National Pollutant Discharge Elimination System (NPDES) Permit Program

FACT SHEET

Regarding an NPDES Permit To Discharge to Waters of the State of Ohio
for Hamilton Water Reclamation Facility

Public Notice No.: 15-08-012
Public Notice Date: August 7, 2015
Comment Period Ends: September 7, 2015

Ohio EPA Permit No.: 1PE00002*ND
Application No.: OH0025445

Name and Address of Applicant:
City of Hamilton
2451 River Road
Hamilton, Ohio 45015

Name and Address of Facility Where Discharge Occurs:
Hamilton Water Reclamation Facility
2451 River Road
Hamilton, Ohio 45015
Butler County

Receiving Water: Great Miami River

Subsequent Stream Network: Ohio River

Introduction

Development of a Fact Sheet for NPDES permits is mandated by Title 40 of the Code of Federal Regulations (CFR), Section 124.8 and 124.56. This document fulfills the requirements established in those regulations by providing the information necessary to inform the public of actions proposed by the Ohio Environmental Protection Agency (Ohio EPA), as well as the methods by which the public can participate in the process of finalizing those actions.

This Fact Sheet is prepared in order to document the technical basis and risk management decisions that are considered in the determination of water quality based NPDES Permit effluent limitations. The technical basis for the Fact Sheet may consist of evaluations of promulgated effluent guidelines, existing effluent quality, instream biological, chemical and physical conditions, and the relative risk of alternative effluent limitations. This Fact Sheet details the discretionary decision-making process empowered to the Director by the Clean Water Act (CWA) and Ohio Water Pollution Control Law (Ohio Revised Code [ORC] 6111). Decisions to award variances to Water Quality Standards (WQS) or promulgated effluent guidelines for economic or technological reasons will also be justified in the Fact Sheet where necessary.

No antidegradation review was necessary.

Effluent limits based on available treatment technologies are required by Section 301(b) of the CWA. Many of these have already been established by the United States Environmental Protection Agency (U.S. EPA) in the effluent guideline regulations (a.k.a. categorical regulations) for industry categories in 40 CFR Parts 405-499. Technology-based regulations for publicly-owned treatment works are listed in the Secondary Treatment Regulations (40 CFR Part 133). If regulations have not been established for a category of dischargers, the director may establish technology-based limits based on best professional judgment (BPJ).

Ohio EPA reviews the need for water-quality-based limits on a pollutant-by-pollutant basis. Wasteload allocations (WLAs) are used to develop these limits based on the pollutants that have been detected in the discharge, and the receiving water's assimilative capacity. The assimilative capacity depends on the flow in the water receiving the discharge, and the concentration of the pollutant upstream. The greater the upstream flow, and the lower the upstream concentration, the greater the assimilative capacity is. Assimilative capacity may represent dilution (as in allocations for metals), or it may also incorporate the break-down of pollutants in the receiving water (as in allocations for oxygen-demanding materials).

The need for water-quality-based limits is determined by comparing the WLA for a pollutant to a measure of the effluent quality. The measure of effluent quality is called Projected Effluent Quality (PEQ). This is a statistical measure of the average and maximum effluent values for a pollutant. As with any statistical method, the more data that exists for a given pollutant, the more likely that PEQ will match the actual observed data. If there is a small data set for a given pollutant, the highest measured value is multiplied by a statistical factor to obtain a PEQ; for example if only one sample exists, the factor is 6.2, for two samples - 3.8, for three samples - 3.0. The factors continue to decline as samples sizes increase. These factors are intended to account for effluent variability, but if the pollutant concentrations are fairly constant, these factors may make PEQ appear larger than it would be shown to be if more sample results existed.

Summary of Permit Conditions

The effluent limits and monitoring requirements proposed for the following parameters are the same as in the previous permit, although some monitoring frequencies have changed: flow, temperature, $CBOD_5$, total suspended solids, ammonia-nitrogen, total phosphorus, nitrate+nitrite-nitrogen, total Kjeldahl nitrogen, oil and grease, pH, free cyanide, cadmium, total chromium, dissolved hexavalent chromium, copper, lead, nickel and zinc.

New water quality-based effluent limits are proposed for mercury. Plant effluent data shows it is able to comply with the proposed 12 ng/l monthly average limit. The proposed daily maximum limit is 1700 ng/l.

New effluent limits are proposed for *Escherichia coli* due to a change in water quality standards. They replace limits for fecal coliform bacteria. The facility is aware of this change and is prepared to comply with the new limits.

Metals monitoring at the downstream station 901 has been removed from the permit.

The limit proposed for total residual chlorine, 0.030 mg/l daily maximum, is slightly lower than the current limit if 0.037 mg/l. The proposed limit is based on the current wasteload allocation.

New monthly monitoring is proposed for dissolved orthophosphate (as P). This monitoring is required by Ohio Senate Bill 1, which was signed by the Governor on April 2, 2015. Monitoring for orthophosphate is proposed to further develop nutrient datasets for dissolved reactive phosphorus and to assist stream and watershed assessments and studies. Ohio EPA monitoring, as well as other in-stream monitoring, is taken via grab sample, orthophosphate is proposed to be collected by grab sample to maintain consistent data to support watershed and stream surveys. Monitoring will be done by grab sample, which must be filtered within 15 minutes of collection using a 0.45-micron filter. The filtered sample must be analyzed within 48 hours.

New monthly monitoring is proposed for total filterable residue (total dissolved solids). While existing data did not show reasonable potential for violations of water quality standards, the proposed monitoring will provide baseline data to characterize its level in the plant effluent.

Annual chronic toxicity testing with the determination of acute endpoints using *Ceriodaphnia dubia* and fathead minnows is proposed to continue. This satisfies the minimum testing requirements of Ohio Administrative Code (OAC) 3754-33-07(B)(11) and will adequately characterize toxicity in the plant's effluent.

Based on the evaluation of existing effluent data, the removal of final effluent monitoring for silver is proposed.

In Part II of the permit, special conditions are included that address sanitary sewer overflow (SSO) reporting; operator certification, minimum staffing and operator of record; whole effluent toxicity (WET) testing; storm water compliance; and outfall signage.

Addressing nutrient-related impairment in the lower Great Miami River (GMR)
Ohio EPA is proposing an adaptive management approach to addressing the nutrient-related impairment in the lower GMR. Adaptive management is an iterative process that involves implementing certain controls to reduce pollutant loads, allowing time to evaluate the effectiveness of the controls and obtain additional information, and then using this new knowledge to guide the next implementation step.

Issuing new NPDES permits to the major municipal wastewater treatment plants (WWTP) is the first step in the process to eliminate impairment in the lower GMR. These permit renewals include:

For the Dayton and Montgomery County Western Regional WWTPs – A seasonal aggregate total phosphorus loading limit that applies for the period July through October. The limit was calculated using the plant's average seasonal flow for the years 2010 through 2014 and a total phosphorus concentration of 1 mg/l. The permits allow 36 months for the plants to meet the seasonal loading limit.

These two plants are the largest and most upstream discharges of the lower Great Miami River watershed and contribute to a significant increase in the total phosphorus concentrations, dissolved oxygen swings and chlorophyll-a values in the river.

For the other major WWTPs – Continued monitoring of total phosphorus in their effluent as well as upstream and downstream of their discharges. These plants also must develop a study that evaluates the technical and financial capability of their existing treatment facilities to reduce total phosphorus to 1 mg/l or lower. This study is required by Ohio Senate Bill 1, which was signed by the Governor on April 2, 2015. The study must be submitted to Ohio EPA by December 1, 2017. Ohio EPA is implementing this Ohio Senate Bill 1 requirement outside of NPDES permits. Instead, Ohio EPA will send a letter instructing all applicable facilities how to comply with the evaluation study required by Ohio Senate Bill 1.

Ohio EPA is working with Ohio Department of Natural Resources and representatives of the Joint Board of the Soil Water Conservation Districts to identify areas for concentrating efforts to reduce agricultural runoff to streams. This effort includes site selection; installing best management practices; and measuring the baseline and success of the practices.

If the river has not returned to full attainment, the next NPDES permit renewals may be informed by an Ohio EPA-approved integrated management plan prepared by the lower GMR dischargers and/or an approved TMDL prepared by Ohio EPA. If supported by these or other applicable reports, the permittees may propose using alternate reduction strategies to achieve future phosphorus reductions. The strategies could include point source-nonpoint source trading, point source-point source trading, habitat restoration offsets, physical watershed alterations and other approved nutrient management/reduction strategies.

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Procedures for Participation in the Formulation of Final Determinations

The draft action shall be issued as a final action unless the Director revises the draft after consideration of the record of a public meeting or written comments, or upon disapproval by the Administrator of the U.S. Environmental Protection Agency.

Within thirty days of the date of the Public Notice, any person may request or petition for a public meeting for presentation of evidence, statements or opinions. The purpose of the public meeting is to obtain additional evidence. Statements concerning the issues raised by the party requesting the meeting are invited. Evidence may be presented by the applicant, the state, and other parties, and following presentation of such evidence other interested persons may present testimony of facts or statements of opinion.

Requests for public meetings shall be in writing and shall state the action of the Director objected to, the questions to be considered, and the reasons the action is contested. Such requests should be addressed to:

Legal Records Section
Ohio Environmental Protection Agency
P.O. Box 1049
Columbus, Ohio 43216-1049

Interested persons are invited to submit written comments upon the discharge permit. Comments should be submitted in person or by mail no later than 30 days after the date of this Public Notice. Deliver or mail all comments to:

Ohio Environmental Protection Agency
Attention: Division of Surface Water
Permits Processing Unit
P.O. Box 1049
Columbus, Ohio 43216-1049

The Ohio EPA permit number and Public Notice numbers should appear on each page of any submitted comments. All comments received no later than 30 days after the date of the Public Notice will be considered.

Citizens may conduct file reviews regarding specific companies or sites. Appointments are necessary to conduct file reviews, because requests to review files have increased dramatically in recent years. The first 250 pages copied are free. For requests to copy more than 250 pages, there is a five-cent charge for each page copied. Payment is required by check or money order, made payable to Treasurer State of Ohio.

For additional information about this fact sheet or the draft permit, contact Ned Sarle, (937) 285-6096, Ned.Sarle@epa.ohio.gov at Southwest District Office or Gary Stuhlfauth, (614) 644-2026, Gary.Stuhlfauth@epa.ohio.gov at Central Office.

Information Regarding Certain Water Quality Based Effluent Limits

This draft permit may contain proposed water-quality-based effluent limits (WQBELs) for parameters that **are not** priority pollutants. (See the following link for a list of the priority pollutants: http://epa.ohio.gov/portals/35/pretreatment/Pretreatment_Program_Priority_Pollutant_Detection_Limits.pdf .) In accordance with ORC 6111.03(J)(3), the Director established these WQBELs after considering, to the extent consistent with the Federal Water Pollution Control Act, evidence relating to the technical feasibility and economic reasonableness of removing the polluting properties from those wastes and to evidence relating to conditions calculated to result from that action and their relation to benefits to the people of the state and to accomplishment of the purposes of this chapter. This determination was made based on data and information available at the time the permit was drafted, which included the contents of the timely submitted NPDES permit renewal application, along with any and all pertinent information available to the Director.

This public notice allows the permittee to provide to the Director for consideration during this public comment period additional site-specific pertinent and factual information with respect to the technical feasibility and economic reasonableness for achieving compliance with the proposed final effluent limitations for these parameters. The permittee shall deliver or mail this information to:

Ohio Environmental Protection Agency
Attention: Division of Surface Water
Permits Processing Unit
P.O. Box 1049
Columbus, Ohio 43216-1049

Should the applicant need additional time to review, obtain or develop site-specific pertinent and factual information with respect to the technical feasibility and economic reasonableness of achieving compliance with these limitations, written notification for any additional time shall be sent to the above address no later than 30 days after the Public Notice Date on Page 1.

Should the applicant determine that compliance with the proposed WQBELs for parameters other than the priority pollutants is technically and/or economically unattainable, the permittee may submit an application for a variance to the applicable WQS used to develop the proposed effluent limitation in accordance with the terms and conditions set forth in OAC 3745-33-07(D). The permittee shall submit this application to the above address no later than 30 days after the Public Notice Date.

Alternately, the applicant may propose the development of site-specific WQS pursuant to OAC 3745-1-35. The permittee shall submit written notification regarding their intent to develop site specific WQS for parameters that are not priority pollutants to the above address no later than 30 days after the Public Notice Date.

Location of Discharge/Receiving Water Use Classification

The Hamilton wastewater treatment plant (WWTP) discharges to the Great Miami River at River Mile 34.0. Figure 1 shows the approximate location of the facility.

This segment of the Great Miami River is described by Ohio EPA River Code: 14-001, U.S. EPA River Reach Code: 05080002-009, County: Butler, Ecoregion: Eastern Corn Belt Plains. The Great Miami River is designated for the following uses under Ohio's WQS (OAC 3745-1-21): Warmwater Habitat, Agricultural Water Supply, Industrial Water Supply, Class A Primary Contact Recreation.

Use designations define the goals and expectations of a waterbody. These goals are set for aquatic life protection, recreation use and water supply use, and are defined in the Ohio WQS (OAC 3745-1-07). The use designations for individual waterbodies are listed in rules -08 through -32 of the Ohio WQS. Once the goals are set, numeric WQS are developed to protect these uses. Different uses have different water quality criteria.

Use designations for aquatic life protection include habitats for coldwater fish and macroinvertebrates, warmwater aquatic life and waters with exceptional communities of warmwater organisms. These uses all meet the goals of the federal CWA. Ohio WQS also include aquatic life use designations for waterbodies which cannot meet the CWA goals because of human-caused conditions that cannot be remedied without causing fundamental changes to land use and widespread economic impact. The dredging and clearing of some small streams to support agricultural or urban drainage is the most common of these conditions. These streams are given Modified Warmwater or Limited Resource Water designations.

Recreation uses are defined by the depth of the waterbody and the potential for wading or swimming. Uses are defined for bathing waters, swimming/canoeing (Primary Contact Recreation) and wading only (Secondary Contact which are generally waters too shallow for swimming or canoeing).

Water supply uses are defined by the actual or potential use of the waterbody. Public Water Supply designations apply near existing water intakes so that waters are safe to drink with standard treatment. Most other waters are designated for agricultural water supply and industrial water supply.

Facility Description

The Hamilton wastewater plant was constructed in 1958 and last upgraded in 2013. The average design flow is 32.0 million gallons per day (MGD) . The plant serves the city of Hamilton and a part of Butler County and has approximately 64,000 customers. The plant has the following treatment processes:

- Influent pumping
- Screening and grit removal
- Scum removal
- Primary settling
- Conventional activated sludge aeration
- Secondary clarification and dechlorination
- Post aeration

The Hamilton wastewater treatment plant has one bypass, station 603. Flows through this station receive primary treatment, bypass secondary treatment and are combined with fully treated flow just prior to the chlorine contact tank. The Hamilton WWTP is currently constructing an upgrade to eliminate this plant bypass. This work should be completed in Fall 2015. The upgrades include installing additional influent and intermediate pumps, converting the aeration system to step feed and refurbishing the secondary clarifiers.

The Hamilton wastewater treatment plant utilizes the following sewage sludge treatment processes:

- Ferric chloride addition
- Gravity thickening
- Dewatering using belt presses
- Lime stabilization

Treated sludge is disposed of by land application at agronomic rates or by hauling to a landfill. Table 1 shows the last five years of sludge removed from the Hamilton treatment plant.

The Hamilton wastewater plant is served by a separate sanitary sewer system. The City and Ohio EPA entered into a consent order addressing five known sanitary sewer overflows (SSOs) and the bypass at the wastewater treatment plant. This modified consent order, case number CV88 10 1450, was filed in the Butler County Common Pleas Court on January 19, 2007.

The consent order required the City to:

- Properly manage, operate and maintain all parts of its sanitary sewer system;
- To develop and implement a system to accomplish this;
- To develop and implement an overflow emergency response plan;
- To develop and implement a plan to ensure adequate capacity to convey and treat base flows and peak flows from its sewer system and any satellite sewer systems; and
- To monitor and report information on the five collection system overflows and on the bypass at the wastewater plant.

Ohio EPA approved the City's *Overflow Emergency Response Plan (OERP)* in January 2008, its *Management, Operations, and Maintenance Summary Document* (MOM Plan) in May 2008, and its *System Evaluation and Capacity Assurance Plan* (SECAP) in July 2009. The Agency also approved the City's *Water Reclamation Facility Phase 2 Preliminary Engineering Report* in August 2012.

To facilitate the reporting required by the consent order, monitoring and reporting tables for five know sanitary sewer overflows (SSOs) were added to the NPDES permit in a July 2008 modification. These SSOs were station numbers 002 (eliminated by the City in 2010), 014 (eliminated in 2011), 022 (eliminated in 2011), 027 and 037. Projects to eliminate the final two SSOs are currently underway and will be completed in early summer 2015. All other sanitary sewer overflows (SSOs) are reported via consent decree and so the SSO Monitoring station 300, typical of most NPDES municipal permits, has not been included in the permit.

The City has an approved pretreatment program. There are five significant non-categorical industrial users that discharge approximately 0.153 MGD and four categorical industrial users that discharge approximately 0.084 MGD to the wastewater plant

Hamilton's potable water comes from groundwater pumped from the Great Miami Valley Buried Aquifer.

Storm water discharges from the Hamilton Water Reclamation Facility are covered under no exposure certification number 1GRN0027*EG, which was issued on May 1, 2014 and expires May 1, 2019. The City must renew the no exposure certification at that time or make other arrangements concerning storm water discharges from the wastewater plant.

<u>Description of Existing Discharge</u>

The Hamilton wastewater treatment plant has an estimated infiltration/inflow (I/I) rate to the collection system of 2.850 MGD. The facility's annual effluent flow rate for the previous five years is presented on Table 2. The City performs the following activities to minimize I/I: cleaning and televising sewer mains to identify rehabilitation needs, sewer lining and point repairs.

Data summarizing the SSO discharges at stations 027 and 037 over the past five years are presented on Table 3.

Data summarizing the discharges through bypass station 603 over the past five years are presented on Table 4.

Table 5 presents chemical specific data compiled from data collected by Ohio EPA and reported in annual pretreatment reports.

Table 6 presents a summary of unaltered Discharge Monitoring Report (DMR) data for outfall 001. Data are presented for the period January 2008 through September 2013, and current permit limits are provided for comparison.

Table 7 summarizes the chemical specific data for outfall 001 by presenting the average and maximum PEQ values.

Table 8 summarizes the results of acute and chronic WET tests of the final effluent.

Table 9 summarizes the screening results of Ohio EPA bioassay sampling of the final effluent.

Under the provisions of 40 CFR 122.21(j), the Director has waived the requirement for submittal of expanded effluent testing data as part of the NPDES renewal application. Ohio EPA has access to substantially identical information through the submission of annual pretreatment program reports and/or from Ohio EPA effluent testing conducted.

Assessment of Impact on Receiving Waters

The Great Miami River from the Mad River to Four Mile Creek has been identified as a priority impaired water on Ohio's 303(d) list. The aquatic life, recreation and human health uses are listed as impaired.

The Great Miami River was evaluated by Ohio EPA staff for aquatic life and recreational use potential during the 2009 and 2010 field seasons. This assessment included the collection of water chemistry and biological sampling at numerous sites in the mainstem Great Miami River and selected tributaries. A summary of the results from this assessment can be found in Table 10.

The complete results of the most recent water quality surveys of the Great Miami River are included in the Technical Support Documents (TSD) "*Biological and Water Quality Study of the Middle Great Miami River and Principal Tributaries, 2009", Jan. 2013; and "Biological and Water Quality Study of the Lower Great Miami River and Selected Tributaries, 2010", May 2012* (Ohio EPA), which are available through this Internet link: http://epa.ohio.gov/dsw/document_index/psdindx.aspx .

The addendum to this fact sheet provides additional information on the impacts that discharges from major municipal wastewater treatment plants are having on water quality in the lower Great Miami River.

Development of Water-Quality-Based Effluent Limits

Determining appropriate effluent concentrations is a multiple-step process in which parameters are identified as likely to be discharged by a facility, evaluated with respect to Ohio water quality criteria, and examined to determine the likelihood that the existing effluent could violate the calculated limits.

Parameter Selection
Effluent data for the Hamilton wastewater treatment plant were used to determine what parameters should undergo WLA. The parameters discharged are identified by the data available to Ohio EPA DMR data submitted by the permittee, compliance sampling data collected by Ohio EPA, and any other data submitted by the permittee, such as priority pollutant scans required by the NPDES application or by pretreatment, or other special conditions in the NPDES permit. The sources of effluent data used in this evaluation are as follows:

Self-Monitoring Data (DMR)	January 2008 through September 2013
Pretreatment Program Data	2009 - 2012
Ohio EPA Data (compliance, survey)	2012- 2013

The data were examined and the following values were removed from the evaluation to give a more reliable PEQ: two values for total residual chlorine of 173. and 290. µg/l.

This data is evaluated statistically, and PEQ values are calculated for each pollutant. Average PEQ (PEQ_{avg}) values represent the 95th percentile of monthly average data, and maximum PEQ (PEQ_{max}) values represent the 95th percentile of all data points (see Table 7).

The PEQ values are used according to Ohio rules to compare to applicable WQS and allowable WLA values for each pollutant evaluated. Initially, PEQ values are compared to the applicable average and maximum WQS. If both PEQ values are less than 25 percent of the applicable WQS, the pollutant does not have the reasonable potential to cause or contribute to exceedances of WQS, and no WLA is done for that parameter. If either PEQ_{avg} or PEQ_{max} is greater than 25 percent of the applicable WQS, a WLA is conducted to determine whether the parameter exhibits reasonable potential and needs to have a limit or if monitoring is required (see Table 11).

Wasteload Allocation
For those parameters that require a WLA, the results are based on the uses assigned to the receiving waterbody in OAC 3745-1. Dischargers are allocated pollutant loadings/concentrations based on the Ohio WQS (OAC 3745-1). Most pollutants are allocated by a mass-balance method because they do not degrade in the receiving water. WLAs using this method are done using the following general equation: Discharger WLA = (downstream flow x WQS) - (upstream flow x background concentration). Discharger WLAs are divided by the discharge flow so that the allocations are expressed as concentrations.

The Hamilton WWTP discharges to the Great Miami River within a large interactive segment (approx. RM 87 to 15) with multiple other dischargers. Wasteload allocations for conservative parameters in this interactive segment were calculated through use of the CONSWLA (CONservative Substance WasteLoad Allocation) model. The study area, showing relative positions of significant dischargers and tributaries, is depicted in Figure 2.

The applicable waterbody uses for this facility's discharge and the associated stream design flows are as follows:

Aquatic life (Warmwater Habitat)		
Toxics (metals, organics, etc.)	Average	Annual 7Q10
	Maximum	Annual 1Q10
Ammonia	Average	Summer 30Q10
		Winter 30Q10
Agricultural Water Supply		Harmonic mean flow
Human Health (nondrinking)		Harmonic mean flow

Allocations are developed using a percentage of stream design flow as specified in Table 16, and allocations cannot exceed the Inside Mixing Zone Maximum (IMZM) criteria. The current limits for ammonia-nitrogen were evaluated using the WLA procedures and are protective of the water quality standards for ammonia toxicity.

Ohio's WQS implementation rules [OAC 3745-2-05(A)(2)(d)(iv)] required a phase out of mixing zones for bioaccumulative chemicals of concern (BCCs) as of November 15, 2010. This rule applied statewide. Mercury is a BCC. The mixing zone phase-out means that as of November 15, 2010 all dischargers requiring mercury limits in their NPDES permit must meet WQS at the end-of-pipe, which for mercury are 12 ng/L (average) and 1700 ng/L (maximum) in the Ohio River.

The data used in the WLA are listed in Table 11 and Table 12. The WLA results to maintain all applicable criteria are presented in Table 13.

Whole Effluent Toxicity WLA

Whole effluent toxicity (WET) is the total toxic effect of an effluent on aquatic life measured directly with a toxicity test. Acute WET measures short term effects of the effluent while chronic WET measures longer term and potentially more subtle effects of the effluent.

WQS for WET are expressed in Ohio's narrative "free from" WQS rule [OAC 3745-1-04(D)]. These "free froms" are translated into toxicity units (TUs) by the associated WQS Implementation Rule (OAC 3745-2-09). WLAs can then be calculated using TUs as if they were water quality criteria.

The WLA calculations for WET are similar to those for aquatic life criteria - using the chronic toxicity unit (TU_c) and 7Q10 flow for the average and the acute toxicity unit (TU_a) and 1Q10 flow for the maximum. These values are the levels of effluent toxicity that should not cause instream toxicity during critical low-flow conditions. For Hamilton, the WLA values are 1.0 TU_a and 12.8 TU_c.

The chronic toxicity unit (TU_c) is defined as 100 divided by the estimate of the effluent concentration which causes a 25% reduction in growth or reproduction of test organisms (IC_{25}):

$$TU_c = 100/IC_{25}$$

This equation applies outside the mixing zone for warmwater, modified warmwater, exceptional warmwater, coldwater, and seasonal salmonid use designations except when the following equation is more restrictive (*Ceriodaphnia dubia* only):

$$TU_c = 100/\text{geometric mean of No Observed Effect Concentration and Lowest Observed Effect Concentration}$$

The acute toxicity unit (TU_a) is defined as 100 divided by the concentration in water having 50% chance of causing death to aquatic life (LC_{50}) for the most sensitive test species:

$$TU_a = 100/LC_{50}$$

This equation applies outside the mixing zone for warmwater, modified warmwater, exceptional warmwater, coldwater, and seasonal salmonid use designations.

<u>Reasonable Potential/ Effluent Limits/Hazard Management Decisions</u>

After appropriate effluent limits are calculated, the reasonable potential of the discharger to violate the WQS must be determined. Each parameter is examined and placed in a defined "group". Parameters that do not have a WQS or do not require a WLA based on the initial screening are assigned to either group 1 or 2. For the allocated parameters, the preliminary effluent limits (PEL) based on the most restrictive average and maximum WLAs are selected from Table 13. The average PEL (PEL_{avg}) is compared to the average PEQ (PEQ_{avg}) from

Table 7, and the PEL_{max} is compared to the PEQ_{max}. Based on the calculated percentage of the allocated value [($PEQ_{avg} \div PEL_{avg}$) X 100, or ($PEQ_{max} \div PEL_{max}$) X 100)], the parameters are assigned to group 3, 4, or 5. The groupings are listed in Table 14.

The final effluent limits are determined by evaluating the groupings in conjunction with other applicable rules and regulations. Table 15 presents the final effluent limits and monitoring requirements proposed for Hamilton WWTP outfall 001 and the basis for their recommendation. Unless otherwise indicated, the monitoring frequencies proposed in the permit are continued from the existing permit.

Water Temperature and Flow
Monitoring for these parameters is proposed to continue in order to evaluate the performance of the treatment plant.

Dissolved Oxygen, Total Suspended Solids, Ammonia-N, and $CBOD_5$
Based on best technical judgment, the limits proposed for dissolved oxygen, total suspended solids, ammonia-nitrogen and 5-day carbonaceous biochemical oxygen demand are a continuation of existing permit limits. The ammonia limits were evaluated and are protective of the water quality standards for ammonia toxicity.

The limits recommended for total suspended solids and $CBOD_5$ are technology-based treatment standards included in 40 CFR Part 133, Secondary Treatment Regulation. Secondary treatment is defined by the Best Practicable Waste Treatment Technology criteria, which are minimum standards required of all publicly owned treatment works.

A reduction in monitoring frequency is proposed for total suspended solids, ammonia-N and $CBOD_5$.

Total Kjeldahl Nitrogen, Nitrate+Nitrite-N, Total Phosphorus
Based on best technical judgment (BTJ), monitoring is proposed to continue for the following nutrient-related parameters: total Kjeldahl nitrogen, nitrate+nitrite-N and total phosphorus. The purpose of the monitoring is to maintain a data set on the point source nutrient load discharged to the receiving water. An eight samples per month monitoring frequency is proposed for total phosphorus, an increase from the previous monitoring frequency of once per month in the current permit.

Monitoring for phosphorus and nitrate + nitrite at the upstream and downstream stations is proposed to continue. The purpose of the monitoring is to maintain a nutrient data set for use in future water quality studies.

Dissolved Orthophosphate
New monthly monitoring is proposed for dissolved orthophosphate (as P). This monitoring is required by Ohio Senate Bill 1, which was signed by the Governor on April 2, 2015. Monitoring for orthophosphate is proposed to further develop nutrient datasets for dissolved reactive phosphorus and to assist stream and watershed assessments and studies. Ohio EPA monitoring, as well as other in-stream monitoring, is taken via grab sample, orthophosphate is proposed to be collected by grab sample to maintain consistent data to support watershed and stream surveys. Monitoring will be done by grab sample, which must be filtered within 15 minutes of collection using a 0.45-micron filter. The filtered sample must be analyzed within 48 hours.

Oil and Grease, Escherichia coli, pH
Limits proposed for oil and grease, *E. coli* and pH are based on Ohio WQS (OAC 3745-1-07). Class A primary contact recreation standards apply to the Great Miami River.

Mercury and Total Residual Chlorine
The Ohio EPA risk assessment (Table 15) places mercury and total residual chlorine in group 5. This placement, as well as the data in Tables 6 and 7 indicates that the reasonable potential to exceed WQS exists and limits are necessary to protect water quality. For these parameters, the PEQ is greater than 100 percent of the

WLA. Pollutants that meet this requirement must have permit limits under OAC 3745-33-07(A)(1). The proposed limits are based on the wasteload allocations.

A review of effluent data shows that the plant should be able to comply with the limits proposed for mercury.

The effluent limit proposed for chlorine is slightly lower than the limit in the current permit and is less than the quantification level of 0.050 mg/L A special condition in Part II of the permit addresses compliance with limits that are below the quantification level.

Nickel, Zinc, Cadmium, Lead, Chromium, Copper, Dissolved Hexavalent Chromium, Free Cyanide, Total Filterable Residue (Dissolved Solids)
The Ohio EPA risk assessment (Table 14) places nickel, zinc, cadmium, lead, chromium, copper, dissolved hexavalent chromium, free cyanide and total filterable residue in groups 2 and 3. This placement, as well as the data in Tables 6 and 7 support that these parameters do not have the reasonable potential to contribute to WQS exceedances, and limits are not necessary to protect water quality. The monitoring proposed for total filterable residue is a new requirement. Monthly monitoring is proposed to document that these pollutants continue to remain at low levels.

Free Cyanide Test Method
Currently there are two approved methods for free cyanide listed in 40 CFR 136.3 that have quantification levels lower than any water quality-based effluent limits:

- ASTM D7237-10 and OIA-1677-09 **-** Flow injection followed by gas diffusion amperometry

These methods will allow Ohio EPA make more reliable water quality-related decisions regarding free cyanide. Because the quantification levels are lower than any water quality-based effluent limits, it will also be possible to directly evaluate compliance with free cyanide limits.

New NPDES permits no longer authorize the use of method 4500 CN-I from Standard Methods for free cyanide testing. The new permits require permittees to begin using one of these approved methods as soon as possible. If a permittee must use method 4500 CN-I during the transition to an approved method, they are instructed to report the results on their DMR and enter “Method 4500 CN-I” in the remarks section.

Arsenic, Barium, Bromodichloromethane, Chloroform, Iron, Molybdenum, Selenium, Strontium, Bis(2-ethylhexyl)phthalate and Silver
The Ohio EPA risk assessment (Table 14) places these parameters in groups 2 and 3. This placement, as well as the data in Tables 5, 6 and 7 support that these parameters do not have the reasonable potential to contribute to WQS exceedances, and limits are not necessary to protect water quality. No new monitoring is proposed. The Agency is proposing to remove the current monitoring requirement for silver

Whole Effluent Toxicity Reasonable Potential
Based on evaluating the WET data presented in Table 8 and Table 9 and other pertinent data under the provisions of OAC 3745-33-07(B), the Hamilton wastewater treatment plant is placed in Category 4 with respect to WET. While this indicates that the plant's effluent does not currently pose a toxicity problem, annual toxicity testing is proposed consistent with the minimum monitoring requirements at OAC 3754-33-07(B)(11). Annual chronic toxicity monitoring with the determination of acute endpoints is proposed for the life of the permit. The proposed monitoring will adequately characterize toxicity in the plant's effluent.

Additional Monitoring Requirements
Additional monitoring requirements proposed at the final effluent, influent and upstream/downstream stations are included for all facilities in Ohio and vary according to the type and size of the discharge. In addition to

permit compliance, this data is used to assist in the evaluation of effluent quality and treatment plant performance and for designing plant improvements and conducting future stream studies.

Sludge
Limits and monitoring requirements proposed for the disposal of sewage sludge by the following management practices are based on OAC 3745-40: land application, removal to sanitary landfill or transfer to another facility with an NPDES permit.

Other Requirements

Compliance Schedule
A six month compliance schedule is proposed for the city to submit a technical justification for either revising its local industrial user limits or retaining its existing local limits. If revisions to local limits are required, the city must also submit a pretreatment program modification request. Details are in Part I.C of the permit.

Sanitary Sewer Overflow Reporting
Provisions for reporting SSOs are again proposed in this permit. These provisions include: the reporting of the system-wide number of SSO occurrences on monthly operating reports; telephone notification of Ohio EPA and the local health department, and 5-day follow up written reports for certain high risk SSOs; and preparation of an annual report that is submitted to Ohio EPA and made available to the public. Many of these provisions were already required under the “Noncompliance Notification”, “Records Retention”, and “Facility Operation and Quality Control” general conditions in Part III of Ohio NPDES permits.

Operator Certification and Operator of Record
Operator certification requirements have been included in Part II of the permit in accordance with rules adopted in December 2006 (OAC 3745-7-02). These rules require the Hamilton Water Reclamation Facility to have a Class IV wastewater treatment plant operator in charge of the sewage treatment plant operations discharging through outfall 001. These rules also require the permittee to designate one or more operator of record to oversee the technical operation of the treatment works.

Storm Water Compliance
Storm water discharges from the Hamilton Water Reclamation Facility are covered under no exposure certification number 1GRN0027*EG, which was issued on May 1, 2014 and expires May 1, 2019. The City must renew the no exposure certification at that time or make other arrangements concerning storm water discharges from the wastewater plant.

Outfall Signage
Part II of the permit includes requirements for the permittee to place and maintain a sign at each outfall to the Great Miami River providing information about the discharge. Signage at outfalls is required pursuant to OAC 3745-33-08(A).

Figure 1. Location of the Hamilton Water Reclamation Facility

Figure 2. Great Miami River Study Area (not to scale)

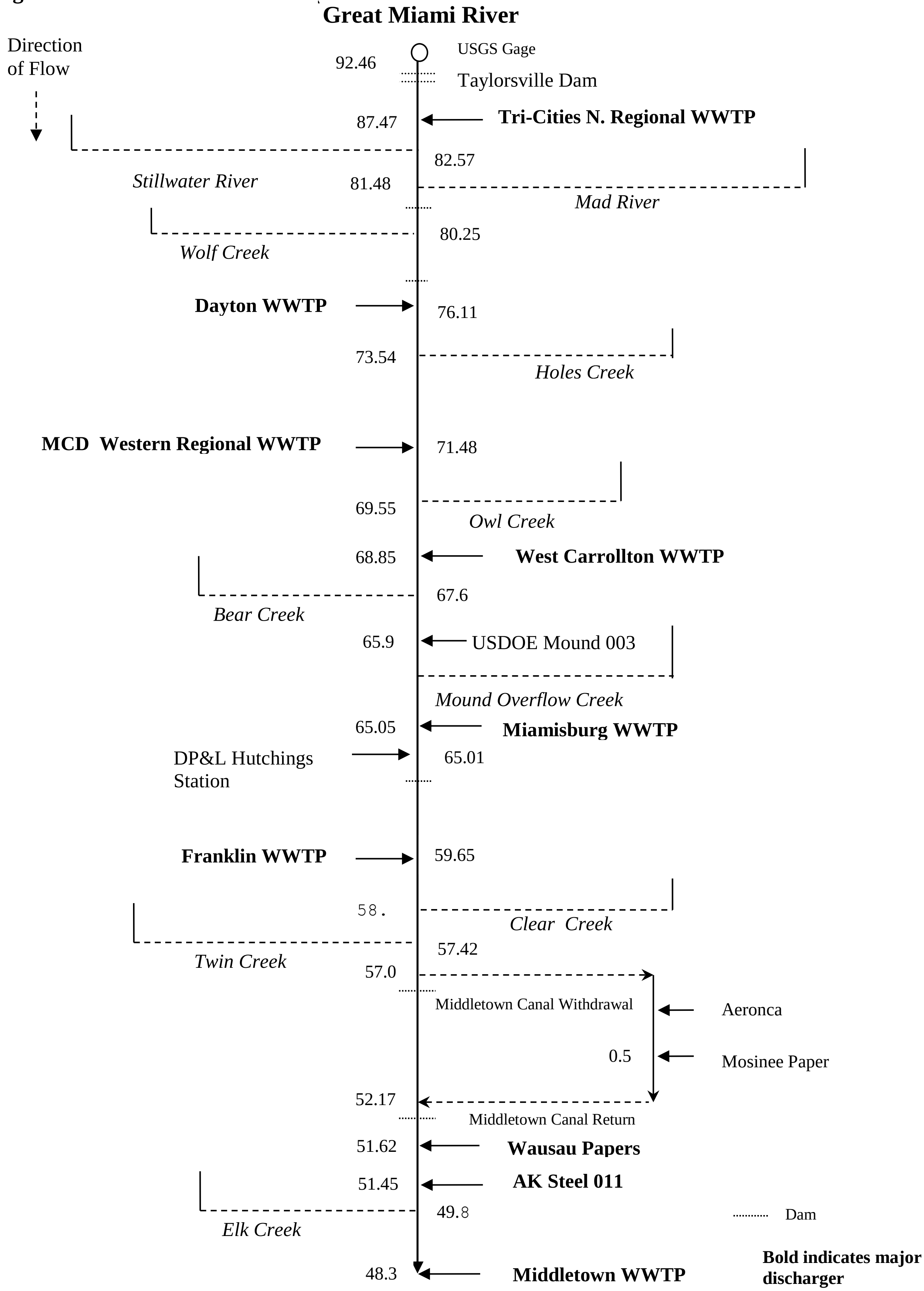

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Figure 2. Great Miami River Study Area – Continued

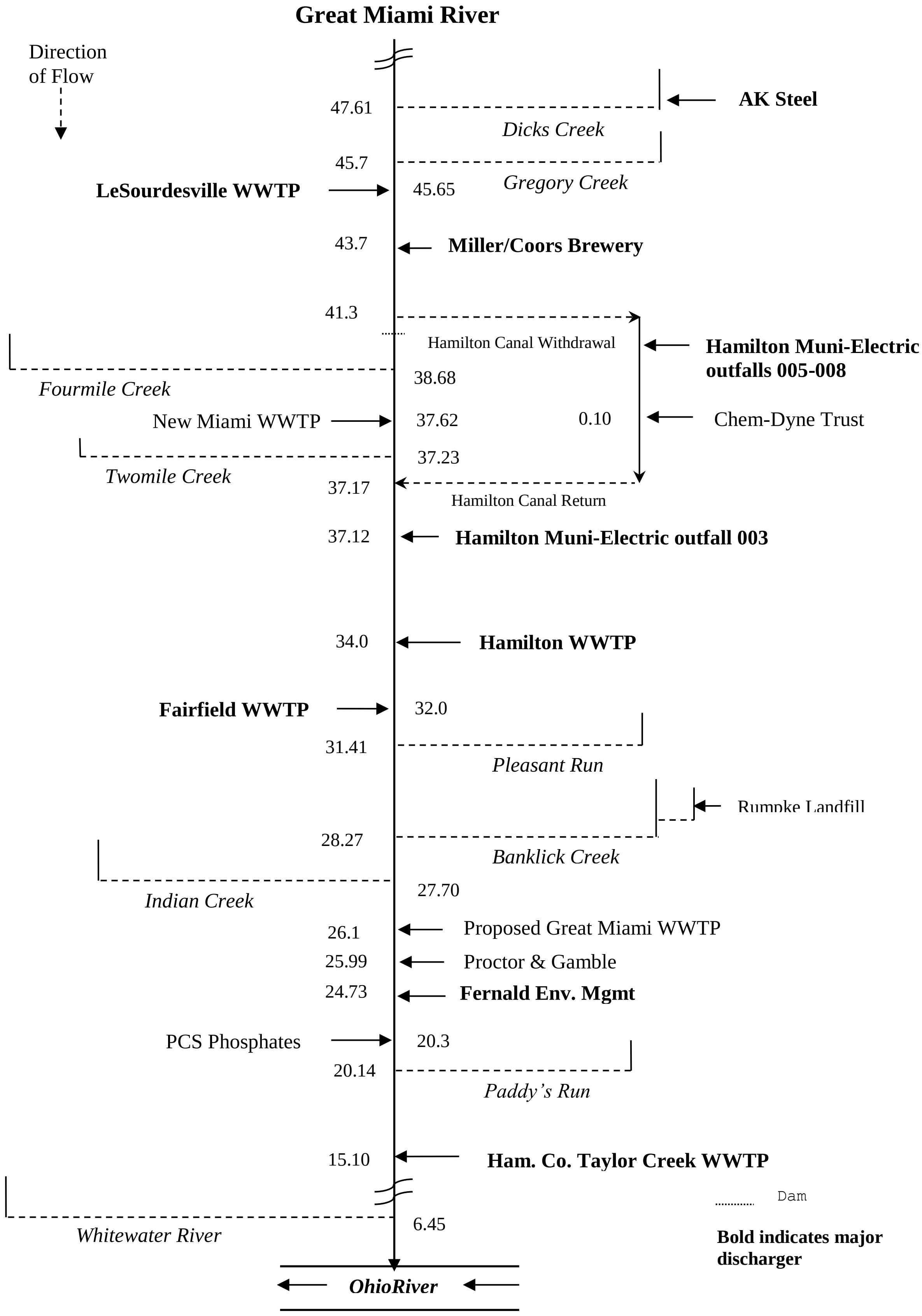

Table 1. Sewage Sludge Removal

Year	Dry Tons Removed Station 581	Dry Tons Removed Station 584
2010	1357	1702
2011	1668	304
2012	1657	--
2013	1094	--
2014	1373	--

Table 2. Annual Effluent Flow Rates

Year	Annual Flow in MGD		
	50th Percentile	95th Percentile	Maximum
2010	10.265	18.374	34.695
2011	11.712	29.010	46.534
2012	7.348	14.484	35.143
2013	7.421	14.569	35.069
2014	7.977	16.291	40.541

MGD = million gallons per day

Table 3. Sanitary Sewer Overflows Discharges

Station 027

		Overflow Total Hours		Overflow Volume	
		Hrs/day		MGAL	
Year	# of Obs.	Mean	Maximum	Mean	Maximum
2010	6	5.0	11	0.188	0.524
2011	36	12.2	24	1.028	7.679
2012	8	6.2	22	0.360	1.574
2013	11	7.0	24	1.748	6.342
2014	16	8.2	24	1.548	8.404

MGAL = million gallons

Station 037

		Overflow Total Hours		Overflow Volume	
		Hrs/day		MGAL	
Year	# of Obs.	Mean	Maximum	Mean	Maximum
2010	9	4.1	11	0.406	1.2103
2011	18	9.0	22	0.461	3.744
2012	10	2.5	8.5	0.246	1.033
2013	15	12.2	24	0.564	3.134
2014	35	7.8	24	0.406	2.507

MGAL = million gallons

Table 4. Bypass Discharges at Station 603

		Bypass Total Hours		Bypass Volume		Total Suspended Solids		$CBOD_5$	
		Hrs/day		MGAL		mg/L		mg/L	
Year	# of Obs.	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum
2010	3	10.7	24	7.210	10.676	16.3	18	59.6	84
2011	48	13.8	24	3.982	14.964	36.4	134	40.3	101
2012	10	11.1	24	2.471	5.485	45.4	166	36.5	88
2013	10	15.0	24	6.070	13.735	82.8	165	28.3	38
2014	15	15.4	24	6.010	19.904	51.5	120	25.6	46

$CBOD_5$ = five-day carbonaceous biochemical oxygen demand
MGAL = million gallons

Table 5. Effluent Characterization Using Ohio EPA and Pretreatment Data

Summary of analytical results for Hamilton outfall 1PE00002001. Units ug/l unless otherwise noted; OEPA = data from analyses by Ohio EPA; PT = data from pretreatment program reports; NA = not analyzed; AA = below detection (detection limit).

PARAMETER	OEPA 06/04/13	OEPA 12/18/12	PT 05/12/13	PT 03/20/12	PT 05/11/11	PT 03/18/10	PT 03/25/09
Arsenic	AA(2.0)	2.8	AA (5)	AA (5)	AA (1.0)	AA (50)	AA (50)
Barium	17	16	NA	NA	NA	NA	NA
Chromium	AA (2.0)	7.4	AA (5)	AA (5)	AA (2.0)	AA (20)	AA (20)
Copper	2.8	4.6	AA (5)	AA (5)	4.0	AA (20)	AA (20)
Dissolved solids, T (mg/l)	562	514	NA	NA	NA	NA	NA
Iron	103	290	NA	NA	NA	NA	NA
Nickel	4.9	13.0	AA (10)	AA (5)	AA (0.2)	AA (20)	AA (20)
Strontium	361	194	NA	NA	NA	NA	NA
Zinc	19	46	47.0	30.0	16.0	110.0	110.0
Nitrate+nitrite(mg/l)	13.9	15.5	NA	NA	NA	NA	NA
Phosphorus, T (mg/l)	2.02	1.84	NA	NA	NA	NA	NA
Bis(2-ethylhexyl) phthalate	AA (11.7)	AA (10.3)	AA (10)	AA (10)	1.4	AA (10)	AA (10)
Bromodichloromethane	1.87	AA (0.5)	AA (5)	AA (5)	AA (1.0)	AA (5)	AA (5)
Chloroform	5.01	AA (0.5)	AA (5)	AA (5)	4.7	AA (5)	AA (5)

Table 6. Effluent Characterization Using Self-Monitoring Data

Parameter	Season	Units	Current Permit Limits		# Obs.	Percentiles		Data Range
			30 day	Daily		50th	95th	
Water Temperature	Annual	C	Monitor		2097	19	26	10-29
Dissolved Oxygen	Summer	mg/l		5.0 min	1070	7.8	8.9	5.6-9.5
Dissolved Oxygen	Winter	mg/l		5.0 min	1027	8.8	9.9	5.2-10
Residue, Total Dissolved	Annual	mg/l	--	--	20	572	640	443-721
Total Suspended Solids	Annual	mg/l	30	45[a]	1665	5	14	0-153
Oil and Grease, Total	Annual	mg/l	--	--	39	1.34	2.59	0-3.1
Oil and Grease, Hexane	Annual	mg/l		10	98	1.8	6.12	0-9.9
Nitrogen, Ammonia (NH3)	Summer	mg/l	2.0	4.0[a]	833	0.13	1.36	0-4.55
Nitrogen, Ammonia (NH3)	Winter	mg/l	5.0	10.0[a]	833	0.19	2.57	0-6.86
Nitrogen Kjeldahl, Total	Annual	mg/l	Monitor		68	1.73	7	0-13.8
Nitrite Plus Nitrate, Total	Annual	mg/l	Monitor		117	4.2	15.9	0.2-26.5
Phosphorus, Total (P)	Annual	mg/l	Monitor		81	0.84	2.7	0.08-3.6
Cyanide, Free	Annual	mg/l	Monitor		69	0	0	0-0.0061
Nickel, Total Recoverable	Annual	ug/l	Monitor		69	0	5.42	0-26
Silver, Total Recoverable	Annual	ug/l	Monitor		69	0	0	0-1.2
Strontium, Total Recoverable	Annual	ug/l	--	--	20	835	1920	205-2370
Zinc, Total Recoverable	Annual	ug/l	Monitor		69	27.2	72.8	0-119
Cadmium, Total Recoverable	Annual	ug/l	Monitor		69	0	0	0-7.2
Lead, Total Recoverable	Annual	ug/l	Monitor		69	0	0	0-0
Chromium, Total Recoverable	Annual	ug/l	Monitor		69	0	0	0-0
Copper, Total Recoverable	Annual	ug/l	Monitor		69	3	16.2	0-24
Chromium, Dissolved Hexavalent	Annual	ug/l	Monitor		69	0	4.6	0-6
Fecal Coliform	Annual	#/100 ml	1000	2000[a]	582	38	349	0-62000
Flow Rate	Summer	MGD	Monitor		1073	9.84	18.5	0-46.5
Flow Rate	Winter	MGD	Monitor		1027	11.7	26.8	4.63-64.3
Flow Rate	Annual	MGD	Monitor		2100	10.7	22.4	0-64.3
Chlorine, Total Residual	Annual	mg/l		0.037	1070	0	0.029	0-0.29
Mercury, Total (Low Level)	Annual	ng/l	Monitor		69	3.5	10.3	0-13.9
pH, Maximum	Annual	S.U.		9.0	2097	7.4	7.8	6.7-9.5
pH, Minimum	Annual	S.U.		6.5	2097	7.2	7.6	6.5-7.9
CBOD 5 day	Summer	mg/l	25	40[a]	796	1	5	0-13
CBOD 5 day	Winter	mg/l	25	40[a]	809	3	7	0-37

a = weekly average limit

Table 7. Projected Effluent Quality

Parameter	Units	# of Samples	# > MDL	Average PEQ	Maximum PEQ
Self-Monitoring (DMR) Data					
Total Dissolved Solids (TDS) [A]	mg/l	22	22	630.8	709.0
Ammonia-S	mg/l	566	533	0.460	1.094
Ammonia-W	mg/l	419	355	2.186	4.355
NO_3+NO_2 [A]	mg/l	119	119	15.48	21.20
Phosphorus [A]	mg/l	83	83	2.365	3.24
Cyanide, free	µg/l	16	1	6.68	9.15
Nickel - TR [A]	µg/l	76	15	17.08	23.4
Silver	µg/l	44	1	0.964	1.32
Strontium [A]	µg/l	22	22	1917.	3214.
Zinc [A]	µg/l	76	73	62.24	94.82
Cadmium	µg/l	69	1	5.256	7.2
Lead	µg/l	69	0	--	--
Chromium - TR [A]	µg/l	74	1	4.862	6.66
Copper - TR [A]	µg/l	76	45	15.51	23.91
$Chromium^{+6}$, diss.	µg/l	69	8	3.693	5.280
Chlorine, tot. res.	µg/l	1068	453	18.40	25.20
Mercury	ng/l	69	64	13.08	20.42
Combined Other Data [B]					
Arsenic	µg/l	7	1	6.132	8.40
Barium	µg/l	2	2	47.16	64.60
Iron	µg/l	2	2	804.5	1102.
Bis(2-ethylhexyl)phthalate [C]	µg/l	7	1	6.336	8.68
Bromodichloromethane [C]	µg/l	7	1	4.095	5.61
Chloroform [C]	µg/l	7	2	7.315	10.02

[A] DMR data combined with Ohio EPA data and/or Pretreatment Program data.
[B] Combined other data sources include Pretreatment Program data and Ohio EPA data.
[C] Carcinogen
MDL = analytical method detection limit
PEQ = projected effluent quality

Table 8. Summary of Acute and Chronic Toxicity Results

	Ceriodaphnia Dubia		*Pimephales promelas*	
Date	**TU_a**	**TU_c**	**TU_a**	**TU_c**
06/15/10	AA	AA	AA	AA
06/14/11	AA	AA	AA	AA
06/19/12	AA	AA	0.8	>16
06/25/13	AA	1.06	AA	AA
06/17/24	AA	AA	AA	AA

AA = non-detection; analytical method detection limit of 0.2 TU_a, 1.0 TU_c
TU_a = acute toxicity unit
TU_c = chronic toxicity unit

Table 9. Ohio EPA Toxicity Screening Results for Outfall 001

	Ceriodaphnia dubia								*Pimephales promelas*							
	24 Hours				48 Hours				24 Hours				48 Hours			
Collection Date	UP	C	%M	TU_a	UP	C	%M	TU_a	UP	C	%M	TU_a	UP	C	%M	TU_a
12/17/12	0	0	0	ND	5	0	0	ND	0	0	0	ND	0	0	0	ND
12/18/12	NT	0	0	ND	NT	0	0	ND	NT	0	0	ND	NT	0	0	ND
12/17/12-12/18/12[a]	NT	0	0	ND	NT	0	5	ND	NT	0	5	ND	NT	0	5	ND
6/3/13	0	NT	0	ND	0	NT	0	ND	0	0	0	ND	0	0	0	ND
6/4/13	NT	0	0	ND	NT	0	0	ND	NT	0	0	ND	NT	0	0	ND
6/3/13-6/4/13[a]	NT	0	0	ND	NT	0	0	ND	NT	0	0	ND	NT	0	0	ND

[a] = 24-hour composite sample
C = laboratory control water
%M = percent mortality in 100% effluent
ND = not determined
NT = not tested
TU_a = acute toxicity units
UP = percent mortality in upstream control water

Table 10. A Summary of the Great Miami River Mainstem Use Designation Status and Causes/Sources of Impairment, 2009-10 Surveys

Location	RM	AL Use Desig.	Attain. Status	Causes of Impairment	Sources of Impairment
Upst. Tri-Cities N. WWTP	87.7	EWH	FULL		
Dst. Tri-Cities N. WWTP	85.8	EWH	PARTIAL	Ammonia (modest toxicity)	Major WWTP (Tri-Cities N. WWTP)
Upst. Mad River to Dst. Bear Creek	82.1 to 66.9	WWH	FULL		
Dst. DP&L Hutchings discharge	64.1	WWH	PARTIAL	Temperature	Industrial Thermal Discharges (DP&L)
Further Dst. DP&L to Dst. Franklin WWTP	62.6 to 58.2	WWH	FULL		
Middletown area	52.6	WWH	PARTIAL	Nutrients	Livestock (grazing or feeding operations), Crop production (crop land or dry land), Municipal point sources
Dst. Wausau Papers to Just Upst. Hamilton WWTP	51.6 to 34.2	WWH	FULL		
Dst. Hamilton WWTP	33.6	WWH	PARTIAL	Temperature	Industrial thermal discharges (Hamilton Muni-Electric Plant)
Upst. Fairfield WWTP to Upst. Banklick Creek	32.7 to 28.7	WWH	PARTIAL	Nutrients, Biochemical Oxygen Demand	Livestock (grazing or feeding operations), Crop production (crop land or dry land), Municipal point sources
Dst. Indian Creek to Upst. Taylor Creek WWTP	26.1 to 15.5	WWH	FULL		
Dst. Taylor Creek WWTP	14.8	WWH	PARTIAL	Nutrients, Biochemical Oxygen Demand	Livestock (grazing or feeding operations), Crop production (crop land or dry land), Municipal point sources
Upst. Whitewater River	8.2	WWH	FULL		

Table 11. Water Quality Criteria in the Study Area

Parameter	Units	Outside Mixing Zone Criteria: Average: Human Health	Outside Mixing Zone Criteria: Average: Agri-culture	Outside Mixing Zone Criteria: Average: Aquatic Life	Outside Mixing Zone Criteria: Maximum Aquatic Life	Inside Mixing Zone Maximum
Antimony	µg/l	4300.	--	190.	900.	1800.
Arsenic	µg/l	--	100.	150.	340.	680.
Barium	µg/l	--	--	220.	2000.	4000.
Benzene [C]	µg/l	710.	--	160.	700.	1400.
3,4-Benzofluoranthene [D]	µg/l	0.49	--	--	--	--
Benzo(a)pyrene [C]	µg/l	0.49	--	--	--	--
Beryllium [A]	µg/l	280.	100.	65.	560.	1100.
Bis(2-ethylhexyl)phthalate [C]	µg/l	59.	--	8.4	1100.	2100.
Boron	µg/l	--	--	3900.	33000.	65000.
Bromodichloromethane [C]	µg/l	460.	--	--	--	--
Cadmium [A]	µg/l	--	50.	5.9	16.	32.
Chlorine, tot. res.	µg/l	--	--	11.	19.	38.
Chlorobenzene	µg/l	21000.	--	47.	420.	850.
Chloroform [C]	µg/l	4700.	--	140.	1300.	2600.
Chromium^{+6}, diss.	µg/l	--	--	11.	16.	31.
Chromium -TR [A]	µg/l	--	100.	210.	4500.	8900.
Copper [A]	µg/l	1300.	500.	24.	40.	80.
Cyanide, free	µg/l	220000.	--	12.	46.	92.
Dibromochloromethane [C]	µg/l	340.	--	--	--	--
Dibenzo(a,h)anthracene [C]	µg/l	0.49	--	--	--	--
1,2-Dichloroethane [C]	µg/l	990.	--	2000.	9600.	19000.
1,1-Dichloroethylene [C]	µg/l	32.	--	210.	1900.	3800.
2,4-Dimethylphenol	µg/l	2300.	--	15.	140.	280.
Ethylbenzene	µg/l	29000.	--	61.	550.	1100.
Fluoride	µg/l	--	2000.	--	--	--
Heptachlor Epoxide [C]	µg/l	0.0011	--	--	--	--
Hexachlorobenzene [B C]	µg/l	0.0077	--	--	--	--
Ideno(1,2,3-c,d)pyrene [C]	µg/l	0.49	--	--	--	--
Iron	µg/l	--	5000.	--	--	--
Lead [A]	µg/l	--	100.	26.	500.	1000.
Mercury [B]	ng/l	12.	10000.	910.	1700.	3400.
Molybdenum	µg/l	--	--	20000.	190000.	370000.
Naphthalene	µg/l	--	--	21.	170.	340.
Nickel [A]	µg/l	4600.	200.	130.	1200.	2400.
Nitrate+Nitrite	mg/l	--	100.	--	--	--
Phenol	µg/l	4600000.	--	400.	4700.	9400.
Selenium	µg/l	11000.	50.	5.0	--	--
Silver [A]	µg/l	--	--	1.3	11.	22.

[A] Aquatic Life Criteria is hardness-based.
[B] Bioaccumulative Chemical of Concern
[C] Carcinogen
[D] Use Criteria for Benzo(b)fluoranthene

Table 11. Water Quality Criteria in the Study Area - Continued.

Parameter	Units	Outside Mixing Zone Criteria: Average: Human Health	Outside Mixing Zone Criteria: Average: Agri-culture	Outside Mixing Zone Criteria: Average: Aquatic Life	Outside Mixing Zone Criteria: Maximum Aquatic Life	Inside Mixing Zone Maximum
Strontium	µg/l	--	--	21000.	40000.	81000.
Tetrachloroethylene [C]	µg/l	89.	--	53.	430.	850.
Thallium	µg/l	6.3	--	17.	79.	160.
Toluene	µg/l	200000.	--	62.	560.	1100.
Total Dissolved Solids (TDS)	mg/l	--	--	1500.	--	--
1,2,4-Trimethylbenzene	µg/l	--	--	15.	140.	280.
Xylenes	µg/l	--	--	27.	240.	480.
Zinc [A]	µg/l	69000.	25000.	310.	310.	610.

[A] Aquatic Life Criteria is hardness-based.
[C] Carcinogen

Table 12. Instream Conditions and Discharger Flow

Parameter	Units		Value	Basis
Upstream Flows				
GMR at Taylorsville				
7Q10	cfs	annual	58.4	USGS gage #03263000, 1970-2012 data
1Q10	cfs	annual	42.0	USGS gage #03263000, 1970-2012 data
30Q10	cfs	summer	73.0	USGS gage #03263000, 1970-2012 data
	cfs	winter	180.3	USGS gage #03263000, 1970-2012 data
Harmonic Mean Flow	cfs	annual	299.9	USGS gage #03263000, 1970-2012 data
Mixing Assumption	%	average	100	Stream-to-discharge ratio
(GMR & Tribs.)	%	maximum	100	Stream-to-discharge ratio
Stillwater River at Mouth				
7Q10	cfs	annual	24.2	USGS gage #03266000, 1970-2012 data
1Q10	cfs	annual	20.4	USGS gage #03266000, 1970-2012 data
30Q10	cfs	summer	29.8	USGS gage #03266000, 1970-2012 data
	cfs	winter	79.4	USGS gage #03266000, 1970-2012 data
Harmonic Mean Flow	cfs	annual	143.3	USGS gage #03266000, 1970-2012 data
Mad River at Mouth				
7Q10	cfs	annual	177.8	USGS gage #03270000, 1970-2012 data
1Q10	cfs	annual	166.9	USGS gage #03270000, 1970-2012 data
30Q10	cfs	summer	210.0	USGS gage #03270000, 1970-2012 data
	cfs	winter	264.7	USGS gage #03270000, 1970-2012 data
Harmonic Mean Flow	cfs	annual	482.7	USGS gage #03270000, 1970-2012 data

Table 12. Instream Conditions and Discharger Flow - Continued.

Parameter	Units		Value	Basis
Wolf Creek at Mouth				
7Q10	cfs	annual	5.13	USGS gage #03271000, 1986-2012 data
1Q10	cfs	annual	4.18	USGS gage #03271000, 1986-2012 data
30Q10	cfs	summer	5.77	USGS gage #03271000, 1986-2012 data
	cfs	winter	14.1	USGS gage #03271000, 1986-2012 data
Harmonic Mean Flow	cfs	annual	23.3	USGS gage #03271000, 1986-2012 data
Twin Creek at Mouth				
7Q10	cfs	annual	5.04	USGS gage #03272000, 1970-2012 data
1Q10	cfs	annual	4.50	USGS gage #03272000, 1970-2012 data
30Q10	cfs	summer	7.26	USGS gage #03272000, 1970-2012 data
	cfs	winter	32.4	USGS gage #03272000, 1970-2012 data
Harmonic Mean Flow	cfs	annual	44.9	USGS gage #03272000, 1970-2012 data
Four Mile Creek at Mouth				
7Q10	cfs	annual	6.67	USGS gage #03272700, 1970-2012 data
1Q10	cfs	annual	5.84	USGS gage #03272700, 1970-2012 data
30Q10	cfs	summer	8.90	USGS gage #03272700, 1970-2012 data
	cfs	winter	24.6	USGS gage #03272700, 1970-2012 data
Harmonic Mean Flow	cfs	annual	50.2	USGS gage #03272700, 1970-2012 data
Holes Creek at Mouth				
7Q10	cfs	annual	1.16	USGS gage #03271300, 2002-2012 data
1Q10	cfs	annual	1.13	USGS gage #03271300, 2002-2012 data
30Q10	cfs	summer	3.54	USGS gage #03271300, 2002-2012 data
	cfs	winter	11.9	USGS gage #03271300, 2002-2012 data
Harmonic Mean Flow	cfs	annual	9.07	USGS gage #03272000, 2002-2012 data
Indian Creek at Mouth				
7Q10	cfs	annual	0.2	USGS gage #03274200, 1961-69 data
1Q10	cfs	annual	0.2	USGS gage #03274200, 1961-69 data
30Q10	cfs	summer	0.3	USGS gage #03274200, 1961-69 data
	cfs	winter	0.8	USGS gage #03274200, 1961-69 data
Harmonic Mean Flow	cfs	annual	1.17	USGS gage #03272800, 1960-72 data
Clear Creek at Mouth				
7Q10	cfs	annual	0.4	USGS gage #03271700, 1959-69 data
1Q10	cfs	annual	0.4	USGS gage #03271700, 1959-69 data
30Q10	cfs	summer	0.6	USGS gage #03271700, 1959-69 data
	cfs	winter	2.5	USGS gage #03271700, 1959-69 data
Harmonic Mean Flow	cfs	annual	3.0	USGS gage #03272000, 1970-2012 data
Elk Creek at Mouth				
7Q10	cfs	annual	0.4	USGS gage #03272200, 1960-67 data
1Q10	cfs	annual	0.4	USGS gage #03272200, 1960-67 data
30Q10	cfs	summer	0.6	USGS gage #03272200, 1960-67 data
	cfs	winter	2.1	USGS gage #03272200, 1960-67 data
Harmonic Mean Flow	cfs	annual	3.0	USGS gage #03272000, 1970-2012 data

Table 12. Instream Conditions and Discharger Flow - Continued.

Parameter	Units		Value	Basis
Bear Creek at Mouth				
7Q10	cfs	annual	0.85	USGS gage #03272000, 1970-2012 data
1Q10	cfs	annual	0.76	USGS gage #03272000, 1970-2012 data
30Q10	cfs	summer	1.23	USGS gage #03272000, 1970-2012 data
	cfs	winter	5.48	USGS gage #03272000, 1970-2012 data
Harmonic Mean Flow	cfs	annual	7.59	USGS gage #03272000, 1970-2012 data
Gregory Creek at Mouth				
7Q10	cfs	annual	0.26	USGS gage #03272200, 1960-67 data
1Q10	cfs	annual	0.26	USGS gage #03272200, 1960-67 data
30Q10	cfs	summer	0.39	USGS gage #03272200, 1960-67 data
	cfs	winter	1.35	USGS gage #03272200, 1960-67 data
Harmonic Mean Flow	cfs	annual	1.93	USGS gage #03272000, 1970-2012 data
Pleasant Run at Mouth				
7Q10	cfs	annual	0.04	USGS gage #03274200, 1961-69 data
1Q10	cfs	annual	0.04	USGS gage #03274200, 1961-69 data
30Q10	cfs	summer	0.06	USGS gage #03274200, 1961-69 data
	cfs	winter	0.16	USGS gage #03274200, 1961-69 data
Harmonic Mean Flow	cfs	annual	0.23	USGS gage #03272800, 1960-72 data
Banklick Creek at Mouth				
7Q10	cfs	annual	0.01	USGS gage #03274200, 1961-69 data
1Q10	cfs	annual	0.01	USGS gage #03274200, 1961-69 data
30Q10	cfs	summer	0.02	USGS gage #03274200, 1961-69 data
	cfs	winter	0.05	USGS gage #03274200, 1961-69 data
Harmonic Mean Flow	cfs	annual	0.07	USGS gage #03272800, 1960-72 data
Twomile Creek at Mouth				
7Q10	cfs	annual	0.02	USGS gage #03274200, 1961-69 data
1Q10	cfs	annual	0.02	USGS gage #03274200, 1961-69 data
30Q10	cfs	summer	0.02	USGS gage #03274200, 1961-69 data
	cfs	winter	0.06	USGS gage #03274200, 1961-69 data
Harmonic Mean Flow	cfs	annual	0.10	USGS gage #03272800, 1960-72 data
Paddy's Run at Mouth				
7Q10	cfs	annual	0.03	USGS gage #03274200, 1961-69 data
1Q10	cfs	annual	0.03	USGS gage #03274200, 1961-69 data
30Q10	cfs	summer	0.05	USGS gage #03274200, 1961-69 data
	cfs	winter	0.13	USGS gage #03274200, 1961-69 data
Harmonic Mean Flow	cfs	annual	0.19	USGS gage #03272800, 1960-72 data
Hamilton WWTP design flow				
	cfs (mgd)	avg.	49.51 (32.0)	DSW
Instream Hardness	mg/l	annual	303.	STORET/DMRs; 753 values, 2008-2013

Table 12. Instream Conditions and Discharger Flow - Continued.

Parameter	Units		Value	Basis
Background Water Quality for the Great Miami River				
Antimony	µg/l	annual	0.	No representative data available.
Arsenic	µg/l	annual	1.0	STORET; 18 values,10 <MDL, 2009-10
Barium	µg/l	annual	92.	STORET; 18 values, 0 <MDL, 2009-10
Benzene	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
Benzo(a)pyrene	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
3,4-Benzofluoranth.	µg/l	annual	0.	No representative data available.
Beryllium	µg/l	annual	0.	No representative data available.
Bis 2EHP	µg/l	annual	0.66	STORET; 5 values, 3 <MDL, 2009
Boron	µg/l	annual	0.	No representative data available.
Cadmium	µg/l	annual	0.	STORET; 18 values,18 <MDL, 2009-10
Chlorine, total res	µg/l	annual	0.	No representative data available.
Chlorobenzene	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
Chloroform	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
Chromium^{+6}, diss	µg/l	annual	0.	No representative data available.
Chromium, total	µg/l	annual	1.0	STORET; 18 values,17<MDL, 2009-10
Copper	µg/l	annual	2.1	STORET; 18 values, 5<MDL, 2009-10
Cyanide, free	µg/l	annual	0.	No representative data available.
Dibenzo(a,h)anthrac.	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
1,2-Dichloroethane	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
1,1-Dichloroethylene	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
2,4-Dimethylphenol	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
Ethylbenzene	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
Fluoride	µg/l	annual	0.	No representative data available.
Heptachlor epoxide	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
Hexachlorobenzene	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
Indeno(1,2,3,-cd)pyr.	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
Iron	µg/l	annual	468.	STORET; 18 values, 0<MDL, 2009-10
Lead	µg/l	annual	1.0	STORET; 18 values, 17<MDL, 2009-10
Mercury	ng/l	annual	0.	No representative data available.
Molybdenum	µg/l	annual	0.	No representative data available.
Napthalene	µg/l	annual	0.	STORET; 6 values, 6 <MDL, 2009
Nickel	µg/l	annual	2.95	STORET; 18 values, 0<MDL, 2009-10
Nitrate+Nitrite	mg/l	annual	1.26	STORET; 26 values, 2<MDL, 2009-10
Phenols	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
Selenium	µg/l	annual	0.	STORET; 18 values,18 <MDL, 2009-10
Silver	µg/l	annual	0.	No representative data available.
TDS	mg/l	annual	412.	STORET; 26 values, 0<MDL, 2009-10
Tetrachloroethylene	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
Thallium	µg/l	annual	0.	No representative data available.
Toluene	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
1,2,4-Trimethylbenz.	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
Xylenes	µg/l	annual	0.	STORET; 3 values, 3 <MDL, 2009
Zinc	µg/l	annual	5.0	STORET; 18 values, 13<MDL, 2009-10

Table 13. Summary of Effluent Limits to Maintain Applicable Water Quality Criteria

Parameter	Units	Average Human Health	Average Agri Supply	Average Aquatic Life	Maximum Aquatic Life	Inside Mixing Zone Maximum
Arsenic [B]	µg/l	--	399.	276.	596.	680.
Bis(2-ethylhexyl)phthalate	µg/l	322.	--	21.	2625. [A]	2100.
Cadmium	µg/l	--	198. [A]	11.	28.	32.
Chlorine, tot. res.	µg/l	--	--	18.	30.	38.
Chromium, total [B]	µg/l	--	397.	387.	7907.	8900.
$Chromium^{+6}$, diss.	µg/l	--	--	23.	32. [A]	31.
Copper	µg/l	3597. [A]	1382. [A]	33.	53.	80.
Cyanide, free	µg/l	3.17e6 [A]	--	67.	281. [A]	92.
Lead [B]	µg/l	--	377.	45.	829.	1000.
Mercury [C]	ng/l	12.	10000. [A]	910.	1700.	3400.
Molybdenum [B]	µg/l	--	--	42720.	385300. [A]	370000.
Nickel [B]	µg/l	18190. [A]	781.	236.	2092.	2400.
Selenium [B]	µg/l	42130.	191.	7.6	--	--
Silver	µg/l	--	--	2.3	18.	22.
TDS	mg/l	--	--	2360.	--	--
Zinc	µg/l	25750. [A]	93340. [A]	533.	507.	610.

[A] Allocation must not exceed the Inside Mixing Zone Maximum.
[B] This parameter would not require a WLA based on reasonable potential procedures, but allocation requested by for use in pretreatment program.
[C] Bioaccumulative Chemical of Concern (BCC); no mixing zone allowed after 11/15/2010, WQS must be met at end-of-pipe, unless requirements for an exception are met as listed in 3745-2-08(L).

Table 14. Parameter Assessment

Group 1: Due to a lack of numeric criteria, the following parameters were not evaluated at this time.

No Parameters

Group 2: PEQ < 25% of WQS or all data below minimum detection limit; WLA not required. No limit recommended, monitoring optional.

Arsenic	Barium	Bromodichloromethane
Chloroform	Chromium, tot.	Iron
Lead	Molybdenum	Nickel
Nitrate+Nitrite	Selenium	Strontium

Group 3: PEQ_{max} < 50% of maximum PEL and PEQ_{avg} < 50% of average PEL. No limit recommended, monitoring optional.

Ammonia-S&W	Bis(2-ethylhexyl)phthalate	Cadmium
$Chromium^{+6}$, diss.	Copper	Cyanide, free
Silver	TDS	Zinc

Group 4: $PEQ_{max} \geq$ 50% but <100% of the maximum PEL or $PEQ_{avg} \geq$ 50% but < 100% of the average PEL. Monitoring is appropriate.

No parameters meet the criteria of this group.

Group 5: Maximum PEQ ≥ 100% of the maximum PEL or average PEQ ≥ 100% of the average PEL,or either the average or maximum PEQ is between 75 and 100% of the PEL and certain conditions that increase the risk to the environment are present. Limit recommended.

Limits to Protect Numeric Water Quality Criteria

Parameter	Units	Applicable Period	Recommended Effluent Limits Average	Recommended Effluent Limits Maximum
Chlorine, tot. res.	µg/l	summer only	18.	30.
Mercury	ng/l	annual	12.	1700.

PEL = preliminary effluent limit
PEQ = projected effluent quality
WLA = wasteload allocation
WQS = water quality standard

Table 15. Final Effluent Limits for Outfall 001

Parameter	Units	Concentration 30 Day Average	Concentration Daily Maximum	Loading (kg/day)[a] 30 Day Average	Loading (kg/day)[a] Daily Maximum	Basis[b]
Water Temperature	°C	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP
Dissolved Oxygen	mg/L	5.0 minimum				BTJ, EP
Total Suspended Solids	mg/L	30	45[c]	3634	5450[c]	BPT, EP
Oil & Grease	mg/L	--	10	--	--	WQS, EP
Ammonia						
Summer	mg/L	2.0	4.0[c]	242	484[c]	BTJ, EP
Winter	mg/L	5.0	10.0[c]	606	1211[c]	BTJ, EP
Total Kjeldahl Nitrogen	mg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP
Nitrate+Nitrite	mg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP
Phosphorus	mg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP, SB1
Orthophosphate, Dissolved (as P)	mg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				SB1
Nickel	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP
Zinc	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP
Cadmium	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP
Lead	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP
Chromium	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP
Copper	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP
Hexavalent Chromium (Dissolved)	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP
E. coli	#/100 mL	126	284[c]	--	--	WQS, EP
Flow Rate	MGD	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP
Chlorine, Total Residual	mg/L	--	0.030	--	--	WLA
Mercury	ng/L	12	1700	0.00146	0.206	WLA
Free Cyanide	µg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M, EP
Acute/Chronic Toxicity						
Ceriodaphnia dubia	TU_a/TU_c	- - - - - - - - - - - Monitor - - - - - - - - - - - -				WET
Pimephales promelas	TU_a/TU_c	- - - - - - - - - - - Monitor - - - - - - - - - - - -				WET
pH	SU	6.5 – 9.0				WQS, EP
Total Filterable Residue (Total Dissolved Solids)	mg/L	- - - - - - - - - - - Monitor - - - - - - - - - - - -				M
Carbonaceous Biochemical Oxygen Demand (5 day)	mg/L	25	40[c]	3028	4845[c]	BPT, EP

[a] Effluent loadings based on average design discharge flow of 32.0 MGD.

[b] Definitions:
BTJ = Best Technical Judgment
BPT = Best Practicable Waste Treatment Technology, 40 CFR Part 133, Secondary Treatment Regulation
EP = Existing Permit
SB1 = Implementation of Senate Bill 1 [ORC 61111.03]
M = BTJ of Division of Surface Water NPDES Permit Guidance 1: Monitoring Frequency Requirements for Sanitary Discharges
WET = Minimum testing requirements for whole effluent toxicity [OAC 3745-33-07(B)(11)]
WLA = Wasteload Allocation procedures (OAC 3745-2)
WQS = Ohio Water Quality Standards (OAC 3745-1)

[c] 7 day average limit.

Addendum 1

Division of Surface Water
June 2015

Lower Great Miami River

Total phosphorus effluent limits for major wastewater treatment plants

Factsheet Addendum

The lower Great Miami River (GMR) was assessed for its aquatic life beneficial use in 2010 as reported in Ohio EPA's 2012 Integrated Water Quality Monitoring and Assessment Report. This study area starts at the confluence with the Mad River at river mile (RM) 81.48 and ends at the Ohio River (RM 0). Two GMR large river assessment units (05080002 90 01 and 05080002 90 02) are included in this assessment. Assessment sites within both assessment units were found to be impaired due to nutrient enrichment (RMs 52.64, 32.7, 31.4, 28.7, and 14.8). These assessment sites indicate that 14.4 river miles are directly impaired, however data show that excessive nutrient enrichment occurs throughout most of the lower GMR. The over-enriched condition begins downstream of the Dayton wastewater treatment plant (WWTP) (RM 76.11) and continues downstream to just upstream of the confluence with the Whitewater River (RM 6.45). In addition to the biological data collected in 2010, chemical and algal data were collected from 2010 through 2012 to fully document this condition: hence, this factsheet addendum outlines the scope of nutrient enrichment in light of all available data. It also documents why Ohio EPA is seeking modest point source effluent phosphorus reductions to address the enrichment. Why point to nonpoint source trading is not an acceptable means of addressing the enrichment is also explained below.

Linkage of nutrients to aquatic life use impairment

Nutrients rarely approach concentrations in the ambient environment that are toxic to aquatic life and, in small amounts, are essential to the functioning of healthy aquatic ecosystems. However, excess nutrients can manifest as multiple problems that affect the beneficial use of a stream, including causes of impairment presented in the section 303(d) list such as:

- Nutrient enrichment (biological indicators)
- Nutrient eutrophication
- Excess primary production
- Dissolved oxygen

These causes are identified by various water quality and biological indicators within the system; however, they are intrinsically linked to the root cause of excess nutrients. In general, the linkage between the causes of impairment due to nutrients can be described as follows: nutrients in excess of the needs of a balanced ecosystem increase algal and aquatic plant life production (Sharpley et al. 1994) and stimulate microbial decomposition of organic matter (Rosemond et al. 2015). This excess primary production and respiration causes negative effects, including large diel fluctuations of dissolved oxygen (DO). Large diel fluctuations of DO are caused by excessive photosynthesis (O_2 production) during daylight hours and ongoing respiration (O_2 consumption) during dark periods. These DO swings stress fish and macroinvertebrates and often result in DO concentrations that fall below DO water quality criterion.

It is important to note that large diel fluctuations in dissolved oxygen that do not cause DO criterion exceedances are stressful to biological life. Comprehensive water quality studies in the Midwest have shown that high diel fluctuations strongly correlate to declines in biological community performance (Miltner 2010; Heiskary and Markus 2003). Additionally, it is possible to see eutrophic conditions in systems where dead organic matter accumulates and decomposes resulting in a seasonal hypoxic (or anoxic) condition (Dodds 2006).

This process of eutrophication, as explained above, shifts species composition away from functional assemblages consisting of intolerant species, benthic insectivores and top carnivores typical of high quality streams. These taxa are replaced by less functionally and biologically diverse assemblages of tolerant species, niche generalists, omnivores and detritivores typical of degraded streams (Ohio EPA 1999). Such a shift in community structure lowers the diversity of the system, thus lowering the Index of Biological Integrity and Invertebrate Community Index scores. This precludes a stream from achieving its desired state of a beneficial aquatic life use.

Seasonality is an important consideration when examining eutrophication. Warm waters are required to produce enough phytoplanktonic organisms that cause shifts in DO as explained above. Light availability is also important. When streams are turbid due to storm events light penetration is not adequate to allow enough production of algae to cause eutrophic conditions. Many studies have documented streams experience eutrophication in late spring and early summer before leaf canopy shades a stream. However, later, when the canopy completely shades waters, algal production cannot proliferate enough to be deleterious to the stream (Dodds 2006). The lower GMR is too wide to be sufficiently shaded to limit photosynthetic primary production. As a result, summertime, low streamflow periods are when eutrophication negatively impacts aquatic life in the lower GMR.

Total phosphorus

Phosphorus is selected as the nutrient of concern to reduce eutrophic impacts because nitrogen is typically present in *ad libitum* concentrations in large rivers in Ohio. Miltner (2010) found that only 12 of 109 Ohio streams analyzed are not limited by phosphorus based on molar ratios. Data from the GMR indicates that it is a phosphorus limited system. Miltner also suggests that the functional difficulty in limiting nitrogen makes forcing phosphorus limitation a desirable option even in streams that are nitrogen limited. In effect, limiting the loading of phosphorus to streams reduces the impacts described above that are caused by excessive algal growth, thus addressing a stream's nutrient enrichment. Statewide total phosphorus (TP) targets for various size drainage area streams have been developed by Ohio EPA (1999) in order to address excess nutrients impacting aquatic life.

The mainstem GMR downstream of the Dayton WWTP exhibits excessive nutrient concentrations and shows signs of over enrichment. The blue dots on Figure 1 shows 7,221 TP concentration sample results monitored at the GMR in Miamisburg (RM 66.65) by Heidelberg University's National Center for Water Quality Research from 1996 to 2012. These data are presented as a concentration duration curve. This means that they are sorted based on streamflow; with high flows on the left and low flows on the right. The thick red line on this plot shows a locally weighted scatterplot smoothing or LOESS (also known as LOWESS) of the concentration data. LOESS is a method used for regressing non-parametric data and is recommended by USGS for data of this sort (Helsel and Hirsch 2002). A LOESS line is included to best understand the concentration trend through flow regimens. The black horizontal line at 0.3 mg/l concentration is the Ohio EPA TMDL TP target for large rivers (from Ohio EPA 1999). The bold, black vertical lines are present to divide up flow regimens and are only present as a reference.

Note on Figure 1 that the TP concentrations are elevated in the high flows on the left side of the plot. This is observed typically throughout Ohio's large rivers (Baker et al. 2006). This indicates the predominantly agricultural land use drained upper GMR exports a great deal of phosphorus-laden sediment during times of high flow. The middle of the plot shows TP concentrations in general below the 0.3 mg/l target. However, unlike most large rivers in Ohio, the TP concentration in the lower GMR again exceeds the target as flows recede (moving to the right) from the median flow. This is explained by the discharge from the multiple large publicly owned WWTPs with little or no TP controls, and is a strong indication of an effluent dominated system.

Through the Ambient Surface Water Monitoring Program, Ohio EPA regularly monitors the nutrient concentration of the lower GMR at a site very close to the one monitored by Heidelberg University and discussed here. While not nearly as many data points have been captured by Ohio EPA, the same trend of increasing TP concentrations during the lower stream flows has been observed.

Note that a Mann-Kendall trend test was carried out by Ohio EPA on the Heidelberg data presented in Figure 1 and determined that no long-term temporal change in concentration occurred over the years 1996-2012.

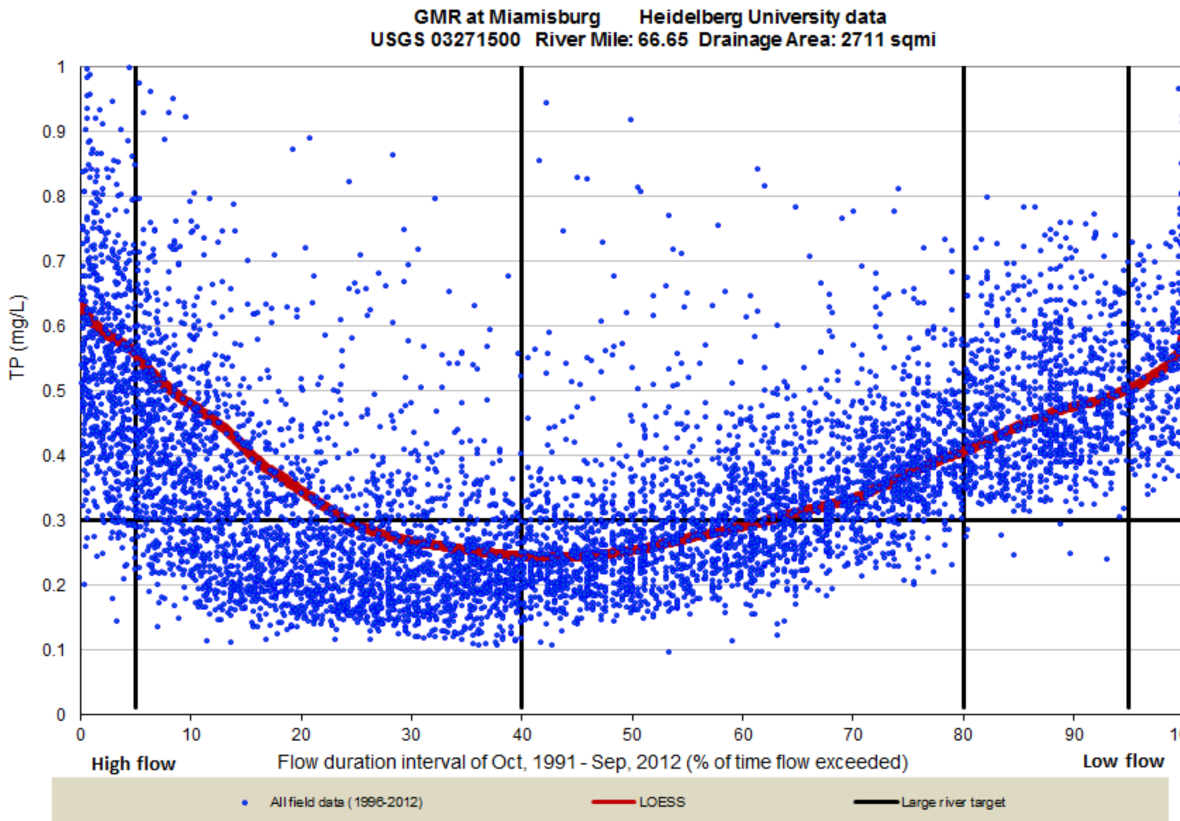

Figure 1 Concentration duration curve of total phosphorus concentrations at the Great Miami River at Miamisburg plotted along the flow duration interval, data from the Heidelberg University National Center for Water Quality Research.

Figure 2 shows a similar plot to Figure 1 except instead of TP this plot represents dissolved reactive phosphorus (DRP) concentrations. This parameter is a fraction of TP that is most readily utilized by algal primary production, the process that drives eutrophic nutrient enrichment. Ohio EPA does not currently have a target for this parameter. Note that the DRP concentration is not elevated during times of high streamflow (the left half of the plot). This is because the TP that is present during high flows is predominantly attached to sediment particles and therefore not dissolved in solution. However similar to TP in Figure 1, the DRP concentrations increase as flow recedes from the median flow, and continue to increase as flows recede to the lowest flow (the right half of the plot). The TP present in properly functioning WWTP effluent is predominantly in the DRP form. Therefore Figure 2 offers more evidence that WWTP discharges are a very significant source of the elevated TP concentrations in the lower flows of the lower GMR.

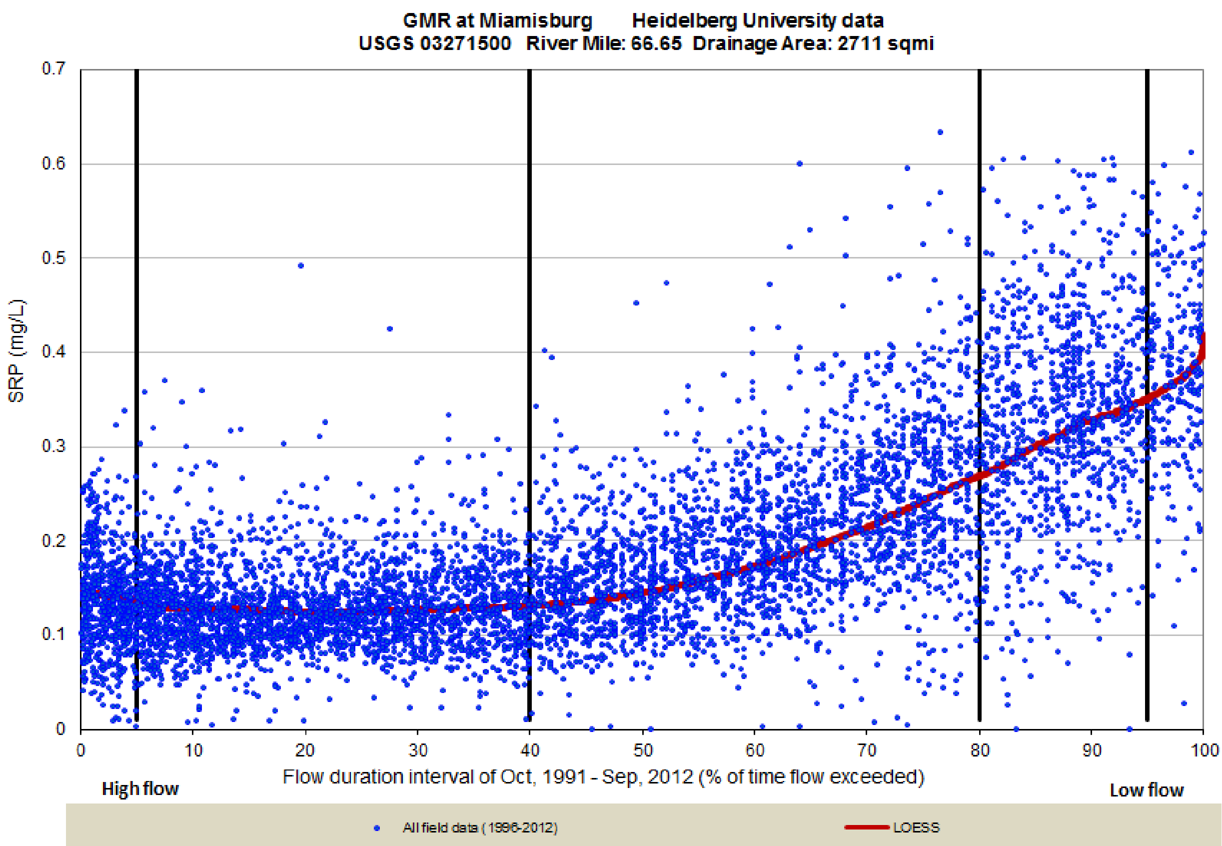

Figure 2 Concentration duration curve of soluble reactive phosphorus concentrations at the Great Miami River at Miamisburg plotted along the flow duration interval, data from the Heidelberg University National Center for Water Quality Research.

Figure 3 is a schematic of the lower GMR's point sources and tributaries; low head dams are also indicated on this schematic. Major WWTPs are denoted by bold face text in this figure. The GMR is unique in Ohio regarding the large amount of wastewater it receives.

Figure 4 shows a typical TP survey Ohio EPA carried out on the lower GMR on August 23-25, 2010. TP concentrations from upstream to downstream (left to right) are shown as blue diamonds. Labels along the top of the plot indicate the discharge locations of the major WWTPs. Labels along the bottom show several tributaries. Notice that downstream of the Dayton WWTP the river experiences a large jump in TP concentration, causing it to exceed the 0.3 mg/l target. Moving downstream the TP concentration decreases slightly due to attenuation, with periodic increases caused by additional WWTP discharges.

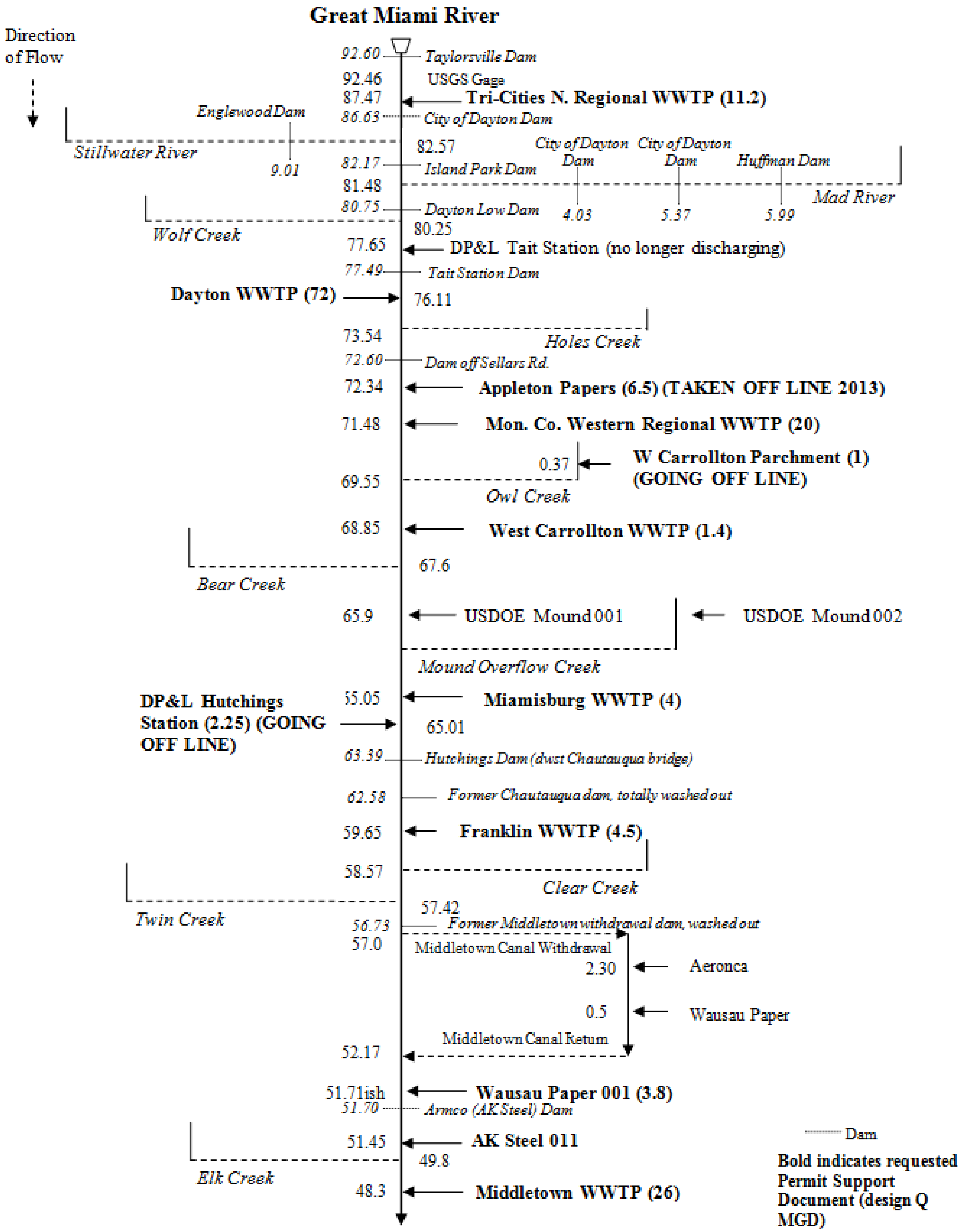

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Figure 3 Schmatic of the lower Great Miami River with point sources, dams and tributaries noted (upper half). Major plants are noted in bold, and their average design flow in million gallons per day are noted in parentheses.

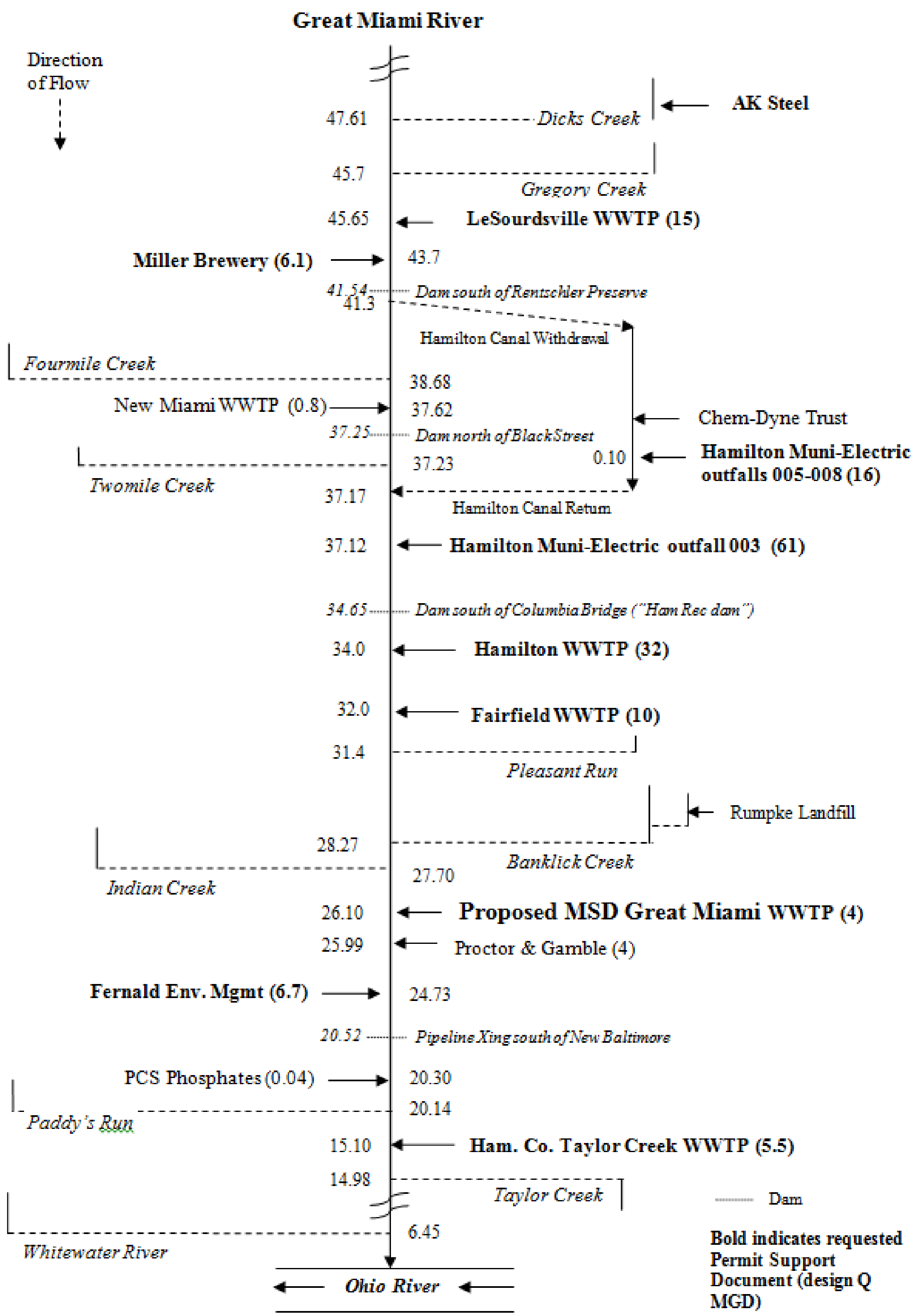
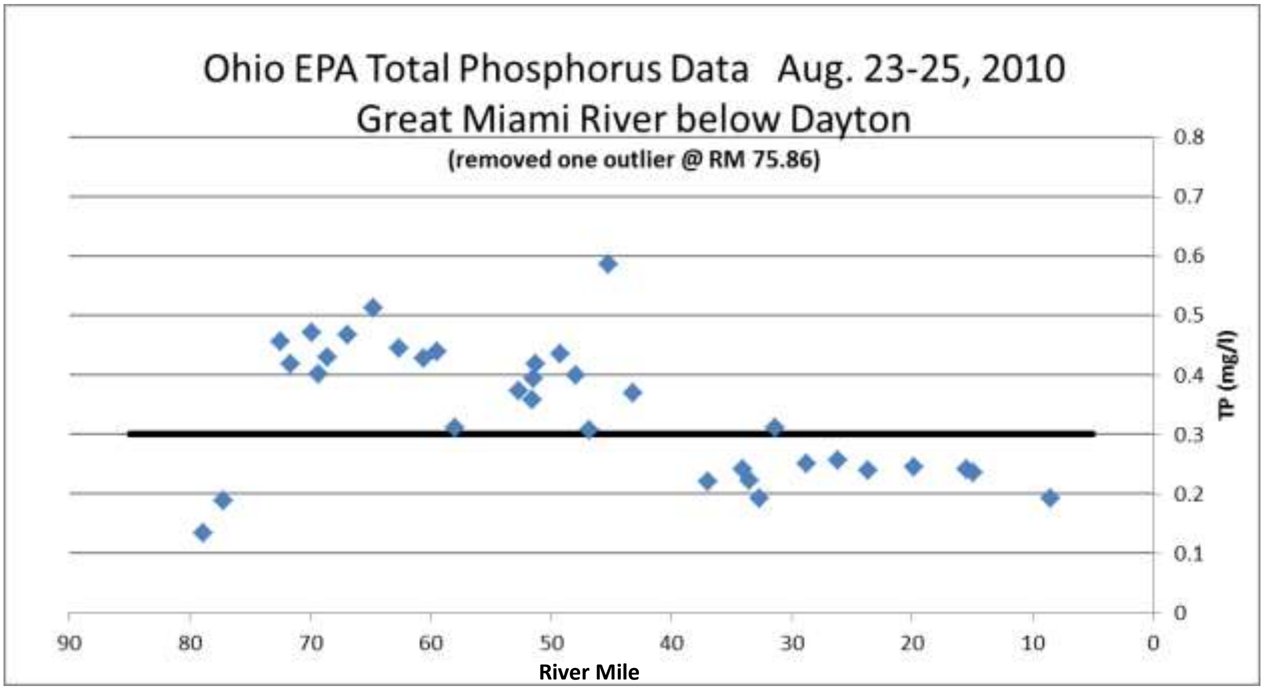


Figure 3 (continued) Schmatic of the lower Great Miami River with point sources, dams and tributaries noted (lower half). Major plants are noted in bold, and their average design flow in million gallons per day are noted in parentheses.



RM	Point source		RM	Point source
76.11	Dayton WWTP		45.65	LeSourdsville WWTP
72.34	Appleton Papers*		43.70	Miller Brewery WWTP
71.48	Mon. Co. W. Reg.		37.12	Ham. Muni-Electric 003
68.85	W.Car. WWTP		34.00	Hamilton WWTP
65.05	M.burg WWTP		32.00	Fairfield WWTP
59.65	Franklin WWTP		27.10	New MSD plant
51.71	Wausau Paper 001		24.73	Fernald WWTP
51.45	AK Steel 011		20.30	PCS Phosphates
48.30	M.town WWTP		15.10	Ham Co Taylor Ck WWTP

RM	Tributary
82.57	Stillwater R
81.48	Mad River
80.25	Wolf Creek
69.55	Owl Creek
47.61	Dicks Creek
41.30	Ham. canal withdrawal
37.17	Ham. canal return

* Appleton Papers has ceased direct discharge to the Great Miami River since these data were collected.

Figure 4 Total phosphorus concentrations during August 23-25, 2010 from upstream to downstream in the lower Great Miami River and tables explaining the labels on the plot.

Figure 5 shows a summary of the TP concentrations in four surveys conducted by Ohio EPA in 2010, and includes the data in Figure 4. All of these surveys occurred during relatively steady state, low streamflows. Additionally, all of these surveys show the same trend of elevated TP concentrations downstream of the Dayton WWTP.

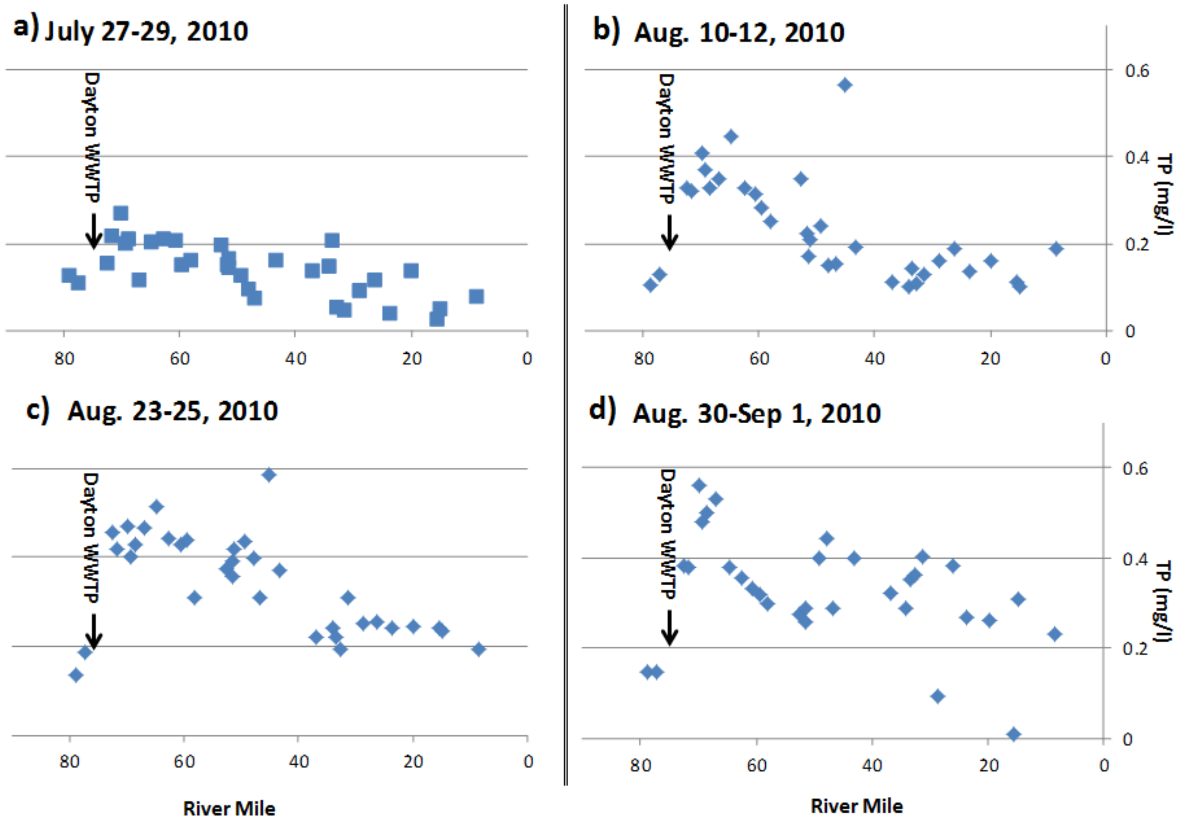


Figure 5 Total phosphorus concentration from four 2010 surveys from upstream to downstream

Chlorophyll *a*

Sestonic (or suspended) chlorophyll *a* (henceforth referred to as "chlorophyll") is a parameter monitored in large rivers (>200 mi^2 drainage area) as an indicator of the concentration of phytoplanktonic organisms (Royer et al. 2008). (Note that periphyton or benthic algae chlorophyll *a* is the parameter that Ohio EPA is currently using to develop nutrient water quality standards for smaller streams; draining areas up to 1,000 square miles.) Figure 6 shows the chlorophyll concentrations as blue diamonds along the lower GMR during a similar time period as the TP data presented in Figure 4. The labels used in Figure 6 are also the same as in Figure 4. The shading in Figure 6 indicate a potential for enrichment with concentrations 40-100 ug/l and over enriched conditions at concentrations >100 ug/l. These thresholds are based on Miltner 2010 and Dodds 2006. Note the sample upstream of Dayton WWTP (the first sample on the left) is on the bottom of the potential for enrichment zone. However the chlorophyll concentrations increase markedly downstream of the Dayton WWTP, and by river mile (RM) 65 this parameter indicates that the river is over enriched throughout the remainder of the lower GMR.

The Heidelberg University data presented in Figures 1 and 2 were collected at RM 66.65. Note on Figure 4 that the TP is elevated above the target concentration at this point during the Ohio EPA August, 2010 data collection. At this river mile the chlorophyll data on Figure 6 indicate only a potential for enrichment however very close downstream the chlorophyll data crosses the threshold to become over enriched. This observation is viewed as the river's response to the nutrient loading from the Dayton WWTP, and to a lesser degree continued loading from other WWTPs, in growing more algal material. This phenomenon is a well-documented interaction between phosphorus loads and residence time (Jarvie 2013, Bowes et al. 2012).

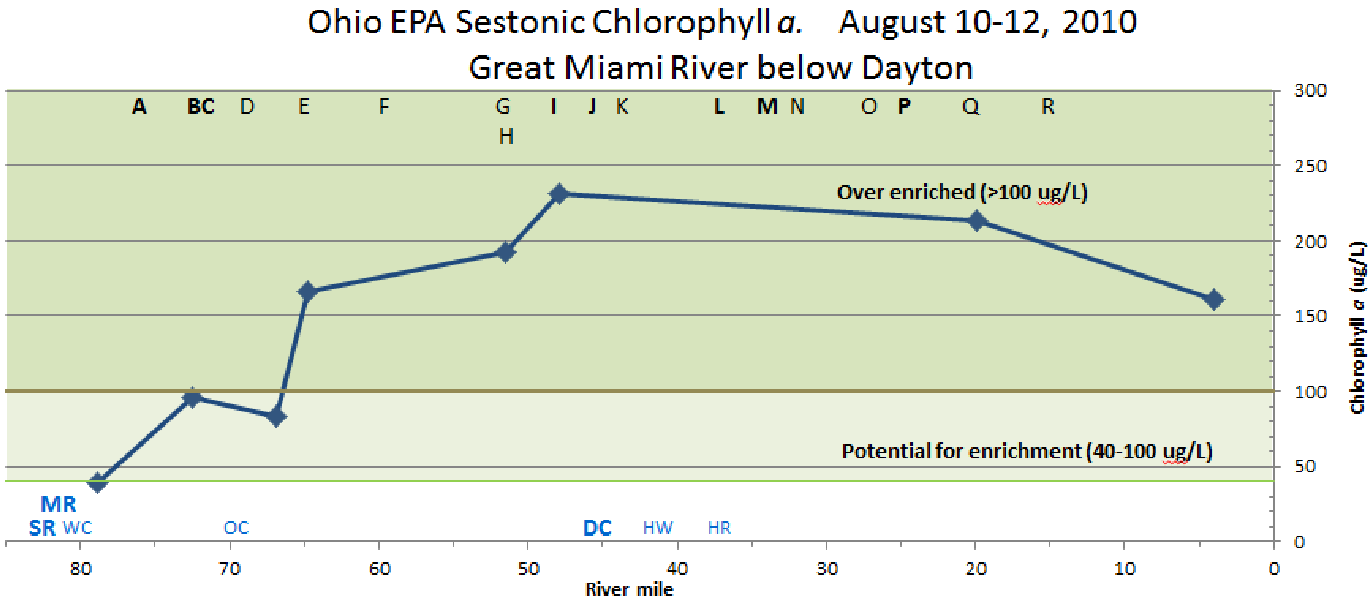


Figure 6 Sestonic chlorophyll *a* concentrations during August 10-12, 2010 from upstream to downstream in the lower Great Miami River. The tables in Figure 4 above explain the labels on the plot.

Several additional chlorophyll sampling events by the Ohio EPA agreed with these findings (84 samples collected during 8 different surveys in 3 years of study, 80% of those samples >40 ug/l and 40% > 100 ug/l). One sample collected in July 2011 near Middletown resulted in 280 ug/l chlorophyll, the highest value found in a lotic system the Ohio EPA's laboratory has ever observed. That high value is included in Figure 7 which shows two additional surveys chlorophyll data. Figure 8 presents a summary of the results of all chlorophyll data collected in the lower GMR 2010-2012.

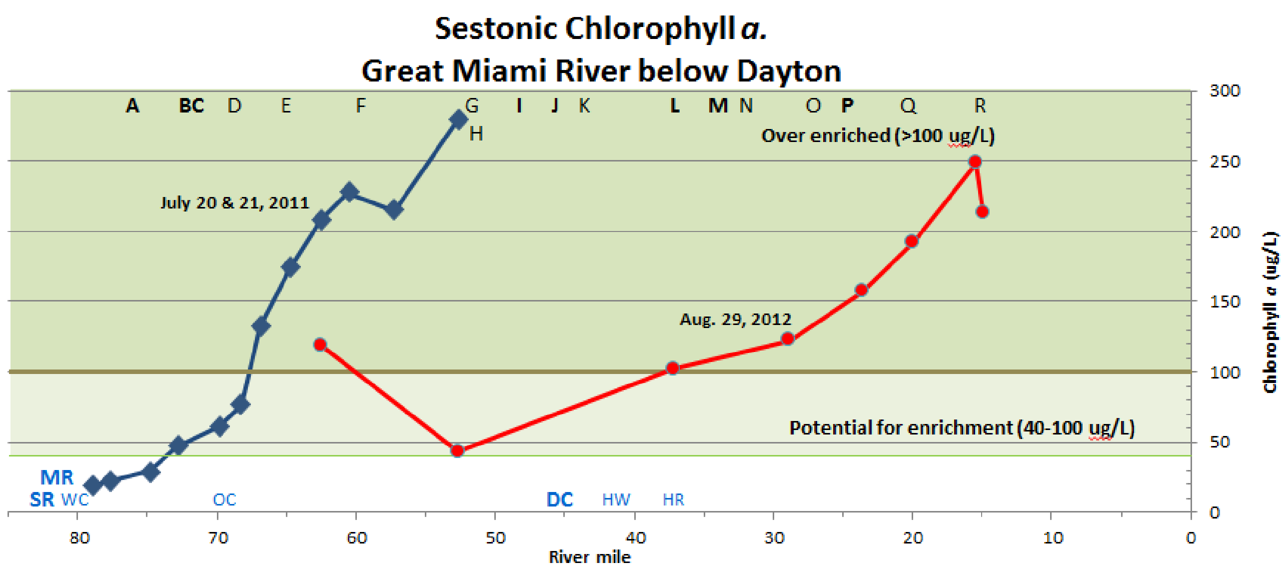


Figure 7 Sestonic chlorophyll *a* concentrations during two surveys, July 20-21, 2011 from Dayton to Middletown (in blue) and August 29, 2012 from Franklin to Miamitown (in red). The tables in Figure 4 above explain the labels on the plot.

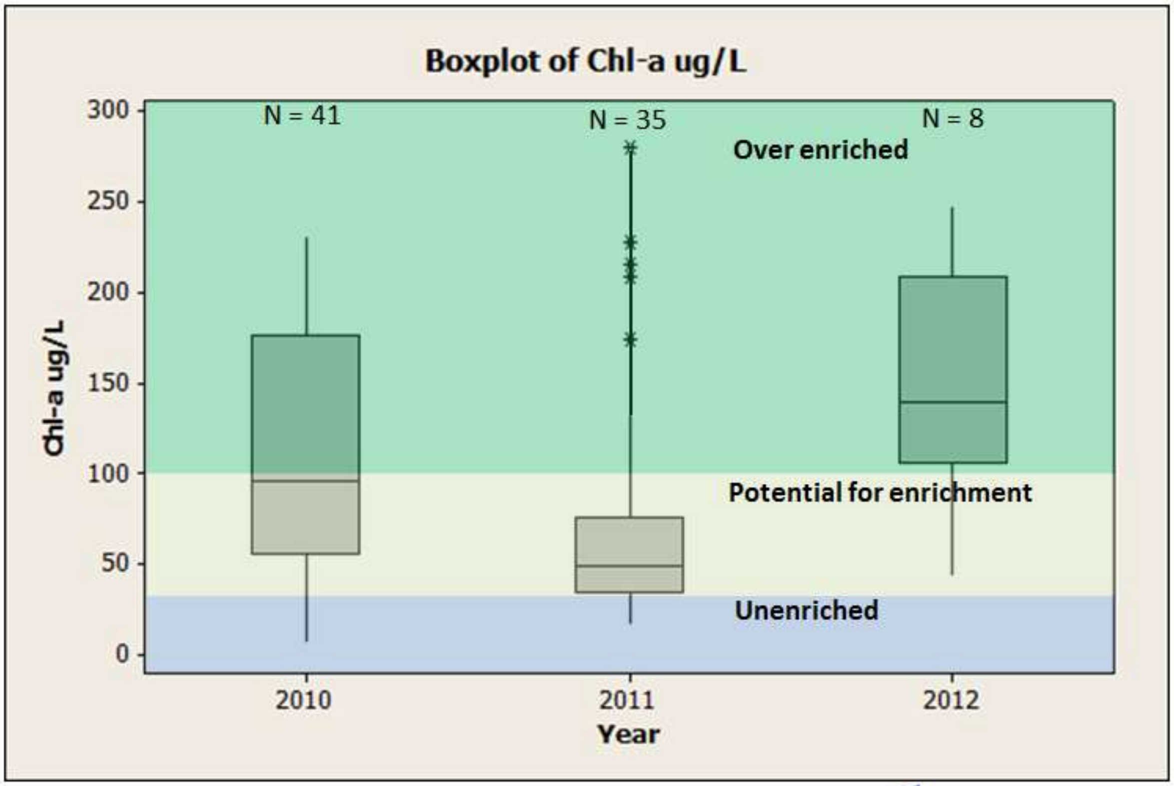


Figure 8 Sestonic chlorophyll *a* concentrations results of all lower GMR Ohio EPA collected data in 2010, 2011 and 2012.

Low head dams and dam pools upstream of these structures are present throughout much of the lower GMR, and the presence of these dams is very likely a contributor to the excessive enrichment. However, chlorophyll data indicate little to no enrichment upstream of Dayton WWTP, as noted in both Figures 6 and 7. This is a stream reach with several dam pools similar to downstream enriched reaches. This provides evidence that the enrichment is primarily fueled by the large nutrient loadings from the Dayton WWTP and downstream.

Dissolved oxygen

Dissolved oxygen (DO) concentrations observed during surveys also confirm enrichment starting around RM 65 and continuing downstream. Figure 9 shows the diel 24-hour range of concentrations at nineteen sampling locations from July 6-7, 2010. These data are presented in the form of boxplots where the horizontal line in the middle of each box sampling site is the median concentration observed. The top and bottom of each box is the 75th and 25th percentiles respectively. Finally the tip of the tails above and below each box shows the maximum and minimum of each sampling site respectively. As noted above, enrichment processes cause DO to swing high during sunlight hours due to photosynthesis and low during the night due to continued respiration. A maximum to minimum range of greater than 9 mg/l is considered by Ohio EPA to be a sign of excessive nutrient enrichment in wadeable streams and small rivers. To put this range into context, Gammons et al. (2011) reported a 24 hour DO range of 9 m/l from Silver Bow Creek, and noted that that range was among the largest reported in the literature. Also, a range of 5 mg/l is considered a sign of over-enrichment in large, eutrophic Minnesota rivers due to a strong negative correlation between increasing 24-h DO swings and decreasing biological condition (Heiskary et al. 2010). The boxes for sites where this was observed are filled in green on Figure 9. Note that the location of the low head dams throughout the lower GMR in addition to the major point sources and tributaries are labeled on this figure. Similar to the inference drawn from the sestonic chlorophyll shown in Figures 6 and 7, DO data do not indicate excessive enrichment in the areas through the City of Dayton, where several dam pools are present. However about ten river miles downstream of the Dayton WWTP DO diel ranges do show signs of enrichment, and this enrichment continues downstream.

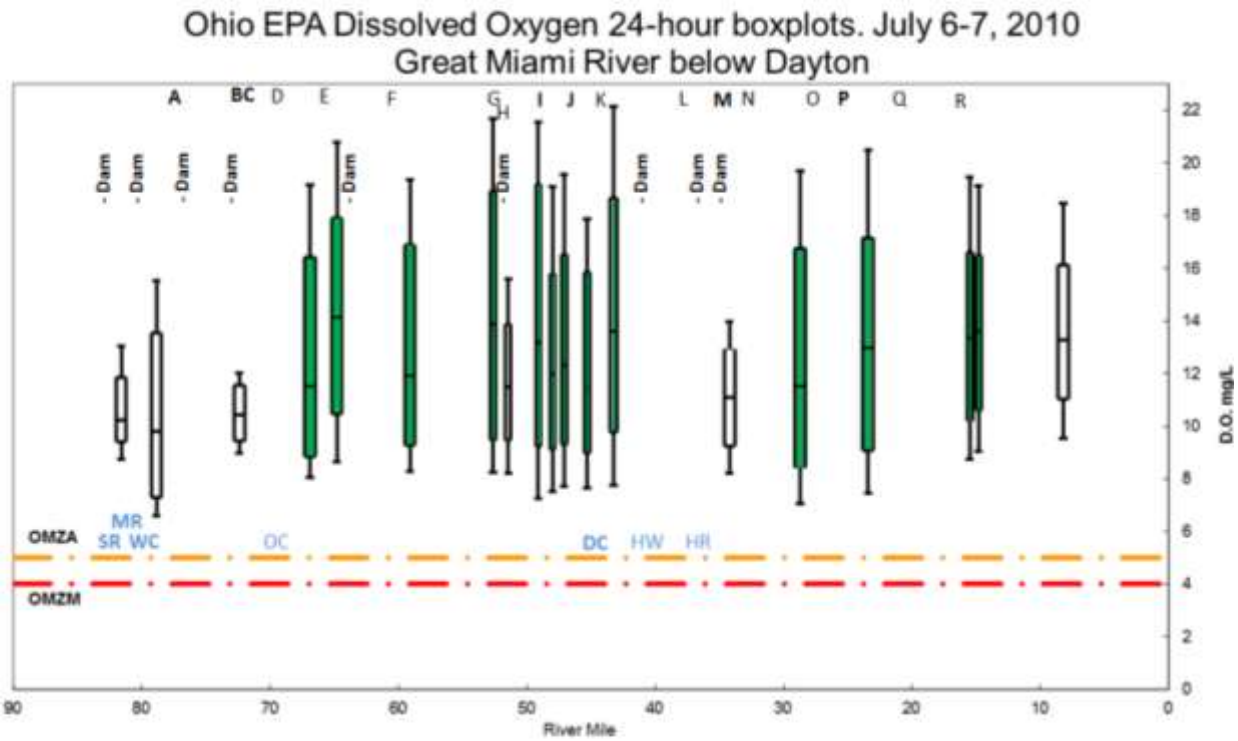


Figure 9 24-hour dissolved oxygen boxplots during July 6-7, 2010 from upstream to downstream in the lower Great Miami River. Sites filled in with green exceed 9 mg/l dissolved oxygen in the 24-hour period. The tables in Figure 4 above explain the labels on the plot.

Ohio EPA has documented enrichment in the GMR in three consecutive years. Figure 10 shows another 2010 DO survey on the lower GMR. In the free flowing river reach downstream of the Fairfield WWTP (labeled "N") diel ranges greater than 9 mg/l again are observed. Figure 11 shows a 2011 DO survey that focused only on the upper half of the lower GMR (from Dayton to Middletwon). Note on this plot that diel ranges greater than 9 mg/l are observed just downstream of Dayton WWTP and continue downstream at all observed points but two. On Figure 11 it is easy to note that enrichment persists in free flowing waters well downstream of the Hutchings Dam at RM 64.4. Figure 12 shows a 2012 survey DO survey that examined the river from Hamilton and downstream. Here again excessive enrichment was observed in a dam pool and at multiple free-flowing sites.

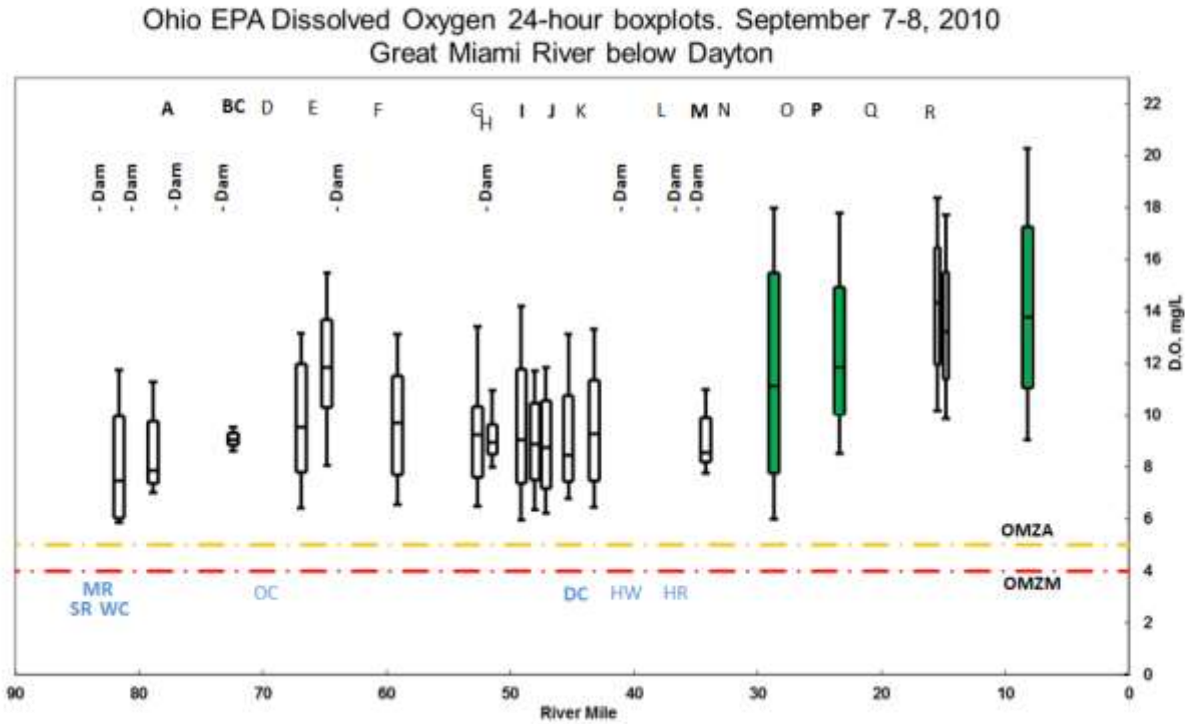


Figure 10 24-hour dissolved oxygen boxplots during September 7-8, 2010 from upstream to downstream in the lower Great Miami River. Sites filled in with green exceed 9 mg/l dissolved oxygen in the 24-hour period. The tables in Figure 4 above explain the labels on the plot.

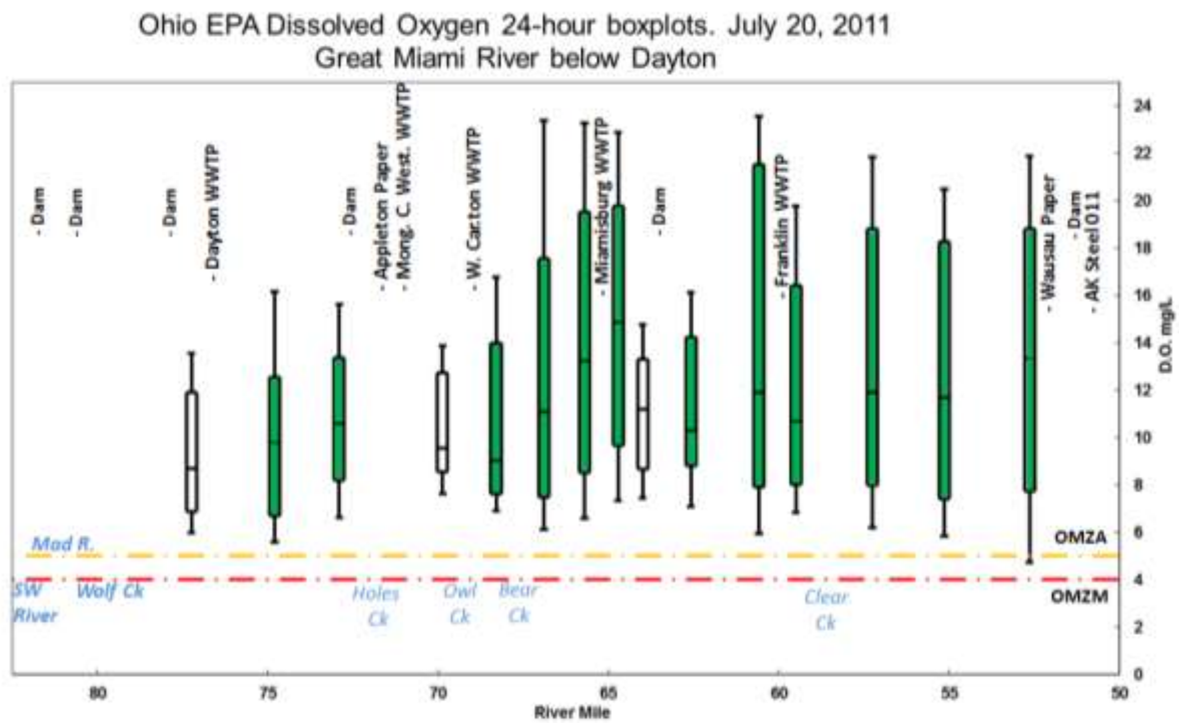


Figure 11 24-hour dissolved oxygen boxplots during July 20, 2011 from upstream to downstream in the upper half of the lower Great Miami River. Sites filled in with green exceed 9 mg/l dissolved oxygen in the 24-hour period. Note the change in scale on the DO axis compared to the previous DO plots; required due to super-saturated dissolved oxygen findings.

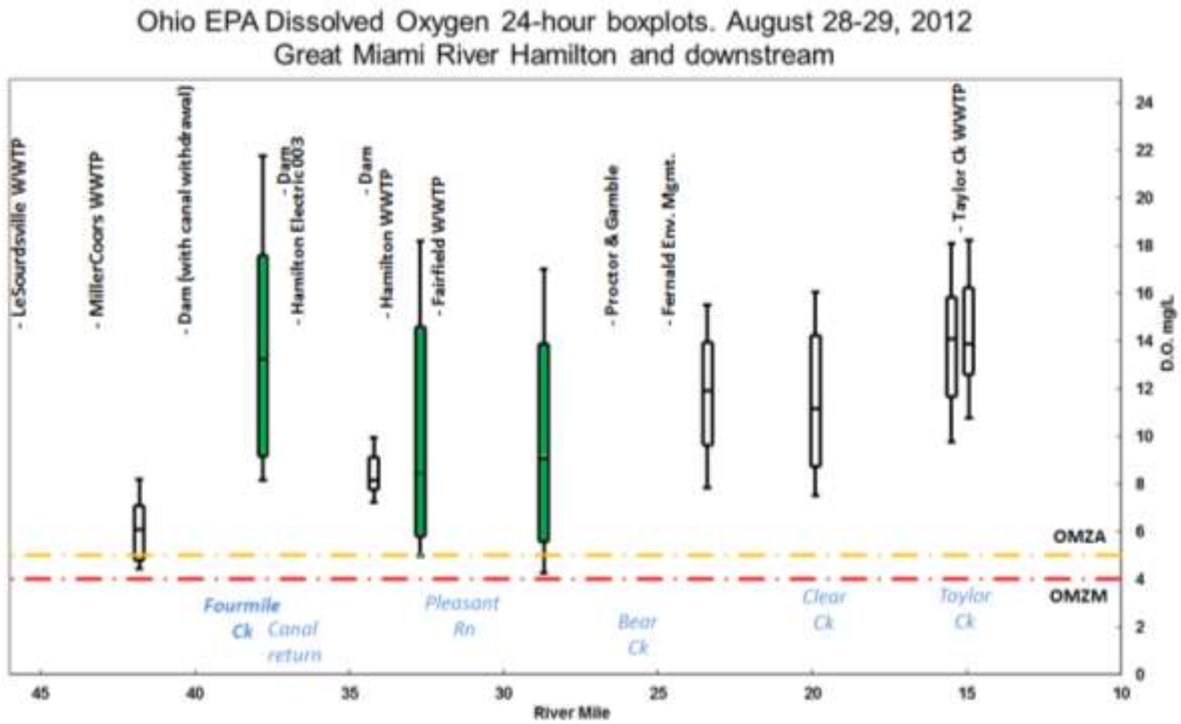


Figure 12 24-hour dissolved oxygen boxplots during August 28-29, 2012 from upstream to downstream in the lower third of the lower Great Miami River. Sites filled in with green exceed 9 mg/l dissolved oxygen in the 24-hour period.

Accounting and interactions of phosphorus

The phosphorus component that is most relevant to eutrophication in streams is soluble reactive phosphorus (SRP) (Baker 2011). Total phosphorus is used instead of SRP to develop TMDLs and permit limits because TP is the most commonly monitored species of phosphorus in waters, and it includes the reactive component. Figure 13 shows the ratio of soluble reactive phosphorus to total phosphorus using the same data from Heidelberg University's monitoring station in Miamisburg that is shown above in Figures 1 and 2. This plot clearly indicates that phosphorus in the dissolved form is the predominate species present in the river in lower streamflow conditions, the right side of the plot. Considering the large phosphorus loads from Dayton WWTP and several other major WWTPs, this clearly indicates that the high concentration of phosphorus in the lower GMR at lower flows is nearly entirely from WWTP effluent.

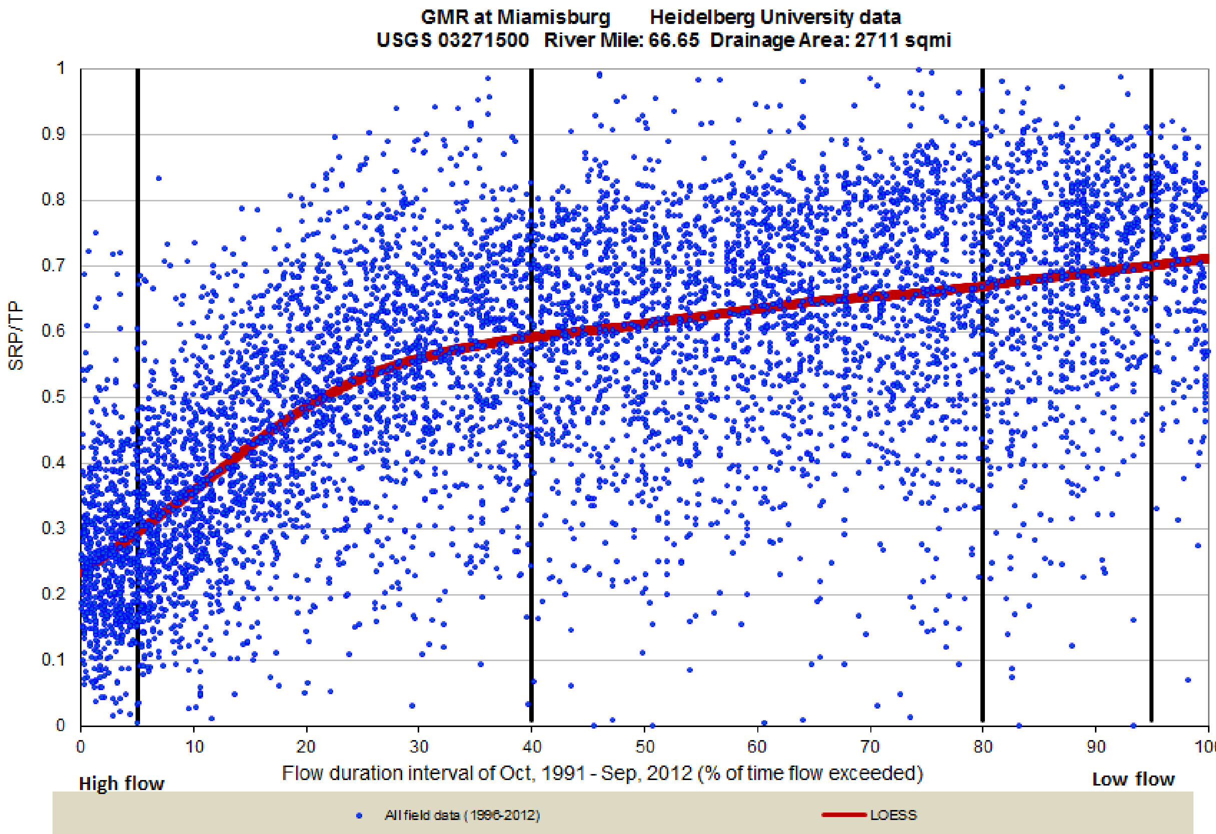


Figure 13 The ratio of soluble reactive phosphorus to total phosphorus concentrations at the Great Miami River at Miamisburg plotted along the flow duration interval, data from the Heidelberg University National Center for Water Quality Research.

Accounting of all lower GMR contributing sources of flows and TP concentrations can be carried out to further show that the lower GMR's TP load is dominated by the WWTPs that directly discharge to the river. This accounting has been calculated using two different background flow conditions for this document.

1) The first condition is that of a "typical" existing summer time day. Gaged and observed streamflow from a low flow period in August 2011 are used for the upstream and tributary flows for this condition. Discharger reported flows from the same time period are used for the point source flows. TP concentrations used are those that were sampled by Ohio EPA during this same time period for all sources.
2) The second background condition examines the TP load contributions based on average daily reported wastewater discharger flows from July through October for a five year period (2010-2014) and tributary and upstream streamflows set at the summertime seven-consecutive day, 10-year recurrence interval (7Q10) flow statistic. This flow statistic is the critical low flow value that is used when calculating conservative (e.g., metals) wasteload allocations for NPDES permitted dischargers. The TP concentrations used to calculate the loads for this second background condition are the same as the first condition.

For these calculations stream flow from to the DPL Hutching's Station, Miamisburg Canal and Hamilton Canal (including the Hamilton Power Station) are not accounted for. This is because the flow from these sources are diverted and then returned to the river.

Figure 14 shows the results of these two loading conditions as the two pie charts on the left half of the figure. These pie charts show that the lower GMR direct point sources are responsible for 68.6% of the TP load contributing to this section of the river on a typical summer day, and 85.3% of the load during the lower background flow 7Q10 condition. The two pie charts on the right half of Figure 14 show the show the relative contributions of streamflow from the flow data used to determine the TP loadings. These pie charts show that the direct lower GMR point sources make up 25.3% of the typical summer day's flow and 45.1% during the 7Q10 flow condition.

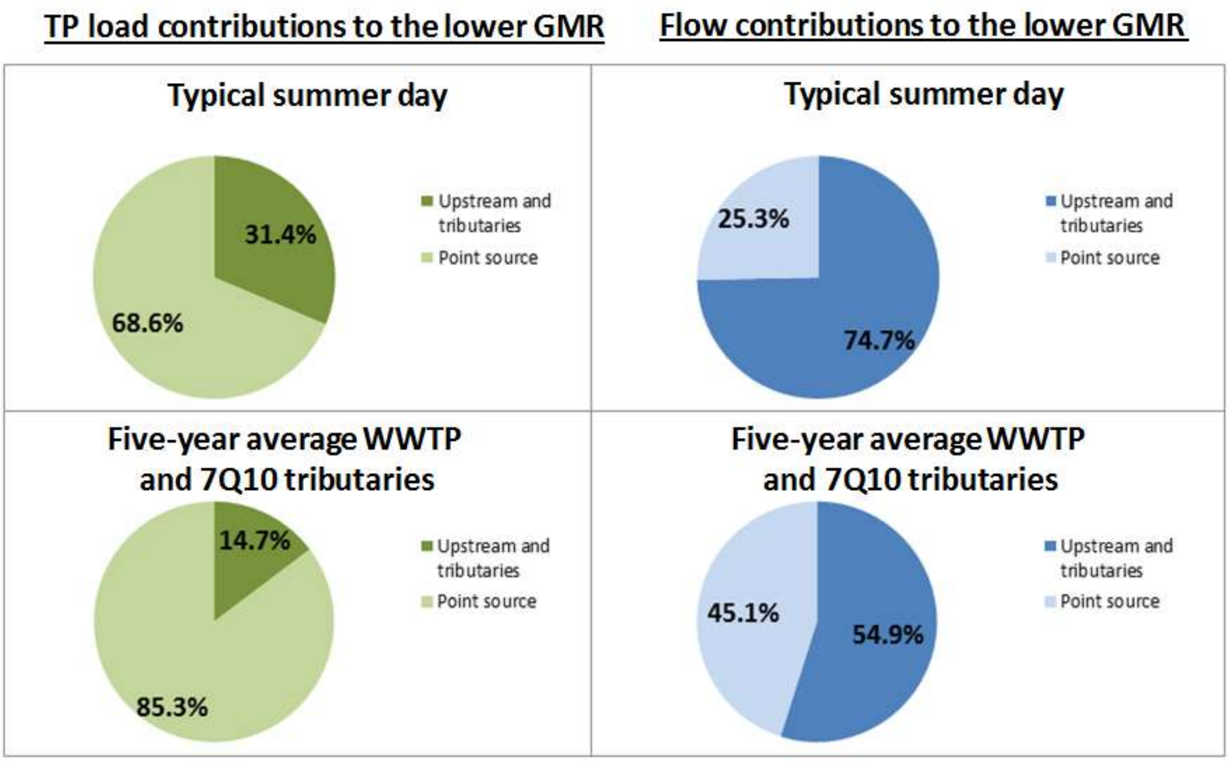


Figure 14 Relative total phosphorus load (left charts) and flow (right charts) contributions to the lower GMR from upstream/tributaries and direct lower GMR point sources. Flow conditions are set at a typical low flow, summer day using August 2011 (upper charts), and with point sources set at their 5-year average discharge flow and upstream/tributary flows set at the 7Q10 flow statistic (lower charts).

In a presentation and corresponding paper Baker et al*.* 2006 specifically notes the lower GMR within a discussion of point source to nonpoint source phosphorus trading in Ohio. In the paper Dr. Baker and colleagues delineate that the effluent borne phosphorus should be considered to have the greatest impact on excessive biological deleterious enrichment. This is because it is during the summertime low flow condition that excessive primary production occurs. Furthermore during low flow conditions other water sources are reduced and therefore offer much less dilution to the WWTP effluent. The ample dissolved nutrients delivered to the GMR from the WWTPs vastly overcome any other mechanisms of nutrient uptake by algae; as discussed below.

Baker et al 2006 also notes that accounting for phosphorus loading into the GMR during low flows the river delivers less phosphorus than it receives from WWTP contributions. Three mechanisms explain this phosphorus attenuation. First, direct algal uptake of phosphorus occurs. Next phosphorus is converted into biomass (*i.e.* fish and other aquatic life) as consumption occurs up the food web. Settling of algae and other aquatic life occurs and can incorporate phosphorus into bed sediments. This documented attenuation is an indication that the river system will respond to phosphorus reduction management.

In addition to the phosphorus being settled to the streambed from algae/biomass, phosphorus rich sediment runoff from the upstream contributing watersheds to the lower GMR delivers great loads of TP downstream throughout the year. Recall that the left side of Figure 1 shows large concentrations of TP during high flows at the Heidelberg sampling station. Furthermore, Figure 13 shows TP that consists of less than 50% soluble reactive phosphorus in 18% of the highest flows (note the change in slope of the red LOESS line around the 18 exceedance percentile flow on the X-axis). While much of the TP is exported out of the watershed during times of high flows, some does settle onto the river substrate, especially so in dam pools. The fate of phosphorus settled within river substrates is next examined.

Internal loading

It has been well documented that in stream systems substrate sediment may provide an "internal" phosphorus load that contributes to low flow summertime algal growth. This is dependent on the mass and aerial extent of fine sediment in the stream, sediment temperature and chemistry, overlying water column concentration and the equilibrium phosphorus concentration (EPC_0) of the substrate sediments (Taylor and Kinishi 1971; Kunishi et al. 1972; Meyer 1979a; Meyer 1979b). This process involves phosphorus that is locked in stream sediments desorbing to become bioavailable within the stream. The inverse can occur in which water column phosphorus can be sorbed into the stream substrate sediment. In general, for a given stream, if the overlying water column phosphorus concentration is less than the substrate's EPC_0, desorption of substrate phosphorus to the water column will occur. The reverse will happen when the overlying water column concentration is greater than the substrate substrate's EPC_0.

Ohio EPA 2015 has developed an evaluation of stream phosphorus critical conditions documenting these processes in detail as they relate to Ohio's streams. In this paper Ohio EPA used nutrient accounting to document streams where phosphorus internal loading via desorption occurs and where phosphorus sorption to the substrate occurs following the EPC_0 concept in tributaries to the GMR.

A Sharpley et al. 2007 study examined the nature of streambed sediments in relation to the EPC_0 concept. This research and the Ohio EPA 2015 paper found that substrates consisting of silts containing a great deal of clay are most favorable for holding more phosphorus; i.e., have relatively higher EPC_0. This is because clay has properties that are favorable to holding more phosphorus. The lower GMR's bed sediments are quite different in nature from the sediments examined in these studies. Most importantly, fine material for phosphorus to bind to in the lower GMR is scarce. Figure 15 shows the results from the Ohio EPA's habitat assessments, or QHEI surveys, of the lower GMR. The top pie chart shows that only one assessment site out of 34 had about half of its bottom sediment as silt. The vast majority of the assessment sites have gravel and cobbles as their bed material. The lower pie chart shows that very little riffle/run embeddedness (or fine sediments within those gravel and cobbles) exist. The QHEI assessments also noted 22 sites with no bank erosion at all, and 12 with "none/moderate" bank erosion. No sites were determined to have heavy bank erosion. All of these indicators point to the fact that the lower GMR's streambed capacity for phosphorus sorption and desorption of dissolved phosphorus is relatively small.

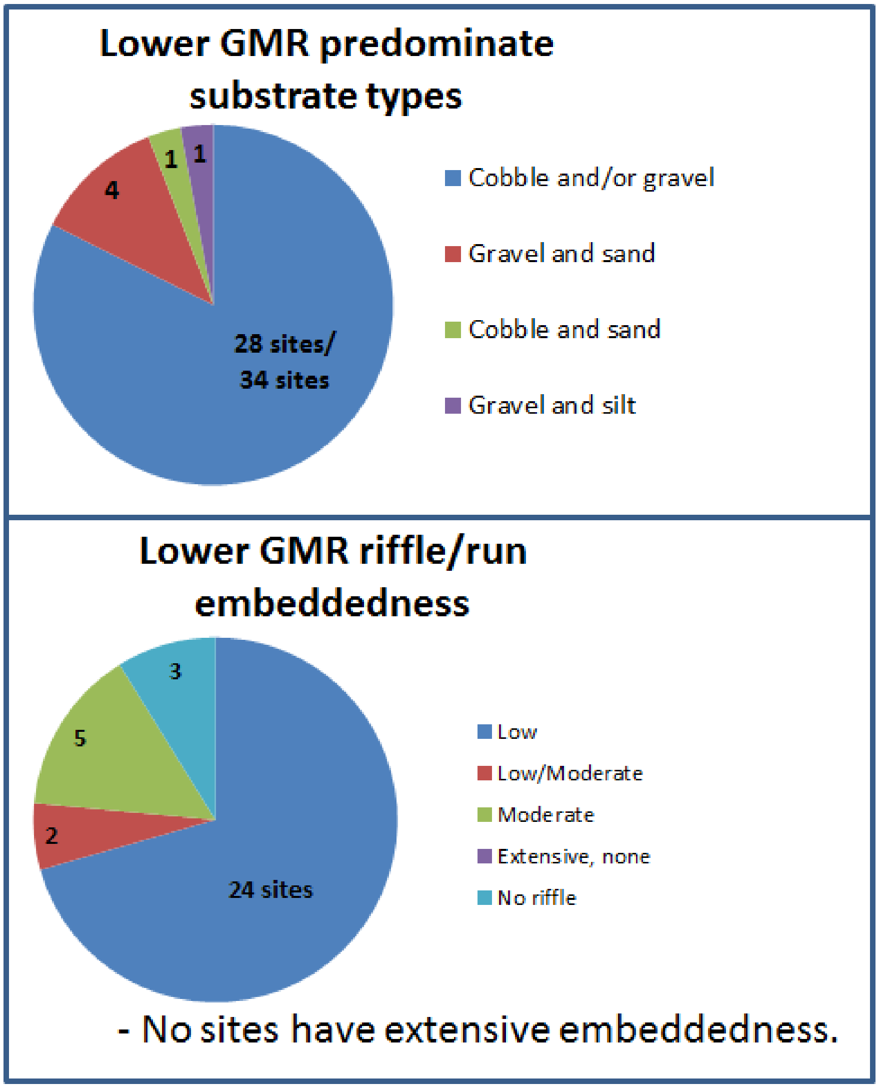


Figure 15 QHEI habitat assessment results for substrate types and stream bed embeddedness for the lower GMR.

The above examination of streambed material notwithstanding, some areas with fine stream substrate are present in the lower GMR; dam pools being the most likely location of these. Following the EPC_0 concept, the lower GMR's steady supply of SRP from wastewater point sources prevents substrate sediment from desorbing phosphorus. Jarvie *et* al*.* 2005 examined river systems similar to the lower GMR, and found this to be true. That research shows that in rivers with no phosphorus controls on major municipal waste treatment, sewage effluent borne phosphorus is the predominate driver of nutrient enrichment. As indicated by Baker et al. 2006 specifically in regards to the GMR, a Chomat and Westphal 2013 study show that streambed sediment is a phosphorus <u>sink</u> in low flow situations when the SRP concentration of the water is elevated; which is all summer for the lower GMR. As a result, internal phosphorus loading is not a significant source of eutrophication-causing phosphorus in the lower GMR.

Specific studies of the lower GMR substrate phosphorus and specifically its EPC_0 have not been carried out. Understanding the dynamics of this issue is very complex and rapidly changes over temporal and spatial scales (Chomat and Westphal 2013; James and Larson 2008; Jarvie et al 2012). For instance research on the Illinois River in Arkansas and Oklahoma found that much of the TP during high flows were originally sourced from point source effluent that had become remobilized (Jarvie et al 2012). Further, a study of the Assabet River in Massachusetts found that dredging dam pool sediments with the idea of removing sunk nonpoint source TP would not address that river's enrichment due to the continual discharge of TP rich effluent (Chomat and Westphal 2013).

It is clear however that the amount of uncontrolled WWTP sourced TP being delivered to the lower GMR must first be addressed before internal loadings are considered. The lead engineer studying pollutant nonpoint source to point source trading coefficients for the Ohio River basin for the Electric Power Research Institute has stated that effluent TP must be reduced before streambed sediment phosphorus reductions will make any difference on the lower GMR's enrichment (Keller, email communication, February 20, 2014). Given this, reducing nonpoint sources of phosphorus loads without reductions in effluent loadings will not ameliorate all of the nutrient enrichment impacts to the lower GMR. Once effluent phosphorus loading is reduced, other measures to reduce nutrient loadings further can be considered if they are necessary to return the river to full attaining its aquatic life use criteria.

Finally, it should be noted that these measures of point source TP load reduction are protective for the lower GMR's aquatic life use. These reductions do not address the total exported load of nutrients to the Ohio River and subsequently to the Gulf of Mexico via the Mississippi River. It is clear that efforts developed to protect the Gulf of Mexico from nutrient enrichment must consider all sources of phosphorus load delivered by the GMR. Baker et al. 2006 and others have documented that in this case the nonpoint source load of nutrients is by far the most important component as it is the majority of exported load.

Ohio EPA recognizes that the relationship between nutrients in the lower Great Miami River and aquatic life indices is not entirely linear or predictable. Therefore, the agency proposes using an adaptive management approach to eliminating the impairment in the lower Great Miami River. The first step is to reduce the phosphorus inputs from the two largest and most upstream discharges (Dayton and Montgomery County Western Regional) that appear to cause a significant increase in the total phosphorus concentrations, dissolved oxygen swings and chlorophyll-a values in the river – as shown in figures 5, 6, 7 and 11 above. After those two inputs are reduced, and the river has time to respond, Ohio EPA will reassess the impaired sites, and determine if further improvement measures are needed. Other mitigation such as dam removal in the river during this time period is also recommended to help reduce the need for including limits in additional permits and/or reducing limits below 1.0 mg/l. Future permit decisions will consider the results of the activities and reassessment.

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