Michigan Department of Environmental Quality
Water Bureau
August 2006

Total Maximum Daily Load for Dissolved Oxygen for Berry Drain Sanilac 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. The 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 Berry Drain near Sandusky (Figures 1 and 2), and to quantify reductions in these sources necessary for attainment of the WQS. Berry Drain and its tributaries in the vicinity of Sandusky are designated as warmwater streams with a D.O. standard of 5 milligrams per liter (mg/l) as a minimum.

The Berry Drain D.O. TMDL reach is located in Sanilac County and is highlighted in Figure 2. Table 1 defines the extent and length of the reach. Note that the reach start location begins at the downstream portion of the reach, while the end location is upstream. A total of 7 river miles are addressed by the TMDL. Berry Drain and its tributaries are maintained straight-cut agricultural drains.

Table 1. Berry Drain D.O. TMDL Reaches.

Water Body	Reach Start	Reach End	Distance (mi.)
Berry Drain	Confluence with Black River (T12N, R15E, Section 19 of Sanilac County)	Stoutenberg Road (T11N, R14E, Section 4 of Sanilac County)	7

Berry Drain has a drainage area of approximately 30 square miles at its confluence with the Black River (Figure 2). Summer season 50 percent (%) and 95% exceedance flows (cubic feet per second [cfs]) for Berry Drain at this location are 1.3 cfs and 0.4 cfs, respectively. Berry Drain low flows were computed from historic data collected at a United States Geological Survey gage, Black River near Fargo, Michigan (Gage Number 04159500).

PROBLEM STATEMENT

The Berry Drain TMDL reach appears on the 2006 Section 303(d) list (Wolf & Wuycheck, 2006) as:

BERRY DRAIN WBID#: **061506A**
County: SANILAC HUC: 4090001 Size: 7 M
Location: Black River confluence u/s to Stoutenberg Road.
Problem: WQS exceedances for D.O.; Nuisance plant growths, phosphorus; macroinvertebrate community rated poor.
TMDL Year(s): 2006 2014 RF3RchID: 4090001 000

This TMDL addresses only the D.O. standard nonattainment in Berry Drain and its tributaries near and below Sandusky.

D.O. monitoring was performed on Berry Drain in the vicinity of Sandusky from June through July 2002 (Trapp, 2005). D.O., temperature, pH, and conductivity were continuously monitored just downstream of the Sandusky Wastewater Treatment Plant (WWTP) outfall near M-46 and at Berkshire Road (Figure 2). Additional data were collected by grab sampling from the stream at the two continuous monitoring stations, by grab sampling from relevant tributaries, and by grab sampling from the Sandusky WWTP effluent. The study revealed warmwater D.O. standard nonattainment and high D.O. diurnal variations in Berry Drain. D.O. concentrations measured at the continuous monitoring site just upstream of M-46 were below the 5 mg/l minimum warmwater D.O. standard 13 out of 13 days of valid data collection. Berkshire Road D.O. concentrations were below the warmwater D.O. standard 16 out of 17 days. A review of the temporal profiles at the two continuous monitoring stations and the WWTP effluent and in-stream background quality suggested that aquatic plants and algae in Berry Drain during high temperature, low flow times enhanced D.O. diurnal variations. The diurnal D.O. variation (average minus minimum concentration) in Berry Drain at Berkshire Road averaged 6.7 mg/l during the study period. The Surface Water Assessment Section (SWAS) assumes a typical unpolluted warmwater stream diurnal variation to be approximately 1 mg/l, based on examination of many D.O. surveys' data. Extremely dense macrophyte growth was observed throughout Berry Drain and its tributaries in 2002. Such growths were not observed in 2004 and 2005.

Follow-up monitoring in Berry Drain and selected tributaries was conducted in the summer of 2005 (Limno-Tech DRAFT, 2005). This study was intended to further delineate reaches having D.O. standard nonattainment. A total of four days, two during dry weather (Table 2) and two during wet weather (Table 3), were monitored. Instantaneous D.O. measurements were taken in the early morning and late afternoon at the locations listed in Tables 2 and 3. Of eight locations monitored, only one showed consistent D.O. standard attainment during the survey (Stone Drain at Stoutenberg Road).

Table 2. Dry Weather D.O. Measurements, Berry Drain and Select Tributaries.

Event	**DRY**		**DRY**	
Date	**7/21/2005**		**8/24/2005**	
	Dissolved Oxygen (mg/l)		**Dissolved Oxygen (mg/l)**	
Location	Morning	Afternoon	Morning	Afternoon
1 - Badgero Dr	6.06	6.72	5.19	5.33
2 – Unnamed Dr at Gates Rd	Dry	Dry	Dry	Dry
3 - Dwight Dr at Custer Rd	0.52	8.70	0.83	2.05
4 - Dwight Dr at Sandusky Rd	3.25	11.75	5.04	12.92
5 - Dwight Dr at Stoutenberg Rd	4.61	11.38	6.52	8.44
6 - Stone Dr at Stoutenberg Rd	7.88	18.10	5.60	13.21
7 - Berry Dr at Custer Rd	4.90	17.36	4.85	10.05
8 - Fye Dr at Rangeline Rd	Not sampled		4.00	11.65

- Shaded cells indicate D.O. concentrations below the WQS of 5 mg/l minimum

Table 3. Wet Weather D.O. Measurements, Berry Drain and Select Tributaries.

Event Date	WET 9/8/2005		WET 9/14/2005	
	Dissolved Oxygen (mg/l)		Dissolved Oxygen (mg/l)	
Location	Morning	Afternoon	Morning	Afternoon
1 - Badgero Dr	2.73	2.67	0.99	1.95
2 - Unnamed Dr at Gates Rd	Dry	Dry	Dry	Dry
3 - Dwight Dr at Custer Rd	0.53	0.65	1.41	0.62
4 - Dwight Dr at Sandusky Rd	4.32	10.68	3.53	8.63
5 - Dwight Dr at Stoutenberg Rd	6.21	7.12	5.47	6.46
6 - Stone Dr at Stoutenberg Rd	7.86	10.71	7.18	9.33
7 - Berry Dr at Custer Rd	4.43	18.30	3.26	16.20
8 – Fye Dr at Rangeline Rd	5.13	13.28	1.25	7.84

- Shaded cells indicate D.O. concentrations below the WQS of 5 mg/l minimum

Qualitative biological surveys (MDEQ, 2002) were performed in 2002, 2004, and 2005 (Schmitt, 2005). In 2002, sampled reaches exhibited nuisance conditions of algae (cladophora) and rooted submergent vegetation. Rooted submergent vegetation was abundant at nuisance levels throughout the reaches. The 2004 visit found nuisance growths of algae (cladophora) at only one sampled location, while the 2005 surveys found no sampled locations with nuisance plant growth. The biosurvey report (Schmitt, 2005) concluded that the macroinvertebrate community, habitat quality, and water chemistry data indicate that Berry Drain is not attaining the warmwater aquatic life WQS. A TMDL is scheduled to address this impairment in 2014. Land use practices have necessitated channelization of Berry Drain and changed the habitat quality from its headwaters to the confluence with the Black River. Poor macroinvertebrate communities could be a result of the less than ideal available habitat found immediately downstream of the Sandusky WWTP.

The 2005 monitoring revealed that there are additional reaches in Berry Drain and its tributaries near Sandusky which are appropriate for inclusion in this TMDL due to D.O. standard nonattainment. The stream reaches of each of the 8 locations in Tables 2 and 3 are included in the D.O. TMDL reach with the exceptions of the reach of location 2 (unnamed drain at Gates Road) which was dry during the 2005 sampling, and the reach of location 6 (Stone Drain at Stoutenberg Road) which was in attainment of the D.O. standard during sampling. The additional nonattaining reaches will be reflected in the 2008 303(d) list and integrated report.

NUMERIC TARGETS

Rule 323.1100 of the Part 4 WQS 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 use for Berry Drain addressed by this TMDL is the warmwater fish and other indigenous aquatic life and wildlife use. 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 is 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(10) or during those periods when the standards specified in subrule (2) of this rule apply.

…(2) 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. For existing point source discharges to these waters, the Director of 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. If existing point source dischargers demonstrate to the Director of 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 Director of the Department and orders, permits, or other actions necessary to implement the approved plans have been issued by the Director of the Department. In the interim, all of the following standards apply:

…(b) For 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(4), 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 Director of 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 Director of the Department may amend a comprehensive plan for cause. In undertaking the comprehensive planning effort the Director of 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 Director 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.

This TMDL will be considered the Comprehensive Plan for this water body referred to in Rule 64(3).

SOURCE ASSESSMENT

Potential sources of D.O. demanding pollutants, such as carbonaceous biochemical oxygen demand (CBOD), ammonia nitrogen, sediments (expressed as total suspended solids or TSS), and

(indirectly) nutrients include point 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 decay process is known as sediment oxygen demand (SOD) and is exacerbated by inputs of TSS. Nutrients such as phosphorus and nitrogen can stimulate plant growths, which in turn can reduce D.O. levels through respiration. These nutrients are often adsorbed onto solids, which can enter waterways during wet weather events as TSS. Sorbed phosphorus can then enter the water column through biochemical processes (Chapra, 1997).

There are four individual National Pollutant Discharge Elimination System (NPDES) permitted discharges and one nonstorm water general permitted discharge to Berry Drain Watershed in the vicinity of Sandusky. The individual permits include the Michigan Department of Transportation's (MDOT's) statewide permit covering storm water (MI0057364). There are four facilities with certificates of coverage under the general industrial storm water permit and two construction sites with notices of coverage authorizing discharge of storm water in the vicinity of Sandusky. See Appendix A, Tables A.1 through A.3 for a listing of all NPDES permittees discharging to the TMDL reach. Figure 2 indicates the location of individual, general storm water discharges and construction sites. Of all of these facilities, one (the Sandusky WWTP) is known to be a relatively significant point source of conventional pollutants in the TMDL reach.

The Sandusky WWTP (MI0020222), with a design flow of 0.445 million gallons per day (MGD), is permitted to continuously discharge treated municipal wastewaters from outfall 001 to Berry Drain in Section 4, T11N, R14E of Watertown Township, Sanilac County. See Table B.1 of Appendix B for the Sandusky WWTP current NPDES permit conventional parameter effluent limits. The facility's current NPDES permit, issued October 1, 2005, requires advanced waste treatment (AWT) limits from March through December. 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 biochemical oxygen demand (BOD) decay rates and high ultimate biochemical oxygen demand to BOD_5 ratios (Chapra, 1997; MDEQ, 1995).

In June of 2005, the Sandusky WWTP entered into an Administrative Consent Order with the Michigan Department of Environmental Quality (MDEQ), Water Bureau (WB), to upgrade its treatment facilities. This Consent Order resulted from numerous violations of ammonia nitrogen and D.O. NPDES permit limits. The Sandusky WWTP is currently making a $6 million dollar investment into improving treatment at the facility. Construction of the expanded and improved facility is expected to be completed by October 31, 2007. The current NPDES permit issued August 10, 2005, contains limits for pre- and post-construction facilities. The conventional parameter limits listed in Table B.1 are in effect until the construction complete date. Once construction is completed, the Sandusky WWTP will have a design flow of 0.95 MGD and will have the conventional limits listed in Table B.2.

From July through September of 2005, the period of the 2005 D.O. and water chemistry monitoring, the Sandusky WWTP effluent had average $CBOD_5$ and ammonia concentrations of 3.1 mg/l and 0.11 mg/l, respectively, according to facility Discharge Monitoring Reports (DMRs). Reported daily maximum $CBOD_5$ and ammonia concentrations were 9.4 mg/l and 1.31 mg/l. The facility reported effluent D.O. levels below the summer permit limit of 7 mg/l minimum for each month, with minimum concentrations ranging from 3.2 to 3.6 mg/l. The TP concentrations averaged 0.51 mg/l. The city of Sandusky has no known combined sewer or sanitary sewer overflows, and none have been known to exist in the past.

Trelleborg YSH Inc-Sandusky (MI0028142) is permitted to discharge 0.3 MGD of treated groundwater, noncontact cooling water, and cooling tower blowdown from outfall 001 to Stone Drain in Section 32, T12N, R14E of Sanilac County. Stone Drain is a tributary to Dwight Drain in

Section 33, T12N, R14E of Sanilac County. This facility's NPDES permit contains no D.O.-related conventional parameter limits, aside from a year-round daily minimum effluent D.O. limit of 6 mg/l which the facility meets consistently. This facility's discharge is not expected to contain D.O. demanding pollutants. See Table B.3 for this facility's NPDES permit limits.

Bay Houston-MI Peat-Sandusky (MI0054453) is permitted to discharge 2.7 MGD of peat mining dewatering water from outfall 002 to Berry Drain in Section 2, T11N, R14E of Sanilac County, approximately 1.6 miles downstream of the Sandusky WWTP discharge. This facility's NPDES permit contains no D.O.-related conventional parameter limits. This facility's discharge is not expected to contain significant amounts of D.O. demanding pollutants. Note that this facility also discharges to Smalldon Drain via outfall 001. Smalldon Drain is not a tributary to the Berry Drain D.O. TMDL reach. WB district staff indicate that Bay Houston-MI Peat-Sandusky will cease discharge by 2009. All pollutant loads to Berry and Smalldon Drains from that facility are expected to be eliminated by that date. Table B.4 contains this facility's NPDES permit limits.

There is one facility discharging to the TMDL reach under the wastewater stabilization lagoon (WWSL) general permit (MIG580000). The Sunset Mobile Home Park (MHP)-Custer Twp WWSL (MIG580320) is authorized to discharge 4.0 million gallons per year (MGY) of treated sanitary wastewater seasonally (October through December and March through May) to Badgero Drain via an unnamed tributary in Section 31, T12N, R14E, of Sanilac County. Badgero Drain is a tributary to Dwight Drain in Section 33, T12N, R14E of Sanilac County. See Table B.5 for the discharge limits for the WWSL general permit under which the Sunset MHP-Custer Twp WWSL discharges. The Sunset MHP-Custer Twp WWSL did not need to be included in the most recent waste load allocation (WLA) for the Sandusky WWTP effluent limit development due to its seasonal discharge and relatively small pollutant load contribution. This WWSL does not discharge during critical periods of low stream flows and high temperatures and did not discharge during the 2005 monitoring conducted on Berry Drain.

Table 4 contains permitted daily conventional pollutant loads for the listed primary point sources. The loads are calculated from the facilities' monthly NPDES permit load limits. For parameters not limited by load, daily loads were estimated from concentration permit limits or estimates of effluent concentrations, and the facility design flows. Note that the facilities may, in fact, be discharging significantly lower loads of these pollutants than they are permitted to discharge. Loads from facilities that do not monitor for the listed parameters were estimated from the daily design flow and the following assumed discharge concentrations (typical of unpolluted ambient surface waters [MDEQ, 1995; Wuycheck, 2003]): $CBOD_5$, 2 mg/l; TSS, 30 mg/l; ammonia nitrogen, 0.1 mg/l; and total phosphorus, 0.1 mg/l. While Bay Houston-MI Peat-Sandusky does have TSS concentration limits, its daily TSS load was estimated using DMR data as its permitted discharge rate is vastly larger than its actual discharge to Berry Drain. Effluent concentrations of TSS are also much lower than the permit limits. This is demonstrated by facility DMRs which indicate long-term periods of no discharge to Berry Drain. DMRs from 2005 show flows to Berry Drain of 0.004 to 1.3 MGD as monthly averages, with 5 months having no flow at all to Berry Drain. Reported TSS levels ranged from 0 to 21 mg/l when discharge occurred. Using a yearly average flow of 0.6 MGD and an average TSS concentration of 11 mg/l during periods of actual discharge, a total daily load of 0.8 lbs/d is calculated. Using the permit limit of 30 mg/l as a monthly average, and the design flow of 2.7 MGD, a vastly larger daily load of 670 lbs/d is calculated. Other Bay Houston conventional pollutant daily loads are based on the above concentrations typical of unpolluted surface waters and the actual discharge rate to Berry Drain, rather than the permitted flow rate. Note again that this facility will cease discharge by 2009.

Table 4. Berry Drain Nonstorm Water Permitted Point Source Conventional Pollutant Loadings.

Daily Load (lbs/d)	Sandusky WWTP	Bay Houston-MI Peat-Sandusky	Trelleborg YSH Inc-Sandusky	Sunset MHP-Custer WWSL
$CBOD_5$	41.1	0.4 *	5.5 *	2.7
TSS	158.9	0.8	74.0 *	5.5
Ammonia nitrogen	21.9	0.2 *	0.2 *	0.8
Total phosphorus	5.5	0.2 *	2.5	0.1

* - Facility not required to monitor for the listed parameters. Loads are estimated.

Table 5 contains estimates of Berry Drain conventional pollutant loads from existing industrial storm water permitted facilities (Table A.2) and areas under the statewide MDOT storm water permit. Storm water loads in Table 5 were estimated based on commercial and transportation land use data contained in the Long-Term Hydrologic Impact Assessment (L-THIA) web-based software created and maintained by Purdue University and USEPA (Purdue University and USEPA, 2001). This geographic information system-based application uses the event mean concentration (EMC) and curve number (CN) procedures to calculate daily pollutant loads based on land use, soil type, and meteorological data. The L-THIA application is supported by staff of USEPA, Region 5.

Table 5. Estimated Berry Drain Conventional Pollutant Loads, Construction Sites, and Industrial and MDOT Storm Water Permittees.

Daily Load (lbs/d)	Industrial Storm Water Permittees (from commercial land use data)
BOD	24.7
TSS	57.5
Total Nitrogen	1.4
Total Phosphorus	0.3

Potential NPS of pollutants were evaluated based on land uses in the drainage basin (Table 6). Land use proportions were derived using the L-THIA application. It is possible that the urban land use proportions (e.g., commercial and residential) are in fact higher than indicated in Table 6 due to increased residential development. Note that the WB district staff indicate no knowledge of concentrated animal feeding operations or problematic agricultural operations in the affected basins.

Table 6. Berry Drain Basin Land Use Categories as Percentages at the Confluence with the Black River.

Land Use Category	Percent Land Use Category
Water	6.7
Commercial	0.7
Agriculture	74.5
High density residential	0.7
Low density residential	1.8
Transportation	0.3
Grass / pasture	7.1
Forest	8.2

Biosurveys and D.O. monitoring indicate that certain pollutants contribute toward D.O. standard nonattainment in Berry Drain near Sandusky. Land use-related inputs of various oxygen demanding pollutants likely contribute toward D.O. standard nonattainment through SOD, and especially respiration from very abundant plant growths observed in 2002.

In this TMDL, storm water permitted facilities, including those under the statewide MDOT permit, and construction sites with notices of coverage (commercial and transportation land uses) are referred to as NPDES land uses. Land uses without NPDES discharge authorization are referred to as nonNPDES land uses (e.g., forest).

Estimates of all land use-related daily loads, from both NPDES and nonNPDES land uses, of BOD ($CBOD_5$ + nitrogenous BOD), TSS, TP, and total nitrogen to Berry Drain near Sandusky were estimated using the L-THIA application. Estimates of these loads appear in Table 7 and represent pollutant loads to the TMDL reach in addition to those generated by the facilities in Table 4. The loads in Table 7 include those to Berry Drain and all of its tributaries. These estimates are based on nonsite-specific data and represent a best approximation using software default EMC and CN values. The land use Berry Drain pollutant loadings in Table 7 include the estimated loads from storm water permitted facilities and construction sites as described in Table 5.

Table 7. Estimated Daily Total Land Use-Related Conventional Pollutant Loads to Berry Drain at its Confluence with the Black River, Including Storm Water Permitted Facilities and Construction Sites.

Pollutant	Daily Load (lbs/d)
BOD	120.5
TSS	2,140
Total nitrogen	87.7
TP	24.7

In accordance with USEPA guidelines regarding NPDES land use runoff, runoff from construction sites with certificates of coverage and Industrial storm water permitted facilities will be considered in the WLA portion of the TMDL. Note that there are no municipalities in the drainage area of concern that are subject to Phase II storm water permits.

LINKAGE ANALYSIS

The observed D.O. standard nonattainment in Berry Drain can be attributed to a number of factors. These factors were assessed using mathematical D.O. models of the reaches 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 the TMDL as it can represent the system without being unnecessarily complex or too data-intensive. The model is based on a D.O. model of Berry Drain that has been used to developed water quality-based effluent limits for the Sandusky WWTP's NPDES permit. Modeling was conducted in accordance with guidance described in the SWAS Procedure 80 (MDEQ, 1995). The models were calibrated to data collected in the summer of 2005. River surveys and D.O. modeling have revealed that plant respiration is the major sink of D.O. in Berry Drain. SOD plays a less significant role in the D.O. problem in the TMDL reaches.

Plant Respiration: The presence of aquatic plants in a water body can have a very significant affect 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.

Phosphorus is an important nutrient of concern in aquatic systems such as Berry Drain and its tributaries. Phosphorus can exist in dissolved forms and particulate forms sorbed to solids expressed as TSS. 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 contributed by inputs of TSS, can be released as dissolved phosphorus under certain conditions, contributing to increased plant growth. Solids that runoff of land into water bodies or that are discharged directly to a stream have particulate phosphorus associated with them. Substantial loads of TSS can therefore result in substantial inputs of phosphorus available for plant use in a stream. The relationship between TSS and total phosphorus is well documented in research literature (Havlin, 2003; Sharpley et al., 1992). Such a relationship has also been documented by past WB efforts (Suppnick, 1996).

As a straight-cut maintained agricultural drain, Berry Drain's riparian vegetation has been removed, and row crops generally are planted and fertilized to the edge of the channel. Conditions of 0% shade exist except for an approximately 1000 foot reach of Berry Drain upstream of its confluence with the Black River. There, conditions of approximately 50% shade are present due to the growth of tall shrubs and some trees (Schmitt, 2005). The conditions of little or no shade, farming to the edge of the stream, and the existence of drainage tiles create ideal conditions for nuisance plant growth in the Berry Drain drainage area, although widespread nuisance growths have not been observed since 2002. Sediment and nutrients enter the channels via overland runoff in the absence of riparian vegetation, and can also enter the channel quickly through field drainage tiles. Sunlight enters the channel unimpeded. The resulting heavy plant growth causes high rates of photosynthesis and respiration. Based on the 2005 and past river surveys and D.O. modeling, D.O. standard nonattainment in Berry Drain appears primarily due to plant respiration. Very high D.O. diurnal variations were measured in 2005, and early morning D.O. standard nonattainment was found in Berry Drain and its tributaries (LimnoTech DRAFT, 2005).

SOD: Solids 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 deposit in direct contact with the water can undergo aerobic decomposition. This process causes diffusion of D.O. from the water column into the sediment layer, depleting D.O. levels in the overlying river water. High levels of TSS in a water body can potentially cause high SOD rates if the solids settle to the bottom and decompose.

River substrates in the reaches sampled in 2004 and 2005 (LimnoTech DRAFT, 2005; Schmitt, 2005) were generally observed to be silty, mucky, and organic in nature. Such substrates are likely due mostly to sediments in runoff from adjacent agricultural fields, urban lands in the city of Sandusky, and effluent from the Sandusky WWTP. Sampling locations in Dwight, Badgero, Fye, and Stone Drains, which receive no discharge from the Sandusky WWTP and much less or no known runoff from the city of Sandusky, were also very silty, indicating that WWTP effluent and urban runoff are not the primary sources of sediments in the drainage area. Note that SOD and sediment deposits are typically highly variable spatially and temporally due to varying flow regimes affecting deposition and scour (Bowie et al., 1985).

TMDL DEVELOPMENT

The TMDL represents the maximum loading of oxygen demanding substances (e.g., sediments), or other parameters that can indirectly cause oxygen demand (e.g., 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. The TMDL development also defines the environmental conditions that will be used when defining allowable levels.

The "critical condition" is defined as the set of environmental conditions that, if controls are designed to protect, will ensure attainment of objectives for all other conditions. For example, the critical conditions for the control of point sources in Michigan are given in R 323.1082 and R 323.1090 of the Michigan WQS. 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).

D.O. models were used to quantify reductions in river D.O. sinks necessary to attain the D.O. standard at critical conditions as described in this TMDL's Margin of Safety discussion. Calibration data show that along the entire 7 mile D.O. TMDL reach of Berry Drain, on average, SOD is responsible for approximately 26% of the D.O. deficit at design conditions, while plant respiration is responsible for approximately 74% of the deficit. Loads of oxygen demanding substances from the Sandusky WWTP are assumed to exert no direct D.O. demand in-stream as the discharge is at stable effluent AWT permit limits 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 Berry Drain exhibit a similar SOD to respiration D.O. deficit ratio as they drain lands similar in use to Berry Drain and show similar amounts of plant growth and sedimentation.

In order to decrease SOD and nutrient loads, the loading of suspended solids to the drain system 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 that of Berry Drain. Wet weather sampling conducted in development of the Grand and Portage Rivers at Jackson D.O. TMDL (Sunday, 2003) showed that except for one wet weather event, TP 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. Suspended solids reduction is therefore the best overall strategy to improve D.O. in the stream.

ALLOCATIONS

The TMDLs are comprised of the sum of individual WLAs for point sources and load allocations (LAs) for NPS and natural background levels. In addition, the TMDL 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:

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

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

The calibrated O'Connor-DiToro D.O. model was used to simulate Berry Drain D.O. concentrations at critical design conditions. Under these conditions, D.O. modeling indicates that plant respiration and SOD must be reduced by approximately 40% to 80%, depending on the individual TMDL

reaches being modeled, to attain the D.O. standard. Therefore, this TMDL targets an overall TSS daily load reduction of 60% in both NPDES and nonNPDES land use-related TSS loads to Berry Drain in the vicinity of and below Sandusky. Modeling indicates that an overall 60% TSS load reduction will result in DO standard attainment in all TMDL reaches, as water quality improvements in less severely nonattaining reaches will directly improve water quality in more severely nonattaining reaches.

Table 8 contains total estimated existing TSS loads to Berry Drain at its confluence with the Black River. This TMDL will focus on NPDES and nonNPDES land use TSS load reductions, as monitoring data and load estimates indicate that land use-related pollution is the primary cause of D.O. standard nonattainment in the affected reaches. Land use TSS loads include those from industrial storm water permittees, which will be treated as point sources in the WLA. Industrial storm water discharges were assumed to comprise 100% of the commercial land uses in the Berry Drain drainage area at its confluence with the Black River (0.7% of the total Berry Drain basin land cover at that point) in order to compute land use-related TSS loads.

WLAs

The D.O. standard nonattainment in the relevant water bodies has been documented during the summer months only. During the summer months (May through September), the most potentially significant point source of oxygen demanding substances to nonattaining reaches, the Sandusky WWTP, is required by its NPDES permit to treat its effluent at AWT limits. These effluent limits are the most restrictive limits which the state of Michigan imposes on municipal wastewater treatment facilities, and effluent of this quality is considered to exert no oxygen demand in-stream (stable effluent). Further reductions in conventional pollutants (CBOD, ammonia nitrogen, and TSS) from this facility will not impact D.O. levels in the critical summer months. The high levels of treatment required by the Sandusky WWTP's NPDES permit lead to high conventional pollutant removal rates throughout the year.

See Table 8 for proposed WLAs and LAs for Berry Drain. No reductions in municipal wastewater treatment facility (WWTP or WWSL) point source loadings are proposed for this D.O. TMDL's WLA for the individual NPDES permit or nonstorm water general permitted facilities. The TSS loads from these facilities are allocated as described in Appendix A, Table A.4.

All NPDES land use-related loads, with the exception of those from MDOT facilities, have been reduced by 67% in both the WLA (industrial storm water permittee loads, attributed to commercial land uses) and the LA (all noncommercial and land use loads) as compared to existing loads outlined in Table 8. This 67% reduction in NPDES land use-related loads is necessary to achieve a 60% reduction in the overall TSS loads to Berry Drain. The WLA includes TSS loads from construction sites with certificates of coverage. No TSS load reduction is targeted for the statewide 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, specifically, M-46, alternately called Sandusky Road.

Table 8. Daily TSS Load Source Allocations and Numeric Targets - Berry Drain at its Confluence with the Black River.

Water Body	Current Daily TSS Load (lbs)	Daily TSS Load Numeric Target (lbs)	WLA Daily TSS Load (lbs)	LA Daily TSS Load (lbs)
BERRY DRAIN:				
Industrial Storm Water Permitted Outfalls*	57.5	19.2	19.2	-
Land Use Related Sources**	2,082	693.2	-	693.2
Existing Individual/General NPDES Permitted Facilities	238.4	238.4	238.4	-
Totals:	2,378			
Daily TSS Load Numeric Target To D.O. TMDL Reach	-	950.7	257.5	693.2

* Primarily attributed to commercial land uses in the city of Sandusky.

** Attributed to noncommercial land uses in the townships of Bridgehampton, Custer, Elmer, Moore, and Watertown.

LAs

TSS inputs resulting from land use-related sediment loads will be the primary targets for reduction in Berry Drain in this TMDL. Table 8 lists the land use source LAs for Berry Drain. The LA values in Table 8 do not include land use loadings due to industrial storm water permittees discharging to the rivers, as those loads are addressed in the WLA. In order to achieve an overall TSS load reduction of 60%, existing TSS loads from industrial storm water permittees and other land use related sources classified as nonurban and not covered under storm water permits have been reduced by 67%. Lands contributing TSS loads to Berry Drain are located in the townships of Bridgehampton, Custer, Moore, Elmer, and Watertown.

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 SWAS effluent limit coordination Procedure 15. 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 Sandusky 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 Berry Drain. Modeling of Berry Drain in other seasons using appropriate 95% exceedance low flows and 90% occurrence temperatures shows no predicted instances of D.O. standard nonattainment. However, the very large diurnal variations documented in Berry Drain may persist into the fall season, possibly leading to early morning D.O. standard nonattainment. The reduction in TSS loads and resulting reduction in phosphorus loads recommended in this TMDL should result in decreased plant activity, D.O. diurnal variations, and SOD in Berry Drain during all seasons.

MONITORING

Future monitoring will be conducted to assess whether activities implemented under the TMDL result in water quality improvements. This monitoring will be conducted as resources allow. Typically, the 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. Monitoring during the fall season may be included to assess standard attainment during that season. Wet weather pollutant load sampling may aid in directing future efforts towards specific areas contributing significant NPS loads.

REASONABLE ASSURANCE ACTIVITIES

Under the NPDES Permit Program, point sources in the vicinity of Sandusky are responsible for meeting their effluent limits for oxygen demanding substances. Compliance is determined based on review of DMR data by the MDEQ. Violations of the Sandusky WWTP's effluent D.O. limit will be addressed by increased treatment provided by the expanded facility.

The Southeast Michigan Council of Governments is involved in Berry Drain and Black River water quality issues through the Macomb-St. Clair Intercounty Watershed Advisory Group. The activities of this group focus on improving water quality in Lake St. Clair by improving water quality in streams draining to the lake and the St. Clair River, such as the Black River. The group's initiatives include the development of watershed management plans, sedimentation reduction, and minimization of land use impacts through storm water control.

The Sanilac County Conservation District (SCCD) is in the process of applying for a CWA Section 319 watershed planning grant for the Black River. Under this program, the SCCD will develop and published a regional Black River Watershed Management Plan (MDEQ, 2000). The plan will identify and evaluate water quality and land use concerns, and recommend and

implement remedies. Public education, volunteer monitoring, and other stewardship activities will be part of the watershed planning process. Specific management recommendations for tributaries or sub-basins under the regional watershed plan may be developed. The MDEQ, WB, reviews and approves each watershed plan developed under Section 319 grants. Certain elements must be included in each plan in order to gain MDEQ approval. Ultimately, the watershed planning process will result in the creation of a stable organization for the planning and management of watershed activities, such as a watershed council. Such an organization will include representatives of numerous local agencies and stakeholders groups. The WB will work with these entities to ensure effective implementation of the TMDL.

The Berry Drain TMDL reaches are designated as a county drain, managed by the Sanilac County Drain Commission. The drain commissioner of Sanilac County and the Michigan Department of Agriculture, manage Berry Drain for water quantity and, to a limited extent, for water quality issues.

Sanilac County administers the National Resources and Environmental Protection Act's Part 91, Soil Erosion and Sedimentation Control (SESC) Program. This program aims to reduce sedimentation 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.

Prepared by: Erik Sunday
Surface Water Assessment Section
Water Bureau
Michigan Department of Environmental Quality
August 28, 2006

REFERENCES

Bowie, B.L., W.B. Mills, D.B. Porcella, C.L. Campbell, J.R. Pagenkoph, G.L. Rupp, K.M. Johnson, P.W.H. Chan, S.A. Gherini, and C.E. Chamberlin. 1985. Rates, Constants, and Kinetic Formulations in Surface Water Quality Modeling. USEPA, ORD, Athens, GA, ERL, EPA/600/3-85/040.

Chapra, S.C. 1997. Surface Water Quality Modeling. McGraw-Hill. New York.

Havlin, J.L. 2004. Technical Basis for Quantifying Phosphorus Transport to Surface and Groundwaters. Journal of Animal Science, ASAS 82(E. Suppl.):E277-E291.

Limno-Tech, DRAFT. 2005. DRAFT Berry Drain Water Quality Monitoring Study. MI/DEQ/SWQ-05/15.

MDEQ. 1995. Great Lakes and Environmental Assessment Section. Procedures Manual, Vol. II. Procedure 80: Guidance on WQBEL Recommendations for Oxygen Demanding Substances. WB, MDEQ.

MDEQ. 2000. Developing a Watershed Management Plan for Water Quality: An Introductory Guide. WB, MDEQ.

MDEQ. 2002. Great Lakes and Environmental Assessment Section. Procedures Manual, Vol. II. Procedure 51: Qualitative Biological and Habitat Survey Protocols For Wadable Streams and Rivers. WB, MDEQ.

O'Connor, D.J. and D.M. DiToro. 1970. Photosynthesis and Oxygen Balance in Streams. Journal of the Sanitary Engineering Division, ASCE 96(2): 547-571.

Purdue University and USEPA. 2001. Long-Term Hydrological Impact Assessments (L-THIA) Web site, January 12, 2006. https://engineering.purdue.edu/~lthia/

Schmitt, G. 2005. Biological Survey of Berry Drain, Sanilac County, Michigan, September 21, 2004 and August 22, 2005.

Sharpley, A.N., S.J. Smith, O.R. Jones, W.A. Berg, and G.A. Coleman. 1992. The Transport of Bioavailable Phosphorus in Agricultural Runoff. Journal of Environmental Quality. 21:30-35.

Sunday, E. 2003. Total Maximum Daily Load for Dissolved Oxygen for the Grand River, Jackson County. MDEQ, WB.

Suppnick, J. 1996. Informational Total Daily Maximum Load for Dissolved Oxygen in Sycamore Creek. MI/DEQ/SWQ-96/049.

Wolf, S. and J. Wuycheck. 2006. Water Quality and Pollution Control in Michigan: Sections 303(d) and 305(b) Integrated Reports. MDEQ, WB.

Trapp, D. 2005. Berry Drain at Sandusky Dissolved Oxygen Study, June – July 2002. MDEQ, WB. MI/DEQ/WB-05/105.

Wuycheck, J. February 12, 2003. Personal Conversation.

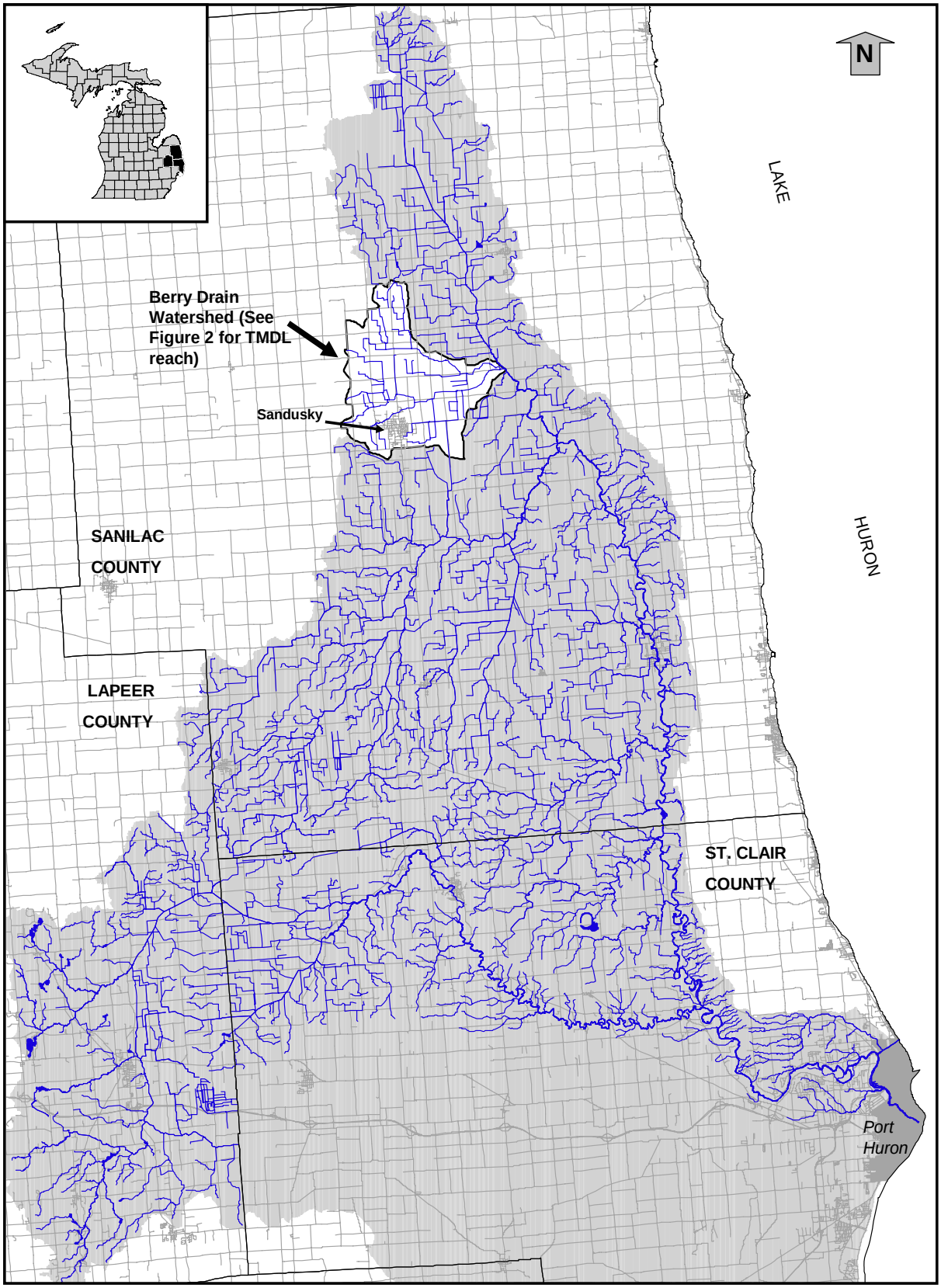

Figure 1: Black River Watershed (HUC 04090001), Lapeer, Macomb, Sanilac, and St. Clair Counties, Michigan.

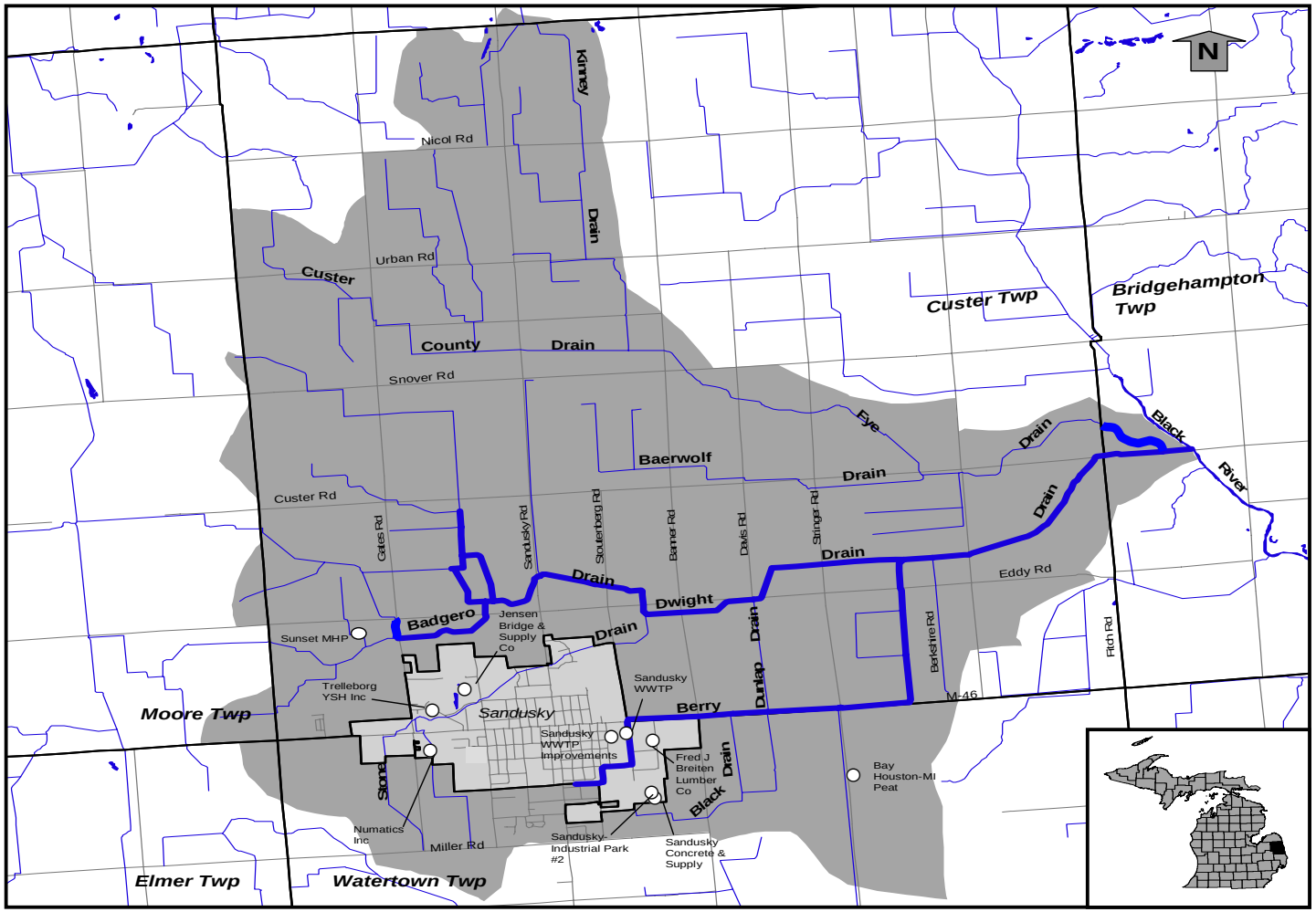

Figure 2: Berry Drain watershed with TMDL reaches highlighted and NPDES discharges indicated

APPENDIX A - PERMITTED OUTFALLS TO BERRY DRAIN IN THE VICINITY OF SANDUSKY

TABLE A.1
Individual and general (nonstorm water) NPDES permitted outfalls to Berry Drain in the vicinity of Sandusky
Source: MDEQ/WB NPDES Permit Management System (NMS)

PERMIT NUMBER	FACILITY	RECEIVING WATER	DESIGN FLOW (MGY)	LATDD	LONGDD
Individual NPDES Permits					
MI0020222	Sandusky WWTP	Berry Drain	346.75	43.420000	-82.819170
MI0054453	Bay Houston-MI Peat-Sandusky	Berry Drain	985.50	43.421940	-82.789440
MI0028142	Trelleborg YSH Inc-Sandusky	Stone Drain	109.5	43.423610	-82.847220
MI0057364	MDOT storm water	-	-	-	-
		Total Design Discharge (MGY):	1441.75		
General Permits:					
MIG580320	Sunset MHP-Custer Twp	Badgero Drain	4.0	43.418055	-82.841666
		Total Design Discharge (MGY):	4.0		

TABLE A.2
NPDES permitted industrial storm water outfalls to Berry Drain in the vicinity of Sandusky

PERMIT NUMBER	FACILITY	TYPE	LATDD	LONGDD
MIS410347	Fred J Breiten Lumber Co	Industrial Storm Water Only	43.418888	-82.816666
MIS410330	Jensen Bridge & Supply Co	Industrial Storm Water Only	43.426111	-82.842500
MIS410349	Numatics Inc-Sandusky	Industrial Storm Water Only	43.418611	-82.847777
MIS410322	Sandusky Concrete & Supply	Industrial Storm Water Only	43.411666	-82.816666

TABLE A.3
Active NPDES permit notice of coverage for construction sites in the Berry Drain drainage area

PERMIT NUMBER	EFFECTIVE DATE	DESIGNATED NAME	LOCATION	LAT	LONG
MIR107476	03/01/04	Sandusky-Industrial Park #2	26 West Speaker Street	43.41244	-82.81712
MIR108506	03/14/05	Sandusky WWTP Improvements	103 South Stoutenberg Road	43.41957	-82.82242

APPENDIX A - PERMITTED OUTFALLS TO BERRY DRAIN IN THE VICINITY OF SANDUSKY

TABLE A.4

Individual and general (nonstorm water) NPDES permitted outfalls to Berry Drain in the vicinity of Sandusky with estimated TSS loads

PERMIT NUMBER	FACILITY	RECEIVING WATER	DESIGN FLOW (MGY*)	Monthly TSS Limit (mg/l)	Annual TSS Loading (lbs)
Individual NPDES Permits					
MI0020222	Sandusky WWTP	Berry Drain	346.75	20	*58,000*
MI0054453	Bay Houston-MI Peat-Sandusky	Berry Drain	985.50	30	*247,000*
MI0028142	Trelleborg YSH Inc-Sandusky	Stone Drain	109.5	30 *	*27,000*
		Total Design Discharge (MGY):	1441.75		
General Permits:					
MIG580320	Sunset MHP-Custer Twp	Badgero Drain	4.0	40 and 70 **	*2,000*
		Total Design Discharge (MGY):	4.0		

* Not limited but assumed maximum monthly TSS concentration

** Seasonal limits, spring and fall

APPENDIX B – SANDUSKY WWTP (MI0020222), TRELLEBORG YSH, INC. – SANDUSKY (MI0028142), BAY HOUSTON MICHIGAN PEAT SANDUSKY (MI0054453), SUNSET MHP-CUSTER TWP CONVENTIONAL PARAMETER NPDES PERMIT LIMITS

Table B.1. Sandusky WWTP NPDES conventional parameter permit limits, pre-expansion.

Parameter	Period	Maximum loading (lbs/day)		Maximum concentration (mg/l)		
		Monthly	7-day	Monthly	7-day	Daily
$CBOD_5$ (mg/l)	Apr 1–Nov 30	15	37	4.0	-	10
	Dec 1–Mar 31	30	44	8.0	-	12
TSS (mg/l)	Year-round	74	111	20	30	-
Ammonia Nitrogen (mg/l)	Apr 1–Apr 30	11	-	3.0	-	-
	May 1–Nov 30	2.0	7.4	0.5	-	2.0
	Dec 1–Mar 31	41	-	11	-	-
TP (mg/l)	Year-round	1.9	-	0.5	-	-
D.O. (min., mg/l)	May 1–Sep 30	-	-	-	-	7.0
	Oct 1–Apr 30	-	-	-	-	6.0

Design flow of 0.445 MGD, outfall 001 is to Berry Drain

Table B.2. Sandusky WWTP NPDES conventional parameter permit limits, post-expansion.

Parameter	Period	Maximum loading (lbs/day)		Maximum concentration (mg/l)		
		Monthly	7-day	Monthly	7-day	Daily
$CBOD_5$ (mg/l)	Jan 1-Feb 28	87	130	11	-	16
	Mar 1 - Dec 31	32	79	4.0	-	10
TSS (mg/l)	Year-round	160	240	20	30	-
Ammonia Nitrogen (mg/l)	Jan 1-Feb 28	120	-	15	-	-
	Mar 1 - Dec 31	4.0	16	0.5	-	2.0
TP (mg/l)	Year-round	4.0	-	0.5	-	-
D.O. (min., mg/l)	Jan 1-Feb 28	-	-	-	-	5
	Mar 1 – Apr 30 Oct 1 – Dec 31	-	-	-	-	6
	May 1 – Sep 30	-	-	-	-	7

Design flow of 0.95 MGD, outfall 001 is to Berry Drain

Table B.3. Trelleborg YSH, Inc.-Sandusky NPDES conventional parameter permit limits

Parameter	Period	Maximum Loading (lbs/d)		Maximum Concentration (mg/l)		
		Monthly	7-day	Monthly	7-day	Daily
TDS (mg/l)	Year-round	-	-	-	-	(report)
TSS (mg/l)	Year-round	-	-	(report)	(report)	-
TP (mg/l)	Year-round	2.5	-	1.0	-	-
D.O. (min., mg/l)	Year-round	-	-	-	-	6

Design flow of 0.3 MGD, outfall 001 is to Stone Drain

Table B.4. Bay Houston-MI-Peat-Sandusky NPDES conventional parameter permit limits

Parameter	Period	Maximum Loading (lbs/d)		Maximum Concentration (mg/l)		
		Monthly	7-day	Monthly	7-day	Daily
TSS (mg/l)	Year-round	-	-	35	-	45
D.O. (min., mg/l)	Year-round	-	-	-	-	(report)

Design flow of 2.7 MGD, outfall 002 is to Berry Drain

Table B.5. Sunset MHP-Custer Twp NPDES conventional parameter permit limits

Parameter	Period	Maximum Loading (lbs/d)		Maximum Concentration (mg/l)		
		Monthly	7-day	Monthly	7-day	Daily
BOD_5 (mg/l)	Year round	-	-	30	45	-
TSS (mg/l)	Mar – May	-	-	70	100	-
	Oct - Dec	-	-	40	45	-
Ammonia	May – Nov	-	-	(report)	-	-
TP (mg/l)	Year-round	-	-	(report)	-	-
D.O. (min., mg/l)	Year-round	-	-	-	-	5

Design flow of 4 MGY