Michigan Department of Environmental Quality
Water Bureau
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Total Maximum Daily Loads for Dissolved Oxygen and Sedimentation/Siltation for Norton Creek Oakland County

INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) 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 (NPS) to restore and maintain the quality of their water resources. The purpose of these TMDLs is to identify the sources of dissolved oxygen (D.O.) standard nonattainment and sedimentation/siltation problems in Norton Creek near Wixom, and to quantify reductions in these sources necessary for attainment of WQS. Norton Creek and its tributaries in the vicinity of Wixom are designated as warmwater streams with a D.O. standard of 5 milligrams per liter (mg/l) as a minimum [Rule 64 (R 323.1064) 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 (NREPA)]. These TMDLs seek to achieve D.O. standard attainment and eliminate sedimentation/siltation issues through the reduction of total suspended solids (TSS) loads to Norton Creek.

Norton Creek is part of the Huron River watershed as illustrated in Figure 1, and is located in portions of Commerce, Lyon, and Milford Townships, and the cities of Novi, Walled Lake, Wixom, and the village of Wolverine Lake in Oakland County. Figure 2 describes the Norton Creek watershed and location of the TMDL reach. The majority of the population in the Norton Creek watershed resides in Wixom, which had 13,263 residents as of the 2000 census. Table 1 defines the extent and length of the reach. A total of approximately 3.1 river miles are addressed by these TMDLs.

Table 1. Norton Creek D.O. and Sedimentation/Siltation TMDL Reach.

Water Body	Reach Start	Reach End	Distance
Norton Creek	Buno Road (T2N, R7E, Section 25 of Oakland County)	Durr Drive (T2N, R8E, Section 30 of Oakland County)	3.1 miles

Norton Creek has a drainage area of approximately 24.2 square miles at its confluence with the Huron River in Section 13, T2N, R7E of Oakland County. Estimated summer season 50 percent (%) and 95% exceedance flows (cubic feet per second [cfs]) for Norton Creek at this location are 2.5 cfs and 0.7 cfs, respectively. Norton Creek low flows were computed from historic data collected at a United States Geological Survey gage, Upper River Rouge at Farmington, Michigan (Gage Number 04166300). Much of the Norton Creek drainage basin is dominated by wetlands. Since the 1980s, a significant portion of the Norton Creek watershed has been dredged as straight-cut channels to facilitate drainage.

PROBLEM STATEMENT

The TMDL reach for Norton Creek appears on the 2008 Section 303(d) list (LeSage and Smith, 2008) as:

Water Body Name: Norton Creek **AUID:** 040900050103-04
Impaired Designated Use: Warmwater Fishery, Other indigenous aquatic life and wildlife
Cause: Dissolved Oxygen, Sedimentation/Siltation **Size: 18.8** miles
Location: Norton Creek from its confluence with the Huron River, upstream to its headwaters and including all tributaries
TMDL Year: 2009

Assessment units are prioritized for TMDL development considering the existing TMDL schedule (i.e., the number of TMDLs currently scheduled for each year), Michigan's five-year rotating watershed cycle, available resources to complete TMDLs, data and supporting information quality and quantity, complexity of the problem and severity of the pollution, and the USEPA's recommendation to develop TMDLs within 13 years of listing. Based on these considerations, the Norton Creek TMDLs, first listed in 1998 (sedimentation/siltation) and 2004 (D.O.), were scheduled for TMDL development in 2009.

The designated use rule (Rule 100 [R 323.1100]) requires the protection of, among other uses and specific to these TMDLs, other indigenous aquatic life and wildlife (R 323.1100(1)(e)) and warmwater fish (R323.1100(1)(d)) uses.

These TMDLs address D.O. standard nonattainment and sedimentation/siltation issues in Norton Creek near Wixom. The D.O. standard nonattainment is associated both with impairment of the warmwater fishery and the other indigenous aquatic life and wildlife designated uses. The excess sedimentation/siltation is associated with impairment of the other indigenous aquatic life and wildlife designated use. These TMDLs do not address WQS nonattainment or associated use impairments due to total dissolved solids or polychlorinated biphenyls in the water column, for which portions of Norton Creek are also listed on the 2008 Section 303(d) list. Those parameters and use impairments will be addressed in separate TMDLs. The listing location for the D.O. and sedimentation/siltation TMDLs will be modified in the 2010 Integrated Report to more explicitly define the impaired reaches for the impaired designated uses. The reach length of 18.8 miles will be reduced to 3.1 miles for the updated D.O. and sedimentation/siltation impairment listings. The upper and lower limits of that modified reach will be as follows:

> The upstream limit is at Durr Drive (Latitude 42.5187; Longitude -83.5448) with the downstream limit at Buno Road (Latitude 42.5527; Longitude -83.5622).

DATA DISCUSSION

D.O.

<u>1980 Water Quality Survey</u>

A 24-hour water quality study was performed on Norton Creek at Wixom in the summer of 1980 (Suppnick, 1981) in order to determine the capacity of the creek to assimilate oxygen-consuming wastes discharged by the Wixom Wastewater Treatment Plant (WWTP) (MI0024384) discharging to Norton Creek, and the Ford-Wixom Assembly Plant (MI0028151) discharging process and noncontact cooling waters to Norton Creek via Congdon Drain in Section 7, T1N, R8E of Oakland County. The 1980 study measured D.O. at seven locations in Norton Creek and Congdon Drain above and below the Wixom WWTP and the Ford-Wixom Assembly Plant discharges.

The 1980 study found minimum D.O. levels less than the current warmwater D.O. standard of 5 mg/l as a daily minimum at several monitoring locations in Norton Creek. Large diurnal D.O. variations (daily average concentration minus daily minimum concentration) were documented throughout the study reach during the 1980 study. A diurnal of approximately 4.5 mg/l was measured at the Durr Drive location (Section 6, T1N, R8E of Oakland County, upstream of the Wixom WWTP), while a diurnal of 3.5 mg/l was recorded at Buno Road (Section 25, T2N, R7E of Oakland County, downstream of the Wixom WWTP). Aquatic plant growth below Congdon Drain was described as "extremely abundant."

A calibrated and verified D.O. model of Norton Creek was created based on the 1980 study. Modeling results concluded that respiration of aquatic plants would prevent attainment of the D.O. standard during drought flow conditions. The modeling concluded that advanced waste treatment (AWT) limits for the summer and fall seasons at the Ford-Wixom Assembly Plant and Wixom WWTP would greatly improve water quality in Norton Creek. Note that the Ford-Wixom Assembly Plant redirected its process and noncontact cooling water discharge to the Wixom WWTP in 1991. Today, this facility has only an industrial stormwater permit (MIS410193) for surface water discharges. The Wixom WWTP upgraded to AWT in 1991.

2002 Water Quality Survey

Dissolved oxygen was monitored continuously in Norton Creek at Wixom, Michigan, from August 7-20, 2002, at Durr Drive and at Buno Road (Sunday, 2003). See Figure 2. The purpose of the study was to determine Norton Creek's compliance with the warmwater D.O. standard and to document changes in stream D.O. dynamics since the 1980 D.O. study.

Significant periods of warmwater D.O. standard nonattainment were documented in Norton Creek at the Durr Drive monitoring location. D.O. concentrations ranged from 2.6 to 6.9 mg/l, with an average study period concentration of 4.7 mg/l. An overall average diurnal D.O. variation of 0.8 mg/l was measured. Norton Creek at the Durr Drive location was in nonattainment of the 5 mg/l minimum warmwater D.O. standard for the majority of the study period. Approximately 62% of the continuously logged data points at the Durr Drive location were less than 5.0 mg/l. D.O. standard nonattainment occurred during both wet and dry weather. During the study period, Norton Creek at the Durr Drive monitoring location had little flow during dry weather. It is possible that relatively stagnant conditions due to low stream flows contributed to the relatively low levels of D.O. observed at this location.

A brief period (less than 12 hours) of D.O. standard nonattainment was documented at the Buno Road location. D.O. concentrations ranged from 4.7 to 8.0 mg/l, with an average concentration of 6.1 mg/l. An overall average diurnal D.O. variation of 0.7 mg/l was recorded at Buno Road. Norton Creek at Buno Road was largely in attainment of the warmwater D.O. standard. Approximately 3.6% of the continuously logged data points at the Buno Road location were less than 5.0 mg/l. The brief period of D.O. standard nonattainment that occurred on August 17, 2002, took place within 12 hours of the start of a wet weather event on August 16. It is possible that NPS pollutants contributed to this standard nonattainment at the Buno Road monitoring location.

The summer 2002 study documented much smaller diurnal variations at Durr Drive and Buno Road than those documented in the 24-hour study of Norton Creek conducted in 1980. The lower diurnals may be due, in part, to the reduction of combined nutrient loads from the Ford-Wixom Assembly Plant and Wixom WWTP since 1980.

Sedimentation/Siltation

The Michigan Department of Environmental Quality (MDEQ) has conducted several biosurveys in Norton Creek since 1971. Biological assessments in 1971, 1972, 1976, 1988, and 1997

indicated the presence of degraded macroinvertebrate communities at Durr, West Maple, and Buno Roads, variously attributed to excess sedimentation/siltation, excessive nutrient levels, and/or low D.O. levels (Figure 2) (Jackson, 1971; Jackson, 1972; Grant, 1976; Evans, 1990; Rippke, 2005).

Additional biosurveys were conducted in 2007 and 2008 using MDEQ Procedure 51 to evaluate benthic macroinvertebrate communities and habitat (MDEQ, 1990). Macroinvertebrate community scores are rated on a scale of -9 to 9, with scores of -4 to 4 considered acceptable, scores -5 or less poor, and 5 or greater, excellent. Negative ratings that are acceptable are indicative of water bodies that are strongly tending toward poor, while positive ratings that are acceptable indicate slight impairment. Fourteen metrics representing stream habitat were qualitatively evaluated at each station, with a range of total possible scores for all metrics of 0 (poor) to 200 (excellent). Macroinvertebrates and habitat were evaluated at four sites: Buno Road (2007 and 2008), upstream of the Wixom WWTP access road (2008), West Maple Road (2007 and 2008) and Durr Drive (2008) (Figure 2).

The 2007 macroinvertebrate results at Buno and West Maple Roads were acceptable (-3) and poor (-6) respectively, with the Buno Road score at the low end of acceptable. The 2008 sampling results at Buno and West Maple Roads were both poor (-5 and -6, respectively), and while the results upstream of the WWTP and the Durr stations were acceptable, both were at the low end of acceptable (-2 and -4, respectively). The 1997 macroinvertebrate sampling results at Buno and West Maple Roads scored poor at both stations (-5 at each station). These results indicate a persistently degraded system over the past 10 years of sampling using the current Procedure 51 methodology. Sample results prior to 1996 cannot be compared to current results due to different scoring methodologies used in the earlier studies.

A notable observation in the macroinvertebrate community survey results in both 2007 and 2008 is the paucity of sensitive organisms at all stations (e.g., certain families of caddiflies, mayflies, and stoneflies), which can be indicative of D.O. and/or sedimentation/siltation concerns.

The habitat evaluations at all stations in 2007 and 2008 rated towards the lower end of good (possible range of scores in the good category 114-154), with scores ranging from 114 (West Maple Road – 2007) to 135 (upstream of the WWTP – 2008). The habitat metric, Epifaunal Substrate/Available Cover, is a measure of the amount of stream channel in the sample reach that contains substrates that are free from sedimentation/siltation impacts and therefore, favorable for epifaunal colonization. Out of a total score of 20 for this metric, the highest score was found at West Maple Road (11 - the low end of good) and lowest at Buno Road (5 – high end of poor). A poor score is indicative of a stream substrate with less than 20% stable habitat, while the low end of good is indicative of 40% stable habitat. All stations sampled in 2007 and 2008 were found to have some degree of siltation.

NUMERIC TARGETS

D.O.

Rule 100 (R 323.1100) requires that all waters of the state are to 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, fish consumption, and total body contact recreation from May 1 to October 31. Regarding D.O., the impaired designated uses for Norton Creek addressed by these TMDLs are the warmwater fish and the other indigenous aquatic life and wildlife uses. The D.O. standard was developed to provide protection of these designated use. Attainment of the warmwater D.O. standard of 5 mg/l as a daily minimum is the target of these TMDLs. 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 milligrams 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:

…(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.

…(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.

Sedimentation/Siltation

The second impaired designated use addressed by these TMDLs is the other indigenous aquatic life and wildlife use associated with the sedimentation/siltation-related impairments to the macroinvertebrate communities found in the TMDL reach.

The TMDL target is the reestablishment of macroinvertebrate communities that, when monitored using Procedure 51, result in a consistent acceptable or excellent rating (e.g., a score of -4 to +9). Macroinvertebrate communities will be evaluated based on a minimum of two Procedure 51 biological assessments conducted in successive years, following the implementation of efforts such as Best Management Practices (BMPs) to stabilize runoff discharges and extremes in stream flow conditions, and minimize sediment loadings to the watershed.

LINKAGE ANALYSIS

D.O.

Factors that can deplete oxygen in Norton Creek include the following:

Biochemical Oxygen Demand (BOD): BOD is the amount of D.O. that a given organic material will consume when it is oxidized by aerobic microorganisms in a water body. BOD has units of mg/l of D.O. consumed in the decomposition process. Potential sources of BOD in Norton Creek include the point source Wixom WWTP and NPS sources such as pet wastes and other organic materials present in surface runoff. When carbon-based compounds are oxidized, the oxygen demand is referred to as carbonaceous BOD, or CBOD. When nitrogen-based compounds are oxidized, it is called nitrogenous BOD, or NBOD. NBOD is exerted when ammonia is oxidized into nitrates and nitrites through nitrification. Organic nitrogen can be converted into ammonia, which can then be oxidized into nitrates and nitrites.

BOD can exist in a solubilized form (such as sugars), as well as in the form of organic solids (particulate matter such as leaf litter). In general, soluble BOD is more readily degraded in the environment than particulate BOD (USEPA, 1985). A portion of the solids in the water column present as TSS may be aerobically biodegradable and exerted as BOD, while a portion of the solids may be biologically unreactive or inert due to a low organic and high mineral content. Particulate BOD may settle out in a water body and contribute to sediment oxygen demand.

Sediment Oxygen Demand (SOD): Solids from NPS and point sources present in the water column of a flowing water body can settle to the stream bed, forming layers of sediments with variable depths and compositions. Organic solids on the surface layer of the bottom in direct contact with the water can undergo aerobic decomposition, causing diffusion of D.O. from the water column into the sediment layer and depleting D.O. levels in the overlying river water. NPS solids contributing to SOD most often enter a water body during runoff events. For point sources, the discharge of sediments, their rate of deposition, and the associated SOD all decrease with increased levels of wastewater treatment (Thomann & Mueller, 1987). SOD and sediment deposits are typically highly variable spatially and temporally due to varying flow regimes affecting deposition and scour (USEPA, 1985).

During the 2002 D.O. monitoring, stream substrates at the Durr Drive and Buno Road monitoring locations were observed to be silty, mucky, and organic in nature. Sediment depths greater than one foot were observed at Buno Road, and evidence of channel dredging was present. At both locations, stream velocities were low and flow conditions were quiescent. These conditions encourage the settling of sediments out of the water column and exacerbate SOD.

Plant Respiration: The presence of aquatic plants in a water body can have a significant effect on levels of D.O. Plants such as rooted macrophytes and algae use 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.

Norton Creek diurnal D.O. variations measured during the 2002 study were not considered to be excessive as they were less than 1 mg/l (MDEQ, 1995). Observed plant growths were not considered to be at levels of overabundance. Therefore, excessive plant growths are not considered to be problematic for D.O. standard attainment in Norton Creek, consistent with observations during the 2007 and 2008 biological surveys. Plant nutrients (phosphorus) are not pollutants of concern for these TMDLs.

The relative importance of the multiple D.O. sinks to the oxygen budget of a stream can be evaluated with a D.O. model that quantifies each oxygen demand present. For Norton Creek, the oxygen budget of the stream was evaluated with a multiple reach Streeter-Phelps D.O. model based on the modified Streeter-Phelps equation. The multiple reach Streeter-Phelps D.O. model is considered appropriate for use in the TMDL as it can represent the system without being unnecessarily complex or overly data-intensive. Model inputs include background and inflow water quality chemistry, CBOD and NBOD decay and deoxygenation rates, reaeration rates, and stream velocity. The model calculates an average daily D.O. concentration at the end of each defined reach. A minimum daily D.O. concentration can be calculated by applying D.O. diurnal variations measured during D.O. studies. The model incorporates stream D.O. contributions from photosynthesis, and D.O. consumption due to plant and algal respiration and SOD in each reach (Thomann and Mueller, 1987).

The TMDL model is based on the calibrated and verified D.O. model of Norton Creek, which was first developed using data from the 1980 Water Bureau (WB) D.O. study and which has been used to develop water quality-based effluent limits (WQBELs) for the Wixom WWTP's NPDES permit. The D.O. model used study-measured values for stream velocity, channel slope, background and inflow water chemistry, and CBOD and NBOD decay rates. Modeled daily maximum, minimum, and average D.O. concentrations were made to match observed D.O. concentrations (model calibration) by adjusting the models inputs for photosynthesis and respiration. For the TMDL analysis, the model was re-calibrated to match D.O. concentration data collected during the 2002 D.O. study.

The recalibrated model was used to calculate the Loading Capacity for these TMDLs. The modeling was consistent with Great Lakes and Environmental Assessment Section (GLEAS) Procedure 80, Guidance on Water Quality-Based Effluent Limit Recommendations for Oxygen Demanding Substances (MDEQ, 1995), which prescribes the selection of model input values. Model inputs which were not measured during DO studies of Norton Creek, such as stream reaeration rates, were calculated as per Procedure 80. Conservative design conditions were incorporated to determine necessary loading reductions also as per Procedure 80. Such modeled conditions included 95% exceedance drought flows and 10% exceedance stream temperatures. The Wixom WWTP was modeled as discharging at its maximum permitted flow rate and at its maximum limits of CBOD and ammonia.

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the oxygen budget of the stream was evaluated with a multiple reach Streeter-Phelps D.O. model that incorporates stream D.O. contributions from photosynthesis, and D.O. consumption due to plant and algal respiration and SOD in each reach (Thomann and Mueller, 1987). Modeling was conducted in accordance with guidance described in the GLEAS Procedure 80 (MDEQ, 1995). The modeling analysis was used to develop the Norton Creek D.O. TMDLs' pollutant Loading Capacity (LC).

Sedimentation/Siltation

Excessive sedimentation/siltation has repeatedly been identified as the leading cause of impairment of the nation's waters. In 1998, approximately 40% of assessed river miles in the United States were impaired or threatened from an imbalanced sediment supply (USEPA, 2000). In appropriate amounts, sediments (both suspended and bedded) are essential to aquatic ecosystems. Natural levels transport nutrients, detritus, and other essential organic matter throughout aquatic environments and replenish intermittently mobile bottom sediments and create valuable micro-habitats, such as pools and sand bars (USEPA, 2006). The effects of excessive sediments on aquatic biota can range in severity from no effects to behavioral effects (e.g., invertebrate drift, fish relocation, and impaired ingestion rates in mussels) to lethal effects (USEPA, 2006). Further, sedimentation/siltation of benthic substrates has been shown to decrease substrate heterogeneity, increase embeddedness, and alter benthic community structure and species diversity (Waters, 1995). Sediments may also have associated stressors such as nutrients, pesticides, and other bound toxins that further stress aquatic organisms.

Human activities that increase soil erosion or alter rates of sediment transport in waterways (e.g., forestry, mining, urban development, industrial activities, agriculture, dredging, channel alteration, and dam construction) are among the most pervasive causes of sediment imbalance in aquatic systems (Waters, 1995; Nietch et al., 2005; USEPA, 2006). Altered hydrology, or more specifically, increased flashiness due to increased runoff rates and volume, in the Norton Creek watershed has been identified as a cause for the lack of stable in-stream habitat, increased in-stream erosion, channel aggradation, and heavy siltation of stable in-stream habitats (Wuycheck, 2009).

Reducing TSS loads in the Norton Creek watershed as prescribed by the D.O. portion of these TMDLs, along with the commensurate decrease in flow volume and rate, should increase macroinvertebrate community diversity and abundance. As sedimentation/siltation are reduced, the negative effects of sedimentation/siltation described above are expected to diminish, with the goal of meeting the other indigenous aquatic life and wildlife designated use.

LC DEVELOPMENT

The LC represents the maximum loading of oxygen demanding substances (BOD) or other parameters that can indirectly cause oxygen demand (sediments, nutrients) that can be assimilated by the water body while still achieving WQS. As indicated in the Numeric Target section, the targets for these TMDLs are the D.O. WQS of 5 mg/l minimum and the reestablishment of macroinvertebrate communities that are rated consistently as acceptable or excellent under Procedure 51.

The LC development defines the environmental conditions that will be used when defining allowable pollutant loads. The "critical condition" is defined as the set of environmental conditions that result in the attainment of WQS and have an acceptably low frequency of occurrence. The critical conditions for the applicability of WQS in Michigan surface waters are given in Rule 90 (R 323.1090), applicability of WQS. Rule 90 requires that the WQS apply at all flows equal to or exceeding the water body design flow. In general, the lowest monthly 95% exceedance flow and 90% occurrence temperature for streams are used as design conditions for oxygen-demanding pollutant loads (CBOD, ammonia nitrogen, and TSS). For these TMDLs,

the critical condition for D.O. is the summer season when high temperatures and low stream flows reduce the assimilative capacity of streams for D.O. consuming pollutants.

In order to quantify reductions in river D.O. demands necessary to attain the D.O. standard at critical conditions, the calibrated and verified D.O. model originally developed with data collected during the 1980 stream survey was updated with and recalibrated to data collected during the 2002 D.O. study. The recalibration involved adjustment of simulated D.O. contributions from photosynthesis, and D.O. sinks from plant respiration and SOD. Since the 2002 survey found much smaller D.O. diurnal variations than those measured during the 1980 survey and at values typical of streams unaffected by excessive plant growth, aquatic plant and algal photosynthesis and respiration were represented in the model simply by subtracting the diurnal variation value from the modeled average D.O. concentration. The D.O. modeling indicates that SOD is the leading cause of D.O. depletion in Norton Creek. Plant respiration and BOD from the Wixom WWTP and NPS play smaller roles in the D.O. problem in the TMDL reach.

The calibrated model was used to predict D.O. under a design scenario, which included drought flow, 90 percent occurrence stream temperature, SOD at the value determined during model calibration, and the presently permitted point source discharge levels of CBOD, ammonia, and D.O. The result for this simulation indicated that the D.O. standard would not be met.
The relative importance of each oxygen demand (SOD, CBOD, and ammonia) was evaluated in the model at the end of each of twenty stream reaches. The model indicated that SOD was by a large margin the greatest overall oxygen demand in the stream followed by CBOD as shown in Table 2. NBOD due to ammonia oxidation is not a factor as the 1980 water quality survey and model calibration have shown nitrification rates to be zero throughout all modeled reaches.

Table 2. Relative Importance of Factors that Deplete Oxygen in Norton Creek.

Oxygen Demand	As a % of Total D.O. Deficit for Each Model Reach	
	Minimum	Maximum
SOD	92	98
CBOD	2	8
Ammonia	0	0

The model analysis continued by decreasing the SOD incrementally in the model until the D.O. standard was met throughout Norton Creek. This required reducing SOD by 84%. The Wixom WWTP's discharge of CBOD and ammonia was not reduced beyond currently permitted levels in the modeling analysis because the currently permitted levels are already at the maximum treatment level achievable (AWT limits of 10 mg/l $CBOD_5$ and 2 mg/l ammonia as daily maxima). This was the scenario from which these TMDLs were developed.

The rate of SOD per unit area is dependent upon sediment depth when depth is less than a critical value of 10 to 20 centimeters (USEPA, 1985). The amount of D.O. consumed in a reach from SOD is also dependent upon the surface area that is covered by oxygen demanding sediment. Both of these parameters (sediment depth and areal coverage) can be expected to decrease as suspended solids loads are decreased to a stream. Modeling the fate of suspended solids discharged to Norton Creek is beyond the scope of these TMDLs and is not necessary since the magnitude of the reduction needed is relatively large. To achieve an 84% reduction in SOD in Norton Creek, a proportionate reduction in the suspended solids discharges is therefore needed.

The sediment load reductions prescribed to meet the warmwater fishery and the other indigenous aquatic life and wildlife designated uses through the attainment of the 5 mg/l minimum D.O. standard are expected to result in achievement of the target of the

reestablishment of macroinvertebrate communities that are rated consistently as acceptable or excellent. TSS load reductions will primarily result from less sediment entering the TMDL reach during wet weather events. This will result in reductions in sedimentation/siltation rates, which will be evident under both wet and dry conditions. This in turn will allow the establishment of desired macroinvertebrate communities to an acceptable level as determined by Procedure 51. If biological assessments conducted after TMDL implementation show that such biocommunities have not been established, reassessment of the sediment load reductions called for under the D.O. TMDL may be necessary.

SOURCE ASSESSMENT

The pollutant of concern for D.O. and sedimentation/siltation in Norton Creek is suspended solids. The effect of suspended solids on D.O. is a secondary effect exerted mostly through SOD. Suspended solids discharged primarily during high flow conditions settle on the stream bottom and have the greatest adverse effect under low flow conditions. Sources of suspended solids to the stream include:

- Point sources with individual National Pollutant Discharge Elimination System (NPDES) permits.
- Permitted storm water sources, which include facilities and land uses covered by general permits and construction sites covered by Permit-by-Rule.
- Runoff from land uses not covered by NPDES permits (e.g., agricultural, forest lands).

Point Sources

There are 40 NPDES permitted point source discharges in the Norton Creek watershed. These include facilities covered under 2 individual NPDES permits, 28 industrial stormwater permits, 2 construction sites covered under Permit-by-Rule Notices of Coverage (NOCs) (construction sites greater than 5 acres in area), and 8 municipal separate sanitary stormwater system (MS4) general permits.

The two individual permits are the Wixom WWTP and Michigan Department of Transportation's (MDOT's) statewide MS4 permit (MI0057364) covering storm water runoff from state-managed roads in the basin (portions of I-96 and M-5). The eight general municipal MS4 permittees include seven under the Storm Water Discharges from Separate Storm Water Drainage Systems general permit (MIG619000), and one covered by the Storm Water Discharges from Municipal Separate Storm Sewer Systems (MS4s) with Controls Based on Six Minimum Measures permit (MIG040000). The MDEQ, WB, has issued ten No Exposure Certifications to facilities whose standard industrial classifications would have otherwise made them subject to industrial stormwater permit coverage. No Norton Creek watershed surface water discharges are covered under any general NPDES permit aside from those mentioned here. There are no known Concentrated Animal Feeding Operations in the watershed. See Appendix A for a listing of all NPDES permitted outfalls discharging to the Norton Creek watershed.

Runoff from the lands covered under the MDOT statewide MS4 permit is considered insignificant in relation to runoff from other land uses. State roads cover approximately 21 acres in the Norton Creek watershed, accounting for less than 0.2% of the total area.

Wixom WWTP

The Wixom WWTP, with a design flow of 2.8 million gallons per day (MGD), is permitted to continuously discharge treated sanitary wastewater from outfall 001 to Norton Creek in Section 30, T2N, R8E of Oakland County. See Appendix B for Wixom WWTP current NPDES permit conventional parameter effluent limits based on the current 2.8 MGD design flow. The Wixom WWTP's current NPDES permit was issued on December 1, 2004, with an expiration

date of October 1, 2008. The permit has been extended until it is formally reissued, which is expected to occur before September 30, 2009. The current permit includes effluent limits based on a design flow of 4.02 MGD from an expanded treatment facility. There is no timetable for facility expansion as such upgrades are dependent on local development. The NPDES permit to be reissued in 2009 will include limits based on the current and increased design flows of 2.8 and 4.02 MGD, respectively.

The facility's current NPDES permit requires AWT limits in the summer and fall seasons (May through November) for both the 2.8 and 4.02 MGD design flows. AWT limits are treatment technology-based effluent limits and are the most restrictive conventional pollutant limits imposed on sanitary wastewater facilities employing biological treatment. Such effluent is assumed to exert no in-stream D.O. demand and is often referred to as "stable effluent" due to very low BOD decay rates and high ultimate BOD to BOD_5 ratios (Chapra, 1997; MDEQ, 1995). The city of Wixom has no known combined sewer or sanitary sewer overflows, and none have been known to exist in the past.

A summary of monthly average data from Wixom WWTP Discharge Monitoring Reports (DMRs) from May 2006 through April 2008 is presented in Table 3. The facility was in compliance with all limits for the listed parameters during the monitoring period. The Wixom WWTP's tertiary treatment system employs enhanced coagulation, flocculation, and sand filters to produce a high quality final effluent with low concentrations of TSS and total BOD. Such effluents contain a low ratio of particulate-to-soluble BOD, such that the rate of settling of any volatile (oxygen-demanding) solids becomes insignificant (Thomann & Mueller, 1987). In addition, any remaining effluent particulate BOD is more resistant to biodegradation in the environment than the soluble portion (USEPA, 1985). Any solids settling from such a highly treated effluent are therefore expected to contribute significantly less SOD than more readily degraded, untreated settled solids from NPS such as pet waste, detritus, or rich organic soils.

Based on the current annual permitted TSS loading averaged over the year, the facility is permitted to discharge 565 pounds per day (lbs/day) TSS. However DMR data show that an average of about 60 lbs/day TSS is actually discharged. The Wixom WWTP produces a very clear effluent, such that ultraviolet disinfection is highly effective and is preferred over chemical disinfection.

Table 3. Wixom WWTP Monthly Average DMR Data from May 2006 through April 2008.

Parameter	Wixom WWTP
Flow (MGD)	2.05
Ammonia (mg N/l)	0.13
$CBOD_5$ (mg/l)	2.03
CBOD % removal	98.7
D.O. (mg/l)	8.9
Total phosphorus (mg P/l)	0.21
TSS (mg/l)	3.19
TSS % removal	97.3

Table 4 contains permitted daily conventional pollutant loads for the Wixom WWTP point source discharge. Facility loads are calculated from the facility's monthly NPDES permit load limits. Note that the facility may, in fact, be discharging significantly lower loads of these pollutants than is permitted to discharge.

Table 4. Norton Creek Permitted Point Source Conventional Pollutant Loadings - Wixom WWTP.

	Wixom WWTP	
Load (lbs/day)	Total Annual Load	Average Daily Load
BOD_5 *	83,000	227
TSS	206,280	565
Total phosphorus	1,800	4.9
Ammonia nitrogen	35,320	97

* - $CBOD_5$ is limited in the Wixom WWTP NPDES permit

Estimates of all land use-related (NPDES permitted and non-NPDES permitted land use) loads of BOD, TSS, total phosphorus, and total nitrogen to the Norton Creek TMDL reach 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). 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 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).

Land use areas in the Norton Creek watershed were based on aerial photography taken by the Southeast Michigan Council of Governments (SEMCOG) in 2000 (SEMCOG, 2003). These land uses and their percentage of the total TMDL watershed area are outlined in Table 5.

Table 5. Norton Creek Basin Land Use Categories as Percentages at the Confluence with The Huron River.

Land Use Category	Percent Land Use Category
Single family residential	26.3
Multiple family residential	4.0
Under development	2.3
Commercial, office, institutional	2.2
Industrial	14.6
Transportation, communications, utilities	5.1
Vacant land in nonresidential areas	1.7
Cultural, outdoor recreation, cemetery	3.8
Active agriculture	4.6
Grassland and shrub	10.9
Woodland and wetland	20.3
Water	4.1

Estimates of pollutant loads from NPDES-permitted land uses, considered to be point sources in these TMDLs, appear in Table 6. These land uses include those covered under the NPDES stormwater permits and those covered under municipal and MDOT statewide MS4 permits. All commercial and industrial land uses were considered to be covered by stormwater permits for load calculations with the L-THIA application, while all residential, transportation, utilities, communications, and mixed urban land uses were considered to be covered under MS4 permits. Loads outlined in Table 6 represent point source pollutant loads to the TMDL reach in addition to those generated by the Wixom WWTP listed in Table 4. Calculated loadings are based on event mean concentration data collected by the Rouge River National Wet Weather Demonstration Project (Cave et al., 1994).

Table 6. Norton Creek Permitted Point Source Conventional Pollutant Loadings – NPDES Land Use Sources.

	Industrial Stormwater Permits		Municipal and MDOT MS4 Permits	
Load (lbs/day) **	Total Annual Load	Average Daily Load	Total Annual Load	Average Daily Load
BOD_5	38,488	105	72,694	199
TSS	220,750	605	208,381	571
Total Phosphorus	529	1.5	1,064	2.9
Total Nitrogen	2,886	7.9	4,582	12.6

** - Facilities' NPDES permits contain no limits for the listed parameters. Loads are estimated from land use data.

NPS

Land uses that are not covered under NPDES permits are considered to be NPS in nature in these TMDLs. For pollutant loads calculations, these land uses were considered to include cropland and pasture, shrub and brush, forest, lakes, streams, and wetlands. Loads from these land uses appear in Table 7.

Table 7. Estimated Daily Non-NPDES Land Use-Related Conventional Pollutant Loads to Norton Creek at its Confluence with the Huron River.

Pollutant	Total Annual Load (lbs/year)	Daily Load (lbs/day)
BOD	12,705	35
TSS	56,895	156
Total Phosphorus	232	0.6
Total Nitrogen	1,402	3.8

ALLOCATIONS

The LC is comprised of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for NPS and natural background levels. In addition, the LC must include a 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:

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

The LC represents the maximum loading of pollutants that can be assimilated by the receiving water while still achieving WQS. The LC is allocated into WLAs for point sources, LAs for NPS, and the MOS. The LC calculated through D.O. modeling of Norton Creek calls for SOD and TSS loads to the TMDL reach to be reduced by 84% for WQS attainment. This reduction of TSS loads to Norton Creek will also result in elimination of the documented sedimentation/siltation problems to the extent that designated uses are impaired.

As detailed in the Source Assessment portion of these TMDLs, loads of TSS from the Wixom WWTP are not expected to contribute significantly towards levels of SOD in Norton Creek. Therefore, TSS reductions from this facility will not be sought. To achieve an 84% TSS load reduction to Norton Creek from the remaining sources, which are land-use related sources, NPDES and non-NPDES land use-related TSS loads will be reduced by 84%. The land-use TSS load reduction calculation is illustrated below using existing TSS loading data from Tables 4, 6, and 7. The TSS load reduction equals a target LC for the non-WWTP TSS fraction of 213 lbs/day TSS, an 84% reduction from the existing land-use TSS load of 1,332 lbs/day. The total LC including the WWTP allocation of 565 pounds is 778 pounds.

$$\text{Overall reduction} = \frac{\text{Existing load - Target load}}{\text{Existing load}}$$

$$= \frac{[(605 + 571) + 156] - [(97 + 91) + 25]\ \text{lbs/d}}{(605 + 571) + 156\ \text{lbs/d}}$$

= 84%

To summarize, D.O. modeling indicates that an overall 84% TSS load reduction from all non-WWTP sources will result in D.O. standard attainment in the TMDL reach. Sedimentation/siltation issues in the Norton Creek watershed will also be addressed through this TSS load reduction. See Table 8 below for a summary of existing and target TSS loads according to the TMDL WLA and LA.

Table 8. Daily TSS WLAs, LAs, and Numeric Targets - Norton Creek at the Mouth of the Huron River.

Water Body	Current Daily TSS Load (lbs)	Daily TSS Loading Capacity (lbs)	WLA Daily TSS Load (lbs)	LA Daily TSS Load (lbs)
NORTON CREEK:				
Wixom WWTP	565	565 *	565 *	-
Industrial Stormwater Permitted Outfalls	605	97	97	-
MS4 Stormwater Permitted Outfalls	571	91	91	-
Non-NPDES Land Use-Related Sources[%]	156	25	-	25
Totals:	1,897			
Daily TSS Load Numeric Target To TMDL Reach		778*	753**	25

% - Attributed to land uses in the townships of Commerce, Lyon, Milford, and Novi, and the cities of Novi, Walled Lake, Wixom, and the village of Wolverine Lake.
* Note the loading capacity for TSS, excluding the Wixom WWTP TSS load for reasons described above, is 213 pounds, an 84% reduction from the current load.
** Note the target WLA for TSS, excluding the Wixom WWTP TSS load for reasons described above, is 188 pounds.

WLAs

WLAs were assigned to sanitary wastewater, industrial storm water, and municipal storm water discharges permitted by an individual NPDES permit or general NPDES permit as described in the sections below. A complete list of NPDES permits addressed in these TMDLs is included in Appendix A.

The D.O. standard nonattainment in Norton Creek has been documented during the summer months only. During the summer months (May through September), the most potentially significant single point source of oxygen demanding substances to nonattaining reaches, the Wixom WWTP, is currently required by its NPDES permit to meet AWT (stable effluent) permit limits for $CBOD_5$ and ammonia. Further reductions in conventional pollutants (CBOD, ammonia nitrogen, and TSS) from this facility are not expected to impact Norton Creek D.O. levels in the critical summer months.

TSS inputs resulting from land use-related sediment loads will be the primary targets for TSS reductions in these TMDLs. Existing TSS loads from all NPDES-permitted land use-related sources have been reduced by 84% in the WLA as described in Table 8. Lands contributing WLA TSS loads to Norton Creek are located in Commerce, Lyon, and Milford Townships and the cities of Novi, Walled Lake, Wixom, and the village of Wolverine Lake in Oakland County.

No specific TSS load reduction is targeted for the statewide MDOT statewide MS4 permit (NPDES land use), as only a very small fraction of the overall transportation land use in the watershed consists of state-maintained roads as described in the Source Assessment section of these TMDLs. Existing and target loads from the MDOT statewide MS4 permit are included in the MS4 Permittees category in Table 8.

LAs

Existing TSS loads from all non-NPDES permitted land use-related sources have been reduced by 84% in the LA as described in Table 8. Lands contributing LA TSS loads to Norton Creek are located in the same jurisdictions as the WLA land-use sources.

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).

These TMDLs use an implicit MOS due to very conservative assumptions incorporated in D.O. modeling used to determine appropriate load reductions for TSS. 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 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 No. 15 (Buda, 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 WQBELs in NPDES WLAs at critical design conditions. For design condition TMDL modeling, the Wixom WWTP was represented as discharging its maximum design flow and maximum permitted concentrations of oxygen demanding substances. This is an extremely unlikely scenario and further lends to the conservative assumptions of the modeling. 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 Norton Creek. Modeling of Norton Creek in other seasons using appropriate 95% exceedance low flows and 90% occurrence temperatures shows predicted D.O. standard nonattainment occurring in the fall season. The reduction in TSS loads recommended in these TMDLs should result in decreased SOD and sedimentation/siltation in Norton Creek during all seasons. The Wixom WWTP's NPDES permit contains AWT permit limits in the summer and fall as a result of the D.O. standard nonattainment predicted by modeling in those seasons.

MONITORING

Future monitoring will be conducted once activities have occurred to reduce TSS loadings to assess whether these activities have resulted in water quality improvements. This monitoring will be conducted as resources allow. Typically, the WB monitors watersheds in accordance with the five-year NPDES permit review process. D.O. 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. Wet weather pollutant load sampling may

aid in directing future efforts toward specific areas contributing significant NPS loads. Norton Creek is next scheduled for monitoring in 2012.

REASONABLE ASSURANCE ACTIVITIES

The Reasonable Assurance section discusses various activities and regulatory controls that are in place or are expected to be in place that will aid in achieveing the pollutant load reductions prescribed by these TMDLs.

Under the NPDES permit program, the Wixom WWTP is required to meet limitations for TSS, CBOD, ammonia, and D.O. To ensure these limitations are met at all times, the facility typically achieves a much better effluent quality than required by its permit. Any violations of the permit limits are dealt with by a well established compliance and enforcement program administered by the MDEQ's Southeast Michigan District Office.

The Huron River Watershed Council (HRWC) works with residents, businesses, and local governments to protect water quality in the watershed, including Norton Creek (HRWC, 2009). The Council coordinates efforts involving public awareness and outreach, land use and conservation, and data collection and analysis. The HRWC has been very instrumental in establishing an effective citizen monitoring network, passing environmental protection ordinances, and disseminating guidance for the preservation and restoration of streams and lakes in the Huron Watershed.

Norton Creek is a tributary of Kent Lake, a recreational impoundment on the Huron River located approximately 5 miles downstream of Norton Creek's confluence with the Huron River. Many entities, including the HRWC, are involved with the implementation of the Kent Lake Subwatershed Management Plan (KLSMP) prepared by the Kent Lake Subwatershed Workgroup (KLSW) with funding from the MDEQ under the CWA Section 319 Program (KLSW, 2002). The KLSMP was approved in August 2002 by the MDEQ. The main goal of the KLSMP is to attain the requirements of the Kent Lake Total Phosphorus TMDL written by MDEQ and approved by USEPA in March 2000. Since many of the actions designed to prevent loadings of nutrients to the watershed will also reduce loadings of TSS, the KLSMP can be a great aid in implementation of the Norton Creek D.O. and sedimentation/siltation TMDLs. The KLSMP also aims to establish a protocol to help subwatershed communities obtain coverage under Phase II stormwater permits by meeting program requirements. The KLSMP employs comprehensive, long-term efforts geared towards control of stormwater runoff through BMPs, conservation planning and standards adoption, and education and stewardship. Such efforts will be conducted within each subwatershed of the Kent Lake drainage basin, including the Norton Creek watershed.

Oakland County administers the Part 91, Soil Erosion and Sedimentation Control (SESC), Program of the NREPA. This program aims to reduce sedimentation/siltation in rivers, lakes, and streams by controlling sediments in runoff from construction sites greater than 1 acre in area, or those located within 500 feet of a water of the state. Temporary (silt fences) and permanent control measures (such as fully vegetation buffer strips) are employed. The MDEQ, WB, oversees the counties' programs to ensure that they are effectively enforcing SESC regulations.

The Norton Creek TMDL reach is designated as a county drain, managed by the Oakland County Drain Commission. The Oakland County Drain Commissioner and the Michigan Department of Agriculture manage Norton Creek for water quantity and, to a limited extent, for water quality issues.

The Oakland Conservation District serves farmers and landowners in the Norton Creek watershed with conservation planning and erosion control through various programs by providing assistance and educational information related to conservation.

Federal regulations require certain industries to apply for an NPDES permit if storm water associated with industrial activity at the facility discharges into a separate storm sewer system or directly into a surface water. There are 28 industrial facilities with storm water discharge authorization within the Norton Creek watershed. Prior to obtaining permit coverage, applicants must certify that they do not have any unauthorized discharges. MDEQ staff conduct inspections of a percentage of permitted, and all regulated, industrial facilities annually. Inspections are utilized to ensure that facilities comply with the regulations, and result in a further reduction in unauthorized discharges and illicit connections. Additionally, as more facilities obtain industrial storm water permits, more illicit discharges will be eliminated. Within Norton Creek there are eight local jurisdictions that have obtained Phase II MS4 permit coverage (Appendix A). Long-term watershed management plans have been or will be developed under these permits, and implementation of BMPs and other pollution prevention activities are underway.

Among other things, these stormwater permits require:

1. Watershed planning that specifically addresses any TMDLs in the watershed, including identification of priority problems and opportunities (including any TMDL established for a parameter within the watershed that may be affected by storm water).

2. Development of a Storm Water Pollution Prevention Initiative that contains short-term and long-term goals for the watershed (which shall include both the protection of designated uses of the receiving waters as defined in Michigan's WQS, and attaining compliance with any TMDL established for a parameter within the watershed).

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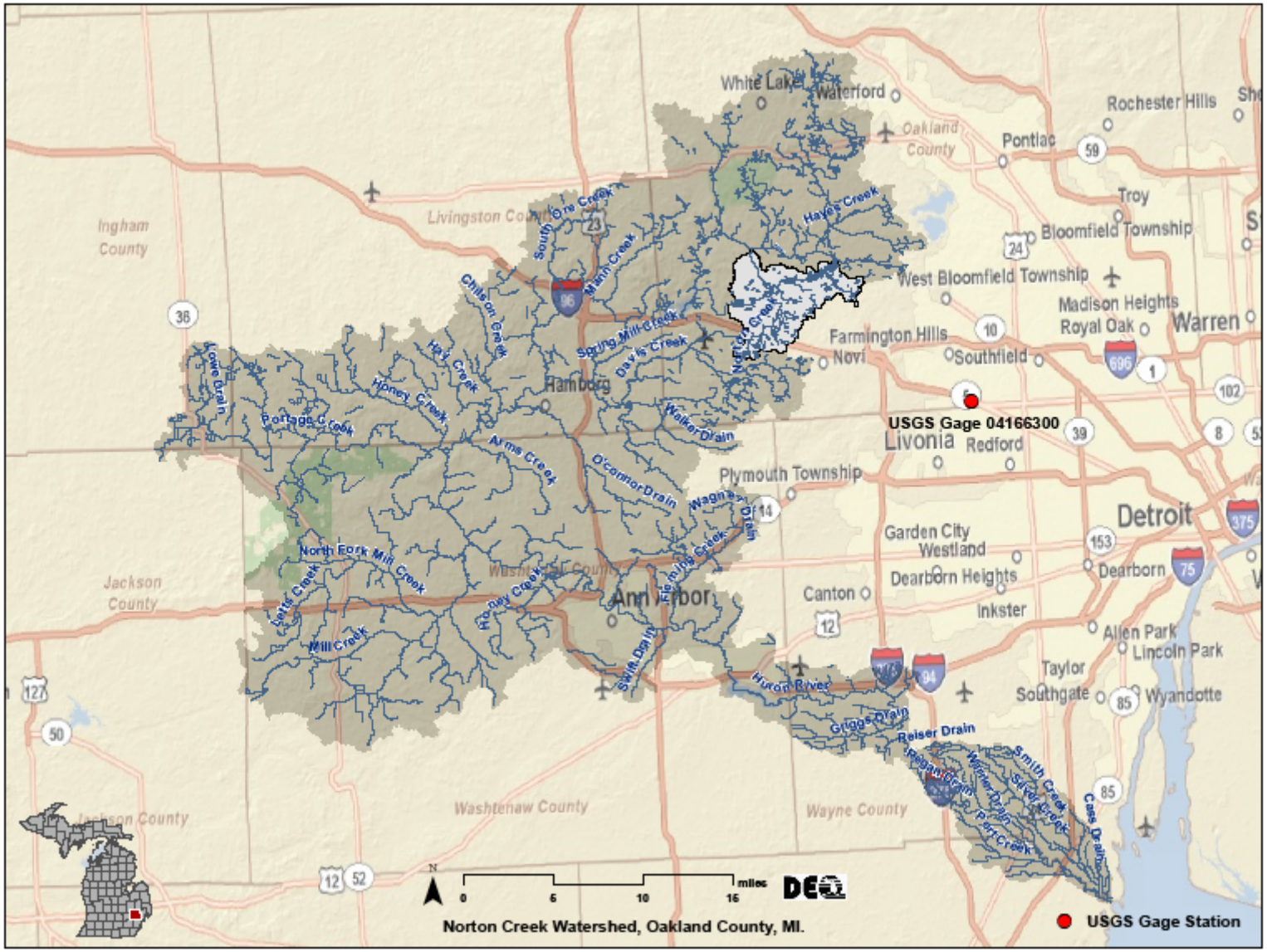

Figure 1. Norton Creek Watershed within Huron River Watershed.

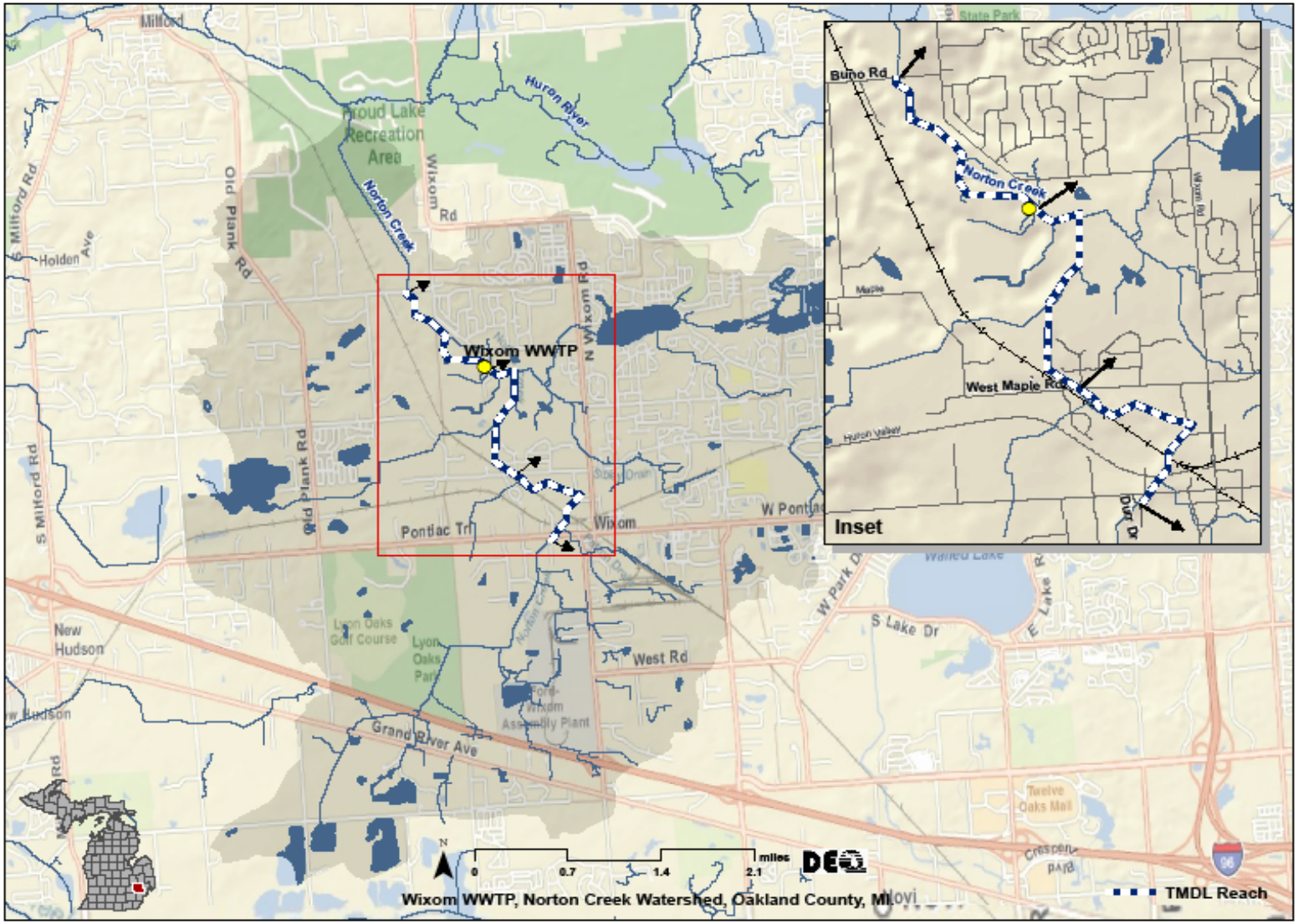

Figure 2. Norton Creek Watershed with TMDL Reach Indicated.

Appendix A. NPDES-Permitted Facilities discharging in the Norton Creek Watershed.

DESIGNATED FACILITY NAME	PERMIT TYPE	PERMIT NO.	CITY OR TWP	REC. WATER
Individual Permits				
Wixom WWTP	Individual	MI0024384	Wixom	Norton Creek
MDOT Statewide MS4	Individual	MI0057364	-	-
Industrial Stormwater				
2V Industries-Wixom	INDSW	MIS410373	Wixom	Norton Crk
American Plastic-Walled Lake	INDSW	MIS410215	Walled Lake	Huron
Atmosphere Heat Treat-Wixom	INDSW	MIS410469	Wixom	Norton Crk
Cadillac Asphalt-Plt 3A-Wixom	INDSW	MIS210392	Wixom	Novi Lyon Drain
Capital Stamping & Machine	INDSW	MIS410443	Wixom	Norton Crk
Chase Nedrow Manufacturing I	INDSW	MIS410667	Wixom	Norton Crk
CSM Manufacturing-Plt 2-Wixom	INDSW	MIS410444	Wixom	Norton Crk
CSX Transportation-Wixom	INDSW	MIS410435	Wixom	Norton Crk
Durr Automation-Wixom	INDSW	MIS410214	Wixom	Norton Crk
Exatec LLC	INDSW	MIS410669	Wixom	Norton Creek
Ford-Wixom Assembly Plt	INDSW	MIS410193	Wixom	Norton Crk
FRIMO Inc	INDSW	MIS410647	Wixom	Norton Crk
Glass & Mirror Craft-Wixom	INDSW	MIS410641	Wixom	Norton Creek
Hawk Tool & Machine-Wixom	INDSW	MIS410474	Wixom	Huron River
Jervis B Webb Co-Wixom	INDSW	MIS210598	Wixom	Norton Crk
Korex Corp-Wixom	INDSW	MIS410190	Wixom	Norton Crk
Mac Valves Inc-Wixom	INDSW	MIS410192	Wixom	Huron River
Matrix Sys Auto-Walled Lake	INDSW	MIS410612	Walled Lake	Mud Lake
Moeller Manufacturing Co Inc	INDSW	MIS410645	Wixom	Walled Lake
NLB Corp	INDSW	MIS410642	Wixom	Huron River
Oaks Concrete Products-Wixom	INDSW	MIS410181	Wixom	Holden Drain
Pascucci Marble & Granite	INDSW	MIS410648	Wixom	Kent Lake
Schupan Recycling-Wixom	INDSW	MIS410630	Wixom	Huron River
Superior Materials LLC	INDSW	MIS210353	Wixom	Novi Lyon Drain
Tiodize/Michigan Inc	INDSW	MIS410629	Wixom	Huron River
TTSI-Wixom	INDSW	MIS410522	Wixom	Norton Crk
UPS-Wixom	INDSW	MIS410194	Wixom	Huron River
Wendt Diacraft	INDSW	MIS410639	Wixom	Norton Crk
General Municipal MS4				
Walled Lake PS MS4-Oakland	MS4	MIS040080	Various	-
Lyon Twp MS4-Oakland	MS4	MIG610034	Various	-
Commerce Twp MS4-Oakland	MS4	MIG610033	Various	-
Walled Lake MS4-Oakland	MS4	MIG610028	Various	-
Wixom MS4-Oakland	MS4	MIG610035	Various	-
Wolverine Lake-Oakland	MS4	MIG610280	Various	-
Oakland Co	MS4	MIG610042	Various	-
Novi-Oakland	MS4	MIG610030	Various	-
Construction Site NOC				
East 20 Ent-Schupan/Tomra/Ubur	CONST	MIR109438	Milford Twp	Huron
MDOT-I-96 at Wixom Rd	CONST	MIR110523	Novi Twp	Norton Crk

Appendix B. Wixom WWTP (MI0024384) Conventional NPDES Permit Limits.

Parameter	Period	Maximum Loading (lbs/day)		Maximum Concentration (mg/l)		
		Monthly	7-day	Monthly	7-day	Daily
$CBOD_5$ (mg/l)	May – Nov.	90	230	4	-	10
	Dec. – March	440	680	19	-	29
	April	350	540	15	-	23
$CBOD_5$ % Removal (minimum)	Year-round	-	-	(report)	-	-
TSS (mg/l)	May – Nov.	470	700	20	30	-
	Dec. – April	700	1100	30	45	-
TSS % Removal (minimum)	May – Nov.	-	-	(report)	-	-
	Dec. – April	-	-	85	-	-
Ammonia Nitrogen (mg/l)	May – Nov.	12	47	0.5	-	2.0
	Dec. – March	(report)	230	(report)	-	10
	April	150	160	6.6	-	7.0
TP (mg/l)	Year-round	1800	-	0.4	-	-
D.O. (min., mg/l)	Year-round	-	-	-	-	6.0

Indicated permit limits apply at current facility design flow of 2.8 MGD.