Michigan Department of Environmental Quality
Water Bureau
August 2007

Total Maximum Daily Load for Dissolved Oxygen for the North Branch Kawkawlin River Bay 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 Michigan's Water Quality Standards (WQS) pursuant to Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA). 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 (NPS) to restore and maintain the quality of their water resources. The purpose of this TMDL is to identify the sources of dissolved oxygen (D.O.) standard nonattainment in the North Branch Kawkawlin River in Kawkawlin (Figure 1), and to quantify reductions in these sources necessary for attainment of the standard. The North Branch Kawkawlin River is designated as a warmwater stream with a D.O. standard of 5 milligrams per liter (mg/l) as a minimum.

The North Branch Kawkawlin River TMDL reach is defined on the 2006 Section 303(d) list (Edly and Wuycheck, 2006) as extending from the confluence with the Kawkawlin River upstream to 8 Mile Road (Figure 1, Station 1). The North Branch Kawkawlin River D.O. TMDL reach is located in Bay County (Figure 1).

Table 1 defines the extent and length of the TMDL reach. Note that the reach start is a downstream location, while the end location is an upstream location. A total of 13 river miles is addressed by this TMDL.

Table 1. North Branch Kawkawlin River D.O. TMDL Reach.

River	Reach Start	Reach End	Distance (mi.)
N. Br. Kawkawlin River	Confluence with Kawkawlin River (T14N, R4E, Section 2)	8 Mile Road (T15N, R4E, Section 18)	13

The North Branch Kawkawlin River has a drainage area of approximately 106 square miles at the confluence with the Kawkawlin River. Summer season 50% and 95% exceedance flows (cubic feet per second [cfs]) for North Branch Kawkawlin River at this location are 0 cfs. All low flows were computed from a United States Geological Survey Grand River flow gage (04143500) located on Beaver Road in Kawkawlin. The watershed consists of flat, lacustrine clay soils that have been artificially drained for agricultural purposes. Over 85% of the naturally occurring soils in the Kawkawlin watershed area are classified by the United States Department of Agriculture as poorly drained (Rivet, 2006).

PROBLEM STATEMENT

North Branch Kawkawlin River TMDL reach appears on the 2006 Section 303(d) list as:

KAWKAWLIN RIVER, N. BR.				WBID#	210501G
County:	Bay	HUC:	4080102	Size:	13 M
Location:	Kawkawlin River confluence u/s to Eightmile Road.				

Problem: **WQS nonattainment for DO**
TMDL YEAR(s): 2007 RF3RchID: 4080103 000

Historically, fish kills on the North Branch Kawkawlin River at Beaver Road (Figure 1, Station 2), downstream of a large wetland complex, have been reported and were likely caused by low D.O. concentrations (Morse, 1994). Continuous and instantaneous measurements of D.O. were conducted by Michigan Department of Environmental Quality (MDEQ) staff in the North Branch Kawkawlin River in the summer (July-August) of 1993 (Holden, 1994). Sample locations are presented in Figure 1. These sample locations were chosen in conjuction with the location of the reported fish kill. Data were collected during the summer due to high temperatures and low flow in the North Branch Kawkawlin River expected during this time period. It is during these conditions that D.O nonattainment usually occurs. The monitoring showed that significant periods of dry weather nonattainment of the D.O. warmwater WQS occur in the North Branch Kawkawlin River.

NUMERIC TARGETS

Rule 100 (Designated uses) of the WQS requires that the North Branch Kawkawlin 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 North Branch Kawkawlin River addressed by this TMDL are the warmwater fish and other indigenous aquatic life and wildlife uses. The D.O. standard was developed to provide protection of these designated uses. Attainment of the warmwater D.O. standard of 5 mg/l as a daily minimum will be the target of this TMDL. The D.O. WQS is defined as follows:

> R 323.1064 Dissolved oxygen in Great Lakes, connecting waters, and inland streams.
> Rule 64. (1) A minimum of 7 milligrams per liter of dissolved oxygen in all Great Lakes and connecting waterways shall be maintained, and, except for inland lakes as prescribed in R 323.1065, a minimum of 7 milligrams per liter of dissolved oxygen shall be maintained at all times in all inland waters designated by these rules to be protected for coldwater fish. In all other waters, except for inland lakes as prescribed by R 323.1065, a minimum of 5 milligrams per liter of dissolved oxygen shall be maintained. These standards do not apply for a limited warmwater fishery use subcategory or limited coldwater fishery use subcategory established pursuant to R 323.1100(11) or during those periods when the standards specified in subrule (2) of this rule apply.
> (2) Surface waters of the state which do not meet the standards set forth in subrule (1) of this rule shall be upgraded to meet those standards. The department may issue permits pursuant to R 323.2145 which establish schedules to achieve the standards set forth in subrule (1) of this rule for point source discharges to surface waters which do not meet the standards set forth in subrule (1) of this rule and which commenced discharge before December 2, 1986. For point source discharges which commenced before December 2, 1986, the dischargers may demonstrate to the department that the dissolved oxygen standards specified in subrule (1) of this rule are not attainable through further feasible and prudent reductions in their discharges or that the diurnal variation between the daily average and daily minimum dissolved oxygen concentrations in those waters exceeds 1 milligram per liter, further reductions in oxygen-consuming substances from such discharges will not be required, except as necessary to meet the interim standards specified in this subrule, until comprehensive plans to upgrade these waters to the standards specified in subrule (1) of this rule have been approved by the department and orders, permits, or other actions necessary to implement the approved plans have been issued by the department. In the interim, all of the following standards apply:

(a) For surface waters of the state designated for use for coldwater fish, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below a minimum of 6 milligrams per liter at the design flow during the warm weather season in accordance with R 323.1090(2) and (3). At the design flows during other seasonal periods, as provided in R 323.1090(3), a minimum of 7 milligrams per liter shall be maintained. At flows greater than the design flows, dissolved oxygen shall be higher than the respective minimum values specified in this subdivision.

(b) For surface waters of the state designated for use for warmwater fish and other aquatic life, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below a minimum of 4 milligrams per liter, or below 5 milligrams per liter as a daily average, at the design flow during the warm weather season in accordance with R 323.1090(3) and (4). At the design flows during other seasonal periods as provided in R 323.1090(3), a minimum of 5 milligrams per liter shall be maintained. At flows greater than the design flows, dissolved oxygen shall be higher than the respective minimum values specified in this subdivision.

(c) For surface waters of the state designated for use for warmwater fish and other aquatic life, but also designated as principal migratory routes for anadromous salmonids, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below 5 milligrams per liter as a minimum during periods of migration.

(3) The department may cause a comprehensive plan to be prepared to upgrade waters to the standards specified in subrule (1) of this rule taking into consideration all factors affecting dissolved oxygen in these waters and the cost effectiveness of control measures to upgrade these waters and, after notice and hearing, approve the plan. After notice and hearing, the department may amend a comprehensive plan for cause. In undertaking the comprehensive planning effort the department shall provide for and encourage participation by interested and impacted persons in the affected area. Persons directly or indirectly discharging substances which contribute towards these waters not meeting the standards specified in subrule (1) of this rule may be required after notice and order to provide necessary information to assist in the development or amendment of the comprehensive plan. Upon notice and order, permit, or other action of the department, persons directly or indirectly discharging substances which contribute toward these waters not meeting the standards specified in subrule (1) of this rule shall take the necessary actions consistent with the approved comprehensive plan to control these discharges to upgrade these waters to the standards specified in subrule (1) of this rule.

SOURCE ASSESSMENT

Potential sources of D.O. demanding pollutants to the North Branch Kawkawlin River (such as carbonaceous biochemical oxygen demand [CBOD], ammonia nitrogen, sediments, and indirectly, nutrients) include point sources and NPS. CBOD and ammonia can be oxidized in the water column, depleting levels of D.O. Decay of deposited organic sediments can also negatively affect in-stream D.O. concentrations. This process is known as sediment oxygen demand (SOD). Nutrients such as phosphorus and nitrogen can stimulate plant growths, which in turn can reduce D.O. levels through respiration.

There is one non-storm water general NPDES permitted point source discharge to the North Branch Kawkawlin River watershed (White Birch Village Mobile Home Park [MHP] Wastewater Stabilization Lagoon [WWSL]). There is also one industrial storm water (R & W Auto Sales), and four MS4 general NPDES permitted point sources. The Michigan Department of Transportation (MDOT) has an individual statewide permit covering storm water (MI0057364). See Table 2 for a listing of all permitted facilities. Figure 2 indicates the location of individual and storm water discharges, where known.

Table 2. NPDES Permitted Point Source Discharges to the North Branch Kawkawlin River TMDL Watershed. Source: MDEQ, Water Bureau's NPDES Permit Management System. Outfall Locations are Illustrated in Figure 2.

Facility	Permit No.	County	Receiving Water	Latitude	Longitude
Individual Permit					
MDOT MS4	MI0057364	Statewide	---	*	*
MIG580000 General Permit	**WWSL**				
White Birch Village MHP	MIG580079	Bay	Hembling Drain	43.673611	84.041666
MIS119000 General Permit	**Storm Water From Industrial Activities**				
R & W Auto Sales	MIS210465	Bay	N Branch Kawkawlin River	43.686944	83.961666
MIG610000 General Permit	**Municipal Separate Storm Sewer System**				
Bay CDC MS4-Bay	MIG610195	Bay	Countywide	*	*
Bay CRC MS4-Bay	MIG610196	Bay	Countywide	*	*
Kawkawlin Twp MS4-Bay	MIG610188	Bay	Townshipwide	*	*
Monitor Twp MS4-Bay	MIG610189	Bay	Townshipwide	*	*

* Exact outfall locations for MS4 permitted facilities are unknown.

The White Birch Village MHP WWSL discharges 8.9 million gallons per year (MGY) seasonally to Hembling Drain in Section 30, T15N, R4E of Bay County. Hembling Drain joins the North Branch Kawkawlin River in Section 27, T15N, R14E of Bay County. The White Birch Village MHP WWSL permit limits are presented in Appendix A.

Table 3 contains permitted annual conventional pollutant loads for White Birch Village MHP. The loads are calculated from the facilities' monthly NPDES permit load limits. For parameters not limited by load and/or concentration limits, annual loads were estimated. Note that the facility may, in fact, be discharging significantly lower loads of these pollutants than it is permitted to discharge.

Table 3. Permitted Daily and Annual Conventional Pollutant Loads for White Birch Village MHP WWSL.

Pollutant	Daily Load (lbs/day)	Annual Load (lbs/yr)
$CBOD_5$	6.11	2,230
TSS	11.2	4,080
Ammonia nitrogen	3.26	1,190
Total phosphorus	0.20	74.0

Table 4 contains estimates of the North Branch Kawkawlin River conventional pollutant loads from the industrial storm water and MS4 general NPDES permitted point sources. Storm water loads in Table 4 were estimated based on residential and commercial land use data contained in 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). This geographic information system-based application uses the event mean concentration and curve number procedures to calculate annual pollutant loads based on land use, soil type, and meteorological data. The L-THIA application is supported by staff of the USEPA, Region 5.

The L-THIA has been developed as a straightforward analysis tool that provides estimates of changes in runoff, recharge, and NPS 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 so as to have minimum impact on the natural environment of the area. Recent 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. Appendix B presents a short description of L-THIA model background geographical information system (GIS) data (Purdue University and USEPA, 2001).

Table 4. Estimated North Branch Kawkawlin River Conventional Pollutant Loads from Industrial Storm Water and MS4 General NPDES Permitted Point Sources.

Pollutant	Daily Load (lbs/day)	Annual Load (lbs/yr)
Biochemical Oxygen Demand (BOD)	17.9	6,539
TSS	38.1	13,923
Ammonia Nitrogen	1.12	409
Total Phosphorus	0.30	108

Potential NPS of pollutants were evaluated based on land use in the drainage basin. Land use proportions were derived using the L-THIA application and are presented in Table 5. It is possible that the urban land use proportions (e.g., commercial and residential) are in fact higher than indicated in Table 5 due to increasing residential development in this area. However, these possible increases in residential and/or commercial development are not expected to significantly affect the TMDL as the overall residential and commercial land use in the watershed is relatively minor when compared to other uses (e.g., agriculture).

Table 5. North Branch Kawkawlin River Basin Land Use Categories as Percentages.

Land Use Category	Percent Land Use Category
Water/Wetlands	33.0
Commercial	0.1
Agriculture	40.2
High Density Residential	0.1
Low Density Residential	0.3
Grass/Pasture	4.0
Forest	22.3

The 1993 summer D.O. survey indicated that certain pollutants contribute toward D.O. standard nonattainment in the North Branch Kawkawlin River in the vicinity of Kawkawlin. Land use-related inputs of various oxygen demanding pollutants (e.g., ammonia, BOD, and total phosphorus) appear to cause the D.O. depressions in North Branch Kawkawlin River, and likely contribute toward D.O. standard nonattainment through SOD, and respiration from abundant plant growths observed throughout the TMDL Reach (Holden, 1994).

Estimates of NPS annual loads of BOD ($CBOD_5$ + nitrogenous BOD), TSS, total phosphorus, and total nitrogen to the North Branch Kawkawlin River were estimated using the L-THIA application. Estimates of NPS loads to the North Branch Kawkawlin River appear in Table 6. These loads impact all North Branch Kawkawlin River tributaries, are based on non-site-specific data, and represent a best approximation using software default even mean concentration and curve number values. These estimates do not include point source loads from the industrial storm water permitted facility and MS4's contained in Table 4 or the WWSL discharge in Table 3.

Table 6. Estimated Daily and Annual NPS Conventional Pollutant Loads.

Pollutant	Daily Load (lbs/day)	Annual Load (lbs/yr)
BOD	123	44,700
TSS	3,230	1,180,000
Total nitrogen	135	49,400
Total phosphorus	39.3	14,300

In accordance with USEPA guidelines, urban runoff via storm water conveyances from Bay City, Kawkawlin Township, and Monitor Township (i.e., the MS4s) will be considered in the waste load allocation (WLA) portion of this TMDL. Industrial storm water permitted facilities will also be considered in the WLA portion of the TMDL.

LINKAGE ANALYSIS

The observed D.O. standard nonattainment in North Branch Kawkawlin River can be attributed to a number of factors. These factors were assessed using mathematical D.O. models of the reach of concern. The model chosen was the O'Connor-DiToro multireach, steady-state D.O. model (O'Connor and DiToro, 1970), based on the modified Streeter-Phelps equation. This model has the capability of simulating diurnal D.O. variation resulting from plant photosynthesis and respiration. The respiration term includes D.O. depletion due to SOD. The O'Connor-DiToro model is considered appropriate for use in this TMDL as it can represent the system without being unnecessarily complex or too data-intensive. Modeling was conducted in accordance with guidance described in the Great Lakes and Environmental Assessment Section (GLEAS) Procedure 80 (MDEQ, 1995). The models were calibrated to data collected in the summer of 1993 (Holden, 1994). A stream design flow of 0.01 cfs was used in the model.

Plant Respiration: The presence of aquatic plants in a water body can have a very significant effect on levels of D.O. Plants, such as rooted macrophytes and algae, utilize photosynthesis during daylight hours to convert carbon dioxide and water into glucose, a process that releases oxygen. The oxygen is released to the surrounding water increasing levels of D.O. Throughout the day and night, plants also respire aerobically. This process removes D.O. from the water column. D.O. concentrations vary throughout the day in response to photosynthesis and respiration. Since the photosynthetic contribution of D.O. occurs only with sunlight, and respiration is relatively constant, levels of D.O. are most often lowest just before sunrise. Plant growth can be encouraged by the addition of nutrients, such as phosphorus, to a water body. This increased growth causes increases in photosynthesis and respiration rates, resulting in exaggerated daytime D.O. concentration peaks and potentially problematic early morning lows.

Phosphorus is an important nutrient of concern when considering D.O. problems in aquatic systems, such as the North Branch Kawkawlin River. Phosphorus can exist in dissolved and particulate forms. When dissolved, some of the phosphorus is available for use by aquatic plants and increased growth can result. Phosphorus, in the particulate form in river sediments, can be released to the water column as dissolved phosphorus under certain conditions, contributing to increased plant growth. Solids that run off of land into water bodies or that are discharged directly to a stream are typically associated with particulate phosphorus. Substantial loads of TSS can therefore result in substantial inputs of phosphorus available for plant use in a stream.

Prolific growths of rooted and detached macrophytes were noted in North Branch Kawkawlin River during a biological survey conducted in the summer of 1993 (Morse, 1994). Elevated nutrient levels, including phosphorus and ammonia, capable of causing nuisance aquatic plant growth, were noted in both the 1993 and 2000 biological surveys (Morse, 1994 and Rockafellow, 2006). This heavy plant growth results in high rates of photosynthesis and respiration. Very high D.O. diurnal variations (ranging from 2.8 to 3.4 mg/l) were measured in 1993 (Holden, 1994), and early morning D.O. standard nonattainment (as low as 1.6 mg/l) was common throughout the TMDL reach. Dry weather chemistry sampling conducted in 1993 and 2000, showed that total phosphorus concentrations exceeded 0.1 mg/l.

SOD: Substrates in nonattaining reaches of the North Branch Kawkawlin River are characterized primarily by fine sediments. In 1993, heavy sediment deposition was observed in the North Branch Kawkawlin River at Station 2 indicating that SOD is likely a contributing factor in D.O. standard nonattainment in the North Branch Kawkawlin River. The North Branch Kawkawlin River flows through a large wetland complex in the area of the TMDL reach, and is characterized by low channel slopes, black organic silt, and resulting low velocities typical of wetland areas. This appears to cause deposition of sediments from the water column, exacerbating SOD. The low velocities also result in relatively low rates of reaeration.

Observations made during the 1993 surveys indicate that stream bank erosion contributes a substantial amount of sediments and SOD to the North Branch Kawkawlin River. Soil surveys by the Soil Conservation Service indicate that poorly drained, highly erodable organic soils pervade the banks of the North Branch Kawkawlin River in the vicinity of Kawkawlin (USDA, 1971).

LOADING CAPACITY DEVELOPMENT

The Loading Capacity (LC) represents the maximum daily loading of oxygen demanding substances, or other parameters that can indirectly cause oxygen demand (sediments and nutrients), that can be assimilated by the water body while still achieving WQS. As indicated in the Numeric Target section, the target for this D.O. TMDL is the WQS of 5 mg/l minimum D.O. TMDL development also defines the environmental conditions that will be used when defining allowable levels.

The “critical condition” is the set of environmental conditions (e.g., flow) used in developing the TMDL that result in attaining WQS and has an acceptably low frequency of occurrence. The critical conditions for the applicability of WQS in Michigan are given in Rule 323.1090 (Applicability of WQS). Rule 323.1090 requires that the WQS apply at all flows equal to or exceeding the water body design flow. The critical conditions for the control of point sources in Michigan are given in R 323.1082 (Mixing Zones). In general, the lowest monthly 95% exceedance flow and 90% occurrence temperature for streams are used as design conditions for developing conventional pollutant loadings.

The LC is the sum of WLAs for point sources, and Load Allocations (LAs) for NPS and natural background levels. In addition, the LC must include a margin of safety (MOS), either implicitly 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:

$$\mathbf{LC = \sum WLAs + \sum LAs + MOS}$$

The LC represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. The overall LC is subsequently allocated into WLAs for point sources, LAs for NPS, and the MOS.

LAs and WLAs are calculated using the best available data and information, recognizing the need for additional monitoring data to determine if the load reductions required by the TMDL result in WQS attainment.

D.O. models were used to quantify reductions in river D.O. sinks necessary to attain the D.O. standard at critical conditions. Calibration data shows that along the 13-mile length of the North Branch Kawkawlin River, D.O. deficits, on average, are caused by SOD (35%) and plant respiration (65%). There are reaches in the North Branch Kawkawlin River where the D.O. deficit is due entirely to either plant respiration or to SOD. Loads of oxygen demanding substances from the White Birch Village MHP WWSL are assumed to exert no direct D.O. demand in-stream as the facility does not discharge during the critical conditions. The calculated relative contributions to the D.O. deficit from plant respiration and SOD will vary depending on the conditions to which the model is calibrated. It is highly likely that the tributaries to the North Branch Kawkawlin River exhibit a similar SOD to respiration D.O. deficit ratio as they drain lands similar in use to the North Branch Kawkawlin River and show similar amounts of plant growth and sedimentation.

In order to decrease SOD and nutrient loads, the loading of suspended sediments to the rivers must be reduced. It is likely that most nutrient inputs to the system are transported with the suspended sediment loads likely to accompany runoff. This is supported by wet weather water chemistry sampling conducted in other watersheds similar to the North Branch Kawkawlin River basin (Sunday, 2003). Wet weather sampling conducted in development of the Grand River at Jackson D.O. TMDL (Sunday, 2003) showed that on average, total phosphorus concentrations are significantly higher than orthophosphate concentrations. These data indicate that most phosphorus loads are adsorbed to solids rather than being in a dissolved form. TSS reduction is therefore the best overall strategy to improve D.O. in the stream.

This D.O. TMDL targets a 74% reduction in TSS loads from most sources to the North Branch Kawkawlin River in the vicinity of Kawkawlin. The 74% TSS load reduction was chosen in part due to the results of D.O. modeling that indicates that SOD and plant activity in the reaches of concern should be reduced by approximately 65% to 81%, depending on the reach under consideration, in order to achieve the D.O. standard. The existence of considerable uncertainties, which make it difficult to quantify the effects of TSS loads on in-stream D.O. levels, make the proposed 74% reduction a reasonable objective.

WLAs

TSS loads for the industrial facility (R&W Auto Sales) and the general permitted MS4s are allocated using the existing loads contained in Table 4 and reducing these loads by 74%. Table 7 contains proposed TSS WLAs for the North Branch Kawkawlin River. The permitted loads from the White Birch Village MHP WWSL will not be reduced as the facility does not discharge during the critical conditions. No TSS load reduction is targeted for the MDOT storm water permit (NPDES land use), as only a very small fraction of the overall transportation land use in the watershed consists of state-maintained roads.

LAs

TSS inputs resulting from NPS will be the primary targets for reduction in the North Branch Kawkawlin River in this TMDL. Table 7 lists the LAs for the North Branch Kawkawlin River. The target LA values in Table 7 represent 74% of the loads of the existing estimated TSS loads contributed by those land uses classified as nonurban (e.g., agriculture, forest, and grass/pasture) and not covered under NPDES MS4 permits. Lands contributing TSS loads to the North Branch Kawkawlin River are located in Kawkawlin and Monitor Townships, Bay County.

Table 7. Daily TSS Load Source Allocations and Numeric Targets.

Water Body	Current Daily TSS Load (pounds/day)	Daily TSS Load Numeric Target (pounds/day)	NPDES Permitted TSS Loads (pounds/day)	WLA Daily TSS Load (pounds/day)	LA Daily TSS Load (pounds/day)	Percent Reduction
North Branch Kawkawlin River						
General NPDES Industrial/Municipal Storm Water Permit*	38.1	9.91	-	9.91	-	74%
Individual NPDES Permit (White Birch Village MHP)**	11.2	11.2	29 (Mar-May) 17 (Oct-Dec)	11.2	-	0%
NPS ***	3,230	840	-	-	840	74%
North Branch Kawkawlin River Total Annual Loads	3,280	861	-	21.1	840	74%

* Primarily attributed to urban or built-up land uses in the vicinity of Kawkawlin .
** Based on average monthly concentrations. Note that permit loads are consistent with this WLA.
***Attributed to nonurbanized/built-up land uses in the townships of Kawkawlin and Monitor that are not under NPDES permit.

The LC for TSS (Daily TSS Load Numeric Target) is calculated as the sum of the WLA and LA, and is equal to 861 pounds/day, based on the year-round standard for the designated uses of warmwater fisheries and other indigenous aquatic life and wildlife.

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 TMDL analysis through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS due to very conservative assumptions incorporated in D.O. modeling. Background flows and tributary inflows are represented at the 95% exceedance summer low flow as determined by the MDEQ, Land and Water Management Division. The summer 95% exceedance flow is a stream flow that would be expected only during periods of severe drought. Stream flows would be expected to be this low for only 5% or less of the time during the summer season. Michigan WQS (R 323.1090), specify that WQS apply at all flows equal to or exceeding the 12-month 95% exceedance low flow. This is the stream flow employed in the modeling of the critical summer season, the very minimum flow at which WQS are to be applied. Similarly, river temperatures are represented at the highest monthly 90% occurrence temperature for the summer season as defined in the Effluent Limit Coordination Procedure 15 (MDEQ, 1980). This temperature would be expected to be exceeded only 10% of the time during the summer months. This design temperature is derived from R 323.1075 of the WQS. Such high temperatures result in lower D.O. saturation concentrations and increased rates of in-stream oxygen utilization. The conservative assumptions regarding stream flow and water temperature are the same as those employed in the determination of water quality-based effluent limit developments in NPDES WLAs at critical design conditions. A large degree of uncertainty in the D.O. modeling is also removed as the models used were calibrated to observed data.

SEASONALITY

Monitoring and modeling indicates that design conditions occurring during the summer season represents the most critical conditions for D.O. standard attainment in the North Branch Kawkawlin River. Modeling of the North Branch Kawkawlin River in other seasons using appropriate 95% exceedance low flows and 90% occurrence temperatures shows no predicted instances of D.O. standard nonattainment.

MONITORING

This TMDL's approach requires that future monitoring 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, Water Bureau (WB), monitors watersheds in accordance with the five-year NPDES permit review process. The North Branch Kawkawlin River will be reevaluated in 2010 when the Kawkawlin/Pine River basin is next scheduled for monitoring. Limited D.O. monitoring (instantaneous measurements similar to those of the 1993 survey) may be conducted in the meantime.

REASONABLE ASSURANCE ACTIVITIES

The industrial storm water permit identified in Table 2 requires that if there is a TMDL established by the MDEQ for the receiving water that restricts a material that could impair or degrade water quality, then the required storm water pollution prevention plan shall identify the level of control for those materials necessary to comply with the TMDL and an estimate of the current annual load of those materials via storm water discharges to the receiving stream. The MDOT statewide permit requires the permittee to reduce the discharge of pollutants to the maximum extent practicable and employ best management practices to comply with TMDL requirements.

The MS4 permits identified in Table 2 require that a watershed management plan be developed and that the plan identify actions specific to storm water controls to achieve the goals of the TMDL.

A tool that may be beneficial to stakeholders in the North Branch Kawkawlin River TMDL Watershed is the *Lower Grand River Watershed Project Information and Education Guidebook.* This tool was created under a federal Clean Water Act Section 319 grant to the Grand Valley Metro Council and was used to motivate stakeholders and decision makers in the watershed to protect water quality. The guidebook includes a summary of activities and products for improving water quality, how to start a successful outreach program, investigating strategy targets, how to make things happen, and how to evaluate the strategy. The following Web site offers helpful information and important links to other groups: http://www.gvsu.edu/wri/isc/lower-grand-river-watershed-management-plan-312.htm.

Bay County administers the Part 91, Soil Erosion and Sedimentation Control (SESC) Program of the NREPA. This program aims to reduce sedimentation in rivers, lakes, and streams by controlling sediments in runoff from construction sites greater than one acre, or those located within 500 feet of a water of the state. Temporary (silt fences) and permanent control measures (such as fully vegetated buffer strips) are employed. The MDEQ, WB, oversees the counties' programs to ensure that they are effectively enforcing SESC regulations.

In November 2006, Governor Jennifer M. Granholm nominated the Kawkawlin River Watershed Project to receive funding under the federal Targeted Watershed Grant Program. The proposed $750,000 project, developed in support of the MDEQ's Saginaw Bay Coastal Initiative, is designed to reduce *E. coli*, sedimentation, and nutrient levels in the Kawkawlin River and will serve as a model partnership effort to address environmental concerns in the watershed.

The project was proposed by the Bay County Drain Commissioner and should result in significant progress toward restoring the Kawkawlin River watershed and Saginaw Bay. The federal Targeted Watershed Grant Program promotes successful community-based approaches and management techniques to protect and restore the nation's waters. The Kawkawlin River Project is based on a watershed management plan developed by local residents and stakeholders. The watershed management plan's goals include increasing public education and participation of watershed activities, protecting public health by the detection and elimination of illicit discharges, improving water quality by promoting the use of agricultural best management practices, and improving and maintaining soil erosion and sediment controls (BASWA).

A stakeholder meeting was held during the public comment period. Stakeholders were determined by identifying municipalities (i.e., counties, townships, and cities) in the TMDL watershed. Copies of the draft TMDL were available upon request and posted on the MDEQ's Web site. Copies of the draft TMDL were also sent out with the stakeholder meeting invitations and available at the stakeholder meeting.

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August 8, 2007

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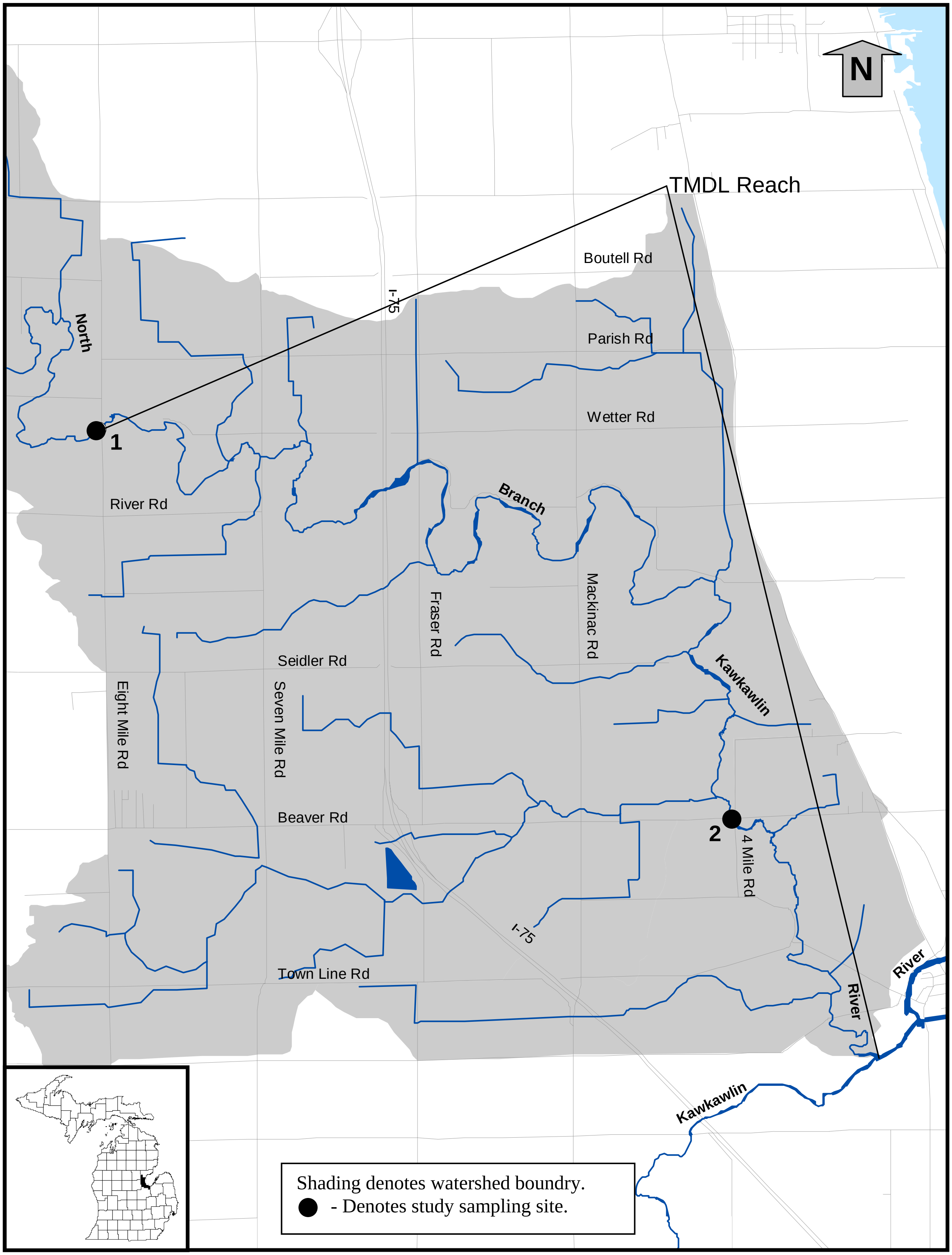

Figure 1: North Branch Kawkawlin River TMDL reach and study sampling sites, Bay County, Michigan, 2003.

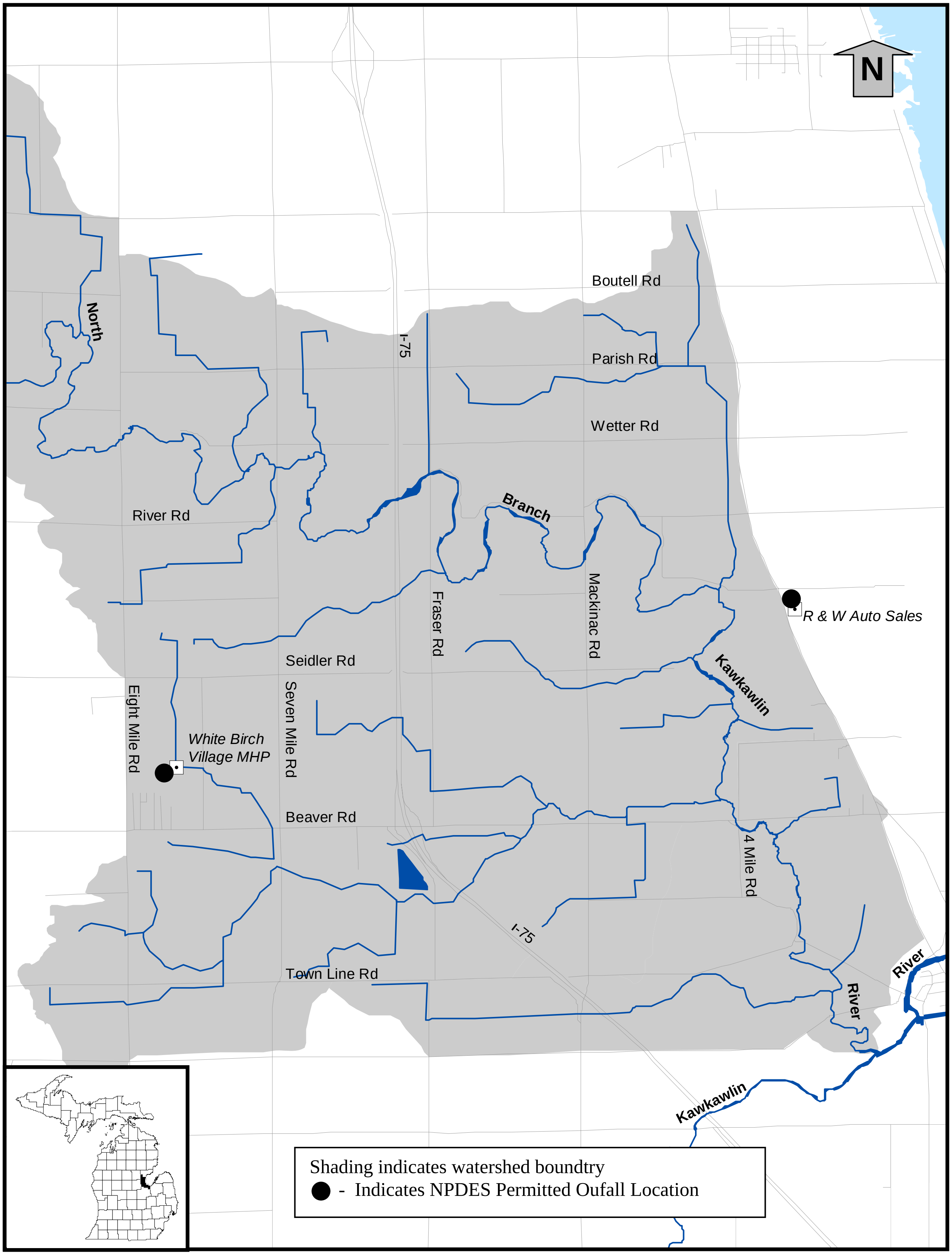

Figure 2: North Branch Kawkawlin River NPDES Permitted Facilities, Bay County, Michigan.

Appendix A. White Birch Village MHP WWSL NPDES Conventional Parameter Permit Limits (Design Flow 8.9 MGY).

		Maximum Loading (lbs/d)		Maximum Concentration (mg/l)		
Parameter	Period	Monthly	7-day	Monthly	7-day	Daily
$CBOD_5$ (mg/l)	Mar – May Oct – Dec	-	-	30	45	-
TSS (mg/l)	Mar – May	-	-	70	100	
	Oct – Dec	-	-	40	45	-
Ammonia Nitrogen (mg/l)	Mar – May Oct – Dec	-	-	(report)	-	-
Total Phosphorus (mg/l)	Mar – May Oct – Dec	-	-	(report)	-	-
DO (min., mg/l)	Mar – May Oct – Dec	-	-	5.0	-	-

Appendix B. Short Description of Online L-THIA Model Background GIS Data.

Layer Name	Type	Source	Description	Format
Basic Themes				
Roads	All County Roads	TIGER	(In Indiana) Roads that can be used to “geocode” a street address, placing it at a specific location on the map. From Census 2000 data set on *link no longer valid, removed 7/3/2017*	Line
Railroads	Railroads	TIGER	Railroads, from Census 2000 data set on *link no longer valid, removed 7/3/2017*	Line
Streams	Streams	USGS	National Hydrography Database, medium resolution (originally digitized from 1:100,000 maps) from Census 2000 data on *link no longer valid, removed 7/3/2017*	Line
Lakes_rivers	County Lakes and Rivers	USGS	Polygons from NHD medium resolution from Census 2000 data on *link no longer valid, removed 7/3/2017*	Polygon
Townships	Civil Townships	TIGER	The names and boundaries of the townships in a county.	Polygon
Cities_towns	City and Towns	TIGER	Municipal outlines from 2000 census, for census designated places.	Polygon
Landuse	Land Use	USGS	30-m resolution National Land Cover Database (based primarily on Landsat TM 1992 imagery.)	Polygon
Highways	Main Highways	TIGER	Statewide major highway network. Created from TIGER data.	Line
Rivers	Lakes and Rivers	USGS	Major water features from the National Hydrography Data Set, or statewide themes from the National Atlas (link no longer valid, removed)	Line
8_dig_wtrsheds	Statewide Watersheds	USGS	Statewide 8-digit Hydrologic Unit Code watersheds.	Polygon
Counties	Counties	TIGER	Names and extents of all counties.	Polygon
Orthophotos	Orthophotos	USGS/NRCS	(In Indiana) 1-m resolution photos by quarter of a 7.5 minute quad, from around 1998, compressed with MrSID then resamples into 2 meter .tif images	Image (.sid)
Topomaps	Topographic Map Images	USGS	(In Indiana) Scanned, rectified image of a U.S. Geological Survey (USGS) 7.5 minute (1:24,000 scale) topographic map. Provided by NRCS.	Image (.tif)
Ned_dem	DEM (Elevation)	USGS	30-m resolution National Elevation Data	Grid
Stream from DEM or Flow from DEM	Flowpath	Calculated	These lines represent calculated overland flow path and NOT an actual stream.	