricultural runoff	Sediment basin or stabilized outlet, buffer/filter strip, nutrient management	10 years (9)	Clear outlet of debris, maintain vegetative cover on ridge, ridge repair, fertilize as needed	Design and installation should be done by a professional	Widely applicable. Do not build in high sediment producing areas unless other conservation measures are installed.	Over application of fertilizer possible	Catches storm water runoff and prevents it from reaching lowlands, reducing runoff velocity and increasing infiltration	$5.00/ft (9) - EQIP	$0.26/ft (9)	Important as Soil Erosion and Sediment Control (SESC) in developing sites. Each diversion must have an outlet.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/362.pdf

Appendix 14 – Structural and Vegetative Best Management Practices

Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	MDEQ/NRCS Link
Other BMPs															
Abandoned Well Closures (Well decommissioning (351))	Well decommissioning seals an abandoned well. Abandoned wells are wells which are no longer in use or are in such disrepair that groundwater can no longer be obtained from them. Benefits include: a) Reduces the risk of groundwater contamination, b) Eliminates the risk of injury, c) Avoids liability under the Michigan Polluter Pay Law	Sediment and attached pollutants, chemicals, nutrients, chloride (salt), pathogens, hydrocarbons	High (13)	Agricultural runoff, hazardous waste spills	Stand alone practice	20 years (9)		High: professional required. A drilled, deep bedrock and artesian well should be closed by a licensed well driller. Farm*A*Syst available for assistance.	Widely applicable.	Groundwater contamination may already be present.	Will prevent surface water from reaching the groundwater supply via the abandoned well.	$50 - $500/closure - Michigan groundwater stewardship program, MDA, EQIP	Low (14)	Filling a well with rocks/gravel will not reduce the groundwater contamination risk. Technical assistance is required to properly close an abandoned well.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/351.pdf
Streambank and Shoreline Protection (580)	Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries, such as bioengineering, rip rap, geotextile materials, and vegetative techniques.	Sediment and attached pollutants	High (streambank erosion, soil mass movement) (12)	Soil erosion	Livestock exclusion, prescribed grazing, buffer/filter strips, diversions, or additional sediment control measures.	20 years (9)	Site inspections conducted to ensure the stream bank structures are staying in place within the first few months of installation and following storm events.	Consult the MDEQ (Water Division or Land Division), local Conservation District, NRCS, or other agencies or consultants.	Widely applicable: site-specific practices will depend on soil type, slope of the bank, river gradient, flow, and uses of the watercourse.		Maintains the capacity of the stream channel.	EQIP: 50% cost share (15)	10% of original cost (11)	Since each reach of a watercourse is unique, stream bank protection techniques must be selected on a site-by-site basis; the specifications for each technique differ. Utilize vegetative species that are native and/or compatible with local ecosystems.	ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/580.pdf
Dam Removal	Releases made from dams commonly cause a decrease in summer temperatures and an increase in winter temperatures downstream. Dam removal benefits fish by: (a) removing obstructions to upstream and downstream migration; (b) restoring natural riverine habitat; (c) restoring natural seasonal flow variations; (d) eliminating siltation of spawning and feeding habitat above the dam; (e) allowing debris, small rocks and nutrients to pass below the dam, creating healthy habitat; (f) eliminating unnatural temperature variations below the dam; and (g) removing turbines that kill fish.	Thermal pollution		Dam	Will depend on the effects of dam removal. Streambank stabilization may be necessary.	Permanent		Design and removal should be done by a professional	Widely applicable to unsafe dams and dams that no longer serve a purpose.	Recent studies show removal of small dams can have limited negative environmental impacts while restoring stream functions. Negative impacts include elevated sediment loads in addition to transformed channel morphology and hydrology. Dam removal may also wreak havoc on already highly disturbed ecosystems. Reservoirs that store high levels of contaminants may release them following dam removal, creating a contaminant plume.	Dam removal will restore natural stream flow and natural seasonal flow variations.	A number of studies (River Alliance of Wisconsin 2003, American Rivers 2003) have found removal costs to be up to 1/3 to 1/5 the cost of repair, especially when the benefits of the dam are minor. Funding sources include: private or community foundation funding, environmental grants, and state or federal assistance programs.	None	Many aging dams are no longer economically practical or cost effective to operate. Similarly, dam operation and maintenance costs tend to increase as a dam ages. These increased costs, combined with the potentially lower revenue, allow for removal to become the most cost effective alternative for the dam owner.	

Appendix 14 – Structural and Vegetative Best Management Practices

Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	MDEQ/NRCS Link
Stabilized Outlets	Outlets are areas which receive discharge water. Stabilized outlets are outlets which reduce the velocity of discharge water to non-erosive velocities. Stabilized outlets help reduce erosion in the area where water is released. Some outlets may also provide treatment of various types of pollutants. Types of outlets include: conveyance outlets (grassed waterway, stone filters, stormwater conveyance channel); water storage outlets (sediment basin, infiltration basin, detention/retention basin, oil/grit separators, Wet ponds and wetlands); conduits; and outlet protection.	Sediment and attached pollutants, hydrologic flow	Dependent on type of outlet used.	Storm water runoff, streambank erosion	Riprap, if needed	Dependent on type of outlet used.	Requires regular maintenance.	Stabilized outlets should be designed by a registered professional engineer.	Widely applicable.	If outlets are not maintained, excessive sediment may be introduced to surface waters downstream.	Stabilized outlets will reduce the velocity of discharge water to non-erosive levels.	Dependent on type of outlet used.	Dependent on type of outlet used.	If the outlet is a county or intercounty drain, permission to discharge must be obtained from the	http://www.deq.state.mi.us/documents/deq-swq-nps-so.pdf
Emergency Spill Kit	Kit materials capture oil, gasoline, and diesel spills on water.	Hydrocarbons		Boat spill					Applicable to lakes						
Pond Construction and Management (378)	A water impoundment made by constructing an embankment or by excavating a pit or dugout. Excavated ponds are made for conditions which require a small supply of water such as a golf course hazard. Embankment ponds hold larger volumes of water. Ponds can be used for storm water management and to attract wildlife. Properly designed and maintained embankment ponds provide a safe, reliable means of water supply, and may become the settling area for sediment and contaminants in the drainage area. If water quantity is more critical than quality, runoff can be used to maintain higher pond levels of an excavated pond.	Sediment and attached pollutants, chemicals, nutrients, flooding	Low (gully erosion, streambank erosion, flooding) None (sheet and rill erosion) N/A (chemicals, nutrients)	Storm water runoff	Slope/Shoreline Stabilization, Seeding, Mulching, Sodding, Pond Sealing or Lining	20 years (2004)	Moderate to High	Design and installation should be done by a professional	Depends on soil suitability. Build ponds in areas where the water supply is adequate for the intended use.	Purple loosestrife (Lythrum salicaria) is an undesirable, exotic perennial which often becomes established in disturbed sites.	Ponds can be used for storm water management.		1% of original cost per unit (2001)	For excavated ponds, consider drainage characteristics, including depth to the water table. For embankment ponds, consider upstream drainage characteristics and how the pond will affect downstream flows, temperatures, etc.	
Composting Facility (317)	A facility for the biological stabilization of waste organic material. The purposed is to treat waste organic material biologically by producing a humus-like material that can be recycled as a soil amendment and fertilizer substitute or otherwise utilized in compliance with all laws, rules, and regulations. Keeps organic debris out of surface waters and away from floodplains, which helps prevent the depletion of oxygen in surface waters.	Nutrients, low dissolved oxygen (DO)		Upland source (yard trimmings and kitchen waste)	N/A	15 years / composting facility (2004)	Composting requires proper aeration, watering and mixing in order to result in a useable end product. Product can be sold, delivered, and applied.	Design and installation should be done by a professional	Widely applicable to dense residential or riparian sites. Soils, topography and climate will all affect the types of composting options available.	Waste needs to be composted and correctly applied as fertilizer. Runoff from compost application may contaminate surface waters.	N/A	$37,000/ composting facility (2004)	Annual Maintenance $370/ year composting facility (2004)	As of March 27, 1993, yard waste collected or generated in Michigan on public property is banned from land fills and incinerators.	

Appendix 14 – Structural and Vegetative Best Management Practices

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Mulching (484)	The process of placing a uniform layer of straw, wood fiber, wood chips or other acceptable materials over a seeded or landscaped area. Helps keep soil particles and their associated attached chemicals (e.g. phosphorus and pesticides) from entering surface waters. Will suppress weed growth and provide a moist area for vegetative growth.	Sediment and attached pollutants	Low to Moderate	Soil erosion	Seeding, soil management, fertilizer management, grading practices, diversions (if needed).	1 year (2004)	Low: inspect mulched areas following storm events to ensure mulch has stayed in place.	Low	Widely applicable	None known.	Seeded area will eventually reduce the velocity and increase infiltration of storm water runoff.	$3.00/acre (2001)	Annual maintenance 100% of original cost per unit (2001)	Mulch should be applied immediately after seeding has occurred. Anchoring of the mulch should be done immediately after the mulch is applied.	
Riprap	A permanent cover of rock used to stabilize stream banks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows. The use of riprap protects stream banks and discharge channels from higher erosive flow velocities and decreases sediment input to a watercourse.	Sediment and attached pollutants	High	Soil erosion, agricultural runoff	Filters. (Riprap is often used in making stabilized outlets, in stream bank stabilization, etc.)	10 + years (SV)	Low: Periodically inspect underlying fabric, adjust and add riprap as needed.	Low: consult technical resources	Widely applicable: riprap is most often used in stream banks, on slopes, and at outlets.	Potential to cause additional erosion downstream.	Reduces down cutting and lateral cutting of erosive flow velocities. Typically not a significant velocity reducer.	$70/square yard (2003b) Including geotextile		MDEQ permit may be required if placed in waters of the state. Explore downstream impacts.	

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Upper Maple River
Watershed Management Plan

June 2010
MDNRE Tracking Code #2007-0118

Appendix 15

Policy Review Document and Spreadsheet

UPPER MAPLE RIVER WATERSHED

POLICY REVIEW DOCUMENT

MDEQ TC# 2007-0118

DECEMBER 2009
PROJECT NO. G080001

Michigan's Nonpoint Source Program

This project has been funded in part by the United States Environmental Protection Agency under assistance agreement for Nonpoint Source Implementation (319) (C9975474-07), and Water Quality Management Planning (205) (C600E257-01) to the Clinton Conservation District, 2003-0038. The contents of the document do not necessarily reflect the views and policies of the Environment Protection Agency, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

INTRODUCTION 3

BACKGROUND 4

METHODOLOGY 6

DEVELOPMENT PRINCIPLES FOR LAND USE PLANNING 7
- Master Plans 7
- Zoning Ordinances 12
- Floodplain Mapping, Overlay Districts, Flood Hazard Mitigation Planning, Floodplain Ordinance 13
- Recreation Plans 15
- Development Plan Requirements 16
- Low Impact Development Ordinance - Development and Division Practices 18

DEVELOPMENT PRINCIPLES ADDRESSING PRIORITY DESIGNATED USE OF AGRICULTURE 19
- Agriculture and Farmland Preservation 19
- Riparian Buffers 21
- Clustering and Open Space Developments 22
- Conservation Easements and Similar Tools 24

DEVELOPMENT PRINCIPLES ADDRESSING PRIORITY POLLUTANT OF SEDIMENT 26
- Storm water Management Standards 26
- Engineered Best Management Practices 27
- Runoff Volume Control 28
- Minimizing Inflow 29
- Soil Erosion and Sedimentation Control 29
- Impervious Surface Reduction 31
  - Reducing Impervious Surfaces 31
  - Parking Lots and Driveways 32
  - Streets and Access 34
  - Street Patterns 35
  - Lot Setbacks/Lot Width/Lot Coverage 36
  - Sidewalks 43

DEVELOPMENT PRINCIPLES ADDRESSING PRIORITY POLLUTANT OF NUTRIENTS 44
- Wetland Preservation 44
- Sanitary Sewer 45
- Septic Systems 46
- Lake Management 47

DEVELOPMENT PRINCIPLES ADDRESSING PRIORITY POLLUTANT OF PATHOGENS 49
- Animal Waste 49
- Agricultural Manure Management 49
- Illicit Discharge Elimination 49

DEVELOPMENT PRINCIPLES ADDRESSING PRIORITY POLLUTANT OF TEMPERATURE 51
- Greenways/Greenbelts 51
- Woodland Preservation 52
- Habitat Preservation - Natural Area Preservation/Restoration 53

DEVELOPMENT PRINCIPLE ADDRESSING PRIORITY POLLUTANT OF PESTICIDES AND CHEMICALS 55

TABLE OF CONTENTS

Wellhead Protection 55

ROAD SALT APPLICATION 57

DEVELOPMENT PRINCIPLES ADDRESSING PRIORITY POLLUTANT OF INVASIVE SPECIES 58
Native and Site Specific Plants 58

CONCLUSIONS 59

IMPLEMENTATION 61

REFERENCES 64

FIGURES/APPENDIX

Figure 1 Future Land Use Map for Clinton County
Figure 2 Composite Future Land Use Plan for Shiawassee County
Model Ordinances Grouped By Each Development Principle

EXECUTIVE SUMMARY

The Upper Maple River Watershed (UMRW) Management Plan stresses the importance of water resources as a vital component of land use decisions at the local level. Communities in the UMRW are interested in achieving sustainable development, defined as economic growth that also protects the environment.

This Policy Review Document provides an assessment of the master plans, zoning ordinances, subdivision rules, and other development standards of the watershed communities that impact water quality. An examination of existing policies is crucial to provide for well crafted and complimentary municipal codes that reflect the desires of the diverse communities within the UMRW. The current path of development in these communities can be evaluated through this process and redirected if necessary. Often, communities find that their development codes and standards give developers little or no incentives to conserve natural areas and, in some cases, actually work against watershed protection. Careful attention to appropriate water resource management can help communities reach a level of sustainable development, which combines economic growth with the protection of natural resources.

Existing land use plans, local ordinances, and development rules were compared to accepted development principles in various water resource protection guidebooks. The UMRW Policy Review Committee selected the three counties in the Watershed (Clinton, Gratiot, and Shiawassee) and two communities (Village of Ovid and Fulton Township) to review.

The assessment reviewed the status of land use planning and zoning is each of the counties and communities selected, and how well the rules and regulations addressed the concerns of the watershed: agricultural preservation, sediment, nutrients, pathogens and bacteria, pesticides and chemicals, invasive species, and renewable energy. The results are summarized in Table 1, color coded as to their level of protection.

The results of this policy review reveal specific areas of the existing development rules that are generally good in their efforts of watershed protection and other areas that need improvement. Specific conclusion related to the Master Plan and Zoning Ordinances are listed below:

- Master Plan five year updates should address the most recent smart growth strategies and analyze changes from the past five year plan.
- Counties in the UMRW should communicate goals with other counties in the region to understand each other's priorities and be able to focus on a specific aspect, such as agricultural protection.

- Counties in the UMRW should work with Gratiot County and Fulton Township to complete Gratiot County's Master Plan to provide additional guidance and direction for the County's level of watershed protection.

- When communities in the Watershed are in the process of creating or updating their Master Plans, they must be aware of how the coordination of plans should occur in the Watershed.

- The counties have adequate site plan review processes, although preservation areas should be updated on future land use maps for easy reference in those reviews.

- Revise zoning to relate each community's intent and purpose to the Master Plan.

- Zoning to encourage flexibility and density in terms of land use, following current smart growth principles, such as encouraging development in infill sites and directing infrastructure spending to designated growth areas.

Specific recommendations for watershed concerns and each development principle are listed throughout this document. Not all of the principles in this review will be applicable to all of the communities and should be considered as guidelines rather than milestones. The use of the principles to begin discussion on these issues will eventually lead to protecting natural and aquatic resources and revising the Master Plan, if necessary.

Model ordinances selected from communities in Michigan that support the development principles are provided at the end of the report for reference.

INTRODUCTION

Purpose

The purpose of this Policy Review Document is to assist communities in the Upper Maple River Watershed (UMRW) with implementation of better development standards and to identify impediments to innovative site design for the purpose of water resource protection. An examination of existing policies is crucial to provide for well crafted and complimentary municipal codes that reflect the desires of the diverse communities within the UMRW. This policy assessment will provide a baseline from which to measure changes in land use practices in the coming years. The current path of development in these communities can be evaluated through this process and redirected if necessary. A similar assessment could be conducted in five years to determine if changes have been made to the rules and regulations that would increase the level of watershed protection.

Watershed Management Plan Goals

The UMRW Management Plan outlines ten goals for reduction of nonpoint source pollution from sediment, nutrients, bacteria and pathogens, high temperature, and pesticides and chemicals. The goals stated in the Watershed Management Plan are:

1. Protect and maintain waterbodies for agricultural use (designated use met).
2. Restore and maintain waterbodies for other indigenous aquatic life and wildlife use (impaired designated use).
3. Restore and maintain waterbodies for warmwater fishery use (impaired designated use).
4. Restore and maintain waterbodies for partial body contact recreational use (threatened designated use).
5. Restore and maintain waterbodies for total body contact recreational use (threatened designated use).
6. Protect and maintain waterbodies for navigational use (designated use met).
7. Preserve high-quality areas.
8. Promote and support desired uses identified during development of this watershed plan.
9. Educate stakeholders about the Watershed and the impacts that stakeholders have on the Watershed.
10. Create a sustainable strategy for implementing the watershed management plan.

The objective of this policy review is to develop and implement specific land-use recommendations using a Watershed-based approach to achieve the Watershed Management Plan goals. This effort will bring together townships, local officials, and planning commissions to protect water quality and reduce nonpoint-source pollution on a multi-township or county-wide basis through the revision of master plans, addition of ordinances for natural resource protection, and zoning to protect water quality.

BACKGROUND

Land Use and Water Resource Protection

Development Impacts to Watercourses. One of the basic concepts accepted in watershed planning is that the amount of impervious cover in a watershed directly relates to its water quality. Increased urbanization results in natural vegetation being replaced with hard surfaces, such as rooftops, roadways, and parking lots. The additional impervious area increases the rate and volume of runoff and decreases water infiltration into the ground. Development often reduces base flow, since water is not infiltrating, which causes perennial streams to become intermittent streams. When more of the water enters the streams as surface runoff, the bankfull channel flows create highly erosive conditions. Other concerns of impervious surfaces include higher concentrations of nutrients in higher volumes of runoff and increased occurrences of heavy metals.

Local Land Use Decisions Have Regional Impacts. Residents, business owners, and local planners are not always aware of the impacts that their individual actions might have on their natural surroundings. Cumulative effects of these actions are not considered in most development and land use decisions. A watershed planning perspective will encourage local planners and developers to look at the entire area contributing to a water body and determine its needs for management and protection. Often, communities find that their development codes and standards give developers little or no incentives to conserve natural areas and, in some cases, actually work against watershed protection. The Upper Maple River Watershed (UMRW) is taking the first step in realizing the regional consequences of the local land use decisions, by evaluating current policies and implementing appropriate measures to enhance and protect water quality while experiencing growth and development. Careful attention to appropriate water resource management can help communities reach a level of sustainable development, which combines economic growth with the protection of natural resources.

Land Use Planning at the Local Level

Townships and cities are responsible for developing land use plans and zoning ordinances, as well as ensuring their implementation. Land use plans and zoning ordinances are the regulatory tools that can be used to protect surface water and groundwater. The planning and zoning process typically starts with a Master Plan, which outlines the vision of how the residents and leaders want the communities to look in future years. The Master Plan is the foundation upon which the Code of Ordinances and zoning ordinances are developed. Formulation of a Master Plan is therefore of highest importance to the communities. A Master Plan should identify goals and a vision for future development in the community. The Code of Ordinances is intended to provide the rules and regulations that will preserve the peace,

health, safety, and welfare of the inhabitants of the community. Design manuals and construction specifications for development guide the alterations of land and water necessary for growth in the community. All of these policies must be integrated to ensure that their goals and objectives are compatible. The policy review requires the examination of all of these documents to be able to assess the capacity of the community to continue to grow and prosper while protecting the natural resources.

Regulations Impacting Land Use at the State Level

State of Michigan statutes that impact land use decisions include management of floodplain development, soil erosion and sedimentation from earth change activities, public health standards, subdivision rules, storm water discharges from municipal separate storm sewer systems, and wetland regulations (MDEQ, 2004).

METHODOLOGY

Existing land use plans and local ordinances were compared to best management practices cited in water resource protection guidebooks. The UMRW Policy Review Committee selected the three counties in the Watershed and two communities to review:

- Clinton County
- Gratiot County
- Shiawassee County
- Village of Ovid in Clinton County
- Fulton Township in Gratiot County

Local Land Use Plans and Ordinances. Existing local development rules were identified by searching for key documents that regulate development in the Upper Maple River Watershed. Comparisons were made between the county-wide and regional master plans and the local zoning ordinances and other development rules.

Guidebooks. The analysis of the existing development rules in the watershed communities was based on several handbooks and documents prepared by organizations throughout the nation. Key references are included in the bibliography. These documents were prepared to provide tools for planning and design that consider water quality protection. They provide a continuum of options for preserving and restoring water resources and demonstrate the connections between plans and ordinances. Specific documents that have been developed for Michigan were also referenced for their identification of how protection measures at the local level can complement and enhance state and federal regulations. All of these tools provide measurements from which to base improvements or modifications in land use planning.

Assessment. The assessment reviewed the status of land use planning and zoning is each of the counties and communities selected, and how well the rules and regulations addressed the concerns of the watershed: agricultural preservation, sediment, nutrients, pathogens and bacteria, pesticides and chemicals, invasive species, and renewable energy. The results are summarized in Table 1, color coded as to their level of protection.

DEVELOPMENT PRINCIPLES FOR LAND USE PLANNING

MASTER PLANS

The first step of managing growth in a community is the development of a Master Plan to guide progress so communities can get the most out of new developments and maximize investments. A Master Plan or a Comprehensive Land Use Plan should state the community's intention for land use, natural resource preservation, and providing infrastructure. The status of Master Plans and Future Land Use Maps in the counties are as follows:

Clinton County

Clinton County completed a Comprehensive Land Use Plan in 2008, which represents collective desires of County residents, business, and local leaders regarding development over the next ten (10) to twenty (20) years. The 2008 Plan is the first major revision of the 2002 Plan and includes projections of population growth, economic activities, land uses, and other related issues of all townships in the County, except for incorporated cities and villages, and the Charter Townships of Watertown, DeWitt and Bath.

For the Upper Maple River Watershed, the Townships of Lebanon, Essex, Greenbush, Duplain, Dallas Bengal, Bingham, Ovid, and Victor follow the Master Plan of Clinton County.

Vision: The Vision Statement of the Clinton County Comprehensive Plan is *"to promote a high quality of life and continued commitment to preserve and enhance the unique and diverse character of the County through policies and programs to promote intergovernmental cooperation, preserve open space, agricultural and natural resources, provide recreational opportunities, ensure efficient and safe transportation network, desirable economic development, and active public participation."* The full document can be found at: http://www.clinton-county.org/board/comp_plan.htm

Critical Issues: The Plan identified the most critical land use issue as the protection of agricultural land and rural quality of the County while allowing for growth and development. The Plan outlines the objectives of ten (10) major goals including: Government, Quality of Life, Agricultural Land Preservation, Land Use, Parks and Recreation, Community Services and Infrastructure, Natural Resources, Economic Development, Transportation, and Public Involvement. These goals were taken into consideration when the goals of the Watershed Management Plan were being developed to ensure that the two plans align. Figure 1 illustrates the Future Land Use Map for Clinton County.

Additional Information: The following background studies were conducted to provide a greater insight into existing conditions and predicted future conditions.

- Demographic summary of past trends, current characteristic and future expectation. Clinton County's population has increased over the past 30 years and is expected to approach 87,000 by 2020 (Tri-County Planning Commission), though most of that growth is expected to occur in the southern areas of the County, which is not part of the watershed.

- Natural and environmental features including a temperate climate, rich agricultural soils, and significant water features of many lakes and rivers. Clinton County is fortunate to have a wealth of natural features throughout the County.

- Cultural and historical resources which are the remaining pieces of the formation of the community ranging from the first churches, schools, and hospitals to mint stills, taverns, and trading posts.

- Existing Land Use (1999) categories were determined through analysis and revision of existing land use maps and field inspections. Of the 14 land use categories described, the two most significant changes in the past decade are the rise in single-family residential units (3.14% increase) and the loss of agricultural land (almost 29,000 acres).

Regional Planning: The Tri-County Regional Planning Commission (TCRPC) is the planning agency for land use planning in the Clinton, Ingham, and Eaton County area. They have completed several planning documents to reach a balance between economic development and natural resource conservation and preservation to maintain and enhance the unique natural assets, quality of life, and economic competitiveness of the area (MNFI, 2008). The Clinton County Potential Conservation Areas map illustrates the prioritization of places identified in the 2008 Comprehensive Plan as Environmentally Significant Lands for conservation. This effort is meeting Goal 1, Objective 4 of the 2008 Plan, "Provide a coordinated approach toward recreational opportunities and open space preservation in the County and the Region". The County is now able to focus conservation efforts on the highest potential conservation areas, identified in the northwest corner of the county along the Maple River in the Maple River State Game Area in Lebanon and Essex Townships and the southeast corner of the county in Bath Township along Vermillion Creek, a small portion of which is within the Rose Lake Wildlife Research area. Assisting with conservation efforts in these areas will be the most cost effective use of their financial resources.

Gratiot County

Gratiot County completed a Strategic Plan in 2002, which outlines the County's history, current condition, and projected future to create a vision for the County, as follows:

Vision: In the year 2007, Gratiot County will be a cohesive community of people enjoying distinct, but interrelated urban and rural living environments; where the natural surroundings and important agricultural resources are protected; and where opportunities abound to live and work in a safe atmosphere, allowing people to enjoy the benefits of well-paying jobs, varying housing choices, excellent public services, superb education, quality health care, ample cultural and leisure opportunities and a healthy family environment.

Critical Issues: In the "Gratiot County Tomorrow" description, nine potential trends are listed that the County deems important to focus on to retain the small-town charm and rural ambiance that will continue to draw people to the County and realize that "Gratiot County is a great place to raise a family." The following key issues in the county were identified and formed the basis of committees for development of the Strategic Plan: Economic Development, Educational Quality, Environmental Issues, Land Use, Quality of Life, Recreation, Transportation, Youth Network Communication, and Communicating the Vision. A vision for each of these issues is supported by guiding principles, goals, strategies, tasks, and community calls for action. A vision facilitator is identified for each issue and is responsible for implementing the tasks and engaging the community in the process.

Regional Planning: Gratiot County is currently in the process of updating their Master Plan, coordinating with the townships and cities and villages to create a unified vision. This County-wide plan began over one year ago, and will be finalized by the end of 2009, at which time it will be available for the public to review.

Shiawassee County

Shiawassee County adopted a Land Use Plan in May 2007, which represents the current Future Land Use Plan in effect and serves as the primary policy guide of the County regarding future land use decisions. The County has maintained a Future Land Use Plan for over 20 years. The last plan was prepared and adopted in 1984. The updated version includes projections of population growth, economic activities, land uses, and other related issues of all townships in the County, except for incorporated cities and villages, and the Charter Townships of Caledonia and Owosso. For the Upper Maple River Watershed, the Townships of Fairfield, Middlebury, Sciota, Bennington, and Shiawassee follow the Land Use Plan of Shiawassee County.

Vision: Although the Land Use Plan does not specifically mention a vision, the following County-Wide Goals are to address the challenges of the County of Shiawassee:

1. Aspire to orderly growth.

2. Recognize the impact of the developing landscape of surrounding communities.

3. Promote the use of available good planning and management techniques to maximize the capabilities of all lands and features.

4. Promote orderly growth in the County while maintaining the rural agricultural character.

Many specific County-Wide Objectives are identified to support these goals. Guidance for how to reach these goals and objectives is detailed in policy recommendations for residential areas, agricultural lands, sensitive lands and other natural resources, commercial areas, and industrial growth areas.

Distinctive land use categories are determined through analysis and revision of existing land use maps and grouped into appropriate categories. The resulting 10 land use categories described in the Land Use Plan are a consolidation of the communities' land use plans to provide an overall vision and long-term plan for growth and development in the County. Figure 2 illustrates the Composite Future Land Use Plan for Shiawassee County.

Critical Issues: The Plan identifies residential development in the County's rural areas as the greatest challenge to the future of the County's agricultural industry. The population in the County has continued to grow at a small, but steady rate, converting agricultural land to rural developments. The goal of agricultural land preservation is the sole focus of the Plan, which identifies agricultural preservation areas that are most critical to the long-term viability of the agricultural industry. This goal was taken into consideration when the goals of the Watershed Management Plan were being developed to ensure that the two plans align.

Additional Information: The following background studies were conducted to provide a greater insight into existing conditions and predicted future conditions.

- Population characteristics provide a summary of past trends, current conditions, and future expectation. Shiawassee County's population has remained stable, with slight increases, over the past 30 years.

- Age composition assists in planning for future needs of children, work force, and the elderly. The trend of a declining younger generation reflects the nation-wide statistic that the population is aging.

- Housing characteristics reveal trends in where people are living and the types of houses they are buying. Household sizes are shrinking, which will affect how developments are designed in the future.

- Economic considerations are important to ensure that an adequate tax base is in place to serve the needs of the community. Unemployment plagues this area as in other areas of Michigan, but the types of jobs available are changing, from agricultural to government and transportation.

Regional Planning: The County Board and Planning Commission are responsible for coordinating the recommendations of the Future Land Use Plan through a variety of ordinances and capital improvements. The implementation of the Plan includes the development and enforcement of zoning ordinances; subdivision control regulations that govern residential growth and utility construction; special purpose ordinances and standards for land use activities that do not fall under a zoning ordinance; capital improvements approved through a planning commission; economic development opportunities; and a continuous education program to gain citizen involvement and support.

Village of Ovid

The Village of Ovid is currently working on updating their Master Plan. The 1989 version consists of a series of maps, charts, and written materials representing concepts of community growth for optimum living conditions.

Fulton Township

Fulton Township is involved in the revisions of the Master Plan for Gratiot County, which is expected to be completed at the end of 2009.

Recommendations

- Master Plan five year updates should address the most recent smart growth strategies and analyze changes from the past five year plan.
- Counties in the UMRW should communicate goals with other counties in the region to understand each other's priorities and be able to focus on a specific aspect, such as agricultural protection.
- Counties in the UMRW should work with Gratiot County and Fulton Township during their Master Plan update to enhance watershed protection.

ZONING ORDINANCES

Zoning Ordinances should enact the rules that support the vision of the Master Plan and Future Land Use Maps.

Clinton County

Clinton County's Zoning Ordinance was updated on October 28, 2008. The ordinance provides for the establishment of Zoning Districts and regulations for those areas of Clinton County, Michigan, lying outside the limits of incorporated cities and villages and some townships.

The zoning map and/or text, which outline the plans and specifications for the future development and redevelopment of the County, are based upon the Clinton County Comprehensive Land Use Plan, as amended. The zoning ordinance includes an explanation of the relationship of each district's intent and purpose to the Comprehensive Land Use Plan. The Comprehensive Land Use Plan has been, and will continue to be, a basis for amending or changing the Ordinance and the Official Zoning Map.

Gratiot County

The effective date of the zoning ordinance was November 19, 1999 and it was updated on November 20, 2001. The zoning ordinance is adopted with reasonable consideration, among other things, of the character of each zoning District, its peculiar suitability for particular uses, the conservation of property values and natural resources, and the general and appropriate trend and character of land, building and population development. The connection to the Master Plan, however, is not clearly explained. The zoning ordinance provides zoning for the following townships: Northstar, Hamilton, Newark and Elba. All incorporated areas and New Haven, North Shade, Fulton, and Washington Townships have their own zoning ordinances.

Shiawassee County

The effective date of the Shiawassee County Zoning Ordinance was February 27, 2003. It is current with amendments through September 19, 2006. The Shiawassee County Zoning Ordinance is to provide for the establishment of Zoning Districts and regulations for those areas of Shiawassee County, Michigan, lying outside the limits of incorporated cities and villages; to encourage and regulate the proper use of land; to provide for the administration, enforcement, and penalties for violation.

The zoning ordinance covers all townships except Caledonia and Owosso. The values and goals of the Land Use Plan are reflected in the zoning ordinance.

Village of Ovid

The Village of Ovid's Zoning Ordinance is located in Chapter 19, Zoning, of the Code of Ordinances, effective in 1984. The zoning ordinance provides for the establishment of zoning districts, within which the proper use of land and natural resources may be encouraged and regulated. A zoning map is included in the ordinance. The current Zoning Ordinance does not mention its support of the Master Plan.

Fulton Township

The Fulton Township Zoning Ordinances, adopted November 11, 1971, regulates land uses within identified zoning Districts, but does not describe their relationship with the Master Plan.

Recommendations

- Revise zoning to relate each community's intent and purpose to the Master Plan.
- Zoning to encourage flexibility and density in terms of land use, following current smart growth principles, such as encouraging development in infill sites and directing infrastructure spending to designated growth areas.

FLOODPLAIN MAPPING, OVERLAY DISTRICTS, FLOOD HAZARD MITIGATION PLANNING, FLOODPLAIN ORDINANCE

State and federal regulations offer some protection of floodplains through restrictions on development in identified and mapped floodplain areas through the National Flood Insurance Program. Flood hazard mitigation planning assesses the impacts of flood management projects on water quality and compensates for that impact in other areas. An overlay district can be established to delineate areas where development is not suitable. A community may also formulate local floodplain regulations to address activities in or near floodplains through a floodplain ordinance. Communities should recognize the extent of the 100-year floodplain and adopt provisions to protect or mitigate impacts to the floodplain.

Development Principle: Create a variable width, naturally vegetated buffer system that encompasses the 100-year floodplain.

Clinton County

Section 303 G, of the Zoning Ordinance outlines the duties of the zoning officials in regard to floodplain management. Duties include notification to governing agencies, verification of elevations, and recording of all flood proofing and/or variances in the proposed area. It shall be the responsibility of the Zoning Official to obtain and utilize the best available flood hazard data for purposes of administering this Ordinance in the absence of data from NFIP and/or Federal Emergency Management Agency (FEMA).

Article 6, Section 610 Floodplains of the Zoning Ordinance discusses prohibited development and delineation of the floodplain. It says that any development requiring site plan and special land use review and approval under any section of the Ordinance shall be prohibited within the one hundred (100) year floodplain of any existing watercourse and/or wetland, unless permitted by the Michigan Department of Environmental Quality (MDEQ). Also, it shall be the petitioner's responsibility to delineate the one hundred (100) year floodplain boundaries through a floodplain determination by MDEQ.

A vegetated buffer system is not mentioned in the ordinance. Victor Township and the Village of Ovid have Flood Insurance Rate Maps (FIRM) issued by FEMA.

Gratiot County

Section 2.30 Floodplain of the Zoning Ordinance prohibits the erection of a building for human occupancy in the floodplain area of lakes, ponds, rivers, and streams and their branches and tributaries as determined by the Federal Emergency Management Agency (FEMA), the County Engineer, the U.S. Army Corp of Engineers, or other official U.S. or Michigan, public agency responsible for defining and determining floodplain areas. A vegetated buffer system is not mentioned.

Shiawassee County

The 2007 Land Use Plan, page 19 item number AA and pages 21 through 24 referring to “Sensitive Lands and Natural Resources” recommends supplemental residential policies to consider respecting the floodplain when siting developments. The 100-year floodplain is not recognized nor is a vegetated buffer system mentioned. FEMA floodplain maps exist for Owosso, Caledonia and Shiawassee Townships, which are located in the Springbrook-Maple River Subwatershed.

Village of Ovid

A Flood Insurance Rate Map (Panel 260318 0001 C) was revised March 2, 1993, that illustrates the areas in the Village that are within the 100-year floodplain, but an overlay district or vegetation buffer system is not mentioned.

Recommendations

- Create and maintain floodplain maps that define the 100-year floodplain for all communities.
- Keep floodplain protection a high priority.
- Communities and Counties participate in the MSWFPA and ASFPM
- Building Inspectors and appropriate local officials obtain their Certified Floodplain Manager certification.
- Adopt overlay district or ordinance to regulate land uses within the floodplain.

RECREATION PLANS

A Michigan Department of Natural Resources (MDNR) approved 5-year Recreation Plan identifies priority lands for acquisition or protection for future recreational use and enables a community to be eligible for various state funding opportunities. Coordination of a recreation plan with the Master Plan is essential for a community to stay true to its visions and character.

Clinton County

The 2008 Comprehensive Land Use Plan Goal #5, Parks & Recreation, outlines steps to identify, acquire, develop, and maintain a vibrant county park system that improves quality of life and natural resource-based parks. The County does not have a current MDNR approved Recreation Plan.

Gratiot County

The 2005 – 2010 Gratiot County Recreation Plan is currently being updated. The County does not have a current MDNR approved Recreation Plan.

Shiawassee County

The Shiawassee County Parks and Recreation Five Year Plan (2010 – 2014) outlines goals for several parks. These goals include maintenance, landscaping and planting, raising community awareness, and recreation additions. The Plan has not yet been approved by the MDNR.

Recommendations

- Develop MDNR approved Five Year Recreation Plans.
- Reference Master Plans and Future Land Use Plans to identify priority land for protection and review appropriateness of designating this for recreation.
- Designate areas within high density residential development sites for recreational use, such as plazas, pocket parks or courtyards, to provide a gathering place for residents, a focal point as well as minimize storm water runoff.

DEVELOPMENT PLAN REQUIREMENTS

The site plan review process represents another opportunity for communities to ensure that the tools presented in this document are used to their best advantage.

Development Principle: Incorporate protective measures into site plans and, ultimately, into developments that preserve natural features and water quality.

Development Principle: Show existing and proposed conditions on site plans.

Clinton County

Section 710 in the zoning ordinance requires the Planning Commission to consider the standard of preserving natural resources to a maximum feasible extent, and that the development as proposed will not cause soil erosion or sedimentation.

Section 715 of the zoning ordinance requires a final site plan to show existing topography (contour interval of two (2) feet); all existing natural features, including but not limited to trees, wooded areas, streams, marshes, ponds and other wetlands; clear indication of all natural features to remain and to be removed.

Clinton County Drain Commissioner's Subdivision Control Procedures includes Preliminary Plat Requirements. In those requirements, the plan must show all pertinent factors including contours, rivers, parks, natural water courses, county drains, or any other natural feature, the existence, location or description of which might be of value in determining the overall requirements for the subdivision. Storm drainage systems must be tentatively shown. The tentative storm layout must generally incorporate minimum design standards. A topographical map must be submitted showing contours at maximum five (5) foot intervals for the entire drainage area affecting the subdivision. The map will show the delineation of the drainage boundary and the acres inside the boundary.

Gratiot County

Section 14.4 of the county zoning ordinance requires as part of the site plan review for all developments to illustrate significant natural features, including but not limited to open space, stands of trees, brooks, ponds, lakes, flood plains, hills, and similar natural assets both on the subject property, and within one-hundred (100) feet of the property lines.

Section 14.5 encourages the landscape to be preserved in its natural state, as much as practical, by removing only those areas of vegetation or making those alterations to the topography that are reasonably necessary to develop the site in accordance with the requirements of the Ordinance.

The permit review under the Drain Commissioner's 2009 Administrative Guidelines for storm water management require the Owner/Developer to submit the conceptual design and layout of the proposed development to the Drain Commissioner or his designee prior to the permit applications. The Developer/Owner shall also submit copies of the conceptual design and layout to the Township or Municipality where the development is proposed for preliminary review and comment. This conceptual design and layout, at a minimum, must include a small location map showing the section and part of the section in which the site is situated, the location and description of all activities that may impact or be impacted by the proposed development or redevelopment both on and off the site, the acreage of the total site and acreage of the area being affected by the development, and, if known, a conceptual layout of the proposed drainage system for the development or redevelopment. The Owner/Developer or the Design Engineer shall submit information including a description of the drainage district/watershed, allowable discharge, and impervious factor in the conceptual design and layout of the proposed development.

Shiawassee County

Page 17 of the 2007 Land Use Plan, under "Subdivision Policies" & "Supplemental Residential Policies," recommends that sanitary sewer lines not be permitted in important agricultural lands. Tables 14.2 and 14.3 in the county zoning ordinance requires an Environmental Impact Assessment for land areas of five acres or more or buildings over 50,000 square feet. The zoning ordinance encourages that natural features be preserved. The Drain Commissioner's Storm Water Management Standards were available for review.

Village of Ovid

The Village of Ovid Zoning Ordinance, Article IX Site Plan Requirements, requires that the site plan include existing natural features and the proposed alterations for those features.

Fulton Township

The Township defers to Gratiot County Drain Commissioner's standards.

Recommendations

- Adopt model development principles of requirement storm water management practices and natural features on site plans.
- Designate priority development areas.
- Revisions to requirements within zoning districts should be reflected in site plan reviews.

LOW IMPACT DEVELOPMENT ORDINANCE - DEVELOPMENT AND DIVISION PRACTICES

Low impact development (LID) mimics predevelopment site hydrology to store, infiltrate, evaporate and detain, retain, or reuse runoff. Many communities that desire to implement these techniques find that their existing design standards and zoning ordinances are not flexible enough to allow these techniques. Applied LID techniques mitigate the effects of development by reducing runoff and pollution levels of the site's storm water during a rain event. LID recommendations are included in planning and zoning recommendations and post construction best management practices throughout the sections of this report.

Clinton County

The 2008 Comprehensive Land Use Plan Goal #4, Land Use, has 10 objectives that promote the principles of LID.

Section 609 of the Zoning ordinance states the developments are preferred to provide for on-site detention/retention storage of storm water or other alternative. Applicable retention, detention, and other storm water issues are to be in accordance with the current CCDC standards and reviewed and approved by the CCDC.

Village of Ovid

Article VIII, Division 3 Special Use Regulations of the Village of Ovid's Zoning Ordinance allows for provisions of housing that promote the principles of LID. For example, allowing the conversion of single-family homes to multi-family dwelling units and group housing developments. Specific LID intensions are not described in the zoning ordinances or supported in other regulations.

Recommendations

- Provide resources to educate developers and local staff on LID techniques.
- Create a goal for LID and adopt policies and ordinances that follow Michigan's state-wide LID manual.
- State the intent of LID in zoning ordinances and allow flexibility in regulations to allow for those practices.

DEVELOPMENT PRINCIPLES ADDRESSING PRIORITY DESIGNATED USE OF AGRICULTURE

AGRICULTURE AND FARMLAND PRESERVATION

Master Plans should describe the importance of agricultural land and rural character in a community. Zoning ordinances can provide regulations for preserving farmland.

Development Principle: If agriculture is an important asset to the community, the Master Plan should describe its importance; identify prime, unique, and/or threatened agricultural land; and set policies for farmland preservation.

Clinton County

The 2008 Comprehensive Land Use Plan Goal #3, Agricultural Land Preservation, emphasizes the preservation of agricultural and open space land through zoning, regulatory controls and a Purchase/Transfer of Development Rights program (PDR, TDR) and PA-116. A digital file for mapping locations of PA-116 lands is maintained by the Tri-County Regional Planning Commission.

An Agricultural Preservation Board reviews all proposed developments within an agriculturally zoned district.

Article 9 of the zoning ordinance addressed preservation of agricultural areas. Lands within 3 defined areas are to be protected and maintained as productive agricultural lands.

1. A-1, Agricultural and Open Space Preservation District
2. A-2, Primary Agriculture District
3. A-3, Agriculture/Residential Transition District

Prime farmlands and PDR parcels are illustrated in the County's Future Land Use Maps.

Gratiot County

Section 4.1 of the county zoning ordinance identifies the Agricultural District and rules for the preservation of prime and important farm lands for future agricultural and related uses.

The 2002 Strategic Plan's vision included protecting important agricultural resources. Goal 6 under the Economic Development Vision is to strengthen the agricultural industry in Gratiot County with opportunities that have a positive impact on producers and the community. Strategies, Tasks, and Community Calls to Action support this goal.

Gratiot County Zoning Ordinances SECTION 2.22 NONCONFORMING USES, BUILDINGS OR STRUCTURES B. Nonconforming Uses 3. Existing Livestock Farming Operations, including Intensive Livestock Operations.

a. Intensive livestock operations in existence at the time of the adoption of this amendment shall not be required to receive approval in accordance with the requirements of this Ordinance unless all of the following occur:

   i. The number of animal units exceeds fifty percent (50%) of the number of animal units existing on the facility at the time of the adoption of this amendment.

   ii. New building(s) exceeding ten thousand (10,000) square feet in total area are constructed.

   iii. Waste storage facilities are constructed which increase storage capacity by fifty percent (50%) or more above the capacity existing at the adoption of this amendment.

Shiawassee County

The 2007 Land Use Plan focuses on the preservation of agricultural land. Residential policies recommended are to direct residential development away from valuable agricultural lands and encourage them to be located on marginal lands not conducive to agricultural use. Agricultural policies encourage preservation of farmland and placing development to minimize conflicts with agricultural operations. The 2007 Land Use Plan includes a map with priority areas for agricultural preservation and recommends that sanitary sewer lines not be permitted in important agricultural lands, thereby protecting those lands from future development.

Article 1, Section 2.6 of the county zoning ordinance indicates that the best agricultural land is to be retained for agricultural use and excludes traditional residential development.

Village of Ovid

Section 19-191 AG of the Village Zoning Ordinance states the intent to preserve prime farmland. Soil characteristics and location give reason to create an agricultural district. Section 19-193 indicates that horticulture requires 2 acres, and livestock requires 5 acres.

Recommendations

- Ensure protection of farmland by adopting Purchase of Development Rights tools and other conservation practices such as cluster development.
- Prohibit the granting of variances.

RIPARIAN BUFFERS

Riparian buffers can be in the form of overlay districts or actual setback limits that are required in the development standards portion of zoning codes. These vegetated systems provide habitat for aquatic wildlife and allow room for floodwaters to flow without damaging structures and dwellings. Storm water runoff is filtered through the buffers before entering surface water, thus improving water quality. Buffers can be part of a riparian trail system or community park that can also increase the awareness of the protection efforts for the streams, rivers, and wetlands in the community. Costs of buffers have been extensively studied, for both the water quality effects and property value effects they have (Heraty, 1993). The water quality improvement benefits have been ascertained, and some studies have indicated that they can increase property values.

Development Principle: Illustrate clear boundaries in master plans and zoning maps of where buffers are required, to help developers and planners evaluate designs and storm water management controls.

A stream buffer can greatly increase its function in both stream protection and flood mitigation by the types of vegetation planted to create the buffer. The purpose of the buffer determines the types of vegetation that will optimize their function.

Development Principle: Describe the objectives of the buffer, the physical delineation of the buffer, and the maintenance requirements.

Development Principle: Preserve or restore riparian buffers with native vegetation that can be maintained throughout the stages of development.

Clinton County

CCDC Subdivision Control Procedures, Section VI, Improvements Required, Part A. Clearing Within Drain Right-of-Way states, “All trees and brush, including the roots thereof, shall be removed from the proposed right-of-way of the drains within the limits of the subdivision, unless otherwise permitted by the Commissioner.”

Gratiot County

Section 2.3 C, Required Lots, Yards and Frontage, of the zoning ordinance indicates that all lots adjacent to a lake, river, stream, or other body of water shall have frontage on the body of water, measured along the shoreline, equal to, or greater than the minimum lot width required by the Zoning District in which the lot is located. The yard adjacent to the body of water shall meet the front yard requirements for the Zoning District in which the lot is located.

Shiawassee County

The 2007 Land Use Plan, pages 21 through 24, supports supplemental sensitive lands and natural resources policies to establish a minimum distance between the edge of a floodplain and the top of river banks to control erosion.

Recommendations

- Identify priority areas benefitting from buffer overlay zone and adopt buffer ordinance.
- Consider the particular characteristics of the riparian zone and waterbody being protected. Different protection and accommodation is required for different types of waterbodies.

CLUSTERING AND OPEN SPACE DEVELOPMENTS

Preserving natural water features and the adjacent lands that support them is one of the most practical ways to protect water resources and manage storm water. An important concept to incorporate into preserving open space for storm water management is the "ecosystem" approach. This approach preserves both the natural features themselves and, as importantly, the functions those features play in creating a sustainable environment for people and wildlife.

Public Act 177 states that a landowner has the option to retain at least 50 percent of the property as open space and place dwellings on the remaining portion. The number of dwellings cannot be less than the number which would be permitted on the land without the open space preservation requirement.

Clustering housing in one area to reduce densities in other areas is a technique that planners have been encouraged to pursue to preserve natural areas and create open space within communities. The concept has not often been viable to developers, however, due to restrictions on lot size and road dimension requirements. The goal of cluster development and open space design should be to reduce impervious cover and conserve the land. Redesigning traditional subdivisions into cluster/open space designs can have a dramatic effect on the reduction of impervious cover and, therefore, reduce storm water runoff. These alternative designs are often less costly for the developers, since construction is limited to smaller areas and less clearing and grading is required.

Cluster housing and open space design can preserve the natural areas of concern. However, the ownership and responsibility of the management must be determined before the designs are accepted. Establishing a legal authority for the area is necessary for the community to understand the concept of open space and address their fears of liability for the residents.

Development Principle: Preserve open spaces in a manner that promotes linking systems through naturally occurring corridors. Rivers, streams, and woodlands can create the backbone of a system of open spaces.

Development Principle: Advocate "by right" open space and cluster development.

Development Principle: Cluster development designs must be comparable in both review and approval time for the developer to consider it a feasible option.

Development Principle: Clearly specify how community open space will be managed and designate a responsible legal entity.

Clinton County

Section 423 of the zoning ordinance encourages a cluster pattern of development in commercial areas.

Section 903 outlines the requirements for a parcel to be eligible for the Agricultural Residential Cluster Option. No more than thirty-five (35) percent of the parent parcel may be developed as a cluster residential development. A minimum of sixty-five (65) percent of the parent parcel shall remain as a single contiguous parcel and be designated as an agricultural/open space preservation area. Developers must guarantee the Planning Commission that the open space will be maintained through the use of a contract or signed agreement.

The 2008 Comprehensive Land Use Plan Goal #7, Natural Resources, is to promote, educate and protect natural and nonrenewable resources, agricultural lands and open space found in the County. Objective 5 of Goal #7 emphasizes the preservation of natural habitats and establishment of key wildlife corridors to sustain and enhance the quality of the natural environment.

Gratiot County

Section 16.7 of county zoning ordinance requires a Planned Unit Development (PUD) is designed with least twenty percent (20%) of the total area of the site preserved in perpetuity for open space. Incentives are given for more open space preservation (preservation above 20%).

PUDs are allowed in each zoning district, which includes flexibility in the density and location of housing units.

A designated open space must be set aside by means of a conveyance approved by the County Board of Commissioners.

Shiawassee County

The 2007 Land Use Plan Residential Policies recommends subdivision policies to encourage conservation designs to permit clustering to preserve natural resources and residential policies that

encourage sound and imaginative land development, in clusters or PUDs, to allow increased density and more usable open space. Low-density residential policies recommend maintaining a minimum open space requirement. High-density residential policies encourage concentrating dwelling units where municipal services already exist. The Shiawassee County Zoning Ordinance; Article 13.1.7 requires 35% open space in Planned Unit Developments.

Village of Ovid

Section 19-171 RA-2 and Section 19-383 of the Village of Ovid Zoning Ordinance gives provisions for grouped housing developments. This allows for increased density which in turn increases open space. Section 19-109 indicates only 1 building per lot.

Recommendations

- Provide incentives for cluster development such as density bonuses.
- Reduce setback requirements, increase open space requirements on valuable land sites.
- In Clinton County, the Potential Conservation Areas (PCAs) should be identified on each Township's Future Land Use map as areas to conserve, and certain preservation techniques should be required in those areas.

CONSERVATION EASEMENTS AND SIMILAR TOOLS

Communities are becoming more aware of the quality of life values that can be enhanced when environmental resources are protected, but parks, natural areas, and scenic landscapes can also have great economic value. Conservation programs that encourage buffers and open spaces have often been cumbersome and difficult to follow for planners and developers. Communities need to be more flexible in their standards and specifications for development if changes are to be seen. Incentives to change and participate in conservation programs must be promoted and enticing enough for the developer to want to participate.

Development Principle: Encourage incentives and flexibility in the form of density compensation, buffer averaging, property tax reduction, storm water credits, transfer of development rights, and by-right open space development to promote conservation of areas of environmental value.

Clinton County

The Tri-County Regional Planning Commission completed a Potential Conservation Areas Report in September 2008 for Clinton, Eaton, and Ingham Counties. The information was compiled by the Michigan Natural Features Inventory, a program of Michigan State University Extension, to identify and rank

potential Conservation areas (PCAs) that remain in the counties. PCA identifies important areas to conserve and protect.

Clinton County contains the most areas of the highest priority sites in the Tri-County region, most of which are included in the Maple River State Game Area, which is not within the Upper Maple River Watershed. The areas of Clinton County within the Upper Maple River Watershed that were ranked medium to high priority are along the Little Maple River, mostly in Duplain Township.

Section 903 of the zoning ordinance accepts a conservation easement, as defined under State law, as an "irrevocable conveyance" for an open space protection measure.

Gratiot County

Section 16.7 details of the zoning ordinance the conservation tools of increased density allowed as an incentive to preserve more acreage of the parcel as open space.

Shiawassee County

Section 13.1.3 of the Shiawassee County Zoning Ordinance lists objectives of Planned Unit Developments which encourages more imaginative and livable housing environments through reduction of individual lot area requirements. The ordinance aims to preserve the natural character of open field, stands of trees, brooks, ponds, floodplains, hills and similar natural assets. It encourages the provision of open space and encourages developers to use a more creative and imaginative approach in the development of a residential area.

Recommendations

- Complete PCA Assessment for entire Upper Maple River Watershed to identify and rank the remaining natural resources.
- Build incentives into zoning ordinance, such as density bonuses, property tax reduction, and transfer of development rights.

DEVELOPMENT PRINCIPLES ADDRESSING PRIORITY POLLUTANT OF SEDIMENT

STORM WATER MANAGEMENT STANDARDS

Water resource protection cannot be accomplished without comprehensive storm water management. Its importance should be reflected in the priorities noted in Master Plans and community regulations and design standards.

Development Principle: Consider storm water management in all land use and land development decisions.

Clinton County

Section 609 of the zoning ordinance and County Drain Commissioner Subdivision Standards & Specifications (to be adopted soon) will require storm water drainage designs for: 100-year, catastrophic flooding, storm event; the 2-year, 24 hour bankfull flood storm event; and the first flush volume. County Road Commission has rules for minimizing runoff from gravel roads.

Gratiot County

Administrative Guidelines for Storm Water Management use a minimum allowable discharge restriction, a 10-year and 25-year standard, and allow flexibility for low impact development designs.

Shiawassee County

The 2007 Shiawassee County Land Use Plan, p 21 - 24 "Sensitive Lands and Natural Resource Policies"; recognizes several sensitive areas to be protected. It aims to regulate development near ground water supply, to identify areas of poor water quality and insufficient land capabilities to support development and discourage development upon those lands, explore storm water policies to control flooding and improve water quality through non-point source runoff control and wellhead protection. The plan suggests intergovernmental coordination to protect the Shiawassee River, Looking Glass River, and Maple River basins through parks, open space and some agricultural uses. Encouraged organizations are “Friends of the Shiawassee” and “Friends of the Looking Glass River”. Draining or filling marshes or wetlands for development reasons other than agriculture are discouraged.

The Land Use Plan, page 22 Item I, explores storm water policies. The Action Plan, page 38, recommends creating engineering design standards.

Recommendations

- Develop model storm water ordinance that can be customized to a locality's conditions and preferences.
- Adopt local storm water ordinance customized to local conditions to control flooding, protect stream channels, and address water quality.

ENGINEERED BEST MANAGEMENT PRACTICES

If not captured and treated, pollutants on parking lots and other impervious surfaces are washed off by storm water into surface water. Developers of large impervious surfaces are often not required to address the quality of storm water, rather just the quantity.

Development Principle: Provide storm water treatment for parking lot runoff that can be integrated into the landscape.

Development Principle: Use bioretention facilities, filter strips, sand filters, and vegetated swales to treat storm water runoff.

Development Principle: Use quantity controls, such as detention and retention areas, to help to improve quality by reducing the volume of water that needs to be treated.

Development Principle: Use vegetated open channels (swales) in the street right-of-way to convey and treat storm water runoff.

Clinton County

Storm water management plans must follow the CCDC standards. Developments are preferred to provide for on-site detention/retention storage of storm water or other alternative. Applicable retention, detention, and other storm water issues are to be in accordance with the current CCDC standards and reviewed and approved by the CCDC. Water quality and stream protection standards are addressed in new rules to be adopted soon.

Gratiot County

Provisions for Low Impact Design are included in the Administrative Guidelines. The conceptual layout of the proposed drainage system must be included in the permit application for development along with a description of the drainage district/watershed, allowable discharge, and impervious factor. The extensive application submittal requirements cover the overall protection of water quality.

Recommendations

- Adopt local storm water ordinances that clearly identify the entity responsible for long-term maintenance and build in a requirement for regular inspection visits.
- Plan for differing storm water issues in older urbanized areas (redevelopment) than in new developments.

RUNOFF VOLUME CONTROL

Many studies have cited that storm water runoff from streets is one of the major contributors of contamination to surface water. Streets that have curbs and gutters actually serve as a collection system for those pollutants, trapping them next to the curb and then washing them into the storm sewer with every rain. Treating storm water as wastewater perpetuates this system of channeling the water and getting it off the streets as soon as possible. Removing curbs and gutters allows runoff to enter grassed swales or open channels which filter runoff and capture pollutants. Grassed swales are becoming a preferred method to handle roadway runoff and are engineered to be wider and shallower than roadside ditches and encourage groundwater recharge.

Development Principle: Use vegetated open channels (swales) in the street right-of-way (ROW) to convey and treat storm water runoff.

Clinton County

In residential drives and public roads, ditches must be located in the ROW and designs approved by the CCRC. Article 11, Section 1404 of the Zoning Ordinance states that ditches shall be of width, depth, and grades to provide for adequate and positive drainage as reviewed and recommended by the CCDC. In the standards to be adopted, open swale drainage systems are preferred to enclosed storm drains.

Gratiot County

Gratiot County Storm Water Management Guidelines encourage storm water detention basins with incentives. An allowable discharge rate calculator is provided, and excess storm water must be retained on site.

Shiawassee County

Shiawassee County Road Commission requires a 100-year storm detention basin.

Recommendations

- Manage rooftop runoff with rooftop gardens, storage, reuse and redirection of runoff into rain barrels.
- Improve design of rooftops and site layout so that the reduced flow from less sloped roofs is directed into pervious surfaces instead of into storm water systems.

MINIMIZING INFLOW

Minimizing flow into the community storm water system may alleviate downstream flooding.

Development Principle: Capture storm water on residential property in rain barrels or rain gardens.

Development Principle: Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas.

Clinton County

Section 504 of the Zoning Ordinance requires roof drainage systems to concentrate roof drainage at collection points along the sides of the dwelling.

Gratiot County

Section IV A.2 of the Gratiot County Zoning Ordinance gives the storm sewer piping requirements.

Shiawassee County

The Shiawassee County Road Commission requires curbs and gutters along roads.

Recommendations

- Manage rooftop runoff with storage, reuse and redirection.
- Reduce the use of curbs and gutters.

SOIL EROSION AND SEDIMENTATION CONTROL

State law allows communities to adopt their own SESC regulations and provide the inspection services to enforce them. Communities that adopt a SESC ordinance can provide a higher level of protection than the County's program. A community SESC ordinance may allow the community to be more involved in overseeing construction sites and assessing the effectiveness of soil erosion programs. Staging of construction activities minimizes the amount of soil exposed for one time and reduces the amount of soil erosion from a site. Rules that restrict clearing or grading of buffers, open space, and native vegetation

during construction should be included in a SESC. Costs of storm water management are reduced when clearing and grading are minimized.

Master Plans should identify soil erosion and sedimentation control as an important activity for the County to support to protect water resources, natural habitats, and aquatic life.

County Enforcing Agents (CEAs) are identified through MDEQ as the agency to oversee the SESC program for that County. Authorized Public Agencies (APA) are public entities within the County that are approved through MDEQ to administer their own SESC programs. Municipal Enforcing Agencies (MEA) are communities that have been approved by MDEQ to administrator their own programs and issue permits from their office. No communities within the Watershed are authorized as MEAs. The Conservation Districts (CD) are also identified as an agency to review site plans for the adequacy of their SESC practices and provide comments to the CEA.

Clinton County	Gratiot County	Shiawassee County
County of Clinton Soil Erosion and Sedimentation Control Ordinance	Soil Erosion and Sedimentation Control Ordinance (2003-1), adopted April 15, 2003.	Soil Erosion and Sedimentation Control Program Guide
CCDC (CEA & APA); CCRC (APA); CCD (CD)	Gratiot County Permits Office (CEA); GCDC (APA); GCRC (APA); GCD (CD)	SC Health Department (CEA); SCDC (APA); SCRC (APA); SCD (CD)

Village of Ovid

Section 19-103 of the village zoning ordinance includes (1) Grading for surface water flows to flooding and erosion and (2) filling above established grade.

Recommendations

- Continue to staff CEAs at a level to be able to enforce regulations.
- Evaluate effectiveness of ordinance administration in reducing impacts of soil erosion.
- Pass MDEQ audits with favorable rating. Provide CEA with adequate staff.

IMPERVIOUS SURFACE REDUCTION

REDUCING IMPERVIOUS SURFACES

Under natural land conditions, most precipitation soaks into the ground or is absorbed by plants. Under developed conditions, much of the land contains impervious surfaces, such as roads, buildings, and parking lots, which do not allow rainwater to soak into the ground. These surfaces can negatively impact both water quantity and quality. Rainwater draining off of impervious surfaces reaches streams faster than in undeveloped areas. These high flow rates result in the erosion of stream banks, loss of vegetation, and impaired water quality due to suspended soil.

Storm water draining off of impervious surfaces also picks up soil and pollutants, which are deposited in the drainageway.

Development Principle: Reduce impervious surface area in a site design to lessen storm water discharge and improve storm water quality.

Clinton County

Section 1337 of the Clinton County Zoning Ordinance requires school sites to be no more than sixty (60) percent covered with impervious surface. The remainder shall be suitably landscaped. Section 432 requires all manufactured housing districts to have paved internal roads, but allows for alternative materials to be used for off-street parking areas as long as they provide adequate drainage. Paving materials in other districts are at the discretion of the Planning Commission.

Gratiot County

Section 2.26 Private Roads of the Gratiot County Zoning Ordinance indicates that private roads will be constructed so as to protect against or minimize soil erosion and prevent damage to the lakes, streams, wetlands, and natural environment of the County.

Pavement widths shall conform to the following table. Any private road serving two (2) or fewer parcels which is subsequently extended to serve more than two (2) parcels shall be upgraded in its entirety to meet the pavement width requirements of this Section.

Standards	**Serving More Than 2 Lots**
Pavement Width	20 feet
Materials	Road surface shall be paved with bituminous aggregate and shall meet the minimum construction standards of the Gratiot County Road Commission for paved local roads.

Section 15.1 and 15.2 indicates parking requirements where some flexibility is allowed.

Shiawassee County

The Zoning Ordinance, Figure 7-1, allows flexibility for parking lot design. 30°-50° parking and 54°-74° parking lot dimensions allow for space efficiency and impervious surface reduction.

Village of Ovid

Article VI, Section 19-290 of the Ovid Zoning Ordinance gives minimum parking space requirements: 200 square feet, or 10 feet by 20 feet for each parking space.

Recommendations

- Allow flexibility in surfaces such as pervious pavement and minimum coverage requirements instead of maximum requirements.
- Design for narrower, more walkable streets with many open spaces within.

PARKING LOTS AND DRIVEWAYS

Rules to establish a minimum number of parking spaces to accommodate patrons at a business and to acquire commercial loans are usually set in excess of the actual needs. This practice leads to paved areas that are seldom used. Alternative parking designs can often reduce the amount of paved area without losing parking spaces. Strategies to reduce the amount of impervious area associated with each stall reduce the overall size of the parking lot, thus reducing the amount of impervious surfaces.

Development Principle: Set a maximum number of spaces allowed.

Development Principle: Construct one-way aisles with angled parking stalls.

Parking requirements are based on the number of parking spaces that are needed for a particular land use or business. Features such as mass transit or a mix of land uses can influence the number of spaces required. Fewer parking spaces can also encourage use of a mass transit system, if available.

Development Principle: Allow shared parking areas when businesses operate on different hours or have different peak seasons when extra parking is required.

Development Principle: Promote shared driveways and alternative driveway surfaces.

The prevalence of sport utility vehicles and trucks has encouraged developers to create designs with larger spaces. Typical dimensions of a parking stall range from 162 to 190 square feet, normally 10 feet wide and 19 feet long.

Development Principle: Eliminate parking stall dimension requirements and allow compact car spaces.

Spillover areas for the additional parking that is required a few times a year can often be constructed with permeable paving materials.

Development Principle: Use pervious material in spillover parking areas.

Clinton County

Article 11 of the Zoning Ordinance requires curb cuts in general residential and commercial areas if needed. Section 1006 of the Zoning Ordinance lists the minimum parking stall dimensions. Section 1103 outlines the minimum spaces required for a parking lot. Section 1106 allows shared use of parking areas. Section 1107 allows the Planning Commission the flexibility to reduce the number of parking spaces required based on findings and conditions. Section 1402 allows multiple residence drives (18" minimum width with 3' shoulder required) with optional paving.

Gratiot County

Section 2.28, Private Driveways and Driveway Spacing, in the Gratiot County Zoning Ordinance allows shared driveways where two (2) residentially zoned lots or parcels may be served by a single private driveway. The driveway must meet the requirements and specifications set out by the Gratiot County Road Commission for private driveways. The minimum road frontage requirement for each lot or parcel shall equal the minimum lot or parcel width of each Zoning District. Section 15.3 sets a minimum number of parking spaces per unit, based on land use. Section 15.2 establishes minimum stall dimensions, although minor adjustments are allowed.

Shiawassee County

The 2007 Land Use Plan, page 26, encourages service drives, limits to curb cuts and promotes shared drive access. Minimum off-street parking requirements are 2 per family dwelling. The Zoning Ordinance, Figure 7-1, allows flexibility for parking lot design. Amendments to Section 6.5.12 outlines shared driveway standards (does not require pavement).

Village of Ovid

Article VI Sec. 19-283 of the Zoning Ordinance requires 2 off-street parking spaces per family dwelling unit. When measurements determining the number of required parking spaces result in a fractional space, fractions < or equal to .5 shall be disregarded and fractions >.5 require 1 parking space (Table, page 1142).

Sec. 19-287 indicates that the joint use of parking by 2 or more facilities may be granted.

Fulton Township

Section 4.2 of the Zoning Ordinances indicates that dwelling properties shall have 2 off-street parking spaces for each dwelling unit.

Recommendations

- Allow on-street parking and integrate walkability into city designs.

STREETS AND ACCESS

Residential, paved streets have become the largest single component of impervious cover in a development. The standard street width of 36 feet is in excess of what is actually needed for adequate local transportation needs in most communities. Narrower streets can reduce the imperviousness of an area without compromising the flow of traffic. On-street parking is often required in residential areas, but sharing a lane for parking and queuing (waiting lane) can accommodate the narrower widths. Regulations for fire and rescue vehicles can be re-evaluated as to their need for access.

Development Principle: Design residential streets for the minimum required pavement width needed for volume of traffic and desired speed. Use a design standard to reflect average daily trips instead of housing density.

Development Principle: Encourage developers to use minimums of design standards.

Clinton County

Section 1403 A-1 of the Zoning Ordinance requires all lots with a structure to have a driveway. Article 11, Section 1101 requires off-street storage of motor vehicles with a minimum of 2 spaces per single or two-family dwelling. Minimum street widths are defined for housing developments, based on Road Commission standards.

Gratiot County

Section 2.26, Private Roads, of the Gratiot County Zoning indicates that road construction requires 20′ width and bituminous aggregate paving.

Shiawassee County

County Road Commission Standards & Specifications Section III (pg. 3) outlines minimum road width. Article 6.5.7 of the Zoning Ordinance states private road standards do NOT require paving for roads serving less than 7 lots. Article 7 sets minimum off-street parking requirements of 2 per family dwelling.

Recommendations

- Design for more walkable cities with narrower roads, and utilize pervious materials.

STREET PATTERNS

Urban settings are normally designed with grid patterns for their network of streets. Newer areas with subdivisions tend to design curvilinear patterns, which can increase the overall street length. Alternative development designs use concepts of cluster housing and open space preservation to reduce impervious surfaces.

Development Principle: Reduce the total length of residential streets by approving alternative street layouts that increase the number of homes per unit length.

Cul-de-sacs were a popular feature in the development boom 20 years ago and still are today. The prospect of less traveled streets and a sense of neighborhood attract home buyers to these lots. However, alternative designs exist that result in the same feeling of living at the end of a road. With open space designs and cluster development, home buyers have greater amenities with natural areas preserved for all to enjoy.

Development Principle: Minimize the number of residential cul-de-sacs and incorporate landscaped areas to reduce their impervious cover.

The large turnarounds that cul-de-sacs normally require add to the imperviousness of a development. The addition of a landscaped island in the center of the turnaround can capture storm water runoff and reduce the amount of imperviousness. Diameters of the turnarounds can also be reduced and still be large enough for emergency vehicles to turn around.

Development Principle: Minimize the radius of cul-de-sacs.

A typical street right-of-way (ROW), which includes the road, curbs and gutters, and sidewalks, ranges from 50 to 100 feet. The reduction of this distance is important to minimize the amount of land disturbed during construction and also to allow for more compact housing developments.

Development Principle: Change development standards by reducing the minimum street width required, requiring sidewalks on only one side of the street, eliminating grassed areas between the sidewalks and the edges of the ROW, and allowing utilities to be buried in the ROW or under the street.

Clinton County

Section 433 of the zoning ordinance requires that no less than eighty (80) percent of the minimum lot width shall be required at the street right-of-way provided one hundred (100) percent of the minimum lot

width is met at the building line. Minimum street widths of 21 feet are established for manufactured housing developments.

Turnaround area/Cul-de-sac must have seventy-five (75) foot radius right-of-way with a fifty (50) foot radius drive surface.

Shiawassee County

Article 6 of the Shiawassee County Zoning Ordinance and the Shiawassee Road Commission sets cul-de-sac and minimum road width specifications. Amendments on page 4 address Shiawassee County Road Commission Standards as requirements. Section 6.5.12 of Amendments addresses shared driveways.

Recommendations

- Relax standards of required street dimensions, discourage cul-de-sacs.
- Set maximum limits instead of minimum limits.
- Construct narrow, well-connected, walkable streets.

LOT SETBACKS/LOT WIDTH/LOT COVERAGE

Local codes provide the restrictions and regulations that govern the shape and dimensions of lots and subdivisions. Setbacks and frontage distances can constrain alternative subdivision designs because of minimum standards that developers must follow. Often these restrictions can increase impervious cover. Large front yard setbacks can increase driveway lengths. Side yard setbacks determine the length of road needed to accommodate all of the houses in the plans. A planning board will not often approve smaller distances, which are required in cluster/open space designs, thus disabling the developer from using the alternative options.

Development Principle: Relax the rules of setback and frontages to accommodate the open space designs allowing houses to cluster in areas most suitable for development.

Clinton County

Section 432 of the county zoning ordinance lists the following schedule of area, height, and placement regulations for each zoning district:

Zoning District	Minimum Acreage/ Lot Size		Minimum Yard Setback			Maximum Lot Coverage Area as Percent of Lot
	Area	Width at Right-of-Way	Front Yard	Side Yard	Rear Yard	GFC
A-1, Agricultural and Open Space District	40 acres	660 ft.	50 ft.	20 ft.	50 ft.	5%
A-2, General Agriculture District	10 acres	330 ft.	50 ft.	20 ft.	40 ft.	25%
A-3, Agriculture Residential Transition District	5 acres	185 ft.	50 ft.	20 ft.	40 ft.	25%
RR, Rural Residential District (low density)	1 acre	135 ft.	50 ft.	15 ft.	40 ft.	30%
R-1, Single Family Residential	15,000 sq. ft.	80 ft.	40 ft.	10 ft.	30 ft.	30%
MF, Multiple Family Residential	3 acres (per zoning lot and/or district)	100 ft. (per zoning lot and/or district)	25 ft.	30 ft.	25 ft.	30%
MH, Manufactured Housing Community						
C-1, Local Commercial	20,000 sq. ft.	100 ft.	50 ft.	15 ft.	15 ft.	50%
C-2, General Commercial	20,000 sq. ft.	100 ft.	50 ft.	20 ft.	20 ft.	50%

Gratiot County

Chapter 13 Schedule of District Regulations

Zoning Districts	Minimum Lot Size		Minimum Setbacks			Maximum Height	Maximum Lot Coverage	Minimum Floor Area
	Area	**Width**	**Front**	**Rear**	**Side**	**(Stories/ft.)**	**(%)**	**(sq. ft.)**
AG-Agricultural District (g)	40 acres	660 ft.	100 ft.	50 ft.	20 ft.	2 ½ /35	20	960 (f)
RP – Rural Preservation District	2 acres	200 ft.	100 ft.	50 ft.	25 ft.	2 ½ /35	20	960 (f)
RR – Rural Residential District	2 acres	200 ft.	60 ft.	30 ft.	10 ft.	2 / 30	30	960 (f)
R-1 – Low Density Residential District	2 acres (a)	200 ft. (b)	40 ft.	30 ft.	10 ft.	2 / 30	30	960 (f)
R-2 – Medium Density Residential District	½ acre (a[1])	100 ft. (b[1])	30 ft.	30 ft.	10 ft.	2 / 30	35	NA
MHP – Manufactured Home Park District	See Chapter 8 for specific regulations.							
B-1 – Local Business District	½ acre (a[1])	100 ft. (b[1])	20 ft.	40 ft. (c)	20 ft. (c)	2 / 30	35	NA
B-2 – Highway Business District	2 acres	150 ft.	100 ft. (e)	50 ft. (d)	30 ft. (d)	2 / 20	35	NA
I-1 – Industrial District	1.5 acres	150 ft.	50 ft. (e)	40 ft. (d)	30 ft. (d)	3 / 45	35	NA

Section13.2 includes the following footnotes to the schedule of district regulations:

J. The minimum lot size may be reduced to 12,000 square feet, if public sanitary sewer is available to the lot.

(a1) The minimum lot size may be reduced to 8,712 square feet, if public sanitary sewer is available to the lot.

K. The minimum lot width may be reduced to eighty (80) feet, if public sanitary sewer is available to the lot.

(b1) The minimum lot width may be reduced to sixty-six (66) feet, if public sanitary sewer is available to the lot.

L. Where a side or rear yard abuts a Residential District, there shall be a minimum of twenty (20) feet, set aside which shall contain a landscaped buffer in accordance with the requirements of Section 2.29 suitable to provide visual screening from the adjacent property. This area shall not be paved or used for parking, loading, vehicle maneuvering, or storage.

M. Where a side or rear yard abuts a Residential District, there shall be a minimum of thirty (30) feet, set aside which shall contain a landscaped buffer in accordance with the requirements of Section 2.29 suitable to provide visual screening from the adjacent property. This area shall not be paved or used for parking, loading, vehicle maneuvering, or storage.

N. No parking area, except for entry drives, shall be located within thirty (30) ft. of the right-of-way line. This required setback area shall be planted and maintained as a landscaped yard.

O. Minimum floor area shall be the Gross Floor Area, as defined in this Ordinance.

P. See Chapter 4, AG - Agricultural District for regulations for permitted lot splits.

Shiawassee County

Schedule of Regulations

Zoning Districts	Maximum Lot Size for Single Family Lots	Minimum Lot Width Measured along a street upon which the lot principally fronts and which extends to the rear lot line:		Minimum Yard Setback of buildings for recorded platted areas, unplatted areas (Parcels with metes and bounds descriptions), and site condominium developments:		
		Interior Lot	Corner Lot	Front Yard as measured from the road R/W	Side yard as measured from side property line	Rear yard as measured from rear property line
A-1 Agricultural Production	2.5 ac.	200 ft.	210 ft.	40 ft.	20 ft.	60 ft.
A-1 ½ Agricultural Production/Rural Residential	2.5 ac.	200 ft.	210 ft.	40 ft.	20 ft.	60 ft.
A-2 Agricultural Production/Rural Residential	2.5 ac.	200 ft.	210 ft.	40 ft.	20 ft.	60 ft.
R-1A One-Family Rural Residential		150 ft.	160 ft.	40 ft.	20 ft.	50 ft.
R-1B One-Family Low-density Residential		150 ft.	160 ft.	40 ft.	20 ft.	50 ft.
R-1C One-Family Medium Density		100 ft.	110 ft.	40 ft.	10 ft.	40 ft.
R-1D Two-Family Residential		100 ft.	110 ft.	40 ft.	10 ft.	40 ft.
R-M1 Multiple Family Residential		100 ft.	1110 ft.	40 ft.	20 ft.	60 ft.
R-M1, if group housing		200 ft.	200 ft.	40 ft.	20 ft.	60 ft.
R-M1 if boarding house		100 ft.	110 ft.	40 ft.	20 ft.	60 ft.
R-T Mobile Home Development		100 ft.	110 ft.	40 ft.	10 ft.	60 ft.

Zoning Districts	Minimum lot area & lot width for each building, structure, or use			Front yard as measured from the road right-of-way line	Side yard as measured from each side of the property line	Rear yard as measured from the rear property line	Maximum total lot coverage, including accessory buildings, as a percent of lot size
	Area	Width Interior Lot	Corner Lot				
O-1 Office and Administrative	10,000 sq. ft.	75. ft.	75. ft.	50 ft.	10 ft.	20 ft.	40%
B-1 Neighborhood Commercial	10,000 sq. ft.	75. ft.	75. ft.	50 ft.	8 ft.	20 ft.	40%
B-2 General Business	10,000 sq. ft.	50 ft.	50 ft.	75. ft.	8 ft.	20 ft.	60%
B-3 Highway Service	15,000 sq. ft.	100 ft.	110 ft.	75. ft.	20 ft.	30 ft.	50%
M-1 Light Industrial	1 acre	150 ft.	160 ft.	75. ft.	25 ft.	50 ft.	50%
M-2 Heavy Industrial	1 acre	150 ft.	160 ft.	75. ft.	25 ft.	50 ft.	50%

Ovid Township

Section 19-8 (d). Minimum setback requirements. Section 19-110 Setback encroachments. Section 19-111 Front Setback reductions.

Village of Ovid Article V. Sec. 19-041 Schedule of Regulations	Minimum lot area for building	Road Frontage	Minimum Lot Dimensions	Minimum front yard	Minimum rear yard	Minimum side yard
Medium Density Residential District (RA-1)	5,000 ft^2 single family; 7,500 ft^2 two-family	50' continuous frontage single-family; 75' duplex	Width 50'; Depth 100'	25' from edge of ROW	35' from lot line	10' except corner lot
General Residential District (RA-2)	12,000 ft^2	100' continuous frontage	Width 100'; Depth 120'	25' from edge of ROW	35' from lot line	10' except corner lot
Commercial - Central Business District (B1)	2,500 ft^2	None		None	None	None
Commercial – General Business District (B2)	10,000 ft^2	100' continuous frontage	Width 100'	25' from edge of ROW	35'	10'
Light Industrial District (L1)	2 acre	200' continuous frontage		50' from edge of ROW	50' from lot line	50' except corner lot
Agricultural District (AG)	1 acre	165' for 1-2 acre parcels, 225' for larger parcels along public thoroughfare	No structure for livestock, feed, or manure within 100' of lot line	25'	35'	10' except corner lot

Fulton Township

Township Zoning Ordinance #14; Page 5, Section 3.2 Height, Area, and Lot Requirements.

Fulton Township (Chapters III- VI)	Minimum lot area/floor area	Minimum lot width	Minimum front yard	Minimum rear yard	Minimum side yard
Agricultural	15,000 sq. ft. lot, 720 sq. ft. floor	100' building line	50' from road ROW	50'	30', two side yards totaling at least 60'
Residential	8,000 sq. ft. lot, 720 sq. ft. floor	No restrictions	10' from lot line	10'	6', two side yards totaling at least 12', min. 10' from road
Commercial	21,780 sq. ft. lot, 720 sq. ft. floor	No restrictions	50' from road ROW	100'	30', two side yards totaling at least 100'
Mobile Homes, Mobile Home and Trailer Park	Follows Act No. 172 of the P.A. of the State of Michigan for 1958, as revised and amended (MSA 5.278 (21) – 5.278 (25) and Act No. 243 of the P.A. of 1959 as revised and amended (MSA 5.278 (31) et seq.)				
Industrial	No restrictions				

Recommendations

- Allow for and encourage cluster development and PUD's.
- Reduce lot setback.

SIDEWALKS

Development standards of requiring sidewalks on both sides of a street increase the impervious surfaces in a community.

Development Principle: Promote more flexible designs allowing sidewalks on only one side of the road.

Development Principle: Relax sidewalk requirements if suitable alternative path systems exist.

Clinton County

Section 432 of the county zoning ordinance requires sidewalks on one side of the street be illustrated in the site plan for review. Section 1326 requires sidewalks of 6 feet in width adjacent to a public street in an area of a "Big Box" site. Article 11 requires sidewalks illustrated on site plan.

Recommendations

- Set flexible standards in other communities.
- Allow flexibility in standards for locations and widths.

DEVELOPMENT PRINCIPLES ADDRESSING PRIORITY POLLUTANT OF NUTRIENTS

WETLAND PRESERVATION

Wetlands are complex systems that serve vital ecological functions and provide many benefits to communities. Wetlands serve seven basic functions:

1. Floral diversity and wildlife habitat protection (provide food, shelter, and breeding sites for wildlife).
2. Fishery and herpetile habitat (provide food, shelter, and breeding sites for most of Michigan's reptiles and amphibians).
3. Flood and storm water storage (regulate the flow of water in a watershed, reducing the danger of downstream flooding).
4. Runoff attenuation (reduce the velocity of runoff, thus reducing erosion and sedimentation).
5. Water quality protection (removes or breaks down sediments, nutrients, and toxins from storm water).
6. Shoreline and stream bank protection (dissipate the erosive forces of wave action, currents, and ice flows along shorelines and stream banks).
7. Aesthetics and recreation (provide opportunities for fishing, nature observation, walking, and photography).

Development Principle: Map wetlands and determine their functional values.

Currently, wetlands five acres or greater in size or contiguous with a body of water are protected under state and federal regulations.

Development Principle: Adopt a local wetlands ordinance to help protect wetlands that are not protected by other laws. Include a clear statement of the community's wetland protection goals, the definition of wetlands covered by the ordinance, standards for protection of wetlands and any allowed uses, and enforcement and penalties to ensure the rules are being carried out.

Development Principle: Create a variable width, naturally vegetated buffer system that encompasses wetlands.

Clinton County

Section 610 of the zoning ordinance prohibits development within the 100-year floodplain of a regulated wetland. According to Section 903, no more than 50% of a regulated wetland may be considered part of an open space requirement in an agricultural preservation area. Although the 2008 Comprehensive Land

Use Plan recommended a wetlands ordinance should be considered, a Wetland Management Ordinance was deemed "not viable" by County Drain Commissioner in an ordinance survey.

Gratiot County

Section 2.26 of the zoning ordinance requires private roads to be constructed so as to protect against or minimize soil erosion and prevent damage to the lakes, streams, wetlands, and natural environment of the County. Section 4.3 requires a separation distance between an Intensive Livestock Operation and a wetland.

Shiawassee County

Shiawassee County 2007 Land Use Plan recognizes wetlands as sensitive areas to protect (p 21 - 24) and recommends creating a wetlands ordinance (pg 38).

Recommendations

- Develop wetlands or aquatic buffer ordinance to protect existing wetlands.
- Determine high priority areas for wetland functional restoration.

SANITARY SEWER

Improving and sustaining rivers, streams, and lakes requires attention to and action on a wide range of contributors to water pollution.

Development Principle: Provide a sewer infrastructure that adequately serves the needs of existing and future populations of the region.

Development Principle: Address sanitary sewer planning and, if appropriate, determine a Sewer Service Area in the Master Plan.

Clinton County

The 2008 Comprehensive Land Use Plan Goal #6, Community Services & Infrastructure, promotes adequate, desirable, and quality services to residents in an efficient, equitable, and cost-effective manner. Objective 6 recommends establishing an urban service boundary.

Gratiot County

The 2007 Land Use Plan recommends that sanitary sewer lines not be permitted in important agricultural lands.

Chapter 3, Sewage Disposal, of the Mid Michigan District Health Department Environmental Health Regulations discusses sewage disposal. Septic Systems: The Basics reviews how to maintain and reduce failure of systems.

Shiawassee County

Article 5.2.5 of the County Zoning Ordinance requires a safe and effective means of collection, treatment, and disposal of waste and must conform with requirements of Shiawassee County Health Department and Michigan Department of Environmental Quality.

Recommendations

- Establish planned expansions of sanitary sewer systems in Master Plan.

SEPTIC SYSTEMS

Inadequate and failing septic systems can have a detrimental impact upon water quality within the community.

Development Principle: Determine site requirements for installing a septic system and a program for identifying and correcting failing septic systems.

Clinton County

Clinton County Drain Commissioner's Subdivision Control Procedures – In the Preliminary Plat Requirements, a "site report furnished by the Department of Health under their rule must be submitted with the plat, unless sanitary sewer capacity is available to serve the proposed development."

Section 305 of the zoning ordinance requires the approval of a sanitary system from the Mid-Michigan District Health Department prior to the issuance of a zoning or land use permit.

Section 526 requires septic systems to be setback from ponds according to the Mid-Michigan District Health Department but no less than 50 feet.

Point of Sale inspections are not required.

Clinton and Gratiot Counties

Mid-Michigan District Health Department (MMDHD) Environmental Health Regulations for septic systems, The Basics, reviews how to maintain and reduce failure of systems. The MMDHD has an effective sewage repair policy. Staff works with people that need a replacement sewage disposal system under a separate set of criteria that new construction must follow. For most lots, alternative replacement options to the costly pumped mound engineered systems are offered and the homeowners make the decision on which alternative to use.

Point of Sale inspections are not required.

Shiawassee County

The 2007 Land Use Plan recommends the sensitive lands and natural resources policies to require strict enforcement of the sanitary code where soil conditions preclude intensive development, and recommends creating an ordinance on page 38.

Shiawassee County Housing Rehabilitation Program offers low interest loans to low income property owners to address sewer repairs.

Shiawassee Point of Sale Ordinance 01-07-26, Article III. Looking Glass emphasis on septic management.

Village of Ovid

Section 17-8, Utility, of the Ovid Zoning Ordinance requires a potable water supply and wastewater disposal system that ensures safety and effectiveness.

Recommendations

- Create Point-of-Sale ordinance to identify failing septic systems.

LAKE MANAGEMENT

Lake management regulations are intended to limit and regulate the number of users and types of uses of lake frontage in order to preserve the qualities of the waters, minimize conflicting land uses, promote safety and minimize boating and water related accidents, minimize overcrowding and pollution and help preserve the quality of recreational use of lands and waters within a community.

Clinton County

Clinton County Drain Commissioner deemed a Lake Management ordinance “not viable”.

Gratiot County

Section 2.25, Riparian Access, in the Gratiot County Zoning indicates in all Districts there shall be at least fifty (50) feet of lake, river, or stream frontage, as measured along the ordinary high water mark of the lake, river, or stream, for each single family dwelling, two-family dwelling unit, or multiple-family dwelling unit utilizing or accessing the lake, river, or stream frontage.

The restrictions of this Section shall apply to all lots and parcels on or abutting any lake, river, or stream in all Districts, regardless of whether access to the lake, river, or stream waters shall be by easement, park, common-fee ownership, single-fee ownership, condominium arrangement, license, or lease.

Shiawassee County

Shiawassee County 2007 Land Use Plan, pages 21 through 24, “Sensitive Lands and Natural Resource Policies” suggests interlocking networks of open space corridors to protect rivers and lakes. The policies recognize lakes as one of six sensitive areas to be protected.

Recommendations

- Educate local officials about Lake Management option to protect lake quality
- Establish lake access rules to regulate use and protect resources.
- Investigate possibility and legality of phosphorus fertilizer ordinance.

DEVELOPMENT PRINCIPLES ADDRESSING PRIORITY POLLUTANT OF PATHOGENS

ANIMAL WASTE

Fully achieving water quality improvements depends on the active participation and increasing support of residents conducting good stewardship practices as part of their daily lives, such as proper disposal of pet waste.

Development Principle: Educate residents about the availability, location, and requirements of properly disposing of pet waste.

Clinton County Section 1324 of the Zoning Ordinance regulates the waste from kennels.

Gratiot County – Section 4.3. Park Rules Ordinance, Parks & Recreation Commission Ordinance #2005-2. Article V(h) indicates that no person shall walk any dog or other animal without having in immediate possession a device to pick up the animal's feces.

Shiawassee County

The Shiawassee County Zoning Ordinance, Table 5-2, gives animal waste storage facility distance requirements from adjoining property line. The regulations include incentives if the waste management system is certified to be in compliance with NRCS and EPA standards.

Recommendations

- Educate public about contamination and proper practices.

AGRICULTURAL MANURE MANAGEMENT

Development Principle: Educate operators about the requirements of properly storing and applying **manure.**

Clinton County Section 609 of the Zoning Ordinance prohibits polluting discharges.

Recommendations

- Education about GAAMPs and best management practices.

ILLICIT DISCHARGE ELIMINATION

A community should eliminate illicit discharges and design new outfalls to treat or manage storm water runoff discharging to bodies of water.

Development Principle: Map the drainage system to identify all points of discharge (especially locations of illicit discharges).

Development Principle: Establish ordinances prohibiting the discharge of pollutants to the sewer system.

Development Principle: Inspect and monitor potential sources of discharge to ensure compliance with local discharge ordinances.

Clinton County

Section 609 of the zoning ordinance prohibits the discharge of runoff from any site, which may contain oil, grease, toxic chemicals, or other polluting materials

Shiawassee County

Illicit discharge elimination is encouraged in the Shiawassee Watershed Management Plan.

Recommendations

- Develop illicit discharge elimination plans for all communities.

DEVELOPMENT PRINCIPLES ADDRESSING PRIORITY POLLUTANT OF TEMPERATURE

GREENWAYS/GREENBELTS

Greenways are areas of preserved, linear open space, which may be left in its natural condition, providing a buffer between a body of water and developed land. This buffer can help to filter storm water runoff and slow its velocity, protecting stream banks and riparian vegetation. Greenways also protect wildlife habitat, providing a corridor for movement and foraging. In addition, greenways provide pathways for pedestrian use and offer significant recreational opportunities, flood protection, and aesthetic beauty.

Development Principle: Include greenways as a planning tool to help preserve high-quality water resources and link community assets such as parks, nature reserves, cultural features, or other important points-of-interest.

Clinton County

Article 6, Section 602 of the Clinton County Zoning Ordinance strives to achieve the prevention of soil erosion and soil depletion and promote surface/ sub-surface water retention through greenway implementation. It also encourages the integration of existing woodlands and other natural features in landscape plans through plantings.

Gratiot County

Section 2.29, Buffers and Greenbelts, of the Gratiot County Zoning Ordinance indicates the following:

In order to provide adequate protective screening for residential areas adjacent to nonresidential uses, Special Land Uses, or uses for which buffer and greenbelts are required under this Ordinance, except for farms as defined in Section 1.7, and intensive livestock operations as defined in Section 1.10, the following regulations shall apply for such buffers and greenbelts.

A. Such greenbelt shall be a strip of at least twenty (20) feet in width planted and maintained with trees. Said trees shall be evergreen and deciduous varieties, and the greenbelt shall be composed of not more than thirty-three (33) percent evergreens. Trees shall be at least six (6) feet in height at the time of planting, and fifteen (15) feet on-center apart; a hedge-row of evergreen bushes at least four (4) feet in height, situated to provide an effective sound and visual buffer.
B. The portion of the greenbelt not covered by such trees or hedges shall be planted with grass or other living material. The greenbelt shall be kept in a healthy growing condition, and neat and orderly in appearance.

C. Any shrubs, bushes, or other plants that project into or across adjacent land may be trimmed back to the property line by the adjacent property owner.
D. The buffer shall not in any way cause a vision hazard at a road intersection, or driveway.
E. Where it is determined by the Planning Commission that insufficient area is available to provide the required greenbelt or that such vegetation screening would be ineffectual, a six (6) foot high sight-obscuring fence or wall or a combination of fence, wall, and plantings may be substituted, except in the front yard.

Shiawassee County

Article 5.2.8 D of the County Zoning Ordinance strongly encourages landowners to maintain a vegetation strip (native species recommended) with minimum of 50 feet from water's edge.

Recommendations

- Encourage greenways to be set aside as conservation areas.

WOODLAND PRESERVATION

Woodlands offer many ecological benefits, including capturing and filtering storm water, moderating temperature through shading and transpiration, and buffering buildings from the sun and wind. The key to protection is clearly defining those resources intended to be preserved, and then drafting goals and policies consistent with this definition.

Development Principle: Adopt local ordinances to protect individual trees, such as street trees in an urbanized community or tree-rows and woodlands in a rural community.

Development Principle: Minimize the amount of clearing and grading of forests to only that needed to build lots, allow access, and provide fire protection. Include provisions for pre-construction, onsite monitoring, and post-construction maintenance.

Development Principle: Assess tree and woodland resources, noting the types and locations of various plant communities, the presence of unique ecosystems, and the location of large "landmark" trees.

Development Principle: Establish priorities and goals for preservation.

Clinton County

Section 903 of the zoning ordinance requires the protection of woodlands to be a requirement of meeting the agricultural cluster option. Section 602 encourages the integration of existing woodlands and other natural features in landscape plans. The Clinton County Zoning Ordinance lists invasive species not allowable to plant. Given is a list of tips for successful tree choices.

Shiawassee County

The Shiawassee County 2007 Land Use Plan, page 38, recommends the creation of a Woodlands Ordinance.

Recommendations

- Establish priorities and goals for tree and woodland preservation.

HABITAT PRESERVATION - NATURAL AREA PRESERVATION/RESTORATION

Land development can lead to fragmentation of wildlife habitat, resulting in disconnecting rivers and wetlands from woodlands and grasslands. Wildlife often require different types of environments for their lifecycles, such as woodlands for shelter, grasslands for food, and wetlands for nesting and rearing young.

Development Principle: Avoid habitat fragmentation by conscientiously linking open spaces with one another, allowing animals to travel from one natural area to the next, meeting their needs for food, shelter, and breeding.

A community's master plan may call for preserving and/or restoring natural areas for wildlife habitat protection.

Development Principle: Conduct a natural areas inventory and develop a natural areas map and plan that identifies prime areas for preservation or restoration.

Clinton County

"Potential Conservation Areas Assessment" (2008) identifies "places on the landscape dominated by native vegetation that have various levels of potential for harboring high quality natural areas and unique natural features."

Chapter 2 in the Land Use Plan, Background Studies on page 8 identifies natural features worth preserving. Chapter 3; Visions, Goals & Objectives emphasizes importance of agricultural and open space land preservation.

Gratiot County

Natural area preservation is mentioned as a goal of the zoning ordinance.

Shiawassee County

The Mid Shiawassee River Watershed Management Plan identifies and outlines the natural areas that need to be protected or enhanced to improve water quality. A table lists those areas and points out the most critical in terms of protection of water quality. Included is woodland, wooded wetland, wetland, and floodplains.

Recommendations

- Create natural connections map and preservation tools.

DEVELOPMENT PRINCIPLE ADDRESSING PRIORITY POLLUTANT OF PESTICIDES AND CHEMICALS

WELLHEAD PROTECTION

The Wellhead Protection Program identifies sources of contamination within the groundwater recharge area. A community may also elect to identify sources of contamination if groundwater is only obtained from private wells.

Development Principle: Identify, map, and protect groundwater recharge areas to maintaining groundwater quality.

The status of Wellhead Protection programs and their Water Supply Serial Number (WSSN) in the Upper Maple River Watershed are summarized below:

Clinton County

Village of Elsie, Wellhead Protection Program WSSN 2120

Village of Maple Rapids, Wellhead Protection Program WSSN 4060

St. Johns, Confirmatory Tritium Testing WSSN 6300

Fowler, Wellhead Protection Program WSSN 2390

Gratiot County

Arcadia & Newark Townships, Source Water Protection

Ithaca, Source Water Protection

Shiawassee County

Fairfield Township (Elsie), Michigan Groundwater Stewardship Program

Recommendations

- Establish Wellhead Protection Programs in all communities with private groundwater wells.

Residents within communities often depend upon groundwater for their drinking water supply. This water is obtained from either municipal or private wells.

Development Principle: Restrict high-risk land use activities in wellhead protection areas

Clinton County

Section 1323 of the zoning ordinance requires CAFOs to follow GAAMPS to protect groundwater from contamination.

Gratiot County

Gratiot County Administrative Guidelines for Storm Water Management encourages water recharge in geologically favorable sites.

Shiawassee County

Shiawassee County 2007 Land Use Plan suggests that local government units should cooperate in the use of surface water and groundwater. The filling and/or draining of marshes or wetlands that represent water recharge areas is discouraged. Protecting and maintaining vegetated open space areas to provide groundwater recharge areas is stated.

Recommendations

- Establish groundwater protection and withdrawal regulations in all communities with private groundwater wells.

ROAD SALT APPLICATION

Recommendations

- Educate maintenance staff on alternative measures.

Wind Ordinance

Develop ordinance to establish rules for siting and operating personal and commercial wind farms.

Gravel Mine Extraction

Develop and implement a mining management plan for watershed

DEVELOPMENT PRINCIPLES ADDRESSING PRIORITY POLLUTANT OF INVASIVE SPECIES

NATIVE AND SITE SPECIFIC PLANTS

Native and site specific plants are adapted to a specific habitat. They tend to be drought and disease tolerant, require little maintenance once established, and help stabilize and restore soil. Native and site specific plants serve valuable storm water function, including absorbing excess nutrients from runoff and stabilizing slopes.

Development Principle: Encourage the use of native and site specific plants through zoning ordinances and prohibit the use of exotic invasive plant species in landscaping.

Development Principle: Require developers to obtain an opinion from the MDEQ/MDNR regarding the likelihood of threatened and endangered species on a site.

Development Principle: Enhance trees and other vegetation at sites by planting additional vegetation and promoting native and site specific plants.

Clinton County

Article 6, Section 602 of the county zoning ordinance requires lawn areas to be planted in species of grass normally grown as permanent lawns in mid-Michigan. Grass may be placed as sod or seeded and mulched. Sod or seed shall be clean, free of weeds and noxious pests or disease.

Gratiot County

Park Rules Ordinance, Parks & Recreation Commission Ordinance #2005-2. Article II, Section 4(c) states that no one shall introduce, plant or attempt to establish any tree, grass, bush, aquatic plant or any other living vegetation within Commission property.

Shiawassee County

Shiawassee Watershed Management Program encourages the protection of native plants. Article 8 of the Zoning Ordinance identifies landscaping requirements, vegetation areas, a minimum coverage percentage, and plant species standards.

Recommendations

- Develop and implement an invasive species management plan for watershed.

CONCLUSIONS

The findings and recommendations of this Policy Review Document are summarized in Table 1.

When communities in the Watershed are in the process of creating or updating their Master Plans, they must be aware of how the coordination of plans should occur in the Watershed. The health of a community and the natural resources are affected by development decisions.

The results of this policy review reveal specific areas of the existing development rules that are generally good in their efforts of watershed protection and other areas that need improvement. The completion of Gratiot County's Master Plan will provide additional guidance and direction for the County's level of watershed protection.

Assessing the current development rules and the identification of the impediments to innovative site design will assist the community to create and implement better development designs. The counties and most communities have adequate site plan review processes, although preservation areas should be updated on future land use maps for easy reference in those reviews.

The principles presented in this document can be adapted to develop goals and objectives for the community Master Plan. They align with two specific "Principles of Smart Growth" that are directly related to environmental protection (Smart Growth Network, 2000):

- Preserve Open Space, Farmland, Natural Beauty and Critical Environmental Areas
  Open space preservation supports smart growth goals by bolstering local economies, preserving critical environmental areas, improving our communities quality of life, and guiding new growth into existing communities. Clinton County has identified an urban service boundary, which defines where development and growth are preferred.
- Strengthen and Direct Development Towards Existing Communities
  Smart growth directs development towards existing communities already served by infrastructure, seeking to utilize the resources that existing neighborhoods offer, and conserve open space and irreplaceable natural resources on the urban fringe.

As the case with many local municipal and state regulations, agricultural land uses are exempt from those rules. Some communities have addressed that gap by requiring certain water quality best Management practices be used when farmland is enrolled in a land protection or conservation arrangements. The "Healthy Water, Rural Pride" initiative is being promoted in several watersheds in southwest Michigan and could become a model for other areas. The status of the initiative should be monitored for its success and transferability to other watersheds.

Not all of the principles in this review will be applicable to the communities and should be considered as guidelines rather than milestones. The use of the principles to begin discussion on these issues will eventually lead to protecting natural and aquatic resources and revising the Master Plan, if necessary. Specific recommendations for each development principle are listed in Table 1.

IMPLEMENTATION

The Watershed Management Plan outlines recommendations to meet the goals and objectives identified by the Steering Committee. Land use planning was determined to be an important part of the sustainability of the Watershed project since future growth could occur in the outer limits of the urban areas. This policy review is just one component of the complex issue of land use planning but will assist the surrounding communities in the Watershed in identifying the next step in the process.

Several recommendations contained in this policy review could involve changes that may not be fully within the control of the communities. Some might require state approval or legislative action. The communities' elected officials should consider these issues when reviewing the recommendations of this report.

Formation of Review Committee

The formation of a committee to oversee the systematic review of the development rules of a community is a beneficial step to determine if changes can or should be made. Communities that have taken the next step and formed a committee to incorporate better site design followed these recommendations to have an effective committee (Center for Watershed Protection, 1998):

1. Encourage planners to consider the model development principles when evaluating their local zoning codes, subdivision ordinances, and landscape ordinances.

2. Encourage the development community to incorporate these model development principles in their land development projects. Show economics or REQUIRE

3. Encourage the formation of local committees to adopt and adapt these model development principles within the context of local growth and environmental protection goals. ???

4. Encourage the lending and insurance communities to consider these principles and examine their role in land development.

5. Encourage local, state, and federal agencies to provide the technical support, financial incentives, and regulatory flexibility needed to promote the model development principles.

6. Encourage environmental groups, watershed organizations, and the general public to use these principles as educational tools.

Community Responsibilities

The elements of a successful strategy for a community to protect water bodies within its jurisdiction by adjusting development rules are as follows:

1. Encourage community-minded, public-spirited individuals to serve on the planning commission, zoning board of appeals, and community board or council. Provide training for these individuals to develop the skills that are required to properly review proposed development sites for adequate water quality protection.

2. Develop a Master Plan and review zoning ordinances periodically to assess if revisions or a total update are necessary. Compare the community Master Plans with County Comprehensive Plans to ascertain if goals are aligned. Be aware of changes in state legislation that might impact plans or ordinances.

3. Support a zoning administrator who communicates well with the residents. Ensure that the administrator understands the Master Plan and the zoning ordinances and is able to administer them as the planning commission so intended. Enable the zoning administrator to help create effective regulations and rules that provide the incentive and the enforcement measures necessary to ensure that the permitted land use activities do not harm water quality.

Implement educational programs for residents, developers, contractors, local planners, and other landowners who should be educated about the impacts that all of their activities together can have on a watershed. Individual actions, such as properly installing silt fencing at construction projects, maintaining private septic systems, and preserving riparian corridors can provide cumulative improvements to water quality.

Model Ordinances

Communities around the country have adopted ordinances using model language developed by organizations such as the U.S. Environmental Protection Agency and the Center for Watershed Protection. A model ordinance should be used as a framework for developing ordinances that include the unique features in the community. For example, wetland and native vegetation ordinances could include more specifics about local vegetation resources that are particular to a community.

The Greater Lansing Regional Committee (GLRC) prepared a booklet of Model Ordinances for Watershed and Natural Resources Protection for the NPDES Phase II program participants in the Tri-County Area (Clinton, Eaton, and Ingham Counties). The booklet identifies development strategies that address storm water. Model ordinances were selected for each strategy that could be adopted by the

communities to strengthen their resource protection measures for the Looking Glass River, Grand River and Red Cedar River Watersheds. Similar ordinances would be applicable to the Upper Maple River Watershed and will therefore be referenced when appropriate. The model ordinances are grouped by each development principle and provided in the Appendix.

REFERENCES

Carlisle/Wortman Associates, Inc. 2008. Clinton County Comprehensive Plan. Ann Arbor, Michigan. 72pp. http://www.clinton-county.org/P&Z/CompPlan/4-Chapter_3_Goals_Objectives.pdf

Carlisle/Wortman Associates, Inc. 2007. Shiawassee County Land Use Plan, Ann Arbor, Michigan. 61 pp.

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Shiawassee County's webpage. http://www.shiawassee.net/.html

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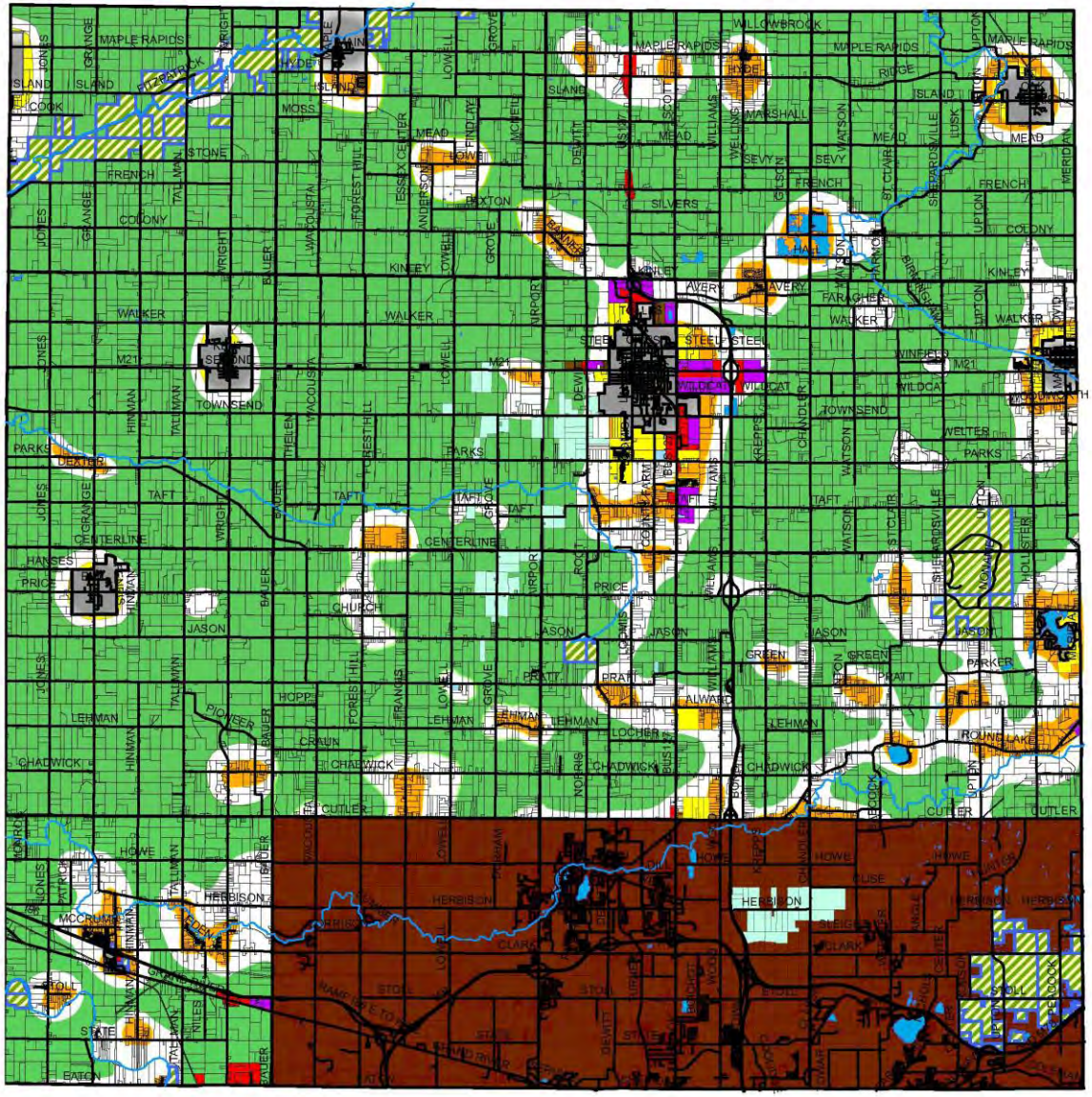
Tri-County Plan http://www.clinton-county.org/PDR/protection_efforts.htm

Clinton County



Future Land Use Map Amendment

Legend

- Residential Center
- Moderate Residential
- Transitional
- Prime Agricultural
- PDR Land
- Industrial
- Community Facility
- Manufacturing
- Commercial
- Mixed Use
- Twp.Lines
- Cities / Villages
- State Land
- Lakes
- Streets
- Rivers / Streams
- Charter Township

Clinton County Final Map Amendment

8

Clinton County
State of Michigan
01/01/2008

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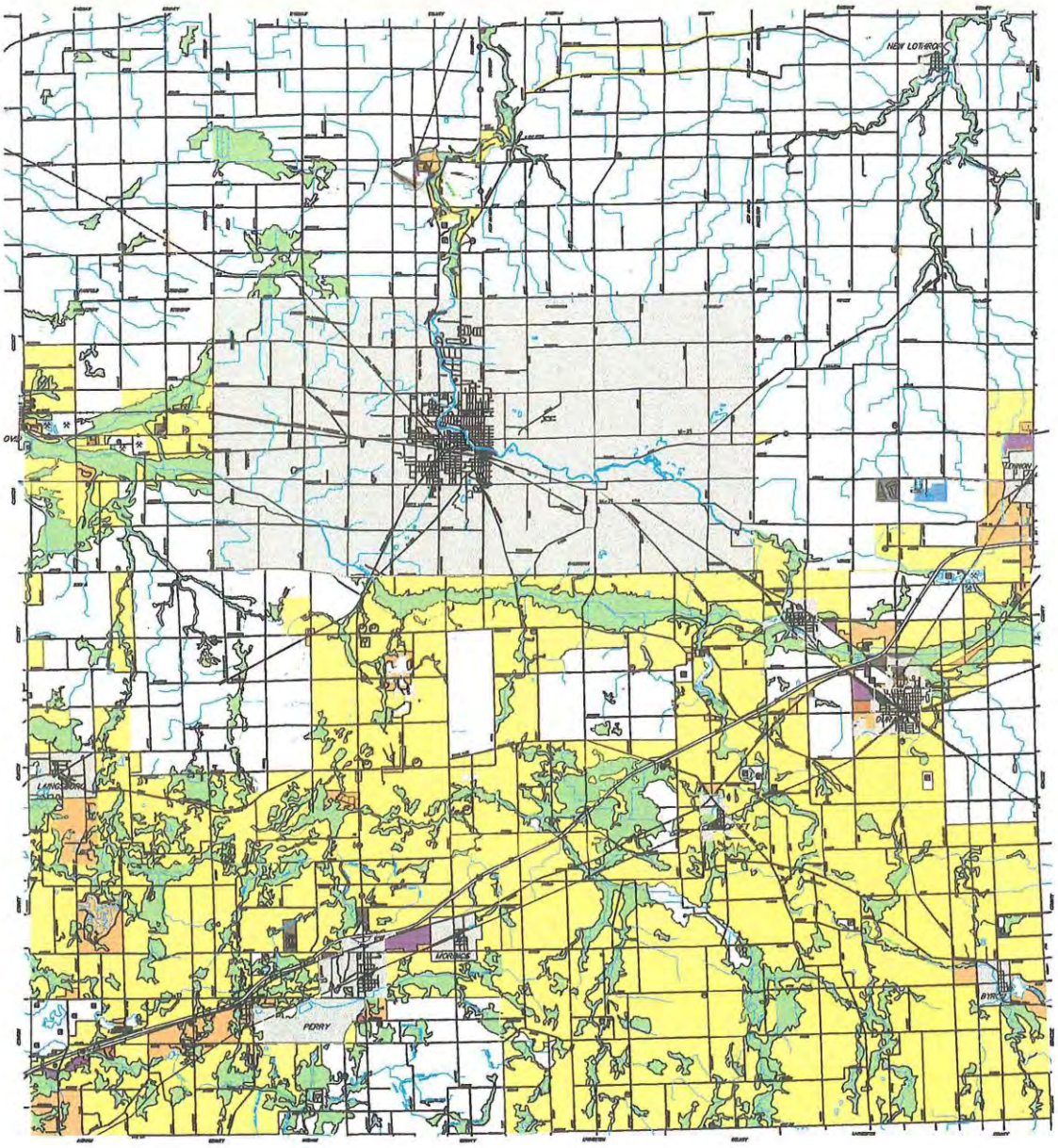

LEGEND

- IMPORTANT AGRICULTURAL
- AGRICULTURAL/RURAL RESIDENTIAL
- LOW DENSITY RESIDENTIAL
- MEDIUM/HIGH DENSITY RESIDENTIAL
- MOBILE HOME PARK/SUBDIVISION
- PUBLIC & NON-PROFIT ORGANIZATIONS
- COMMERCIAL
- INDUSTRIAL
- LANDFILL
- LARGE NATURAL FEATURE COMPLEXES (FLOODPLAIN/CONSERVATION/WETLAND)
- NOT IN THE COUNTY PLANNING AREA
- RECREATION
- GRAVEL PIT

COMPOSITE FUTURE LAND USE

Shiawassee County

Adopted May 23, 2007

MODEL ORDINANCES

LAND USE PLANNING

Development Plan Requirements

Environmentally sensitive future land use plan:
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-AppendixN-EnvironmentallySensitiveMasterPlan.pdf

Environmental impact assessment options:
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-appendixp-environmentalassessmentrequirements.pdf

Regarding groundwater protection:
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-appendixu-groundwaterprotection.pdf

Floodplains

Floodplain management model ordinance:
http://www.leelanau.cc/downloads/floodplain_model_ordinance_from_liaa.pdf

Stream Corridors

Natural River zoning ordinance:
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-AppendixJ-SampleNaturalRiversOrdinance.pdf

AGRICULTURE

Land Conservation and Development Techniques

Model Stormwater Management/Impervious Surface Mitigation Ordinance from the Greater Lansing Regional Committee
http://www.mywatersheds.org/publications/GLRC%20Manuals/FINAL%20Ordinance%20MANUAL.pdf

Model open space development ordinance:
http://www.epa.gov/owow/nps/ordinance/mol3.htm#topofpage

Overlay district model ordinance:
http://www.leelanau.cc/downloads/resource_protection_model_ordinance_from_liaa_1.pdf

Lot averaging model ordinance:
http://www.leelanau.cc/downloads/lot_averaging_model_ordinance_from_liaa_1.pdf

Sand dune preservation overlay:
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-AppendixM-SampleSandDuneOverlay.pdf

Great Lakes shoreline protection overlay zone:
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-appendixs-shorelineprotection.pdf

Cluster development and Planned Unit Development ordinances:
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-appendixt-clusterandpudexamples.pdf

Hamburg Township, Michigan, open space community zoning ordinance:
http://www.epa.gov/owow/nps/ordinance/documents/C2c-Hamburg.pdf

SEDIMENT

Storm Water Management

City of DeWitt Stormwater Ordinance
Model Stormwater Management/Impervious Surface Mitigation Ordinance from the Greater Lansing Regional Committee
http://www.mywatersheds.org/publications/GLRC%20Manuals/FINAL%20Ordinance%20MANUAL.pdf

Model ordinance for stormwater control, operation, and maintenance:
http://www.epa.gov/owow/nps/ordinance/mol4.htm#topofpage

Model ordinances for stormwater management:
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-AppendixH-SampleStormwaterOrdinance.pdf

http://www.leelanau.cc/downloads/stormwater_management_model_ordinance_from_liaa.pdf

Kent County model stormwater ordinance:
http://www.accesskent.com/YourGovernment/DrainCommisioner/pdfs/kc_modelordinance.pdf

Grand Traverse County stormwater ordinance:
http://www.epa.gov/owow/nps/ordinance/documents/D2a-GrandTraverse.pdf

Soil Erosion and Sedimentation Control

Erosion and sedimentation control model ordinances:
http://www.epa.gov/owow/nps/ordinance/mol2.htm#ml2
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-AppendixG-SampleSESCOrdinance.pdf

Steep slope development model ordinance:
http://www.leelanau.cc/downloads/steep_slope_model_ordinance_from_liaa.pdf

High risk erosion areas model ordinance:
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-AppendixK-HREAOverlayZones-BluffErosionHazLine.pdf

Critical dune areas model ordinance:
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-AppendixL-CriticalDuneOrdinance.pdf

Grand Traverse County soil erosion ordinance:
http://www.epa.gov/owow/nps/ordinance/documents/Grandtra.pdf

Impervious Surface Reduction

Model post-construction stormwater runoff control ordinance:
http://www.epa.gov/owow/nps/ordinance/mol6.htm

Model ordinance:
http://www.leelanau.cc/downloads/stormwater_management_model_ordinance_from_liaa.pdf

Private road regulations model ordinance:
http://www.leelanau.cc/downloads/private_road_standards_from_liaa.pdf

NUTRIENTS

Phosphorus Reduction

Model Phosphorus Ban Ordinance from the Greater Lansing Regional Committee
http://www.mywatersheds.org/publications/GLRC%20Manuals/FINAL%20Ordinance%20MANUAL.pdf

Muskegon County Ordinance to Ban Fertilizer Containing Phosphorus
http://co.muskegon.mi.us/boardofcommissioners/ordinances/phosphorus_ordinance.pdf

Ordinances for aquatic buffer zones and set backs:
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-appendixr-sensitiveareaprotection.pdf

http://www.epa.gov/owow/nps/ordinance/mol1.htm

Ada Township, Michigan, Riparian Protection ordinance:
http://www.ada.mi.us/propamend/Buffer-Ordinance-05-06-05-Draft.pdf

Wetland Preservation
Meridian Township Wetland Protection Ordinance
http://library1.municode.com:80/default-test/template.htm?view=browse&doc_action=setdoc&doc_keytype=tocid&doc_key=4f160dd9add89f7ee761ced26c041558&infobase=13564

Model Wetland and Watercourse Protection and Restoration Ordinance from the Greater Lansing Regional Committee
http://www.mywatersheds.org/publications/GLRC%20Manuals/FINAL%20Ordinance%20MANUAL.pdf

Wetland protection model ordinances:
http://www.leelanau.cc/downloads/wetlands_model_ordinance_from_liaa.pdf
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-AppendixE-SampleDEQWetlandOrdinance.pdf

http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-AppendixF-SampleEnablingActsWetlandOrdinance.pdf

Lake Preservation

Keyhole development ordinance:
http://www.deq.state.mi.us/documents/deq-ess-cm-ftg-AppendixI-SampleKeyholeDevelopmentRegulations.pdf

PESTICIDES AND CHEMICALS

Groundwater

Illicit discharges model ordinance:
http://www.epa.gov/owow/nps/ordinance/mol5.htm

Model ordinance for groundwater protection overlay district:
http://www.epa.gov/owow/nps/ordinance/mol7.htm#groundwater

Washtenaw County Ordinance for the Inspection of Residential Onsite Water and Sewage Disposal Systems:
http://www.epa.gov/owow/nps/ordinance/documents/WashtenawCounty.pdf

TEMPERATURE

Greenways

Looking Glass River Overlay District
http://www.mywatersheds.org/publications/GLRC%20Manuals/FINAL%20Ordinance%20MANUAL.pdf

City of Ann Arbor greenway ordinance (Chapter 42):
http://library4.municode.com/gateway.dll/MI/michigan/9631?f=templates&fn=default.htm&npusername=11782&nppassword=MCC&npac_credentialspresent=true&vid=default

Cascade Charter Township landscape and greenbelt ordinance:
http://www.cascadetwp.com/ReferenceDesk/OrdinancesResolutions/Zoning/Chapter20.htm
Woodland Preservation
Model Trees and Woodlands Protection Ordinance from the Greater Lansing Regional Committee:
http://www.mywatersheds.org/publications/GLRC%20Manuals/FINAL%20Ordinance%20MANUAL.pdf

Tree preservation model ordinance:
http://www.leelanau.cc/downloads/tree_preservation_ordinance_from_liaa.pdf

City of Auburn Hills Woodland Preservation Ordinance:
http://www.auburnhills.org/departments/communitydevelopment/Shared%20Documents/Woodland%20Preservation%20Ordinance.pdf

Forest Resource Ordinance for Frederick County, Maryland:
http://www.epa.gov/owow/nps/ordinance/documents/E6-Frederick.pdf

Habitat Preservation

Overview of weed laws:
http://www.epa.gov/greenacres/weedlaws/index.html

Model weed ordinance that allows for the presence of native species:
http://web.dcp.ufl.edu/ckibert/BCN6585/EPALandscaping/JMLRApndx.html

Madison, Wisconsin, Natural Lawn Ordinance {Chapter 27.05(2)(f)2 and 3}:
http://library10.municode.com/gateway.dll/1?f=templates&fn=default.htm&vid=nextpage:500000&npusername=50000&nppassword=MCC&npac_credentialspresent=true

Habitat ordinance from Portland, Oregon, metropolitan area:
http://www.metro-region.org/library_docs/nature/2nd_pdf_ord_05-1077b_only__071405.pdf

PATHOGENS

Sanitary Sewer planning and infrastructure

Grand Haven Township sewer ordinance:
http://www.ght.org/OnlineResources/Ordinances/Ordinance%20%23180%20-%20Sewer%20Usage%20and%20Administration%20Ordinance.pdf

City of Owosso sewer ordinance:
http://ci.owosso.mi.us/ReferenceDesk/CityCode/Chapter34.htm

Animal Waste

Model Pet Waste Ordinance from the Greater Lansing Regional Committee:
http://www.mywatersheds.org/publications/GLRC%20Manuals/FINAL%20Ordinance%20MANUAL.pdf

Farmington Hills animal waste ordinance (Chapter 6, Article II, Section 6-37):
http://library4.municode.com/gateway.dll/MI/michigan/11155?f=templates&fn=default.htm&npusername=12046&nppassword=MCC&npac_credentialspresent=true&vid=default

Illicit Discharge

Model Illicit Discharge Ordinance from the Greater Lansing Regional Committee:
http://www.mywatersheds.org/publications/GLRC%20Manuals/FINAL%20Ordinance%20MANUAL.pdf

INVASIVE SPECIES

Model Native Vegetation Ordinance from the Greater Lansing Regional Committee:
http://www.mywatersheds.org/publications/GLRC%20Manuals/FINAL%20Ordinance%20MANUAL.pdf

MISCELLANEOUS

Surface water protection ordinance (water reservoirs):
http://www.epa.gov/owow/nps/ordinance/mol7.htm#surfacewater

Model lighting ordinance:
http://www.leelanau.cc/downloads/model_lighting_ordinance_2003_1.pdf

Model Grease and Sand Interceptor Policy from the Greater Lansing Regional Committee:
http://www.mywatersheds.org/publications/GLRC%20Manuals/FINAL%20Ordinance%20MANUAL.pdf

Upper Maple River Watershed
Policy Review - Priority Spreadsheet

Policy Review Criteria	Goal	Clinton County	Gratiot County	Shiawassee County	Village of Ovid (Clinton County)	Fulton Township (Gratiot County)
Land Use Planning and Zoning						
Master Plans/Future Land Use Maps	Master Plan and Comprehensive Land Use Plan should state the community's intention for land use, natural resource preservation, and providing infrastructure.	2008 Comprehensive Land Use Plan	2002 Gratiot County Strategic Plan	2007 Land Use Plan	Waiting for most recent Master Plan. Working on new Plan.	Working with Gratiot County on updated Master Plan
Zoning Ordinance	Zoning Ordinances should enact the rules that support the vision of the Master Plan and Future Land Use Maps.	County Zoning Ordinance	County Zoning Ordinances	County Zoning Ordinances	Village of Ovid Zoning Ordinance	Fulton Township Zoning Ordinance
Floodplain Mapping, Overlay District Flood Hazard Mitigation Planning, Floodplain Ordinance	Extent of 100-year floodplain is recognized and provisions to protect or mitigate impacts to the floodplain are adopted.	County Zoning Ordinance; Victor Township, Village of Ovid have FIRMS	County Zoning Ordinance	2007 Land Use Plan; Floodplains mapped in Owasso, Caledonia and Shiawassee Townships	Floodplain mapped	Not addressed
Recreation Plan - updated	A MDNR approved 5-year Recreation Plan identifies priority lands for acquisition or protection for future recreational use.	Parks, Recreation & Open Space Plan 2008-2012, approved by MDNR	Gratiot County Recreation Plan 2005-2010, adopted 2005	County Parks & Recreation Five-Year Plan 2010-2014	Not addressed	Not addressed
Development Review Process	Existing and future plans for natural features are illustrated in site plan. Protective measures are included in site plans to ensure that developments preserve natural features and water quality	County Zoning Ordinance and Clinton County Drain Commissioner's Development Standards	County Zoning Ordinance and Drain Commissioners 2009 Administrative Guidelines	2007 Land Use Plan and County Zoning Ordinance	Zoning Ordinance	Defers to Gratiot County
Low Impact Development Ordinance - development and division practices	Impacts of development to communities resources are minimized through infiltration and reduction of impervious surfaces.	2008 Comprehensive Land Use Plan and Zoning Ordinance	Not addressed	Not addressed	Zoning Ordinance	Not addressed

Upper Maple River Watershed
Policy Review - Priority Spreadsheet

Policy Review Criteria	Goal	Clinton County	Gratiot County	Shiawassee County	Village of Ovid (Clinton County)	Fulton Township (Gratiot County)
Agriculture						
Agriculture/Farmland Preservation	Master Plans describe importance of agricultural land and rural character in community. Zoning ordinances provide regulations for preserving farmland	2008 Comprehensive Land Use, Clinton County Zoning Ordinance, Purchase of Development Rights program	2002 Strategic Plan and Zoning Ordinance	2007 Land Use Plan, Purchase of Development Rights program, County Zoning Ordinance	Zoning Ordinance	Not addressed
Riparian Ordinance - riparian setbacks	Buffer overlay zones are identified and regulated for stream protection and flood control	County Drain Commissioner Subdivision Control Procedures	Zoning Ordinance	Buffer = 25'; Trout 50 - 100'; 2007 Land Use Plan	Not addressed	Not addressed
Clustering and Open Space Developments - protect open spaces, natural resource protection	Cluster development is allowed and incentivized. Land conservation techniques are utilized to keep land preserved in perpetuity	2008 Comprehensive Land Use Plan	Zoning Ordinance	2007 Land Use Plan Residential Policies, and Zoning Ordinance	Zoning Ordinance	Not addressed
Conservation Easements and Similar Tools	Encourage incentives and felxibility to promotes conservation of valuable areas	PCA and Zoning Ordinance	Zoning Ordinance	Zoning Ordinance	Not addressed	Not addressed

Upper Maple River Watershed
Policy Review - Priority Spreadsheet

Policy Review Criteria	Goal	Clinton County	Gratiot County	Shiawassee County	Village of Ovid (Clinton County)	Fulton Township (Gratiot County)
Sediment						
Storm Water Standards	Storm Water Standards and criteria are developed to regulate for flood control, stream protection, and water quality.	County Zoning, County Drain Commissioner Subdivision Standards & Specifications, and County Road Commission	Administrative Guidelines for Storm Water Management	2007 Land Use Plan, Drain Criteria?	Follows County regulations	Follows County regulations
Engineered Best Management Practices	Designs for water quality are incorporated into designs standards.	Clinton County Drain Commissioner's Development Standards	Administrative Guidelines for Storm Water Management	Zoning Ordinance	Follows County regulations	Follows County regulations
Runoff Volume Control	Reduction of runoff volume is incorporated into designs, allowing flexibility in street and development drainage systems.	Standards to be adopted	Administrative Guidelines for Storm Water Management	Shiawassee County Road Commission	Not addressed	Not addressed
Minimizing Inflow	Disconnect downspouts and other direct connections to the storm sewer	County Zoning Ordinance and Drain Commissioner's Development Standards	Zoning Ordinance	Shiawassee County Road Commission	Not addressed	Not addressed
SESC, Construction Management Ordinance	Soil erosion and sedimentation control is identified as an important activity of the County and other enforcing agents.	County of Clinton Soil Erosion and Sedimentation Control Ordinance	Soil Erosion and Sedimentation Control Ordinance	Soil Erosion and Sedimentation Control Program Guide	Village of Ovid Zoning Ordinance	Follows County regulations
	Adequate staff is available to effectively administer and enforce SESC ordinance	Clinton County Drain Commissioner (CEA & APA); CCRC (APA); CCD (CD)	Gratiot County Permits Office (CEA); GCDC (APA); GCRC (APA); GCD (CD)	Shiawassee County Health Department (CEA); SCDC (APA); SCRC (APA); SCD (CD)	Follows County regulations	Follows County regulations
Impervious Surface Reduction - parking lot designs and parking space requirements, alternative materials	Flexibility is allowed for alternative paving materials and requirements	Zoning Ordinance	Zoning Ordinance	Zoning Ordinance	Zoning Ordinance	Not addressed
Parking Lots and Driveways	Alternative parking lots and driveways designs are permitted to reduce imperviousness.	Zoning Ordinance Section 1402 Allows Multiple Residence Drives (18" minimum width with 3' shoulder required) paving optional. Article 11 requires curb cuts in general residential and commercial areas if needed.	Zoning Ordinance	Zoning Ordinance and Land Use Plan	Zoning Ordinance	Zoning Ordinance
Streets and Access	Reduced street widths and on-street parking requirements are allowed to reduce imperviousness	Zoning Ordinance	Zoning Ordinance	County Road Commission Standards & Specifications	Follows County regulations	Follows County regulations
Street Patterns	Standards are flexible for street length and width, sidewalk locations, and cul-de-sacs to reduce imperviousness	Zoning Ordinance	Not addressed	Zoning Ordinance and Shiawassee County Road Commission Standards	Not addressed	Not addressed
Lot Setbacks/Lot Width/Lot Coverage	Relaxed rules for specific dimensions allows more options for developers, such as open space and cluster development designs.	County Zoning Ordinance	County Zoning Ordinance	County Zoning Ordinance and Planned Unit Development	Township Zoning Ordinance	Township Zoning Ordinance

Upper Maple River Watershed
Policy Review - Priority Spreadsheet

Policy Review Criteria	Goal	Clinton County	Gratiot County	Shiawassee County	Village of Ovid (Clinton County)	Fulton Township (Gratiot County)
Sidewalks	Flexibility is allowed for sidewalks on only one side of the street or the use of alternative pathways and trails to reduce imperviousness	Section 432 requires sidewalks on one side of the street be illustrated in the site plan for review. Section 1326 requires sidewalks of 6 feet in width adjacent to a public street in an area of a "Big Box" site. Article 11 requires sidewalks illustrated on site plan.	Not addressed	Zoning for particular use	Not addressed	Not addressed
Nutrients						
Wetland Preservation	Identification and delineation of wetlands provides support for ordinance and regulations to protect and preserve existing and restored wetlands.	2008 Comprehensive Land Use Plan	Zoning Ordinance	Zoning Ordinance required setbacks - 2007 Land Use Plan	Not addressed	Not addressed
Sanitary System Standards	Master Plan provides sewer service area that adequately serves the community.	2008 Comprehensive Land Use Plan	Mid Michigan District Health Department, Environmental Health Regulations and 2007 Land Use Plan	County Zoning Ordinance; Article 5.2.5 requires safe and effective means of collection, treatment, and disposal of waste and must conform with requirements of Shiawassee County Health Department and Michigan Department of Environmental Quality	Follows County regulations	Follows County regulations
Septic Ordinance	An ordinance regulating the siting, installation, and maintenance of septic systems reduces failures and identifies faulty systems.	Mid-Michigan District Health Department Environmental Health Regulations - offers altrnatives for replacement systems. No Point of Sale Inspection	Mid-Michigan District Health Department Environmental Health Regulations - - offers altrnatives for replacement systems. No Point of Sale Inspection.	Shiawassee Point of Sale Ordinance and 2007 Land Use Plan	Township Zoning Ordinance	Not addressed
Lake Management	Minimize lake access and usage to preserve water quality	Deemed "viable" by County Drain Commissioner in ordinance survey	Zoning Ordinance, Section 2.25 - Riparian Access limits number of access areas and use of lake and rivers	2007 Land Use Plan - page 21 - 24 "Sensitive Lands and Natural Resource Policies"	Not addressed	Not addressed

Upper Maple River Watershed
Policy Review - Priority Spreadsheet

Policy Review Criteria	Goal	Clinton County	Gratiot County	Shiawassee County	Village of Ovid (Clinton County)	Fulton Township (Gratiot County)
Pathogens and Bacteria						
Animal Waste (Pets & Kennels)	Educate residents about the availability, location, and requirements of properly disposing of pet waste	Zoning Ordinance	Zoning ordinance, Park Rules Ordinance, Parks & Recreation Commission Ordinance	County Zoning Ordinance	Not addressed	Not addressed
Agricultural Manure Management	Educate operators about the requirements of properly storing and applying manure	Section 609 of the Zoning Ordinance prohibits polluting discharges.	Follows State guidelines	Follows State guidelines	Follows State guidelines	Follows State guidelines
IDEP Illicit Discharge Ordinance	Map drainage system and outfalls to support Illicit Discharge Elimination Discharge ordinance and inspection program.	Zoning Ordinance	Not addressed	Encouraged in Shiawassee Watershed Management Program	Not addressed	Not addressed
High Temperature						
Greenways/Greenbelts	Plan for use of greenways and greenbelts to protect watercourses and other resources.	County Zoning Ordinance	Zoning Ordinance	County Zoning Ordinance	Not addressed	Not addressed
Woodland Preservation	Assess individual trees and woodlands to support protection measures of ordinances and standards to minimize tree removal during construction projects	Not addressed	Not addressed	2007 Land Use Plan	Not addressed	Not addressed
Habitat Preservation - Natural Area Preservation/Restoration	Assess natural areas to identify unique and sensitive areas important for ecosystem.	Land Use Plan	2002 Strategic Plan and Zoning Ordinance	Shiawassee Watershed Management Program	Not addressed	Not addressed
Pesticides and Chemicals						
Wellhead Protection Areas	Identify and map wellhead protection areas to preserve groundwater	Dallas Township (Fowler - Source Water Protection); Duplain Township (Elsie); Essex Township (Maple Rapids), St. Johns (Confirmatory Tritium Testing)	Arcadia & Newark Townships (Ithaca - Source Water Protection)	Fairfield Township (Elsie); Michigan Groundwater Stewardship Program	Not addressed	Not addressed
Groundwater Protection	Restrict high-risk land uses in groundwater recharge areas.	County Zoning Ordinance	Administrative Guidelines for Stormwater Management; Introduction encourages water recharge in geologically favorable sites	2007 Land Use Plan	Not addressed	Not addressed
Road Salt Application	Reduce environmental impact from salt runoff.	Road Commission has procedure for sensible salting and investigates alternative methods and materials.	Not addressed	Not addressed	Not addressed	Not addressed
Invasive Species						
Invasive Species Management	Use native and site specific plants to maximize viability and reduce threat of invasive species.	County Zoning Ordinance	Park Rules Ordinance, Parks & Recreation Commission Ordinance	Shiawassee Watershed Management Program and County Zoning Ordinance	Not addressed	Not addressed

Upper Maple River Watershed
Policy Review - Priority Spreadsheet

Policy Review Criteria	Goal	Clinton County	Gratiot County	Shiawassee County	Village of Ovid (Clinton County)	Fulton Township (Gratiot County)
Renewable Energy						
Wind Ordinance	Allow and promotes the effective and efficient use of wind energy conversion systems.	Not addressed	Zoning Ordinance, Chapter 14, Section 14.4 Site Plan Review, D. Wind Energy Facility Special Use Site Plan Review Required. Wind Energy Overlay District Map to be created. Adopted May 5, 2009.	Zoning Ordinance; Amendment 09 02-01 Page 1 promotes the effective and efficient use of wind energy conversion systems. Wind ordinance approved 4/1/10	Not addressed	Not addressed
Other						
Gravel Mine Extraction	Minimize disturbance and impact on adjacent land uses. Protect groundwater and sedimentation, limit dewatering.	2008 Comprehensive Land Use Plan Goal #7, Objective 11. Article 4 includes overlay district where land must be rezoned to a mining district to allow mining.	Not addressed	Not addressed	Not addressed	Not addressed

Meeting Goal and following recommended principle
Could improve using concepts from Model Ordinance
Not addressed
Red text indicates impediment to development principle

Subwatershed	Township/City/Village	County	Floodplain Mapping	Master Plans	Wellhead Protection Areas	Other Info
Alder Creek	Lake Victoria	Clinton				
Alder Creek	Middlebury Township	Shiawassee				
Alder Creek	Ovid Township	Clinton				
Alder Creek	Sciotia Township	Shiawassee				Info from Looking Glass: 1. (p. 30) Surface water quality in the townhsip is negatively impacted by high fecal coliform counts, nonpoint nutrient loading, sedimentation. 2. Plan inlcudes 10 environmental strategies (p 61 & 61); emphasis on septic system management.
Alder Creek	Victor Township	Clinton				
Baker Creek	Duplain Township	Clinton				
Baker Creek	Fairfield Township	Shiawassee				
Baker Creek	Middlebury Township	Shiawassee				
Baker Creek	Village of Elsie	Clinton			X	
Collier Creek - Maple River	Essex Township	Clinton				
Collier Creek - Maple River	Fulton Township	Gratiot				
Collier Creek - Maple River	Greenbush Township	Clinton				
Collier Creek - Maple River	Village of Maple Rapids	Clinton			X	
Collier Creek - Maple River	Washington Township	Gratiot				
Coon Creek - Bear Creek	Bennington Township	Shiawassee				Info from Looking Glass: 1. Sensitive Lands and Natural Resource Policies: provide regional coordination to protect valuable & irreplaceable natural resources in the township including rivers, wooded land, and lakes (p. 77). 2. Land Use Area Needs: Wetlands are valuable as their own highest and best use (P. 82). 3. Wetland Conservation: Classification of land as "conservation/floodplain/wetland" in order to identify sensitive environmental features. Such areas should not be used for high-intensity uses. Significant area along Looking Glass with this designation (p. 85).
Coon Creek - Bear Creek	Middlebury Township	Shiawassee				
Coon Creek - Bear Creek	Sciotia Township	Shiawassee				Info from Looking Glass: 1. (p. 30) Surface water quality in the townhsip is negatively impacted by high fecal coliform counts, nonpoint nutrient loading, sedimentation. 2. Plan inlcudes 10 environmental strategies (p 61 & 61); emphasis on septic system management.
Coon Creek - Bear Creek	City of Laingsburg	Shiawassee				Info from Looking Glass: Under 1994 Parks and Recreation Plan (p. 51), natural resource areas are to be protected and developed. The plan includes a recommendation that the lowland south of the sewage lagoons be designated as natural area and developed as an interpretive trail.

Subwatershed	Township/City/Village	County	Floodplain Mapping	Master Plans	Wellhead Protection Areas	Other Info
Doty Brook - Hayworth Creek	Bingham Township	Clinton				
Doty Brook - Hayworth Creek	City of St. Johns	Clinton				
Doty Brook - Hayworth Creek	Essex Township	Clinton				
Doty Brook - Hayworth Creek	Greenbush Township	Clinton				
Doty Brook - Hayworth Creek	Ovid Township	Clinton				
Ferdon Creek - Maple River	Duplain Township	Clinton				
Ferdon Creek - Maple River	Elba Township	Gratiot				
Ferdon Creek - Maple River	Essex Township	Clinton				
Ferdon Creek - Maple River	Greenbush Township	Clinton				
Ferdon Creek - Maple River	Washington Township	Gratiot				
Hayworth Creek	Bengal Township	Clinton				
Hayworth Creek	City of Fowler	Clinton				
Hayworth Creek	Dallas Township	Clinton				
Hayworth Creek	Essex Township	Clinton				
Hayworth Creek	Lebanon Township	Clinton				
Little Maple	Lake Ovid	Clinton				
Little Maple	Ovid Township	Clinton				
Little Maple	Victor Township	Clinton				
Nile Drain - Bear Creek	Elba Township	Gratiot				
Nile Drain - Bear Creek	Fulton Township	Gratiot				
Nile Drain - Bear Creek	Hamilton Township	Gratiot				
Nile Drain - Bear Creek	Newark Township	Gratiot				
Nile Drain - Bear Creek	North Star Township	Gratiot				
Nile Drain - Bear Creek	Village of Ashley	Gratiot				
Nile Drain - Bear Creek	Washington Township	Gratiot				
North Shade Drain	Fulton Township	Gratiot				
North Shade Drain	New Haven Township	Gratiot				
North Shade Drain	Newark Township	Gratiot				
North Shade Drain	North Shade Township	Gratiot				
Ovid - Maple River	Bennington Township	Shiawassee				Info from Looking Glass: 1. Sensitive Lands and Natural Resource Policies: provide regional coordination to protect valuable & irreplaceable natural resources in the township including rivers, wooded land, and lakes (p. 77). 2. Land Use Area Needs: Wetlands are valuable as their own highest and best use (P. 82). 3. Wetland Conservation: Classification of land as "conservation/floodplain/wetland" in order to identify sensitive environmental features. Such areas should not be used for high-intensity uses. Significant area along Looking Glass with this designation (p. 85).
Ovid - Maple River	Middlebury Township	Shiawassee				
Ovid - Maple River	Ovid Township	Clinton				
Ovid - Maple River	Owosso Township	Shiawassee				

Subwatershed	Township/City/Village	County	Floodplain Mapping	Master Plans	Wellhead Protection Areas	Other Info
Ovid - Maple River	Village of Ovid	Clinton				
Pine Creek	Cleveland Village?	Gratiot				
Pine Creek	Fulton Township	Gratiot				
Pine Creek	Newark Township	Gratiot				
Pine Creek	North Shade Township	Gratiot				
Pine Creek	Village of Perrington	Gratiot				
River Styx - Pine Creek	Arcada Township	Gratiot				
River Styx - Pine Creek	New Haven Township	Gratiot				
River Styx - Pine Creek	Newark Township	Gratiot				
South Fork Hayworth Creek	Bengal Township	Clinton				
South Fork Hayworth Creek	Bingham Township	Clinton				
South Fork Hayworth Creek	Essex Township	Clinton				
Spring Brook - Maple River	Bennington Township	Shiawassee				Info from Looking Glass: 1. Sensitive Lands and Natural Resource Policies: provide regional coordination to protect valuable & irreplaceable natural resources in the township including rivers, wooded land, and lakes (p. 77). 2. Land Use Area Needs: Wetlands are valuable as their own highest and best use (P. 82). 3. Wetland Conservation: Classification of land as "conservation/floodplain/wetland" in order to identify sensitive environmental features. Such areas should not be used for high-intensity uses. Significant area along Looking Glass with this designation (p. 85).
Spring Brook - Maple River	Caledonia Township	Shiawassee				
Spring Brook - Maple River	Shiawassee Township	Shiawassee				
Stevens Drain - Maple River	Duplain Township	Clinton				
Stevens Drain - Maple River	Elba Township	Gratiot				
Stevens Drain - Maple River	Greenbush Township	Clinton				
Stevens Drain - Maple River	Ovid Township	Clinton				
Stevens Drain - Maple River	Village of Elsie	Clinton			X	

Government Body	Plan Preparers and Date	Zoning Authority	Planning provisions that relate to the watershed
Bennington Township	Rowe Engineering Inc. 2000	Shiawassee County	Sensitive Lands and Natural Resource Policies: provide regional coordination to protect valuable & irreplaceable natural resources in the township including rivers, wooded land, and lakes (p. 77)
			Land Use Area Needs: Wetlands are valuable as their own highest and best use (P. 82).
			Wetland Conservation: Classification of land as "conservation/floodplain/wetland" in order to identify sensitive environmental features. Such areas should not be used for high-intensity uses. Significant area along Looking Glass with this designation (p. 85).
City of Laingsburg	Capital Consultants 1997	Shiawassee County	The Looking Glass River flows through the SW areas of the City (Sec. 3-4).
			Significant undevelopable wetland and floodplain areas exist along the river (Sec. 4-2).
			City streets are paved but not curbed; drainage is adequate in most areas, drainage through settling ponds, into Laingsburg Drain, into Looking Glass (Sec. 7-8).
			In 1995, residents did not consider storm drainage a concern (Sec. 9-1).
			Under 1994 Parks and Recreation Plan (p. 51), natural resource areas are to be protected and developed. The plan includes a recommendation that the lowland south of the sewage lagoons be designated as natural area and developed as an interpretive trail.
Sciota Township	Brenda Moore AICP, PCP 2001	Shiawassee County	Objective of plan is to protect and preserve natural resources, unique character, and environmental quality of the area (p. 3).
			Segment of Looking Glass River runs through the southern portion of the township (Fig 4-1).
			Portion of township suffers water erosion resulting in sediment pollution of surface water resources (Fig. 4-2).
			(p. 30) Surface water quality in the townhsip is negatively impacted by high fecal coliform counts, nonpoint nutrient loading, sedimentation.
			Plan inlcudes 10 environmental strategies (p 61 & 61); emphasis on septic system management.
Shiawassee Township		Shiawassee County	Planning done by Shiawassee County, no local master plan available
Victor Township		Clinton County	Planning done by Clinton County, no local master plan available. County plan currently under revisions, old Clinton county CDP is available online.

Upper Maple River
Watershed Management Plan

June 2010
MDNRE Tracking Code #2007-0118

Appendix 16

Preservation of Other Lands

APPENDIX 16 - PRESERVATION OF OTHER LANDS

Beyond federal, state, and local laws to conserve and preserve lands, the greatest opportunity to protect and preserve water quality and natural resources rests with the landowner in how they manage their lands. Most of the land in the Watershed is private ownership. Seven main tools are available for land preservation in Michigan: conservation easements, purchase of development rights, open space/conservation development, public purchase, USDA Land Conservation Programs, PA 116, and land donations.

The land preservation tools are defined as follows:

- Conservation Easement: a voluntary legal agreement between a landowner and a land trust, conservancy or government agency that permanently limits the uses of the property.
- Purchase of Development Rights (PDR): compensates landowners for the appraised, fair market value of their development rights in exchange for a permanent agricultural conservation easement on the property.
- Open Space/Conservation Development: usually results in smaller, clustered lots and an area of permanently protected open space.
- Public Purchase: where a governmental unit purchases land. It includes a binding agreement authorized by a public body and recorded with the Register of Deeds for property to be removed from the tax rolls.
- USDA Land Conservation Programs: land conservation programs through the USDA Natural Resources Conservation Service include Conservation Reserve Program, Wetland Reserve Program, Farmland Preservation Program and many more.
- PA 116: PA 116, called the Farmland and Open Space Preservation Program, is designed to preserve farmland and open space through agreements that restrict development for a temporary period, and provide tax incentives for participation.
- Land Donation: total or partial gift of land, possibly with restrictions on future use.

Each land preservation tool can be configured to fit the landowner's idea of what to do with the land. However, each tool differs from the others in significant ways that must be kept in mind when making decisions about how to preserve land. Also, because the specific land conservancy or organization may have a specific mission in what type of land they protect, a discussion must be had to determine the best tool to protect the land.

Many organizations are willing to provide technical assistance to landowners on how to better manage their lands to protect natural resources and water quality. These organizations include Conservation Districts, MSU County Extension Offices, Natural Resources Conservation Services, Land Conservancies, Department of Natural Resources and Environment, Department of Agriculture, and United States Fish and Wildlife Service.

Upper Maple River
Watershed Management Plan

June 2010
MDNRE Tracking Code #2007-0118

Appendix 17

Information & Education (I&E) Strategy

Goal No. 1:	Watershed Education: Increase Public Awareness of Watershed and All Pollutants
Objective:	Increase public knowledge and broaden awareness of the Watershed. Develop partnerships among stakeholders by sharing ideas, resources, and facilitating cooperative activities that increase public awareness of watershed management and impact land use policies.
Message:	A watershed is an area of land that drains to a common point. You live in the Upper Maple River Watershed. You impact the watershed. Changes in land use may impact stream flows, creating water quality, stream stability, and flooding concerns.
Critical Areas:	Entire Watershed

Target Audience	**Measurable Milestone**			**Potential Partners**	**Estimated Costs [(Include Technical Assistance (hrs) and Financial Assistance (total amount and funding source)]**	**Evaluation Methods**
	Awareness (within 1 year)	**Education (within 3 years)**	**Action (within 5 years)**			
All watershed residents	Develop a multi-page newspaper insert with a map and information about the watershed	Post watershed info on 4 billboards in the watershed.	Post watershed boundary signs on 12 major roads.	Friends of the Maple River, Road Commissions	$500 to develop newspaper insert,$5,000 to print insert, $2,500/month for 6 months to post info on billboards, $60/watershed boundary sign. Total = $80,060	Number of calls/comments requesting information about the watershed.
	Publish newspaper articles, newsletters, and website updates informing the public about activities, findings, and progress on the Maple River Watershed Projects.	Publish regularly scheduled newspaper articles, newsletters, and website updates informing the public about activities, findings, and progress on the Maple River Watershed Projects.	Publish monthly newspaper articles, newsletters, and website updates informing the public about activities, findings, and progress on the Maple River Watershed Projects.	Local newspapers, Michigan State University Extension, Conservation Districts, Friends of the Maple River, Clinton County Regional Educational Service Agency, Shiawassee Regional Education Service District, Gratiot-Isabella Regional Education Service District, Farm Bureau, Michigan United Conservation Club, Chamber of Commerce, Churches	No cost to publish newspaper articles. Total = $0	Number of people attending various activities promoted in articles.
	Attend 10 festivals and other public events to distribute 2,000 brochures about the state of the Maple River Watershed.	Hold one meeting in every sub-watershed (16 locations) to report on activities to help build a sense of community within each sub-watershed	Monitor water quality at output of each sub-watershed (16 locations).	Friends of the Maple River, Conservation Districts, Lake Associations, Subwatershed groups	$1,500 to develop brochures and $1.50/each to print, $50/meeting; time for sampling donated by Friends of the Maple River, $25/sample for supplies and water quality analysis. Total = $5,700	Number of people attending subwatershed meetings
	Work on implementation of the Heritage Water Trail.	Organize "Float the Maple River" once a year to address changes/improvements to the river.		Friends of the Maple River, Conservation districts	All time/work donated by Friends of the Maple River Total = $0	Number of comments received about the Heritage Water Trail, Number of participants

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Critical Areas:	Entire Watershed

Target Audience	**Measurable Milestone**			**Potential Partners**	**Estimated Costs [(Include Technical Assistance (hrs) and Financial Assistance (total amount and funding source)]**	**Evaluation Methods**
	Awareness (within 1 year)	**Education (within 3 years)**	**Action (within 5 years)**			
Urban Residents (areas with sewer infrastructure)	Identify all storm water catch basins, outlets, and receiving waters in the watershed.	Develop flyers or brochures about storm water drains and the danger for transporting pollutants. Print 500 brochures.	Complete stencils on 200 storm drain sewers.	All municipalities in the watershed with sewer infrastructure, County GIS Coordinators	$1,500 to develop brochures and $1.50/each to print, $5/marker (100 markers) and $20/stencil template (50 templates). Total = $3,750	Number of completed storm drain stencils.
Hunter, Fishers, Outdoor Enthusiasts	Develop and print 2000 brochures about the watershed and keeping it clean. Place brochures and watershed materials near hunting/outdoor equipment and licensing areas in sporting goods stores and bait shops.	Attend one Department of Natural Resources Hunter Recreational Safety Education Class in each County to encourage keeping the watershed clean.		Chamber of Commerce, Department of Natural Resources, Conservation Clubs	$1,500 to develop brochures and $1.50/each to print; $50/meeting. Total = $4,650	Evaulation survey at end of class to test increase in knowledge based on brochure. Number of comments received about the watershed from people in the hunter safety classes.
Teachers	Develop and distribute a list of topics, presentations, and presenters available to speak at elementary, middle & high school classes.	Attend curriculum meetings and present water quality and conservation topics to all grade levels in the surrounding schools	Find grant money for teacher education and natural resource teaching materials	Clinton County Regional Educational Service Agency, Shiawassee Regional Education Service District, Gratiot-Isabella Regional Education Service District, Michigan State University Extension, Conservation Districts		Number of changes made to curriculum to include water quality and conservation topics. Number of teachers using the updated curriculum.
Students	Purchase and/or utilize Enviroscape models for watershed education	Have conservation related poster contests for younger students, and a video contest for older students. Broadcast results on local cable TV.	Develop and maintain a watershed education classroom	Clinton County Regional Educational Service Agency, Shiawassee Regional Education Service District, Gratiot-Isabella Regional Education Service District, Michigan State University Extension, Conservation Districts	$1,500 for environscape, $3,000 to develop and variable cost to maintain watershed education classroom. Total = $4,500 plus class room maintenance.	Number of children taking part in contests, number of people using the watershed education classroom (monthly hits on the web site?)

Goal No. 1:	Watershed Education: Increase Public Awareness of Watershed and All Pollutants
Objective:	Increase public knowledge and broaden awareness of the Watershed. Develop partnerships among stakeholders by sharing ideas, resources, and facilitating cooperative activities that increase public awareness of watershed management and impact land use policies.
Message:	A watershed is an area of land that drains to a common point. You live in the Upper Maple River Watershed. You impact the watershed. Changes in land use may impact stream flows, creating water quality, stream stability, and flooding concerns.
Critical Areas:	Entire Watershed

Target Audience	**Measurable Milestone**			**Potential Partners**	**Estimated Costs [(Include Technical Assistance (hrs) and Financial Assistance (total amount and funding source)]**	**Evaluation Methods**
	Awareness (within 1 year)	**Education (within 3 years)**	**Action (within 5 years)**			
Local Business and Restaurants	Develop and distribute 500 coasters with watershed info printed on them	Develop a brochure of local businesses utilizing local products or other sustainable practices. Print 2000 brochures.	Partner with businesses to promote water quality enhancements.	Chamber of Commerce, Michigan State University Extension, Conservation Districts, Local business owners	$200 to develop coaster; $0.25/coaster, $1,500 to develop brochure; $1.50 each to print Total = $4,825	Number of businesses who incorporate water quality enhancements into their services.
Riparian landowners	Develop and distribute 2,000 brochures about basics of hydrology and stream stability and the need for preserving wetlands and floodplains. Recognize good stewardship by giving awards through Farm Bureau, Conservation District, etc.	Conduct 2 workshops about wetland restoration and floodplain regulations.	Work with landowners to develop 5 wetland restoration plans. Work with landowners to develop 10 plans for riparian buffer/filter strip installation.	County Planning Commissions, County Drain Commissioners, Conservation Districts, Natural Resources Conservation Service, Farm Bureau	$1,500 to develop and $1.50/each to print; $300/workshop, $1,500/wetland restoration plan; $1000 buffer/filter strip plan. Total = $22,600	Acres of restored wetlands, acres of buffer/filter strips installed, and decrease in floodplain development violations.
Landowners in Upper Maple River Watershed	Work on distribution list using access program created by MDEQ during planning phase.	Update distribution list quarterly.	Update distribution list quarterly.	Conservation Districts, Friends of the Maple River	No cost, time donated by Friends of the Maple River	The increase in number of people active in the Friends of the Maple River organization.

Goal No. 2:	Restore and maintain waterbodies for other indigenous aquatic life and wildlife use.
Goal No. 3:	Restore and maintain waterbodies for warmwater fishery use.
Objective:	Implement watershed focused land-use planning. Educate stakeholders about the environmental impacts of land use activities. Create a sense of individual responsibility for the proper use and care of surface water resources.
Pollutant:	Sediment.
Message:	Human actions may increase sedimentation and adversely affect water quality. Sediment changes the flow capacity of the stream and impairs aquatic habitats.
Critical Areas (Subdistricts):	**High Priority =** Collier Creek - Maple River, Ferdon Creek, Hayworth Creek, Pine Creek, and Nile Drain - Bear Creek. **Medium Priority =** Spring Brook - Maple River, Coon Creek - Bear Creek, South Fork Hayworth Creek, Doty Brook - Hayworth Creek, and Baker Creek. **Low Priority =** Ovid - Maple River, Stevens Drain - Maple River, Little Maple River, River Styx - Pine Creek, North Shade Drain, and Alder Creek.

Target Audience	Measurable Milestone			Potential Partners	Estimated Costs	Evaluation Methods
	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)			
Upper Maple River Monitoring Committee	Use the High Impact Targeting System (HIT) tool to help identify priority and critical areas for the UMR monitoring committee. Incorporate HIT into 4 meetings per year (HIT Grant ends Sept '09)	Attend 2 workshops to teach conservation planners how to use the HIT tool in digital watershed	Make management plan decisions based on results of HIT tool	Natural Resources Conservation Service, Michigan Department of Agriculture, Michigan State University Institute of Water Research, Conservation Districts	$300/workshop Total = $600	Number of meetings where HIT was presented or used. Survey attendees of meetings regarding the HIT tool.
Natural resource managers and planners	Attend field days, expos, and public meetings to present the HIT tool or demonstrate it. Incorporate HIT into 4 field days per year (HIT Grant ends Sept '09)	Attend 2 workshops to teach conservation planners how to use the HIT tool in digital watershed	Make management plan decisions based on results of HIT tool	Natural Resources Conservation Service, Michigan Department of Agriculture, Michigan State University Institute of Water Research, Conservation Districts	$125/field day; $300/workshop Total = $1,100	Number of field days where HIT was presented or used. Survey attendees of field days regarding the HIT tool.
Agricultural producers	Publish 3 newspaper articles (two in spring, 1 in fall), develop and distribute 2000 brochures on conservation practices (including benefits of no till practices, buffer strips and livestock exclusion) which landowners can implement.	Conduct 10 workshops on benefits of no till practices, to be held on a local farm that currently implements those practices.	Meet with 30 local agricultural producers (door to door talks) to discuss how to implement no till practices and what funds are available to help reduce costs to change tilling practices.	Natural Resources Conservation Service, Michigan Department of Agriculture, Michigan State University, Conservation Districts, Farm Bill, 319 Grant funds	No cost for newspaper articles, $1,500 to develop brochures and $1.50/each to print; $300/workshop; $50/meeting Total = $9,000	Number of workshop attendees, number of landowners contacted in door to door talks.

Goal No. 2:	Restore and maintain waterbodies for other indigenous aquatic life and wildlife use.
Goal No. 3:	Restore and maintain waterbodies for warmwater fishery use.
Objective:	Implement watershed focused land-use planning. Educate stakeholders about the environmental impacts of land use activities. Create a sense of individual responsibility for the proper use and care of surface water resources.
Pollutant:	Sediment.
Message:	Human actions may increase sedimentation and adversely affect water quality. Sediment changes the flow capacity of the stream and impairs aquatic habitats.
Critical Areas (Subdistricts):	**High Priority =** Collier Creek - Maple River, Ferdon Creek, Hayworth Creek, Pine Creek, and Nile Drain - Bear Creek. **Medium Priority =** Spring Brook - Maple River, Coon Creek - Bear Creek, South Fork Hayworth Creek, Doty Brook - Hayworth Creek, and Baker Creek. **Low Priority =** Ovid - Maple River, Stevens Drain - Maple River, Little Maple River, River Styx - Pine Creek, North Shade Drain, and Alder Creek.

Target Audience	Measurable Milestone			Potential Partners	Estimated Costs	Evaluation Methods
	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)			
Clinton County private landowners	Through CTAI (Conservation Technical Assistance Initiative) provide information and technical assistance to private landowners in order to implement conservation practices funded through the Farm Bill.	Promote and implement existing Farm Bill programs Environmental Quality Incentives Program (EQIP), Conservation Security Programs (CSP), and Conservation Reserve Program (CRP).	Implementation of practices in the amount of more than $1.4 Million US Dollars in FY2008.	Natural Resources Conservation Service, Michigan Department of Agriculture, Farm Service Agency	No cost for technical and financial assistance, provide through existing programs.	Funding amount and utilization of practices in the County.

Goal No. 2:	Restore and maintain waterbodies for other indigenous aquatic life and wildlife use.
Goal No. 3:	Restore and maintain waterbodies for warmwater fishery use.
Objectives:	Implement manure management planning and implement watershed focused land-use planning. Educate stakeholders about the environmental impacts of land use activities. Create a sense of individual responsibility for the proper use and care of surface water resources.
Pollutant:	Nutrients
Message:	Human actions may increase nutrients in waterbodies and adversely affect water quality. Nutrient rich waters encourage excessive plant growth, deplete oxygen and impair aquatic habitats.
Critical Areas (Subdistricts):	**High Priority =** Collier Creek - Maple River, Hayworth Creek, Pine Creek, Ferdon Creek - Maple River, and Stevens Drain - Maple River. **Medium Priority =** River Styx - Pine Creek, North Shade Drain, Nile Drain - Bear Creek, Spring Brook - Maple River, and Coon Creek - Bear Creek. **Low Priority =** Doty Brook - Hayworth Creek, Baker Creek, Ovid - Maple River, South Fork Hayworth Creek, Little Maple River, and Alder Creek.

Target Audience	Measurable Milestone			Potential Partners	Estimated Costs	Evaluation Methods
	Awareness (within 1 year)	**Education (within 3 years)**	**Action (within 5 years)**			
Home Owners/Riparian Landowners/Lake Associations	Create a display about effects of, and BMPs to control, excessive nutrients for use at fairs, events, meetings etc. Create lawn care management (phosphorous management) brochures for fairs, events, etc.	Attend 1 workshop, sponsored by retailers, to calibrate applicators.	Test soil for 100 landowners and send samples to Michigan State University Extension for analysis.	Lawn and Garden Retailers, Master Gardeners	$1,200 to create display;$1,500 to develop brochures and $1.50/each (print 1000); $300/workshop; $12/soil sample Total = $5,700	Number of people in attendance at events.
Local Agricultural Producers	Distribute information about Farmstead System, Cropping System, Livestock System, and Groundwater Stewardship Program	Conduct total of 20 evaluations for: Farmstead System, Cropping System, and Livestock System	Assist with completion of 5 Comprehensive Nutrient Management Plans (CNMP)	Michigan State University Extension, Conservation Districts	$100/evaluation; $7,500/CNMP Total = $39,500	Number of CNMPs completed
		Conduct 3 education programs and 3 field days to demonstrate management practices or programs that decrease environmental risk.	Complete the design and construction plans for 5 BMPs that decrease environmental risk.	Michigan State University Extension, Conservation Districts	$300/program; $225/field day; $500/BMP design. Total = $4,075	Number of BMPs constructed.
	Develop and print 2,000 brochures about the benefits of buffers along waterbodies.	Conduct 1 workshop to show the benefits of buffers (their capacity to filter and clean up runoff from agricultural fields). Workshop to be held at local site where buffers are already installed and working correctly.	Complete water quality monitoring at 4 farms (20 tile outlets). Location/subdistrict to monitor on will be determined based on critical areas).	Michigan State University Extension, Conservation Districts	$1,500 to develop brochures and $1.50/each to print, $300/workshop, time for sampling donated by Friends of the Maple River, $25/sample for supplies and water quality analysis Total = $5,300	Number or acres of buffer/filter strips installed.
Local Government Officials & Policy Makers	Develop and print 2,000 brochures about effects of excessive phosphorus and identify BMPs that address the problems. Explore rules/regulations to see if phosphorous ban for residential lawn applications is needed.	Attend 5 informational sessions to discuss the effects of excessive phosphorous and identify BMPs that address the problems. Explore rules/regulations to see if phosphorous ban for residential lawn applications is needed.		Clinton County Green Space, Michigan State University Extension, Conservation Districts	$1,500 to develop brochures, $1.50/each to print; $50/meeting Total = $4,750	Number of rules/regulations drafted and approved for phosphorous regulation.
Certified Commercial Fertilizer Applicators	Conduct a Healthy Lawn Care Seminar for Lawn Care Services	Recruit companies to become endorsed members of the Healthy Lawn Care Program	Promote limited use of slow-release nitrogen fertilizer plus low-phosphorous or no phosphorus fertilizers	Michigan State University Extension, Conservation Districts	$300/seminar Total = $300	Number of applicators using low or no-phosphorous fertilizers.
Fertilizer Applicators	Develop and print 2000 brochures about correct application of fertilizers.	Attend 2 workshops to teach seasonal workers correct fertilizer application techniques.		Road Commissions, Michigan State University Extension	$1,500 to develop brochures, $1.50/each to print; $300/workshop Total = $5,100	

Objectives:	Implement manure management planning and implement watershed focused land-use planning. Educate stakeholders about the environmental impacts of land use activities. Create a sense of individual responsibility for the proper use and care of surface water resources.
Pollutant:	Nutrients
Message:	Human actions may increase nutrients in waterbodies and adversely affect water quality. Nutrient rich waters encourage excessive plant growth, deplete oxygen and impair aquatic habitats.
Critical Areas (Subdistricts):	**High Priority =** Collier Creek - Maple River, Hayworth Creek, Pine Creek, Ferdon Creek - Maple River, and Stevens Drain - Maple River. **Medium Priority =** River Styx - Pine Creek, North Shade Drain, Nile Drain - Bear Creek, Spring Brook - Maple River, and Coon Creek - Bear Creek. **Low Priority =** Doty Brook - Hayworth Creek, Baker Creek, Ovid - Maple River, South Fork Hayworth Creek, Little Maple River, and Alder Creek.

Target Audience	Measurable Milestone			Potential Partners	Estimated Costs	Evaluation Methods
	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)			
Golf Courses, Campgrounds	Utilize existing brochures and information about fertilizer management on golf courses and at campgrounds, to educate the facilities in the watershed.	Schedule meetings with golf courses and campgrounds (total 8 meetings) to urge nutrient management (using low or no-phosphorous fertilizers etc.).	Promote limited use of slow-release nitrogen fertilizer plus low-phosphorous or no phosphorus fertilizers	Michigan State University Extension, Conservation Districts	$50/meeting Total = $400	Number of golf courses and campgrounds using low or no-phosphorus fertilizers.
Greenhouse and Nursery Operators	Distribute information about the Greenhouse and Nursery program	Conduct total of 5 evaluations for Greenhouse and Nursery System		Michigan State University Extension, Conservation Districts, Master Gardeners	$100/evaluation Total = $500	The increase in the number of participants in the Greenhouse and Nursery System.
Woodlot Owners (including municipalities and schools)	Educate landowners about the ecology of woodlots and stream/water quality especially in riparian areas. Educate about proper forestry management including reforestation, windbreak establishment, and other tree planting projects.	Write 15 forest management plans	Perform 50 site visits and assist 150 landowners	Clinton County, Pheasants Forever, Quality Deer Management, Fowler Conservation Club	$500/management plan; $50/site visit; $200/landowner assistance Total = $40,000	Number of landowners assisted with forest management plans, site visits, reforestation projects, and phone assists.
Dairy farms	Educate farmers about the use of filter mounds as a suitable and cost effective alternative for disposing of milk house waste.	Attend 5 one-on-one talks with landowners to education them about filter mounds being a viable tool.	Help create NRCS standards for filter mounds.	Michigan Department of Environmental Quality, Natural Resources Conservation Service, Michigan State University, Michigan Milk Producers Association, local contractors and consultants	$50/talk; $200 to create standards document Total = $450	Number of filter mounds constructed and monitored.

Goal No. 2:	Restore and maintain waterbodies for other indigenous aquatic life and wildlife use.
Goal No. 3:	Restore and maintain waterbodies for warmwater fishery use.
Goal No. 4:	Restore and maintain waterbodies for partial body contact recreational use.
Goal No. 5:	Restore and maintain waterbodies for total body contact recreational use.
Objective:	Implement manure management planning and plan enforcement. Educate stakeholders about the environmental impacts of land use activities. Create a sense of individual responsibility for the proper use and care of surface water resources.
Pollutant:	*E. coli* /Pathogens
Message:	Human actions may increase the chances of E. coli/pathogen contamination in waterbodies. Bacterial contamination from agricultural runoff (over/improper application of manure), failing septic systems, and over population of waterfowl create unsafe water for human contact.
Critical Areas (Subdistricts):	**High Priority =** Pine Creek, Little Maple River, Spring Brook - Maple River, Alder Creek, and River Styx - Pine Creek. **Medium Priority =** North Shade Drain, Hayworth Creek, Stevens Drain - Maple River, Ferdon Creek - Maple River, and Baker Creek. **Low Priority =** South Fork Hayworth Creek, Ovid - Maple River, Doty Brook - Hayworth Creek, Nile Drain - Bear Creek, Collier Creek - Maple River, and Coon Creek - Bear Creek.

Target Audience	Measurable Milestone			Potential Partners	Estimated Costs	Evaluation Methods
	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)			
Riparian Property Owners	Get a copy of septic maintenance brochures from the Health Department and print 2000 copies of the brochure for distribution. Distribute 100 AWRI Riparian Landowner Guides.	3 presentations on septic maintenance (1 in each county - Clinton, Gratiot, and Shiawassee).	Assistance with technical and financial issues for 25 septic system repairs.	Health Departments, Friends of the Maple River, Conservation Districts	$1.50/each to print brochures. $25/each AWRI guide (total $2,500) to print and distribute. $300/ presentation. No cost for technical and financial assistance, if provided through existing programs. Total = $6,400	Number of flyers distributed to target audiences. Number of people attending presentations. Exit surveys at end of presentations. Number of septic system repairs completed.
	Develop and print 2000 mailers about the effects of manure applied fields and feedlot runoff on receiving stream water quality. Write 4 articles about proper manure management and publish in local paper and/or newsletter.	Conduct volunteer monitoring training for 1 group in each County.= (Clinton, Gratiot & Shiawassee)	Complete volunteer water quality monitoring at 6 different sites.	Friends of the Maple River, Natural Resources Conservation Service, Conservation Districts, Michigan State University Extension	$1,200 to develop mailer and $1.50/each to print; no cost for newspaper articles. Cost for monitoring donated as match by Friends of the Maple River. Total = $4,200	Number of contacts made as a result of mailers and articles. Number of participants in monitoring training. Number of sites monitored.

Goal No. 2:	Restore and maintain waterbodies for other indigenous aquatic life and wildlife use.
Goal No. 3:	Restore and maintain waterbodies for warmwater fishery use.
Goal No. 4:	Restore and maintain waterbodies for partial body contact recreational use.
Goal No. 5:	Restore and maintain waterbodies for total body contact recreational use.
Objective:	Implement manure management planning and plan enforcement. Educate stakeholders about the environmental impacts of land use activities. Create a sense of individual responsibility for the proper use and care of surface water resources.
Pollutant:	*E. coli* /Pathogens
Message:	Human actions may increase the chances of E. coli/pathogen contamination in waterbodies. Bacterial contamination from agricultural runoff (over/improper application of manure), failing septic systems, and over population of waterfowl create unsafe water for human contact.
Critical Areas (Subdistricts):	**High Priority =** Pine Creek, Little Maple River, Spring Brook - Maple River, Alder Creek, and River Styx - Pine Creek. **Medium Priority =** North Shade Drain, Hayworth Creek, Stevens Drain - Maple River, Ferdon Creek - Maple River, and Baker Creek. **Low Priority =** South Fork Hayworth Creek, Ovid - Maple River, Doty Brook - Hayworth Creek, Nile Drain - Bear Creek, Collier Creek - Maple River, and Coon Creek - Bear Creek.

Target Audience	Measurable Milestone			Potential Partners	Estimated Costs	Evaluation Methods
	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)			
Local Agricultural Producers	Present information at 3 agricultural workshops and meetings about E. coli inputs from agricultural operations.	Conduct 1 demonstration farm tour.	Complete BMP design (to prevent runoff) plans at 10 farms.	Friends of the Maple River, Natural Resources Conservation Service, Conservation Districts, Schools, Michigan State University Extension	$300/workshop; $125/farm tour: $100/day for van rental, $50/day for supplies. $500/BMP design plan. Total = $6,125	Exit questionnaires at workshops to measure increase in agricultural producers' awareness of project and E. coli issues. Number of participants in farm tour. Number of BMPs implemented.
	Distribute 2000 brochures about CRP (Conservation Reserve Program), EQIP (Environmental Quality Incentives Program), and MAEAP (Michigan Agricultural Environmental Assurance Program) programs for managing manure and feedlot runoff.	Work with 6 producers to complete livestock assist.	Complete manure testing and 100 soil tests on 100 acres, or have 3 producers get MAEAP verified in livestock system.	Natural Resources Conservation Service, Michigan Department of Agriculture, United States Department of Agriculture, Michigan Department of Environmental Quality, Farm Bureau, Conservation Districts, Michigan State University Extension, Green Source	$1,500 to develop brochures, $1.50/each to print. No cost for application assistance, if provided through existing program. $12/soil test. Total = $5,700	Number of mailings to target audiences, number of producers in livestock assist , number of producers MAEAP verified.

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Critical Areas (Subdistricts):	**High Priority =** Pine Creek, Little Maple River, Spring Brook - Maple River, Alder Creek, and River Styx - Pine Creek. **Medium Priority =** North Shade Drain, Hayworth Creek, Stevens Drain - Maple River, Ferdon Creek - Maple River, and Baker Creek. **Low Priority =** South Fork Hayworth Creek, Ovid - Maple River, Doty Brook - Hayworth Creek, Nile Drain - Bear Creek, Collier Creek - Maple River, and Coon Creek - Bear Creek.

Target Audience	Measurable Milestone			Potential Partners	Estimated Costs	Evaluation Methods
	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)			
Local Government Officials & Policy Makers	Develop annual news articles and fact sheets in conjunction with Health Departments about Septic System Regulations	Conduct 3 workshops on proposed model ordinances, one in each county.	Assist Clinton, Gratiot & Shiawassee Counties with adoption of regulations or ordinances for septic systems.	Health Departments, Friends of the Maple River, Conservation Districts, Michigan State University Extension	$1,500 to develop news articles and fact sheets; $300/workshop; $3,000/ordinance development Total = $5,400	Number of calls received in response to articles and fact sheets. Attendance at workshops with Counties. Number of adopted regulations or ordinances.

Goal No. 2:	Restore and maintain waterbodies for other indigenous aquatic life and wildlife use.
Goal No. 3:	Restore and maintain waterbodies for warmwater fishery use.
Objective:	Educate stakeholders about the environmental impacts of land use activities. Create a sense of individual responsibility for the proper use and care of surface water resources.
Pollutant:	High Temperature.
Message:	Human actions may adversely impact the temperature of waterbodies. Lack of riparian vegetation and a dense drain network cause increased stream temperatures.
Critical Areas (Subdistricts):	**High Priority =** North Shade Drain, South Fork Hayworth Creek, River Styx - Pine Creek, Nile Drain - Bear Creek, and Pine Creek. **Medium Priority =** Stevens Drain - Maple River, Hayworth Creek, Ferdon Creek - Maple River, Alder Creek, and Ovid - Maple River. **Low Priority =** Little Maple River, Doty Brook - Hayworth Creek, Collier Creek - Maple River, Baker Creek, Coon Creek - Bear Creek, and Spring Brook - Maple River.

Target Audience	Measurable Milestone			Potential Partners	Estimated Costs	Evaluation Methods
	Awareness (within 1 year)	**Education (within 3 years)**	**Action (within 5 years)**			
Riparian landowners	Develop and advertise a program for riparian tree planting in local newspapers, conservation district tree sales notices, drain notices etc.	Conduct 2 workshops about importance of riparian habitats and tree sales.	Assist 10 riparian landowners with planting trees.	County Planning Commissions, County Drain Commissioners, Conservation Districts, Natural Resources Conservation Service	$500 to develop tree planting program, $300/workshop, $1,000/buffer Total = $11,100	Number of trees planted in the riparian zone.
Local Government Officials & Policy Makers	Conduct workshop on Low Impact Development practices to reduce impervious surfaces.	Contact communities that have not et adopted storm water criteria for LID.	Adopt LID ordinance in all communities in the Watershed to reduce impervious surfaces.	County Planning Commissions, County Drain Commissioners, Conservation Districts	$300/workshop, $3,000/ordinance assistance Total = $3,300	Number of LID ordinances adopted.

Goal No. 2:	Restore and maintain waterbodies for other indigenous aquatic life and wildlife use.
Goal No. 3:	Restore and maintain waterbodies for warmwater fishery use.
Objective:	Educate stakeholders about the environmental impacts of land use activities. Create a sense of individual responsibility for the proper use and care of surface water resources.
Pollutant:	Pesticides and Chemicals.
Message:	Human actions may increase the amount of pesticides and chemicals in waterbodies and adversely affect water quality. Harmful toxins can enter waterways through over or improper application of herbicides and pesticides, and the lack of riparian buffer on lakes.
Critical Areas (Subdistricts):	**High Priority =** Collier Creek - Maple River, Nile Drain - Bear Creek, Hayworth Creek, Spring Brook - Maple River, and Pine Creek. **Medium Priority =** Ferdon Creek - Maple River, Coon Creek - Bear Creek, Doty Brook - Hayworth Creek, Baker Creek, and Ovid - Maple River. **Low Priority =** South Fork Hayworth Creek, Stevens Drain - Maple River, Little Maple River, River Styx - Pine Creek, North Shade Drain, and Alder Creek.

Target Audience	Measurable Milestone			Potential Partners	Estimated Costs	Evaluation Methods
	Awareness (within 1 year)	Education (within 3 years)	Action (within 5 years)			
Local Agricultural Producers	Write articles for conservation district/county newsletters about proper disposal of chemicals and pesticides.	Participation of 25 farms in Farm*A*Syst program.	Advertise the periodic household hazardous waste (HHW) collection events held in the watershed. Strongly encourage people to attend and properly dispose of HHW.	Michigan State University Extension, Michigan Department of Agriculture, Groundwater Stewardship Program, Conservation Districts	No cost for articles. No cost for technical and financial assistance, if provided through existing programs. Total = $0	Number of Farm*A*Syst conducted and number of farms committed to change or meet the highest level of protection. Amount of waste collected during chemical collection days.
Residents and landowners/Lake Association Owners	Write and publish newspaper articles about the benefits of buffers along waterbodies and lake shores, and the correct application of chemicals and pesticides. .	Conduct 2 workshops in conjunction with the Lake Association meetings to talk about the benefits of buffers along the lake shore and the correct application of chemicals and pesticides.	Assist 20 landowners along lakes to develop buffer planting plans (10 on Rainbow Lake and 10 on Lake Victoria) and assist 10 riparian landowners with tree/buffer planting plans.	County Drain Commissioners, Michigan State University Extension, Conservation Districts, Lake Associations, Natural Resources Conservation Service	No cost for articles, $300/workshop, $200/buffer plan Total = $6,600	Number of people who attend the workshops, number of buffers installed.