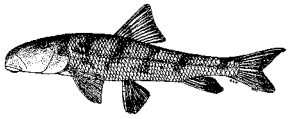
State of Ohio
Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of the Mad River Basin, 2003

Logan, Champaign, Clark, Miami, Greene, and Montgomery Counties, Ohio



May 25, 2005

Bob Taft, Governor
Joseph P. Koncelik, Director

Biological and Water Quality Study of the Mad River and Selected Tributaries 2003

Logan, Champaign, Clark, Miami, Greene and Montgomery Counties, OH

May 25, 2005
OEPA Technical Report EAS/2005-5-5

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NOTICE TO USERS

Ohio EPA incorporated biological criteria into the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1988), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio's surface water resources.

The following documents support the use of biological criteria by outlining the rationale for using biological information, the methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results:

Ohio Environmental Protection Agency. 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989b. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Plan. & Assess., Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989c. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. Water Quality Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 1990. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale, methods, and application. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Since the publication of the preceding guidance documents, the following new publications by the Ohio EPA have become available. These publications should also be consulted as they represent the latest information and analyses used by the Ohio EPA to implement the biological criteria.

DeShon, J.D. 1995. Development and application of the invertebrate community index (ICI), pp. 217-243. in W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Rankin, E. T. 1995. The use of habitat assessments in water resource management programs, pp. 181-208. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological criteria program development and implementation in Ohio, pp. 109-144. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological response signatures and the area of degradation value: new tools for interpreting multimetric data, pp. 263-286. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. 1995. Policy issues and management applications for biological criteria, pp. 327-344. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. The role of biological criteria in water quality monitoring, assessment, and regulation. Environmental Regulation in Ohio: How to Cope With the Regulatory Jungle. Inst. of Business Law, Santa Monica, CA. 54 pp.

These documents and this report may be obtained by writing to:

Ohio EPA, Division of Surface Water
Monitoring and Assessment Section
4675 Homer Ohio Lane
Groveport, Ohio 43125
(614) 836-8777

ACKNOWLEDGMENTS

The following Ohio EPA staff is acknowledged for their contribution to this report:

Watershed Protection Efforts – Hugh Trimble
Point Source Evaluations – MaryAnne Mahr
Chemical Water Quality - Louise Snyder
Sediment Quality – Greg Buthker
Physical Habitat - Chuck McKnight
Biological Assessment - Chuck McKnight
Data Management - Dennis Mishne, Louise Snyder, Mary Ann Silagy, MaryAnne Mahr
TSD coordination - Chuck McKnight
Reviewers - Jeff DeShon, Diana Zimmerman, and Marc Smith

This evaluation and report were possible only with the assistance of the study team, many full and part time field staff, and the chemistry analyses provided by the Ohio EPA Division of Environmental Services. Property owners who permitted access for sampling are also gratefully acknowledged for their cooperation.

Copies of this report are located on the Ohio EPA internet web page (www.epa.state.oh.us/dsw/document_index/psdindx.html) or may be available on CD from:

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FOREWORD

What is a Biological and Water Quality Survey?

A biological and water quality survey, or "biosurvey", is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year the Ohio EPA conducts biosurveys in 4-5 watersheds study areas with an aggregate total of 250-300 sampling sites.

The Ohio EPA employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three major objectives: 1) determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained; 2) determine if use designations assigned to a given water body are appropriate and attainable; and 3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices. The data gathered by a biosurvey is processed, evaluated, and synthesized in a biological and water quality report. Each biological and water quality study contains a summary of major findings and recommendations for revisions to WQS, future monitoring needs, or other actions which may be needed to resolve existing impairment of designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply, as well as human health concerns are also addressed.

The findings and conclusions of a biological and water quality study may factor into regulatory actions taken by the Ohio EPA (*e.g.,* NPDES permits, Director's Orders, the Ohio Water Quality Standards [OAC 3745-1], Water Quality Permit Support Documents [WQPSDs]), and are eventually incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d]).

Hierarchy of Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators consisting of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach includes a hierarchical continuum from administrative to true environmental indicators (Figure1). The six "levels" of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes in health, ecology, or other effects (ecological condition, pathogens). In this process the

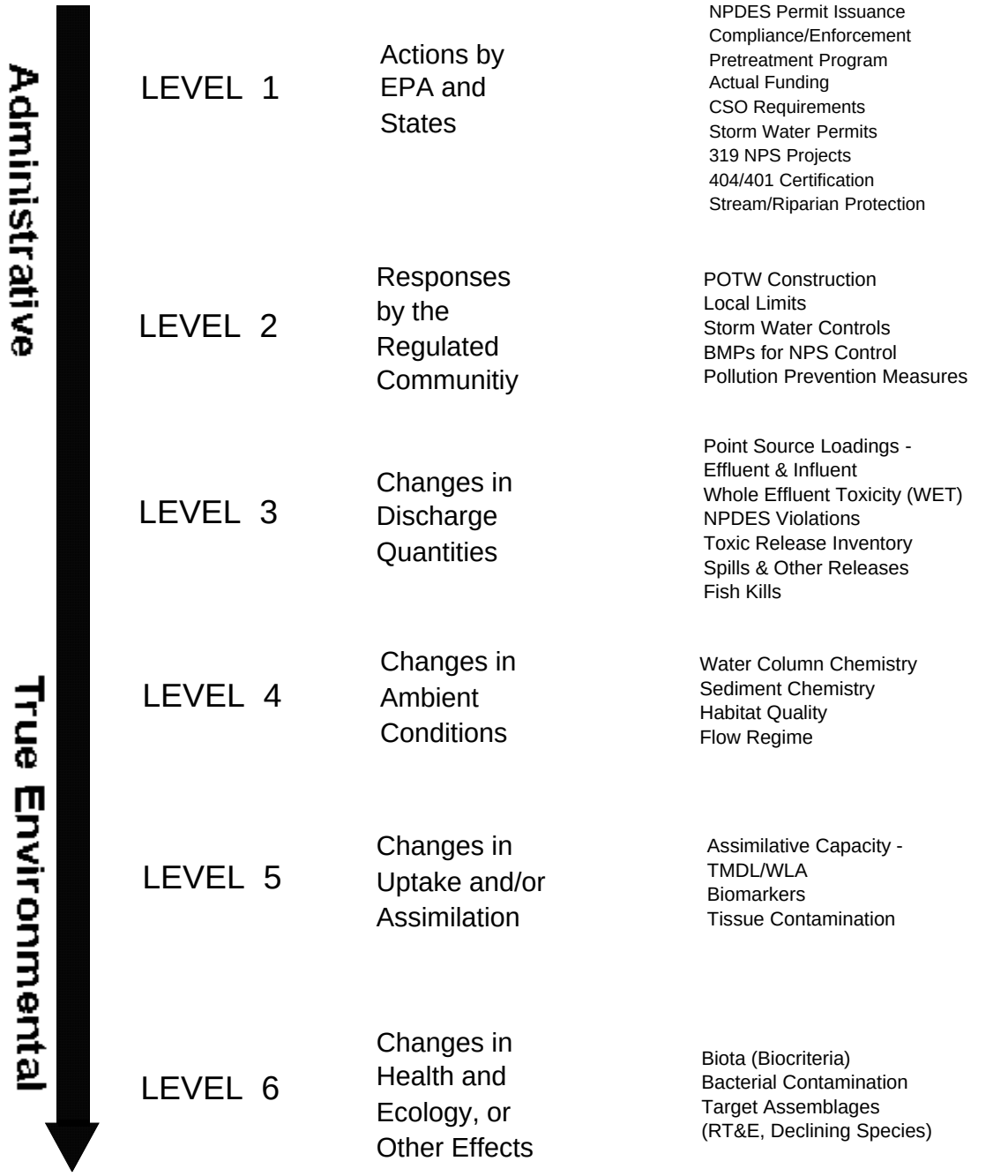

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by the U.S. EPA.

results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition.
Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.,* rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

Describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Integrated Report, the Ohio Nonpoint Source Assessment, and other technical bulletins.

Ohio Water Quality Standards: Designated Aquatic Life Use
The Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. In applications of the Ohio WQS to the management of water resource issues in Ohio's rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting for aquatic life generally results in water quality suitable for all uses. The five different aquatic life uses currently defined in the Ohio WQS are described as follows:

1) *Warmwater Habitat (WWH)* - this use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration*

target for the majority of water resource management efforts in Ohio.

2) *Exceptional Warmwater Habitat (EWH)* - this use designation is reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (*i.e.,* declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.*

3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall.

4) *Modified Warmwater Habitat (MWH)* - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned by state or federal law;* the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat.

5) *Limited Resource Water (LRW)* - this use applies to small streams (usually <3 mi^2 drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis (*i.e.,* true ephemeral streams), or other irretrievably altered waterways.

Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each. As such the system of use designations employed in the Ohio WQS constitutes a "tiered" approach in that varying and graduated levels of protection are provided by each. This hierarchy is especially apparent for parameters such as dissolved oxygen, ammonia-nitrogen, temperature, and the biological criteria. For other parameters such as heavy metals, the technology to construct an equally graduated set of criteria has been lacking, thus the same WQS criteria may apply to two or three different use designations.

Ohio Water Quality Standards: Non-Aquatic Life Uses

In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply, and human health concerns as appropriate. The recreation uses most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) uses. The criterion for designating the PCR use can be having a water depth of at least one meter over an

area of at least 100 square feet or, lacking this, where frequent human contact is a reasonable expectation. If a water body does not meet either criterion, the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.,* fecal coliform, *E. coli)* and the criteria for each are specified in the Ohio WQS.

Attainment of recreation uses are evaluated based on monitored bacteria levels. The Ohio Water Quality Standards state that all waters should be free from any public health nuisance associated with raw or poorly treated sewage (Administrative Code 3745-1-04, Part F). Additional criteria (Administrative Code 3745-1-07) apply to waters that are designated as suitable for full body contact such as swimming (PCR- primary contact recreation) or for partial body contact such as wading (SCR- secondary contact recreation). These standards were developed to protect human health, because even though fecal coliform bacteria are relatively harmless in most cases, their presence indicates that the water has been contaminated with fecal matter.

Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake. The Agricultural Water Supply (AWS) and Industrial Water Supply (IWS) use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be an urban area where livestock watering or pasturing does not take place, thus the AWS use would not apply. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical-specific indicators. Human health concerns are additionally addressed with fish tissue data, but any consumption advisories are issued by the Ohio Department of Health.

MECHANISMS FOR WATER QUALITY IMPAIRMENT

The following paragraphs are provided to present the varied causes of impairment that affect the resource quality of lotic systems in Ohio. While the various perturbations are presented under separate headings, it is important to remember that they are often interrelated and cumulative in terms of the detrimental impact that can result.

Habitat and Flow Alterations

Habitat alteration, such as channelization, impacts biological communities directly by limiting the complexity of living spaces available to aquatic organisms. Consequently, fish and macroinvertebrate communities are not as diverse. Indirect impacts include the removal of riparian trees and field tiling to facilitate drainage. Following a rain event, most of the water is quickly removed from tiled fields rather than filtering through the soil, recharging groundwater, and reaching the stream at a lower volume and more sustained rate. As a result, small streams more frequently go dry or become intermittent.

Tree shade is important because it limits the energy input from the sun, moderates water temperature, and limits evaporation. Removal of the tree canopy further degrades conditions

because it eliminates an important source of coarse organic matter essential for a balanced ecosystem. Erosion impacts channelized streams more severely due to the lack of a riparian buffer zone to slow runoff, trap sediment and stabilize banks. Additionally, deep trapiziodal channels lack a functioning flood plain and therefore cannot expel sediment as would occur during flood events along natural watercourses.

The lack of water movement under low flow conditions can exacerbate impacts from organic loading and nutrient enrichment by limiting reaeration of the stream. The amount of oxygen soluble in water decreases as temperature increases. This is one reason why tree shade is so important. The two main sources of oxygen in water are diffusion from the atmosphere and plant photosynthesis. Turbulence at the water surface is critical because it increases surface area and promotes diffusion, but channelization eliminates turbulence produced by riffles, meanders, and debris snags. Plant photosynthesis produces oxygen, but at night, respiration reverses the process and consumes oxygen. Oxygen is also used by bacteria that decay dead organic matter. Nutrient enrichment can promote the growth of nuisance algae that subsequently dies and serves as food for bacteria. Under these conditions, oxygen can be depleted unless it is replenished from the air.

Sedimentation

Whenever the natural flow regime is altered to facilitate drainage, increased amounts of sediment are likely to enter streams either by overland transport or increased bank erosion. The removal of wooded riparian areas furthers the erosion process. Channelization keeps all but the highest flow events confined within the artificially high banks. As a result, areas that were formerly flood plains and allowed for the removal of sediment from the primary stream channel no longer serve this function. As water levels fall following a rain event, interstitial spaces between larger rocks fill with sand and silt and the diversity of available habitat to support fish and macroinvertebrates is reduced. Silt also can clog the gills of both fish and macroinvertebrates, reduce visibility thereby excluding site feeding fish species, and smother the nests of lithophilic fishes. Lithophilic spawning fish require clean substrates with interstitial voids in which to deposit eggs. Conversely, pioneering species benefit. They are generalists and best suited for exploiting disturbed and less heterogeneous habitats. The net result is a lower diversity of aquatic species compared with a typical warmwater stream with natural habitats.

Sediment also impacts water quality, recreation, and drinking water. Nutrients absorbed to soil particles remain trapped in the watercourse. Likewise, bacteria, pathogens, and pesticides which also attach to suspended or bedload sediments become concentrated in waterways where the channel is functionally isolated from the landscape. Community drinking water systems address these issues with more costly advanced treatment technologies.

Nutrients

The element of greatest concern is phosphorus because it critical for plant growth and it is often the limiting nutrient. The form that can be readily used by plants and therefore can stimulate nuisance algae blooms is orthophosphate (PO_4^{-3}). The amount of phosphorus tied up in the nucleic acids of food and waste is actually quite low. This organic material is eventually converted to orthophosphate by bacteria. The amount of orthophosphate contained in synthetic detergents is a great concern however. It was for this reason that the General Assembly of the State of Ohio enacted a law in 1990 to limit phosphorus content in household laundry detergents sold in the Lake Erie drainage basin to 0.5 % by weight. Inputs of phosphorus originate from both point and nonpoint sources. Most of the phosphorus discharged by point sources is soluble. Another characteristic of point sources is they have a continuous impact and are human in origin, for instance, effluents from municipal sewage treatment plants. The contribution from failed on-lot septic systems can also be significant, especially if they are concentrated in a small area. The phosphorus concentration in raw waste water is generally 8-10 mg/l and after secondary treatment is generally 4-6 mg/l. Further removal requires the added cost of chemical addition. The most common methods use the addition of lime or alum to form a precipitate, so most phosphorus (80%) ends up in the sludge.

A characteristic of phosphorus discharged by nonpoint sources is that the impact is intermittent and associated with stormwater runoff. Most of this phosphorus is bound tightly to soil particles and enters streams from erosion, although some comes from tile drainage. Urban stormwater is more of a concern if combined sewer overflows are involved. The impact from rural stormwater varies depending on land use and management practices and includes contributions from livestock feedlots and pastures and row crop agriculture. Crop fertilizer includes granular inorganic types and organic types such as manure or sewage sludge. Pasture land is especially a concern if the livestock have access to the stream. Large feedlots with manure storage lagoons create the potential for overflows and accidental spills. Land management is an issue because erosion is worse on streams without any riparian buffer zone to trap runoff. The impact is worse in streams that are channelized because they no longer have a functioning flood plain and cannot expel sediment during flooding. Oxygen levels must also be considered, because phosphorus is released from sediment at higher rates under anoxic conditions.

There is no numerical phosphorus criterion established in the Ohio Water Quality Standards, but there is a narrative criterion that states phosphorus should be limited to the extent necessary to prevent nuisance growths of algae and weeds (Administrative Code, 3745-1-04, Part E). Phosphorus loadings from large volume point source dischargers in the Lake Erie drainage basin are regulated by NPDES permit limits. The permit limit is a concentration of 1.0 mg/l in final effluent. Research conducted by the Ohio EPA indicates that a significant correlation exists between phosphorus and the health of aquatic communities (Association Between Nutrients, Habitat, and Aquatic Biota in Ohio Rivers and Streams, MAS/1999-1-1). It was concluded that biological community performance in headwater and wadeable streams was highest where phosphorus concentrations were lowest. It was also determined that the lowest phosphorus

concentrations were associated with the highest quality habitats, supporting the notion that habitat is a critical component of stream function. The report recommends WWH biocriteria of 0.08 mg/l in headwater streams (<20 mi^2 watershed size), 0.10 mg/l in wadeable streams (>20-200 mi^2) and 0.17 mg/l in small rivers (>200-1000 mi^2).

Organic Enrichment and Low Dissolved Oxygen

The amount of oxygen soluble in water is low and it decreases as temperature increases. This is one reason why tree shade is so important. The two main sources of oxygen in water are diffusion from the atmosphere and plant photosynthesis. Turbulence at the water surface is critical because it increases surface area and promotes diffusion. Drainage practices such as channelization eliminate turbulence produced by riffles, meanders, and debris snags. Although plant photosynthesis produces oxygen by day, it is consumed by the reverse process of respiration at night. Oxygen is also consumed by bacteria that decay organic matter, so it can be easily depleted unless it is replenished from the air. Sources of organic matter include poorly treated waste water, sewage bypasses, and dead plants and algae.

Dissolved oxygen criteria are established in the Ohio Water Quality Standards to protect aquatic life. The minimum and average limits are tiered values and linked to use designations (Administrative Code 3745-1-07, Table 7-1).

Ammonia

Ammonia enters streams as a component of fertilizer and manure run-off and wastewater effluent. Ammonia gas (NH_3) readily dissolves in water to form the compound ammonium hydroxide (NH_4OH). In aquatic ecosystems an equilibrium is established as ammonia shifts from a gas to undissociated ammonium hydroxide to the dissociated ammonium ion (NH_4^{+1}). Under normal conditions (neutral pH 7 and 25EC) almost none of the total ammonia is present as gas, only 0.55% is present as ammonium hydroxide, and the rest is ammonium ion. Alkaline pH shifts the equation toward gaseous ammonia production, so the amount of ammonium hydroxide increases. This is important because while the ammonium ion is almost harmless to aquatic life, ammonium hydroxide is very toxic and can reduce growth and reproduction or cause mortality.

The concentration of ammonia in raw sewage is high, sometimes as much as 20-30 mg/l. Treatment to remove ammonia involves gaseous stripping to the atmosphere, biological nitrification and de-nitrification, and assimilation into plant and animal biomass. The nitrification process requires a long detention time and aerobic conditions like that provided in extended aeration treatment plants. Under these conditions, bacteria first convert ammonia to nitrite (*Nitrosomonas*) and then to nitrate (*Nitrobacter*). Nitrate can then be reduced by the de-nitrification process (*Pseudomonas*) and nitrogen gas and carbon dioxide are produced as by-products.

Ammonia criteria are established in the Ohio Water Quality Standards to protect aquatic life. The maximum and average limits are tiered values based on sample pH and temperature and linked to use designations (Administrative Code 3745-1-07, Tables 7-2 through 7-8).

Metals

Metals can be toxic to aquatic life and hazardous to human health. Although they are naturally occurring elements many are extensively used in manufacturing and are by-products of human activity. Certain metals like copper and zinc are essential in the human diet, but excessive levels are usually detrimental. Lead and mercury are of particular concern because they often trigger fish consumption advisories. Mercury is used in the production of chlorine gas and caustic soda and in the manufacture of batteries and fluorescent light bulbs. In the environment it forms inorganic salts, but bacteria convert these to methyl-mercury and this organic form builds up in the tissues of fish. Extended exposure can damage the brain, kidneys, and developing fetus. The Ohio Department of Health (ODH) issued a statewide fish consumption advisory in 1997 advising women of child bearing age and children six and under not to eat more than one meal per week of any species of fish from waters of the state because of mercury. Lead is used in batteries, pipes, and paints and is emitted from burning fossil fuels. It affects the central nervous system and damages the kidneys and reproductive system. Copper is mined extensively and used to manufacture wire, sheet metal, and pipes. Ingesting large amounts can cause liver and kidney damage. Zinc is a by-product of mining, steel production, and coal burning and used in alloys such as brass and bronze. Ingesting large amounts can cause stomach cramps, nausea, and vomiting.

Metals criteria are established in the Ohio Water Quality Standards to protect human health, wildlife, and aquatic life. Three levels of aquatic life standards are established (Administrative Code 3745-1-07, Table 7-1) and limits for some elements are based on water hardness (Administrative Code 3745-1-07, Table 7-9). Human health and wildlife standards are linked to either the Lake Erie (Administrative Code 3745-1-33, Table 33-2) or Ohio River (Administrative Code 3745-1-34, Table 34-1) drainage basins. The drainage basins also have limits for additional elements not established elsewhere that are identified as Tier I and Tier II values.

Bacteria

High concentrations of either fecal coliform bacteria or Escherichia coli (E. coli) in a lake or stream may indicate contamination with human pathogens. People can be exposed to contaminated water while wading, swimming, and fishing. Fecal coliform bacteria are relatively harmless in most cases, but their presence indicates that the water has been contaminated with feces from a warm-blooded animal. Although intestinal organisms eventually die off outside the body, some will remain virulent for a period of time and may be dangerous sources of infection. This is especially a problem if the feces contained pathogens or disease producing bacteria and viruses. Reactions to exposure can range from an isolated illness such as skin rash, sore throat,

or ear infection to a more serious wide spread epidemic. Some types of bacteria that are a concern include *Escherichia*, which cause diarrhea and urinary tract infections, *Salmonella*, which cause typhoid fever and gastroenteritis (food poisoning), and *Shigella*, which cause severe gastroenteritis or bacterial dysentery. Some types of viruses that are a concern include polio, hepatitis A, and encephalitis. Disease causing microorganisms such as cryptosporidium and giardia are also a concern.

Since fecal coliform bacteria are associated with warm-blooded animals, there are both human and animal sources. Human sources, including effluent from sewage treatment plants or discharges by on-lot septic systems, are a more continuous problem. Bacterial contamination from combined sewer overflows are associated with wet weather events. Animal sources are usually more intermittent and are also associated with rainfall, except when domestic livestock have access to the water. Large livestock farms store manure in holding lagoons and this creates the potential for an accidental spill. Liquid manure applied as fertilizer is a runoff problem if not managed properly and it sometimes seeps into field tiles.

Bacteria criteria are established in the Ohio Water Quality Standards to protect human health. The maximum and average limits are tiered values and linked to use designation, but only apply during the May 1-October 15 recreation season (Administrative Code 3745-1-07, Table 7-13). The standards also state that streams must be free of any public health nuisance associated with raw or poorly treated sewage during dry weather conditions (Administrative Code 3745-1-04, Part F).

Sediment Contamination

Chemical quality of sediment is a concern because many pollutants bind strongly to soil particles and are persistent in the environment. Some of these compounds accumulate in the aquatic food chain and trigger fish consumption advisories, but others are simply a contact hazard because they cause skin cancer and tumors. The physical and chemical nature of sediment is determined by local geology, land use, and contribution from manmade sources. As some materials enter the water column they are attracted to the surface electrical charges associated with suspended silt and clay particles. Others simply sink to the bottom due to their high specific gravity. Sediment layers form as suspended particles settle, accumulate, and combine with other organic and inorganic materials. Sediment is the most physically, chemically, and biologically reactive at the water interface because this is where it is affected by sunlight, current, wave action, and benthic organisms. Assessment of the chemical nature of this layer can be used to predict ecological impact.

The Ohio EPA evaluation of sediment chemistry results are evaluated using a dual approach, first by ranking relative concentrations based on a system developed by Ohio EPA (2003) and then by determining the potential for toxicity based on guidelines developed by MacDonald et al (2000). The Ohio EPA system was derived from samples collected at ecoregional reference sites. Specific Reference Values are site specific ecoregional based metals concentrations and

are used to identify contaminated stream reaches. The MacDonald guidelines are consensus based using previously developed values. The system predicts that sediments below the threshold effect concentration (TEC) are absent of toxicity and those greater than the probable effect concentration (PEC) are toxic.

Sediment samples collected by the Ohio EPA are measured for a number of physical and chemical properties. Physical attributes included % particle size distribution (sand $60 F, silt 5-59 F, clay #4 F), % solids, and % organic carbon. Due to the dynamics of flowing water, most streams do not contain a lot of sediment and samples often consist mostly of inert sand. This scenario changes if the stream is impounded by a dam or channelized. Chemical attributes included metals, volatile and semi-volatile organic compounds, pesticides, and poly-chlorinated biphenyls (PCBs).

Biological and Water Quality Study of the Mad River 2003

Logan, Champaign, and Clark, Miami, Greene and Montgomery Counties, OH

State of Ohio Environmental Protection Agency
Division of Surface Water
Lazarus Government Center
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INTRODUCTION

Ambient biological, water column chemical and sediment sampling was conducted in the Mad River basin from June to October 2003 as part of the five-year basin approach for monitoring, assessment, issuance of National Pollution Discharge Elimination System (NPDES) permits and to facilitate a Total Maximum Daily Load (TMDL) assessment. This study area included over 61 miles of the Mad River beginning in the headwaters and extending to near the confluence with the Great Miami River at Dayton, Ohio. Subwatersheds within the study area included Macochee Creek, Kings Creek, Nettle Creek, Buck Creek and Mud Run. Where possible, tributary streams with at least 4 mi^2 of drainage were sampled.

Specific objectives of this evaluation were to:

1) Monitor and assess the chemical, physical and biological integrity of the streams within the 2003 Mad River study area;

2) Characterize the consequences of various land uses on water quality within the Mad River watershed;

3) Evaluate the influence of the West Liberty, Urbana, St. Paris, Springfield and Clark County Southwest Regional, Fairborn and other wastewater treatment plants (WWTPs) and unsewered communities;

4) Evaluate the potential impacts from spills, nonpoint source pollution (NPS), and habitat alterations on the receiving streams; and

5) Determine the attainment status of the current designated aquatic life uses and non-aquatic use designations and recommend changes where appropriate.

The findings of this evaluation factor into regulatory actions taken by the Ohio EPA (*e.g.*, NPDES permits, Director's Orders, the Ohio Water Quality Standards [OAC 3745-1], Water Quality Permit Support Documents [WQPSDs]) and are incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d]).

SUMMARY

Aquatic Life Use Attainment Status and Trends

The 2003 Mad River study area included five Watershed Assessment Units and a Large River Assessment Unit of the Mad River mainstem where the drainage area exceeded 500 mi^2 (Figure 2). These were: Mad River-headwaters to downstream Kings Cr. (RM43.8); Mad River-downstream Kings Cr. to downstream Chapman Creek (RM 43.8 to RM 32.6); Buck Creek; Mad River-downstream Chapman Cr to upstream Mud Creek (RM 32.6 to RM 10.4, excluding Buck Cr and mainstem >500mi^2); Mad River tributaries from upstream Mud Creek to mouth (RM 10.4 to RM 0.0) and the Mad River mainstem only from downstream Donnels Creek (RM 18.3) to the confluence with the Great Miami River (mainstem >500mi^2). Summary statistics related to aquatic life use and a synopsis for each assessment unit is provided in Table 1. The comments provided for each assessment unit include principal causes and sources of impact on aquatic life and recreational uses.

The applicability of the IBI and MIwb has never been fully assessed for use on Coldwater Habitat (CWH) streams in Ohio. Initially, WWH IBI and MIwb indices and scoring expectations were used to evaluate CWH sites in the Mad River study area. However, the results consistently lagged behind other measures of resource quality where the WWH wading or boat sample scoring parameters were used (with drainage area in excess of 20mi^2). It was apparent that some modification was needed in the evaluation of the fish in wadable and boatable CWH reaches in the Mad River watershed.

The fish fauna in wadable and boatable CWH stream reaches, in composition, were similar to that encountered in small headwater streams. The IBI includes sunfish and sucker species richness for sites that exceed 20mi^2 drainage area. The diversity of these groups was reduced when compared with expectations developed for warmwater streams in Ohio. The procedure for evaluating headwater sites substitutes minnow and headwater species in lieu of sunfish and sucker species along with lower overall predicted species richness. Use of headwater IBI scoring of all CWH sites regardless of drainage area proved to be a more accurate reflection of actual community condition. The CWH designated sites also performed similarly to headwater warmwater streams in that the MIwb was not illustrative of community disruption due to water quality or habitat condition. Additional discussion detailing this approach to evaluate CWH fish community condition can be found in the Methods portion of this report.

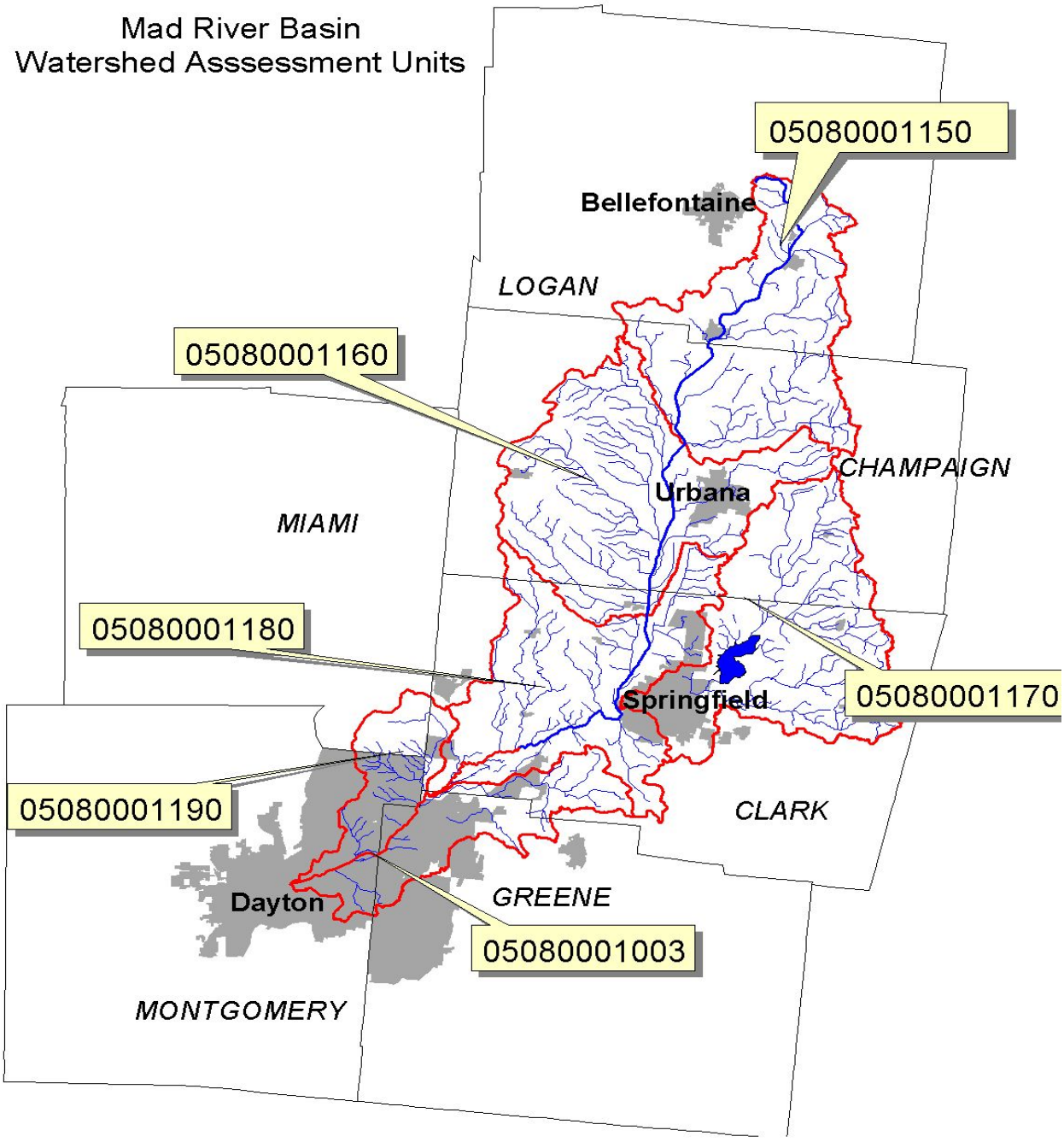


Figure 2 Watershed assessment units (WAUs) in the Mad River watershed. (WAU 05080001003 encompasses the mainstem of the Mad River from RM 18.4 to the confluence with the Great Miami River.)

During 2003, sampling in the Mad River watershed resulted in the assessment of aquatic life uses at 110 sites ranging in drainage area from 0.6 mi^2 to 657 mi^2. The Aquatic Life Use Attainment table (Table 2) provides biological metric scores for each of the sampled locations. Eighty-five (79.4%) of the sites fully met current or recommended aquatic life use. Sixteen (14.5%) of the sites partially met and six (5.6%) of the sites were not attaining their designated or recommended use. Three sites were located on watercourses that went dry. Consequently, an aquatic life use was not ascribed pending the development of headwater habitat designations, assessment protocols, and biocriteria.

The 2003 biological sampling effort on the Mad River mainstem, in large part, replicated sampling conducted in 1994. The condition of the macroinvertebrate community, as reflected by the two surveys, has remained relatively stable or improved slightly (Figure 3). ICI scores ranged between marginally good to exceptional in 1994 and from good to exceptional in 2003. Somewhat higher ICI scores were recorded in 2003 for the reach downstream from the West Liberty WWTP to the downstream limit of the CWH portion of Mad River. A lower density of tolerant macroinvertebrate taxa on the artificial substrates and increased diversity of mayflies, caddisflies and stoneflies collected from the natural substrates suggested a decline in nutrient concentrations possibly due to the higher base flow condition that was encountered in 2003. Comparison of the fish community results yielded similar conclusions. In 1994, the presence of nuisance algae and macrophytes that, at times, nearly enveloped the stream in the CWH reach was thought to be a consequence of nutrient inputs from the surrounding agricultural land. This condition was greatly reduced in 2003. The macroinvertebrate community was in good to exceptional condition in the WWH reach of the Mad River in both 1994 and 2003. The IBI results from the two years reflected a similar longitudinal improvement in the WWH portion of the mainstem. The fish community demonstrated a gradual transition that involved a decline in coldwater components of the community and gained more typical WWH structural and compositional attributes. No significant impact on biological community function was attributed to the discharge of treated wastewater from the Springfield, Clark County Southwest Regional, or Fairborn WWTPs in either sampling year.

Macroinvertebrate taxa identification and enumeration data from each sampled location are provided in Appendix Table A-4. Fish species collection and relative number information are provided in Appendix Table A-5.

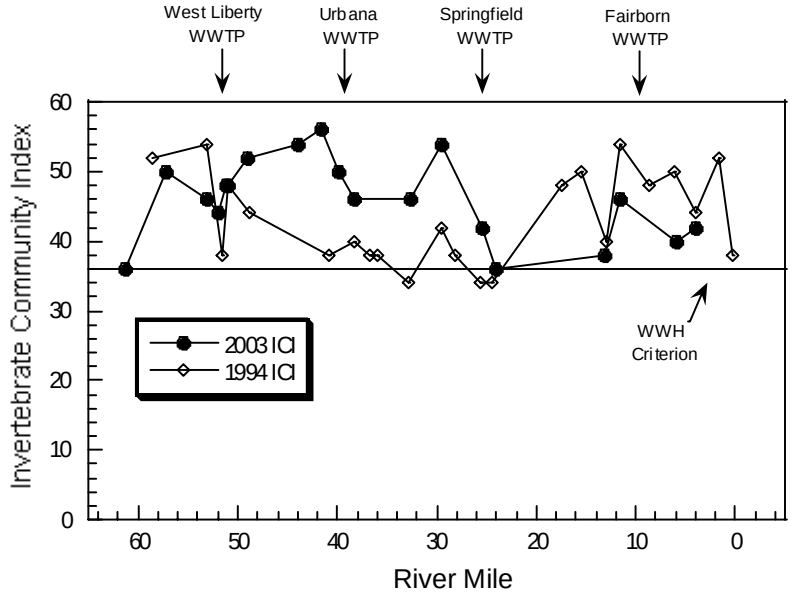


Figure 3 Longitudinal trend of the Invertebrate Community Index (ICI) in the Mad River in 1994 and 2003. The WWH biocriterion was used to evaluate both CWH and WWH designated reaches.

The Ohio Department of Natural Resources, Division of Wildlife maintains a recreational brown trout fishery through annual stocking of the Mad River mainstem and selected tributaries upstream from Buck Creek. The majority of fish are stocked in October or November after being raised in hatcheries for approximately 11 months. The 2002 stocking of the Mad River with approximately 19,000 yearling trout equated to 383 trout per kilometer. Ohio EPA sampling of 15 mainstem sites in 2003 yielded an average of 55 trout per kilometer of which the majority was from the 2002 year class (Figure 4). Relatively high densities of brown trout were recorded upstream from the West Liberty WWTP (RM 51.0) and the reach from RM 39.9 to RM 32.7 (SR 36 to Tremont City Rd.). Larger trout (> 300 gms) were encountered sporadically and were more common at RM 51.1 (Pimtown Rd.) and between RM 39.9 (SR. 36) and RM 32.7 (Tremont City Rd). The occurrence of larger trout was strongly associated with deep water combined with woody cover. Efforts to establish and maintain these habitat attributes should be encouraged to benefit the survival of larger brown trout and maximize non-game fish species diversity.

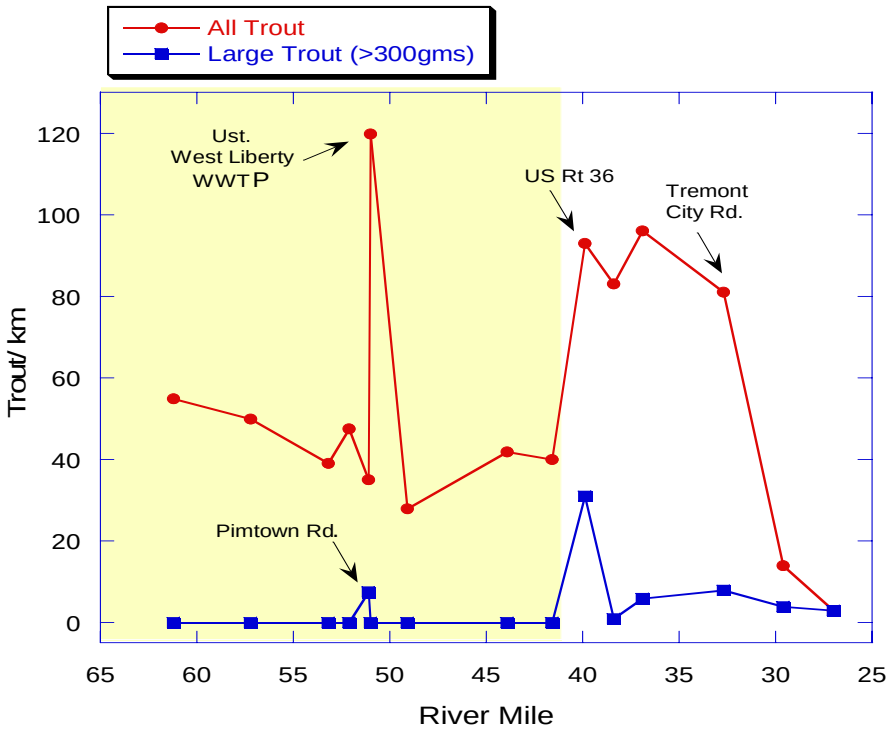


Figure 4 Relative number of all trout and larger trout (exceeding 300 gms) collected by Ohio EPA from the CWH portion of the Mad River June-October, 2003. Shaded area represents the reach where the headwater and wading electrofishing techniques were employed. The remainder was sampled via boat mounted electrofishing equipment.

Table 1 Summary of Mad River assessment unit scoring. The assessment unit score is an average grade of aquatic life use status. An assessment unit score of 80 is used as the benchmark above which a watershed in considered to be in good condition relative to aquatic life uses. A maximum assessment unit score of 100 is possible if all monitored sites meet designated aquatic life uses. The method of calculation is presented in the 2002 Integrated Water Quality Monitoring and Assessment Report (www.epa.state.oh.us/dsw/tmdl/2002IntReport/2002OhioIntegratedReport.html). The comments provided include principal causes and sources of impact on aquatic life and recreational uses and significant contaminants in sediment and fish tissue.

Upper Mad River WAU# (5080001 150)	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	18	16	88.8	2	10.2	-	-	**94.0**
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	7.9	7.9	100	-	-	-	-	

Comments

The Upper Mad River Assessment Unit includes the Mad River and tributaries from the headwaters to downstream from Kings Cr. (RM 43.8). The high WAU overall attainment score (94.0) reflects the majority of sites meeting aquatic life use designations. The mainstem reach of the Mad River supported healthy fish and macroinvertebrate communities. Twenty-one sites were in full attainment of the designated or recommended CWH use. Two sampled locations produced fish community results that were in the fair range: Macochee Ditch at RM 0.7 (Lippincott Rd.) and Kings Creek at RM 3.9. Low IBI scores at both locations were attributed to limited habitat. These sites, along with additional sites that only marginally met the CWH use, have been altered to facilitate agricultural production. Improvements in beneficial habitat characteristics, such as promoting increased sinuosity and the development of additional instream cover, is recommended to restore and improve the biological resources.

Dissolved oxygen measurements in Glady Creek were depressed on three of the six 2003 sampling dates and nutrient values were somewhat elevated above typical ecoregional expectations. These results were likely linked to the presence of wetlands and a peat bog harvesting operation in the headwaters. Elevated nitrate levels documented in Kings Creek were apparently due to the intertwining of agricultural practices in the watershed with the shallow groundwater aquifers and surface flow in the stream.

Based on the five sites sampled for bacteria (fecal coliform and *E. coli*), the PCR use designation was not attained in this assessment unit (Table 27, Figure 9 and Figure 10, Appendix Table A-2). Elevated concentrations occurred primarily on higher flow days after precipitation. Bacteria levels were consistently elevated at the Macochee Creek site (RM 2.95).

Thirteen organic compounds were detected in the water column in the Upper Mad River watershed assessment unit (Table 28, Appendix Table A-3). Similar to the entire Mad River study area, higher herbicide levels were typically detected in the June sampling rather than in August reflecting the spring application of herbicides and the impacts of runoff.

Table 1 continued.

Mad River/ Nettle Creek WAU# 5080001 160	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	26	19	73	4	15	3	12	**89.5**
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	11.2	11.2	100			-	-	

Comments

The Mad River/Nettle Creek Assessment Unit includes the Mad River and tributaries downstream from Kings Cr. (RM 43.8) to downstream from Chapman Cr. (RM 32.6). Biological and habitat assessments were conducted at 31 sites in 2003 ranging in drainage area between 0.6 mi^2 and 264 mi^2. Twenty-three sites within the assessment unit have been designated or are recommended for a CWH aquatic life use. Nineteen sites were in full attainment of the CWH use. Three sites supported biological communities that partially attained ecoregional expectations and one site, Stoney Creek, was in nonattainment of the CWH use. Eight sites within the assessment unit have been designated or recommended for WWH aquatic life use. Five sites were in full attainment of the WWH use. Dugan Run partially met WWH biocriteria and two sites on the St. Paris tributary to Nettle Creek were not attaining the use. One site, Russell Creek, went dry before sampling could be completed. The WAU overall attainment score was 89.5.

The high WAU overall attainment score reflects the majority of sites meeting aquatic life use designations. The mainstem reach of the Mad River supported healthy fish and macroinvertebrate communities. Impairments were documented in several tributaries. Most noticeable was the degraded condition of the St. Paris tributary to Nettle Creek which resulted from organic and nutrient loading from the WWTP and an improperly functioning SSO. Other sources of impairment included urban runoff from Urbana into Dugan Run and enrichment and habitat limitations associated with agricultural practices in the watershed.

The PCR use designation was not attained in this assessment unit based on the ten sites sampled for fecal coliform and *E. coli*. The highest median concentrations in the assessment unit occurred in the St. Paris tributary at RM 2.66 upstream from the St. Paris WWTP discharge. Elevated bacteria concentrations throughout the survey area generally occurred after precipitation.

Chemical water quality results were largely within the range of expected values. Low dissolved oxygen readings were recorded sporadically at several tributary sites. Ammonia and phosphorus concentrations were generally low.

Elevated metals and organic chemical contamination were documented in sediments in Dugan Run and the St. Paris tributary to Nettle creek.

Table 1 continued.

Buck Creek WAU# (5080001 170)	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	10	10	100	-	-	-	-	**79.6**
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	8.8	5.2	59.1	3.6	40.9	-	-	

Comments

The aquatic life uses in a significant portion of streams within the Buck Creek watershed had not been verified with biological sampling prior to 2003. A Coldwater Habitat (CWH) use is recommended for the principle streams in the watershed upstream from C.J. Brown Reservoir: Buck Creek upstream from C.J. Brown reservoir, East Fork Buck Creek, and Dugan Ditch. The Warmwater Habitat use is recommended for the entirety of Beaver Creek and Sinking Creek.

The only portion of the Buck Creek assessment unit where the designated aquatic life use was not met was downstream from C.J. Brown Reservoir. Buck Creek partially attained the WWH aquatic life use at RM 6.4, a short distance downstream from the lake outlet (RM 7.1). The site was typical of stream reaches below similarly constructed reservoirs in Ohio. The stream was channelized and water released from the lake likely carried with it an abundance of fine organic material. Ammonia levels were elevated but did not exceed water quality standards. The estimated extent of the partially attaining reach was 3.6 miles beginning immediately downstream from the lake outlet.

Based on the three sites sampled for bacteria (fecal coliform and *E. coli*), the PCR use designation was not attained in the Buck Creek assessment unit Elevated concentrations occurred primarily on two of the five sampling dates (September 3 and 22) after significant rainfall in the basin. Some of the highest concentrations of the entire survey occurred on September 22 in Buck Creek at RM 0.60 downstream from Springfield's numerous CSOs.

Chemical constituents in the water column and sediment were not directly implicated in impacts on aquatic life uses. Nevertheless, ammonia-N concentrations in Sinking Creek downstream from the Brookside Village MHP were consistently elevated above the 90th percentile of background levels for the Eastern Corn Belt Plain ecoregion. Elevated stream nitrate levels upstream from C.J. Brown Reservoir were attributed to the interaction between groundwater and surface water.

Sediment ammonia, manganese and zinc values downstream from C.J. Brown Reservoir (RM 6.5) were elevated. Polycyclic aromatic hydrocarbon compounds (PAHs) and Chlordane concentrations in the sediment at RM 0.6 were above levels that could predictably impact on aquatic communities. Dieldrin, PCB-1254 , sediment ammonia and lead values were also elevated. The contaminants at RM 0.6 reflected the urbanized nature of the lower watershed.

Table 1 continued.

Mad River from below Chapman Cr to above Mud Creek (excluding Buck Cr) (RM 32.6 to RM 10.4); excluding mainstem >500mi^2 WAU# 5080001 180	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	17	12	70.6	4	23.5	1	5.8	
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	14.2	10.3	72.5	3.9	27.5	-	-	**66.5**

Comments

This assessment unit includes Mad River tributaries streams between Chapman Creek and Mud Creek (except for Buck Creek) and the Mad River mainstem reach from RM 32.6 to RM 24.0 at which point the drainage area exceeds 500mi^2. Biological and habitat assessments were conducted at 21 sites. Seventeen locations were on tributaries to the Mad River with drainage areas of 2.6 mi^2 to 25.6 mi^2. The remaining four sites were on the Mad River.

The first sampled location downstream from Buck Creek (RM 25.8) only partially met ecoregional expectations with an IBI score in the fair range. One factor that tended to depress the IBI scoring on the mainstem was an abundance of white suckers. Their presence likely was a continuation of the community structure that typified the CWH portion of the Mad River. There did not appear to be any obvious impact due to inputs from Buck Creek or the surrounding urban area. It is noteworthy however, that this site is apparently subject to variations in water quality due to urban runoff as evidenced by a 10°C difference in temperature recorded with 24-hr monitoring equipment between July 22-24 in the Mad River at RM 25.57 following a rain event.

All the sampled tributary streams in the assessment unit are designated or recommended for the WWH aquatic life use. Twelve sites were in full attainment of the WWH use. Four sites supported biological communities that partially attained ecoregional expectations. Nonattainment was documented at one tributary sampling location. On the mainstem, 10.3 miles of full attainment and 3.9 miles of partial attainment were documented for the reach prior to the 500mi^2 drainage area delineation. The WAU overall attainment score was 66.5.

Moore Run at RM 4.1 was the only site in the assessment unit with both impacted fish and macroinvertebrate communities that resulted in nonattainment of the WWH use. The site was in a severely habitat limited reach (QHEI = 28.5). Biological condition progressively improved at the two additional downstream sampling locations on Moore Run. Both sites had moderately improved habitat and additional flow volume. The site at RM 2.5 had a silty muck substrate and thick growths of aquatic macrophytes. EPA personnel noted a petroleum odor and an oily sheen on the water surface. The fish community marginally met ecoregional expectations but the macroinvertebrate community was in only fair condition. Low dissolved oxygen readings and significant sediment contamination were documented in this reach of Moore Run. Stormwater and process discharges at the International Truck and Engine facility upstream are possible pollutant sources at this site. Permit adequacy and compliance should be investigated along with a review of operational procedures at the facility to limit water quality impacts.

The PCR use designation was not attained. Median bacteria concentrations were generally higher in the four tributaries sampled when compared to the three mainstem sites with the highest medians measured in Donnels Creek (RM 3.70) and Jackson Creek (RM 0.90).

Table 1 continued.

Lower Mad River Tribs. WAU# 5080001 190	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Sites < 50mi^2 drainage area	14	9	64.3	2	14.2	3	21.4	**75.0**
Miles of assessed streams with > 50mi^2 and < 500mi^2 drainage area	-	-	-	-	-	-	-	

Comments

Biological and habitat assessments were conducted at 14 sites in 2003 in the Lower Mad River Tributaries assessment unit ranging in drainage area between 4.6 mi^2 and 26.4 mi^2. Nine sites were in full attainment of designated or recommended aquatic life uses. Three sites supported biological communities that partially attained ecoregional expectations. Two sites failed to meet designated or recommended aquatic life use designations. The WAU overall attainment score was 75.0.

The WAU overall attainment score reflects the majority of sites meeting aquatic life use designations. Several Mad River tributaries were impaired. Most noticeable was the degraded condition of Mud Creek at RM 5.0 due to organic and nutrient loading from an unpermitted WWTP. Other sources of assessment unit impairment included urban runoff in Hebble Creek and loss of substrate heterogeneity in Mud Run resulting from past practices at the Portland Cement Landfill #1.

Apparent throughout the entire Mad River watershed, applicable recreational use designations were not attained in this assessment unit (Table 27**,** and Figure 10, Appendix Table A-2). The highest median bacteria concentrations of the entire survey occurred in Lilly Creek (4900 colonies/100ml fecal coliform, 1900 colonies/100ml *E. coli*). This urban stream also experienced consistently elevated TSS concentrations and was one of the more contaminated sediment sites in the survey.

Table 1 continued.

Mad River Mainstem (mainstem exceeding 500mi^2 drainage area) Downstream Donnels Creek (RM18.4) to mouth LRAU# (5080001 003)	**Aquatic Life Attainment Status**							**Assessment Unit Score**
	Total	**Full**		**Partial**		**NON**		
		#	%	#	%	#	%	
Assessed Miles with > 500 mi^2 drainage area	18.4	15.4	83.7	3.0	16.4	-	-	**83.7**

Comments

A 3.0 mile reach of partial attainment of the WWH aquatic life use appeared to be a lingering condition whereby the fish community maintained characteristics of a headwater fauna (brook fauna) even though the stream, based on watershed area, is much larger. A limited diversity of sunfish species and an abundance of white suckers depressed the IBI scores at the four sites between RM 17.5 and 9.0. The IBI score at RM 17.5 was below ecoregional expectations. Additionally, marginally attaining IBI scores resulted at the three subsequent sites as remnant headwater community characteristics persisted. This situation was likely a result of the extensive past channel alteration of the river upstream from Buck Creek. The channelization has increased the contribution of groundwater in the stream. Short time of travel (approx 10 hrs Springfield to the mouth) also extended the reach where the headwater characteristics were evident. Water chemistry was generally very good. Given the exceptionally elevated flows experienced during the survey, bacteria concentrations, however, were frequently elevated and the PCR use designation was not attained.

Table 2 Aquatic life use attainment status of the Mad River basin, June-October, 2003. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb) and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate (ICI) communities. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

Stream River Mile Invertebrate/Fish	Attainment Status	IBI	MIwb	ICI/ narrative	QHEI	Drainage Area
LRAU: 5080001 003 Mad River downstream Donnels Creek (RM18.4) to mouth						
Mad River			*WWH*			
17.5/17.5	Partial	34*	8.4ns	G	77.5	527
13.1/13.1	Full	41^{ns}	9.2	G	83.5	554
11.5/11.5	Full	38^{ns}	9	46	83	554
9.0/8.6	Full	40^{ns}	9.2	G	81.5	617
6.0/6.0	Full	43	8.7	40	77.5	622
4.0/4.0	Full	52	10.1	42	76.5	642
1.6/1.6	Full	52	9.7	G	74	654
0.3/0.3	Full	50	9.5	G	61	657
WAU: 5080001 150 Upper Mad River						
Mad River			*CWH*			
61.3/61.2	Full	54	NA	G	85	7.4
57.2/57.2	Full	40	NA	50	62	20.4
53.2/53.2	Full	41	NA	46	67.5	34
52.0/52.1	Full	41	NA	44	72	36
51.1/51.1	Full	40	NA	48	79	56
51.0/51.0	Full	41	NA	48	72	56
49.1/49.1	Full	39^{ns}	NA	52	63	63
43.9/43.9	Full	42	NA	54	68.5	91
Sugar Creek			*undesignated/ CWH recommended*			
---/1.0	(Full)	38^{ns}	NA		42.5	3.6
Peters Ditch			*undesignated/ CWH recommended*			
---/0.1	(Full)	42	NA		63	5.2
Macochee Creek			*CWH*			
6.2/6.2	Full	56	NA	E	74	5.2
3.7/7	Full	44	NA	VG	68	13.5
3.0/3.0	Full	42	NA	46	78	14.1
1.4/.4	Full	46	NA	G	62.5	16.6
0.1/0.1	Full	44	NA	G	71	19.1
Macochee Ditch			*CWH*			
3.4/3.4	Full	36^{ns}	NA	MG^{ns}	46	5
0.7/0.7	Partial	30*	NA	G	33.5	7.8
Glady Creek			*CWH (verified)*			
3.6/4.2	Full	36^{ns}	NA	MG^{ns}	66.5	10
Kings Creek			*CWH*			
6.1/6.1	Full	36^{ns}	NA	MG^{ns}	69.5	8.5
3.9/3.9	Partial	35*	NA	38	60	29

Stream River Mile Invertebrate/Fish	Attainment Status	IBI	MIwb	ICI/ narrative	QHEI	Drainage Area
WAU: 5080001 150 continued.						
Kings Creek				*CWH*		
0.1/0.1	Full	43	NA	44	81	41.8
Trib. to Kings Creek (RM 4.99/3.18)				*Undesignated/ CWH recommended*		
1.0/1.0	Full	42	NA	VG	74.5	10.2
Trib. to Kings Creek (RM 0.46)				*CWH*		
0.4/0.6	Full	36[ns]	NA	G	59.5	8.9
WAU:5080001 160 Mad River/ Nettle Creek						
Mad River				*CWH*		
41.6/41.6	Full	48	NA	56	73	160
39.9/39.9	Full	41	NA	50	79.5	162
38.4/38.4	Full	41	NA	46	69	188
32.7/32.7	Full	36[ns]	NA	46	76	264
Muddy Creek				*WWH existing/ CWH recommended*		
6.3/6.3	Partial	34*	NA	G	56.5	12
0.4/0.5	Full	44	NA	48	65.5	22.8
Spring Run				*CWH existing/ WWH recommended*		
0.7/0.7	Full	52	NA	MG[ns]	37.5	3.7
Dugan Run				*WWH*		
1.2/1.2	Partial	32*	7.1*	G	59	23
Nettle Creek				*CWH*		
8.2/8.2	Full	44	NA	40	89	8
7.1/7.1	Full	46	NA	MG[ns]	60	12
4.4/4.5	Full	44	NA	50	72	15
2.5/2.8	Partial	34*	NA	G	69	19.8
0.1/---	(Full)	NA	NA	48		46.2
Anderson Creek				*CWH*		
5.9/.9	Full	48	NA	G	71.5	5.4
3.7/3.7	Full	52	NA	MG[ns]	68.5	10.7
1.0/1.0	Full	38[ns]	NA	G	68.5	17.2
Harban Creek				*CWH (verified)*		
---/0.1	(Full)	58	NA		75	0.6
Russell Creek				*PHWH candidate*		
0.1/---	NA		NA	P*		
Owens Creek				*CWH existing/ WWH recommended*		
0.1/0.1	Full	54	NA	VG	66	5.7
Hog Creek				*CWH existing/ WWH recommended*		
0.6/0.6	Full	44	NA	G	69.5	0.9
Trib. to Nettle Creek (RM 8.80)				*WWH*		
2.7/2.7	NON	42	NA	P*	44.5	1.1
2.6/2.6	NON	46	NA	VP	73	1.2
Stony Creek				*CWH existing/ WWH recommended*		
0.7/0.7	NON	38[ns]	NA	P*	51	1.5
Storms Creek				*CWH (verified)*		
2.1/2.7	Full	50	NA	G	76	5.8
0.7/0.7	Full	46	NA	G	61	9.1
Chapman Creek				*CWH*		
10.1/10.1	Partial	30*	NA	MG[ns]	68	5.8

Stream River Mile Invertebrate/Fish	Attainment Status	IBI	MIwb	ICI/ narrative	QHEI	Drainage Area
WAU:5080001 160 continued.						
Chapman Creek				*CWH*		
6.9/6.9	Full	56	NA	VG	76	10.5
4.0/4.0	Full	48	NA	52	61.5	18.6
0.8/0.8	Full	45	NA	48	57.5	24.7
Deer Creek				*CWH existing/ WWH recommended*		
0.6/0.6	Full	48	NA	G	72.5	0.9
Blacksnake Creek				*CWH existing/ WWH recommended*		
0.4/0.4	Full	48	NA	MG[ns]	41.5	3.2
WAU: 5080001 170 Buck Creek						
Buck Creek				*PHWH candidate*[c]		
19.5/---	NA		NA	P*		3.8
				CWH (verified)		
17.5/17.5	Full	54	NA	VG	82.5	9.5
13.1/13.1	Full	46	NA	48	73.5	30.5
				WWH		
6.4/6.4	Partial	44	8.7	24*	69.5	82
0.6/0.6	Full	46	9.4	52	60	141
Beaver Creek				*CWH existing/ WWH recommended*		
10.2/10.2	Full	54	NA	G	63	11
4.5/4.5	Full	51	8.2[ns]	52	62	21
				WWH		
0.7/0.7	Full	38[ns]	7.8[ns]	54	83	39
Sinking Creek				*WWH (verified)*		
4.6/4.6	Full	38[ns]	NA	MG[ns]	55.5	10.5
East Fork Buck Creek				*CWH (verified)*		
5.2/5.0	Full	40	NA	G	51	5
0.3/0.3	Full	37[ns]	NA	54	78	28
U.T. to East Fork Buck Creek				*PHWH candidate*		
0.9/---	NA		NA	F*		
Dugan Ditch				*undesignated/ CWH recommended*		
2.2/2.2	Full	42	NA	VG	34.5	11.2
WAU: 5080001 180 Downstream Chapman Cr. to upstream Mud Cr. (excluding Buck Cr)						
Mad River				*CWH*		
29.6/29.6	Full	44	NA	54	73.5	310
27.0/27.0	Full	46	NA	G	79	323
				WWH		
25.5/25.8	Partial	35*	8.7	42	84.5	464
24.1/24.1	Full	38[ns]	9	G /36(X12)	75	490
Moore Run				*WWH*		
4.1/4.1	NON	28*	NA	F*	28.5	6.6
2.5/2.5	Partial	38[ns]	NA	F*	49.5	9.3
0.8/0.8	Full	46	NA	MG[ns]	65	18.2
Kenton Creek				*WWH*		
0.3/0.7	Partial	48	NA	F*	67.5	4.8
Pondy Creek				*CWH existing/ WWH recommended*		

Stream River Mile Invertebrate/Fish	Attainment Status	IBI	MIwb	ICI/ narrative	QHEI	Drainage Area
1.1/1.1	Partial	32*	NA	MG[ns]	47.5	5.5
WAU: 5080001 180 continued.						
Dry Run				*CWH existing/ WWH recommended*		
0.3/0.3	Full	38[ns]	NA	G	48.5	2.7
Mill Creek				*WWH (verified)*		
3.2/3.2	Full	46	NA	VG	83	5.1
0.1/0.1	Full	52	NA	MG[ns]	70.5	15.3
Rock Run				*WWH (verified)*		
0.1/0.1	Full	46	NA	VG	74	9.1
Miller Creek				*WWH (verified)*		
0.1/0.1	Full	40	NA	VG	75	2.6
Donnels Creek				*EWH existing/ WWH recommended*		
7.5/7.5	Full	48		VG	81.5	11.2
3.7/3.7	Full	44	8.2[ns]	VG	73	23.1
1.9/1.9	Partial	40	7.7*	VG	62.5	25.6
East Fork Donnels Creek				*WWH (verified)*		
2.9/2.9	Full	46	NA	MG[ns]	84	5.5
0.1/0.1	Full	52	NA	E	77.5	9.1
Jackson Creek				*EWH existing/ WWH recommended*		
3.8/3.8	Full	48	NA	VG	61.5	5
0.9/0.9	Full	56	NA	MG[ns]	52	8.7
WAU: 5080001 190 Lower Mad River tribs.						
Mud Creek				*undesignated/ WWH recommended*		
5.0/5.0	NON	40	NA	P*	50.5	5.9
2.5/2.5	Partial	46	NA	F*	56.5	9.1
0.6/0.6	Full	52	NA	MG[ns]	82	19.6
Mud Run				*WWH (verified)*		
9.7/9.7	Full	56	NA	E	65	11.8
7.8/7.8	Full	54	9.2	56	77	20.4
3.3/3.3	Full	40	7.8[ns]	56	69	25.5
2.0/2.0	Full	51	8.0[ns]	48 (x12)	73	26.4
0.8/0.8	Partial	41	6.4*	48	57	27.2
Clear Creek				*WWH (verified)*		
0.5/0.5	Full	48	NA	G	65	5.2
Trib. to Mud Run (RM 9.8)				*undesignated/ WWH recommended*		
0.7/0.7	NON	24*	NA	G	65.5	5.6
Drylick Run				*undesignated/ WWH recommended*		
1.6/1.7	Full	40	NA	MG[ns]	74.5	4.6
Hebble Creek				*MWH*		
5.0/5.0	Full	30*	NA	F*	34	5
0.1/---	(Full)		NA	G		
Lilly Creek				*MWH*		
0.1/0.1	Partial	22*	NA	F	70.5	6.6

Table 2 continued.

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

INDEX - Site Type	LRW	MWH channel modified	CWH	WWH	EWH
IBI Headwater - Wading/ Boat	18/18	24/24	40	40/ 42	50
MIwb Wading/ Boat	4.0/4.0	6.2/5.8	-/6.6	8.3/ 8.5	9.4/ 9.6
ICI	8	22	36	36	46

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.

ns Nonsignificant departure from biocriterion (<4 IBI or ICI units; <0.5 MIwb units).

a Narrative evaluation used in lieu of ICI (E=Exceptional; G=Good; MG[ns]=Marginally Good; F=Fair; P=Poor).

b Use attainment status based on one organism group is parenthetically expressed.

N/A Not Applicable. The MIwb is not applicable to headwater sites.

c Designation of aquatic life use for small watercourses that can be best characterized as a Class III Primary Headwater Habitat (PHWH) water body will remain undesignated pending promulgation of the PHWH use in the Ohio Water Quality Standards. Primary Headwater Habitat classes are defined in *Ohio Environmental Protection Agency. 2002. Field Evaluation Manual for Ohio's Primary Headwater Streams, Final Version 1.0. Division of Surface Water, Columbus, Ohio.* When the PHWH use becomes codified, these streams will be assigned an appropriate aquatic life use utilizing the Ohio EPA rulemaking process established for designating aquatic life uses for Ohio streams.

Recreational Use Attainment Status

The Primary Contact Recreation (PCR) use status throughout the Mad River watershed was assessed using results from bacterial sampling. A total of 165 samples from 33 sites were submitted for fecal coliform and *E. coli* analysis. Most sites were sampled for bacteria (fecal coliform and *E. coli*) five times within a thirty day period in order to determine recreational use attainment (Table 27, Appendix Table A-2). Sampling results indicated elevated bacteria levels throughout the watershed, potentially impairing the PCR use (Table 27**,** Figure 9 and Figure 10, Appendix Table A-2). High precipitation rates and the resulting runoff contributed to the elevated bacteriological levels and exceedances of the PCR criteria. Precipitation for the July to September period exceeded normal levels by between 4.89 to 13.25 inches at Dayton and West Liberty, respectively. High median concentrations were attributed to a St. Paris sanitary sewer overflow (SSO) in the St. Paris tributary and numerous Springfield CSOs in Buck Creek. The highest median bacteria concentrations of the entire survey occurred in Lilly Creek (4900 colonies/100ml fecal coliform, 1900 colonies/100ml *E. coli*).

Chemical Water Quality

Inorganic water chemistry grab samples and field measurements were collected at 110 sites in the Mad River study area at two-week intervals (six times) from mid-July to late September (Table 25). Analysis included a variety of parameters including nutrients and metals (Figure 50, Appendix Table A-1). Thirty two of these sites were also sampled for organic compounds twice during the survey (Table 28, Appendix Table A-3). Additionally, Datasonde™ continuous monitors were deployed at 16 sites for a 48-hour period in July and again in September. Water

chemistry results which exceeded State of Ohio Water Quality Criteria Standards (WQS) are presented in Table 26.

Water chemistry was generally good throughout the entire Mad River watershed. One feature that water chemistry results made apparent was the interaction between groundwater and surface water in the study area. The cool water temperature in the upper portion of the watershed and elevated nitrate levels both were associated with groundwater recharge of surface waters. Detection of organic compounds was principally related to agricultural land use. Higher herbicide levels were detected in the June sampling rather than in August reflecting the spring application of herbicides. While water chemistry results were not severely impacted, it was apparent that management practices to minimize the release of nutrients and organic compounds from agricultural areas and in urban runoff should be encouraged.

Sediment Quality

A total of 37 sediment samples were analyzed for various physical and chemical properties. Physical attributes measured included particle size distribution, % solids and % total organic carbon. Chemical attributes measured included metals, volatile and semi-volatile organic compounds, pesticides and polychlorinated biphenyls (PCBs). Chemical quality of sediment is a concern because many pollutants bind strongly to soil particles, are persistent in the environment and accumulate in the food chain.

Throughout the Mad River watershed, sediment contamination was principally associated with urban sources (CSOs and stormwater) and the International Truck and Engine Corporation. Contaminant concentrations exceeded likely effect values of metals and organics at multiple locations in each assessment unit (see Sediment Methods discussion, page 40) but observed impacts were not manifest to any great extent. One stream reach where sediment contamination likely did contribute to impaired biological function was Moore Run downstream from International Truck and Engine Corporation (RM 2.46). Ammonia, phosphorus, metals and PAHs were present in concentrations likely to impact biological communities.

Unusually high sediment ammonia values recorded in both urban and rural locations within the basin. Typically sediment ammonia values in Ohio are below the Ontario sediment disposal guideline of 100 mg/kg. Elevated values were associated with wetlands in the upper watershed and human activities such as: urban runoff, hypolimnetic water release from Brown Reservoir. Other potential sources include failed onsite systems and land applied manure. The highest sediment ammonia level (5400 mg/kg) ever recorded in the 16 counties of the Southwest District of Ohio was documented at Moore Run (RM 2.46).

Fish Tissue

The Ohio Department of Health (ODH) issued a statewide fish consumption advisory in 1997 advising women of child bearing age and children six and under to eat not more than one meal per week of any species of fish from waters of the state because of mercury concerns. Additionally, one meal per month advisories have been established for the Mad River from U.S.

Route 36 to mouth for channel catfish and carp due to PCB contamination and largemouth bass due to mercury contamination. For additional information related to fish consumption advisories, see the 2004 Fish Consumption Advisory report available at http://www.epa.state.oh.us/dsw/fishadvisory/index.html.

RECOMMENDATIONS

Current and recommended aquatic life, water supply and recreation uses are presented in Table 3. A number of the tributary streams evaluated in this study were originally designated for aquatic life use in the 1978 and 1985 Ohio WQS; others were previously undesignated. The current biological assessment methods and numerical criteria did not exist then. This study, as an objective and robust use evaluation, is precedent setting in comparison to the 1978 and 1985 designations. Several subbasin streams have been evaluated for the first time using a standardized biological approach as part of this study. Ohio EPA is obligated by a 1981 public notice to review and evaluate all aquatic life use designations outside of the Warmwater Habitat (WWH) use prior to basing any permitting actions on the existing, unverified use designations. Thus, some of the following aquatic life use recommendations constitute a fulfillment of that obligation.

The Coldwater Habitat (CWH) aquatic life use designation is recommended for the unnamed tributary to Kings Creek (RM 4.99/3.18), Peters Ditch and Sugar Creek. The 2003 sampling confirmed the CWH use for Glady Creek.

Numerous aquatic life use designations are being proposed in the Mad River/Nettle Creek assessment unit which includes Mad River tributary streams downstream from Kings Creek to downstream from Chapman Creek. Spring Run, Owens Creek, Hog Creek, Russell Creek, Blacksnake Creek, and Deer Creek had all been previously designated with a CWH use but without biological verification. Results from the 2003 study demonstrated that the WWH use is the more appropriate designation. Stony Creek will need to be revisited before an accurate aquatic life use can be assigned. The stream was heavily impacted by an improperly operated wastewater treatment from the Lakewood Swim Club. The swim club is not expected to reopen in 2005. The CWH use was verified for Harban Creek, and Storms Creek. Muddy Creek is currently listed as a WWH stream that had been verified with past biological data. This designation is not consistent with the results of the 2003 sampling effort. Review of the Ohio EPA database produced fish index scores from the early 1970s but no macroinvertebrate sampling results. The two Muddy Creek sites sampled in 2003 produced fish and macroinvertebrate assemblages that were consistent with a CWH use.

Buck Creek upstream from C. J. Brown reservoir and East Fork Buck Creek are listed as CWH streams in the 1978 and 1985 water quality standards; but prior to this most recent survey the aquatic life use had not been confirmed. The 2003 biological and habitat results verified the designation on the East Fork Buck Creek and for Buck Creek from RM 17.5 to C.J. Brown reservoir. Sampling of fish and macroinvertebrates on Dugan Ditch produced assemblages consistent with the CWH aquatic life use (CWH) despite a highly modified habitat. With the

addition of Dugan Ditch, the CWH designation encompasses all the principle streams in the Buck Creek watershed upstream from C. J. Brown Reservoir. Beaver Creek was designated CWH upstream from Sinking Creek but the use had not been verified with biological information. Based on the information gathered in the 2003 sampling effort, a WWH aquatic life use was judged most appropriate for this reach of Beaver Creek even though groundwater contributed significantly to the volume of stream flow. A WWH use was confirmed for Sinking Creek.

Recommended aquatic life use designations for the assessment unit that encompasses the Mad River from below Chapman Cr to above Mud Creek include a WWH use for Pondy Creek and Dry Run. Both streams were previously designated CWH but without biological verification. The appropriateness of the WWH use was demonstrated for Rock Run, Miller Creek, Mill Creek, and East Fork Donnels Creek. Jackson Creek and Donnels Creek had unconfirmed EWH use designations but did not consistently support the diversity of fish and macroinvertebrates that would merit the use. The WWH aquatic life use is a more appropriate designation.

Tributaries to the Mad River downstream from Mud Creek for which no aquatic life use had been assigned prior to the 2003 study included Mud Creek, Dry Lick Run, an unnamed tributary to Mud Creek (RM 9.8) and Lilly Creek. Mud Run and Clear Creek were originally designated as WWH in the 1978 and 1985 Ohio WQS but the use had not been confirmed. Instream and riparian habitat attributes of Lilly Creek have been significantly altered and the stream flows through an urbanized landscape. Little likelihood exists that the stream can be significantly improved to the point that a WWH fauna is likely. Consequently, the Modified Warmwater Habitat use (MWH) is recommended for Lilly Creek. Previous investigation concerning the correct aquatic life use for Hebble Creek also resulted in a MWH designation. The 2003 field work confirmed conditions remain consistent with this use. These were the only sampled streams in the entire study area where the MWH use was considered applicable.

Table 3 Waterbody use designations for the Mad River basin. Designations based on the 1978 and 1985 water quality standards appear as asterisks (*). Designations based on Ohio EPA biological field assessments appear as a plus sign (+). Designations based on the 1978 and 1985 standards for which results of a biological field assessment are now available are displayed to the right of existing markers. A delta (Δ) indicates a new recommendation based on the findings of this report.

Water Body Segment	Use Designations												
		Aquatic Life Habitat						Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Mad river - headwaters to Buck creek (RM 26.15)	+					+			+	+		+	
- Buck creek to Eastwood park (RM 2.7)	+	+							+	+		+	
- Eastwood park to the mouth		+							+	+		+	
Lilly creek				Δ					Δ	Δ		Δ	
Hebble run				+						+		Δ	
Mud run		*+							*+	*+		*+	
Clear creek		*+							*+	*+		*+	
Trib. to Mud run (RM 9.8)		Δ							Δ	Δ		Δ	
Mud creek		Δ							Δ	Δ		Δ	
Dry Lick run		Δ							Δ	Δ		Δ	
Smith ditch		*							*	*		*	
Rubsam ditch						*			*	*		*	
Medway creek						+			*	*		+	
Jackson creek		Δ	*						*+	*+		*+	
Donnels creek		Δ	*						*+	*+		*+	
East fork		*							*+	*+		*+	
Rock run		*+							*+	*+		*+	
Miller creek		*+							*+	*+		*+	
Mill creek		*+							*+	*+		*+	
Buck creek - park boundaries between C.J. Brown reservoir and the mouth	+	+							+	+		+	
- headwaters to C.J. Brown reservoir						*+			*+	*+		*+	
- all other segments		+							+	+		+	
Beaver creek - Sinking creek (RM 2.8) to the mouth		+							+	+		+	
- all other segments		Δ				*			*+	*+		*+	
Sinking creek		*+							*+	*+		*+	
East fork						*+			*+	*+		*+	
Dugan Ditch						Δ			Δ	Δ		Δ	
Pandy creek (Pondy creek)	*	Δ				*			*+	*+		*+	
Dry run	*	Δ				*			*+	*+		*+	
Moore run		+							+	+		+	
Kenton creek		+							+	+		*	

Water Body Segment	Use Designations												
		Aquatic Life Habitat						Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Chapman creek						+			+	+		+	
Panther creek	*					*			*	*		*	
Deer creek	*	Δ				*			*+	*+		*+	
Blacksnake creek	*	Δ				*			* +	* +		*+	
Storms creek	*					* +			*+	* +		*+	
Cedar run						+			+	+		+	
East branch						+			*	*		+	
West branch						+			*	*		+	
Cedar bog	*					*			*	*		*	
Bogles run	*					*			*	*		*	
Stony creek	*	Δ							*+	*+		*+	
Bull branch	*					*			*	*		*	
Nettle creek - RM 8.2 to the mouth						+			+	+		Δ	
- all other segments		+							+	+		Δ	
Anderson creek						+			+	+		+	
Russell creek	*	*				*			*	*		*	
Harban creek	*					*+			*+	*+		*+	
Hog creek	*	Δ				*			*+	*+		*+	
Owens creek	*	Δ				*			*	*		*	
St. Paris tributary		+							+	+		Δ	
Dugan run		+							+	+		+	
Muddy creek		+				Δ			+	+		Δ	
Spring run	*	Δ				*			*+	*+		* +	
Kings creek						+			+	+		+	
Unnamed tributary (Kings creek RM 0.46)						+			+	+		+	
Unnamed tributary (Kings creek RM Glady creek	*					Δ *+			Δ * +	Δ * +		Δ *+	
Mac-a-cheek ditch						+			+	+		+	
West Liberty tributary						+			+	+			+
Mac-o-chee creek						+			+	+		+	
Hefflefinger ditch						+			+	+		+	
Peters Ditch						Δ			Δ	Δ		Δ	
Sugar Creek						Δ			Δ	Δ		Δ	

METHODS

Determination of the CWH use

The Ohio EPA has not formally developed expectations of ambient biological performance in support of the Coldwater Habitat (CWH) aquatic life use designation. While other, qualitative and narrative criteria already exist for *designating* streams as CWH (Ohio EPA 1987b), these do not provide numerical end-points by which *attainment* of the CWH use can be objectively judged. Prior biological assessments of the Mad River employed an interim procedure for determining the CWH use attainment status of cool or cold-water streams within the basin. Essentially, the WWH biological criteria were used, as is, for evaluating CWH use attainment status, as well as communicating about the relative condition of the benthic invertebrate and fish assemblages (*i.e.* IBI, MIwb, and ICI). While the use of the WWH biological criteria to evaluate CWH rivers and streams is not codified in the Ohio Water Quality Standards ([OAC] 3745-1-07, Table 7-17), these were deemed, at that time, fair and reasonable. Other factors related to the definition of the CWH use in the Ohio WQS (*e.g.,* sanctioned stocking of salmonids by Ohio DNR) have been, and will continue to be, factored into the evaluation.

However, in light of the experience gained through past experimental application of the WWH biocriteria within the Mad River basin, the 2003 ecological evaluation contained herein will deviate from the previous interim measures of community performance, namely the application the headwater WWH biocriterion to *all* CWH designated waters. Problems with the wholesale and untested use of the WWH biocriteria to CWH streams were primarily manifest in fish community assessments of water bodies draining areas greater than 20 miles^2 (i.e., non-headwaters). The headwater IBI seemed to function well in elucidating community quality and appeared to yield meaningful information across a gradient of environmental conditions from headwater streams. Furthermore, increasing divergence from other biotic and abiotic environmental indicators were observed with increasing stream size (physical habitat, chemical water quality, sediment quality, etc.), from the CWH designated headwaters of the Mad River and its tributaries. The congruency between cool water fish faunas in general and temperate headwater fish faunas specifically is rational and expected. Both types of systems are, in many instances, controlled or strongly influenced by significant contribution of ground water to surface flow. Generally, the fish fauna found in both environs are adapted to higher steam gradients, characterized by low species richness, and often dominated by taxa adapted to a cool thermal regime and its attendant effects upon primary, secondary and tertiary productivity. Given demonstrated sensitivity of the headwater IBI, its use in evaluating fish communities of CWH streams draining 20 miles^2 or greater, is recommended, until a fully calibrated set of community measures are developed for the CWH use designation.

Benthic macroinvertebrate communities appeared to retain adequate taxa richness and complex functional organization throughout a wide range of CWH designated streams or stream segments. Although community composition was skewed towards stenothermic taxa, sufficient ecological complexity was present so as to allow the use of the WWH ICI to assess the overall

condition of the assemblage. As this measure appeared to function well in coldwater environments, the ICI will continue to be employed to evaluate macroinvertebrate quality, until a fully calibrated set of community measures are developed for the CWH use designation.

Ohio's CWH use designation should be amended to read that four or more coldwater macroinvertebrate taxa must be present and, if a quantitative sample is taken, nine percent or more of the organisms collected must be coldwater types. The coldwater taxa list used for this study is contained in Table 4 and should be considered an interim list for use until a more detailed analysis of the data base can be accomplished. Table 8-2 in the Biological Criteria Users Manual (OEPA 1987b) was amended to include additional taxa that demonstrate a preference for coldwater streams.

In contrast to the above, the IBI and MIwb derived from fish collection of CWH streams or stream segments within the Mad River catchment, failed to reliably generate meaningful information outside of headwater environments. In order to fully appreciate the antecedents of this phenomenon, it is important to consider the drainage history of the basin. Due to extensive channelization, completed near the turn of the last century, and the shallow depth of the water table underlying much of the watershed, over half of the Mad River's course and most upper tributaries were abruptly converted to cool or coldwater streams. In many instances, channelization and excavation directly connected the high yield shallow water table of the region with the surface channels, converting once temperate streams, to cold or coolwater environments. The extent of the ground water influence in modifying the thermal regime of the Mad River was profound, effectively creating *headwater-like* environments for segments draining areas far in excess of 20 miles^2. The attendant biological adaptation to the "new" coldwater thermal regime was the establishment of a brook or headwater fauna through nearly half of the Mad River mainstem. Even sites draining areas as large 300 miles^2 were found to support fish assemblages typically associated with very small waters. The unnatural persistence of a brook or headwater fish fauna throughout much of the Mad River mainstem was first recognized and described by Trautman (1981).

Both the IBI and MIwb are calibrated to account for natural ecological succession associated with increasing stream order or size (net accrual of species, species replacement, increased autotrophy, etc.). The apparent retarded rate of ecological succession rendered these non-headwater fish community measures unsuitable for the evaluation of CWH segments of the Mad River and larger tributaries so designated. Expected species richness, diversity, and functional and structural organization, contained within these indices, are ecologically impossible to achieve for the larger CWH streams or stream segments. Therefore, to reduce the likelihood of erroneous or otherwise inaccurate evaluations, the use of fish community measures developed for waters draining an area greater than 20 miles^2 (i.e., wading and boat methodologies) were not used to assess CWH status the larger Mad River Basin streams. Given unique ecological realities of the Mad River, as presently drained and configured, the headwater IBI alone was employed as an interim measure to evaluate the condition of the fish communities of *all* CWH designated waters within the catchment.

Table 4 Ohio EPA coldwater macroinvertebrate taxa list.

Crustacea	**Diptera**
Gammarus minus	*Dicranota sp.*
Ephemeroptera	*Pedicia sp.*
Ameletus sp.	*Thaumalea americana*
Baetis tricaudatus	*Apsectrotanypus johnsoni*
Epeorus sp.	*Macropelopia decedens*
Habrophlebiodes sp.	*Meropelopia sp.*
Timpanoga (Dannella) simplex	*Radotanypus florens*
Litobrancha recurvata	*Trissopelopia ogemawi*
Odonata	*Zavrelimyia sp.*
Lanthus parvulus	*Diamesa sp.*
Plecoptera	*Pagastia orthogonia*
Peltoperla sp.	*Odontomesa ferringtoni*
Amphinemura sp.	*Prodiamesa olivacea*
Soyedina sp.	*Brillia parva*
Leuctra sp.	*Chaetocladius piger*
Eccoptura xanthenes	*Corynoneura n. sp. 5*
Megaloptera	*Eukiefferiella devonica group*
Nigronia fasciatus	*Heleniella sp.*
Trichoptera	*Heterotrissocladius marcidus*
Dolophilodes sp.	*Metriocnemus eurynotus*
Wormaldia sp.	*Parachaetocladius sp.*
Ceratopsyche slossonae	*Parametriocnemus sp.*
Ceratopsyche ventura	*Psilometriocnemus triannulatus*
Diplectrona sp.	*Rheocricotopus eminellobus*
Parapsyche sp.	*Thienemanniella boltoni*
Rhyacophila sp. (excluding *R. lobifera*)	*Polypedilum (P.) albicorne*
Glossosoma sp.	*Polypedilum (Uresipedilum) aviceps*
Oligostomis sp.	*"Constempellina" n. sp. 1*
Frenesia sp.	*Micropsectra sp.*
Goera sp.	*Neostempellina reissi* (= *"Stempellina" n. sp. 1*)
Lepidostoma sp.	*Paratanytarsus n. sp. 1*
Psilotreta rufa	*Zavrelia n. sp. 1*
Molanna sp.	

Sediment Methods

Fine grain sediment samples were collected in the upper 4 inches of bottom material at all Mad River basin locations using decontaminated stainless steel scoops. Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 2001). Sediment grab samples were homogenized in stainless steel buckets, transferred into appropriate containers, placed on ice in a cooler (to maintain 4^{o}C), and shipped to the Ohio EPA analytical laboratory. Sediment data is reported on a dry weight basis. Sediment evaluations were conducted using guidelines established in MacDonald et al. (2000), Ohio EPA Sediment Reference Values (SRV) (2003), and Ontario Sediment Quality Guidelines (Persuad 1993).

Consensus-based sediment quality guidelines (SQGs) for freshwater ecosystems were developed by MacDonald, Ingersoll and Berger (2000) to be used as an effective tool for assessing sediment quality. Sediment Quality Goals (SQGs) were developed using 12 previously published freshwater ecosystem studies derived from a variety of approaches. A consensus-based SQG developed 28 chemicals of concern matching sediment chemistry and toxicity data to provide a unifying synthesis of existing SQGs. The SQGs are predictive of toxicity in sediments containing mixtures of contaminants, but do not consider the potential for bioaccumulation. Each of the 28 chemicals is evaluated in the following categories: Threshold Effect Concentration (TEC) - concentrations below which adverse effects are unlikely to occur; Probable Effect Concentration (PEC) - concentrations above which adverse effects usually or always occur; Between the TEC and PEC - concentrations between which adverse effects frequently occur.

Ohio Specific Sediment Reference Values (SRVs) were developed by Ohio EPA to identify representative background sediment metal concentrations for lotic (flowing) water bodies. Sediment samples were taken from reference areas throughout the state that have been used historically to develop the biological criteria as part of the State of Ohio's water quality standards. These reference areas were selected as being representative of the least impacted conditions in the watershed. Specific Reference Values are site-specific background metal concentrations based upon ecoregions and are used to identify whether a site has been contaminated. In all, seventeen of the eighteen sediment metals sampled were evaluated by Ohio EPA SRVs. Specific Reference Values are guidelines, not Ohio EPA standards or criteria.

A limited suite of nutrient parameters was evaluated in this report. Ontario Severe Effect Level (SEL) guidelines (Persuad 1993) were used to evaluate Total Organic Carbon and Total Phosphorus. Sediment ammonia was evaluated using the Persuad open water disposal guidelines. Ohio and MacDonald SQGs do not have nutrient sediment parameter guidelines.

Whenever possible, composite samples from a cross-section of the stream channel were collected, with silts and clays comprising at least 30% of the sample. Sediments composed of sand and larger sized particles (>60 microns) are often stable inorganic silicate minerals and not usually associated with contaminants. Given that the finer grained silts and clays (<60 microns)

are much more chemically, physically and biologically interactive, collection efforts were biased toward collecting these types of sediments. Fine-grained material is defined as having a particle size < 60 microns with a settling time > 30 seconds. The percent fine-grained material is included in sediment summary tables as % FGM. Collecting fine-grained material in the channelized sections of the Mad River is very difficult due to the rich sand and gravel deposits from glacial outwash and the high energy of the stream flow.

WATERSHED ASSESSMENT UNIT REPORTS

[Many of the graphs included with the following summaries include dotted lines representing percentile concentrations from least impacted regional reference sites of similar size (Ohio EPA 1999). Statistical data were segregated by ecoregion (all streams in the Mad River watershed are in the Eastern Corn Belt Plains (ECBP) ecoregion) and further stratified by three ranges of stream and river size for these analyses as follows: headwater streams (0-20 sq. mi.); wadeable streams (> 20-200 sq. mi.); and small rivers (> 200-1000 sq mi.).]

Upper Mad River Watershed Assessment Unit (WAU 05080001 150)

Located in Logan and Champaign counties, the Upper Mad River watershed assessment unit encompasses a drainage area of 135 mi^2 (86,189acres). The area includes the Mad River mainstem from the headwaters to the confluence of Kings Creek at RM 43.82. Tributaries in the assessment unit include Macochee Creek (drainage area 19.1 mi^2, confluence RM 51.75), Macochee Ditch (drainage area 7.98 mi^2, confluence RM 46.09), Glady Creek (drainage area 12.7 mi^2, confluence RM 45.05), and Kings Creek (drainage area 43.6 mi^2, confluence RM 43.82). While agriculture is the predominant land use (Figure 11) with row crop and pasture/hay accounting for 47.2% and 33.5%, respectively, of the total watershed area, a significant portion (17.9%) of the land is covered by deciduous forest (University of Cincinnati, 2001). The largest communities in this watershed are West Liberty and the unsewered community of Zanesfield with respective 2000 census populations of 1813 and 220.

Most of the dischargers in this assessment unit discharge to unnamed tributaries to the Mad River mainstem. Upstream from Zanesfield, the Rockin' Ridge Resort (formerly known as Maple Ridge Resort) discharges at RM 1.00 to a tributary which enters the Mad River at RM 63.0 while Kamp-a-Lott discharges to a tributary (RM 0.20) entering the Mad River at RM 61.41. Indian Hills Mobile Home Park (MHP) discharges at RM 2.44 to a tributary which flows into the mainstem at RM 59.0. Kirkmont Center discharges at RM 0.70 to a tributary which enters another tributary (confluence RM 1.93) which subsequently flows into the Mad River at RM 58.8. The Village of West Liberty WWTP discharges at RM 0.20 to a tributary (*i.e.* West Liberty Tributary) entering the Mad River at RM 51.06. Macochee Ditch receives the wastewater discharge from the West-Liberty Salem School at RM 3.22. Freshwater Farms of Ohio discharges at RM 0.16 to a drainage ditch entering an unnamed tributary at RM 1.69 which then flows into Kings Creek at RM 0.65.

Table 5 Aquatic life use attainment status of the Upper Mad River watershed assessment unit (headwaters to below Kings Creek), June- October, 2003. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb) and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate (ICI) communities. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

Stream River Mile Invertebrate/Fish	**Attainment Status**	**IBI**	**MIwb**	**ICI/ narrative**	**QHEI**	**Drainage Area**
WAU: 5080001 150						
Mad River				*CWH*		
61.3/61.2	Full	54	NA	G	85	7.4
57.2/57.2	Full	40	NA	50	62	20.4
53.2/53.2	Full	41	NA	46	67.5	34
52.0/52.1	Full	41	NA	44	72	36
51.1/51.1	Full	40	NA	48	79	56
51.0/51.0	Full	41	NA	48	72	56
49.1/49.1	Full	39[ns]	NA	52	63	63
43.9/43.9	Full	42	NA	54	68.5	91
Sugar Creek				*undesignated/ CWH recommended*		
---/1.0	(Full)	38[ns]	NA		42.5	3.6
Peters Ditch				*undesignated/ CWH recommended*		
---/0.1	(Full)	42	NA		63	5.2
Macochee Creek				*CWH*		
6.2/6.2	Full	56	NA	E	74	5.2
3.7/3.7	Full	44	NA	VG	68	13.5
3.0/3.0	Full	42	NA	46	78	14.1
1.4/.4	Full	46	NA	G	62.5	16.6
0.1/0.1	Full	44	NA	G	71	19.1
Macochee Ditch				*CWH*		
3.4/3.4	Full	36[ns]	NA	MG[ns]	46	5
0.7/0.7	Partial	30*	NA	G	33.5	7.8
Glady Creek				*CWH (verified)*		
3.6/4.2	Full	36[ns]	NA	MG[ns]	66.5	10
Kings Creek				*CWH*		
6.1/6.1	Full	36[ns]	NA	MG[ns]	69.5	8.5
3.9/3.9	Partial	35*	NA	38	60	29
0.1/0.1	Full	43	NA	44	81	41.8
Trib. to Kings Creek (RM 4.99/3.18)				*Undesignated/ CWH recommended*		
1.0/1.0	Full	42	NA	VG	74.5	10.2
Trib. to Kings Creek (RM 0.46)				*CWH*		
0.4/0.6	Full	36[ns]	NA	G	59.5	8.9

Table 5 continued.

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

INDEX - Site Type	LRW	MWH channel modified	CWH	WWH	EWH
IBI Headwater - Wading/ Boat	18/18	24/24	40	40/ 42	50
MIwb Wading/ Boat	4.0/4.0	6.2/5.8	-/6.6	8.3/ 8.5	9.4/ 9.6
ICI	8	22	36	36	46

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns Nonsignificant departure from biocriterion (<4 IBI or ICI units; <0.5 MIwb units).
a Narrative evaluation used in lieu of ICI (E=Exceptional; G=Good; MG=Marginally Good; F=Fair; P=Poor).
b Use attainment status based on one organism group is parenthetically expressed.
N/A Not Applicable. The MIwb is not applicable to headwater sites.

Aquatic Life Uses

Biological and habitat assessments were conducted at 23 sites in 2003. Drainage areas at the locations ranged between 3.6 mi^2 and 91.0 mi^2. Aquatic life attainment status for the sampled sites is presented in Table 5.

All the sampled streams in the assessment unit are designated or recommended for the CWH aquatic life use. Twenty-one sites were in full attainment of the CWH use. Two sites supported biological communities that partially attained ecoregional expectations.

The high WAU score (94.0; Table 1, pg. 21) reflects the majority of sites meeting the CWH use designation. Lower than predicted fish community performance was documented where full attainment of the CWH use was not achieved. Two sampled locations produced fish community results that were in the fair range: Macochee Ditch at RM 0.7 (Lippincott Rd.) and Kings Creek at RM 3.9. Low IBI scores at both locations were attributed to limited habitat. These sites, along with additional sites that only marginally met the CWH use, have been altered to facilitate agricultural production. Improvements in beneficial habitat characteristics, such as promoting increased sinuosity and the development of additional instream cover, is recommended to restore and improve the biological resources in the upper Mad River assessment unit.

The present condition of the Mad River is the result of extensive channelization and levee construction as early as 1915 that facilitated row crop agriculture (Trautman 1981). These activities ranged from simple bank shaping to large scale channelization and levee projects. Prior to modification, this section of the Mad River contained what was described as prime physical habitat for aquatic life (Trautman 1981). At that time, the stream meandered greatly, and contained numerous alternating pool-riffle-run complexes. The dredging cut through vast deposits of permeable glacial drift and outwash that hold and discharge great quantities of cool groundwater, augmenting stream flow and mediating annual temperatures of the mainstem and several tributaries. Habitat alteration has had a profound influence upon the macrohabitats and aquatic communities within the upper Mad River. These activities completely modified the stream, creating a straight artificial ditch, lacking riffles and pools, and hemmed in by levees

derived from the dredge spoils. Agricultural production has significantly benefited by the alteration of the stream channel. Additionally, without the dredging described above, the recreational brown trout fishery, maintained with stocking by the Ohio DNR, would not exist. Though some recovery has occurred within this reach, macrohabitats are still simplified.

The entire reach of the Mad River mainstem was in full attainment of the CWH use. Macroinvertebrate results reflected good to exceptional condition and the fish community was rated marginally good to exceptional. The consistently high quality macroinvertebrate condition indicated that chemical water quality was not a negative factor on the biota of the stream. It is important to note that evaluation of the fish results was done using the headwater IBI metrics and scoring regardless of drainage area. Pervasive channel modifications and a strong ground water influence have created ecological conditions conducive to the maintenance of a fish fauna, in composition, similar to that encountered in WWH headwater streams. The justification for utilizing the WWH headwater IBI criterion in the absence of validated CWH expectations is provided in the methods portion of this report.

No impact was attributed to effluent discharged from the West Liberty WWTP. Biological scores were similar, if not identical, upstream and downstream from the WWTP tributary.

The Mad River upstream from Buck Creek, Macochee Creek, Macochee Ditch, and Kings Creek and two sampled tributaries were designated with the CWH aquatic life use based on previous biological surveys. The 2003 biological sampling results validated that use.

Sugar Creek and Peters Ditch are the two most upstream tributaries in the Mad River study area. Results from fish community sampling were inconclusive as to the appropriate aquatic life use (CWH vs. WWH) of either tributary. Since no macroinvertebrate sampling was conducted, it is recommended that the streams be provisionally designated as CWH until the issue can be fully evaluated. The coldwater use is consistent with other streams that flow into the Mad River in this assessment unit. Peters Ditch supported relatively high species richness and yielded an IBI score in the very good range (IBI= 42). Sugar Creek supported a marginally good fish community (IBI= 38). The stream was channelized with little instream cover; this likely prevented the establishment of a more diverse fish assemblage.

Glady Creek was designated with the CWH aquatic life use in the 1978 and 1985 Ohio WQS. The current biological assessment methods and numerical criteria did not exist then. This study, as an objective and robust use evaluation, is precedent setting in comparison to the 1978 and 1985 designations. Typically, the decision to designate CWH has been weighted heavily towards the occurrence of at least coldwater four macroinvertebrate taxa. Macroinvertebrate sampling in 2003 occurred during a period of elevated flow and produced only one coldwater taxon, the caddisfly *Ceratopsyche slossonae*, at RM 3.6. However, a more definitive 1986 quantitative sample at RM 0.4 near the confluence with the Mad River included 4 coldwater taxa

representing 11% of the number of organisms collected. Brown trout, redside dace, mottled sculpins and brook sticklebacks, four coldwater fish species, were recorded at RM 4.2 in 2003. When all evidence is taken together, the original CWH designation is supported.

The fish and macroinvertebrate communities marginally met CWH expectations in Glady Creek. Dissolved oxygen measurements were depressed on three of the six 2003 sampling dates and nutrient values were somewhat elevated above typical ecoregional expectations. These results were apparently linked to the presence of wetlands and a peat bog harvesting operation in the headwaters.

The macroinvertebrate assemblages in Kings Creek were in marginally good to very good condition at the three sites sampled. Fish community performance, however, was more varied and reflected habitat quality. QHEI values ranged from 60 to 81. The site with the lowest fish and habitat scores was Kings Creek at RM 3.9. The community was predominated by mottled sculpins. Brown trout, redside dace and brook sticklebacks were also present. This was a direct reflection of the cold groundwater fed nature of the stream. Lacking in the community was a diversity of other species; only eleven fish taxa were recorded. Evaluation based on the headwater IBI yielded a score of 35 which was reflective of a fair fish community. The principle anthropogenic influences that limited the community were the channelization of the stream and nutrient enrichment. Since sampling was concluded in 2003, two small WWTPs have been eliminated upstream from RM 3.9. Elevated nitrate levels documented in Kings Creek were apparently due to the intertwining of agricultural practices in the watershed with the shallow groundwater aquifers and surface flow in the stream.

Recreational Uses

Based on the five sites sampled for bacteria (fecal coliform and *E. coli*), the PCR use designation was not attained in this assessment unit (Table 27, Figure 9 and Figure 10, Appendix Table A-2). Elevated concentrations occurred primarily on higher flow days after precipitation. Bacteria levels were consistently elevated at the Macochee Creek site (RM 2.95). This site recorded the second highest fecal coliform median (2500 colonies/100ml) and the third highest *E. coli* median (620 colonies/100ml) of the 33 sites sampled in the Mad River basin for bacteria. Additional samples were analyzed for bacteria on September 23 at the next site upstream (RM 3.70) and from a field tile entering Macochee Creek just upstream from RM 2.95. Field tile results were not elevated. However, both fecal coliform (7700 colonies/100ml) and *E. coli* (2400 colonies/100ml) exceeded maximum PCR criteria at RM 3.70. (Results for these two extra samples were analyzed past holding time and as such are not included in Table 26 or Table 27.)

Chemical Water Quality

Inorganic water chemistry grab samples and field measurements were collected at 20 sites in this assessment unit at two-week intervals (six times) from mid-July to late September (Table 25). All samples were analyzed for a variety of parameters including nutrients and metals (Figure 12-Figure 14, Appendix Table A-1). Four of these sites were also sampled for organic compounds

twice during the survey (Table 28, Appendix Table A-3). Bacteria samples (fecal coliform and *E. coli*) were collected at five sites five times within a thirty-day period in order to determine recreational use attainment (Table 27, Appendix Table A-2). Additionally, a Datasonde™ continuous monitor was deployed in the Mad River mainstem at RM 50.98 downstream from the West Liberty WWTP for a 48-hour period in July and again in September (Figure 7).

Stream flows from May through September 2003 as measured by the USGS gage station in the Mad River at West Liberty (RM 52.05) are presented in Figure 5. On specific conventional water chemistry sampling days during the 2003 survey, the gage recorded a mean daily high of 68 cfs on July 15 and a mean daily low on August 26 of 32 cfs. On bacteria sampling days mean daily flows ranged from 33 cfs on August 25 to 125 cfs on September 3. Total precipitation of 23.8 inches was recorded in West Liberty (MCD 2003) from July through September 2003, a departure of 13.25 inches above normal for the period (Figure 6).

Water chemistry results which exceeded State of Ohio WQS criteria in the assessment unit are presented in Table 26 and Table 27.

Daytime dissolved oxygen concentrations dropped below CWH WQS criteria several times at the Glady Creek site (RM 4.17) and once at the headwater site in Macochee Creek (RM 6.16). Slightly to moderately higher concentrations of ammonia-n, nitrite-N, total kjeldahl nitrogen (TKN), chemical oxygen demand (COD), total phosphorus, and total suspended solids (TSS) were also documented in Glady Creek compared to other stream segments in the assessment unit. (Field crews, observing a reddish tint in this creek throughout the survey, discovered peat bogs and a sphagnum moss peat farm approximately four miles upstream from the site.)

Excluding the headwater site (RM 6.13), some of the highest nitrate-nitrite-N levels of the survey were recorded in Kings Creek and the two tributaries sampled (overall median concentration of 7.1 mg/l). Depth to groundwater is shallow in this agricultural watershed, with stream base flow derived largely from groundwater recharge. A Miami Conservancy District (MCD) study found that shallow wells (< 50ft deep) in agricultural areas in the Mad River watershed typically had higher groundwater nitrate concentrations than deeper wells (MCD 2003). Nitrate-nitrite-N concentrations of 6.96 mg/l and 9.9 mg/l were measured in July 2003 in two such wells in the Kings Creek watershed during the MCD study. Reflecting the interaction between groundwater and surface water, the impact of excess nitrogen and other potential contaminants leaching into the shallow aquifer is also likely to impact the streams in this watershed through groundwater recharge. Two facilities (CMT Machining and Mar-Nel MHP) located within 2000 lineal feet of Kings Creek (just north of the site sampled on Kennard Kings Creek Road at RM 3.9) discharged to dry wells during the 2003 survey and may also have had an impact on the surface water through groundwater recharge. Both discharges have since been eliminated with CMT Machining completing a mound system in August 2003 and the MHP closing in August 2004. While still quite low, median nitrate concentrations also increased sharply in the Mad River mainstem from 0.64 mg/l at the headwater site (RM 61.23) to 2.71 mg/l at RM 57.23. Similar to the Kings Creek watershed, in addition to agriculture, the wastewater infiltration lagoons at the

Royal Coach MHP (near RM 58.0) may also be impacting the river through groundwater recharge.

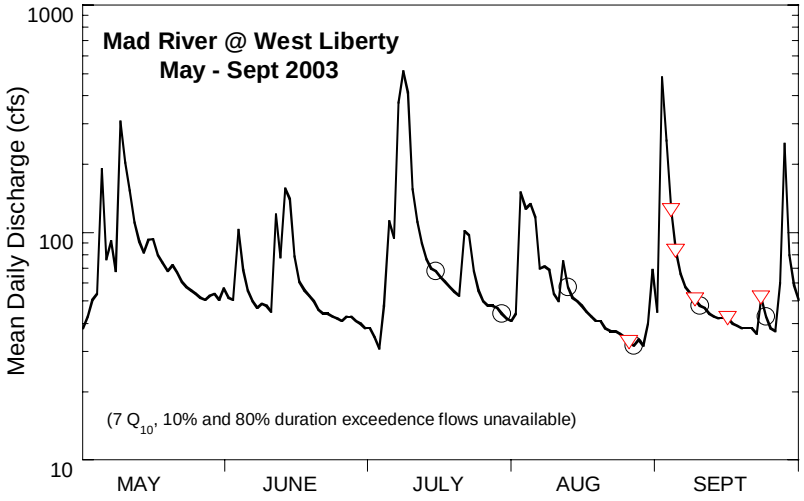
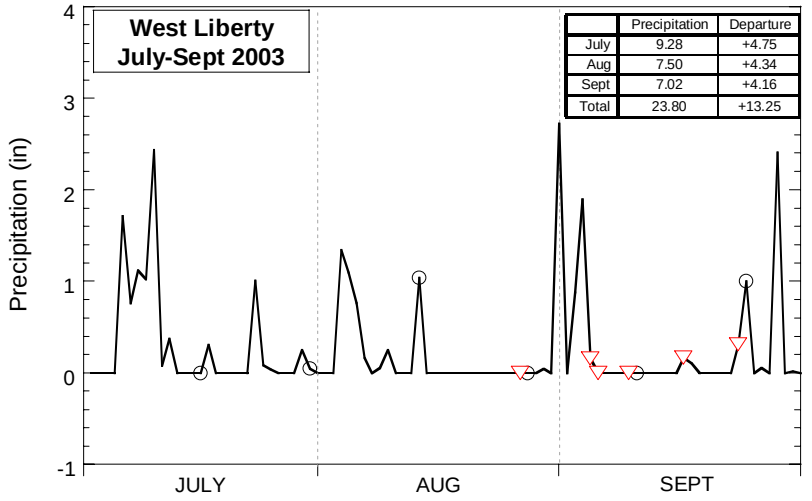


Figure 5

May through September, 2003 flow hydrograph for the Mad River at West Liberty (USGS station # 03266560) RM 52.05. Open circles indicate river discharge on water chemistry sampling days in the watershed. Triangles indicate river discharge on bacteriological sampling days.



	Precipitation	Departure
July	9.28	+4.75
Aug	7.50	+4.34
Sept	7.02	+4.16
Total	23.80	+13.25

*Rain gages are read every morning at or near 8:00 am. Therefore, these readings reflect the previous 24 hour catch.

Figure 6

Daily precipitation recorded for West Liberty from July through September (MCD, 2003). Open circles represent conventional water chemistry sampling days. Triangles represent bacteriological sampling days in the Upper Mad River watershed assessment unit.

Phosphorus concentrations were low throughout the watershed with an overall median of 0.015 mg/l and 97% of values well below the 90th percentile ECBP ecoregion background levels. The highest concentrations occurred in Glady Creek (median 0.153 mg/l).

Thirteen organic compounds were detected in the water column in the Upper Mad River watershed assessment unit (Table 28, Appendix Table A-3). Similar to the entire Mad River study area, higher herbicide levels were typically detected in the June sampling rather than in August reflecting the spring application of herbicides and the impacts of runoff. Atrazine, Simazine, and bis (2-ethylhexyl) adipate were the most frequently detected compounds with each

accounting for 5 of the 29 detections while metolachlor was detected in four of the samples. (There are no WQS criteria applicable for these four chemicals.) Concentrations of aldrin and dieldrin exceeded non-drinking water human health WQS criteria in Glady Creek at RM 4.17 while heptachlor epoxide exceeded its criterion in the Mad River at RM 61.23.

Chemical Sediment Quality

Sediment quality was evaluated at seven sites in WAU 05080001 150 (Table 6 and Table 7). Four of the sites were on the headwaters of the Mad River and three were on the tributaries. The Mad River (RM 43.90) upstream from Kings Creek was the only site in this WAU to have fine grain material (FGM) in the sample below the goal of 30%.

Sediment calcium (132,000 mg/kg) at Kings Creek (RM 0.1) was the only metal detected in this WAU to be over the Ohio sediment reference guidelines. Nothing unusual was noted in the appearance of the sediment. All other sediment metals were below the Ohio reference values for all seven sites in this WAU.

Sediment arsenic was between the MacDonald TEC and PEC at 4 of 7 sites but never exceeded the Ohio sediment reference guidelines. Normally sediments between the MacDonald TEC and PEC indicate that adverse benthic effects frequently occur. Ohio sediment reference guidelines are used to identify sediment concentrations that are above background. Background sediment arsenic for this ecoregion is considered to be less than 18 mg/kg, which is higher than the MacDonald TEC value of 9.79 mg/kg. Measured sediment arsenic levels in WAU 150 were not considered to be problematic.

A trace amount of acetone was found in six of seven sediment samples. Acetone is most likely a laboratory contaminant. Acetone was found to be contaminating the methanol used to clean sampling equipment.

The legacy insecticide Dieldrin (0.0097 mg/kg) was detected in the sediments of Glady Creek at levels between the MacDonald TEC and PEC. This amount of Dieldrin is expected to cause adverse affects to benthic organisms.

Results from Kings Creek (RM 0.1) detected the plasticizer, bis (2-ethylhexyl) phthalate (1.08 mg/kg). This compound does not have a sediment reference value.

Sediment ammonia exceeded the Ontario sediment disposal guideline (100 mg/kg) at three of the seven sites. The third highest sediment ammonia level (520 mg/kg) recorded during the survey was documented in Glady Creek (RM 4.17). This site was investigated due to the red color of the water seen during field visits. Peat bogs are scattered throughout this area of Logan and Champaign Counties. The red color was caused from sphagnum peat bogs draining to Glady

Creek. Failed septic systems and farm practices combined with wetland conditions are suspected for the high ammonia levels.

Watershed Protection Efforts

The Upper Mad River Watershed Steering Committee has been active since the early 1990s in the Logan and Champaign Counties of the watershed. This roughly corresponds to the Upper Mad River WAU (USGS HUC 05080001 150) and the Mad River/Nettle Creek WAU (05080001 160). Clean Water Act Section 319 grants were awarded to the group in the FFY 1993, 1997 and 2001 grant cycles. Since 1993 the Mad River Steering Committee has implemented a series of best management practices to demonstrate their use and effectiveness in restoring and protecting water quality. Included in the program are rotational grazing with exclusion of livestock, wooded and grass filter strips, shoreline stabilization, and in-stream habitat enhancement. Generalized nitrate contamination was documented in the Kings Creek subwatershed which may have been caused from excess fertilizer applications and/or defective on-lot sewage systems. As a result, nitrate reduction has become a major part of the program. One producer has cooperated to install and use a manure separation device to improve efficiency in handling manure. Another initiative is a fertilizer application reduction insurance program to demonstrate the potential wastes in over application of chemical fertilizers. A watershed action plan was developed for this region of the Mad River; however it currently doesn't meet the criteria for funding under the 319 program. No load reduction estimations can be developed until the new action plan is developed, a process currently underway.

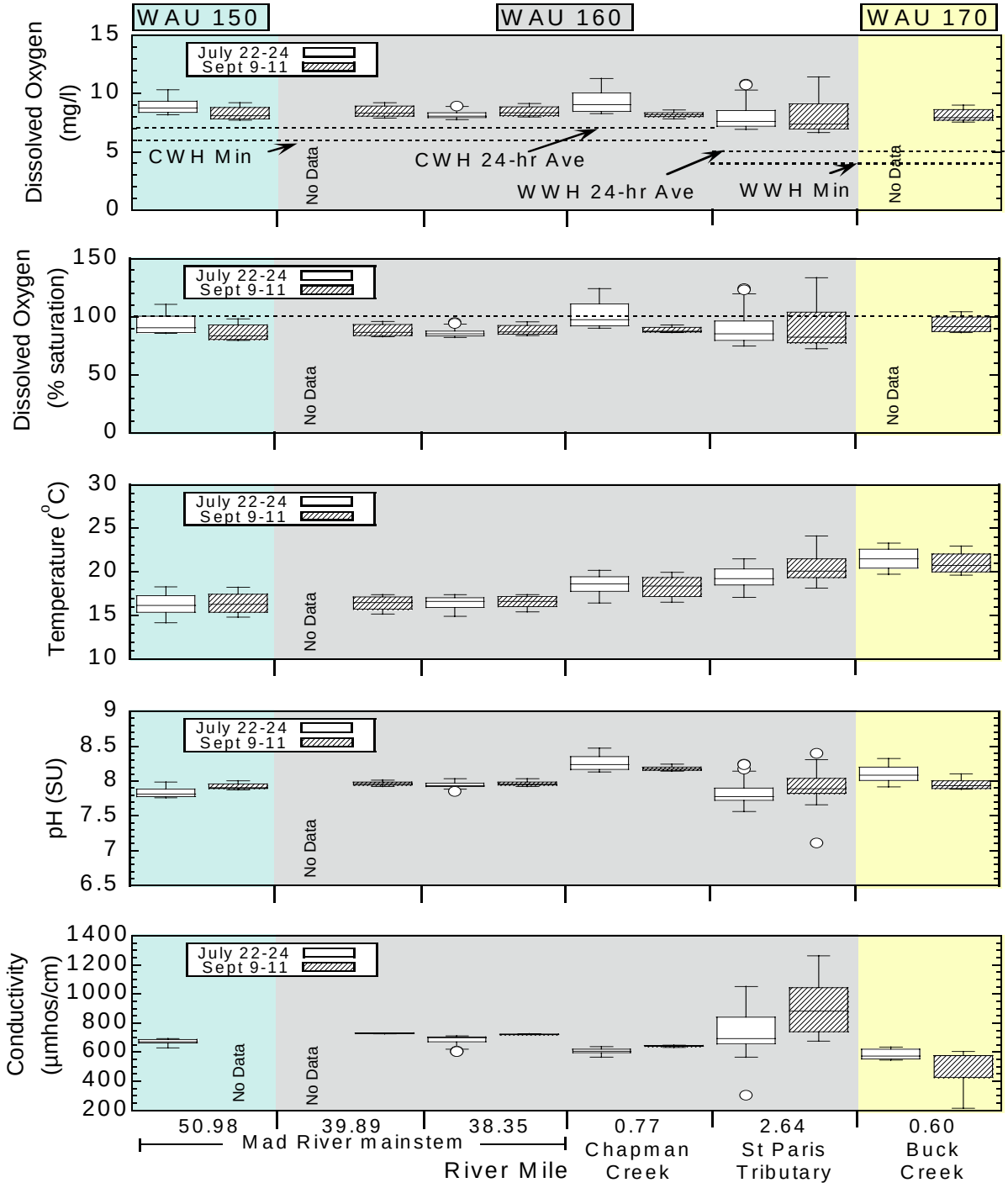


Figure 7 Distributions of dissolved oxygen (concentrations and saturations), temperature, pH, and conductivity recorded hourly with Datasonde™ continuous monitors in the Mad River basin (WAUs 150, 160 and 170) in 2003.

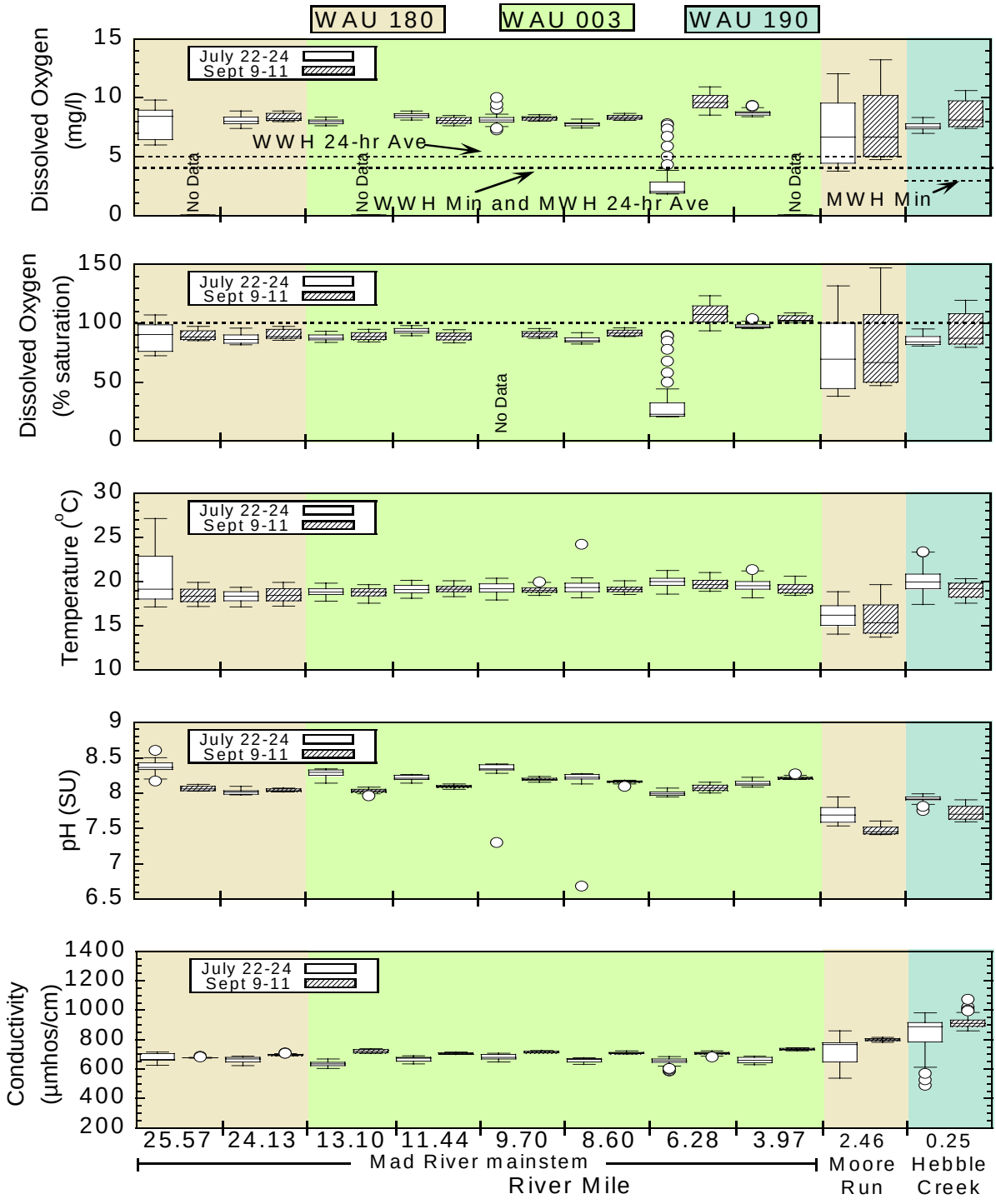


Figure 8 Distributions of dissolved oxygen (concentrations and saturations), temperature, pH, and conductivity recorded hourly with Datasonde™ continuous monitors in the Mad River basin (WAUs 180, 003, and 190) in 2003.

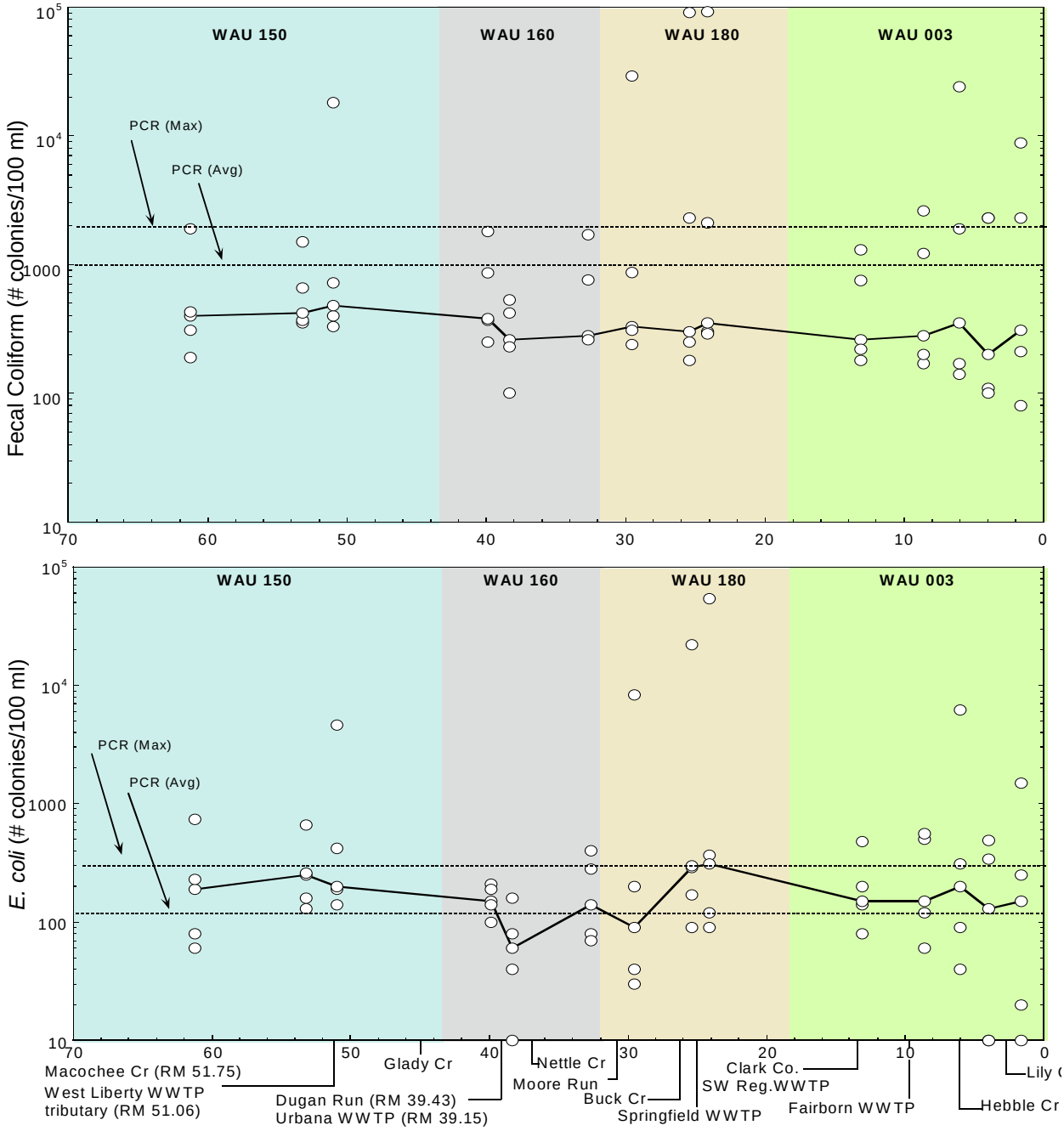


Figure 9 Longitudinal plots of fecal coliform (top) and *E. coli* (bottom) bacteria results from the Mad River mainstem during the 2003 survey. Dotted lines represent WQS criteria . The solid line depicts the median value at each river mile sampled. Watershed Assessment Units (WAUs) are shown in each plot.

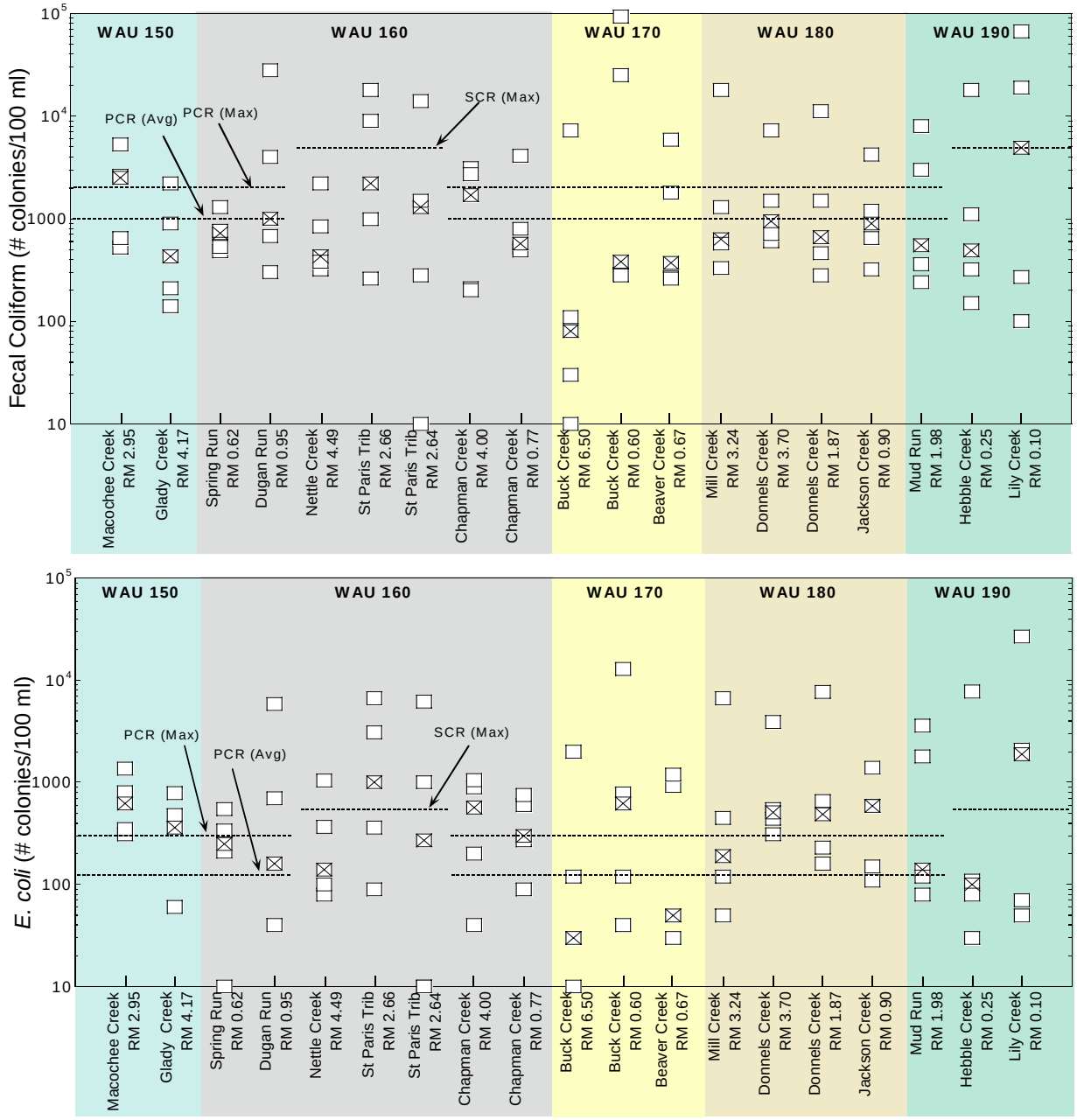


Figure 10 Plots of fecal coliform (top) and *E. coli* (bottom) bacteria results from tributaries in the Mad River watershed during the 2003 survey. Dotted lines represent applicable WQS criteria . The 'X' depicts the median value at the site sampled. Watershed Assessment Units (WAUs 150-190) are shown in each plot.

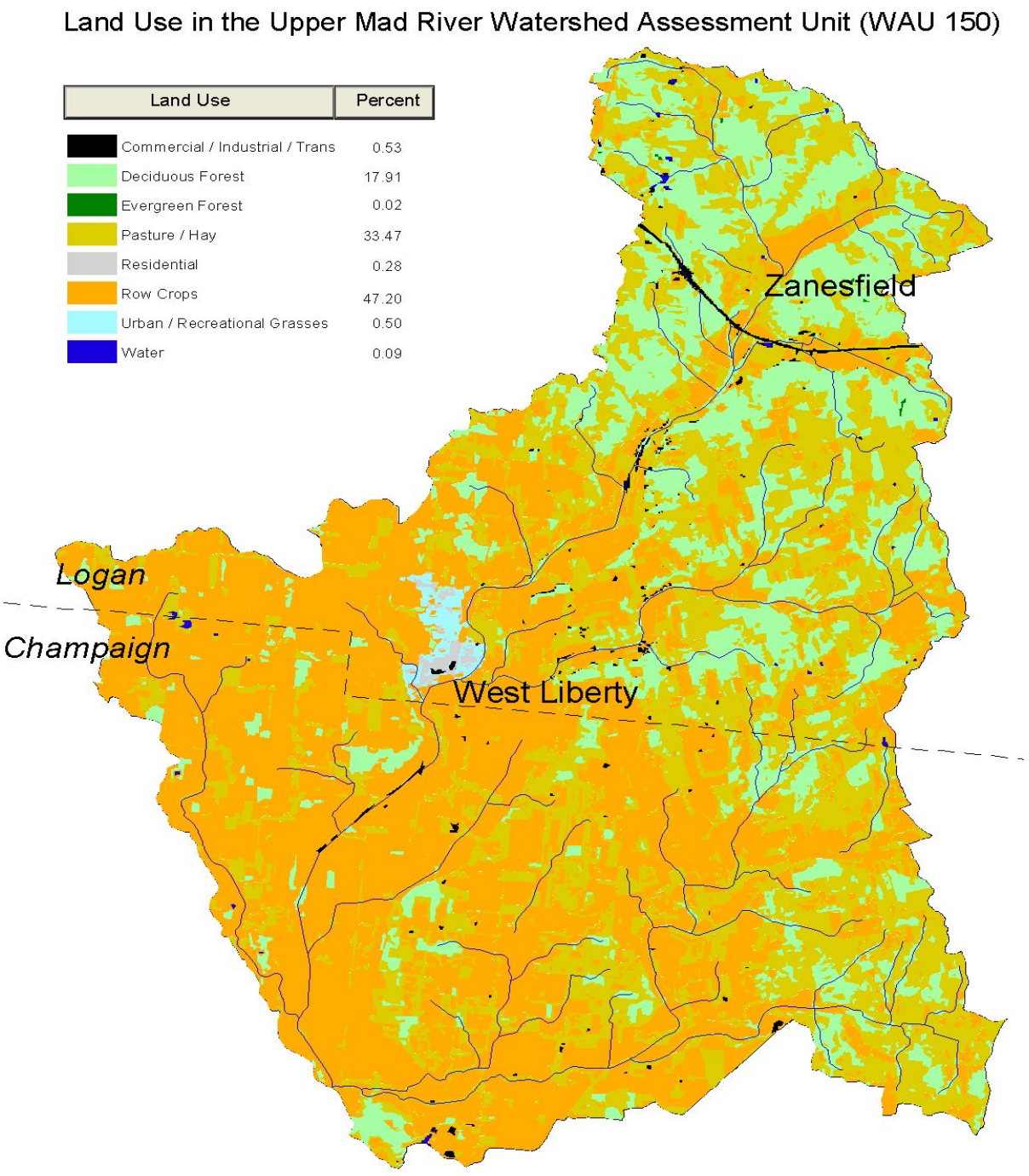


Figure 11 Land Use in the Upper Mad River Watershed Assessment Unit (WAU 05080001 150); (University of Cincinnati, 2001.).

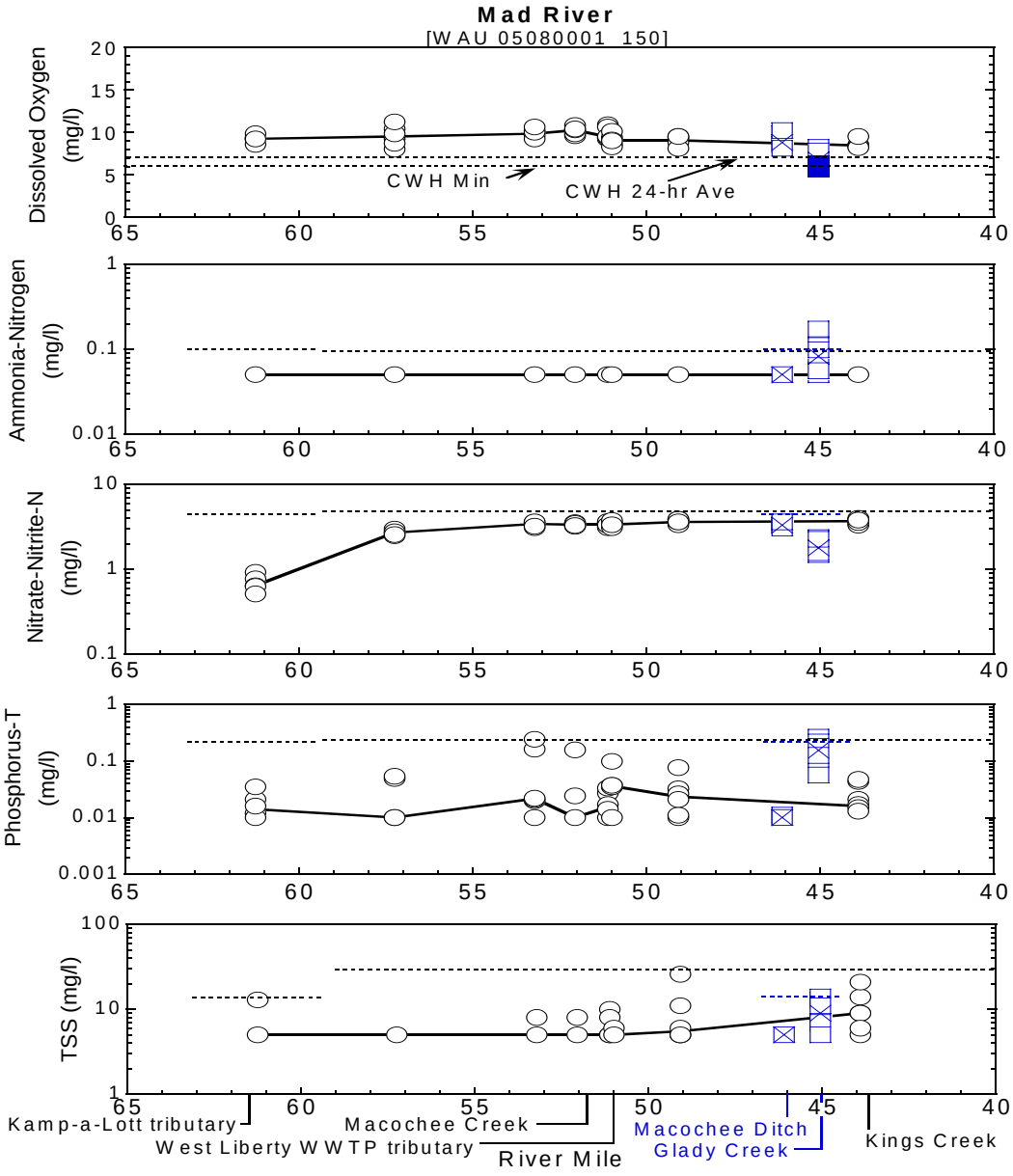


Figure 12 Longitudinal plots of water chemistry daytime grabs in the Mad River (circles), Macochee Ditch RM 0.66 (squares), and Glady Creek RM 4.17 (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in the Mad River mainstem while an 'X' depicts the medians for Macochee Ditch and Glady Creek. WQS criteria are shown in the dissolved oxygen plot. (Values below criteria are shown as solid circles or squares.) Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

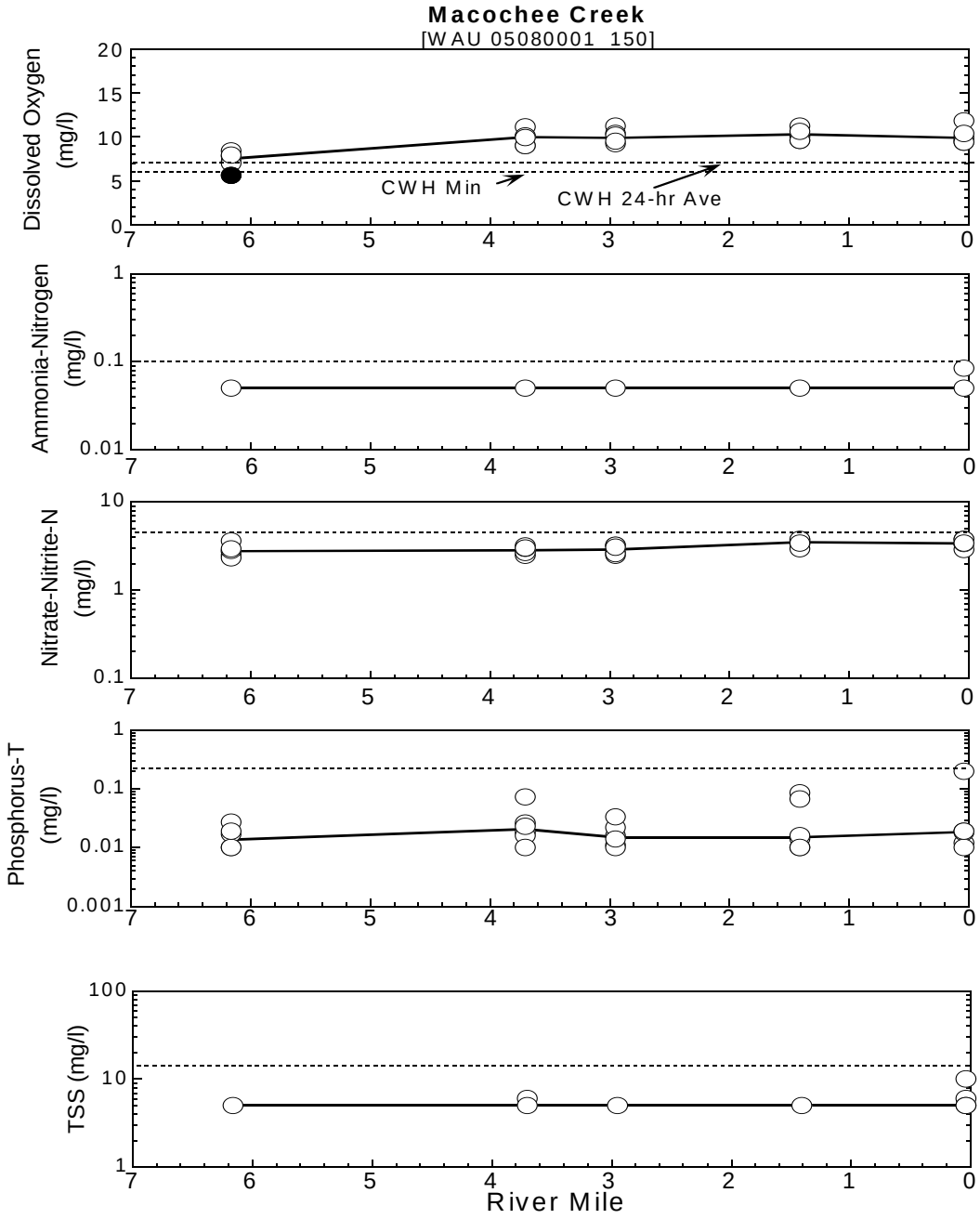


Figure 13 Longitudinal plots of water chemistry daytime grabs in Macochee Creek during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled. WQS criteria are shown in the dissolved oxygen plot. (Values below criteria are shown as solid circles.) Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

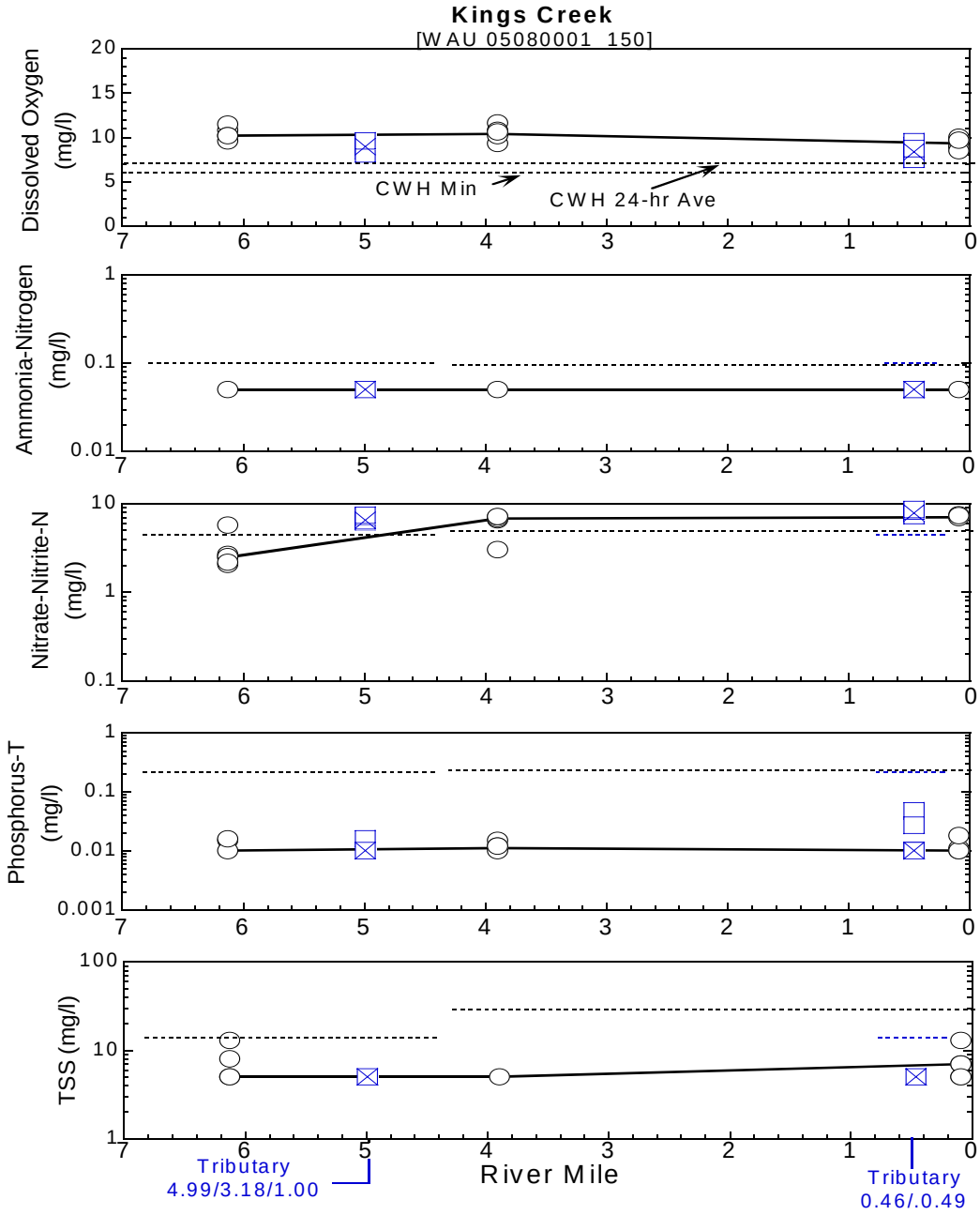


Figure 14 Longitudinal plots of water chemistry daytime grabs in Kings Creek (circles) and two unnamed tributaries (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in Kings Creek while an 'X' depicts the medians for the tributaries. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

Table 6 Concentrations (mg/kg) of metals and nutrients in sediment samples collected in the Upper Mad River watershed assessment unit (WAU 05080001 150) during 2003. Parameter concentrations were evaluated based on Ohio EPA sediment metal reference sites (2003), MacDonald (2000) Sediment Quality Guidelines (SQG) and Persuad (1993). Values above guidelines are highlighted.

Parameter	**Site Location (RM)**									
	Mad River CR 5 RM 61.23	**Mad River** TR 173 RM 53.21	**Mad River** Pimtown Rd **Dup A** RM 50.98	**Mad River** Pimtown Rd **Dup B** RM 50.98	**Mad River** Ust. Kings Creek RM 43.9	**Macochee Creek** SR 287 RM 2.95	**Glady Creek** Sullivan Rd RM 4.17	**Kings Creek** SR. 290 RM 0.09	***Reference***	
									Ohio	**MacD**
Al-T [O]	18700	17500	17400	17800	13900	17200	18400	17400	39000	*
As-T [OM]	9.9 #	9.48	9.11	11.0 #	7.56	11.4 #	11.4 #	5.94	18	9.79-33
Ba-T [O]	140	126	139	163	126	132	126	196	240	*
Ca-T [O]	27600	48400	61300	72000	81200	32200	12500	132000+	120000	*
Cd-T [OM]	0.346	0.406	0.367	0.418	0.349	0.317	0.383	0.350	0.9	0.99-4.98
Cr-T [OM]	20	18	18	19	15	20	<20	<23	40	43.4-111
Cu-T [OM]	13.5	13.2	11.6	14.8	8.0	13.0	10.2	9.4	34	31.6-149
Fe-T [O]	17200	16400	16000	17500	13400	17600	14900	12800	33000	*
Hg-T [OM]	0.062	0.059	0.041	0.045	<0.029	<0.028	<0.037	<0.045	0.12	0.18-1.06
K-T [O]	4320	3970	3360	3870	3300	3370	3900	3530	11000	*
Mg-T [O]	10700	16200	16900	16600	18500	14200	6840	17400	35000	*
Mn-T [O]	536	306	396	439	430	490	319	268	780	*
Na-T *	<2950	<2880	<2250	<2330	<2570	<2670	<3300	<3830	*	*
Ni-T [OM]	<24	<23	<18	<19	<21	<21	<26	<31	42	22.7-48.6
Pb-T [OM]	28	24	<18	<19	<21	<21	<26	<31	47	35.8-128
Se-T [O]	<1.18	<1.15	<0.90	<0.93	<1.03	<1.07	<1.32	2.19	2.3	*
Sr-T [O]	102	85	104	122	164	57	42	232	390	*
Zn-T [OM]	64.9	66.2	63.8	76.2	49.2	63.9	59.0	61.4	160	121-459
									Ohio	**Pers.**
NH_3-N [P]	85	110 [L]	96	110 [L]	40	46	520 [L]	55	*	100
TOC [P]	3.6%	4.2%	4.7%	4.3%	NA	3.7%	5.2%	NA	*	10.0%
pH *	7.4	7.5	7.6	7.7	7.6	7.9	7.5	7.6	*	*
P-T [P]	404	601	554	619	533	397	575	474	*	2000
%FGM [O]	31.4%	43.3%	34.0%	35.1%	20.9%ú	43.0%	34.5%	39.3%	30.0%	*
COD*	55000	20300	34300	17300	58400	35900	70800	78000	*	*

↘ Below the goal of 30% Fine Grain Material in sample
%FGM Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)
NA Compound not analyzed. * Not evaluated
[O] Evaluated by Ohio EPA (2003) [M] Evaluated by MacDonald (2000) [P] Evaluated by Persuad (1993)

Ohio SRV Guidelines (2003)
+ above background for this area

Ontario Sediment Guidelines (Persuad (1993)
L > Open Water Disposal Guidelines; equivalent to the Lowest Effect Level (LEL)-applicable to NH_3-N only.
• > severe effect level (disturbance in benthic community can be expected)

MacDonald (2000) Sediment Quality Guidelines (SQG)
TEC-PEC Threshold effect concentration (TEC) - Probable effect concentration (PEC)
Above which adverse effects frequently occur
■ **>PEC** Probable effect concentration (PEC) -Above which adverse effects usually or always occur

Table 7 Sediment concentrations of organic compounds (priority pollutant scan) detected in the Upper Mad River watershed assessment unit (WAU 05080001 150) during 2003. Individual compounds were evaluated by the MacDonald Sediment Quality Guidelines (2000).

River / Landmark	Analysis Performed	Compound Detected	Result mg/kg unless noted	
Mad River RM 61.23 CR 5 TOC= 3.6% Fine Grain Material = 31.4 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone	0.075 * BDL BDL BDL	
Mad River RM 53.21 TR 173 TOC= 4.2 % Fine Grain Material = 43.3 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone	0.082 * BDL BDL BDL	
Mad River RM 50.98 Pimtown Road TOC= 4.7% / 4.3% Fine Grain Material = 34.0%/35.1%	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone	**Dup A** 0.074 * BDL BDL BDL	**Dup B** 0.079 * BDL BDL BDL
Mad River RM 43.90 Ust. Kings Creek TOC= NA Fine Grain Material = 20.9%/21.7%	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone	0.140 * BDL BDL BDL	
Macochee Creek RM 2.95 SR. 287 TOC=3.7% Fine Grain Material = 43.0 %	1) VOC 2) BNA 3) Pesticides 4) PCBs		BDL BDL BDL BDL	
Glady Creek RM 4.17 Sullivan Rd. TOC=5.2 % Fine Grain Material = 34.5 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone Dieldrin	0.104 * BDL 0.0097 # BDL	
Kings Creek RM 0.09 SR 290 TOC= NA Fine Grain Material = 39.3 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone bis(2-Ethylhexyl)phthalate	0.139 * 1.08 * BDL BDL	

* Not evaluated NA Compound not analyzed BDL Below Detection Limit TOC Total Organic Carbon

1) Volatile Organic Compounds (VOC) U.S. EPA Method 8260B
2) Base Neutral & Acid Extractibles (BNA) U.S. EPA Method 8270
3) Pesticides U.S. EPA Methods 8082A
4) Polychlorinated biphenyls (PCBs) U.S. EPA Method 8082A

Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)

MacDonald (2000) Sediment Quality Guidelines (SQG)

TEC-PEC Threshold effect concentration (TEC) - Probable effect concentration (PEC)
Above which adverse effects frequently occur

■ **>PEC** Probable effect concentration (PEC) -Above which adverse effects usually or always occur

Point Source Evaluations

Rockin' Ridge (Maple Ridge) - unnamed tributary (RM 1.00) to the Mad River (RM 63)
Permit # -1PR00101
Lat.: $83^0$42'24", Long.: $40^0$22'37"

Rockin' Ridge Resort is located in Logan County at 3299 SR 540, Bellefontaine. It is a recreational vehicle resort with cabins and a campground. The original waste disposal system was a septic tank, holding tanks, dry wells and leach field. The swimming pool water discharged without authorization from a National Pollutant Discharge Elimination System (NPDES) permit to an unnamed tributary to the Mad River.

An upgrade to the treatment facility (7500 gpd design flow) was partially completed in 2000. The proposed upgrade included aeration, clarification and sand filter treatment. However, before completion occurred, the resort went out of business. The system installation was delayed due to the resort closure and transfer of ownership. Final installation of the system was completed in July, 2004 with the extension of sanitary sewers throughout the resort. All of the existing structures (minus the shelter house) were reportedly tied in. Current wastewater treatment for this facility consists of a trash trap, surge tank, aeration tanks, clarifier, two sand filters, chlorination and dechlorination.

An Ohio EPA inspection in 2004 indicated unsatisfactory areas for the treatment plant. Sand filters were not being rotated and the chlorination/dechlorination tablets units were empty. Monthly Operating Reports were submitted intermittently, prompting Ohio EPA to send "failure of submission" notices in 2004.

Kamp-A-Lott Campground - unnamed tributary (RM 0.20) to the Mad River (RM 61.41)
Permit # -1PZ00109
Lat.: 40^0N21'9"; Long.: 83^0W40'44"

Kamp-A-Lott is located in Logan County at 1888 CR 25A, Zanesfield. Kamp-A-Lott is a recreational campground that consists of 182 camp lots, 4 bath houses and one laundry, and is operated on a seasonal basis. Five, off-season cabins, discharge wastewater up to 400 gallons per day (gpd) per cabin, 2000 gpd total. Kamp-A-Lott's wastewater treatment system is an extended aeration package plant that was permitted and inspected by Ohio personnel in 2003. During the 2003 inspection, the presence of solids in the weir at the plant was noted. Infiltration and Inflow (I/I) into the system was noted as an issue during previous site inspections. An I/I study was required as a follow-up to a February, 2003 inspection. The plant was upgraded to ultraviolet disinfection in 2004. Sludge from the treatment system is hauled by Kelly's Septic Service to the City of Rushsylvania WWTP. The campground is currently contracting with a company to reseal all manholes, as well as reline some of the sanitary sewer due to infiltration which has caused the plant to be hydraulically overloaded.

Numeric violations of NPDES permit limits were evaluated from 2003 to 2004. NPDES violations, reported through SWIMS, revealed a total of 40 for Kamp-A-Lott. For the nearly two years of data evaluated, constituents violating permit limits were mostly conventional wastewater components with ammonia-N and TSS reported with the greatest frequency.

Indian Hills MHP - unnamed tributary (RM 2.44) to the Mad River (RM 59.0)
Permit # -1PV00108
Lat.: $40^0$20'45"; Long.: $83^0$42'17"

Indian Hills MHP is located in Logan County at TR 55 in Bellefontaine and is composed of 25 pads for mobile homes. The wastewater treatment plant is designed to treat 0.0075 million gallons per day (MGD) of effluent. The treatment works originally consisted of a trash trap, aeration, sand filters and chlorination. An Ohio EPA inspection in 2001 was in response to a complaint from the Logan County Health Department relating to sewage emanating onto an adjacent property. During the site inspection, Ohio EPA discovered the sand filters were inoperable, and the facility operator had a conveyance pipe from the filter bed discharging to the field behind the property.

Ohio EPA issued a Permit-To-Install (PTI-No. 05-11217) for an upgrade to the facility in 2001. An extended aeration facility was constructed and includes equalization basins (4,800 gallons), extended aeration tanks, settling tank fixed media, chlorination/dechlorination and post aeration.

Numeric violations of NPDES permit limits were evaluated from 2002 to 2004. NPDES violations reported through SWIMS, revealed a total of 48 for Indian Hills WWTP. For the nearly two years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included TSS (56%), ammonia-N, and $cBOD_5$ reported with the greatest frequency. The NPDES violations have occurred in all seasons except the fall. Final effluent limitation violations have increased (doubled from 2003 to 2004) since the upgrade of the wastewater treatment plant was completed in August 2002.

Kirkmont Center - unnamed tributary (RM 0.70) to unnamed tributary (RM 1.93) to the Mad River (RM 58.8)
Permit # - 1PZ00069
Lat.: $83^0$38'36"; Long.:40^0W20'07"

The Kirkmont Center is located in Logan County at 6946 County Road 10, Zanesfield**.** It is a year-round conference and retreat center operated by the Miami Presbyterian Church, USA. The initial treatment works was built in 1961 and currently treats wastewater from picnic shelter restrooms, three lodges, a pool house, and a residential house. The current system treats 10,000 gpd. Rain events increase influx to 27,000 gpd. due to I/I problems and cause violations of the NPDES permit.

The new extended aeration treatment system was installed uphill from the original plant between

manhole #3 and #4, utilizing the original collection lines holding tank and sand filters. Sewage emanated from a hole in this line and was repaired. Recommendations are to modify manholes # 8 and #9 by raising the level, adding slope, grouting the manhole and adding water-tight lids. Should these efforts fail then replacing the line will need to occur.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 30 for the Kirkmont Center. For the nearly six years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included TSS and ammonia-N (NH3-N), reported with the greatest frequency. The NPDES violations all occurred in the fall of 2003.

Royal Coach Estates MHP - infiltration lagoon near Mad River
Lat.: $40^0$18'39.6; Long.: $83^0$41'9.06

Royal Coach MHP is located in Logan County at 6946 County Rd 10 in Zanesfield. Royal Coach MHP has been in existence since the 1970s and currently has a 20,000 gpd extended aeration wastewater treatment plant. The treatment plant effluent discharges to an infiltration lagoon that infiltrates into groundwater. the Mad River is approximately 1200 feet away and 130 feet lower than the park wastewater discharge. An Ohio EPA inspection in 2002 noted the lagoon had filled with sludge and had a strong septic odor which resulted in neighborhood complaints. Ohio EPA contacted the facility to obtain an NPDES permit and abandon the current infiltration lagoon.

West liberty Salem School - Macochee Ditch (RM 3.22)
Permit # -1PT00066
Lat.: $83^0$45'10.7"; Long.: $40^0$12'50.7"

West Liberty Salem School is located in Logan County at 7208 SR 68, West Liberty. The West Liberty Salem School WWTP was originally built in 1988. It was upgraded to an extended aeration facility utilizing treatment by a grinder pump station, flow equalization, extended aeration, clarification, fixed media upflow filter, dosing station, surface sand filter, chlorination, dechlorination, and aerated sludge holding.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 37 for the school. For the nearly six years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included dissolved oxygen, $cBOD_5$, and ammonia-N (NH3-N) reported with the greatest frequency. Most violations occurred in 2001, slowly tapering off through 2004.

West Liberty WWTP – "West Liberty Tributary" (RM 0.20) to the Mad River (RM 51.06)
Permit # -1PC00012
Lat.: $40^0$14'45"; Long.: $83^0$45'45"

The West Liberty WWTP is located in Logan County 1050 Rd 262, West Liberty. The WWTP was built in 1940 with modifications in 1972, 1993-1994, and 2003. The treatment trains consist of grit removal, communition, bar screen, flow equalization, oxygen ditch, secondary clarification, chlorination, dechlorination (sulfur dioxide) and post aeration. The village of West Liberty is nearly all sewered with a collection system that contains seven lift stations. The facility has a design flow of 0.5 MGD. Sewage solids are land applied at agronomic rates.

In 1997 and 1998, the Village of West Liberty initiated a sewer rehabilitation program for I/I problems with the collection system (Phase 1 and Phase 2). Sluggish reductions reflected in flow metering suggested continued I/I problems and facility bypass events in 2001 validated that further improvements were needed. In 2003, Phase 2 continued with collection line and manhole lining rehabilitation, further reducing hydraulic overloading events.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a minimum of 24 for the West Liberty WWTP. For the nearly six years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included dissolved oxygen, pH and chlorine reported with the greatest frequency. Most violations occurred in February of 2000 (62%), gradually reducing in frequency through 2002. No violations were reported through SWIMS during 2003 and 2004.

Freshwater Farms – drainage ditch (RM 0.16) to unnamed tributary (RM 1.69) to Kings Creek (RM 0.65)
Permit # -1IN00167
Outfall 001-Lat.:$83^0$44'59.8", Long.:$40^0$08'48.2"

Freshwater Farms is located in Clark County at 2624 U.S 68 North, Urbana. Freshwater Farms is Ohio's largest indoor fish hatchery and aquaculture operation. It has rearing facilities for fish and crustaceans for commercial sales, fish processing and retail sales.

Freshwater Farms of Ohio is a vertically integrated hatchery, grow-out facility, processing, marketing, and retail operation that generates approximately 1500 gpd of wastewater from the processing and retail part of the system. This water is currently collected in a septic tank and hauled to a waste water treatment facility. Approximately 700 gpm of well water is pumped to the “once through” races, rearing tanks and rearing operations. Two effluent lines leading from the rearing tanks and ponds tie into a 12" field tile. This discharge goes from the field tile to an unnamed tributary to Kings Creek, Kings Creek and ultimately to the Mad River (approximately two miles away). An NPDES permit application has not been submitted for this discharge.

Farm-raised rainbow trout, largemouth bass, yellow perch, bluegill, channel catfish and other species can be purchased in various sizes for pond stocking. Freshwater Farms provides advice on pond setup and maintenance. The facility was constructed by converting several poultry, hog and cattle barns into indoor aquaculture operations. An interconnected spring-fed lake system located in a large abandoned quarry operation is used for fish culturing activities.

Mad River /Nettle Creek Watershed Assessment Unit (WAU 05080001 160)
the Mad River \ Nettle Creek watershed assessment unit encompasses 98,167 acres (153.4 mi^2) in Champaign and Clark counties. It includes the Mad River mainstem downstream from the confluence of Kings Creek (RM 43.82) to the confluence of Chapman Creek at RM 32.58. Tributaries of the Mad River in the assessment unit include Muddy Creek (drainage area 22.9 mi^2, confluence RM 41.72), Dugan Run (drainage area 23.4 mi^2, confluence RM 39.43), Nettle Creek (drainage area 46.2 mi^2, confluence RM 37.18), Stony Creek (drainage area 1.78 mi^2, confluence RM 35.05), Storms Creek (drainage area 9.26 mi^2, confluence RM 33.90), and Chapman Creek (drainage area 24.4 mi^2, confluence RM 32.58). Additionally, Anderson Creek enters Nettle Creek at RM 0.20 and drains 17.7 mi^2.

Row crop agriculture and pasture/hay account for 67.5% and 19%, respectively, of the total land use in this watershed assessment unit (Figure 17) (University of Cincinnati, 2001). Nine percent is covered by deciduous forest. The City of Urbana and the communities of St. Paris and Tremont City (unsewered) are the largest communities in this watershed with respective 2000 census populations of 11613, 1998, and 349, respectively.

Effluent from the largest discharger in the assessment unit, the City of Urbana WWTP, enters the Mad River mainstem at RM 39.15. Four facilities discharge in the Dugan Run watershed. International Fiber Corporation discharges noncontact cooling water at RM 1.54. Orbis Corporation discharges noncontact cooling water and stormwater to Dugan Run at RM 1.84 and has two additional stormwater outfalls. Johnson Welded Products discharges noncontact cooling water at RM 0.21 to a tributary entering Dugan Run at RM 1.75 while the Fox River Paper Company discharges noncontact cooling water and stormwater at approximately RM 0.16 to an unnamed tributary entering Dugan Run near RM 2.26.

Graham High School discharges at RM 1.2 to an unnamed tributary entering Nettle Creek at RM 6.67. The Village of St. Paris WWTP discharges at RM 2.65 to the St. Paris tributary. Stony Creek receives the discharge from the Lakewood Swim Club at RM 0.85. Valley View MHP currently discharges wastewater to dry wells in the Bogles Run watershed and is under a schedule of compliance requiring wastewater improvements. Urbana Local Elementary School discharges to an intermittent tributary of Bogles Run via a field tile. Graham South Elementary School discharges at RM 10.40 on Chapman Creek.

Additionally, the Tremont City Landfill site lies approximately 300 feet north of Chapman Creek west of Tremont City. The 80 acre site is divided into the former Waste Transfer Facility (14 acres), the closed Sanitary Landfill (58 acres), and the Barrelfill, also known as the Industrial Waste Disposal (IWD) Chemical Waste Landfill (8.5 acres). The former Waste Transfer Facility, permitted in 1977 as a hazardous waste treatment facility, subsequently underwent clean closure pursuant to Ohio EPA's hazardous waste rule requirements in 1985 when operations ceased. The Sanitary Landfill, permitted as a solid waste disposal facility in 1969, closed under Ohio EPA's solid waste rules in 1995, and is currently engaged in post-closure monitoring and undertaking

corrective actions pursuant to those rules. The U.S. EPA and Ohio EPA's Division of Emergency and Remedial Response (DERR) launched an investigation of the closed Tremont City Landfill site in 1999 and concluded that contamination exists which has migrated from the disposal areas and affected groundwater, soils, and sediments. The agencies are currently focusing their attention on the Barrelfill area, operated from 1976 to 1979 by IWD, a subsidiary of Danis, as a drum and barrel disposal area. Historical records indicate that 47,000 drums of industrial wastes were placed in a series of cells or trenches excavated to a depth of 15 to 25 feet within the glacial till and covered with soil. Potentially hazardous waste streams include paint sludges, glues, resins, asbestos, and ink sludges. In October 2003, U.S. EPA and the parties responsible for contamination related to the Barrelfill signed a legal order to conduct a Remedial Investigation/Feasibility Study (RI/FS). The first phase of the Remedial Investigation (RI), including the installation and sampling of groundwater wells, collection of soil and soil gas samples, and excavating five test pits has been completed. Based on the data collected, a second phase has begun which includes the installation of additional groundwater monitoring wells and an aquifer test. Analysis of stream water samples collected at RM 0.77 in Chapman Creek during the 2003 survey, however, did not reveal any elevated concentrations downstream from the Tremont City Landfill.

Table 8 Aquatic life use attainment status of the Mad River/Nettle Creek watershed assessment unit, June-October, 2003. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb) and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate (ICI) communities. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

Stream River Mile Invertebrate/Fish	Attainment Status	IBI	MIwb	ICI/ narrative	QHEI	Drainage Area
WAU:5080001 160						
Mad River				*CWH*		
41.6/41.6	Full	48		56	73	160
39.9/39.9	Full	41		50	79.5	162
38.4/38.4	Full	41		46	69	188
32.7/32.7	Full	36[ns]		46	76	264
Muddy Creek				*WWH existing/ CWH recommended*		
6.3/6.3	Partial	34*		G	56.5	12
0.4/0.5	Full	44		48	65.5	22.8
Spring Run				*CWH existing/ WWH recommended*		
0.7/0.7	Full	52		MG[ns]	37.5	3.7
Dugan Run				*WWH*		
1.2/1.2	Partial	32*	7.1*	G	59	23
Nettle Creek				*CWH*		
8.2/8.2	Full	44		40	89	8
7.1/7.1	Full	46		MG[ns]	60	12
4.4/4.5	Full	44		50	72	15
2.5/2.8	Partial	34*		G	69	19.8
0.1/---	(FULL)	NA		48		46.2

Table 8. continued.

Stream River Mile Invertebrate/Fish	Attainment Status	IBI	MIwb	ICI/ narrative	QHEI	Drainage Area
Anderson Creek				*CWH*		
5.9/.9	Full	48		G	71.5	5.4
3.7/3.7	Full	52		MG[ns]	68.5	10.7
1.0/1.0	Full	38[ns]		G	68.5	17.2
Harban Creek				*CWH (verified)*		
---/0.1	(Full)	58			75	0.6
Russell Creek				*(PHWH candidate)*		
0.1/---	NA			P*		
Owens Creek				*CWH existing/ WWH recommended*		
0.1/0.1	Full	54		VG	66	5.7
Hog Creek				*CWH existing/ WWH recommended*		
0.6/0.6	Full	44		G	69.5	0.9
Trib. to Nettle Creek (RM 8.80)				*WWH*		
2.7/2.7	NON	42		P*	44.5	1.1
2.6/2.6	NON	46		VP*	73	1.2
Stony Creek				*CWH existing (unverified/ to be determined)*		
0.7/0.7	NON	38[ns]		P*	51	1.5
Storms Creek				*CWH (verified)*		
2.1/2.7	Full	50		G	76	5.8
0.7/0.7	Full	46		G	61	9.1
Chapman Creek				*CWH*		
10.1/10.1	Partial	30*		MG[ns]	68	5.8
6.9/6.9	Full	56		VG	76	10.5
4.0/4.0	Full	48		52	61.5	18.6
0.8/0.8	Full	45		48	57.5	24.7
Deer Creek				*CWH existing/ WWH recommended*		
0.6/0.6	Full	48		G	72.5	0.9
Blacksnake Creek				*CWH existing/ WWH recommended*		
0.4/0.4	Full	48		MG[ns]	41.5	3.2

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

INDEX - Site Type	LRW	MWH channel modified	CWH	WWH	EWH
IBI Headwater - Wading/ Boat	18/18	24/24	40	40/ 42	50
MIwb Wading/ Boat	4.0/4.0	6.2/5.8	-/6.6	8.3/ 8.5	9.4/ 9.6
ICI	8	22	36	36	46

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns Nonsignificant departure from biocriterion (<4 IBI or ICI units; <0.5 MIwb units).
a Narrative evaluation used in lieu of ICI (E=Exceptional; G=Good; MG=Marginally Good; F=Fair; P=Poor).
b Use attainment status based on one organism group is parenthetically expressed.
N/A Not Applicable. The MIwb is not applicable to headwater sites.

Aquatic Life Uses

Biological and habitat assessments were conducted at 31 sites during 2003 in the Mad River/ Nettle Creek assessment unit; sites ranged in drainage area from 0.6 to 264 mi^2. Twenty-three sites within the assessment unit have been designated or are recommended for the CWH aquatic life use. Nineteen sites were in full attainment of the CWH use. Three sites supported biological communities that partially attained ecoregional expectations and one site, Stoney Creek, was in nonattainment of the CWH use. Eight sites within the assessment unit have been designated or recommended for the WWH aquatic life use. Five sites were in full attainment of the WWH use. Dugan Run partially met WWH biocriteria and two sites on the St. Paris tributary to Nettle Creek were not attaining the use. One site, Russell Creek, went dry before sampling could be completed.

The high WAU overall attainment score (89.5; Table 1, pg. 25) reflects the majority of sites meeting aquatic life use designations. The mainstem reach of the Mad River supported healthy fish and macroinvertebrate communities. Impairments were noted in several tributaries. Most noticeable was the degraded condition of the St. Paris tributary to Nettle Creek which resulted from organic and nutrient loading from the WWTP and an improperly functioning SSO. Other sources of impairment included urban runoff from the City of Urbana into Dugan Run and enrichment and habitat limitations associated with agricultural practices in the watershed.

Attainment status in CWH designated streams (Mad River, Nettle Creek, Anderson Creek, Storms Creek, Chapman Creek and Muddy Creek) was contingent largely on the condition of the fish community based on resultant IBI scores. It is important to note that evaluation of the fish results for the Mad River mainstem and sites located at the mouth of Chapman Creek was done using the headwater IBI metrics and scoring regardless of drainage area. Pervasive channel modifications and a strong ground water influence have created ecological conditions conducive to the maintenance of a fish fauna, in composition, similar to that encountered in WWH headwater streams. The justification for utilizing the WWH headwater IBI criterion in the absence of validated CWH expectations is provided in the methods portion of this report. The macroinvertebrate condition was rated marginally good to exceptional at the eighteen sampled CWH locations in the assessment unit and indicated that chemical water quality was not a pervasive negative factor on the biota of the stream.

Physical habitat of the Mad River upstream from Springfield was significantly altered to facilitate agricultural production in the floodplain. In the intervening years prior to the 2003 survey, recovery in beneficial attributes has been an ongoing process. As a result, QHEI scores for the four sampled mainstem stations in the assessment unit increased from an average of 63.5 in 1994 to 74.4 in 2003. The extent that natural conditions can be restored will remain limited due to the placement of levees along the stream. However, the placement of habitat structures and bank stabilization efforts to benefit the trout fishery will likely benefit the fish community as a whole. The fish and macroinvertebrate sampling produced assemblages that were reflective of good resource conditions in the Mad River.

Russell Creek went dry before biological sampling could be completed. A limited macroinvertebrate fauna was collected. Assignment of an aquatic life use is not appropriate given the inability of the site to develop any semblance of reproducing fish and macroinvertebrate communities. A more realistic classification of these streams could be made using Primary Headwater Habitat guidelines. Therefore, it is recommended that Russell Creek remain undesignated until the Primary Headwater Habitat designations are promulgated.

Chemical degradation of the St. Paris WWTP tributary was evident in the poor condition of the macroinvertebrate community at RM 2.7. The community had limited diversity and was predominated by facultative isopods. Downstream from the WWTP discharge (RM 2.6), the macroinvertebrate community was further reduced and rated very poor. No mayflies were collected from either site. IBI scores were similar upstream and downstream from the discharge and met WWH expectations. The scores, which approached the EWH criteria, are somewhat suspect, however. The IBI scoring has not been fully evaluated for such small drainage areas (less than 2 mi^2). Tolerant fish species were numerically predominant but, given the limited expectations of the small drainage area, did not significantly affect the resultant IBI scores. No sensitive taxa or darter-sculpin taxa were recorded from either site. In addition, the stream contained masses of filamentous algae. SSO releases and wastewater discharged by the WWTP were likely sources of the impairment.

The WWH use is appropriate for the St. Paris WWTP tributary even though the watercourse has been modified. The fish community met the use and improvements in water quality makes macroinvertebrate community attainment likely in the future.

Lingering impact was noted in the biological community sampling of Nettle Creek at RM 7.1, downstream from the St. Paris WWTP tributary. The fish community was in relatively good condition, but the macroinvertebrates only marginally met expectations. An unusually high abundance of isopods was noted and the available habitat should have supported a wider diversity of mayfly taxa.

Nettle Creek at RM 2.5/2.8 (SR 560) was in partial attainment of the CWH use. The fish community lacked the expected diversity of sensitive taxa and scored an IBI in the fair range (34). Additionally, tolerant species comprised 62 percent of the population. The macroinvertebrate community reflected moderate enrichment but was still considered to be in good condition. The contrasting biological community results and a lack of impact noted in the water chemistry data suggested one or more features in the physical habitat was restricting the development of a fully attaining CWH fish community. This location was atypical of other Nettle Creek sites in that the pools contained a heavy accumulation of sand. Sand can limit the fish diversity by creating a monotonous stream bottom in slow current areas. Additional investigation is needed to determine if sedimentation at this site is localized or an indication of a more widespread problem and what remediation activities might be implemented.

Muddy Creek is listed in the Ohio WQS as a WWH stream and as having been field verified with biological data. This listing is not consistent with the results of the 2003 sampling effort. Review of the Ohio EPA database produced fish index scores from the early 1970s but no macroinvertebrate sampling results. Two of the four sampling dates were prior to the time when the Ohio EPA was created. Sampling two sites in 2003 produced fish and macroinvertebrates that were consistent with a recommended CWH use. Partial attainment of the CWH use was achieved at RM 6.3 from a limited physical habitat condition which supported only a fair fish community. Biological results near the mouth (RM 0.4-0.5) fully met CWH expectations Brown trout and mottled sculpins were present at both sites along with 4 and 5 coldwater macroinvertebrate taxa, respectively.

Four locations were sampled on Chapman Creek from RM 10.1 to RM 0.8. Chapman Creek is designated CWH; however, the upper site (RM 10.1) yielded only one coldwater macroinvertebrate taxon. Macroinvertebrates were sampled under high flow conditions which may have limited sampling efficiency. The remaining three sites yielded a diversity of coldwater taxa consistent with the use. The biota of all sampled locations was reflective of at least moderate nutrient enrichment. However, only one site (RM 10.8) did not meet CWH expectations with an IBI score in the fair range (30). The fish community at RM 10.8 was dominated by a few tolerant taxa, namely blacknose dace, bluntnose minnows and creek chubs.

Stony Creek was designated as CWH in a previous WQS rulemaking but the use was never verified. Biological sampling results at RM 0.7 indicated a severe nutrient/ organic loading problem related to the release of wastewater from the Lakewood Swim Club. The macroinvertebrate community was in poor condition and, as such, negated an accurate assessment of the correct aquatic life use. Only one coldwater macroinvertebrate taxon was collected (the caddisfly *Ceratopsyche slossonae*) but water temperatures recorded by Ohio EPA field staff never exceeded 18° C. The swim club is not expected to reopen in 2005. Therefore, it is recommended that additional sampling be conducted in order to arrive at the appropriate aquatic life use and to determine if conditions in the stream have improved.

A WWH aquatic life use is recommended for Spring Run, Owens Creek, Hog Creek, Deer Creek and Blacksnake Creek. While groundwater likely contributed to the overall good condition of aquatic communities, coldwater taxa were not present to the extent that would justify a CWH designation. WQS rulemakings in 1978 and 1985 designated these streams as CWH but the use was never verified with biological sampling. This study, as an objective and robust use evaluation, is precedent setting in comparison to the 1978 and 1985 designations. These streams supported the WWH use with very good to exceptional fish communities and, at minimum, marginally good macroinvertebrate assemblages.

Dugan Run is a channelized watercourse that flows through the City of Urbana. Consequently, impacts attributed to habitat alteration and polluted runoff were evident at RM 1.2 in the fish community and chemical sampling results. A relatively diverse macroinvertebrate sample was

collected including ten EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa. Both the IBI and MIwb scores were in the fair range and, consequently, the WWH use was partially met.

Harban Creek was one of a limited number of Mad River tributaries that did not appear to have had the natural habitat modified to facilitate agricultural practices. Fish sampling produced a typical assortment of high quality headwater species. Mottled sculpin, brook stickleback and redside dace were included which supported the current CWH use. No macroinvertebrate sampling was conducted, but based on the fish community and the high quality habitat at RM 0.1, the current CWH aquatic life use is judged appropriate.

Recreational Uses

The Primary Contact Recreation (PCR) use should be applied to all of the sampled tributaries within the Mad River/Nettle Creek assessment unit. Muddy Creek, Nettle Creek, and the St. Paris tributary were designated Secondary Contact Recreation (SCR) in the early rulemakings based on less stringent parameters than are currently being applied. Application of the Primary Contact Use will minimize the potential for health effects resulting from full body contact.

The PCR use designation was not attained in this assessment unit based on the ten sites sampled for fecal coliform and *E. coli* (Table 27, Figure 9 and Figure 10, Appendix Table A-2). The highest median concentrations in the assessment unit occurred in the St. Paris tributary at RM 2.66 upstream from the St. Paris WWTP discharge. The village reported an active sanitary sewer overflow (SSO) upstream from a lift station on Park Street at RM 3.16. This SSO was eliminated in September 2003. Elevated bacteria concentrations throughout the survey area generally occurred after precipitation.

Chemical Water Quality

Inorganic water chemistry grab samples and field measurements were collected at 33 sites in this assessment unit at two-week intervals (six times) from mid-July to late September (Table 25). All samples were analyzed for a variety of parameters including nutrients and metals (Figure 18-Figure 24, Appendix Table A-1). Seven of these sites were also sampled for organic compounds twice during the survey (Table 28, Appendix Table A-3). Bacteria samples (fecal coliform and *E. coli*) were collected at ten sites five times within a thirty day period at 10 sites in order to determine recreational use attainment (Table 27, Appendix Table A-2). Datasonde™ continuous monitors were deployed at two sites in the Mad River mainstem (RM 39.89 and RM38.35), in Chapman Creek (RM 0.77) and in the St. Paris tributary (RM 2.64) downstream from the St. Paris WWTP for a 48-hour period in July and again in September (Figure 7).

Stream flows from May through September 2003 (Figure 15) as measured by the USGS gage station in the Mad River at Urbana (RM 39.9) were well above normal with sixty-five percent (65%) of mean daily flows exceeding the 10% duration exceedence flow of 208 cfs (USGS 2004 and 2000). (The 10% duration exceedence flow represents the discharge which was equaled or exceeded 10% of the time over the period of record.) On specific conventional water chemistry sampling days during the 2003 survey, the gage recorded a mean daily high of 280 cfs on July 15

and a mean daily low on August 27 of 147 cfs. On bacteria sampling days, mean daily flows ranged from 154 cfs on August 25 to 511 cfs on September 3. Total precipitation of 21.1 inches was recorded in Urbana from July through September 2003 (MCD 2003), a departure of 10.33 inches above normal for the period (Figure 16).

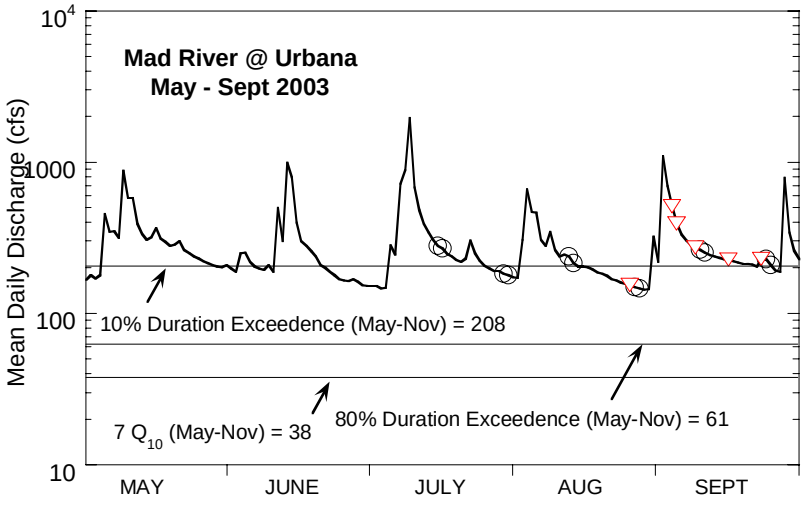
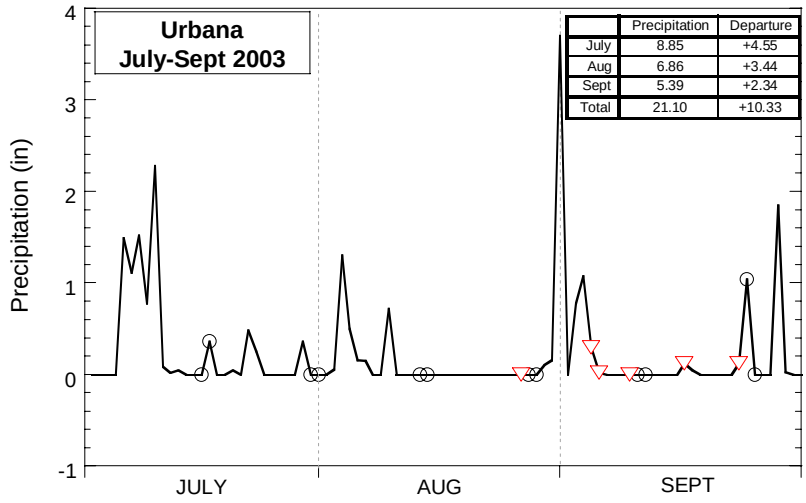


Figure 15

May through September, 2003 flow hydrographs for the Mad River at Urbana (RM 39.9). Low flow conditions ($7Q_{10}$), 10% and 80% duration exceedence flows are based on USGS station #03267000 (period of record 1925-1931, 1939-1997). Open circles indicate river discharge on water chemistry sampling days. Triangles indicate river discharge on bacteriological sampling days.



	Precipitation	Departure
July	8.85	+4.55
Aug	6.86	+3.44
Sept	5.39	+2.34
Total	21.10	+10.33

Figure 16

Daily precipitation recorded for Urbana from July through September (MCD, 2003). Open circles represent conventional water chemistry sampling days. Triangles represent bacteriological sampling days in the Mad River / Nettle Creek watershed assessment unit.

*Rain gages are read every morning at or near 8:00 am. Therefore, these readings reflect the previous 24 hour catch.

Water chemistry results which exceeded State of Ohio Water WQS in the assessment unit are presented in Table 26 and Table 27.

Two sites in the Anderson Creek watershed (Russell Creek at RM 0.01 and Anderson Creek at RM 3.67 just downstream from the Russell Creek confluence (RM 3.71)) experienced multiple daytime dissolved oxygen concentrations below the CWH WQS criteria (Figure 22). Field

notes document lower flows throughout the survey at both locations. Dissolved oxygen concentrations also dropped below applicable criteria on one occasion each in Dugan Run (RM 3.99), Storms Creek (RM 0.70), Chapman Creek (RM 6.92), and Deer Creek (RM 0.60).

Ammonia-N levels remained low in this assessment unit with 90% of values less than or equal to the minimum detection limit (MDL) of 0.05 mg/l. Phosphorus concentrations were also generally low with an overall median of 0.043 mg/l; 93% of values well below reference background levels. The highest concentrations occurred in Nettle Creek at RM 8.23 (median 0.31 mg/l) and in the St. Paris tributary at RM 2.64 downstream from the St. Paris WWTP (median 0.22 mg/l).

While the median nitrate-nitrite-N for the entire Mad River/Nettle Creek assessment unit was 3.41 mg/l, levels measured at RM 0.01 in Harban Run, a tributary of Russell Creek (confluence RM 1.19), were the second highest of the entire survey (median 10 mg/l). Concentrations remained elevated at the mouth of Russell Creek (median 6.65 mg/l). Other areas in the assessment unit with median nitrate-nitrite-N levels above applicable 90th percentile reference values include Dugan Run at RM 0.95 (6.03 mg/l), Nettle Creek at RM 8.23 (4.86 mg/l), and Chapman Creek at RM 10.11 (6.52 mg/l) and RM 6.92 (4.66 mg/l).

Elevated levels of TSS (80 mg/l), iron (7610 : g/l), lead (20 : g/l), zinc (76 : g/l), and aluminum (5570 : g/l) were documented on August 13 in Chapman Creek at RM 6.92 downstream from the small unsewered community of Thackery. Field personnel observed crews replacing storm sewers in the area with no sediment erosion controls in place.

Eight organic compounds were detected in the water column in this watershed assessment unit (Table 28, Appendix Table A-3) with atrazine and metolachlor each accounting for 25% of the 44 total detections. Heptachlor epoxide exceeded non-drinking water human health WQS criterion in the Mad River at RM 38.35 and in Nettle Creek at RM 4.49.

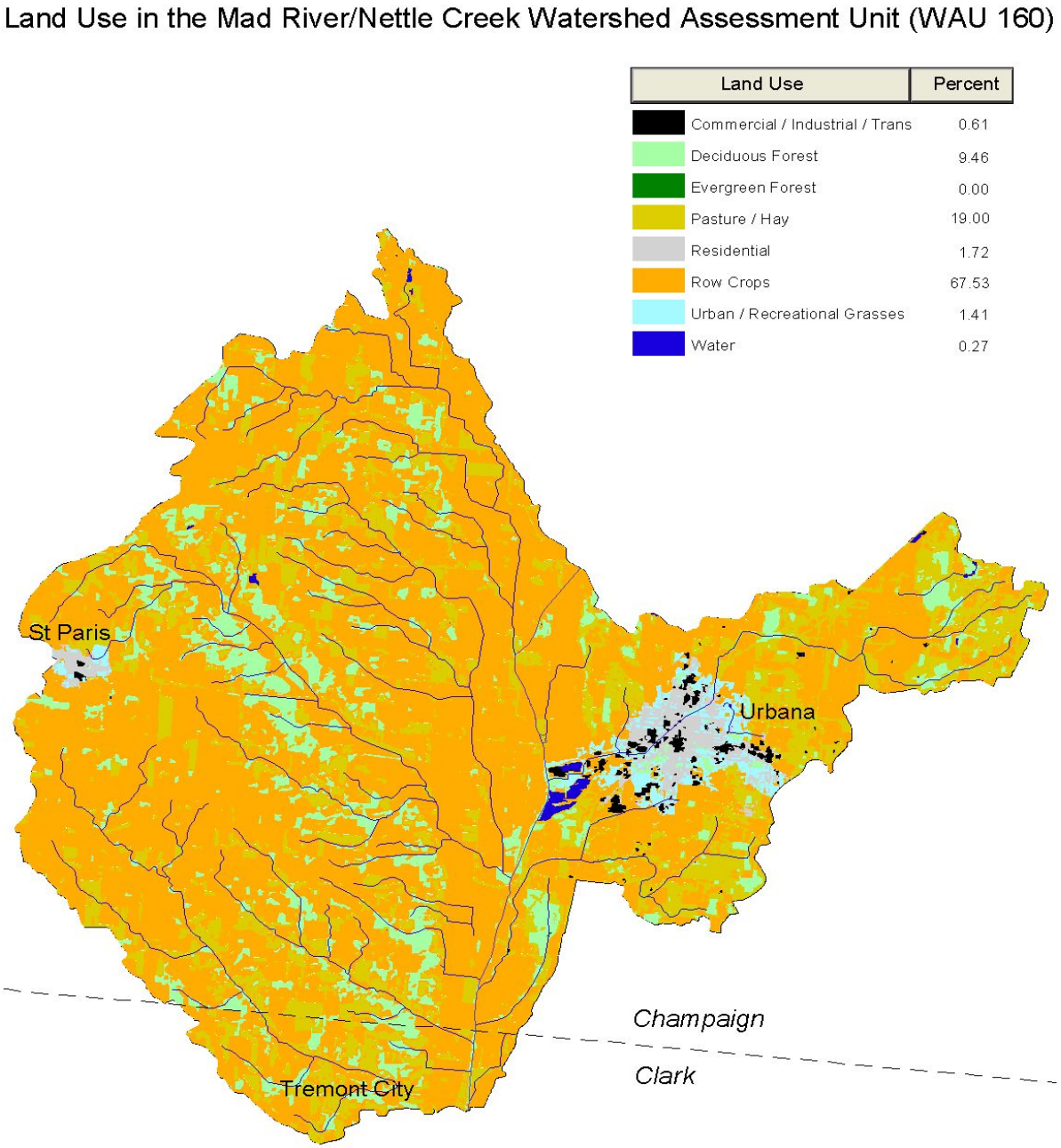


Figure 17 Land Use in the Mad River/Nettle Creek Watershed Assessment Unit (WAU 05080001 160); (University of Cincinnati, 2001).

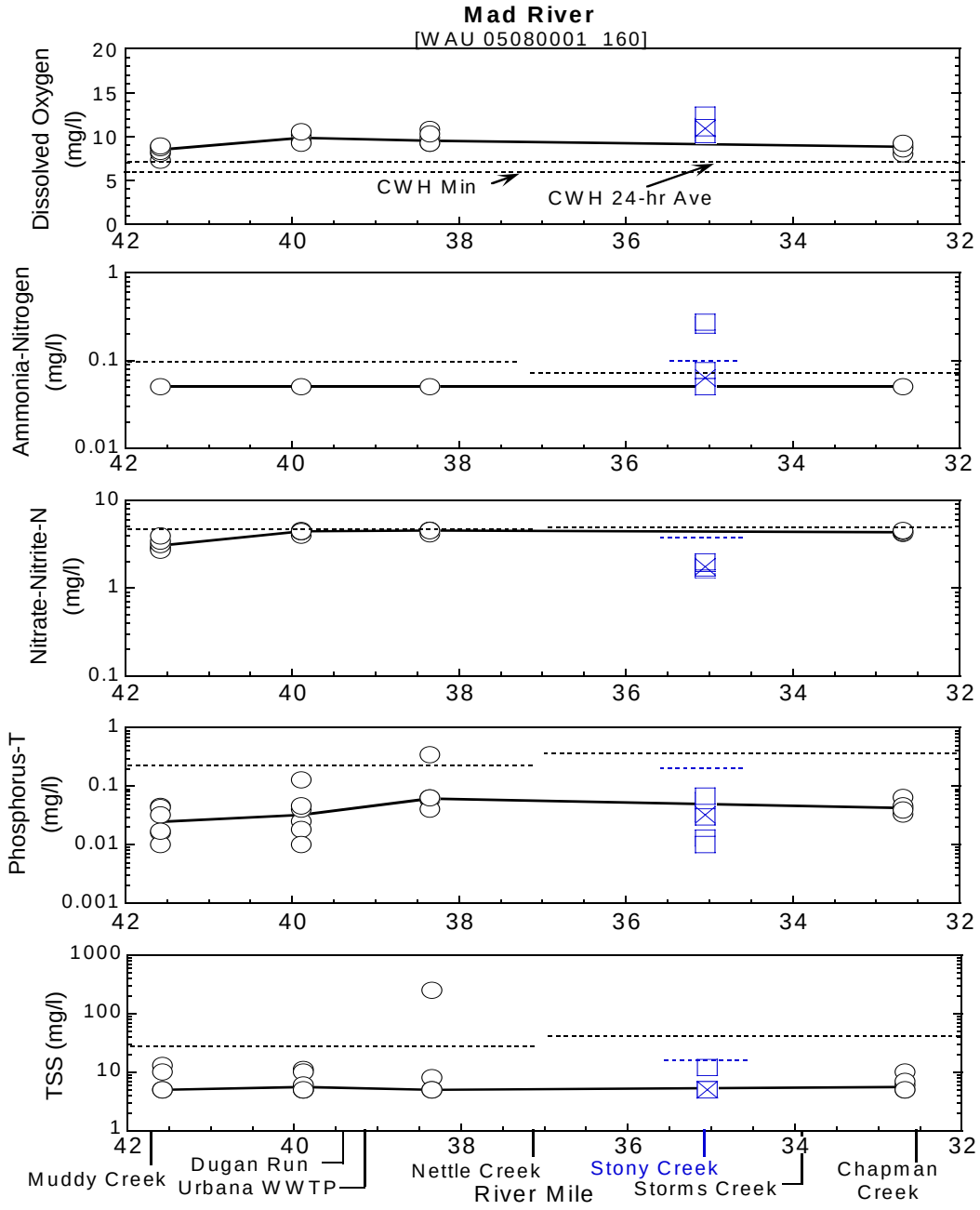


Figure 18 Longitudinal plots of water chemistry daytime grabs in the Mad River mainstem (circles) and Stony Creek RM 0.70 (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in the Mad River while an 'X' depicts the median for Stony Creek. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

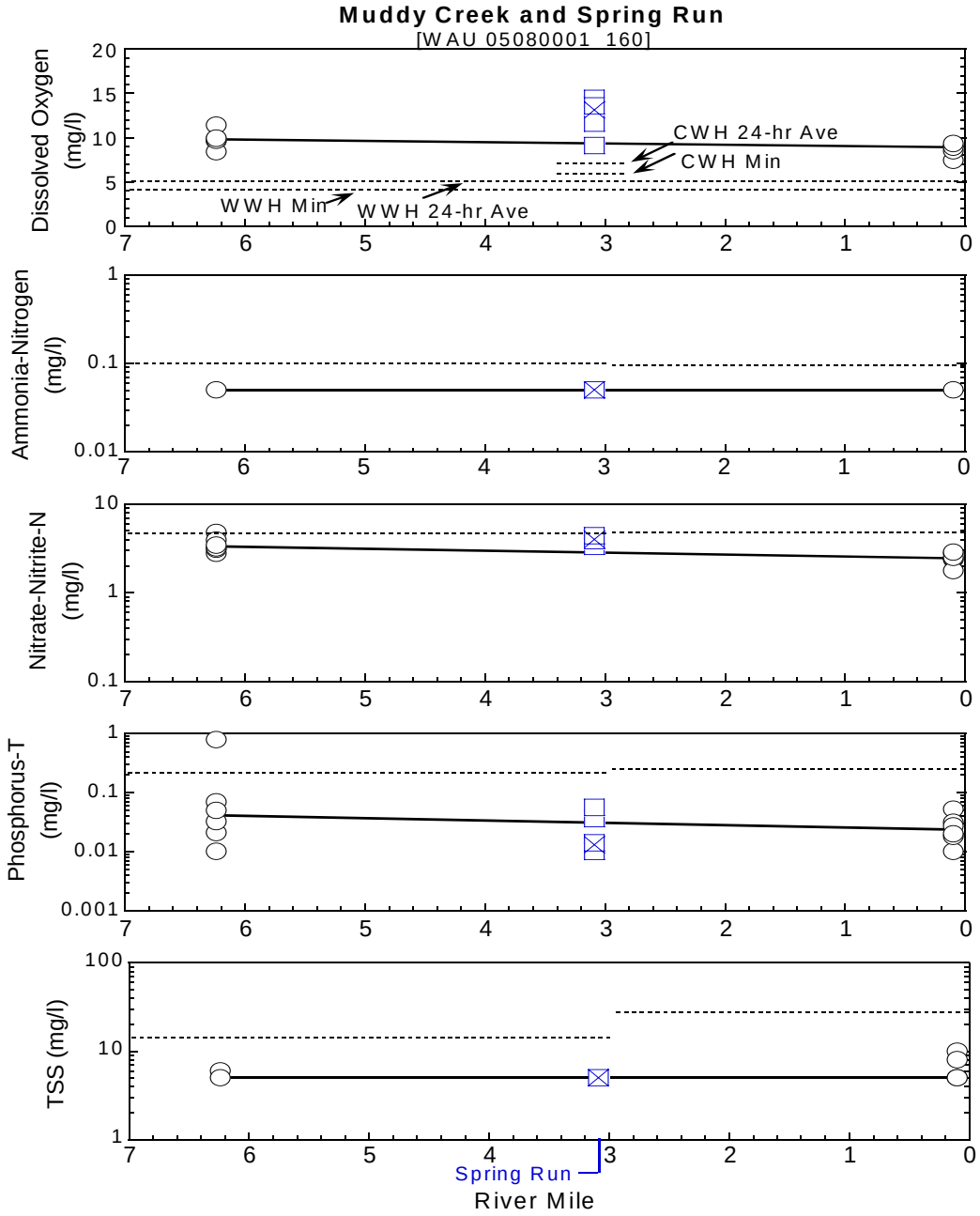


Figure 19 Longitudinal plots of water chemistry daytime grabs in Muddy Creek (circles) and Spring Run RM 0.62 (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in Muddy Creek while an 'X' depicts the median for Spring Run. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

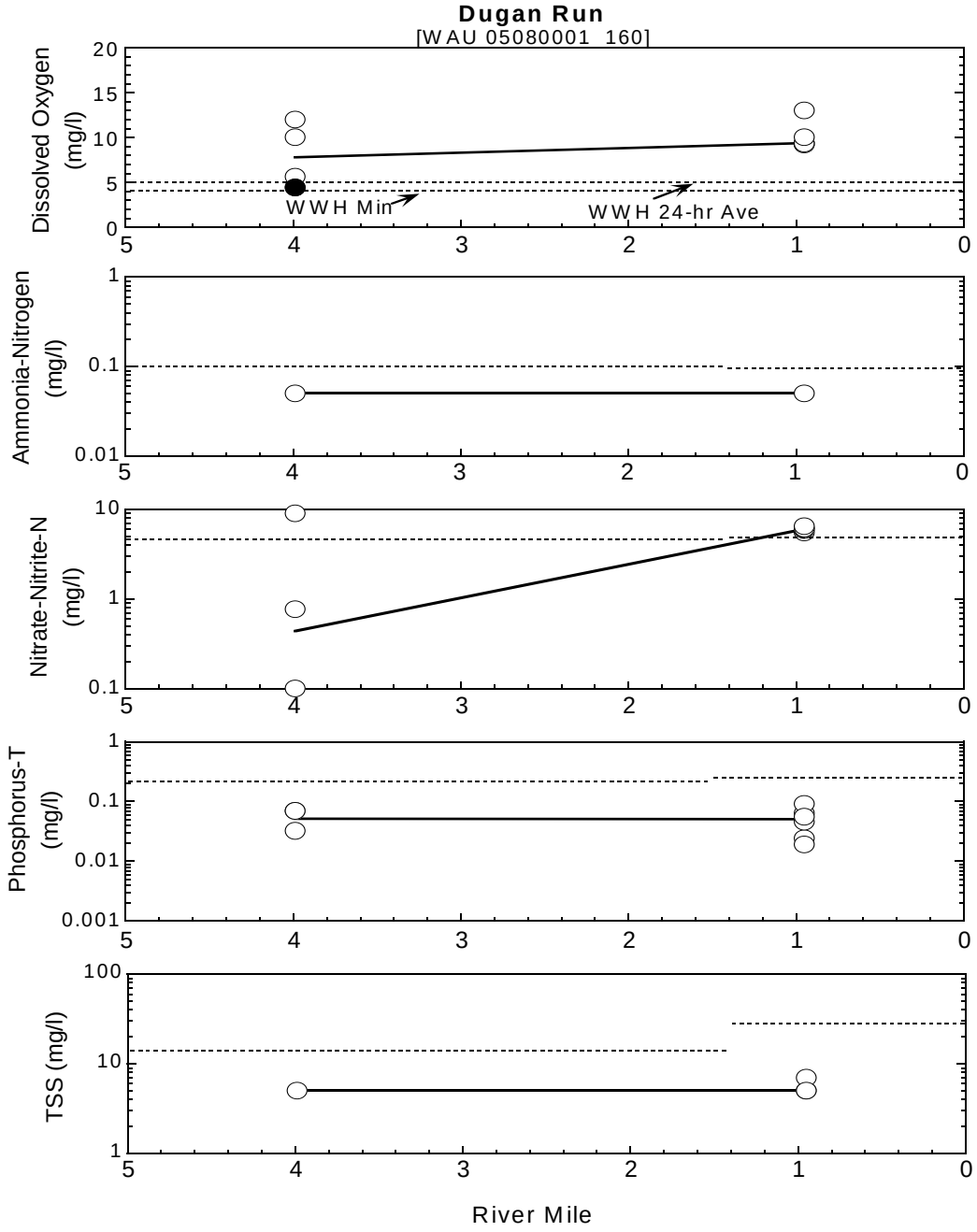


Figure 20 Longitudinal plots of water chemistry daytime grabs in Dugan Run during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

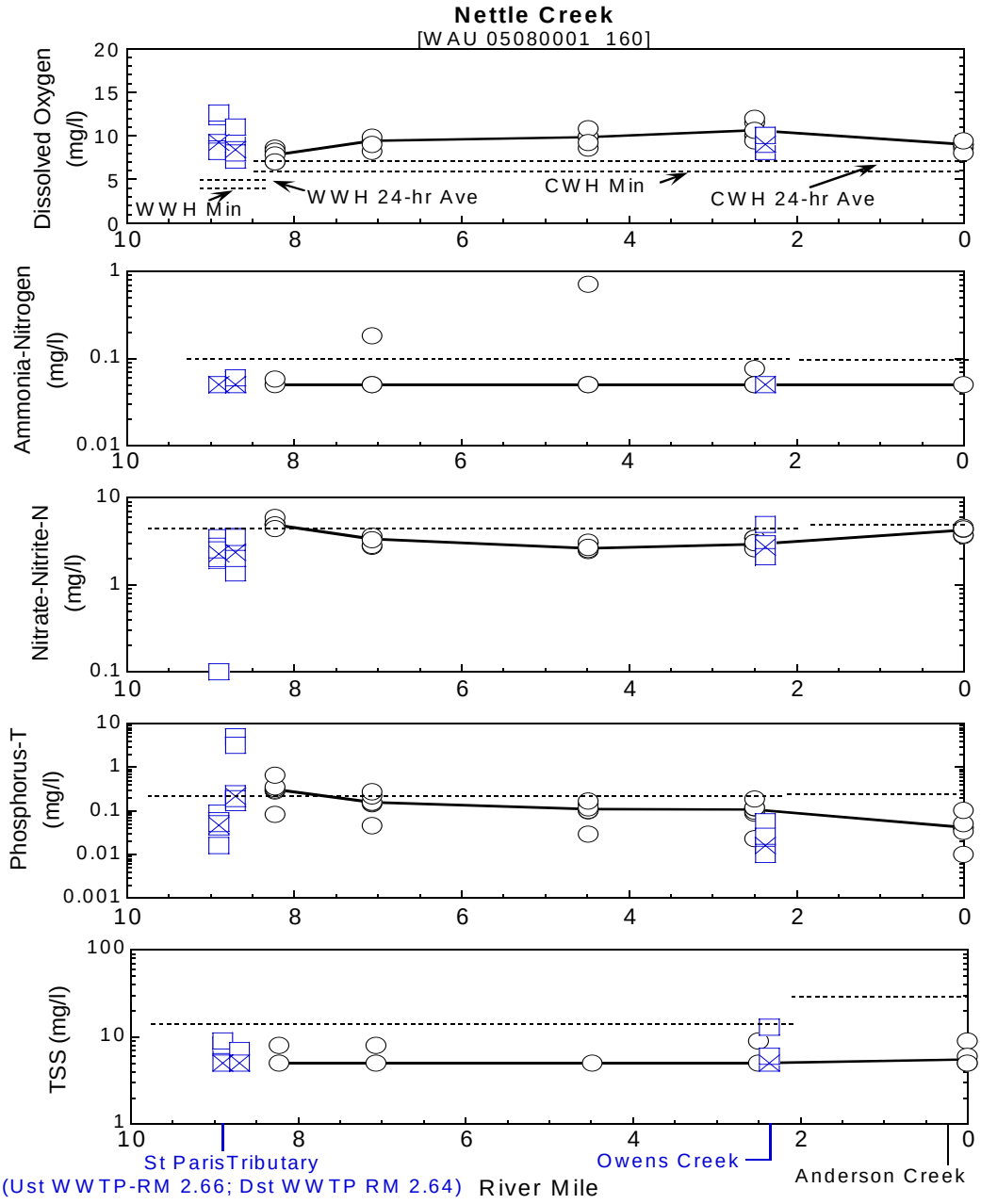


Figure 21 Longitudinal plots of water chemistry daytime grabs in Nettle Creek (circles), the St. Paris tributary upstream (RM 2.66) and downstream (RM 2.64) of the St. Paris WWTP (squares), and Owens Creek RM 0.10 (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in Nettle Creek while an 'X' depicts the median for the tributaries. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

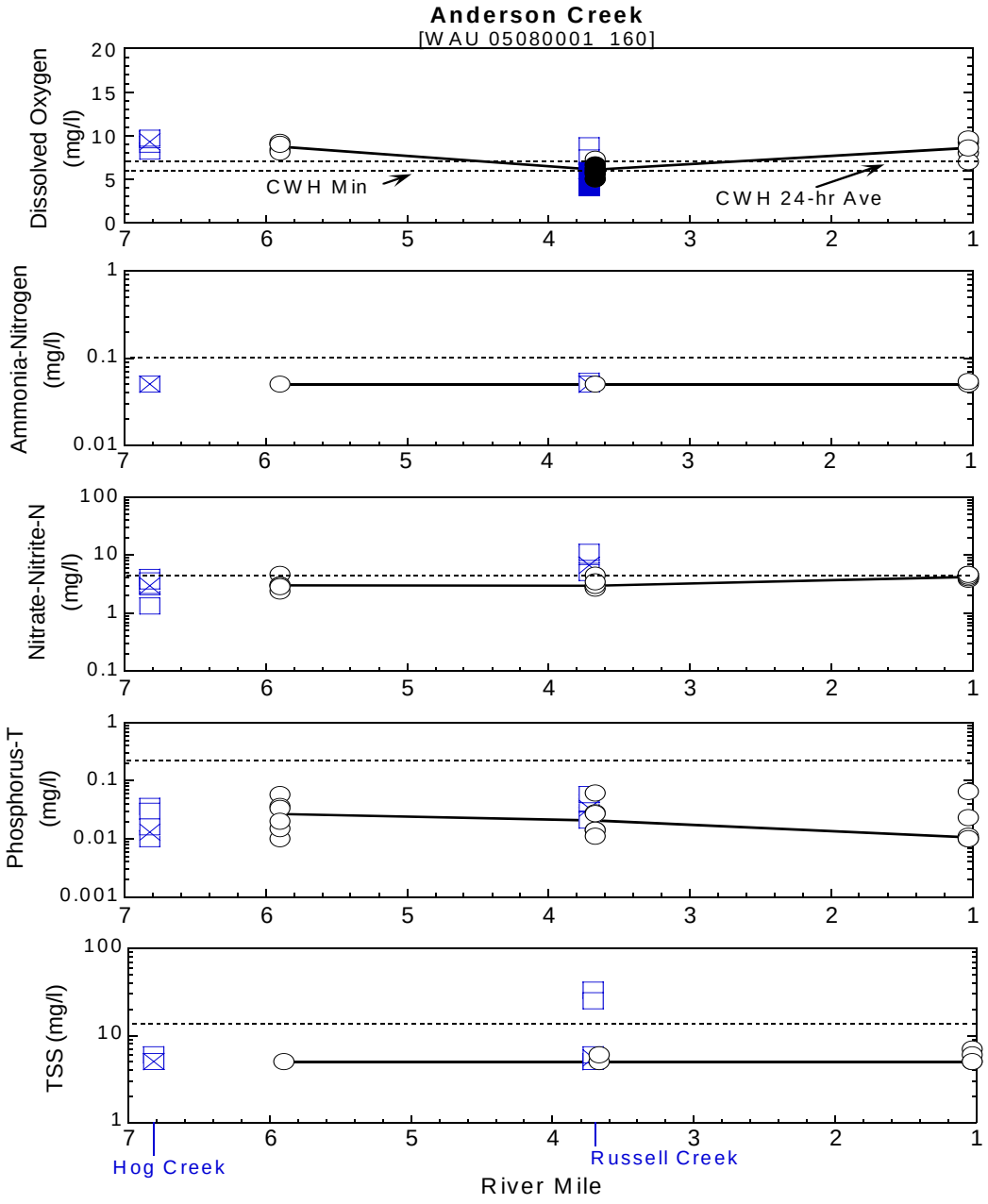


Figure 22 Longitudinal plots of water chemistry daytime grabs in Anderson Creek (circles), Hog Creek RM 0.60 (squares), and Russell Creek RM 0.01 (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in Anderson Creek while an 'X' depicts the median for the tributaries. WQS criteria are shown in the dissolved oxygen plot. (Values below criteria are shown as solid circles or squares.) Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

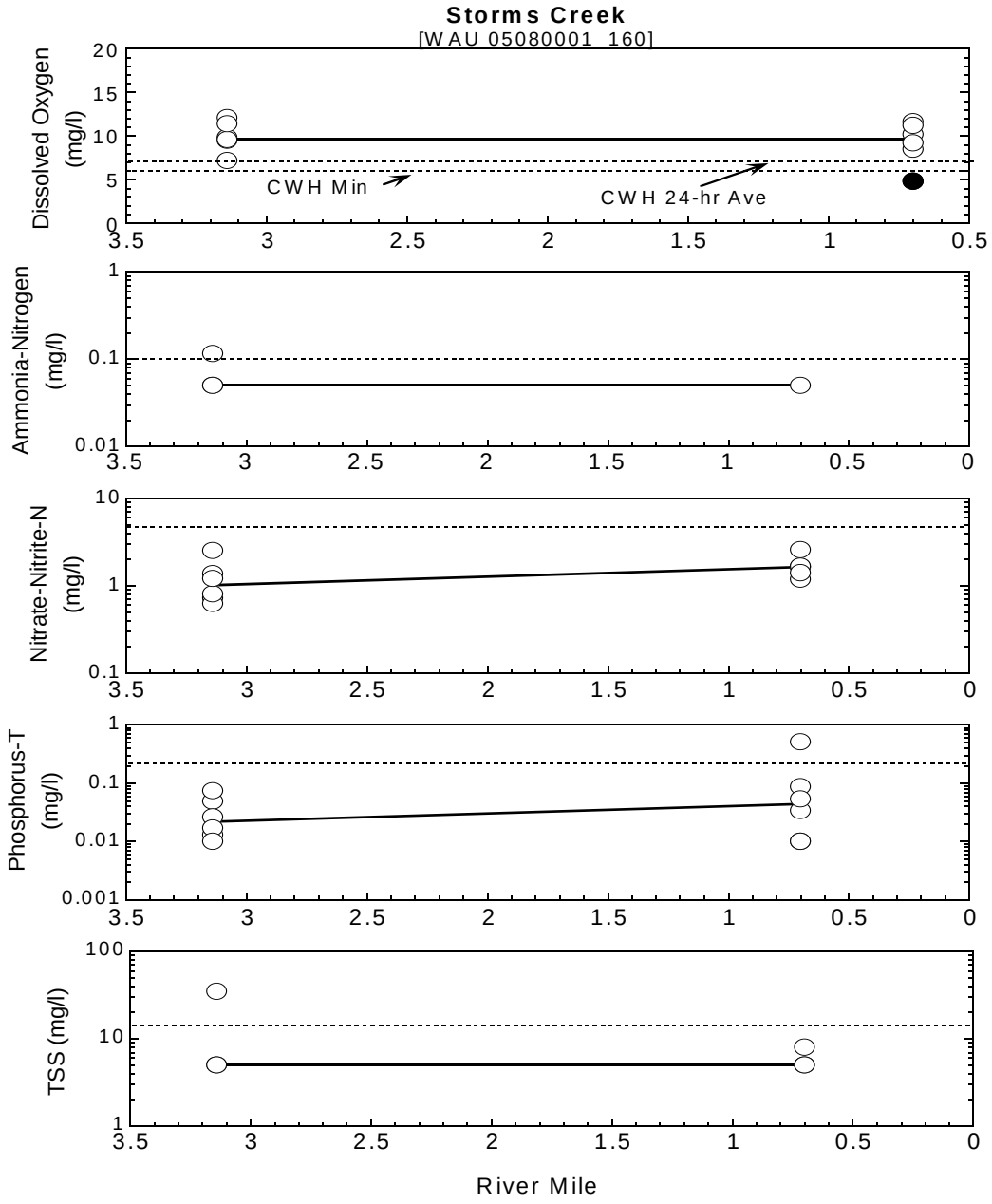


Figure 23 Longitudinal plots of water chemistry daytime grabs in Storms Creek during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled. WQS criteria are shown in the dissolved oxygen plot. (Values below criteria are shown as solid circles.) Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

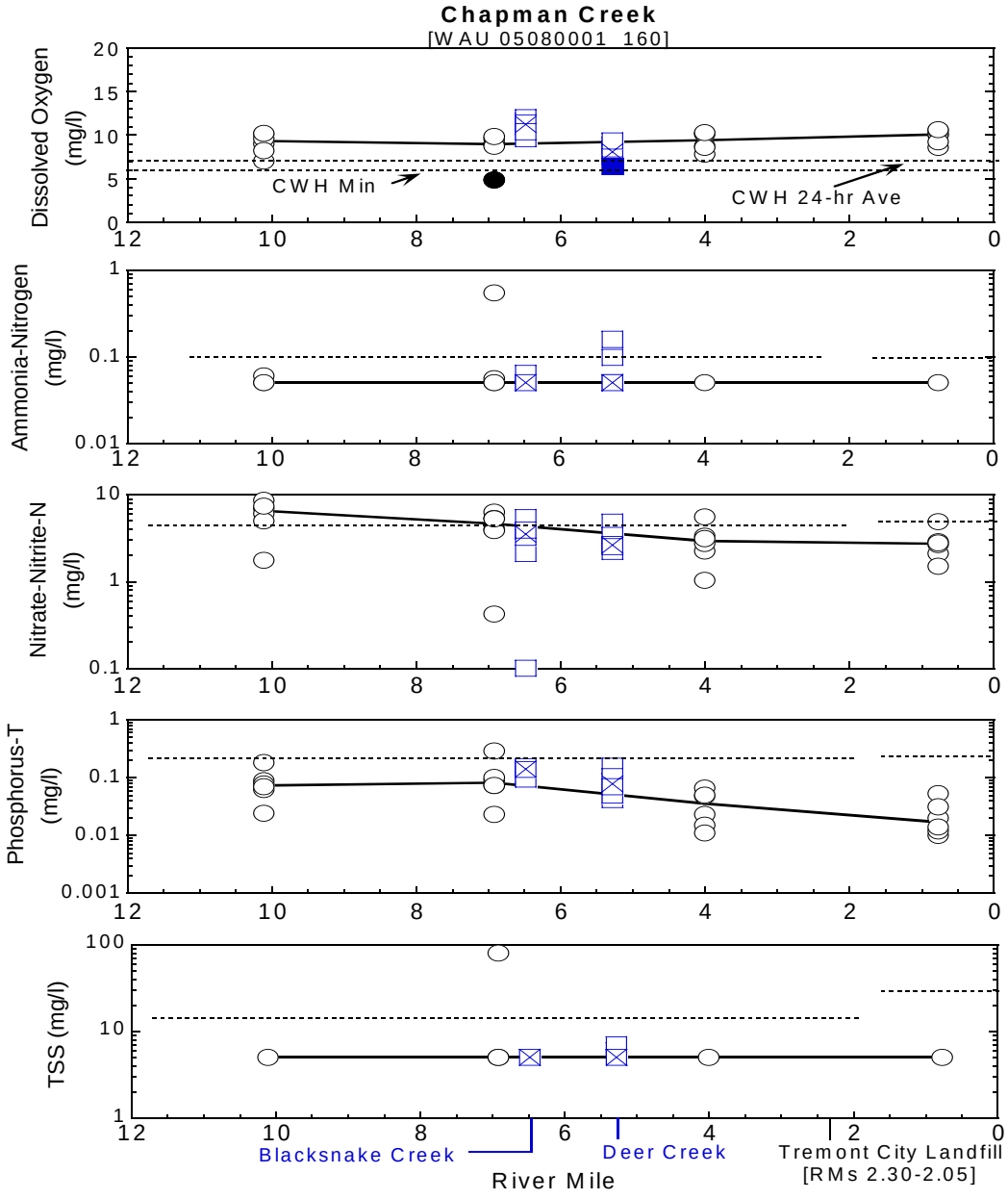


Figure 24 Longitudinal plots of water chemistry daytime grabs in Chapman Creek (circles), Blacksnake Creek RM 0.42 (squares) and Deer Creek RM 0.60 (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in Chapman Creek while an 'X' depicts the median for the tributaries. WQS criteria are shown in the dissolved oxygen plot. (Values below criteria are shown as solid circles or squares.) Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

Watershed Protection Efforts

The watershed protection efforts for this assessment unit are included in the discussion under WAU 05080001 150.

Chemical Sediment Quality

Sediment quality was evaluated at eight sites in WAU 05080001160 (Table 9 and Table 10). Two of the sites were on the Mad River and six were on the tributaries.

Mainstem sediment results were below any Ohio Sediment Reference Value Guidelines used to evaluate sediment metals. Sediment arsenic at Mad River RM 39.89 was between the MacDonald TEC and PEC, but below the Ohio SRV of 18 mg/kg. Sediments between the MacDonald TEC and PEC indicate that adverse benthic effects should frequently occur, but Ohio's sediment is naturally higher in arsenic and not considered to adversely affect benthic organisms at concentrations below the Ohio SRV. The only organic chemical detected in one of the two mainstem sites was the laboratory contaminant acetone.

Two tributary samples reflected contamination from urban influences and wastewater discharges. Results from three of the tributary sites were below any sediment guidelines used to evaluate metals and organic samples. All six tributary sites had sediment particle size below the goal of 30% fine grain material (FGM).

Dugan Run (RM 0.95) drains the city of Urbana which has considerable industrial land use and runoff. In addition to stormwater runoff, it appears that dumping of industrial and solid waste has occurred near RM 0.95. The sampling location is next to Muzzy Road and provides easy access to Dugan Run.

Results from Dugan Run revealed the sediment s mercury, zinc, copper and lead concentrations above the Ohio Sediment Reference guidelines. Lead was above the MacDonald Probable Effect Concentration range, indicating that adverse effects to benthic organisms usually or always occur. Copper, mercury, and zinc were between the MacDonald Threshold Effect Concentration (TEC) and the Probable Effect Concentration (PEC), meaning adverse effects to benthic organisms frequently occur. Sediment arsenic was between the MacDonald TEC and PEC, but below the Ohio SRV of 18 mg/kg and not considered to adversely affect benthic organisms.

Dugan Run was also contaminated with organic chemicals. Eleven different Polycyclic Aromatic Hydrocarbons (PAH) compounds were detected at a total level (37.26 mg/kg total PAH) exceeding the MacDonald Probable Effect Concentration range, indicating that adverse effects to benthic organisms usually or always occur. Six of the eleven PAH compounds were individually over the MacDonald PEC. Total chlordane (0.0207 mg/kg) exceeded the MacDonald PEC. Total Polychlorinated Biphenyls (0.2997 mg/kg) were detected between the MacDonald TEC and PEC.

The St. Paris tributary (RM 2.64), a tributary to Nettle Creek, is downstream from the outfall for the St. Paris WWTP. Concentrations of lead and zinc were over the Ohio Sediment Reference Guidelines (SRVs) and between the MacDonald TEC and PEC.

Results from the St. Paris tributary sediments detected ten different PAH compounds (17.04 mg/kg total). Five of the ten PAH compounds were individually over the MacDonald PEC. The lab contaminant acetone was also detected at 0.11 mg/kg.

Spring Run (RM 0.62) at Woodville Pike was the only site in the watershed to have sediment ammonia levels (160 mg/kg) over the Ontario sediment disposal guideline (100 mg/kg). This site is far away from any development and in the middle of flat farmland. Runoff from farm practices into Spring Run may be one potential source of ammonia.

Table 9 Concentrations (mg/kg) of metals and nutrients in sediment samples collected in the Mad River/Nettle Creek watershed assessment unit (WAU 05080001 160) during 2003. Parameter concentrations were evaluated based on Ohio EPA sediment metal reference sites (2003), MacDonald (2000) Sediment Quality Guidelines (SQG) and Persuad (1993). Values above guidelines are highlighted.

Parameter	Site Location (RM)								*Reference*	
	Mad River Ust. Urbana WWTP RM 39.89	**Mad River** Dst. Urbana WWTP RM 38.35	**Spring Run** Woodville Pk RM 0.62	**Dugan Run** Muzzys Rd RM 0.95	**Nettle Creek** Runkle Rd RM 4.49	**St. Paris Trib** Dst WWTP RM 2.64	**Chapman Creek** Snyder-Domer Rd RM 4.00	**Chapman Creek** Upper Valley Pk RM 0.77		
									Ohio	**MacD**
Al-T [O]	14600	11900	23300	18500	10800	18300	8580	6090	39000	*
As-T [OM]	10.0 #	7.06	6.81	11.8 #	6.50	8.61	9.71	6.52	18	9.79-33
Ba-T [O]	132	129	145	184	85.0	168	55.5	46.7	240	*
Ca-T [O]	80200	73200	29300	53400	45600	84400	46800	51800	120000	*
Cd-T [OM]	0.384	0.408	0.298	0.76	0.227	0.617	0.160	0.131	0.9	0.99-4.98
Cr-T [OM]	15	18	23	28	<19	25	<16	<16	40	43.4-111
Cu-T [OM]	10.6	17.4	10.8	97.2 +#	9.2	29.9	6.3	<5.3	34	31.6-149
Fe-T [O]	14100	13700	15000	18300	12600	16600	10600	9500	33000	*
Hg-T [OM]	0.066	0.052	<0.037	0.290 +#	<0.034	0.061	0.05	<0.026	0.12	0.18-1.06
K-T [O]	2950	2260	4830	3860	2240	4460	1900	1480	11000	*
Mg-T [O]	17800	18000	7860	20500	15600	27600	17800	18500	35000	*
Mn-T [O]	441	392	301	317	390	348	252	257	780	*
Na-T *	<2500	<2110	<3150	<2470	<3080	<3810	<2710	<2670	*	*
Ni-T [OM]	<20	<17	<25	<20	<25	<31	<22	<21	42	22.7-48.6
Pb-T [OM]	<20	24	<25	141 +■	<25	47 +#	22	<21	47	35.8-128
Se-T [O]	<1.00	<0.84	<1.26	<0.99	<1.23	<1.52	<1.08	<1.07	2.3	*
Sr-T [O]	158	132	63	66	117	220	66	88	390	*
Zn-T [OM]	58.6	67.3	61.9	180 +#	91.9	255 +#	45.5	35.2	160	121-459
									Ohio	**Pers.**
NH_3-N [P]	59	19	160 [L]	67	36	91	40	24	*	100
TOC [P]	5.5%	5.5%	4.6%	5.9%	4.4%	5.1%	3.8%	3.5%	*	10.0%
pH *	7.6	7.6	7.6	7.6	7.4	7.5	7.5	8.0	*	*
P-T [P]	457	604	589	526	1180	1090	294	221	*	2000
%FGM [O]	31.7%	48.2%	27.4%ú	22.1%ú	24.8%ú	23.1%ú	12.3%ú	14.7%ú	30.0%	*
COD*	19700	64400	43600	53700	122000	144000	39700	28900	*	*

↘ Below the goal of 30% Fine Grain Material in sample
%FGM Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)
NA Compound not analyzed. * Not evaluated
[O] Evaluated by Ohio EPA (2003) [M] Evaluated by MacDonald (2000) [P] Evaluated by Persuad (1993)

Ohio SRV Guidelines (2003)
+ above background for this area

Ontario Sediment Guidelines (Persuad (1993)
L > Open Water Disposal Guidelines; equivalent to the Lowest Effect Level (LEL)-applicable to NH_3-N only.
• > severe effect level (disturbance in benthic community can be expected)

MacDonald (2000) Sediment Quality Guidelines (SQG)
TEC-PEC Threshold effect concentration (TEC) - Probable effect concentration (PEC)
Above which adverse effects frequently occur
■ >PEC Probable effect concentration (PEC) -Above which adverse effects usually or always occur

Table 10 Sediment concentrations of organic compounds (priority pollutant scan) detected in the Mad River/Nettle Creek watershed assessment unit (WAU 05080001 160) during 2003. Individual compounds were evaluated by the MacDonald Sediment Quality Guidelines (2000).

River / Landmark	Analysis Performed	Compound Detected	Result mg/kg unless noted
Mad River RM 39.89 Ust. Urbana WWTP TOC = 5.5 % Fine Grained Material = 31.7%	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone	0.088 * BDL BDL BDL
Mad River RM 38.35 Dst. Urbana WWTP TOC = 5.5 % Fine Grained Material = 48.2%	1) VOC 2) BNA 3) Pesticides 4) PCBs		BDL BDL BDL BDL
Spring Run RM 0.62 Woodville Pk. TOC = 4.6 % Fine Grained Material = 27.4%	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone	0.070 * BDL BDL BDL
Dugan Run RM 0.95 Muzzys Rd. TOC = 5.9 % Fine Grained Material = 22.1%	1) VOC 2) BNA 3) Pesticides 4) PCBs 	 Anthracene Benz(a)anthracene Benzo(a) pyrene Benzo(b)fluoranthene Benzo[g,h,i]perylene Benzo(k)fluoranthene Chrysene Fluoranthene Indeno[1,2,3-cd]pyrene Phenanthrene Pyrene **Total PAH** Alpha-Chlordane Gamma-Chlordane **Total Chlordane** PCB-1242 PCB-1254 PCB-1260 **Total PCB**	BDL 0.63 # 3.18 ■ 2.99 ■ 3.09 * 2.04 * 2.96 * 3.84 ■ 6.98 ■ 2.20* 3.60 ■ 5.75 ■ **37.26 ■** 0.0074* 0.0133* **0.0207 ■** 0.0876* 0.160* 0.0521* 0.2997 #

Table 10 Continued.

River / Landmark	Analysis Performed	Compound Detected	Result mg/kg unless noted
Nettle Creek RM 4.49 Runkle Rd. TOC = 4.4 % Fine Grained Material = 24.8%	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone 3&4 Methylphenol	0.116* 0.77 * BDL BDL
St. Paris Trib RM 2.64 Dst St. Paris WWTP TOC = 5.1 % Fine Grained Material = 23.1%	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo[g,h,i]perylene Benzo(k)fluoranthene Chrysene Fluoranthene Indeno[1,2,3-cd]pyrene Phenanthrene Pyrene **Total PAH**	0.110 * 1.27 ■ 1.38 # 1.55* 1.09* 1.45* 1.77 ■ 3.31 ■ 1.15* 1.43 ■ 2.64 ■ **17.04** # BDL BDL
Chapman Creek RM 4.00 Snyder-Domer Rd TOC = 3.8% Fine Grained Material = 12.3%	1) VOC 2) BNA 3) Pesticides 4) PCBs		BDL BDL BDL BDL
Chapman Creek RM 0.77 Upper Valley Pk TOC = 3.5% Fine Grained Material = 14.7%	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone	0.046* BDL BDL BDL

* Not evaluated NA Compound not analyzed BDL Below Detection Limit TOC Total Organic Carbon

1) Volatile Organic Compounds (VOC) U.S. EPA Method 8260B
2) Base Neutral & Acid Extractibles (BNA) U.S. EPA Method 8270
3) Pesticides U.S. EPA Methods 8082A
4) Polychlorinated biphenyls (PCBs) U.S. EPA Method 8082A

Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)

MacDonald (2000) Sediment Quality Guidelines (SQG)

TEC-PEC Threshold effect concentration (TEC) - Probable effect concentration (PEC)
Above which adverse effects frequently occur

■ **>PEC** Probable effect concentration (PEC) -Above which adverse effects usually or always occur

Point Source Evaluations

Fox River Paper Company - Urbana Mill (Howard Paper Corp, Inc) – outfalls 001 and 002 - unnamed tributary (RM 0.16) and outfall 003 - storm sewer to tributary to Dugan Run (RM 2.26)
Permit # -1IA00003
Outfall 001- Lat.: $40^0$06'40.83"; Long.: $83^0$45'34.74" - noncontact cooling water roof drains and parking lot runoff
Outfall 002 – Lat.: $40^0$06'43.85"; Long.: $83^0$45'32.40" - roof drains runoff from loading docks
Outfall 003 - Lat.: $40^0$06'35.64"; Long.: $83^0$45'42.84" - parking lot and facility grounds to stormwater sewer.

Fox River Paper Company, Urbana Mill, is located in Champaign County at 700 W Court St, Urbana. This facility manufactures fine grade printing papers. The site has two 80" paper machines and a converting operation. This facility is a non-integrated mill as all pulp is purchased from various suppliers.

Fox River currently operates a 100 acre wastewater spray field approximately one-half mile northwest of the mill. Approximately 200,000 gpd of wastewater is sent to this field. The remainder of the waste stream is sent to the Urbana WWTP. The spray field lies within the Glaciated Till Plains Section of the Central Lowlands physiologic province near the gently rolling ridge known as the Springfield Moraine. The Mad River is approximately 1.5 miles west of the site.

A 1998 Ohio EPA investigation noted degradation of Fox Paper's spray fields due to sprayers not working properly. The sprayers were clogged by paper fibers which caused uneven distribution of paper waste leading to matted fibers on the ground and subsequent ponding on the soil surface. This promoted runoff and odor concerns. Ohio EPA recommended that Fox River bring their spray fields up to optimal operating condition until a more permanent solution of wastewater wasting can be implemented.

Numeric violations of NPDES permit limits were evaluated from 2000 to 2001. NPDES violations, reported through SWIMS, revealed a total of 19 for the Fox River Paper Co. For the nearly two years of data evaluated, constituents violating permit limits were water temperature and pH. Monitoring violations (sampling frequency or reporting) violations occurred from 2001 and increased each year through 2004. By 2003 and 2004 there was a reporting violation for nearly every month. Since the effective date of the NPDES permit, there have been 41 missed weekly monitoring events for outfall 001, causing 123 violations (one for each missed flow, pH and temperature).

Johnson Welded Products, **Inc** - unnamed tributary (RM 0.21) to Dugan Run (RM 1.75)
Permit # -1IS00000
Outfall 001 – Lat.: $40^0$06'09"; Long.: $83^0$46'03"

Johnson Welded Products, Inc is located in Champaign County at 625 S. Edgewood Avenue, Urbana. This company uses approximately 200,000 pounds of coiled steel per week and manufactures air tanks for brake systems to be used in heavy vehicles, trucks and trailers. Two shifts operate five days per week. Noncontact cooling water discharges to a pond that overflows to an unnamed tributary to Dugan Run. Sanitary waste is discharged into the Urbana sanitary sewer.

Sampling of the outfall for chlorine residual allows the entity to document chlorine attenuation through the noncontact cooling water detention pond. Residual chlorine in the city's distribution system is the source of chlorine in the cooling water system.

International Fiber Corporation (Fiber Sales and Development) - Dugan Run (RM 1.54)
Permit # - 1IH00020
Lat.: $40^0$06'15"; Long.: $83^0$46'16"

The International Fiber Corporation is located in Champaign County at 1228 Muzzy Rd, Urbana. This industry manufactures powdered cellulose for use as filtering aids and edible fibers in food, pharmaceutical, and industrial product lines. Processed wood pulp which has been previously bleached is cut and milled to a variety of particle sizes. Process water and stormwater discharge from outfall 001 at an estimated 1.296 MGD. Stormwater runoff consists of roof drains and parking lots discharges and is collected in a 20,000 ft^2 area prior to discharging to Dugan Run.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 35 for International Fiber Corporation. For the nearly six years of data evaluated, constituents violating permit limits were mostly temperature and pH reported with the greatest frequency. Seasonal patterns indicated violations occurred in all seasons except for summer.

Orbis Corporation - Dugan Run (RM 1.84)
Permit # - 1IN00093
Outfall 001 (at catch basin) – Lat.: $40^0$06'19"; Long.: $83^0$45'56" - non contact cooling water and stormwater
Outfall 002 – Lat.: $40^0$06'24"; Long.: $83^0$46'01" - stormwater to Dugan Run
Outfall 003 – Lat.: $40^0$06'23"; Long.: $83^0$46'02" - stormwater to Dugan Run

Orbis Corporation is located Champaign County at 200 Elm Street, Urbana. Orbis Corporation manufactures injection molds for construction of plastic storage containers with a projected outflow of 480,000 gpd. An Ohio EPA inspection in 2003 addressed the NPDES for temperature and pH of recent years. Faulty monitoring equipment, the cause of the violations,

was replaced by new Oakton 100 series monitoring equipment.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 34 for Orbis Corporation. For the nearly six years of data evaluated, violations were documented for 1999 to 2002 only, most occurring in 2002. Constituents violating permit limits were temperature and pH in order of frequency. There were no violations indicated for the summer months of any of the years reported.

Graham High School - unnamed tributary (RM 1.2) to Nettle Creek (6.67)
Permit # - 1PT00088
Lat.: $40^0$07'30"; Long.: $83^0$54'40"

Graham High School is located in Champaign County at 7800 State Route 36, St. Paris. In 1999 Graham High School's treatment system was upgraded to an extended aeration package plant (4000 gpd) with a settling tank, one new slow surface sand filter, one existing slow surface sand filter, chlorination/dechlorination tank with post-aeration and a sludge holding tank. Prior to the upgrade, the sewage system consisted of a septic tank, dosing tank and two slow surface sand filters. The system was upgraded to meet BADCT limits.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations reported through SWIMS, revealed a total of 33 for the school. For the nearly six years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included dissolved oxygen, $cBOD_5$ and ammonia-N (NH3-N) reported with the greatest frequency. No seasonal patterns were observed, although the majority of years showed minimal to no violations in the spring.

Graham South Elementary School - Chapman Creek (RM 10.40)
Permit # - 1PT00089
Lat.: $40^0$05'15"; Long.: $83^0$57'15"

Graham South Elementary School is located in Champaign County at 2955 St. Paris-Jackson Road, St. Paris. The school's treatment system was upgraded in December 1999. The upgrade included an extended aeration package plant (1900 gpd) with a settling tank, one new slow surface sand filter and one existing slow surface sand filter, chlorination/dechlorination tank with post-aeration, and a sludge holding tank. Prior to the upgrade, the sewage system consisted of a septic tank, dosing tank and two slow surface sand filters. The system was upgraded to meet BADCT limits.

Numeric violations of NPDES permit limits were evaluated from 2000 to 2004. NPDES violations, reported through SWIMS, revealed a total of 60 for Graham South Elementary School. For the nearly five years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included dissolved oxygen and $cBOD_5$ and

ammonia-N (NH3-N) reported with the greatest frequency. Eighty-three percent (83%) occurred after the upgrade and the following two years (2000-2001).

St. Paris WWTP - St. Paris Tributary (RM 2.65) to Nettle Creek
Permit # -1PB00029
Lat.: $40^0$07'25"; Long.: $83^0$57'01"

The St. Paris WWTP is located in Champaign County at 454 Huffman Drive, St Paris. The treatment facility was built in 1954 with modifications in 1970 and a new facility in 1990. The expansion in 1990 consisted of a bar screen, comminutor, sequencing batch reactor, chlorination/dechlorination and post aeration.

The treatment system serves a population of approximately 2000 people, sewage from Graham Middle School when in session (700 people), industrial contribution from KTH Parts Industries, and Beach Manufacturing, Inc. An upgrade to the Park Street Lift Station was completed in December 2003 which eliminated the overflow pipe that bypassed the entire treatment process. This overflow discharged to St. Paris Tributary and was considered a Separate Sewer Overflow (SSO). Phase 1 of an I/I evaluation was implemented, replacing manhole rubber boots in 7 of 19 leaking manholes. The facility sludge is ultimately disposed of at a sanitary landfill. The effluent outfall 001 will be moved in the future approximately 1000' upstream from its location due to conflicts in easement ownership rights.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 73 for the St. Paris WWTP, most occurring in 1999. For the nearly six years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included dissolved oxygen, TSS and $cBOD_5$ reported with the greatest frequency.

In the spring of 2003, excess zinc was thought to have contributed to ammonia-N violations by inhibiting nitrification in the plant. The source of the zinc was thought to be KTH Parts Industries. This company took the zinc phosphate process off-line in October 2003. Approximately 800-1,000 gallons of process wastewater containing zinc phosphate are generated at every six weeks. Beech Manufacturing was also associated with zinc phosphate from their paint line. Beech reported taking this process off-line in October of 2004 and switching to a zinc-free phosphate solution.

Urbana Elementary School - unnamed tributary of Bogles Run
Permit # - 1PT00100
La.: $40^0$04'02"; Long.: $83^0$44'12"

Urbana Local Elementary School is located in Champaign County at 2468 State Route 54 in Urbana. An Ohio EPA Permit to Install (PTI) number 05-11659 was issued on August 14, 2001, to upgrade the wastewater treatment system. The original sewage system consisted of a septic

tank and two slow surface sand filters. A school consolidation program prompted the treatment facility upgrade to a flow design of 6,000 gpd. Upgrades included the addition of a trash trap, flow equalization tank, an extended aeration package plant with a settling tank, two existing slow surface sand filters, chlorination/dechlorination tank with post-aeration, and a sludge holding tank.

An Ohio EPA inspection in 2002 documented an accumulation of grass and solids in the southern sand filter bed. Ohio EPA advised that filters required maintenance for best leaching capability and proper mechanical function.

Numeric violations of NPDES permit limits were evaluated from 2003 to 2004. NPDES violations, reported through SWIMS, revealed a total of 11 for the Urbana Elementary School. For the nearly two years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included TSS, ammonia-N (NH3-N) and fecal coliform bacteria reported with the greatest frequency. Seasonal patterns indicated violations occurred in late winter to early summer.

Valleyview MHP WWTP - swale in Bogles Run watershed
Permit # -1PY00002
Lat.: 40^0N04'09"; Long.: 83^0W46'06"

Valleyview MHP is located in Champaign County at 110 E. Hickory Grove Rd and US68, Urbana. The facility has 48 mobile home pads and has been in existence since 1965 with an expansion in 1971 and an Ohio EPA NPDES permit issued in 2002. The treatment plant is an extended aeration facility with no tertiary treatment, utilizing a trash trap, extended aeration to stilling ponds then discharge to a swale that acts as an infiltration lagoon. During wet weather, this swale has the potential to overflow to Bogles Run. An effluent flow volume of approximately 10,000 gpd was reported in 2003.

The City of Urbana determined that there is capacity in the lift station used by the Champaign County Nursing facility and Lawnview School to handle the flow from Valleyview MHP. This lift station is located north and across US68 from Valleyview MHP. The plan is to connect both the EconoLodge (drywell) and Valleyview MHP to this lift station and subsequently the City of Urbana.

Ohio EPA files noted that in 2002 the maintenance company for Valleyview MHP reported 9 inches of floating solids, foam, weeds and sewage on the final clarifiers. In 2002, an Ohio EPA inspection called attention to the need for concrete lids to the trash traps, the abandonment of the current discharge location and the need for an all weather road to allow proper hauling of sewage sludge offsite.

Numeric violations of NPDES permit limits were evaluated from 2003 to 2004. NPDES violations, reported through SWIMS, revealed a total of 59 for Valleyview MHP. For the nearly

two years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included dissolved oxygen, TSS and $cBOD_5$ reported with the greatest frequency. A malfunctioning blower motor, in the aeration basin, promoted the TSS and $cBOD_5$ violations while the absence of post aeration was explained as the reason for reduced dissolved oxygen levels. Violations occurred in all seasons with the least number of violations reported in the fall. No Monthly Operating Reports (MORs) were submitted for August, September and October of 2003 or January of 2004.

Urbana WWTP - Mad River (RM 39.15)
Permit # -1PD00011
001 – Lat.: 40^0N05'46"; Long.: 83^0W47'50"

The Urbana WWTP is located in Champaign County at 1547 Muzzy Rd, Urbana. The facility was built in the 1950s with a major modification in 1990 converting it to a conventional activated sludge wastewater treatment facility. It was designed in 2003 for 3.0 MGD. The treatment train consists of a comminutor, static screen grit removal, primary settling, trickling filters, activated sludge treatment, secondary clarification, chlorination/dechlorination and post aeration.

An I/I study commenced in 1993 implementing flow metering equipment, manhole inspections, sewer line inspections, annual cleaning of collection lines and problematic areas for blockages inspected quarterly. Data from 2002 estimated I/I at 10,000 gpd. The average daily flow rate for the facility from 1998-2000 was recorded as follows- 1998: 2.96 MGD, 1999: 1.875 MGD and 2000: 1.729 MGD. Industrial users contribute an estimated 0.700 MGD. Due to downsizing practices at the industrial users, reduced outflow volumes have contributed to the reduced average daily flows recorded at the treatment facility.

There have been a varied number of problematic areas for the wastewater treatment system over the last decade. Since 1993, the wastewater facility has experienced difficulty in maintaining consistent dissolved oxygen levels above 6 mg/l. This has been attributed to plugged ceramic disk fine-bubble diffusers.

Oil and grease problems have plagued and hindered the wastewater treatment plant for several years. There are an estimated 600 grease traps in the collection system and the city and local health departments are currently evaluating sites to reduce grease flows.

In 1999, TSS loads were attributed to the Cornnuts Company which contributed 200,000 gpd of waste flow. The company ceased operations in May 1999.

Sewage odor complaints noticed by citizens near the Troy Pike Bridge were most likely attributed to the stockpiling of sludge and bypassing events at the facility. A 2003 Ohio EPA inspection documented pin floc sludge rising in the clarifier tanks, the effluent was a grayish/brown and the chlorine contact tank walls had a greenish tint along with visible solids in

the tank. Color problems resulting from routine papermaking contributed by Fox River Paper Co (600,000 gpd) occasionally turns effluents a light gray.

The City of Urbana's waste solids are treated in a pasteurization process to produce a Class A Enviro Soil. Approximately 34% of Enviro Soil is composted and sold to citizens. The remaining 66% is land applied at agronomic rates.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of seven for the Urbana WWTP. For the nearly six years of data evaluated, constituents violating permit limits were fecal coliform bacteria and TSS reported with the greatest frequency. All violations occurred in 1999 and 2004.

Ohio EPA conducted bioassays in 1991, 1999 and 2004 of the Urbana WWTP outfall 001 effluents, upstream and mixing zone waters. Two acute bioassays, conducted by the Ohio EPA in March and May 1994, indicated the presence of acute toxicity to one or both test organisms for final effluent. In March 1999, the final effluents were not acutely toxic, although chronic toxicity was evident for *Ceriodaphnia dubia* for reproduction. An Ohio EPA acute toxicity test in April 2004 resulted in acute toxicity to *P. promelas* from the final effluent.

Buck Creek Watershed Assessment Unit (WAU 05080001 170)

The Buck Creek assessment unit, located in Champaign and Clark counties, encompasses a drainage area of 141 mi^2. Major tributaries in the watershed include Beaver Creek (drainage area 39.7 mi^2, confluence RM 6.00), the East Fork Buck Creek (drainage area 28.8 mi^2, confluence RM 12.81), and Dugan Ditch (drainage area 11.5 mi^2, confluence RM 15.93). As part of a flood control project, the U.S. Army Corps of Engineers impounded Buck Creek approximately seven miles upstream from its confluence with the Mad River creating the Clarence J. Brown Reservoir (2120 acres). The project, completed in 1974, provides water supply storage and recreation, and operates to increase natural low-flow conditions downstream from the dam in the interest of water quality. Additionally, Sinking Creek, a tributary of Beaver Creek (confluence RM 2.80), drains 13.9 mi^2 and is impounded at RM 6.0, creating Clark Lake, a 100 acre fishing lake and wildlife area. Agriculture is the predominant land use (Figure 26) with row crop and pasture/hay respectively accounting for 42.8% and 33.8% of the total watershed area (University of Cincinnati, 2001). Other land uses include deciduous forest (7.76%), residential (6.88%), urban/recreational grasses (3.58%), commercial/industrial/transportation (2.79%), and water (2.35%). The largest community in the watershed is the City of Springfield with a 2000 census population of 65358. Other towns in the watershed include the villages of South Vienna, Catawba, and the unsewered community of Mutual.

At the time of the 2003 survey, the aquatic life use designation in effect for Buck Creek was Coldwater Habitat (CWH) from the headwaters to C.J. Brown Reservoir (~RM 11.2) and Warmwater Habitat (WWH) in all other segments. Beaver Creek was designated CWH upstream from the Sinking Creek confluence and WWH from Sinking Creek (also WWH) to the mouth. The East Fork Buck Creek was designated CWH. The recreation use designation for all of the above streams was Primary Contact Recreation (PCR). Two streams sampled in 2003, Dugan Ditch and an unnamed tributary to the East Fork Buck Creek, were previously undesignated.

There are numerous dischargers in the basin. O.S. Kelly discharges to Buck Creek in Springfield at RM 3.22. Cascade Corporation discharges to a tributary of Mill Run which subsequently enters Buck Creek at RM 3.37 through a combined sewer overflow (CSO #40). Beaver Creek receives the wastewater discharge from Beaver Valley Resort and Campground (RM 5.35), All Seasons Resorts Tomorrow's Star RV Resorts (RM 5.70), Harmony Estates Mobile Home Park (MHP) (discharge at RM 0.16 to a tributary entering at RM 6.10), Bridgewood MHP (discharge at approximately RM 1.3 to a tributary entering at RM 6.10), and South Vienna WWTP (RM 8.65). Ports Petroleum discharges at RM 0.94 to a tributary (confluence RM 1.58) of a tributary which enters Beaver Creek at RM 9.34. Sinking Creek receives the wastewater discharge from Northeastern High School at RM 4.59 and Brookside Village MHP at RM 4.70. The Catawba WWTP discharges at RM 2.70 to an unnamed tributary which enters the East Fork Buck Creek at RM 1.00. Additionally, the City of Springfield's sewer system contains approximately 57 active combined sewer outfalls (CSOs) in the Buck Creek watershed which may discharge during rain events. Thirty-seven of these discharge directly to Buck Creek between RM 5.5 and RM 0.2 while the remainder discharge to tributaries of Buck Creek in this same reach.

Table 11 Aquatic life use attainment status of the Buck Creek watershed assessment unit, June- October, 2003. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb) and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate (ICI) communities. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

Stream River Mile Invertebrate/Fish	Attainment Status	IBI	MIwb	ICI/ narrative	QHEI	Drainage Area
WAU: 5080001 170						
Buck Creek				*(PHWH candidate)*		
19.5/---	NA			P*		3.8
				CWH (verified)		
17.5/17.5	Full	54		VG	82.5	9.5
13.1/13.1	Full	46		48	73.5	30.5
				WWH		
6.4/6.4	Partial	44	8.7	24*	69.5	82
0.6/0.6	Full	46	9.4	52	60	141
Beaver Creek				*CWH existing/ WWH recommended*		
10.2/10.2	Full	54		G	63	11
4.5/4.5	Full / Full	51	8.2^{ns}	52	62	21
				WWH		
0.7/0.7	Full	38^{ns}	7.8^{ns}	54	83	39
Sinking Creek				*WWH (verified)*		
4.6/4.6	Full	38^{ns}		MG^{ns}	55.5	10.5
East Fork Buck Creek				*CWH (verified)*		
5.2/5.0	Full	40		G	51	5
0.3/0.3	Full	37^{ns}		54	78	28
U.T. to East Fork Buck Creek				*(PHWH candidate)*		
0.9/---	NA			F*		
Dugan Ditch				*undesignated/ CWH recommended*		
2.2/2.2	Full	42		VG	34.5	11.2

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

INDEX - Site Type	LRW	MWH channel modified	CWH	WWH	EWH
IBI Headwater - Wading/ Boat	18/18	24/24	40	40/ 42	50
MIwb Wading/ Boat	4.0/4.0	6.2/5.8	-/6.6	8.3/ 8.5	9.4/ 9.6
ICI	8	22	36	36	46

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns Nonsignificant departure from biocriterion (<4 IBI or ICI units; <0.5 MIwb units).
a Narrative evaluation used in lieu of ICI (E=Exceptional; G=Good; MG=Marginally Good; F=Fair; P=Poor).
b Use attainment status based on one organism group is parenthetically expressed.
N/A Not Applicable. The MIwb is not applicable to headwater sites.

Aquatic Life Uses

The aquatic life use in a significant portion of streams within the Buck Creek watershed had not been verified based on biological sampling prior to 2003. Stream reaches for which an aquatic life use had been designated in the 1978 and 1985 Ohio WQS but not confirmed include: Buck Creek upstream from C.J. Brown reservoir, Beaver Creek from the headwaters to Sinking Creek, Sinking Creek, East Fork Buck Creek, and Dugan Ditch. This study, as an objective and robust use evaluation, is precedent setting in comparison to the 1978 and 1985 designations. Additionally, appropriate aquatic life uses of two undesignated watercourses, an unnamed tributary to the South Fork Buck Creek and Dugan Ditch, were investigated.

Two sites went dry before biological sampling could be completed. Buck Creek at RM 19.5 (St. Rt. 29) and the unnamed tributary to the South Branch Buck Creek supported a very limited macroinvertebrate fauna. Assignment of an aquatic life use is not appropriate given the inability of the sites to develop any semblance of reproducing fish and macroinvertebrate communities. A more realistic classification of these streams could be made using Primary Headwater Habitat (PHWH) guidelines. Therefore, it is recommended that the upper reaches of Buck Creek beginning at RM 19.5 (St. Rt. 29) and the unnamed tributary to the South Branch Buck Creek remain undesignated until the PHWH designations are promulgated.

Nine sites with drainage areas <50 mi^2 met the existing or recommended aquatic life use (Table 11). Two sites with drainage areas >50 mi^2 represented 7.2 miles of the Buck Creek downstream from C. J. Brown reservoir. Full attainment of the designated WWH use was met for 3.6 miles of the stream while 3.6 miles partially met expectations.

Buck Creek upstream from C.J. Brown reservoir and East Fork Buck Creek are listed as CWH streams in the 1978 and 1985 water quality standards; but prior to this most recent survey the aquatic life use had not been confirmed. The 2003 biological and habitat results were consistent with a CWH use on the East Fork Buck Creek and for Buck Creek from RM 17.5 to C.J. Brown reservoir. Biological sampling on Buck Creek at RMs 17.5 and 13.1 yielded 5 and 7 coldwater macroinvertebrate taxa, respectively. The CWH aquatic life use was verified for the East Fork Buck Creek based on sampling at RMs 5.2 and 0.3. The site at RM 5.2 (Number 10 Road) yielded only three coldwater macroinvertebrate taxa but the channelized habitat likely limited community diversity. Five coldwater macroinvertebrate taxa were identified from RM 0.3 (Baldwin Lane).

Sampling of fish and macroinvertebrates at RM 2.2 (Pisgah Rd) on Dugan Ditch produced assemblages consistent with CWH despite a highly modified habitat (QHEI = 34.5). The native fauna included five coldwater macroinvertebrate taxa and two coldwater fish species. With the addition of Dugan Ditch, the CWH designation will encompass all the principle streams in the watershed upstream from C.J. Brown Reservoir.

Beaver Creek is designated CWH upstream from Sinking Creek but, based on the information gathered in the 2003 sampling effort, a WWH aquatic life use is recommended. Qualitative

macroinvertebrate sampling yielded only one coldwater macroinvertebrate taxon at RM 10.2. Sampling at RM 4.5 produced two coldwater taxa. Collection of four coldwater macroinvertebrate taxa at RM 0.7 (Croft Rd.) in 2003 appeared to be a reflection of a higher than normal contribution of groundwater to the surface flow. Sampling conducted in 1984 and 1994 at RM 0.7 produced no more than two coldwater macroinvertebrate taxa and was the basis for the WWH designation downstream from Sinking Creek. The results suggest that the presence of macroinvertebrates that favor coldwater conditions fluctuates in Beaver Creek depending of the level of the groundwater table.

A WWH aquatic life use is recommended for Sinking Creek. Biological communities at RM 4.6 marginally met WWH expectations. No coldwater macroinvertebrates were collected. A somewhat modified habitat and degraded water quality likely limited the establishment of a more diverse fish and macroinvertebrate fauna. The Brookside Village WWTP discharge apparently contributed nutrients and/or organic matter. As a result, pollution tolerant carp, yellow bullheads and green sunfish populated the stream. The stream could benefit from restoration and protection of riparian areas. Recovery from previous modifications to the stream channel and riparian area were ongoing and can, with acceptable water quality, be expected to support improved biological communities.

Downstream from C.J. Brown reservoir, Buck Creek partially attained the WWH aquatic life use. The site at RM 6.4 was only a short distance downstream from the lake outlet (RM 7.2). Conditions at the site were typical of those encountered below similarly constructed reservoirs in Ohio. The stream was channelized and water released from the lake likely carried with it an abundance of fine organic material which favors filter feeding macroinvertebrate taxa. As a result, both the total taxa and number of mayflies and caddisflies were limited compared to the diversity observed both upstream from the reservoir (RM 13.1) and further downstream at RM 0.6. The macroinvertebrate community was only in fair condition (ICI= 24) at RM 6.4 but improved to an exceptional level (ICI= 52) at RM 0.6 even though the lower site was also extensively channelized. Fish sampling results were indicative of good to very good conditions at both locations downstream from the reservoir. Additional flow contributed by groundwater downstream from the reservoir appeared to increase the ability of the stream to attenuate negative effects that limited habitat, urban runoff and CSO releases might have had on the biota of Buck Creek.

Recreational Uses

The recreation use designation for all of the above streams was Primary Contact Recreation (PCR). Based on the three sites sampled for bacteria (fecal coliform and *E. coli*), the PCR use designation was not attained in the Buck Creek assessment unit Table 6 and Table 7, Figure 10, Appendix Table A-2). Elevated concentrations occurred primarily on two of the five sampling dates (September 3 and 22) after significant rainfall in the basin (Figure25). Some of the highest concentrations of the entire survey occurred on September 22 in Buck Creek at RM 0.60 downstream from Springfield's numerous CSOs.

With the exception of elevated values on September 22, the lowest concentrations of bacteria in the watershed occurred at RM 6.5 in Buck Creek upstream from the confluence of Beaver Creek and downstream from C.J. Brown Reservoir.

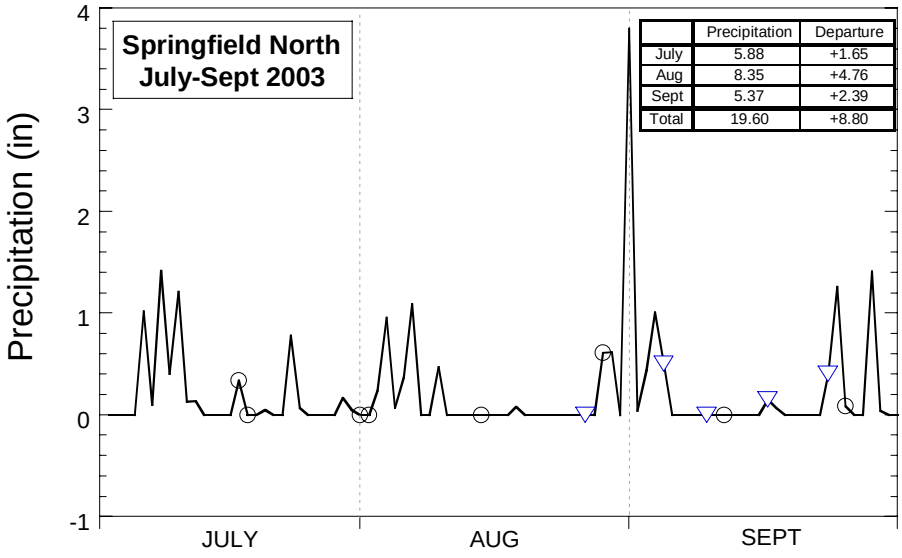
Chemical Water Quality

Inorganic water chemistry grab samples and field measurements were collected at 13 sites in this assessment unit at two-week intervals (six times) from mid-July to late September (Table 25). All samples were analyzed for a variety of parameters including nutrients and metals (Figure 27 - Figure 29, Appendix Table A-1). Three of these sites (Buck Creek RM 6.50 and RM 0.60, and Beaver Creek RM 0.67) were also sampled for organic compounds (volatiles, semivolatiles, pesticides, and polychlorinated biphenyls (PCBs)) twice during the survey (Table 28, Appendix Table A-3). At the same three sites, bacteria samples (fecal coliform and *E. coli*) were also collected five times within a thirty-day period in order to determine recreational use attainment (Table 27, Appendix Table A-2). Additionally, a Datasonde™ continuous monitor was deployed in Buck Creek at RM 0.60 for a 48-hour period in July and again in September (Figure 7). While there was no active stream flow gauging station in the Buck Creek assessment unit during the 2003 survey, total precipitation of 19.6 inches was recorded in Springfield (MCD 2003) from July through September 2003, a departure of 8.8 inches above normal for the period (Figure25).

Water chemistry results which exceeded State of Ohio WQS criteria are presented in Table 26 and Table 27.

Wide variances in daytime dissolved oxygen (DO) concentrations were recorded in the headwaters of Buck Creek at RM 19.5 (6.2 mg/l - >20mg/l). This area lacked a riparian canopy and became interstitial early in the survey. The small unnamed tributary (drainage area ~1.4 mi^2) in the East Fork Buck Creek watershed also became interstitial early in the summer and remained so throughout much of the survey. Concentrations of DO, copper, lead and iron exceeded WQS criteria in this tributary on August 27 following a thunderstorm. Lead exceeded WQS criteria at RM 0.6 in Buck Creek adjacent to Snyder Park on this date also. This site is downstream from most of Springfield's CSOs and immediately downstream from CSO #004.

While well within WQS criteria , ammonia levels downstream from C.J. Brown Reservoir in Buck Creek at RM 6.5 (median 0.161 mg/l) were consistently elevated above the 90^{th} percentile ecoregion background level. In January 2005, leachate outbreaks from an old active construction and demolition (C&D) landfill were discovered entering Buck Creek upstream from this site and may have contributed to the higher ammonia-N levels. Ammonia-N concentrations in Sinking Creek downstream from the Brookside Village MHP were also typically elevated (median 0.18 mg/l) above background. Additionally, field notes indicated that the Sinking Creek site frequently appeared murky. Confirming these observations, water chemistry results documented that the site experienced the most consistently elevated total suspended solids (TSS) levels (median 24 mg/l) in the Buck Creek watershed assessment unit and the second highest median levels in the entire survey area.



*Rain gages are read every morning at or near 8:00 am. Therefore, these readings reflect the previous 24 hour catch.

Figure25. Daily precipitation recorded for Springfield North from July through September (data per Miami Conservancy District, 2003). Open circles represent conventional water chemistry sampling days and triangles represent bacteriological sampling days in the Buck Creek assessment unit.

The highest nitrate-nitrite-N concentrations (median 11.6 mg/l) of the entire Mad River survey were measured in Buck Creek at Pisgah Rd (RM 17.53). Levels remained elevated at RM 13.13 (median 8.01 mg/l). Median temperatures at these two CWH sites (16.25 ^{o}C at RM 17.53 and 17.00 ^{o}C at RM 13.13) were significantly lower than at WWH sites downstream from C.J. Brown Reservoir where median temperatures ranged from 22-23^{o}C. Elevated stream nitrate levels above the reservoir may in part reflect the interaction between groundwater and surface water. The Miami Conservancy District reported that higher groundwater nitrate concentrations in the Mad River watershed are typically found in shallow wells (< 50ft deep) in agricultural areas (MCD 2003). A nitrate-nitrite concentration of 11.9 mg/l was measured in June 2003 during the MCD study in one such well located adjacent to Buck Creek near the confluence of Dugan Ditch. Elevated levels in the aquifer are likely to impact the nitrate load in stream sections that derive base flow largely from groundwater recharge.

Phosphorus concentrations generally remained low in the watershed with an overall median of 0.037 mg/l and 95% of values well below the 90th percentile ECBP ecoregion background levels (0.206 to 0.22 mg/l). The highest concentration (1.51 mg/l) occurred in Buck Creek at RM 0.6 on September 10. (This site is immediately downstream from Springfield CSO 004; however, field notes do not indicate anything unusual nor was there precipitation in the area the entire week prior to sampling.)

All eleven organic compounds detected in the water column in the Buck Creek watershed assessment unit were pesticides (Table 28, Appendix Table A-3). Similar to the entire Mad

River watershed, the herbicides atrazine, metolachlor, and Simazine were the most frequently detected compounds accounting for 18%, 18%, and 15%, respectively, of the 33 detections, . Concentrations of aldrin exceeded the non-drinking water human health WQS criteria at both Buck Creek sites sampled.

Watershed Protection Efforts

Since 2000 the Lower Mad River Watershed Protection Project has been implementing a water quality protection project as part of a Section 319 funded grant. Among the objectives of the grant were to reduce nutrient and sediment loading to streams in the Mad River Watershed through installation of grass and tree filter strips, use of cover crops to reduce erosion, and pumping of septic tanks. Coupled with the installation of these Best Management Practices (BMPs) were education programs to increase awareness of water quality impacts and threats. Estimated load reductions in the Buck Creek assessment unit are listed below.

Load reductions from Cover Crops

Acres Established 714.4
Sediment saved 685 (tons/yr)
Phosphorus 785 (lbs/yr)
Nitrogen 1596 (lbs/yr)

Load reductions from Grass and Tree Filter Strips

Acres Established 38.7
Sediment saved 243 (tons/yr)
Phosphorus 471 (lbs/yr)
Nitrogen 768 (lbs/yr)

Load reductions from Septic Tank pumping

Gallons per day adequately treated 20,700
TSS 4533.3 (lbs/yr)
BOD 8839.9 (lbs/yr)
Phosphorus 944.45 (lbs/yr)
Nitrogen 2493.4 (lbs/yr)
Ammonia 1888.9 (lbs/yr)

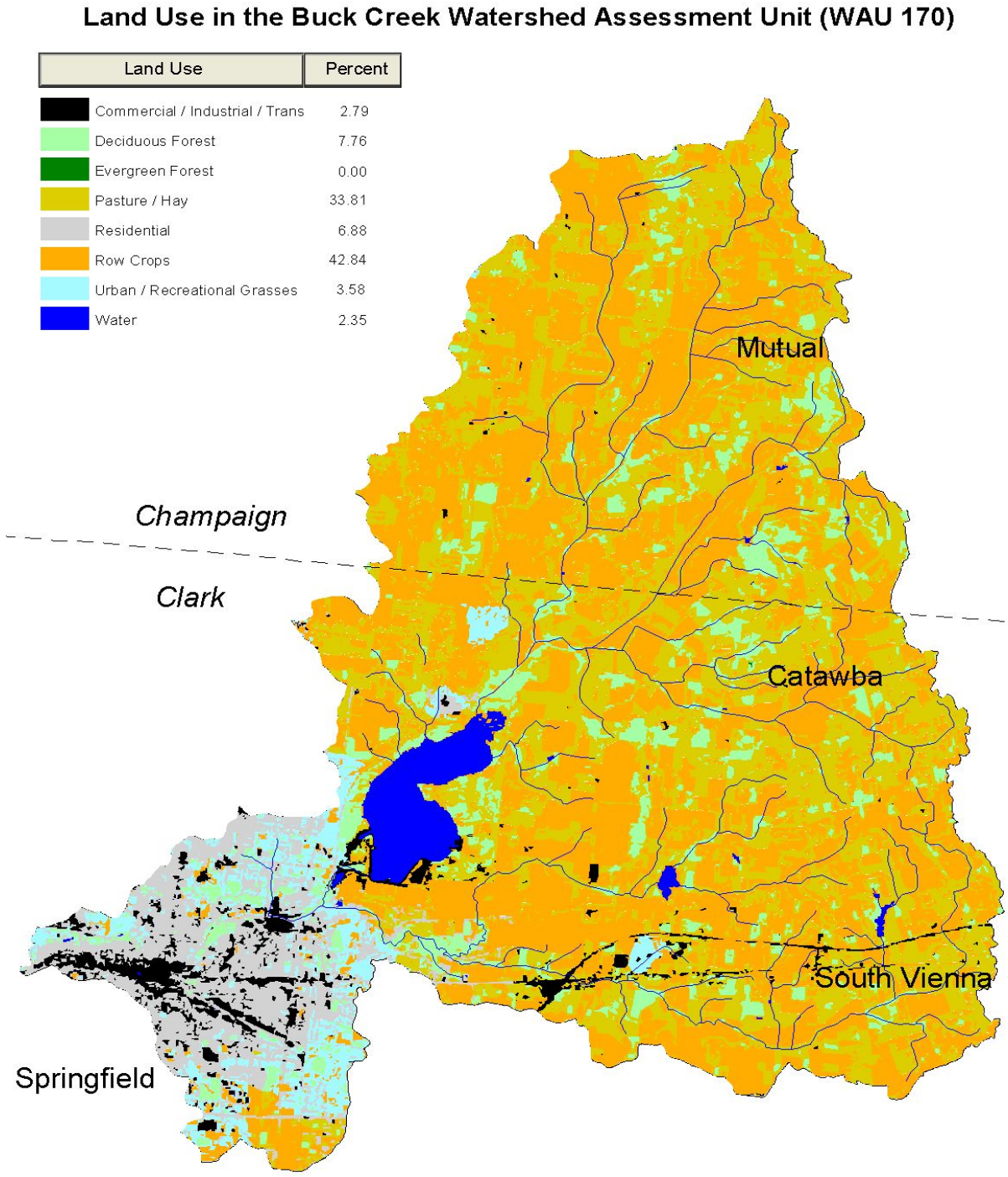


Figure 26 Land Use in the Buck Creek Watershed Assessment Unit (WAU 170); (University of Cincinnati, 2001).

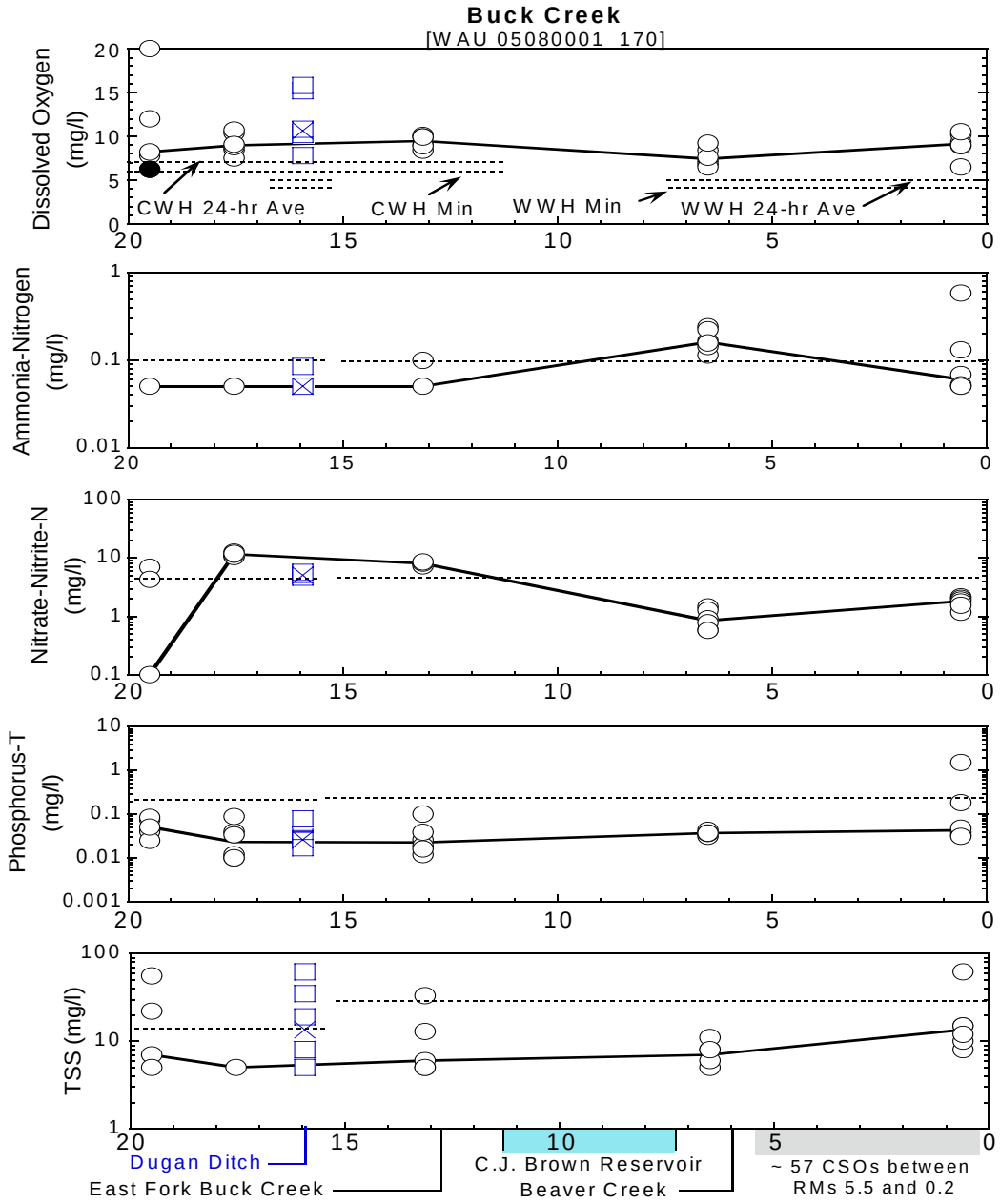


Figure 27 Longitudinal plots of water chemistry daytime grabs in Buck Creek (circles) and Dugan Ditch RM 2.16 (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in Buck Creek while an 'X' depicts the median for Dugan Ditch. WQS criteria are shown in the dissolved oxygen plot. (Values below criteria are shown as solid circles or squares.) Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

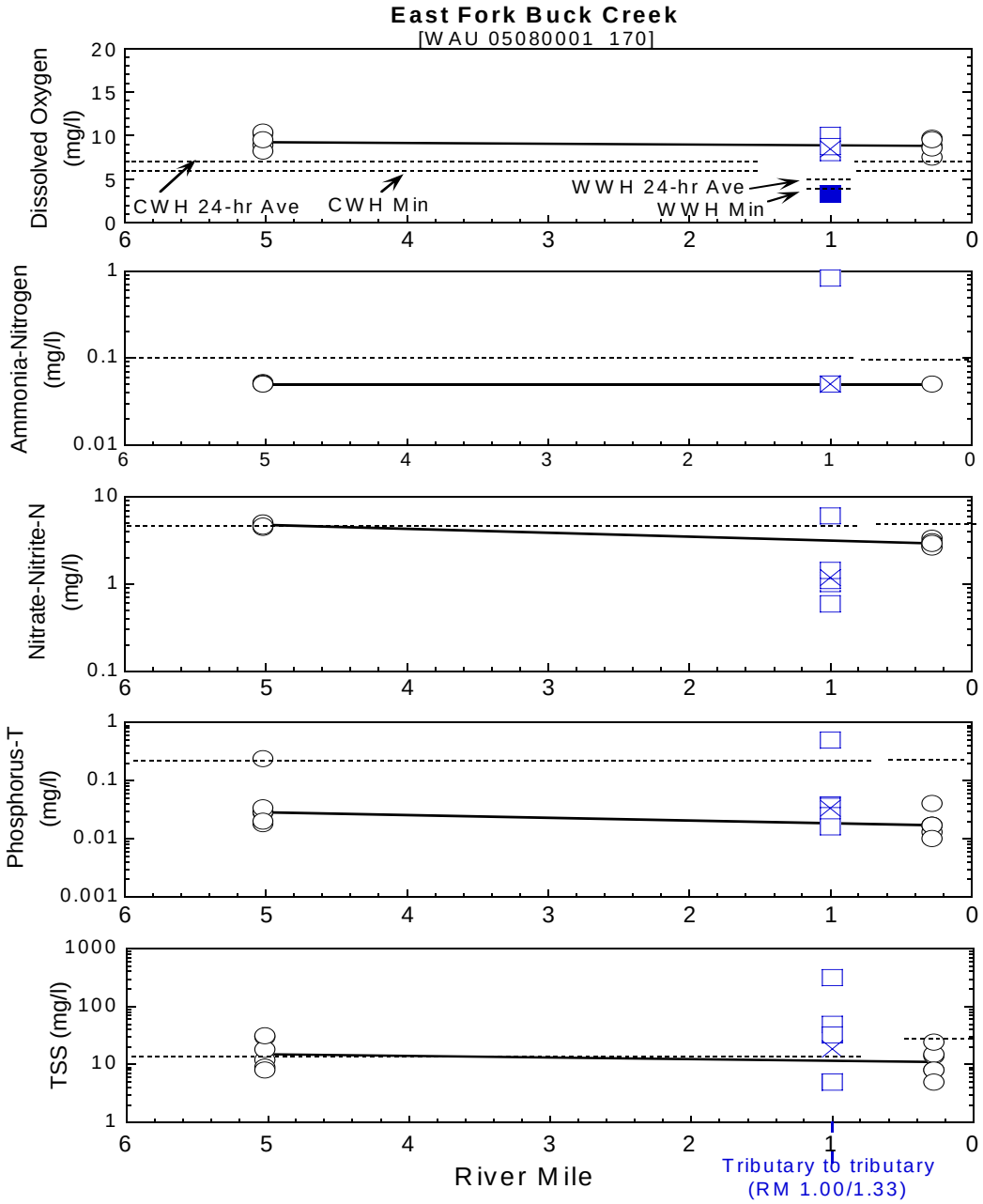


Figure 28 Longitudinal plots of water chemistry daytime grabs in East Fork Buck Creek (circles) and an unnamed tributary RM 0.94 (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in East Fork Buck Creek while an 'X' depicts the median for the tributary. WQS criteria are shown in the dissolved oxygen plot. (Values below criteria are shown as solid circles or squares.) Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

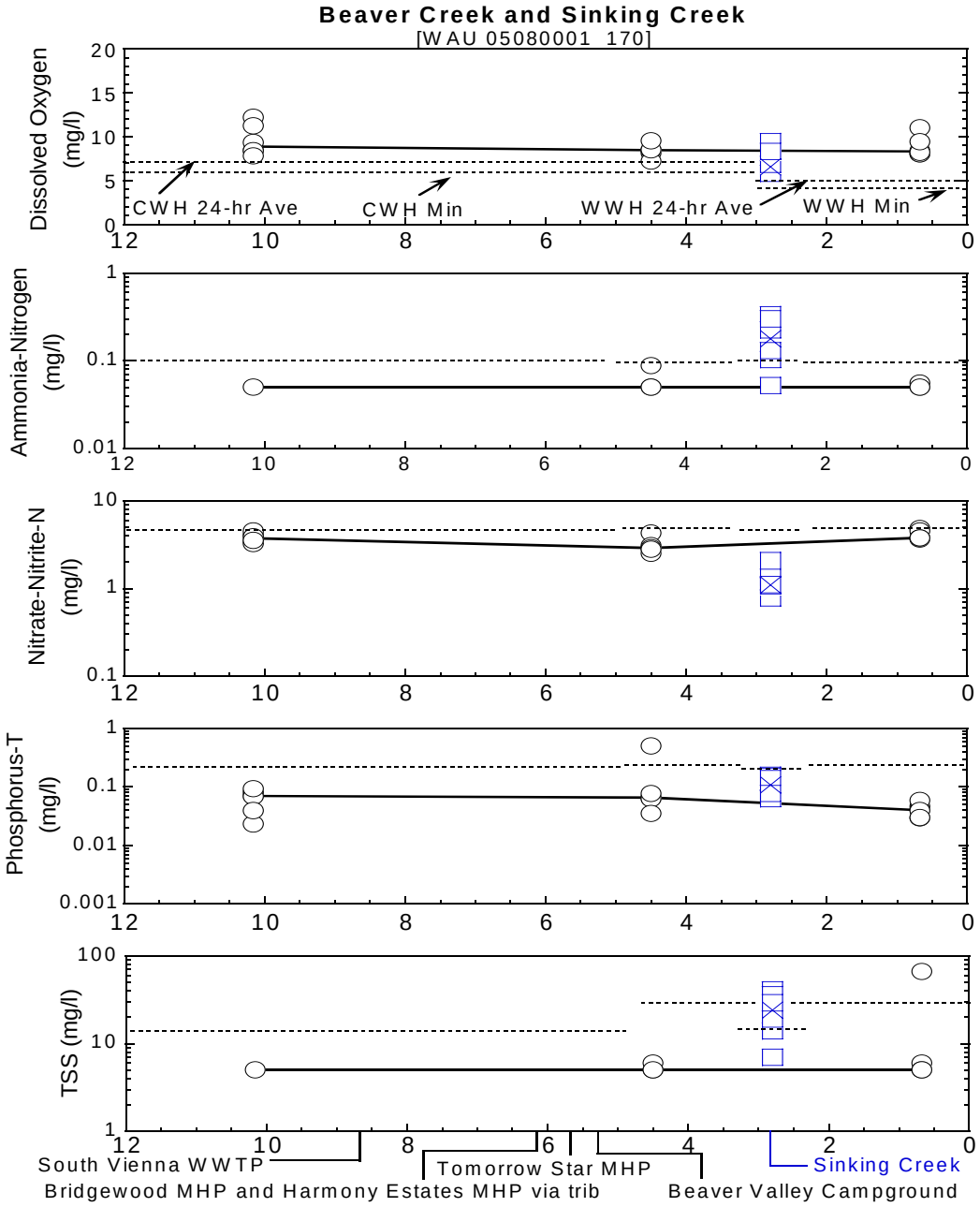


Figure 29 Longitudinal plots of water chemistry daytime grabs in Beaver Creek (circles) and Sinking Creek RM 4.60 (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in Beaver Creek while an 'X' depicts the median for Sinking Creek. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

Chemical Sediment Quality

Sediment quality was evaluated on the Buck Creek mainstem (RMs 6.50 and 0.60) and Beaver Creek (RM 0.67) (Table 12 and Table 13). All three sampling sites were on the eastern part of the watershed in Springfield and Moorefield townships.

The metals results from Beaver Creek (RM 0.67) at Croft Road were within the Ohio SRV sediment guidelines. Sediment ammonia (180 mg/kg) was elevated, exceeding the Ontario sediment disposal guidelines for ammonia. A large farm with row crop agriculture and cattle is in the immediate watershed.

Acetone and 3,4 methyl phenol were also found in sediments at Beaver Creek (RM 0.67). Acetone (0.240 mg/kg) is most likely laboratory contamination. Acetone was found to be contaminating the methanol used to clean sampling equipment. The cresols (3,4 methyl phenol) were detected at 8.29 mg/kg. There is no standard associated with this compound. Cresols are used for wooden pole and railroad tie preservation.

Buck Creek (RM 6.5) at old Reid Park was sampled in an area that was rich in dark sediment and a major depositional zone. Manganese (1320 mg/kg) and zinc (265 mg/kg) were above the Ohio SRV sediment guidelines. Zinc was measured between the MacDonald TEC and PEC, meaning that adverse benthic effects frequently occur.

Sediment ammonia (320 mg/kg) exceeded the Ontario sediment disposal guidelines of 100 mg/kg. No CSOs are in this section of Buck Creek. This site is downstream from the discharge of CJ Brown Reservoir, which could be providing significant organic material from the bottom of the lake and it was discovered early in 2005 that Springfield CD & D Landfill, a construction and demolition fill, had significant leachate breakouts discharging to a tributary to Buck Creek. The leachate, which was high in ammonia, entered Buck Creek upstream from the 2003 sediment sampling location. The current owner of the landfill believed the leachate breakout problem existed prior to his purchase of the fill. A large Canada goose and duck population upstream in the park may also be contributing to the high Total Organic Carbon (TOC) and ammonia levels documented. TOC was 10% of the sample, which if from anthropogenic sources, would be considered at the Ontario severe effect level. Fine grain material (FGM) in the sample was 27.4% which was below the goal of 30% FGM

Buck Creek (RM 0.60) at Snyder Park is downstream from thirty CSO discharges on Buck Creek. Total polycyclic aromatic hydrocarbons (PAHs) concentration was 29.60 mg/kg, which exceeded the MacDonald probable effect concentration (PEC). Adverse effects usually or always occur to benthic organisms at this level. Six different individual PAH compounds and total Chlordane were also over the MacDonald PEC. Dieldrin and PCB-1254 were detected between the MacDonald PEC and TEC. Adverse affects frequently occur at these levels.

A total PAH concentration of 29.60 mg/kg in an urban watershed is not unusual. The PAH compounds found in sediment can be associated with deposition of particulate matter from automobile and diesel exhaust and other combustion sources, paving of highways with asphalt, and coating of driveways and roads with coal tar based sealants.

Results from Buck Creek (RM 0.60) at Snyder Park detected lead (78 mg/kg) over the Ohio SRV sediment guidelines and between the MacDonald TEC and PEC. Sediment ammonia (330 mg/kg) exceeded the Ontario sediment disposal guidelines (100 mg/kg). Decomposition of human waste from 30 CSOs in the drainage area is suspected to be a major source of sediment ammonia. Fine grain material (FGM) in the sample was 25.5%, which was below the goal of 30% FGM for particle size.

Table 12 Concentrations (mg/kg) of metals and nutrients in sediment samples collected in the Buck Creek watershed assessment unit (WAU 05080001 170) during 2003. Parameter concentrations were evaluated based on Ohio EPA sediment metal reference sites (2003), MacDonald (2000) Sediment Quality Guidelines (SQG) and Persuad (1993). Values above guidelines are highlighted.

Parameter	**Site Location (RM)**				
	Buck Creek Old Reid Pk RM 6.50	**Buck Creek** Snyder Park RM 0.60	**Beaver Creek** Croft Road RM 0.67	***Reference***	
				Ohio	**MacD**
Al-T [O]	12200	9800	18900	39000	*
As-T [OM]	9.61	5.25	9.71	18	9.79-33
Ba-T [O]	205	99.6	145	240	*
Ca-T [O]	70300	53300	81500	120000	*
Cd-T [OM]	0.618	0.495	0.342	0.9	0.99-4.98
Cr-T [OM]	<56	29	<25	40	43.4-111
Cu-T [OM]	24.5	17.8	11.3	34	31.6-149
Fe-T [O]	14000	11400	15700	33000	*
Hg-T [OM]	<0.098	0.078	0.061	0.12	0.18-1.06
K-T [O]	<3760	2280	4230	11000	*
Mg-T [O]	10300	14700	16400	35000	*
Mn-T [O]	1320+	378	549	780	*
Na-T *	<9390	<3560	<4130	*	*
Ni-T [OM]	<75	<28	<33	42	22.7-48.6
Pb-T [OM]	<75	78+ #	<33	47	35.8-128
Se-T [O]	<3.76	<1.42	<1.65	2.3	*
Sr-T [O]	177	92	178	390	*
Zn-T [OM]	265+ #	87.1	69	160	121-459
				Ohio	**Pers.**
NH_3-N [P]	320 [L]	330 [L]	180 [L]	*	100
TOC [P]	10%	4.7%	5.7%	*	10.0%
pH *	7.8	7.5	7.7	*	*
P-T [P]	1390	623	1060	*	2000
%FGM [O]	27.4%ú	25.5%ú	38.8%	30.0%	*
COD*	319000	84600	99600	*	*

↘ Below the goal of 30% Fine Grain Material in sample
%FGM Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)
NA Compound not analyzed. * Not evaluated
[O] Evaluated by Ohio EPA (2003) [M] Evaluated by MacDonald (2000) [P] Evaluated by Persuad (1993)

Ohio SRV Guidelines (2003)
+ above background for this area

Ontario Sediment Guidelines (Persuad (1993)
L > Open Water Disposal Guidelines; equivalent to the Lowest Effect Level (LEL)-applicable to NH_3-N only.
• > severe effect level (disturbance in benthic community can be expected)

MacDonald (2000) Sediment Quality Guidelines (SQG)
TEC-PEC Threshold effect concentration (TEC) - Probable effect concentration (PEC)
Above which adverse effects frequently occur
■ **>PEC** Probable effect concentration (PEC) -Above which adverse effects usually or always occur

Table 13 Sediment concentrations of organic compounds (priority pollutant scan) detected in the Buck Creek watershed assessment unit (WAU 05080001 170) during 2003. Individual compounds were evaluated by the MacDonald Sediment Quality Guidelines (2000).

River / Landmark	**Analysis Performed**	**Compound Detected**	**Result** mg/kg unless noted
Buck Creek RM 6.50 Old Reid Pk. TOC = 10.0% Fine Grained Material = 27.4 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone 3&4 Methylphenol	0.428 * 16.2 * BDL BDL
Buck Creek RM 0.60 Snyder Park TOC = 4.7% Fine Grained Material = 25.5%	1) VOC 2) BNA	Acetone Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo[g,h,i]perylene Benzo(k)fluoranthene Chrysene Fluoranthene Indeno[1,2,3-cd]pyrene Phenanthrene Pyrene **Total PAH** bis(2ethylhexyl)phthalate 3&4 Methylphenol	0.122 * 2.22 ■ 2.39 ■ 2.67 * 1.81 * 2.10 * 2.94 ■ 5.92 ■ 2.04 * 2.91 ■ 4.60 ■ **29.60 ■** 0.93 * 2.31 *
	3) Pesticides	Dieldrin Alpha-Chlordane Gamma-Chlordane **Total Chlordane**	0.0141 # 0.0084 * 0.0158 * **0.0242 ■**
	4) PCBs	PCB-1254 **Total PCB**	0.159* **0.159 #**
Beaver Creek RM 0.67 Croft Road TOC =5.7 % Fine Grained Material = 38.8 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone 3&4 Methylphenol	0.240 * 8.29 * BDL BDL

* Not evaluated NA Compound not analyzed BDL Below Detection Limit TOC Total Organic Carbon

1) Volatile Organic Compounds (VOC) U.S. EPA Method 8260B
2) Base Neutral & Acid Extractibles (BNA) U.S. EPA Method 8270
3) Pesticides U.S. EPA Methods 8082A
4) Polychlorinated biphenyls (PCBs) U.S. EPA Method 8082A

Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)

MacDonald (2000) Sediment Quality Guidelines (SQG)

TEC-PEC Threshold effect concentration (TEC) - Probable effect concentration (PEC) Above which adverse effects frequently occur

■ **>PEC** Probable effect concentration (PEC) -Above which adverse effects usually or always occur

Point Source Evaluations

South Vienna WWTP - Beaver Creek (RM 8.65)
Permit #: 1PA00021
Lat.: $39^0$54'43.9", Long.: $83^0$38'03.6"

The South Vienna WWTP is in Clark County at 149 West Main Street in South Vienna. The treatment works were constructed in 1992 and consists of individual on-lot septic tanks connected to the sanitary sewer, one aerated lagoon, a facultative/stabilization lagoon, and two rock filters. The average hydraulic flow of the wastewater treatment system is 0.0772 million gallons per day (MGD). The treatment system has two lift stations serving a population of 605 people. The facility underwent a treatment works upgrade in 2003, adding post aeration to the process.

The collection system is a separate sewer system. The influent can bypass both lagoons and go directly to the rock filters. There is also an internal bypass capability of the facultative/stabilization lagoon after passing through the aerated lagoon. Neither treatment unit bypasses go directly to area streams.

South Vienna's NPDES permit contains a Schedule of Compliance, which required the submittal of a Permit-to-Install application to upgrade the existing wastewater treatment plant and a study to identify and eliminate/reduce sources of inflow and infiltration. The Village has failed to comply with the Schedule of Compliance with regards to the I/I study.

On August 17, 2001, Ohio EPA issued South Vienna a Permit-to-Install (PTI No. 05-11683) for upgrades to the existing wastewater treatment plant. Upgrades consisted of installing post-aeration, which will allow the Village to meet a final effluent limit for dissolved oxygen of 7.0 mg/l.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 46 for South Vienna WWTP. Most violations were reported in 2002 and 2003. For the data evaluated, constituents violating permit limits were mostly dissolved oxygen.

Ports Petroleum Fuel Mart #764 - field tile to tributary (RM 0.94) to tributary (RM 1.58) to Beaver Creek (RM9.34)
Permit #: 1PZ00092
Lat.: $39^0$56'08.1", Long.: $83^0$36'42.8"

Ports Petroleum (Fuel Mart #764) is a gas station, truck stop and convenience store in Clark County at 404 N Urbana Rd, South Vienna. On August 27, 1986, Ohio EPA issued a Permit-to-Install (PTI No. 05-2052) to Port Petroleum for an on-site sewage system. The on-site sewage system consists of a 1,500-gallon septic tank, lift station, diversion box and 440 linear feet of

leach lines. The existing system was designed to serve an average hydraulic flow of no more than 175 gpd. This was based on a maximum of 7 employees over a 24-hour period. This system was not designed for public restrooms. It is Ohio EPA's understanding that Ports Petroleum currently has public restrooms, which generate an additional sewage flow not accounted for in the PTI.

In July 2002, Ohio EPA issued Fuel Mart #764 an NPDES permit for stormwater runoff. Stormwater from the fuel islands passes through an oil/water separator prior to discharge to the unnamed tributary or "swale" to Beaver Creek. The swale is across the road from the Fuel Mart catch basins, which drain to a farm field. An oil/water separator was implemented as a best management practice by Fuel Mart #764 for this type of facility. In August 1998, Fuel Mart #764 developed a stormwater pollution prevention plan.

Ohio EPA Permit Files note that in 1996, during an excavation at the facility a ruptured leaching line at the facility allowed sewage and diesel fuel to migrate offsite to the grounds behind the facility. In 1990, a farmer noted a ditch full of petroleum, extending about 75 yards behind the N. Urbana Rd. property. In June 2001, a complaint-investigation lead to the discovery of diesel and gas fuel in a ditch near the facility extending about 200 yards. The release was due to diesel from the fueling islands washing into drains during heavy rainfall. An Ohio EPA inspection in 2001 documented catch basins on the property containing petroleum odors and sheens and fuel oil on soil adjacent to the catch basins.

In January 1996, Ohio EPA issued Fuel Mart #764 a NPDES general permit for petroleum related corrective action. The ground water remediation system consists of two oil/water separators, one aeration-tank, and one carbon absorption tank with a sediment filter. Corrective measures were under the authority of the State Fire Marshal's Bureau of Underground Storage Tank program. In May 2002, Fuel Mart #764 submitted a Notice of Intent to cease the discharge from the ground water remediation system.

An Ohio EPA inspection in October of 2004 indicated that breakout of sewage at this facility was reoccurring. During the inspection, sewage was observed seeping on the southern side of the leach field for approximately 200 sq. ft. Grey sewage fungus was observed along with sewage odors. Beyond this area partially treated effluent was observed to be blackish in color. The inspection port on the south side of the leach field appeared to have ponding of partially treated effluent, and a noticeable sewage odor. The sewage was discharging to a swale area in violation of Ohio Revised Code (ORC) 6111.04, *Acts of Pollution Prohibited* and declared to be a public nuisance.

Numeric violations of NPDES permit limits were evaluated from 2002 to 2004. NPDES violations, reported through SWIMS, revealed a total of 16 for Fuel Mart #764. For the data evaluated, constituents violating permit limits were all reported as oil/grease.

Bridgewood MHP-Unnamed tributary (RM 1.3) to Beaver Creek (RM 6.10)
Permit#:1PV00112
Lat.: $39^0$56'09"; Long: $83^0$39'07.3"

The Bridgewood Mobile Home Park is in Clark County at 1001 North Buena Vista Road, South Vienna. On January 16, 2003, a Permit-to-Install (PTI No.05-12387) was issued to Bridgewood MHP as required by the Schedule of Compliance in the Bridgewood NPDES permit. Current treatment consists of a trash trap, an equalization tank, aeration tanks, final clarifier, dosing tank, surface sand filters, chlorination tank with post aeration, dechlorination tank, and a sludge holding tank. The wastewater treatment plant was designed to serve an average hydraulic flow of no more than 7,500 gpd. On July 22, 2004, Ohio EPA representatives confirmed that the treatment system was installed in accordance with the detailed plans issued within the PTI permit.

Violations of the NPDES permit were evaluated from March 2002 through September 2004 due to this facility receiving an effective NPDES permit on March 1, 2002. During a period from March 1, 2002 through September 2003, the permit required only monitoring of the final effluent. The facility reported numerous monitoring frequency violations during this period and at times failed to submit the required Monthly Operating Reports (MORs). From April 2004 through September 2004, five monitoring frequency violations were reported.

Numeric violations of NPDES permit limits were evaluated from 2003 to 2004. Numeric violations, reported through SWIMS from September 2003 through June 2004 revealed a total of 55 for Bridgewood MHP. For the data evaluated, constituents violating permit limits were mostly conventional wastewater components and included ammonia-N and TSS, reported with the greatest frequency. No seasonal patterns for the violations were detected.

Harmony Estates MHP (Moore Enterprises) – tributary (RM 0.16) to Beaver Creek (RM 6.10)
Permit #: 1PV00007
Lat.: $39^0$55'35.6", Long.: $83^0$40'06.4"

Harmony Estates is at 1136 Big Hill Road, South Charleston. The wastewater treatment plant consist of a bar screen, aeration tank, clarifier, dosing chamber, slow surface sand filters, ultraviolet disinfection, and post aeration. The wastewater treatment plant is designed to serve an average hydraulic flow of 50,000 gpd. In 1997, an expansion of the facility was proposed due to increased hydraulic loading of the plant. The limited assimilative capacity of the receiving stream (Beaver Creek) prompted Ohio EPA to recommend that I/I be addressed prior to the expansion. The Harmony Estates NPDES permit contains a Schedule of Compliance, which required a study to identify and eliminate/reduce sources of I/I. Harmony Estates has failed to comply with the Schedule of Compliance with regards to the I/I study.

Complaint calls to the Ohio EPA Spill Hotline of sewage emanating from the ground around mobile homes has been reported over the years. Most complaints were related to sand filter

problems during 2002-2004. Repeated difficulty with sand filters not being maintained and routinely alternated, resulted in them being clogged, holding water, and spilling over the containment walls.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 100 for Harmony Estates MHP, most occurring in 2000 and 2002. For the data evaluated, constituents violating permit limits were mostly conventional wastewater components and included fecal coliform bacteria, ammonia-N (NH3-N) and TSS. The most frequent parameters in the violations during the past three years were TSS and ammonia-N, reported with the greatest frequency. Violation events never occurred in October for any years.

Tomorrow's Stars RV Resorts (All Seasons Resorts, Hidden Oaks Campground) - Beaver Creek (RM 5.70)
Permit #: 1PX00043
Lat.: $39^0$55'30.4", Long.: $83^0$40'35"

Tomorrow's Stars RV Resorts is in Clark County at 6716 East National Rd in South Charleston. Treatment consists of two equalization tanks, four aeration chambers, two clarifiers, two fixed media clarifiers, dosing chamber, two slow surface sand filters, chlorination/dechlorination tank and a sludge holding tank. The discharge pipe (001) is located along East National Road which flows through a PVC tile underneath the road to the Beaver Creek. This treatment system was designed for an average hydraulic flow of 18,400 gpd. Ohio EPA issued a NPDES permit to the Tomorrow's Stars RV Resorts in March 2004.

Two Ohio EPA inspections of the treatment works revealed unacceptable conditions for this facility. An inspection in 2003 documented a grayish-black effluent with black solids and sewage fungus noted at the discharge point. An inspection in 2004 noted pin-floc flowing over a clarifier weir, and a second clarifier with large amounts of solids.

Recent improvements to the treatment works consist of upgrades to various pumps, return lines and valves. Repairs were also conducted at the lift station (one of two pumps was not operable) and a curtilaged area was installed around the treatment system. Owners of the resort have also been recently ordered to locate the plans that would address the discharge points for the swimming pool discharge and backwash from the drinking water wells.

Numeric violations of NPDES permit limits were evaluated through August of 2004. NPDES violations, reported through SWIMS, revealed a total of 18 for Tomorrow's Stars RV Resorts. For the data evaluated, constituents violating permit limits were mostly conventional wastewater components and included dissolved oxygen and ammonia-N (NH3-N). Dissolved oxygen was reported with the greatest frequency. Violations occurred in mid-spring and summer only in 2004.

Beaver Valley Resort (VIP World Resorts, Inc.) - Beaver Creek (RM 5.35)
Permit #: 1PX00042
Lat.: $39^0$55'24.1"; Long: $83^0$40'56.7"

Beaver Valley Resort is in Clark County at 6725 East National Road in South Charleston. The treatment works consist of a trash trap, lift station, aeration tanks, and clarifier. Ohio EPA issued an NPDES permit to the Beaver Valley Resort in 2004 that requires upgrades to the existing wastewater treatment plant to be completed by March 2006.

An Ohio EPA inspection in 2004 indicated minor problems at the treatment facility. The lift station had only one of two pumps operational and new lines were needed for the diffuser. In May 2004, the air diffuser lines and return lines were replaced in the aeration tanks. In August 2004, an air diffuser was added to the discharge channel to increase the oxygen level and mix the chlorine for better disinfection. Phase I facility upgrades will address a sludge holding tank, surface sand filters, and chlorination/dechlorination tank with post aeration. Phase II of the facility upgrade is planned and will address an equalization basin and aeration tank/clarifier replacement.

Numerical violations of NPDES permit limits were evaluated from August of 2004. NPDES violations, reported through SWIMS, revealed a total of 31 for Beaver Valley Resorts. For the data evaluated, constituents violating permit limits were mostly conventional wastewater components and included dissolved oxygen and chlorine reported with the greatest frequency.

Brookside Village MHP-(JGR Properties, Inc) - Unnamed tributary of Sinking Creek (RM 4.70)
Permit #: 1PV00097
Lat.: $39^0$56'48.3"; Long.: $83^0$40'45.4"

Brookside Village Mobile Home Park is in Clark County at 1962 Mahar Rd, South Vienna. Current treatment consists of a trash trap, lift station, aeration tank, rectangular clarifier, tertiary lagoon system, and chlorination/dechlorination tank with post aeration. On August 26, 1999, Ohio EPA recommended enforcement action against Brookside Village MHP for failure to comply with the terms and conditions of their NPDES permit and violations of Chapter 6111 of the Ohio Administrative Code. The enforcement action is pending at the State of Ohio Attorney General's Office.

As a result of the enforcement action, Brookside Village MHP did obtain a Permit-to-Install (No. 05-11477) on June 1, 2001 for a partial upgrade to the existing wastewater treatment plant. Upgrades consist of a chlorination/dechlorination tank with post aeration and flow monitoring. Additional upgrades necessary to bring the wastewater treatment into compliance include (but are not limited to) an equalization basin, sludge holding tank, and surface sand filters. The wastewater treatment plant is designed to serve an average hydraulic flow of 40,000 gpd.

Ohio EPA files from 2003 indicated receiving facility correspondence relating to debris clogging the lagoon overflow pipe and causing the lagoon to rise, bypass dechlorination, and overrun the banks. In 2004, the tertiary lagoon was documented at capacity during an inspection.

An Ohio EPA inspection in 2004 recorded grayish/white sewage fungus observed on the sides of the chlorine contact tank and the dechlorination tank. The final effluent was whitish in color and opaque. Grey sewage fungus covered the receiving stream bottom for approximately 50 feet downstream from the outfall and had an associated sewage odor. Sewage fungus has been documented in the receiving stream, downstream from this outfall since 1997. Sewage fungus downstream from wastewater treatment plants is typically due to high organic levels in streams that allows for rapid sewage fungus colonization.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 93 for Brookside MHP. For the data evaluated, constituents violating permit limits were mostly conventional wastewater components and included dissolved oxygen, $cBOD_5$ and ammonia-N (NH3-N) reported with the greatest frequency. No seasonal patterns were observed, although the majority of years showed minimal to no violations in the spring.

Northeastern High School - field tile to Sinking Creek (RM 4.59)
Permit #: 1PT00033
Lat.: $39^0$56'50", Long.: $83^0$40'53.9"

Northeastern High School is in Clark County at 1480 Bowman Rd, Springfield. Northeastern's treatment system consists of a lift station/settling tank, aeration tank, clarifier, and chlorine contact tank. This treatment system was installed in 1968. Ohio EPA issued a NPDES permit to Northeastern in July 2003. This permit requires upgrades to the existing system to be completed by July 1, 2006.

On April 26, 2004, Ohio EPA issued a Permit-to-Install (PTI No. 05-13071) for upgrades to the existing wastewater treatment plant. The PTI is for installation of a new wastewater treatment plant that will consists of flow equalization tank, aeration tank, clarifier tank, tertiary dosing, slow surface sand filters, chlorination/dechlorination tank with post aeration, and a sludge holding tank. The new wastewater treatment plant is designed for an average hydraulic flow of 10,000 gpd. The existing wastewater treatment plant will be abandoned after the new plant is operational.

An Ohio EPA inspection in 2004 found the treatment plant severely corroded and in disrepair. Upon arrival for the inspection, Ohio EPA field personnel found the entry gate to the treatment area not secured. There was no sludge holding tank, the chlorinator had rusted away and a broken airline in the aeration tank eliminated aeration capabilities.

Numeric violations of NPDES permit limits were evaluated from 2003 to 2004 due to this facility receiving a NPDES permit in July of 2003. NPDES violations, reported through SWIMS, revealed a total of four for Northeastern High School (limited samples were taken as noted above). For the data evaluated, fecal coliform bacteria violated permit limits. Ohio EPA files for Northeastern High School document the submittal failure of MORs in a timely manner in 2003 and 2004. Monitoring frequency violations were also noted due to the failure to obtain effluent samples from 2003 until March of 2004.

Catawba WWTP - Unnamed Tributary (RM 2.70) to East Fork Buck Creek (RM 1.00)
Permit #: 1PA00020
Lat.: $39^0$59'21.4"; Long: $83^0$38'24.3"

The Catawba WWTP is in Clark County on Runyon Short Road in Catawba. The treatment facility was constructed in 1987 utilizing a three-cell controlled discharge lagoon. Design capacity is 0.0225 MGD. Effluent flows through a controlled lagoon system that discharges approximately 3-5 days per month, for about seven months out of the year. Outfall 001 discharges to an unnamed tributary of East Fork Buck Creek near Runyon Short Road. The entire service area is sewered, serving around 386 people. There have been no facility modifications since 1987.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 15 for the Catawba WWTP. For the data evaluated, constituents violating permit limits were mostly conventional wastewater components and included dissolved oxygen and TSS reported with the greatest frequency.

Cascade Corporation-Unnamed tributary of "Mill Run" (local name) under Sheridan Ave. to Buck Creek (RM 3.37)
Permit #-1IS00020
Lat.: 39^0 54' 35.2", Long.: 83^0 46' 27.1"- Outfall 001
Lat.: 39^0 54' 35.3", Long.: 83^0 46' 27.3"- Outfall 002

Cascade Corporation is in Clark County at 2501 Sheridan Avenue, Springfield. Cascade manufactures forklift truck attachments. Discharges consist of stormwater (outfall 001) and a discharge associated with groundwater remediation activities.

In approximately 1996, remediation of contaminated groundwater containing chromium, hexavalent chromium, and Volatile Organic Compounds (VOCs) was initiated. Treatment consisted of a chromium treatment system and an air stripping system. Lime Settling Tanks were added to the treatment process in 2001 and 2003 because the air stripper causes the calcium in the groundwater to precipitate and coat the bottom of the receiving stream. Although the quality has improved from previous years, deposition in the stream was still documented during an inspection in 2004.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004 and reported for outfall 001. NPDES violations reported through SWIMS, revealed a total of 36 for Cascade Corporation. For the data evaluated, constituents violating permit limits included TSS and pH reported with the greatest frequency. Winter months showed the fewest violations. The installation of the second of two Lime Tanks occurred in 2003. This resulted in a dramatic reduction in NPDES violations in 2004. Only one violation of pH occurred through August 2004.

BP Oil No. 09771 - storm sewer to Buck Creek
Permit # -1GU00197
Lat.: $39^0$55'45", Long.: $83^0$51'00"

BP Oil No. 09771 is located in Clark County at 2112 W. Main St, Springfield. This facility is approved for coverage under the Ohio EPA General Permit for Petroleum Related Corrective Actions due to groundwater contamination at the site.

BP Oil is situated on less than an acre of property. In response to groundwater contamination of petroleum products, a mobile treatment system consisting of an oil/water separator tank, transfer tank, and particulate filters followed by activated carbon filtration was moved to the site. The pump and treat system has a design flow of 0.0014 MGD and sampling of the effluent is performed one time per month during discharge.

O.S. Kelly Company Metallurgical Products - Buck Creek (RM 3.22)
Permit #: 1IS00023
Lat.: 39°55' 40", Long.: 83°48' 19" - Outfall 001
Lat.: 39°55' 40.4", Long.: 83°48'14.6" – Outfall 002

O.S. Kelly Company is in Clark County at 318 E. North St. in Springfield. O.S. Kelly is a foundry operation that produces gray and ductile iron castings for piano plates. The company produces 1500 upright plates per year and 2400 grand plates per year. There are approximately 32 personnel on three shifts. Recently, O.S. Kelly Company had been directed by Ohio EPA to develop and implement a stormwater pollution prevention plan.

Outfall 001 is an intermittent discharge of noncontact cooling water for hydraulics used in processes. Discharge occurs every five weeks for approximately five hours, which generates approximately 450 gpd. A water/glycol mix previously was reported on MORs for outfall 001, but is currently collected in a holding tank for reuse or hauled off-site for disposal. Outfall 001 historically discharged into a trench drain at the loading area. During an inspection in 2003, the entire loading dock area was blanketed with gray and black foundry sand. This was later observed in the trench drain which discharges directly to Buck Creek. The O.S Kelly Co. was instructed by Ohio EPA to prevent sand from entering the storm drain.

During 2004, outfall 001 was eliminated and the noncontact cooling water from 001 was re-routed to discharge through 002. This is the result of the installation of a total recycling cooling system.

Outfall 002 consists of noncontact cooling water where water additives are not used. The compressors, which generate 60,000 gpd, discharge to a catch basin, which then discharges to Buck Creek.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004 for outfall of 002. NPDES violations, reported through SWIMS, revealed a total of five for O.S. Kelly Company. Four of those violations occurred through August of 2004. For the data evaluated, constituents violating permit limits were TSS and pH reported with the greatest frequency. Seasonal patterns demonstrated violations occurring in the summer and winter months only.

Spills, Overflows and Unauthorized Releases

Pollutant discharges from spills, overflows, permit violations and other unauthorized releases can be significant sources of lethal and sublethal stresses to the aquatic communities in the Mad River watershed.

City of Springfield combined sewer overflows (CSOs) are a significant source of pollutants in the 05080001170 WAU. Stormwater containing raw sewage, bacteria, urban runoff, and other contaminants is discharged into Buck Creek, Mill Run and Indian Run when the sewer system capacity is exceeded. Overflow events can occur with as little as 0.25 inches of rain falling in the watershed if the ground is already saturated by precipitation. Table 14 documents the CSO locations, estimated average CSO events per year and volumes of flow from the CSOs. Camp, Dresser & McKee, a consultant for the City of Springfield, prepared this information. The estimates are based upon historical information, rainfall estimates and current abatement technologies undertaken by the city. It is estimated that 1.06-1.44 billon gallons of sewage is discharged throughout the sixty CSO structures in Springfield. Combined Sewer Overflow #1 alone can discharge between 0.5-0.75 billion gallons annually to the Mad River at RM 25.34. The remaining CSOs discharge to Buck Creek and its tributaries.

Spill reports from Ohio EPA Emergency Response documented twenty two wastewater spills from 1998 to 2003 discharged from Harmony Estates MHP into Beaver Creek.

Table 14 Combined Sewer Overflow Locations with Calibrated Model Estimates of Annual Overflows[1]

CSO ID	Discharge To:	Approximate location *(Industrial discharger)*	Overflows per year	Annual overflow Volume range (MG/yr)
Buck Creek Central				
003	Buck Creek	Main St. & Buck Creek	30-38	10-14
004	Buck Creek	Avenue B. & Harshman Rd.	32-45	6-8
005	Buck Creek	Snyder St. & Overlook Dr.	15-23	2-3
006	Buck Creek	Bechtle Ave. & Kinsman Ave. *(Rawac Plating Co.-69,222 gal/day)*	18-25	4-6
010	Buck Creek	Shaffer St. in Snyder Park	4-5	0.1-0.1
011	Buck Creek	DT&I Railroad in Snyder Park	14-20	2-2
013	Buck Creek	S. Of Buck Creek, E. of Plum St.	25-33	9-12
017	Buck Creek	Rockway St. At Buck Creek	24-31	2-3
018	Buck Creek	Rockway St.	0-0	0-0
023	Buck Creek	S. of Buck Ck., W. of Water St.	30-31	5-6
024	Buck Creek	Water St. Bridge, S .of Buck Ck.	17-17	018
070	Buck Creek	Rockway St. Tunnel	8-9	7-9
027	Buck Creek	Front St. at Chestnut St.	3-4	0-0.1
028	Buck Creek	Front St. S. of Sherman Ave., N. of Buck Creek	4-5	0.3-0.4
030	State Ditch	Northern Ave. & Cedarview Dr.	1-1	0.1-0.1
031	State Ditch	Northern Ave. & E. of Cedarview Dr.	24-34	11-14
036	Buck Creek	Lagonda Ave., N. of Buck Ck	24-34	3-5
069	Buck Creek	Water Front &Warder St.	5-7	0.2-0.2
Buck Creek Northwest				
007	Buck Creek	Klobdenz Ave.	18-25	2-3
012	Buck Creek	McCreight Ave. & Yellow Springs St.	12-16	11-15
014	Buck Creek	E. of Plum St., N. of Buck Ck (in Cliff Park)	48-50	8-10
015	Buck Creek	Ward St., E. of Plum St.	4-5	1-2
019	Buck Creek	Fountain Ave. & Ferncliff Pl.	13-19	4-5
020	Buck Creek	Fountain Ave. & Warder St. *(Mercy Medical Center-101,441 gal/day)*	12-18	5-6
021	Buck Creek	Warder St. West of Limestone St.	51-54	9-12

Table 14 Continued.

CSO ID	Discharge To:	Approximate location *(Industrial discharger)*	Overflows per year	Annual overflow Volume range (MG/yr)
Buck Creek Northwest (continued)				
022	Buck Creek	Limestone St. & Warder St.	6-8	3-4
062	Ditch to Buck Creek	Malden Ave & Shelby Dr.	19-27	23-31
Buck Creek East				
025	Buck Creek	E. of Water St. Bridge @ Spencer St. *(Springfield Uniform Launday-69,616 gal/day)*	43-57	13-18
026	Buck Creek	Warder St.,W. of Power St.	35-46	14-19
029	Buck Creek	Sherman Ave. Bridge, E. of Buck Ck. *(Metaltek-11,728 gal/day)*	16-23	5-7
032	Buck Creek	Park Ave., S. of Buck Ck.	10-15	1.1-1.5
033	Buck Creek	E. of Park Ave @ James St., S.of Buck Ck	11-16	1.0-1.3
034	Buck Creek	W. of Belmont Ave @ Henry St.	22-31	10-14
035	Buck Creek	W. of Belmont Ave Bridge, S. of Buck Ck BOD Load (3,900-5,400 Lbs/yr)	37-45	21-29
037	Buck Creek	CCC & St. Louis Bridge. W. of Burnett	19-22	0.8-1.1
038	Open Channel #150 to Buck Ck East	Burnette Rd. at DT&I Railroad *(A&E Powdercoating- 273 gal/day)*	12-16	4-6
039	Ditch to Buck Creek	Main St. at DT&I Railroad *(Community Hospital-85,221 gal/day)*	20-26	19-26
068	Buck Creek	Levee & Watne Ave.	13-17	1-2
Mill Creek				
059	Mill Creek	W. of Sturgeon St. , S. of City Limits	23-31	12-17
082	Mill Creek	Behind 232 W. Auburn Ave.	9-13	3-4
Indian Run (enclosed in tunnel)				
002	Ditch to wetland near Ohio Edison to Mad River	Sigler St. & Pleasant St. *(Moyno, Inc.- 138,731 gal/day)*	17-25	4-6
008	Indian Run to Buck Creek ***sanitary eliminated* 2003?**	Main St. & Bell Ave. BOD Load (6,000-8,200 Lbs/yr) TSS Load (54,200-73,300 lbs/yr)	17-25	38-51

Table 14 Continued.

CSO ID	Discharge To:	Approximate location	Overflows per year	Annual overflow Volume range (MG/yr)
Mill Run				
040	Buck Creek	Penn & Section St.	83-90	89-121
041	Mill Run	East St. at DT&I Railroad TSS Load (43,600-59,000 lbs/yr) *(Olan Mills-29,074 gal/day)*	26-35	30-41
042	Mill Run	East St. at Harrison St. BOD Load (4,100-5,600 Lbs/yr) TSS Load (51,400-69,500 lbs/yr)	26-33	35-48
043	Mill Run	East St. & Harrison St.	39-51	2-3
044	Mill Run	East of East St., South of Harrison St.	24-31	9-12
045	Mill Run	Pine St.and CCC & St. Louis Railroad	5-6	0.3-0.3
046	Mill Run	LayfayetteSt and CCC & St. Louis Railroad	9-10	0.4-0.5
047	Mill Run	Burt St. & Railroad, South of Mill Run *(Fuel Systems LLC-27,477 gal/day)*	19-25	2.4-3.3
050	Mill Run	Burt St. & Railroad, North of Mill Run	16-21	2-3
053	Mill Run	Belmont Ave.& Kenton Ave.	11-17	4-6
055	Mill Run	Sheridan Ave, & Belmont Ave *(Springfield Metal Finishing-1,122 gal/day)*	32-41	12-16
056	Mill Run	Douglass Ave. Extension at Mill Run	26-34	17-23
057a	Mill Run	Douglass Ave. Extension at Mill Run	6-8	2-2
057b	Mill Run	Douglass Ave. Extension at Mill Run *(Cascade Corporation-5,132 gal/day)*	45-47	6-8
067	Mill Run	York St. At Mill Run	7-9	0.2-0.3
001	Mad River (RM 25.34)	WWTP outfall (system relief) BOD Load (261,600-362,300 Lbs/yr) TSS Load (886,800-1,201,900 lbs/yr)	79-83	573-775
040	Buck Creek	Penn & Section St. (Lions Cage) BOD Load (31,500-41,700 Lbs/yr) TSS Load (136,000-183,700) lbs/yr)	83-90	89-121
038	Open Channel #150 to Buck Ck East	Burnette Rd. at DT&I Railroad	12-16	4-6

[1]From City of Springfield CSO Long-Term Control Plan
Camp Dresser & McKee April 30, 2004

Mad River (downstream Chapman Creek to upstream Mud Creek)
Watershed Assessment Unit (WAU 05080001 180)

This watershed assessment unit, encompassing 81,928 acres (128 mi^2) in Champaign and Clark counties, includes the Mad River mainstem downstream from Chapman Creek (RM 32.58) to the confluence of Donnels Creek (RM 18.38) and tributaries of the mainstem downstream from Chapman Creek to upstream from the Mud Creek confluence (RM 10.54). (Watershed Assessment Unit 05080001 003 exclusively covers the Mad River mainstem from the Donnels Creek confluence to the mouth.) Tributaries of the mainstem in the assessment unit include Moore Run (drainage area 18.3 mi^2, confluence RM 30.75), Pondy Creek (drainage area 6.8 mi^2, confluence RM 28.67), Mill Creek (drainage area 15.5 mi^2, confluence RM 25.30), Rock Run (drainage area 9.1 mi^2, confluence RM 24.12), Donnels Creek (drainage area 26.4 mi^2, confluence RM 18.38), and Jackson Creek (drainage area 9.56 mi^2, confluence RM 17.04).

Similar to other assessment units in the upper part of the Mad River watershed, predominant land uses (Figure 36) include row crop agriculture (54.4%), pasture/hay (20.4%) and deciduous forest (8.5%) (University of Cincinnati, 2001). Populations (provided in parentheses) of the numerous communities in the watershed per the 2000 census include the Villages of North Hampton (370), Lawrenceville (302), and Donnelsville (293), and the unincorporated Census Defined Place (CDP) of Crystal Lakes (1411). Additionally, the assessment area encompasses portions of the City of Springfield, the Village of Enon (2638), Park Layne CDP (4519), Green Meadows CDP (2318), and the majority of Northridge CDP (6853). The communities of Lawrenceville and Donnelsville were unsewered during the 2003 survey. In September 2004, Ohio EPA received revisions to a permit to install (PTI) application for sanitary sewer extensions to connect the Village of Donnelsville, Tecumseh Local School District, and the Gifford Apartment Complex (WAU 05080001 190) to the Clark County Southwest Regional sewerage collection system.

There are many dischargers in the assessment unit. The City of Springfield WWTP and the Enon Municipal Water Treatment Plant (WTP) discharge to the Mad River mainstem at RM 25.34 and RM 19.62, respectively. Moore Run receives the wastewater discharge from Harvest Square MHP (RM 4.46), Rolling Hills MHP (discharge at RM 0.61 to a tributary entering at RM 4.32), International Truck and Engine Corporation (process water discharge at RM 0.1 and storm and noncontact cooling water at RM 0.2 to a tributary entering at RM 3.26), and KTK Industrial Park (RM 2.17). Additionally, Sunset Terrace MHP currently discharges wastewater to dry wells in the Moore Run watershed. Sunset Terrace has submitted a Permit to Install (PTI) for upgrades to the wastewater treatment plant which would eliminate this discharge to groundwater and establish a point source discharge to Moore Run. In the Pondy Creek watershed, Country Air MHP discharges to a drainage ravine entering a tributary (RM 0.71) which subsequently enters Pondy Creek at RM 2.37, and Fink Meats discharges at RM 1.5 to a tributary entering Pondy Creek at RM 0.3.

Springfield Beckley Municipal Airport, the Ohio Air National Guard (178th Fighter Wing), BP Oil, and Competition Accessories all discharged in the Mill Creek watershed during the 2003 survey. Springfield-Beckley Municipal Airport discharges wastewater to Mill Creek at RM 5.32

(Outfall 001) and stormwater at RMs 5.38, 5.48, 5.60, and 5.77 (Outfalls 002 through 005, respectively). Two additional stormwater outfalls discharge to a tributary of Mud Run in the Lower Mad River Tributaries watershed assessment unit 05080001 190. The Ohio Air National Guard discharges stormwater through two outfalls to a drainage tributary which enters Mill Creek at RM 5.00. An additional stormwater outfall discharges at RM 4.41 to a tributary entering Mud Run at RM 9.8 in WAU 05080001 190. During the spring of 2003, stormwater runoff from Buckeye Resources, a mulch processing and storage operation, impacted an unnamed tributary entering Mill Creek near RM 3.18 downstream from Springfield-Xenia Road. Stormwater containment and storage facilities were installed and completed in the summer of 2004. BP Oil (Site #09760) discharges treated groundwater at RM 1.14 to a tributary entering a tributary at RM 1.17 which then enters Mill Creek at RM 0.6. Competition Accessories discharged at RM 1.15 just upstream from BP Oil. This unpermitted discharge was eliminated and wastewater was tied in to the City of Springfield WWTP in March 2004.

Rockway Elementary School discharges to Rock Run at RM 0.40. Miller Creek, a tributary of Rock Run (confluence RM 1.58), receives the discharge from Greenlawn Village Condo (RM 1.63), Westwind Properties L.L.C. (discharge at RM 0.07 to a tributary which enters at RM 1.55), and Rolling Terrace MHP (RM 1.03).

The Village of North Hampton WTP discharged to Donnels Creek at RM 10.1 during the 2003 survey. Subsequent to the survey, backwash from the system was connected to the Village's centralized sewerage collection system and ultimately to the Village of New Carlisle WWTP in the Great Miami River basin. BP Oil (Ison Residence) discharges treated groundwater (petroleum corrective actions) to Donnels Creek at RM 3.54. The East Fork Donnels Creek (confluence RM 3.78) receives the discharge from Northwestern High School (discharge at RM 0.69 to a tributary entering at RM 7.22) and Chateau Estates MHP (RM 6.55). These latter two facilities will be tied in to the Village of North Hampton and taken off-line by December 2005.

Tecumseh High School discharges via a drainageway which ultimately enters Jackson Creek at RM 1.96. Pleasant Valley MHP discharges at RM 5.60 to Warden Ditch which enters Smith Ditch at RM 1.24 which then enters the Mad River at RM 12.28.

Numerous entities discharge to unnamed tributaries of the Mad River mainstem. Moyno Incorporated discharges noncontact cooling water via subsurface storm sewers to a tributary of the Mad River in Springfield. Clearview MHP discharges at RM 0.14 to a tributary entering the mainstem at approximately RM 24.98 while Boone Station discharges at RM 0.39 to a tributary which enters the Mad River near RM 23.2. Tecumseh Court MHP discharges at RM 1.39 to a tributary entering the Mad at RM 21.93. Edgewood MHP discharges to a small drainageway which flows approximately 0.35 miles before it infiltrates into the ground, ending prior to reaching the mainstem (near RM 22.8). Similarly, Enon Heights MHP discharges to a drainage tributary which flows 0.4 miles before infiltrating into the ground in a field adjacent to the Mad River. During very high flows this discharge could potentially reach the Mad River near RM 21.1.

Additionally, two of the City of Springfield's CSOs (#059 and #082) are located on a tributary to Mill Creek. The treatment plant's influent bypass (CSO #001) discharges to the Mad River through the plant's outfall at RM 25.34 and is largest contributor of overflow volume and pollutant load of all of the City's CSO discharges.

Aquatic Life Uses

Biological and habitat assessments were conducted at 21 sites in 2003. Seventeen locations were on tributaries of the Mad River with drainage areas of 2.6mi^2 to 25.6 mi^2. The remaining four sites were on the Mad River. Aquatic life attainment status for the sampled sites is presented in Table 15.

The Mad River from the headwaters to the confluence of Buck Creek is designated Coldwater Habitat. This aquatic life use is the result of extensive hydromodification that has occurred to facilitate agricultural activities in the adjacent lands. Channel modifications began as early as 1915 (Trautman 1981) that penetrated deposits of permeable glacial drift and outwash. These deposits hold and discharge great quantities of cool groundwater, augmenting stream flow and mediating annual temperatures of the mainstem and several tributaries. These activities completely modified the stream, creating a straight artificial ditch, with limited riffle and pool habitat, and hemmed in by levees derived from the dredge spoils. Though some recovery has occurred, macrohabitats are still greatly simplified. Sampling sites at RM 29.6 and 27.0 are within the CWH reach on the Mad River.

The Mad River downstream from Buck Creek (RM 26.15), Moore Run and Kenton Creek are designated as WWH streams based on previous biological surveys. The remaining tributary streams evaluated in this assessment unit were originally designated for aquatic life use in the 1978 and 1985 Ohio WQS. The current biological assessment methods and numerical criteria did not exist then. This study, as an objective and robust use evaluation, is precedent setting in comparison to the 1978 and 1985 designations. Several sub-basin streams were evaluated for the first time using a standardized biological approach as part of this study.

All the sampled tributaries in the assessment unit are designated or recommended for the WWH aquatic life use. Twelve sites were in full attainment of the WWH use. Four sites supported biological communities that partially attained ecoregional expectations. Nonattainment was documented at one tributary sampling location. On the mainstem, 10.3 miles of full attainment and 3.9 miles of partial attainment were documented for the reach below the 500mi^2 drainage area delineation (See WAU 0508001 003). The WAU overall attainment score was 66.5 (Table 1).

Table 15 Aquatic life use attainment status of the Mad River from below Chapman Creek to above Mud Creek watershed assessment unit, June- October, 2003. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb) and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate (ICI) communities. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

Stream River Mile Invertebrate/Fish	Attainment Status	IBI	MIwb	ICI/ narrative	QHEI	Drainage Area
WAU: 5080001 180						
Mad River				*CWH*		
29.6/29.6	Full	44		54	73.5	310
27.0/27.0	Full	46		G	79	323
				WWH		
25.5/25.8	Partial	35*	8.7	42	84.5	464
24.1/24.1	Full	38^{ns}	9	G	75	490
Moore Run				*WWH*		
4.1/4.1	NON	28*		F*	28.5	6.6
2.5/2.5	Partial	38^{ns}		F*	49.5	9.3
0.8/0.8	Full	46		MG^{ns}	65	18.2
Kenton Creek				*WWH*		
0.3/0.7	Partial	48		F*	67.5	4.8
Pondy Creek				*CWH existing/ WWH recommended*		
1.1/1.1	Partial	32*		MG^{ns}	47.5	5.5
Dry Run				*CWH existing/ WWH recommended*		
0.3/0.3	Full	38^{ns}		G	48.5	2.7
Mill Creek				*WWH (verified)*		
3.2/3.2	Full	46		VG	83	5.1
0.1/0.1	Full	52		MG^{ns}	70.5	15.3
Rock Run				*WWH (verified)*		
0.1/0.1	Full	46		VG	74	9.1
Miller Creek				*WWH (verified)*		
0.1/0.1	Full	40		VG	75	2.6
Donnels Creek				*EWH existing/ WWH recommended*		
7.5/7.5	Full	48		VG	81.5	11.2
3.7/3.7	Full	44	8.2^{ns}	VG	73	23.1
1.9/1.9	Partial	40	7.7*	VG	62.5	25.6
East Fork Donnels Creek				*WWH (verified)*		
2.9/2.9	Full	46		MG^{ns}	84	5.5
0.1/0.1	Full	52		E	77.5	9.1
Jackson Creek				*EWH existing/ WWH recommended*		
3.8/3.8	Full	48		VG	61.5	5
0.9/0.9	Full	56		MG^{ns}	52	8.7

Table 15 continued.

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

INDEX - Site Type	LRW	MWH channel modified	CWH	WWH	EWH
IBI Headwater - Wading/ Boat	18/18	24/24	40	40/ 42	50
MIwb Wading/ Boat	4.0/4.0	6.2/5.8	-/6.6	8.3/ 8.5	9.4/ 9.6
ICI	8	22	36	36	46

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns Nonsignificant departure from biocriterion (<4 IBI or ICI units; <0.5 MIwb units).
a Narrative evaluation used in lieu of ICI (E=Exceptional; G=Good; MG=Marginally Good; F=Fair; P=Poor).
b Use attainment status based on one organism group is parenthetically expressed.
N/A Not Applicable. The MIwb is not applicable to headwater sites.

The reach of the Mad River from Chapman Creek (RM 32.6) to Buck Creek (RM 26.15) supported fish and macroinvertebrate communities that were consistent with the designated CWH use. The fish community continued to differ from WWH expectations in that diversity of round-bodied suckers and proportion of top carnivores were limited, but a relatively diverse assemblage of sensitive species was present. Good to exceptional macroinvertebrate communities were recorded within this reach at RMs 29.6 and 27.0. The Mad River at RM 27.0 possessed a number of beneficial habitat attributes and supported an improved fish assemblage compared to the RM 29.6 site.

The first sampled location downstream from Buck Creek (RM 25.8) produced an IBI score in the fair range; however, macroinvertebrate results from RM 25.5 were in the good range. One factor that tended to depress the IBI scoring on the mainstem was an abundance of white suckers. Their presence likely was a continuation of the community structure that typified the CWH portion of the Mad River. There did not appear to be any obvious impact due to inputs from Buck Creek or the surrounding urban area. It is noteworthy, however, that this site is apparently subject to variations in water quality due to urban runoff as evidenced by a 10°C difference in temperature recorded with 24 hr monitoring equipment between July 22-24 in the Mad River at RM 25.57 following a rain event.

Pondy Creek and Dry Run are two streams for which a WWH aquatic life use is appropriate rather than the current CWH use. Neither stream supported the requisite minimum of 4 coldwater macroinvertebrate taxa.

Jackson Creek and Donnels Creek are currently designated as Exceptional Warmwater Habitat streams. However, neither stream supported exceptional communities of both organism groups that would warrant this use. Biological index scores ranged relatively widely from fair (MIwb= 7.7 for Donnels Creek at RM 1.9) to exceptional, IBI = 56 for Jackson Creek at RM 0.9). Habitat conditions of the two streams, while not severely disrupted also varied and, in places, lacked the variety of beneficial attributes and morphologic features associated with EWH streams. Biological sampling results were more reflective of a Warmwater Habitat aquatic life

use. This recommendation should not be taken as a downgrading of the EWH use that was based on unverified designations in the 1978 and 1985 Water Quality Standards. Rather, this is the first time these streams have been evaluated using biological and habitat data.

Mill Creek, Rock Run, Miller Creek and East Fork of Donnels Creek were listed as WWH streams in the 1978 and 1985 water quality standards, but, prior to this most recent survey, the aquatic life use had not been verified. The 2003 biological and habitat results were consistent with and support the WWH designation.

Moore Run at RM 4.1 was the only site in the assessment unit with both impacted fish (IBI=28) and macroinvertebrate (fair) communities that resulted in nonattainment of the WWH use. The site was in a severely habitat limited reach (QHEI = 28.5). Thick silt substrates predominated except for a portion of the stream underlain with concrete. Biological condition progressively improved at the two additional downstream sampling locations on Moore Run which had moderately improved habitat and additional flow volume. The site at RM 2.5 had a silty muck substrate and thick growths of aquatic macrophytes. EPA personnel noted a petroleum odor and an oily sheen on the water surface. The fish community marginally met ecoregional expectations but the macroinvertebrate community remained in fair condition. Low dissolved oxygen readings and significant sediment contamination was documented in this reach of Moore Run. Stormwater and process discharges at the International Truck and Engine facility upstream are possible pollutant sources at this site. Permit adequacy and compliance should be investigated along with a review of operational procedures at the facility to limit water quality impacts.

None of the remaining sites appeared to be severely impaired but three other tributary sites only partially attained the WWH aquatic life use. Sampling of Kenton Creek at RM 0.3 yielded a very good fish assemblage. The eighteen fish species collected from a stream with less than 5mi^2 drainage area was an indication that macrohabitat and water quality conditions were more than sufficient for maintaining the WWH aquatic life use. In contrast, the macroinvertebrate community was predominated by isopods and blackflies. Abnormally high precipitation and resultant flows that scoured and redistributed the rocky substrate negatively affected the macroinvertebrate community. Blackflies are tolerant of organic pollution but their abundance was likely a case of a pioneering species with a short life cycle taking advantage of newly available living space. Pondy Creek at RM 1.1 supported a low density and diversity of macroinvertebrate taxa that marginally attained WWH expectations and a fair condition fish assemblage. This was a small, shallow, channelized stream. It appeared that the flow would naturally be absorbed into the underlying gravel as groundwater level receded if not replenished by rain events. Donnels Creek at RM 1.9 supported a very good macroinvertebrate community and fish sampling produced an IBI that met the WWH aquatic life use. The MIwb score was only in the fair range. The lower than expected MIwb appeared related to natural conditions in that flow was declining compared with conditions upstream as water was absorbed into the underlying glacial till.

The majority of tributary streams in the assessment unit, except as noted above, were in relatively good condition both in terms of habitat quality and biological performance. It should be noted that the small streams in the area were not affected by flow alteration due to tiling of adjacent agricultural fields to the extent that has occurred in other areas of Ohio.

Recreational Uses

As observed throughout the entire Mad River study area and primarily due to the excessive flows, the PCR use designation was not attained in this assessment unit (Table 27, Figure 9 and Figure 10, Appendix Table A-2). Median concentrations were generally higher in the four tributaries sampled compared to the three mainstem sites with the highest medians measured in Donnels Creek (RM 3.70) and Jackson Creek (RM 0.90).

Chemical Water Quality

Inorganic water chemistry grab samples and field measurements were collected at 21 sites in this assessment unit at two-week intervals (six times) from mid-July to late September (Table 25) and analyzed for a variety of parameters (Figure 37-Figure 43, Appendix Table A-1). Eight sites were also sampled for organic compounds twice during the survey (Table 28, Appendix Table A-3). Samples were analyzed for bacteria (fecal coliform and *E. coli*) at seven sites on five occasions within a thirty-day period in order to determine recreational use attainment (Table 27, Appendix Table A-2). Additionally, Datasonde™ continuous monitors were deployed in the Mad River mainstem upstream (RM 25.57) and downstream (RM 24.13) of the Springfield WWTP and in Moore Run downstream from International Truck (RM 2.46) for a 48-hour period in July and again in September (Figure 8).

Similar to the entire study area, mean daily flows from May through September 2003 measured by two USGS gage stations in the Mad River (Figure 33 and Figure 34), were well above normal with sixty-one percent (61%) of St. Paris Pike flows and forty-two percent (42%) of Springfield flows exceeding 10% duration exceedence flows (USGS 2004 and 2000). As stated previously, the 10% duration exceedence flow represents the discharge which was equaled or exceeded 10% of the time over the period of record. On water chemistry sampling days, the St. Paris Pike and Springfield gages recorded mean daily lows of 275 cfs and 372 cfs, respectively, on August 28 and mean daily highs of 534 cfs and 760 cfs, respectively, on July 16. Flows were also elevated above 10% duration exceedence flows on four of the six days sites were sampled for bacteria. Total precipitation of 21.46 inches was recorded at the Springfield WWTP (MCD 2003) from July through September 2003, a departure of 10.77 inches above normal for the period (Figure 35).

Water chemistry grab sample results which exceeded State of Ohio WQS Criteria Standards (WQS) are presented in Table 26 and Table 27.

Significant fluctuations in dissolved oxygen and temperature were measured from July 22-24 by the Datasonde™ hourly monitor placed in the Mad River at RM 25.57, upstream from the Springfield WWTP. While D.O. concentrations ranged from 5.98 mg/l to 9.79 mg/l, temperatures varied widely from 17.14°C to 27.14°C. The Springfield WWTP precipitation station measured 0.93 inches of rainfall in the 24-hour period beginning at 8 a.m. on July 21 (MCD 2003). This site is downstream from Buck Creek (confluence RM 26.15) and most of the City of Springfield's CSO.

The greatest diurnal D.O. variations of the entire survey, however, occurred in Moore Run at RM 2.46, downstream from International Truck and Engine. Datasonde™ D.O. concentrations and corresponding saturations ranged from 3.7 mg/l (38%) to 12 mg/l (132%) in July and from 4.7 mg/l (47%) to 13.2 mg/l (147%) in September. Additionally, four of the 47 hourly measurements taken in July dropped below the minimum WQS criterion of 4.0 mg/l. Datasonde™ median pH values at the site were the lowest of any Datasonde™ location in the survey (7.69 SU in July and 7.45 SU in September). Similarly, in addition to being substantially lower than values measured upstream at RM 4.10 (median 8.25 SU), pH values measured in the biweekly grab samples collected at the two downstream sites in Moore Run, RM 2.46 (median 7.81 SU) and RM 0.79 (median 7.93 SU), were the lowest in the entire assessment unit. Field notes indicate that macrophytes covered much of the stream at RM 2.46 during the survey and the stream bottom substrate was composed predominately of muck. While conditions may partially reflect localized wetland characteristics, International Truck and Engine is also impacting the stream. Per the entity's monthly operating reports (MORs), median pH values of weekly measurements taken from outfall 001 and outfall 002 in 2003 were 7.70 SU and 7.20 SU, respectively, compared to a median pH of 8.13 SU at the entity's upstream monitoring location. International Truck and Engine is also a major contributor to the nutrient load to the stream. Per entity MORs, the median total phosphorus concentration of the 11 samples collected from outfall 001 in 2003 was 3.16 mg/l. Additionally, composite samples (24-hours) of outfall 001 final effluent collected in conjunction with bioassays in March and May 2004 indicate total phosphorus concentrations of 3.27 mg/l and an extraordinarily elevated 55.8 mg/l, respectively. Nitrate-nitrite-N concentrations ranged from 9.29 mg/l (March) to 11.9 mg/l (May).

Ammonia-N levels in the assessment unit generally remained low with 85% of values less than or equal to the minimum detection limit (MDL) of 0.05 mg/l. The highest median ammonia-N concentration in this assessment unit was measured in Mill Creek at RM 0.01 where values approached the 90th percentile reference concentration of 0.1 mg/l. Concentrations of ammonia-N in Pondy Creek minimally exceeded the WQS criterion on August 27 (0.52 mg/l). Atypically low conductivity (58 µmhos/cm), total dissolved solids (40 mg/l), alkalinity (20.8 mg/l), chloride (<5.0 mg/l), sulfate (7.4 mg/l), sodium (<5 mg/l), and hardness (24 mg/l $CaCO_3$) were also recorded at the site on this day. Results may reflect the geology of the area and the interstitial/losing nature of this stream reach. Precipitation data (MCD 2003) indicate that 0.18 inches (Springfield WWTP) to 0.61 inches (Springfield North) of rain fell in the area during the 24-hour period beginning at 8 a.m. on August 26. Additionally, field notes indicate a heavy

downpour occurred immediately prior to sample collection at the site on August 27 at 1:00 p.m. Prior to this period, however, the area received no rainfall for the preceding nine days.

Nitrate-nitrite-N and total phosphorus overall medians of 2.66 mg/l and 0.05 mg/l were measured, respectively, for the entire assessment unit. The highest nitrate-nitrite-N concentrations were measured in Jackson Creek at RM 3.80 (median 5.26 mg/l) whereas the highest total phosphorus concentrations occurred at RM 2.46 in Moore Run (median 0.20 mg/l).

Eleven organic compounds were detected in the water column during the survey (Table 28, Appendix Table A-3) with the majority of occurrences (71%) in the June sampling rather than August. Metolochlor accounted for 19% of the detections followed by Atrazine (17%), bis (2-ethylhexyl) phthalate (14%), and Simazine (12%). Concentrations of heptachlor epoxide exceeded the non-drinking water human health WQS criterion in the June sampling at RM 25.43 and RM 24.13 in the Mad River and in Moore Run at RM 4.10 and RM 2.46.

Two incidents in this assessment unit demonstrate the continued need for adequate stormwater controls throughout the watershed. Following a heavy rain on July 31 in the late afternoon (~ 5:30 p.m.), Ohio EPA fish crews observed sediment laden water discharging from a channel to the Mad River mainstem between SR 68 and Lower Valley Pike in the area of RM 24.8 (Figure 30). The discharge muddied the Mad River downstream for three to four miles and likely extended further. The Springfield WWTP precipitation station measured 1.88 inches of rain in the 24-hour period beginning at 8 a.m. on July 31 (MCD 2003). Given that the water chemistry samples collected at RM 24.13 at Lower Valley Pike on July 31 were collected at 1:00 p.m. before the rainfall began, this runoff event is not reflected in the results and TSS was not elevated (6 mg/l). While there was a newer condominium development in the area, follow-up investigations one week later were unable to determine the exact source of the runoff and the channel was totally dry.

The second incident occurred in Rock Run (Figure 31 and Figure 32). On September 11 and September 25 field crews observed extensive turbidity in Rock Run near the mouth (RM 0.1) and total suspended solids (TSS) concentrations were considerably elevated (79 mg/l on September 11 and 296 mg/l on September 25). In addition to elevated levels of aluminum (6630 µg/l), arsenic-T (9.3 µg/l), and lead-T (15.1 µg/l), concentrations of iron (12200 µg/l) exceeded the Agricultural Water Supply (AWS) criterion at the site on September 25. The source of the turbidity was tracked to an Ohio Department of Transportation (ODOT) culvert replacement project on US 40 in Rock Run upstream near RM 0.3. Sediment stormwater erosion controls were subsequently required.

Sediment runoff adversely impacts fish and the aquatic environment. It is imperative to implement best management practices (BMPs) to reduce the pollutant load delivered to receiving streams in order to protect and restore the water quality of Ohio streams.

Figure 30.

Sediment laden runoff entering the Mad River near RM 24.8 on July 31, 2003. The Springfield WWTP precipitation station measured 1.88 inches of rainfall in the 24-hour period beginning at 8 a.m. on July 31 (MCD 2003).

Figure 31.

Sediment laden water is apparent in Rock Run near the mouth (RM 0.10) on September 25, 2003.

Figure 32.

Rock Run entering the Mad River (RM 24.12) downstream from Lower Valley Pike on September 25, 2003. The sediment plume, entering the mainstem from the mouth of Rock Run and extending downstream, is visible on the right side of the photograph.

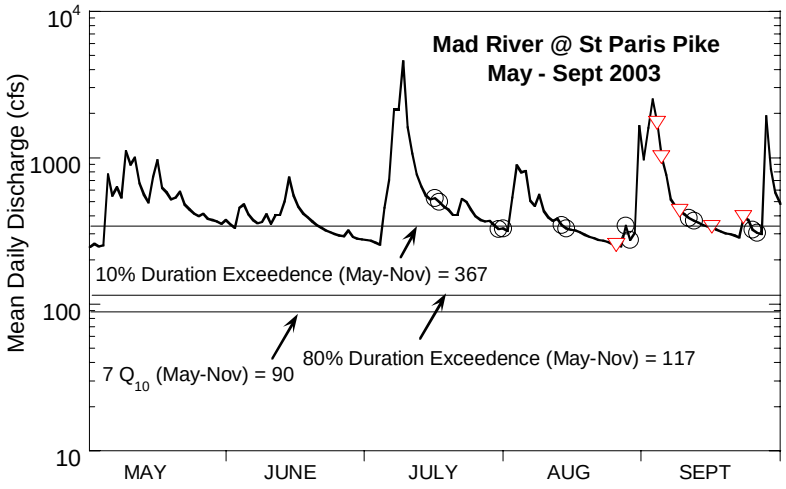


Figure 33.

May through September, 2003 flow hydrographs for the Mad River at St. Paris Pike at Eagle City (RM 29.5). Low flow conditions ($7Q_{10}$), 10% and 80% duration exceedence flows are based on USGS station #03267900 (period of record 1965-1995). Open circles indicate river discharge on water chemistry sampling days. Triangles indicate river discharge on bacteriological sampling days.

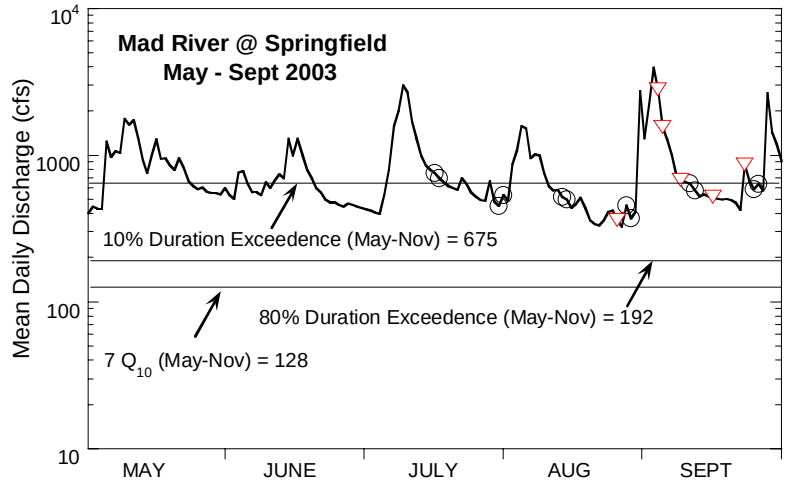
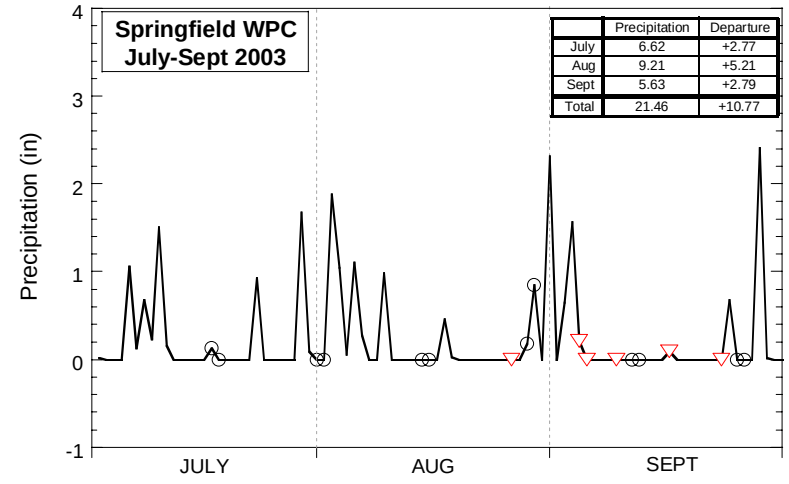


Figure 34.

May through September, 2003 flow hydrographs for the Mad River near Springfield (RM 24.1). Low flow conditions ($7Q_{10}$), 10% and 80% duration exceedence flows are based on USGS station #03269500 (period of record 1914-1997). Open circles indicate river discharge on water chemistry sampling days. Triangles indicate river discharge on bacteriological sampling days



	Precipitation	Departure
July	6.62	+2.77
Aug	9.21	+5.21
Sept	5.63	+2.79
Total	21.46	+10.77

Figure 35.

Daily precipitation recorded for the Springfield WWTP from July through September (MCD, 2003). Open circles represent conventional water chemistry sampling days. Triangles represent bacteriological sampling days in the watershed assessment unit.

*Rain gages are read every morning at or near 8:00 am. Therefore, these readings reflect the previous 24 hour catch.

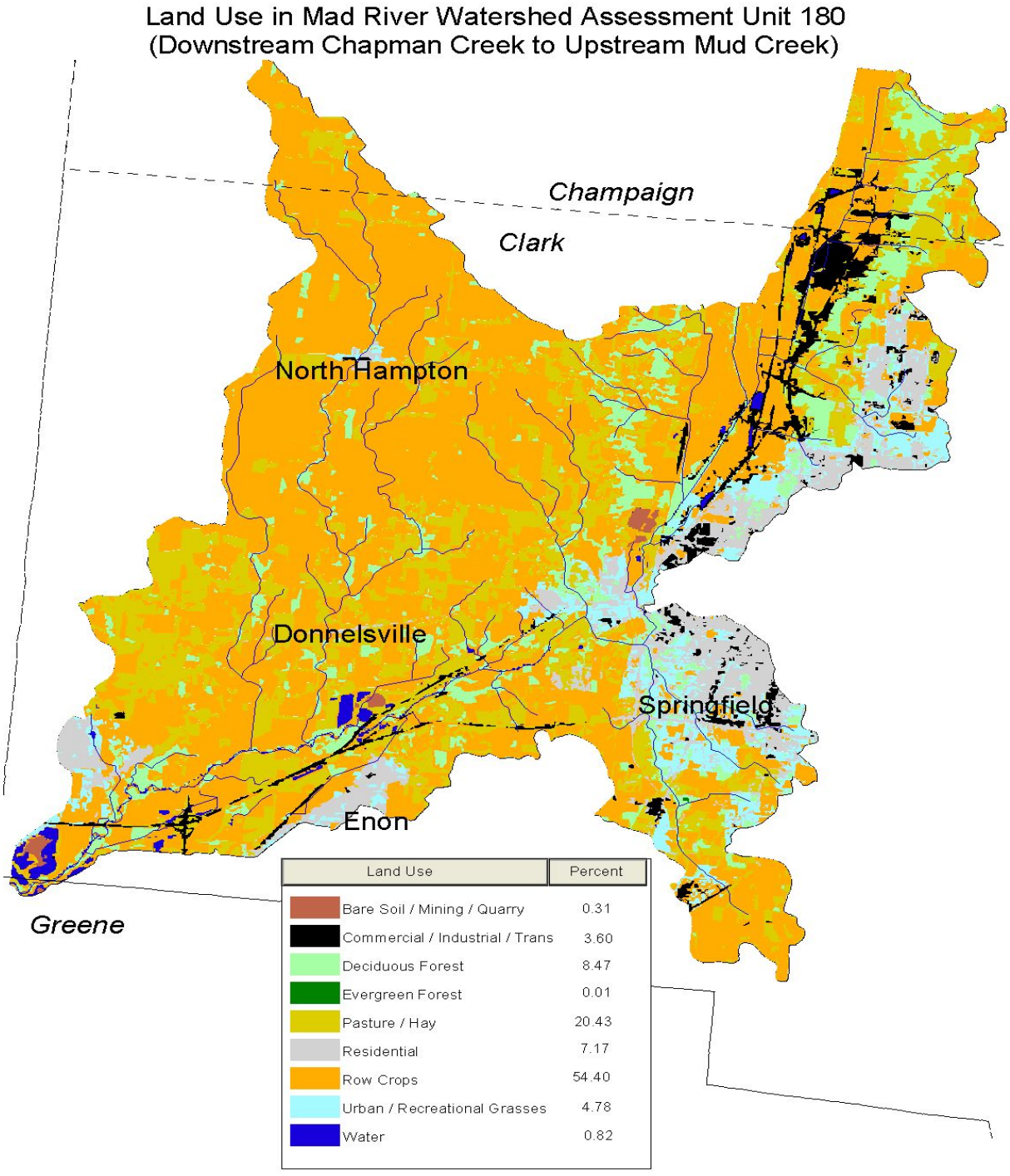


Figure 36. Land Use in the Mad River (Downstream Chapman Creek to Upstream Mud Creek) Watershed Assessment Unit (WAU 05080001 180); (University of Cincinnati, 2001).

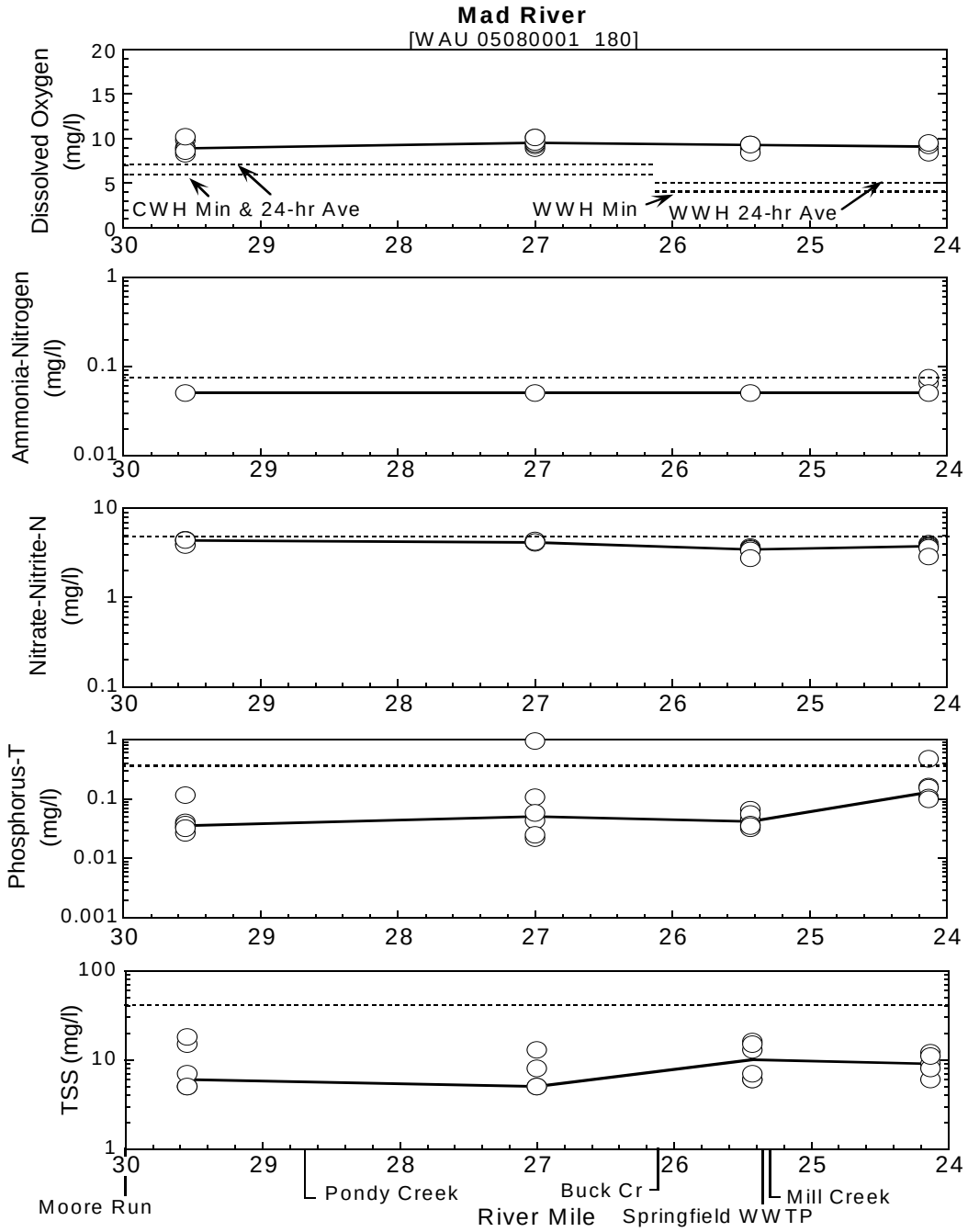


Figure 37. Longitudinal plots of water chemistry daytime grabs in the Mad River during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

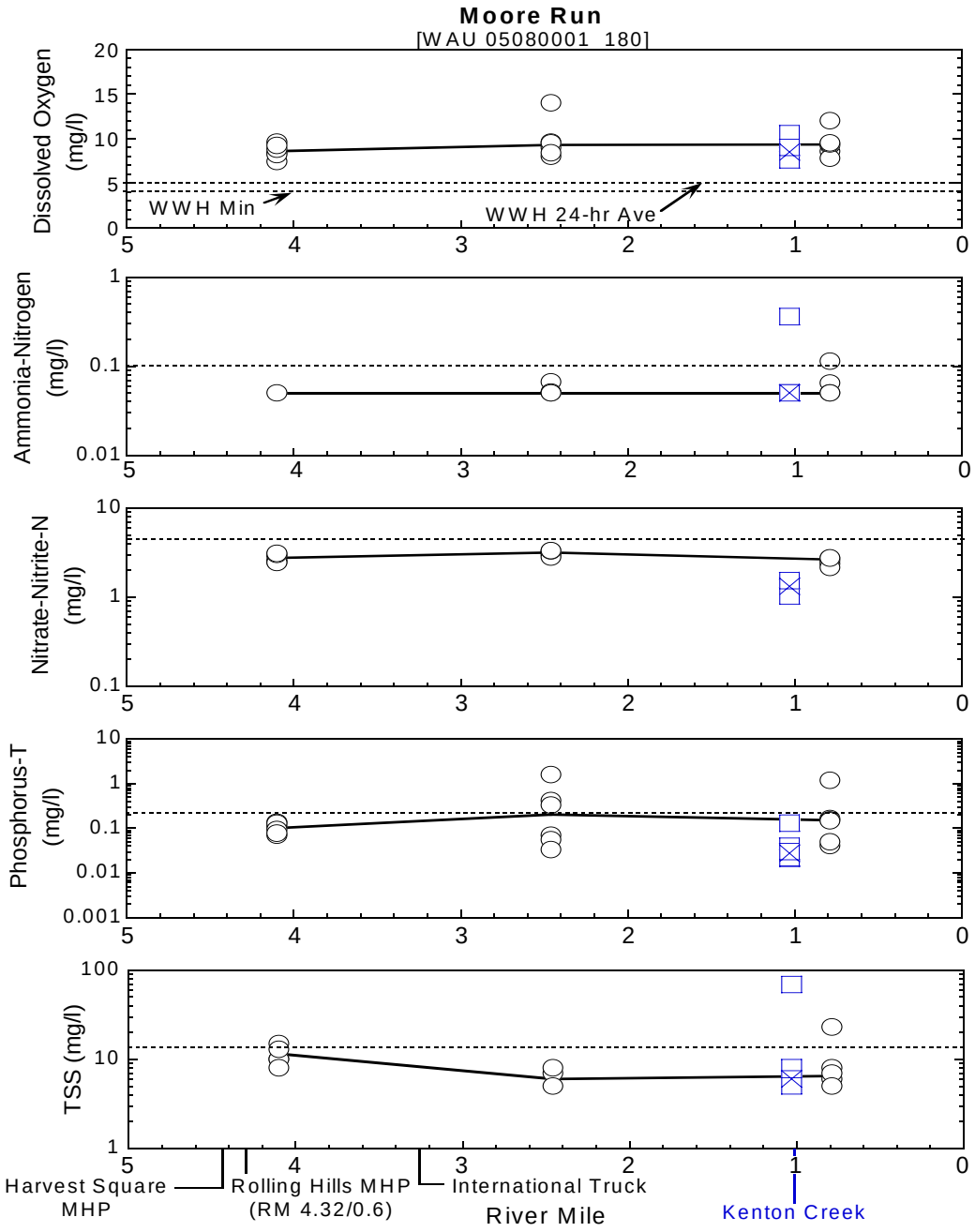


Figure 38. Longitudinal plots of water chemistry daytime grabs in Moore Run (circles) and Kenton Creek RM 0.30 (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in Moore Run while an 'X' depicts the median in Kenton Creek. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

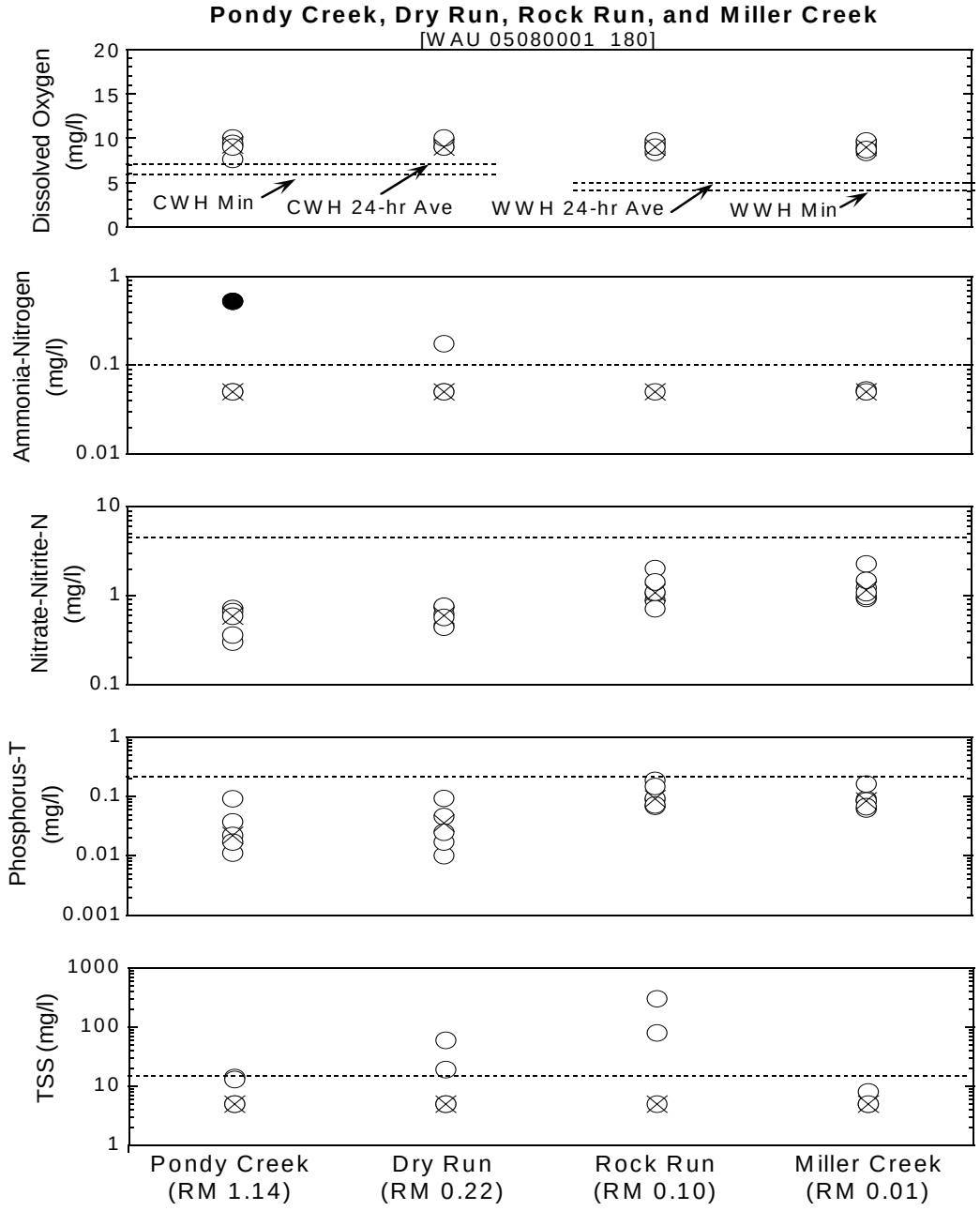


Figure 39. Longitudinal plots of water chemistry daytime grabs in Pondy Creek, Dry Run, Rock Run, and Miller Creek during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The median value at each site is depicted by an 'X'. WQS criteria are shown in the dissolved oxygen plot. Values above WQS criterion in the ammonia-N plot are depicted by a solid circle. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

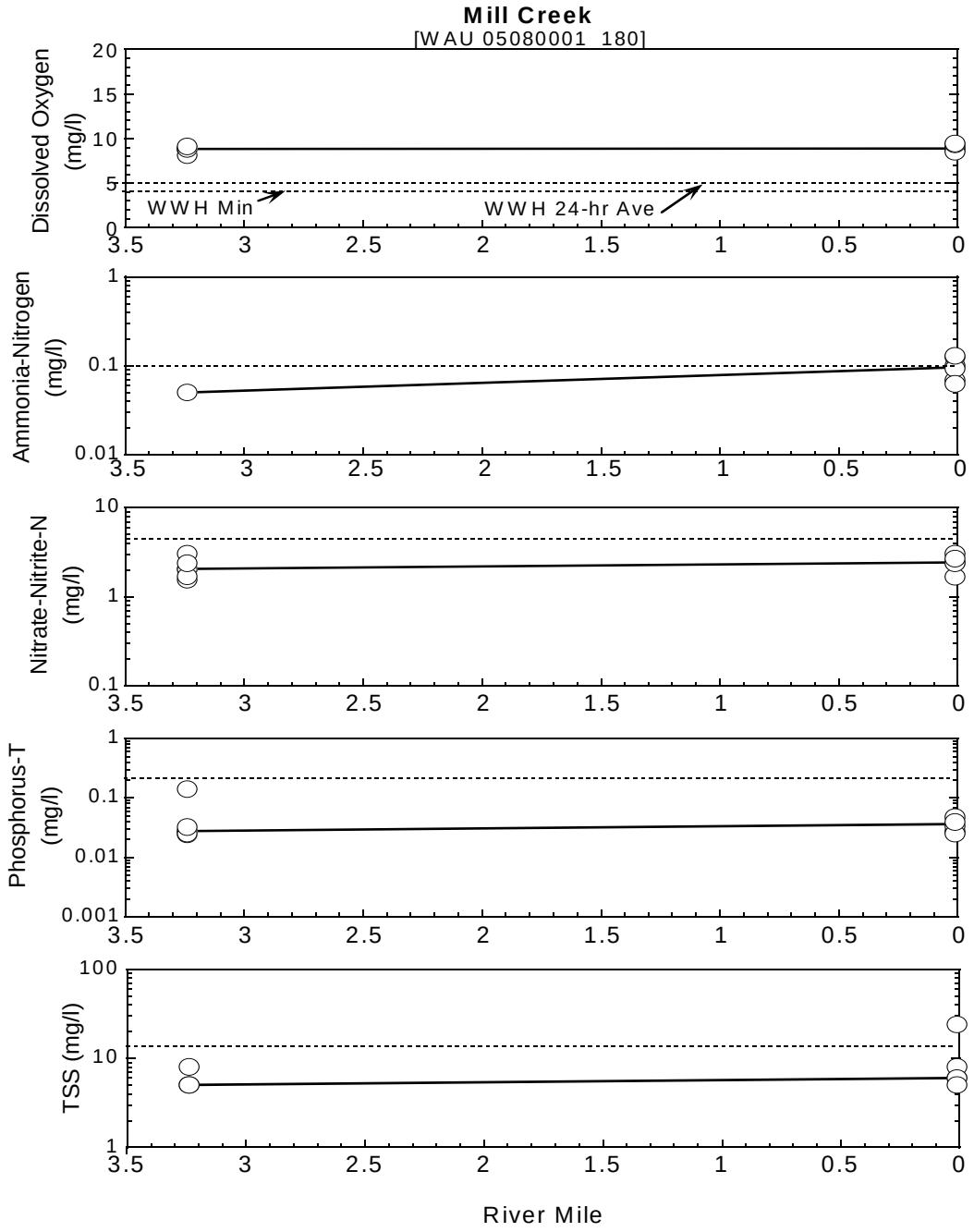


Figure 40. Longitudinal plots of water chemistry daytime grabs in Mill Creek during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

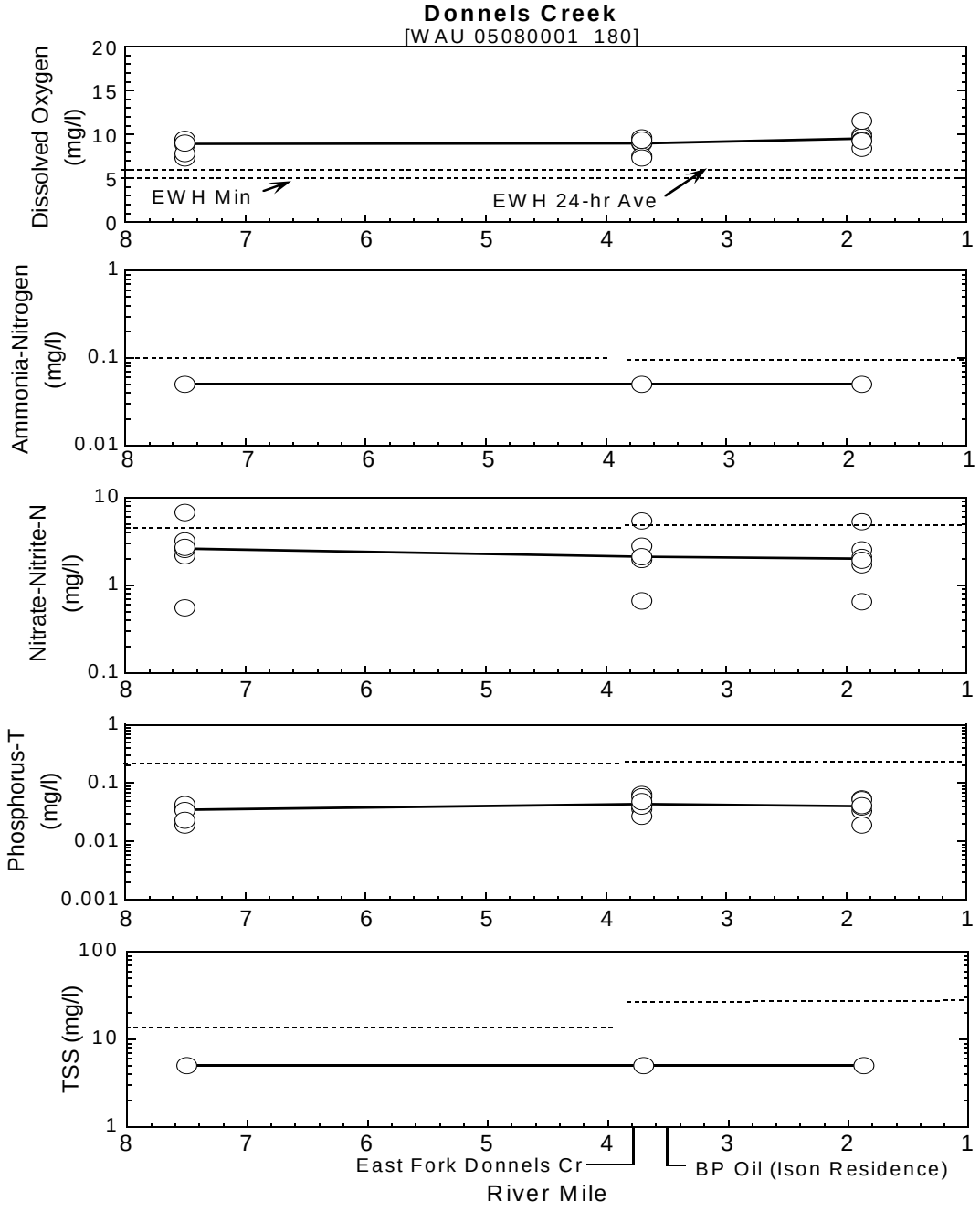


Figure 41. Longitudinal plots of water chemistry daytime grabs in Donnels Creek during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

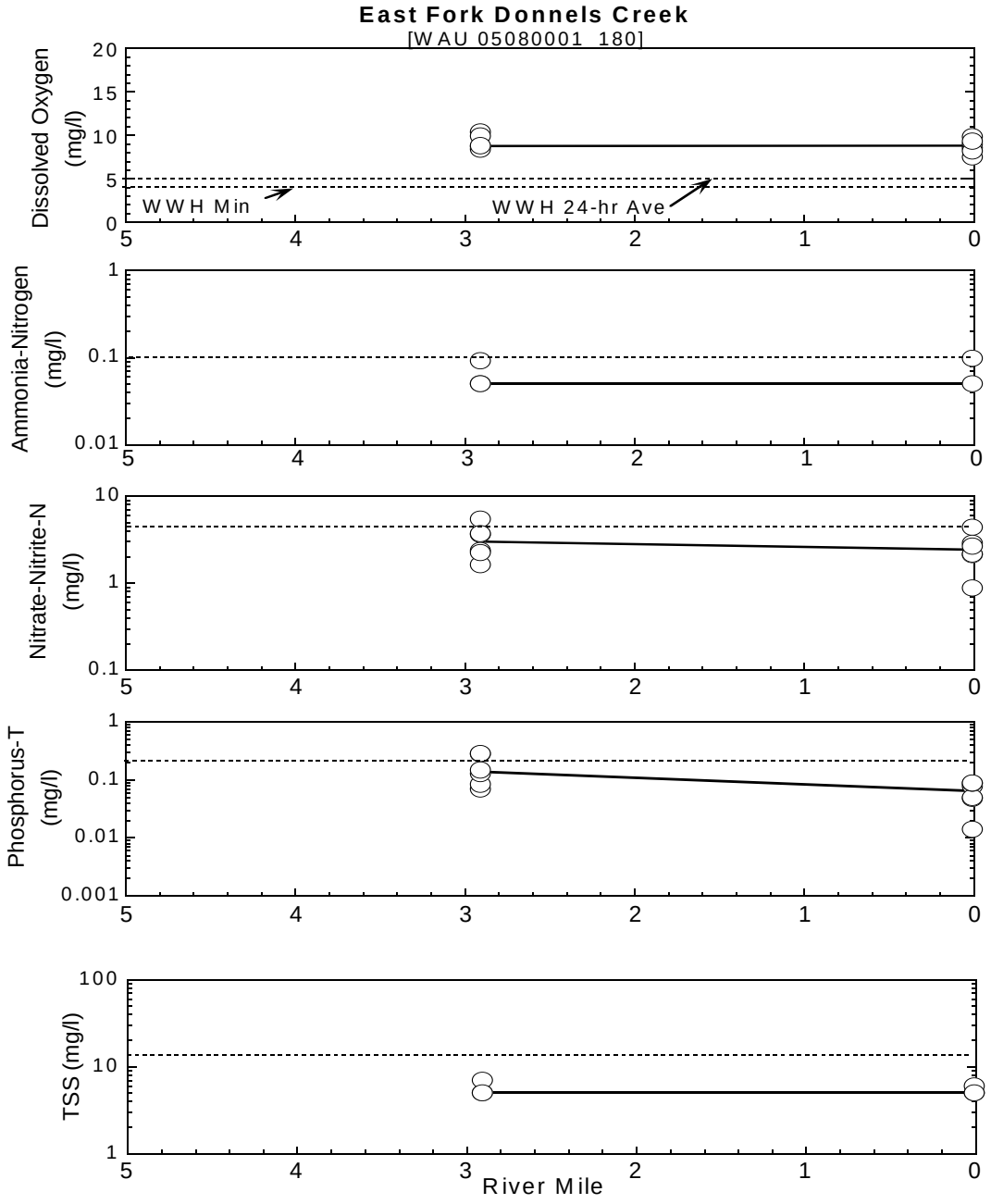


Figure 42. Longitudinal plots of water chemistry daytime grabs in East Fork Donnels Creek during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

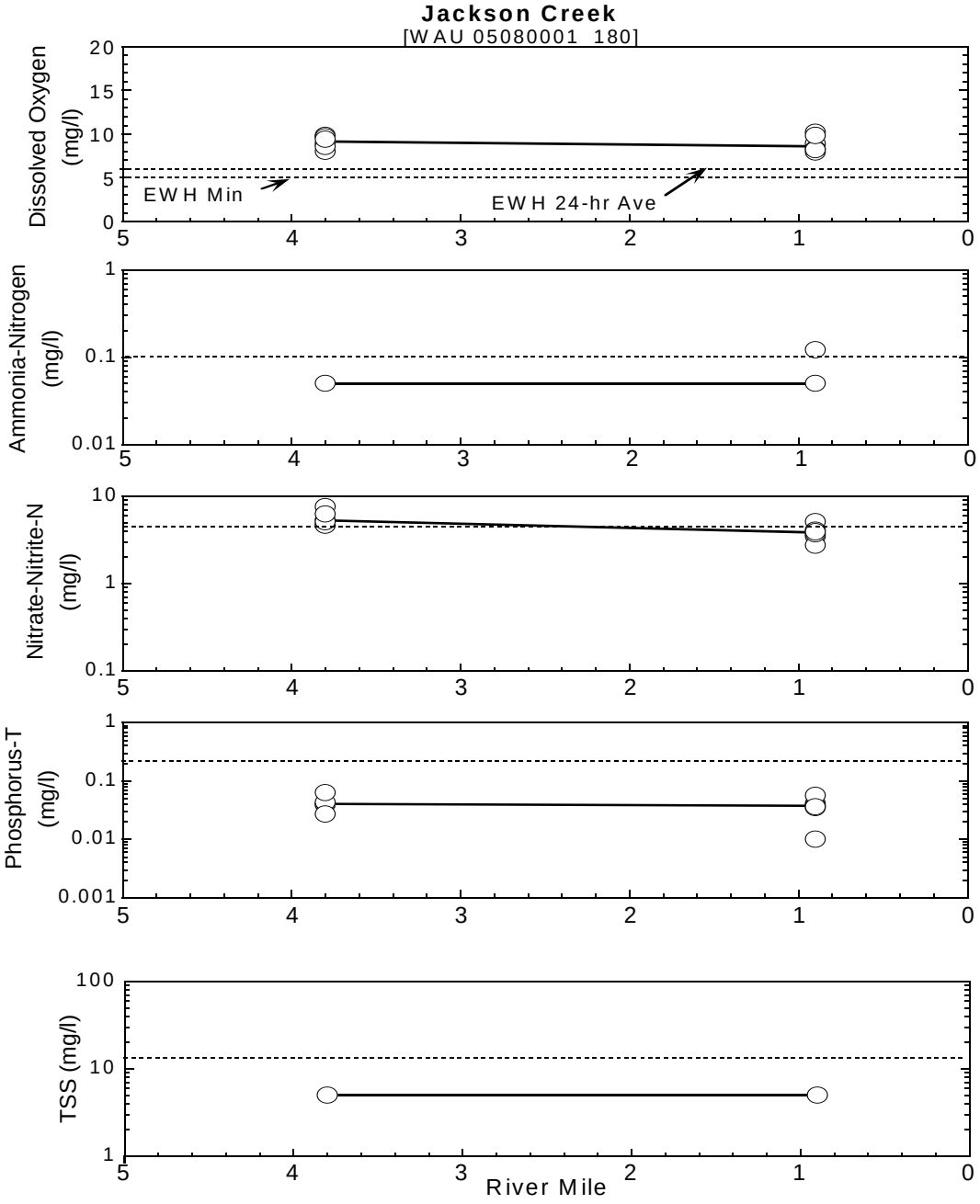


Figure 43. Longitudinal plots of water chemistry daytime grabs in Jackson Creek during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

Chemical Sediment Quality

Sediment quality was evaluated at seven sites in WAU 05080001180 (Table 16 and Table 17). Three of the sites were on the mainstem of the Mad River and four were on three tributaries. The watershed covers 81,961 acres (128 mi^2) and is in Clark and Champaign Counties.

A trace amount of acetone was found in all seven sediment samples. Acetone is most likely a laboratory contaminant of the methanol used to clean sampling equipment.

Fine grain material (FGM) in the samples was below the goal of 30% FGM at three of the seven sites.

The legacy pesticides 4, 4'-DDE and methoxychlor were detected in the farming area of Jackson Creek (RM 0.90). There is no guideline for methoxychlor and 4, 4'-DDE (a breakdown byproduct of DDT) was between the MacDonald TEC and PEC. All metal results were below sediment guidelines.

The most contaminated site in this assessment unit and the entire Mad River survey area was on Moore Run (RM 2.46) downstream from the International Truck and Engine Corporation (Navistar). Barium, cadmium, lead, manganese, and zinc were above the Ohio SRV sediment guidelines. Zinc, lead and cadmium were between the MacDonald TEC and PEC, meaning that adverse benthic effects frequently occur.

Ten different PAH compounds were detected in the sediments of Moore Run for a total of 26.90 mg/kg. This level of total PAHs is over the MacDonald PEC, meaning that adverse benthic effects usually or always occur. Six of the ten PAH compounds were over the MacDonald PEC.

The highest sediment ammonia level (5400 mg/kg) ever recorded in the 16 counties of the Southwest District of Ohio was documented at Moore Run (RM 2.46). This is 54 times the Ontario sediment disposal guideline (100 mg/kg).

Sediment phosphorus was 2950 mg/kg, the highest sediment phosphorus documented during the survey. Sediment phosphorus at this level is over the Ontario severe effect level; disturbances of the benthic community can be expected. During a bioassay conducted on May 4, 2004 phosphorus in the final effluent was 55.8 mg/kg. This level of phosphorus in the effluent indicated the phosphate dip tank was dumped into the treatment system. There is no phosphorus limit in the International Truck and Engine Corporation NPDES permit.

None of the sediment contamination seen at RM 2.46 was evident at Moore Run, upstream from the Navistar facility (RM 4.10). All metals were below the Ohio SRV sediment guidelines, no PAH compounds were detected, and nutrients were below all sediment guidelines.

Mill Creek is an urban watershed with two CSOs present upstream from the sampling location at the mouth (RM 0.01). Cadmium, copper, mercury, and lead were documented above the Ohio SRV sediment guidelines for this area and between the MacDonald TEC and PEC, meaning that adverse benthic effects frequently occur. The PAH, flouranthene (0.68 mg/kg), was detected at a level between the MacDonald TEC and PEC.

the Mad River sites in the middle part of the watershed were contaminated with mercury. The sampling location at St. Paris Pike (RM 29.55) had sediment levels of mercury at 1.25 mg/kg. The Mad River, upstream from the Springfield WWTP (RM 25.43), had the highest mercury detected in the entire survey (4.94 mg/kg). Both mercury levels were above the Ohio SRV sediment guidelines and above the MacDonald PEC; adverse affects to benthic organisms usually or always occur. Sediment arsenic at these two Mad River sites were between the MacDonald TEC and PEC, but below the Ohio SRV of 18 mg/kg. Normally sediments between the MacDonald TEC and PEC indicate that adverse benthic effects frequently occur, but Ohio's SRV value is naturally higher than the MacDonald guidelines for arsenic and not considered to adversely affect benthic organisms.

Polycyclic aromatic hydrocarbons (PAHs) were detected at 2 of 3 mainstem sites. The Mad River, upstream from the Springfield WWTP (RM 25.43) had four PAH compounds detected, all between the MacDonald PEC and TEC, for a total of 4.26 mg/kg. The site downstream from the Springfield WWTP (RM 24.1) had six different PAH compounds detected. Five of the six PAH compounds were between the MacDonald TEC and PEC for a total of 5.37 mg/kg.

Table 16. Concentrations (mg/kg) of metals and nutrients in sediment samples collected in watershed assessment unit (WAU) 05080001 180 (Mad River -Downstream Chapman Creek to Upstream Mud Creek) during 2003. Parameter concentrations were evaluated based on Ohio EPA sediment metal reference sites (2003), MacDonald (2000) Sediment Quality Guidelines (SQG) and Persuad (1993). Values above guidelines are highlighted.

Parameter	Site Location (RM)							*Reference*	
	Mad River St. Paris Pike RM 29.55	**Mad River** Ust Springfield WWTP RM 25.43	**Mad River** Dst Springfield WWTP RM 24.13	**Moore Run** Countyline Rd RM 4.10	**Moore Run** Dst Int'l Truck RM 2.46	**Mill Creek** @ mouth RM 0.01	**Jackson Creek** Lower Valley Pk RM 0.9		
								Ohio	**MacD**
Al-T [O]	16400	8550	11900	16100	19700	12500	11500	39000	*
As-T [OM]	10.2 #	5.06	10.3 #	5.74	8.07	8.32	6.3	18	9.79-33
Ba-T [O]	130	73.2	161	192	312+	134	76.4	240	*
Ca-T [O]	70000	64900	91500	36500	83600	63200	37400	120000	*
Cd-T [OM]	0.285	0.295	0.448	0.324	1.70+#	3.67 +#	0.178	0.9	0.99-4.98
Cr-T [OM]	<22	<17	<19	<26	<35	39	<18	40	43.4-111
Cu-T [OM]	14.7	8.5	21.1	17.7	23.9	40.4+#	18.4	34	31.6-149
Fe-T [O]	15700	10000	16400	14800	24800	13200	12200	33000	*
Hg-T [OM]	1.25+ ■	4.94+ ■	0.048	<0.041	<0.055	0.281+#	<0.038	0.12	0.18-1.06
K-T [O]	3470	2140	2510	3220	4070	2740	2200	11000	*
Mg-T [O]	20700	19300	20800	11000	21400	23400	15300	35000	*
Mn-T [O]	397	396	851+	207	816+	376	446	780	*
Na-T *	<3620	<2750	<3200	<4350	<5800	<2720	<2940	*	*
Ni-T [OM]	<29	<22	<26	<35	<46	<22	<24	42	22.7-48.6
Pb-T [OM]	<29	31	<26	41	84+#	94 +#	<24	47	35.8-128
Se-T [O]	<1.45	<1.10	<1.28	<1.74	<2.32	<1.09	<1.18	2.3	*
Sr-T [O]	125	95	181	39	112	58	65	390	*
Zn-T [OM]	124	49.7	86.7	93.9	241+#	130	95.5	160	121-459
								Ohio	**Pers.**
NH_3-N [P]	78	20	36	81	5400[L]	92	76	*	100
TOC [P]	4.7%	4.8%	5.4%	4.8%	6.1%	5.1%	3.7%	*	10.0%
pH *	7.6	7.9	7.6	8.1	7.7	7.7	7.5	*	*
P-T [P]	587	396	690	505	2950 •	561	754	*	2000
%FGM [O]	26.4%ú	10.4 %ú	42.7%	46.6%	44.2%	23.6 %ú	30.6%	30.0%	*
COD*	62100	12900	102000	75000	188000	60900	38700	*	*

↘ Below the goal of 30% Fine Grain Material in sample
%FGM Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)
NA Compound not analyzed. * Not evaluated
[O] Evaluated by Ohio EPA (2003) [M] Evaluated by MacDonald (2000) [P] Evaluated by Persuad (1993)

Ohio SRV Guidelines (2003)
+ above background for this area

Ontario Sediment Guidelines (Persuad (1993)
L > Open Water Disposal Guidelines; equivalent to the Lowest Effect Level (LEL)-applicable to NH_3-N only.
• > severe effect level (disturbance in benthic community can be expected)

MacDonald (2000) Sediment Quality Guidelines (SQG)
TEC-PEC Threshold effect concentration (TEC) - Probable effect concentration (PEC)
Above which adverse effects frequently occur
■ **>PEC** Probable effect concentration (PEC) -Above which adverse effects usually or always occur

Table 17. Sediment concentrations of organic compounds (priority pollutant scan) detected in watershed assessment unit (WAU) 05080001 180 (Mad River -Downstream Chapman Creek to Upstream Mud Creek) during 2003. Individual compounds were evaluated by the MacDonald Sediment Quality Guidelines (2000).

River / Landmark	**Analysis Performed**	**Compound Detected**	**Result** mg/kg unless noted
Mad River RM 29.55 St. Paris Pike TOC = 4.7 % Fine Grained Material = 26.4 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone bis(2-Ethylhexyl)phthalate 3&4 Methylphenol	0.194 * 0.77 * 2.56 * BDL BDL
Mad River RM 25.43 Ust. Springfield WWTP TOC = 4.8 % Fine Grained Material = 10.4 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone Chrysene Fluoranthene Phenanthrene Pyrene **Total PAH**	0.065 * 0.70 # 1.49 # 0.90 # 1.17 # **4.26** # BDL BDL
Mad River RM 24.13 Lower Valley Pike Dst Springfield WWTP TOC = 5.4 % Fine Grained Material = 42.7%	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone Benzo(a) pyrene Benzo(b)fluoranthene Chrysene Fluoranthene Phenanthrene Pyrene **Total PAH** Methoxychlor	0.094 * 0.64 # 0.71 * 0.74 # 1.41 # 0.68 # 1.19 # **5.37** # 0.011 * BDL
Moore Run RM 4.10 Countyline Rd TOC = 4.8 % Fine Grained Material = 46.6 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone	0.118 * BDL BDL BDL
Moore Run RM 2.46 Dst. International Truck TOC = 6.1 % Fine Grained Material = 44.2 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone Benz(a)anthracene Benzo(a) pyrene Benzo(b)fluoranthene Benzo[g,h,i]perylene Benzo(k)fluoranthene Chrysene Fluoranthene Indeno[1,2,3-cd]pyrene Phenanthrene Pyrene **Total PAH**	0.149 * 1.62 ■ 2.04 ■ 2.81 * 1.75 * 2.31 * 2.57 ■ 5.41 ■ 2.08 2.07 ■ 4.24 ■ **26.90** ■ BDL BDL

Table 17. Continued.

River / Landmark	**Analysis Performed**	Compound Detected	**Result** mg/kg unless noted
Mill Creek RM 0.01 @ mouth TOC = 5.1% Fine Grained Material = 23.6%	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone Fluoranthene	0.072 * 0.68 # BDL BDL
Jackson Creek RM 0.90 Lower Valley Pike TOC = 3.7 % Fine Grained Material = 30.6 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone 4,4'-DDE Methoxychlor	0.139 * BDL 0.007 # 0.0219 * BDL

* Not evaluated NA Compound not analyzed BDL Below Detection Limit TOC Total Organic Carbon

1) Volatile Organic Compounds (VOC) U.S. EPA Method 8260B
2) Base Neutral & Acid Extractibles (BNA) U.S. EPA Method 8270
3) Pesticides U.S. EPA Methods 8082A
4) Polychlorinated biphenyls (PCBs) U.S. EPA Method 8082A

Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)

MacDonald (2000) Sediment Quality Guidelines (SQG)

TEC-PEC Threshold effect concentration (TEC) - Probable effect concentration (PEC)
Above which adverse effects frequently occur

■ **>PEC** Probable effect concentration (PEC) -Above which adverse effects usually or always occur

Watershed Protection Efforts

Since 2000 the Lower Mad River Watershed Protection Project has been implementing a water quality protection project as part of a Section 319 funded grant. Among the objectives of the grant were to reduce nutrient and sediment loading to streams in the Mad River Watershed through installation of grass and tree filter strips, use of cover crops to reduce erosion, and pumping of septic tanks. Coupled with the installation of these Best Management Practices (BMPs) were education programs to increase awareness of water quality impacts and threats. Estimated load reductions for WAU 05080001 180 are listed below. In addition to the other BMPs listed, this project also cooperated with the Clark County Engineer to install a storm water retention pond near the intersection of SR 41 and US 68. Loading reduction calculations for this pond were not available.

Load reductions from Cover Crops

Acres Established	74.8
Sediment saved	125 (tons/yr)
Phosphorus	143 (lbs/yr)
Nitrogen	286 (lbs/yr)

Load reductions from Grass and Tree Filter Strips

Acres Established	23.7
Sediment saved	197 (tons/yr)
Phosphorus	341 (lbs/yr)
Nitrogen	636 (lbs/yr)

Load reductions from Septic Tank pumping

Gallons per day adequately treated	21,200
TSS	4642.8 (lbs/yr)
BOD	9053.5 (lbs/yr)
Phosphorus	967.25 (lbs/yr)
Nitrogen	2553.5 (lbs/yr)
Ammonia	1934.5 (lbs/yr)

Point Source Evaluations

Harvest Square MHP (Moore Enterprise) - Moore Run (RM 4.46)
Permit # - 1PV00082
Lat.: $40^0$01'53"; Long.: $83^0$47'21"

Harvest Square MHP is located in Champaign County at 5646 US 68 in Urbana. Harvest Square has 121 home lots with approximately 235 residents. The design flow for the facility is 20,400 gpd with a daily average flow design of 30,000gpd. Current treatment consists of a comminuter, two 15,000 gpd aeration tanks, clarification, one 2300 gallon chlorine contact tank and an infiltration lagoon. An expansion/upgrade occurred due to concern over groundwater contamination from the infiltration lagoon. The expansion/upgrade included a 10,200 gallon flow equalization tank, a 4600 gallon sludge holding tank, three 833 square foot sand filters and a 2300 gallon chlorine contact tank. Sludge disposal is hauled by a local septage hauler and is taken to a landfill or wastewater treatment facility.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 120 for Harvest Square MHP. Most violations occurred in 2000, 2001 and 2003, respectively. For the nearly six years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included chlorine (51%) and $cBOD_5$ reported with the greatest frequency. No seasonal patterns were observed in the violations, although for most years, May through September were the prominent months when violations occurred.

International Truck and Engine Corporation - (Navistar International) - unnamed tributary (RMs 0.1 and 0.2) to Moore Run
Permit # -1IN00022
Outfall 001 (RM 0.1) – Lat.: $40^0$00'50"; Long.: $83^0$47'46" - domestic sewage, treated industrial wastewater from metal finishing operations
Outfall 002 (RM 0.2) – Lat.: $40^0$00'48"; Long. : $83^0$47"43" - non contact cooling water and storm water outfall

The International Truck and Engine Corporation Springfield Assembly Plant (ITEC-SAP) is located in Clark County at 6125 Urbana Rd (US 68), Springfield. The International Truck and Engine Corporation assembles medium and heavy-duty trucks. Assemblage and painting of the trucks are conducted at this facility. This facility also conducts metal finishing processes which include zinc phosphate treatment, cleaning, machining, grinding, and electro deposition of primer.

Three areas of the facility generate waste that is sent to the treatment plant- the finish paint assembly (industrial, sanitary and E-Coat waste), the truck sales (sanitary), and processing center (sanitary). The primary source of process wastewater is in the thirteen-stage pretreatment and priming system at the paint facility. Other sources are the result of routine maintenance cleaning

activities. The waste stream components are from surface preparation coatings and paints.

Wastewater treatment of the industrial waste includes equalization, oil/water separation, coagulation, clarification, filtration and pH adjustment. Combined industrial and sanitary wastewater is biologically treated, which entails aeration, clarification, chlorination and stabilization. The average design flow of all processes and sanitary wastewater (outfall 001) combined is 0.200 million gallons per day (MGD). Land application of sludge is conducted southeast of Tremont City along Moore Run, south of Bowlesville.

The facility has a Total Toxic Organics (TTO) Management Plan to address spill containment, disposal, and cleanup procedures. One source of TTOs entering the waste stream has been identified as occurring through the floor drains or catch basins connected to the industrial wastewater.

Biomonitoring results from 1991-2004 have been mixed. Four acute bioassays were conducted by Ohio EPA in March 1991, August and October 1994 and May 2004. The 1991 acute toxicity test resulted in toxicity to fathead minnows (*P. promelas)* in the final effluent. The 1994 acute toxicity tests ended with no toxicity to either fathead minnows or the daphnid *Ceriodaphnia. dubia.* In 1998, as a requirement of the NPDES permit renewal, International conducted a short term (7-day) static toxicity test. This was administered to both test organisms, to determine toxic effects to growth, survival and reproduction. Tests were conducted in control, upstream and final effluent waters. Upstream waters only indicated toxicity to survival of fathead minnows. Final effluents indicated reproductive toxicity to daphnids. Entity generated toxicity testing in 1999 reported acute toxicity to the daphnids in final effluent waters. The bioassay test in 2004 resulted in acute toxicity to daphnids in the mixing zone sample. Extreme phosphorus and nitrate-N concentrations have been noted in the final effluent which could have some potential toxic impacts to the test organisms and instream aquatic life.

According to ITEC-SAP the toxic events have been attributable to blending of high strength industrial wastewater into the conventional wastewater treatment system. The high strength material is generated during periods of scheduled maintenance shutdowns. The material is blended slowly into the conventional wastewater system and at times, the blending is aggressive, resulting in toxicity.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 70 for International Truck and Engine Corporation. Most violations occurred in 1999, 2002 and 2003. For the nearly six years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included TSS, ammonia-N and Oil and Grease reported with the greatest frrequency. Total Suspended Solids violation catalysts were related to “shearing the biomass”. One plausible source of $cBOD_5$ violations was related to clarifier freezing and obstructing flow through the weir. When production increased, solids went over the weir. Low numbers of microorganism ratios, higher industrial blends, and fewer nutrients, sometimes exacerbated by hydraulic

overload during seasonal maintenance, all contributed to NPDES violations.

KTK Industrial Park WWTP - Moore Run (RM 2.17)
Permit # - 1PZ00003
Lat.: $40^0$00'02"; Long.: $83^0$48'18"

KTK Industrial Park is located in Clark County at 5171 Urbana Rd (US 68), Springfield. The KTK Industrial Park domestic wastewater plant was built in 1984 and operations are carried out by the direction of the Clark County Board of Commissioners. All facilities that use this facility discharge domestic wastewater. The following are a list of industries in the industrial park- Findley Industries, Steward Manufacturing, Springfield Holding company, Valco Truck and Trim, Fontaine Modification, Scherer Electric Co and R @L Hydraulics Inc.

The treatment system is an extended aeration facility consisting of a flow equalization tank, extended aeration, final clarification, chlorination dosing tank, slow surface sand filters, and post aeration tank. Sludge is hauled to the Clark County Southwest Regional WWTP. The original design flow for the facility was 17,000 gpd. Flow reduction from company closings has occurred since 1993, decreasing effluent discharges from 10,000 gpd to an average 3,000 gpd. The plant is receiving less than a 1/3 of its designed flow volume which poses operational challenges.

In 2003, an Ohio EPA inspection noted floating sludge in the clarifier and sand filters. In 2004, an Ohio EPA inspection disclosed air diffusers were inoperable, and the sand filters were holding water. The clarifier had a blanket of solids on the surface and pin floc sludge was present in the weirs to the receiving stream. In 2004, Scherer Electric Co caused an upset at Clark County Southwest Regional WWTP from the discharge of oily sludge.

Numeric violations of NPDES permit limits were evaluated for most of 2004 when an NPDES permit was implemented. NPDES violations, reported through SWIMS, revealed one violation of ammonia-N for KTK Industrial Park WWTP in 2004. In December 2004 an industry discharged an oily black material that was eventually attributed to a parts washing operation. Release of this waste flushed oily solids to the sewer and subsequently adversely affected the KTK WWTP. No effluent violations at the WWTP were reported.

Rolling Hills MHP WWTP (Moore Enterprises) - unnamed tributary (RM 0.61) to Moore Run (RM 4.32)
Permit # - 1PV00047
Lat.: $40^0$1'49"; Long.: $83^0$46'49"

Rolling Hills Mobile Home Park (MHP) is located in Champaign County at 5579 Urbana Rd. (US 68), Urbana. It was established in 1971 and houses approximately 227 trailers. A PTI **(**No. 05-11692) was issued on August 1, 2001, for upgrades to the existing wastewater treatment plant. Upgrades to the package plant consisted of the addition of parallel dual aeration tanks,

dual clarifiers, tertiary dosing, four slow surface sand filters and ultraviolet disinfection. The existing aeration tanks were converted to equalization tanks and existing clarifiers were converted to a sludge holding tank. The wastewater treatment plant was completed in March, 2003. The system was upgraded to meet BADCT limits.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 378 for Rolling Hills MHP, 46% occurring in 2000 and 2001. The violation trend diminished from 2003 into 2004. For the nearly six years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included TSS and $cBOD_5$ reported with the greatest frequency.

Sunset Terrace MHP – dry well in Moore Run watershed
Permit # - 1PV00118
Lat.: $40^0$03'14"; Long.: $83^0$46'41"

Sunset Terrace Mobile Home Park is located in Champaign County at 4071 Urbana Rd. (US 68), Urbana. Sunset Terrace MHP has a package wastewater treatment system serving 51 mobile home lots and one house. The treatment train is an extended aeration system designed for 10,000 gpd utilizing aeration, diffused air, and a clarifier. The treated effluent discharges to a dry well. Sunset Terrace MHP submitted a Permit to Install for upgrades to the wastewater treatment plant on November 8, 2004. A comment letter concerning deficiencies was sent from Ohio EPA on November 23, 2004. To date, a revised PTI with detailed plans has not been submitted to the Ohio EPA. The proposed upgrade would eliminate the discharge to the dry well and establish a point source discharge to Moore Run. The upgrade will include a flow equalization tank, larger clarifiers, a sludge waste tank, filters and ultraviolet disinfection. Sunset Terrace MHP's Schedule of Compliance requires completion of WWTP improvements by September, 2005.

Numeric violations of NPDES permit limits were evaluated from 2002 to 2004. NPDES violations, reported through SWIMS, revealed a total of 62 for Sunset Terrace MHP. Sixty-eight percent of the violations occurred in 2002 and 2003. For the nearly three years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included TSS, pH, and $cBOD_5$ reported with the greatest frequency. The cause of the violations was described as a buildup of solids in the clarifier that ultimately affected oxygen demand. As of 2003, this facility had no chlorine disinfection. Temporarily, a chlorine tube was installed in the weir until the upgrade occurs. Raising the baffle in the clarifier to prevent solids overflows has also been implemented.

Fink Meats Company, Inc. - unnamed tributary (RM 1.5) of Pondy Creek (RM 0.3)
Permit # - 1IH00010
Lat.: $39^0$57’51. 70”; Long.: $83^0$51’54. 70”

Fink Meats is located in Clark County at 2475 Troy Rd, Springfield. This facility is a wholesale distributor of meat products and has been in existence since the 1970s. Fink Meats generates

process wastewater as a result of cleaning equipment and making products. The waste water treatment process consists of a flow diversion chamber, grease traps, extended aeration, dosing tank, slow surface sand filters and chlorine disinfection. The waste stream is batch cooling water, sanitary waste and wash-up water.

The facility was designed for a maximum flow of 10,000 gpd with an estimated flow averaging 6,075 gpd. Sludge is reported to be hauled once per year from the facility. An Ohio EPA inspection in 1998 noted the weirs in the treatment plant had excessive algae and solids buildup. An Ohio EPA inspection in 2004 noted the general condition of the package plant was in severe disrepair with corroded systems and a sand filter wall that had collapsed.

Rolling Terrace MHP - Miller Creek (RM 1.03)
Permit # -1PV00058
Lat.: $39^0$57'4.9"; Long.: $83^0$52'19.70"

Rolling Terrace MHP is located in Clark County at 3322 Kappel Dr, Springfield. Rolling Terrace has been in existence since the 1960s with 36 mobile home pads. The treatment system is an Aero-O-Flow WWTP. Treatment consists of an aeration tank and clarifier and discharges at 15,000 gpd to Miller Creek.

Springfield WWTP - Mad River (RM 25.34)
Permit # -1PE00007
Lat.: $39^0$54'56"; Long.: $83^0$51'03"

The Springfield WWTP operates a trickling filter/complete mix activated sludge treatment plant designed to treat 25 MGD. The Springfield facility was built in 1935, with successive upgrades occurring in 1988, 1999 and 2002 when influent monitors were added for temperature, turbidity and pH. The Phase III upgrade in the late 1990s was proposed to reduce the frequency and duration of bypass events. Springfield's collection system is composed of 70% separate sanitary sewer and 30% combined sewer. The facility serves a population of approximately 83,000. Treatment of the wastewater consists of a bar screen, grit removal, primary sedimentation, trickling filter rock media, activated sludge, secondary clarification, disinfection with sodium hypochlorite, dechlorination with sodium bisulfite, and post aeration. Springfield has fourteen Significant Industrial Users- eight categorical industrial users and 6 non-categorical users

The city contracts with an outside hauler for biosolids disposal. Biosolids are land applied at agronomic rates in the vicinity of Conrad Rd and CR 193 near the Chapman Creek watershed. Three other land parcels are located off Heck Hill Rd (CR 26) near Woodville Pike (CR 30) most likely draining to the Nettle Creek or Muddy Creek watersheds.

There are 58 combined sewer overflow (CSO) points in the city collection system. These overflows discharge between 1,062 to1,437 million gallons per year. The largest overflow point is at the wastewater treatment plant. This bypass diverts influent around the plant after initial

fine screening treatment. The plant bypass activates on average 79 to 83 times per year. This annual average overflow volume is between 573 and 775 million gallons. The City of Springfield has submitted a Long Term Control Plan designed to minimize and control any water quality impacts from these discharges. The City of Springfield has spent $700,000 for line replacement or line separation to convert combined sewers to separate sewers. The City of Springfield monitors five CSOs on a rotational basis and reports that data to the Ohio EPA. In 2004, the city developed a combined sewer system Operational Plan, completed stress testing, and completed bacteria characterization work, all required for compliance of the NPDES permit.

On February 14, 2003, the City of Springfield was issued a PTI (No. 05-12271) for the installation of a sanitary sewer extension known as the Southern Interceptor. This 9-mile sewer project extends South and East of Springfield. The purpose of the project is to provide both capacity relief to the Mill Run and Buck Creek interceptor sewers, and provide sewer service to unsewered areas south and east of the city.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004 when an NPDES permit was implemented. NPDES violations, reported through SWIMS, revealed a total of 13 for the Springfield WWTP. For the nearly six years of data evaluated, constituents violating permit limits were mostly chlorine reported with the greatest frequency.

Ohio EPA conducted five bioassay events in the summer of 1994, 1999, spring of 2004 and summer of 2004. Two acute bioassays, conducted by Ohio EPA in May and June of 1994, indicated no acute toxicity for both test organisms in effluent and receiving waters. In June of 1999, Ohio EPA conducted a chronic bioassay (fathead minnows and daphnids) which documented no toxicity to either test species. The acute toxicity tests in 2004 revealed mixed results. The spring sample indicated toxicity to both test organisms in the effluent grab sample while the summer sample endpoints indicated no toxicity to either test organism.

Springfield-Beckley Municipal Airport - Mill Creek (RMs 5.32, 5.38, 5.48, 5.60, 5.77), outfalls 001-005 (and unnamed tributary to Mud Run, outfalls 006-007 in WAU 190)
Permit# -1PS00009
Outfall 001 - Lat.: $39^0$51'07"; Long.: $83^0$49'38" – wastewater treatment plant final effluent
Outfall 002 - Lat.: $39^0$51'06"; Long.: $83^0$49'36" - stormwater outfall to Mill Creek - aircraft deicing, fueling areas
Outfall 003 - Lat.: $39^0$51'03"; Long.: $83^0$49'30" - stormwater outfall to Mill Creek
Outfall 004 - Lat.: $39^0$50'59"; Long. : $83^0$49'26" - stormwater outfall to Mill Creek
Outfall 005 - Lat.: $39^0$50'51"; Long.: $83^0$49'49" - stormwater outfall to Mill Creek - aircraft deicing and fueling areas.
Outfall 006 - Lat.: $39^0$50'46"; Long.: $83^0$50'55" - stormwater outfall to an unnamed tributary of Mud Run - aircraft deicing, fueling areas
Outfall 007 – Lat.: $39^0$51'07"; Long.: $83^0$49'38" - stormwater outfall to an unnamed tributary of Mud Run - aircraft deicing, fueling areas

The Springfield-Beckley Municipal Airport wastewater treatment plant is a satellite plant that is owned and operated by the City of Springfield. Treatment consists of an intermittent cycle extended aeration system that serves the airport, the Ohio Air National Guard Base and Air Park Ohio, a small commercial/industrial development. The waste from all three areas includes domestic and commercial/industrial waste. The treatment plant has a design capacity of 70,000 gpd. The treatment process consists of a comminutor, two parallel ICEAS, chlorine contact and post aeration. The treatment facility operates well below capacity and is estimated as operating at half the design. Constituents of concern in stormwater are Jet A gasoline, herbicides, weed killers, fertilizers, cryotech runway de-icer (potassium acetate), diesel fuels and unleaded fuels.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 65 for Springfield Municipal (an average 13 violations per year). For the nearly six years of data evaluated, constituents violating permit limits were mostly TSS violations due to hydraulic overloading of the wastewater facility. Most violations occurred in 2001 and occurred mostly in the spring through early winter months.

Ohio Air National Guard (178th Fighter Wing) - unnamed tributary to Mill Creek (RM 5.0) (and unnamed tributary (RM 4.41) to Mud Run (RM 9.8) in WAU 190).
Permit # - 1IO00000
Outfall 001 - $39^0$50'48"; $83^0$50'32" - stormwater outfall to an unnamed tributary of Mud Run
Outfall 002 - $39^0$51'6"; $83^0$50'5" - stormwater outfall to an unnamed tributary of Mill Creek
Outfall 003 - $39^0$51'06"; $83^0$49'36" - stormwater outfall to an unnamed tributary of Mill Creek

The U.S Department of the Air Force owns and operates the Ohio Air National Guard Airport hereinafter referred to as the OANG Base. The OANG Base is approximately 188 acres located in Clark County at 901 Fontaine Lane and is located to the north of the Springfield-Beckley Municipal Airport in Springfield. As of December 2001, The OANG Base obtained an NPDES permit for the discharge of storm water associated with air field activities, including aircraft fueling, aircraft deicing, aircraft maintenance, aerospace ground equipment maintenance, ground vehicle maintenance, fueling of ground vehicles, and facilities maintenance.

In 2002, ten oil and water separators/interceptors were replaced. Floor drains and wash rack separators were connected to sewers to the Springfield Beckley Airport wastewater treatment plant. In 2004, the OANG Base obtained authorization to use a deicing product with sodium chloride called “Aspen”. “Aspen” contains sodium chloride, magnesium chloride, calcium magnesium and acetate, sodium acetate, magnesium acetate and hexahydrate.

Outfalls 001 and 002 have been tested historically for various compounds such as glycol, ammonia, $cBOD_5$, arsenic, lead, total suspended solids (TSS), oil and grease, and volatile compounds. Recently, the majority of compounds have been found to be below detection; however, ammonia-n was detected at outfall 002 during a spring sampling event. Sampling during deicing season did not reveal any components of concern in the creek.

Numeric violations of NPDES permit limits were evaluated from 2001, when an NPDES permit was implemented, to 2004. NPDES violations, reported through SWIMS, revealed a total of 17 for the Ohio Air National Guard (none in 2004). For the nearly four years of data evaluated, constituents violating permit limits were pH, TSS and dissolved oxygen reported with the greatest frequency. The NPDES violations all occurred in the fall of 2003. When the City of Springfield extends sanitary sewers to this area, the airport wastewater treatment plant will be tied in and decommisioned.

BP Oil No. PL747 - Ison Residence - unnamed tributary to Donnels Creek
Permit # - 1GU00096
Lat.: $39^0$55'00"; Long.: $84^0$00'00"

BP Oil No. PL747 is located in Clark County at 366 N. Hampton Rd in Springfield. This facility is approved for coverage under the Ohio EPA General Permit for Petroleum Related Corrective Actions due to groundwater contamination at the site. In response to groundwater contamination of petroleum products, a mobile treatment system consisting of an oil/water separator tank, transfer tank, and particulate filters followed by activated carbon filtration was moved to the site. The pump and treat system has a design flow of 0.029 MGD and sampling of the effluent is performed one time per month during discharge.

BP Oil No. 09760 – North America – tributary to tributary to Mill Creek
Permit # -1GU00019
Lat.: $39^0$53'69"; Long.: $84^0$48'68"

BP Oil No. 09771 is located in Clark County at 2300 S. Limestone Street, Springfield. This facility is approved for coverage under the Ohio EPA General Permit for Petroleum Related Corrective Actions due to groundwater contamination at the site.

BP Oil is situated on less than an acre of property and its discharge flows in a westerly direction to Mill Creek. In response to groundwater contamination of petroleum products, a mobile treatment system consisting of an oil/water separator tank, transfer tank, and particulate filters followed by activated carbon filtration was moved to the site. The pump and treat system has a design flow of 0.0072 MGD and sampling of the effluent is performed one time per month during discharge.

Competition Accessories - unnamed tributary (RM 1.15) of Mill Creek (RM 1.15/1.17)
Permit # - No Permit Required

Competition Accessories is located in Clark County at 343 West Leffel Lane, Springfield. Historically, this facility had a wastewater treatment plant with an unpermitted discharge to an unnamed tributary of Mill Creek. In March 2004, the wastewater treatment plant was taken off-line and abandoned. Wastewater from this facility is now going to a sanitary sewer collection system and ultimately to the Springfield WWTP.

Chateau Estates Mobile Home Park - East Fork Donnels Creek (RM 6.55)
Permit # -1PV00056
Lat.: $39^0$58'45"; Long.: $83^0$55'32

Chateau Estates Mobile Home Park (MHP) is located in Clark County at 3454 Folk Ream Road, Springfield and is comprised of 225 mobile home pads. The existing wastewater treatment plant is an extended aeration facility consisting of a comminutor, a bypass bar screen, settling tanks, chlorination chamber and a tertiary lagoon. This plant has been hydraulically overloaded since 1995 as evident by the loading violations and reported flow values. From 1999 through 2005, yearly flow values ranged from 0.01 to 0.29 MGD with an average flow of 0.06 MGD. The design capacity of the wastewater treatment plant is 0.035 MGD.

Chateau Estates MHP is currently in Significant Noncompliance (SNC) with the requirements of their NPDES permit. Reasons reported for the violations are mechanical, the need for a greater retention time in the lagoon to reduce ammonia-N, and a sludge blanket buildup to a hydraulically overloaded plant. Chateau Estates MHP is currently exploring connection options to the sewers for the Village of North Hampton.

On August 19, 2004, a PTI (No. 05-13399) was issued to the Village of North Hampton to extend sanitary sewers to the Chateau Estates Mobile Home Park and Northwestern Local School District wastewater treatment plantx, with ultimate disposal at the City of New Carlisle WWTP. The projected date to begin construction for the sanitary sewer extension is in the second quarter of 2005 with a projected completion date by the end of the year of 2005. The Chateau Estates MHP's and Northwestern Local School District wastewater treatment plants should be abandoned by December 2005.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004 when an NPDES permit was implemented. NPDES violations, reported through SWIMS, revealed a total of 359 for Chateau Estates MHP. For the nearly four years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included ammonia-N (NH3-N), TSS and $cBOD_5$ reported with the greatest frequency. The NPDES violations occurred year round and are documented as having occurred since 1995.

Northwestern Local Schools (elementary, middle and high schools) – unnamed tributary (RM 0.69) to East Fork Donnels Creek (RM 7.22)
Permit # - 1PT00012
Lat.: $39^0$21'83"; Long.: $83^0$54'30"

The Northwestern Local Schools are located in Clark County at 5610 Troy Road., Springfield. The Northwestern Local Schools, Troy Rd. campus, includes an elementary, middle and high schools. The wastewater facility serves all of these facilities and the school bus garage. The treatment facility is an extended aeration system utilizing an equalization tank, aeration tank,

clarifier, four slow surface sand filters, chlorination, dechlorination and a sludge holding tank. The wastewater facility has a design flow of 36,000 gpd.

On August 19, 2004, a PTI (No. 05-13399) was issued to the Village of North Hampton to extend sanitary sewers to the Chateau Estates Mobile Home Park and Northwestern Local School District wastewater treatment plants with ultimate disposal at the City of New Carlisle WWTP. The projected date to begin construction for the sanitary sewer extension is in the second quarter of 2005, with a projected completion date by the end of the year of 2005. The Northwestern Local School District wastewater treatment plant should be tied in and abandoned by December 2005.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004 when an NPDES permit was implemented. NPDES violations, reported through SWIMS, revealed two violations of ammonia-N violations for Northwestern Local Schools.

Westwind Apartments (Westwind Properties, LLC) - unnamed tributary (RM 0.07) to Miller Creek (RM1.55)
Permit # -1PW00036
Lat.: $39^0$57'28"; Long.: $83^0$52'02"

Westwind Apartments is located in Clark County at 2107 Troy Road in Springfield. The treatment plant for the apartments has been operating since 1962 and has submitted a permit application to Ohio EPA for its discharge. Westwind Apartments currently operates an extended aeration, activated sludge facility.

Clearview MHP (Suburban Properties) - unnamed tributary (RM 0.14) to the Mad River (RM 24.98)
Permit # - 1PV00098
Lat.: $39^0$54'49"; Long.: $83^0$51'35"

Clearview Mobile Home Park (MHP) is located in Clark County at 2710 Dayton Road, Springfield. The final effluent discharge is 0.14 miles from the confluence of the Mad River. The wastewater treatment plant consists of a trash trap, a flow equalization tank, an extended aeration package plant with a settling tank, dosing chamber, two slow surface sand filters, chlorination/dechlorination tank with post aeration and a sludge holding tank. The wastewater treatment facility was in disrepair and an enforcement case was taken against the owner of Clearview MHP. By September, 2000, a PTI was issued to upgrade the plant to 15,000 gpd average flow to serve 50 lots. The upgrade replaced the lift station, a trash trap and installed a flow equalization tank, sludge holding tank and chlorination/dechlorination.

In April and May 1999, raw sewage was overflowing from the lift station to the tributary of the Mad River. Cross contamination of the mobile home park drinking water occurred in 2000 when it was documented that sewage bacteria entered the drinking water wells. In June 2000, the Ohio

Attorney Generals Office, on behalf of the Director of the Ohio EPA, filed a complaint with the Clark County Common Pleas Office to enforce Ohio's water pollution control and drinking water laws. The new wastewater treatment plant was completed in December, 2000, under PTI No. 05-11172. During the period from January, 2001, through December, 2005, the operations of this discharger resulted in an average effluent flow of 10,000 gpd.

Problems at the facility over the past six years included a lift station repair in April 1999, however overflows continued as documented in August, 1999. In 1999, a filter bed leakage was discovered and repaired when sewage was noted "leaking out into the tributary. An Ohio EPA inspection in 2004 recorded deficiencies again in the sand filter beds that were clogged with solids and weeds. Only one of the two pumps was operating at the lift station and a flow metering device was not operable. In May 2003, a PTI was issued to Clark County Utilities Department for the installation of a sanitary sewer extension to serve Clearview MHP, Edgewood MHP, Enon Heights MHP and surrounding area. This sewer project is in jeopardy due to funding issues.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004 when an NPDES permit was implemented. NPDES violations, reported through SWIMS, revealed a total of 30 for Clearview MHP. Eighty-seven percent (87%) of violations occurred in 2000. No violations occurred from September of 2002 until August of 2004. For the nearly six years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included TSS and ammonia-N (NH3-N) reported with the greatest frequency.

Edgewood MHP - unnamed tributary (RM 0.35) to the Mad River (RM 22.8)
Permit # -1PV00100
Lat.: $39^0$54'33"; Long.: $83^0$53'03"

Edgewood MHP is located in Clark County at 3770 Dayton Rd, Springfield. The treatment works was originally built in 1972. The existing wastewater treatment plant is an extended aeration plant consisting of a trash trap, settling tanks, dosing chamber, slow surface sand filters, and chlorination/dechlorination tank with post aeration. The design flow for this facility is 0.01 MGD.

In January 2001, a PTI (No. 05-11226) was issued to Edgewood MHP for upgrades to the existing wastewater treatment plant. Upgrades included the installation of flow equalization, converting one of the clarifiers to a sludge holding tank, installing a fixed media clarifier and a dechlorination tank. This upgrade did not occur. Instead, in May, 2003, a PTI was issued to Clark County Utilities Department for the installation of a sanitary sewer extension to serve Clearview MHP, Edgewood MHP, Enon Heights MHP and the surrounding area. This sewer project is in jeopardy due to funding issues.

In 2002, an Ohio EPA inspection disclosed solids in the creek downstream from the final outfall. Edgewood's effluent constitutes the majority of flow for this creek.

Numeric violations of NPDES permit limits were evaluated from 2003 through August of 2004. NPDES violations reported through SWIMS, revealed a total of 16 for Edgewood MHP. For the approximate two years of data evaluated, constituents violating permit limits were mostly ammonia-N. Reasons given for past ammonia-N violations were storm events, insufficient chlorine supply and insufficient retention time to reduce ammonia-N concentrations. All of the violations occurred in fall and winter of 2003.

Tecumseh Court MHP - unnamed tributary to the Mad River
Permit # -1PV000126
Lat.: $39^0$55'20"; Long.: $83^0$54'44"

Tecumseh Court MHP is located in Clark County at 5550 W. National Road, Springfield. The existing sewage system for the park consists of a septic tank with a discharge through a field tile to an unnamed tributary of the Mad River. The sewage system serves 26 mobile home pads with an estimated flow of 7,800 gpd. On several occasions, Ohio EPA requested a NPDES permit application for the discharge which was in violation of Ohio Revised Code (ORC) 6111.04 and Ohio Administrative Code (OAC) Rule 3745-33-02(A). An application was finally submitted in August, 2004, as required by Director's Final Findings and Orders. A recent Ohio EPA inspection at the facility noted black sludge deposits and sewage fungus beneath and downstream from the outfall.

Enon Heights MHP - unnamed tributary (RM 0.4) to the Mad River (RM 21.1)
Permit # - 1PV00106
Lat.: $39^0$53'55"; Long.: $83^0$53'52"

Enon Heights Mobile Home Park is located in Clark County at 4460 Dayton Rd, Springfield. The mobile home park began discharging in the early 1970s. New ownership was established in 2001. Wastewater treatment consists of a 5,000 gallon septic tank, subsurface sand filter and polishing lagoon. During dry weather, this discharge infiltrates into the ground rather than flowing into the Mad River.

On March 31, 2001, a PTI was issued to Edgewood for the installation of a new wastewater treatment plant. Upgrades should have included the installation of an extended aeration package plant with flow equalization, aeration tanks, settling tanks, sludge holding tank, dosing chamber, slow surface sand filters, and ultraviolet disinfection with post aeration. The design capacity of this wastewater treatment plant was 13,500 gpd. This upgrade did not occur. Instead, in May 2003 a PTI was issued to Clark County Utilities Department for the installation of a sanitary sewer extension to serve Clearview MHP, Edgewood MHP, Enon Heights MHP and the surrounding area. This sewer project is in jeopardy due to funding issues.

Numeric violations of NPDES permit limits were evaluated from 2003 through August of 2004. NPDES violations, reported through SWIMS, revealed a total of 22 for Enon Heights MHP. For

the year of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included fecal coliform bacteria and dissolved oxygen reported with the greatest frequency. No seasonal patterns were noted for the violations.

Enon Water Treatment Plant - Mad River
Permit # - 1IX00032
Lat.: $39^0$53'05"; Long.: $83^0$56'12"

The Enon Water Treatment Plant is located in Clark County at 2825 Enon Rd, Enon. The plant is a Municipal Water Supply and Ion Exchange treatment facility producing potable waters for approximately 1300 customers. The Ion Exchange wastewater is discharged from the brine storage tank at a controlled rate to avoid a slug discharge. Discharge waste volume is 30,000 gpd from a 600,000 gpd production rate of potable water. The process used to treat the drinking water is cationic exchange softening, chlorination and fluoridation.

Moyno Incorporated (Robbins and Myers, Inc.) - stormsewers to an unnamed tributary of the Mad River
Permit # -1IS00019
Lat.:$39^0$55'18"; Long.: $83^0$50'40"

Moyno Inc. is located in Clark County at 1895 W. Jefferson St, Springfield. This facility manufactures and markets the Moyno® brand of pumps, multiphase fluids transfer systems, grinders and controls. The company has an extensive international distribution network that serves a wide range of industries including water and wastewater treatment, pulp and paper manufacturing, specialty chemicals, food and beverage, pharmaceuticals, mining, petrochemical, and oil and gas transfer. Moyno® Products are marketed internationally under the R&M® brand name.

Moyno Inc. was issued an Ohio EPA NPDES permit in 1983 for two outfall locations (001 and 002). These outfalls discharged noncontact cooling water from two different sources in the facility. Currently the remaining outfall 001 carries noncontact cooling water from various facility processes to a manhole near the guard house prior to discharge to a storm sewer.

Pleasant Valley Estates MHP - Warden Ditch (RM5.6) to Smith Ditch (RM 1.24) to the Mad River (RM 12.28)
Permit # - 1PV00105
Lat.: $39^0$3'44"; Long.: $83^0$55'23"

Pleasant Valley Estates MHP is located at 2125 S. Tecumseh Rd, Springfield. A PTI (No. 05-11800) was issued on January 31, 2002 for an upgrade to their wastewater system. The wastewater treatment facility is an extended aeration package plant consisting of a trash trap, flow equalization tank, settling tank, dosing chamber, four slow surface sand filters, ultraviolet disinfection with post aeration and a sludge holding tank. The average design flow is

approximately 52,000 gpd. The system was upgraded to meet BADCT limits.

During inspections in 1997, 1999, 2000 and 2001, solids were observed in the tributary immediately at and downstream from Pleasant Valley's outfall. An Ohio EPA inspection in July 2004 validated that the wastewater treatment plant had been upgraded. The final effluent appeared clear and odor free and the receiving stream did not appear to have solids.

Numeric violations of NPDES permit limits were evaluated from September, 2000, when the NPDES permit became effective, through 2004. NPDES violations, reported through SWIMS, revealed a total of 114 numeric and over 1,000 frequency violations for Pleasant Valley MHP. Ninety-six percent (96%) of the numeric violations occurred during the period from October, 2000, through April, 2003. For period of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included $cBOD_5$, TSS, ammonia-N and dissolved oxygen.

Tecumseh High School WWTP - unnamed drainage ditch to Jackson Creek (RM 1.96)
Permit # -1PT00042
Lat.: $39^0$54'52":Long.: $83^0$59'45"

Tecumseh High School is located in Clark County at 9830 West National Road, New Carlisle. The wastewater treatment plant is an extended aeration package plant with a settling tank, chlorination/dechlorination tanks and post aeration. This facility received an Ohio NPDES permit in 2001. The operations of this discharger results in a daily design flow of 38,000 gpd.

On July 12, 2001, the Ohio EPA received a PTI (No. 05-11686) for the installation of a sanitary sewer extension to Clark County Southwest Regional WWTP to serve the Village of Donnelsville, Tecumseh Local School District, Gifford Apartment Complex and other residential and non residential sites. Revisions to this application have been completed and resubmitted to the Ohio EPA in 2004. The treatment plants for Tecumseh Local School and Gifford Apartment Complex will be abandoned with the completion of the sewer extension which began in January 2005. The projected completion for installation of the sewer extension is July 2005.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of 28 for Tecumseh High School. Sixty-four percent (64%) of the violations occurred in 2003. For the nearly six years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included $cBOD_5$, TSS and chlorine reported with the greatest frequency.

Lower Mad River Tributaries Watershed Assessment Unit (WAU 05080001 190)
The Lower Mad River Tributaries watershed assessment unit, encompassing 64,116 acres (100.2 mi^2) in Clark, Miami, Montgomery, and Greene counties, includes tributaries in the Mad River basin from the Mud Creek confluence at RM 10.54 to the mouth. Direct tributaries of the Mad River mainstem in the assessment unit include Mud Creek (drainage area 22.9 mi^2, confluence RM 10.54), Mud Run (drainage area 27.4 mi^2, confluence RM 10.07), Hebble Creek (drainage area approximately 10.5 mi^2, confluence RM 6.07), and Lilly Creek (drainage area approximately 7 mi^2, confluence RM 2.72). Other streams assessed include Clear Creek which enters Mud Run at RM 8.95 and drains 5.34 mi^2, an unnamed tributary entering Mud Run at RM 9.8 with a drainage area of approximately 5.6 mi^2, and Dry Lick Run which enters Mud Creek at RM 0.83 and drains 7.13 mi^2.

Compared to watershed assessment units in the upper portions of the Mad River watershed, a much higher proportion of the land cover in this lower assessment unit (Figure 44) is comprised of residential (17.4%), commercial/industrial/transportation (6.5%), and urban/recreational grasses (17.8%). However, row crop agriculture and pasture/hay, predominately in the northern and eastern sections of this assessment unit, account for 33% and 17%, respectively, of the total land use (University of Cincinnati, 2001). Forested areas cover 6.8% of the land. The assessment area encompasses parts of the Cities of Dayton, Riverside, Huber Heights, Fairborn, and Beavercreek. It also includes portions of the Village of Enon, Green Meadows CDP, Park Layne CDP, and Holiday Valley CDP. Additionally, Wright Patterson Air Force Base (WPAFB), located between the cities of Dayton and Fairborn on 7,611 acres (11.9 mi^2) in Greene and Montgomery Counties, is the headquarters for the Material Command whose primary function is national defense as well as research and development, testing, and aircraft maintenance. The facility has a workforce numbering approximately 22,000 people, making it the fifth largest employer in the state of Ohio.

The aquatic life use designation in effect during the 2003 survey for Mud Run and Clear Creek was Warmwater Habitat (WWH) and the recreation use designation was Primary Contact Recreation (PCR). The Modified Warmwater Habitat (MWH) and Secondary Contact Recreation (SCR) designations were in effect in Hebble Creek. Other streams in the assessment unit (Mud Creek and its tributary Dry Lick Run, the unnamed tributary entering Mud Run at RM 9.8, and Lilly Creek) were previously undesignated.

Many of the point sources in the assessment unit discharge in the Mud Run watershed. An unnamed tributary entering Mud Run at RM 9.8 receives stormwater discharges from both the Ohio Air National Guard (OANG) (178^{th} Fighter Wing) at RM 4.41, and Springfield-Beckley Municipal Airport at RMs 4.27 and 4.05, as well as wastewater from Hustead Elementary School at RM 1.50. (Both the OANG and Springfield-Beckley Municipal Airport have additional outfalls to Mill Creek in WAU 05080001 180.) Greenon High School discharges at RM 0.65 to a tributary which enters another unnamed tributary at RM 1.22 which then enters Mud Run at RM 9.2. Other dischargers in the assessment unit include the Huber MHP, discharging to a small drainageway which flows approximately 0.5 miles before, in all likelihood, infiltrating into

the ground prior to reaching the Mad River mainstem (near RM 7.25), and Gifford Apartment Complex (Hackworth Apartments) which has an unpermitted discharge to Mud Creek at RM 5.04.

WPAFB has multiple stormwater and noncontact cooling water outfalls to Hebble Creek and tributaries to the Mad River in this assessment unit. (WPAFB also has multiple outfalls discharging directly to the Mad River mainstem in WAU 05080001 003). Outfall 020 discharges at RM 0.29 to a tributary entering the Mad River at RM 9.64. Four outfalls (016–019) discharge directly to Bass Lake or to the tributary draining Bass Lake which subsequently enters the Mad River at RM 8.27. An unnamed tributary entering the Mad River at RM 6.88 receives discharges from Outfall 014 (RM 1.13) and Outfall 015 (RM 0.30/0.73). Hebble Creek receives the discharge from Outfalls 013 (RM 3.06), 012 (RM 3.00, after combining with outfall 021), 011 (RM 2.85), 010 (RM 2.58), 009 (near RM 2.32), 008 (RM 2.00), 007 (RM 1.82), 006 (RM 0.39 to a tributary entering at RM 1.62) and 005 (RM 0.49 to a tributary entering at RM 1.00 after combining with outfall 022).

Additionally, Southwestern Portland Cement (SWPC) Landfill No. 1, a former cement kiln dust (CKD) disposal area covering approximately 180 acres, is located northeast of WPAFB in the Mud Run watershed. The Ohio EPA Division of Emergency and Remedial Response conducted a Preliminary Assessment/Site Investigation (PA/SI) at the landfill on May 19-20, 2003 (OEPA 2003). During the investigation, the Ohio EPA sampled soil, groundwater, sediment, and surface water throughout the disposal site and surrounding area. Groundwater in the aquifer beneath the landfill was observed to have elevated pH and total dissolved solids (TDS), low hardness, and concentrations of the metals selenium and arsenic above Maximum Contaminant Levels (MCLs). Groundwater discharge is expressed in the form of seeps which coalesce to form intermittent surface water drainage to Mud Run. In addition to elevated TDS, low hardness, and pH values above 12 SU, leachate seeps sampled contained elevated concentrations of copper, lead, selenium, nickel, and vanadium. WQS criteria for copper, lead, and nickel are dependent on water hardness ($CaC0_3$). As the water discharges from the onsite seeps and migrates toward Mud Run, pH neutralizes and soluble metals begin to precipitate from solution. Samples taken at five locations in Mud Run (RM 3.35-ustream at Spangler Road, RM 2.65-confluence of tributary fed by Seep #2, RM 2.40, RM 2.18-confluence of tributary fed by Seep #1, and RM 2.03-Haddix Road) during the May sampling were, for the most part, within acceptable WQS criteria . Selenium was elevated in Mud Run at RMs 2.65 and 2.18 while a pH of 10.4 SU was measured at RM 2.18. Analysis of stream water samples collected in Mud Run downstream from Landfill No. 1 as part of the summer 2003 survey did not reveal any elevated parameters. Concentrations of arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc were less than applicable minimum detection limits (MDLs) in all water samples collected during the summer both upstream (RM 3.33) and downstream (RM 1.98) of Landfill No. 1. Hardness, TDS, and pH values were also comparable upstream and downstream from the site.

Aquatic Life Uses

Biological and habitat assessments were conducted at 14 sites in 2003 in the Lower Mad River Tributaries assessment unit ranging in drainage area between 4.6 and 26.4 mi^2 (Table 18). Nine sites were in full attainment of designated or recommended aquatic life uses. Two sites supported biological communities that partially attained ecoregional expectations. Three sites failed to meet designated or recommended aquatic life use designations. The WAU overall attainment score was 73.2%. (Table 1).

The WAU attainment score reflects the majority of sites meeting aquatic life use designations. However, several Mad River tributaries were impaired. Most noticeable was the degraded condition of Mud Creek at RM 5.0 due to organic and nutrient loading from an unpermitted WWTP. Other sources of assessment unit impairment included urban runoff in Hebble Creek and loss of substrate heterogeneity in Mud Run resulting from past practices at the Portland Cement Landfill #1.

Mud Run and Clear Creek are listed as WWH streams in the 1978 and 1985 Water Quality Standards, but, prior to this most recent survey the aquatic life use had not been verified. The 2003 biological and habitat results were consistent with the designation. Hebble Creek was a designated MWH stream based on a previous biological survey. Four sampled streams, Mud Creek, an unnamed tributary to Mud Run (RM 2.18), Dry Lick Run and Lilly Creek, are previously undesignated tributaries to the Mad River.

The discharge from an unpermitted WWTP servicing Gifford Apartment Complex (Hackworth Apartments) negatively affected the macroinvertebrate community at US 40 on Mud Creek (RM 5.0). Black septic sediments and sewage fungus were present below the discharge. Snails and midges predominated and suggested low dissolved oxygen levels were impacting the stream. The WTTP discharge was located within the reach of stream where fish sampling was conducted. As a result, the IBI score met ecoregional expectations but was calculated based on collected fish of which only a portion were subjected to the inadequately treated sewage. The obvious release of sewage masked potential impacts attributable to the extensive plant nursery operation upstream from the site. The stream biota benefited from the addition of groundwater derived flow at RM 2.5 and RM 0.6. The IBI score increased at both sites into the exceptional range and the macroinvertebrate qualitative sampling produced assemblages reflective of fair and marginally good conditions, respectively.

The Portland Cement landfill #1 was a significant concern located in the Mud Run watershed. Upstream from the landfill, four sampled locations all met WWH expectations. Macroinvertebrate results were consistently in the exceptional range. The fish results were more variable upstream from the facility owing to differing degrees of habitat modification and groundwater contribution. Fish index scores were in the marginally good to exceptional range.

Table 18. Aquatic life use attainment status of the Lower Mad River Tributaries watershed assessment unit, June-October, 2003. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb) and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate (ICI) communities. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

Stream River Mile Invertebrate/Fish	Attainment Status	IBI	MIwb	ICI/ narrative	QHEI	Drainage Area
WAU: 5080001 190						
Mud Creek				*undesignated/ WWH recommended*		
5.0/5.0	NON	40		P*	50.5	5.9
2.5/2.5	Partial	46		F*	56.5	9.1
0.6/0.6	Full	52		MG^{ns}	82	19.6
Mud Run				*WWH (verified)*		
9.7/9.7	Full	56		E	65	11.8
7.8/7.8	Full	54	9.2	56	77	20.4
3.3/3.3	Full	40	7.8^{ns}	56	69	25.5
2.0/2.0	Full	51	8.0^{ns}	48	73	26.4
0.8/0.8	Partial	41	6.4*	48	57	27.2
Clear Creek				*WWH (verified)*		
0.5/0.5	Full	48		G	65	5.2
Trib. to Mud Run (RM 9.8)				*undesignated/ WWH recommended*		
0.7/0.7	NON	24*		G	65.5	5.6
Drylick Run				*undesignated/ WWH recommended*		
1.6/1.7	Full	40		MG^{ns}	74.5	4.6
Hebble Creek				*MWH*		
5.0/5.0	Full	30		F	34	5
0.1/---	(Full)			G		
Lilly Creek				*MWH recommended*		
0.1/0.1	Partial	22*		F	70.5	6.6

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

INDEX - Site Type	LRW	MWH channel modified	CWH	WWH	EWH
IBI Headwater - Wading/ Boat	18/18	24/24	40	40/ 42	50
MIwb Wading/ Boat	4.0/4.0	6.2/5.8	-/6.6	8.3/ 8.5	9.4/ 9.6
ICI	8	22	36	36	46

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns Nonsignificant departure from biocriterion (<4 IBI or ICI units; <0.5 MIwb units).
a Narrative evaluation used in lieu of ICI (E=Exceptional; G=Good; MG=Marginally Good; F=Fair; P=Poor).
b Use attainment status based on one organism group is parenthetically expressed.
N/A Not Applicable. The MIwb is not applicable to headwater sites.

Downstream from the landfill (RM 0.8), the streambed was coated with a thick solidified layer that was apparently a remnant of past practices at Portland Cement. As a result, substrates were effectively cemented together and interstitial spaces were eliminated. The fish assemblage was acceptably diverse but the community structure was not consistent with a WWH use, likely due to the condition of the substrate. The WWH use was partially met with the MIwb score in the fair range. Water quality did not appear a significant source of impairment. Macroinvertebrate sampling continued to yield ICI score in the exceptional range. Since ICI scoring is based largely on sampling that utilizes artificial substrates, any impact on natural substrate quality due to cement kiln dust was minimized.

The unnamed tributary to Mud Run (RM 2.18) supported macroinvertebrates that reflected a good community conditions. Conversely, fish sampling produced a limited assemblage of headwater species and a poor IBI score resulted. The lack of a more diverse fish suggested a proclivity for the stream to become intermittent during periods of limited rainfall. In this way, the unnamed tributary to Mud Run may be better classified as a Primary Headwater Habitat. It is recommended that the WWH use be applied until the applicability of the primary headwater use is investigated. Based on the 2003 survey, this stream was in nonattainment of the recommended use principally due to natural conditions pertaining to a limited watershed size and hydrology.

A WWH aquatic life use is recommended for Dry Lick Run. Sampling at RM 1.6/1.7 yielded a marginally good macroinvertebrate community and a good fish community; however, both assemblages were less diverse than expected given the variety of instream habitats present. These results were consistent with an intermittent flow condition during periods of limited rainfall. The sampled location was downstream from the Carriage Hill MetroPark providing some assurance that the good habitat attributes will be maintained. One concern for the maintenance of an acceptable biological resource comes from development in the upper reaches of the watershed that may alter the hydrology and introduce pollutants to the system.

The uppermost site on Hebble Creek (RM 5.0) supported fish and macroinvertebrate communities that met expectations for the designated MWH use. Both assemblages were in fair condition and affected by marginal habitat and water quality associated with the urbanized condition of the watershed. The macroinvertebrate community was in good condition near the mouth and benefited from improved instream habitat and wooded riparian area. No fish sampling was conducted due to limited access near the mouth.

The modified warmwater habitat aquatic life use (MWH) is recommended for Lilly Creek because establishment of fully functioning biological communities is unlikely given the existing physical limitations of the drainage. The QHEI score of 75 at RM 0.1 would normally be strong evidence for a WWH use, however, the relatively good habitat at the site was very much anomalous. Lilly Creek flows through an urban area and suffered from ailments common to urbanized streams including alteration of the natural flow regime due to hardening of the landscape and pollutants contained in stormwater runoff and sediments. Additionally, a series of small eutrophic impoundments overflowed into Lilly Creek upstream from RM 0.1 and

introduced an organic load and nutrients to the stream. The biological sampling yielded results that partially met a MWH use due to the poor condition of the fish community. Tolerant and pioneering fish species predominated at RM 0.1 and generated an IBI score of 22. Macroinvertebrate sampling produced a largely facultative assemblage that was consistent with a MWH aquatic life use.

Recreational Uses

Much like the entire Mad River watershed, applicable recreational use designations were not attained in this assessment unit (Table 27 and Figure 10, Appendix Table A-2). The highest median bacteria concentrations of the entire survey occurred in Lilly Creek (4900 colonies/100ml fecal coliform, 1900 colonies/100ml *E. coli*). This urban stream also experienced consistently elevated TSS concentrations with the highest median concentration of the survey (27 mg/l) and all values above the reference background value. A lagoon located in Eastwood MetroPark, like Eastwood Lake, serves as part of a groundwater recharge system for the City of Dayton. To maintain the water level in the lagoon, water is pumped into the lagoon from a branch of the Mad River, moves through the lagoon and then enters Lilly Creek at the west end of the park near RM 0.19 (Five Rivers MetroPark, 2005).

Chemical Water Quality

Field measurements and inorganic water chemistry grab samples were collected at 14 sites in this assessment unit at two-week intervals (six times) from mid-July to late September (Table 25). Samples were analyzed for a variety of parameters including nutrients and metals (Figure 45 - Figure 47, Appendix Table A-1). Four of these sites (Mud Run RM 3.33 and RM 1.98, Hebble Creek RM 0.25, and Lilly Creek RM 0.10) were also sampled for organic compounds (volatiles, semivolatiles, pesticides, and polychlorinated biphenyls (PCBs)) twice during the survey (Table 28, Appendix Table A-3). Bacteria samples (fecal coliform and *E. coli*) were collected at three sites (Mud Run RM 1.98, Hebble Creek RM 0.25, and Lilly Creek RM 0.10) five times within a thirty-day period in order to determine recreational use attainment (Table 27, Appendix Table A-2). Additionally, a Datasonde™ continuous monitor was deployed in Hebble Creek at RM 0.25 for a 48-hour period in July and again in September (Figure 8). There were no stream flow or precipitation stations located in this assessment unit during the 2003 survey; see pertinent flow and precipitation figures in both WAU 05080001 180 and 05080001 003.

Water chemistry results which exceeded State of Ohio Water Quality Criteria Standards (WQS) are presented in Table 26 and Table 27.

Datasonde™ monitors placed in Hebble Creek at RM 0.25 in both July and September (Figure 8) recorded consistently elevated conductivities with medians near 900 µmhos/cm (the highest of any site in the survey). July values were highly variable ranging from 490-991 µmhos/cm. Field notes indicate higher flow and slight turbidity at the site from recent precipitation. Biweekly

grab sampling results for conductivity (median 888 µmhos/cm) and chloride (median 86 mg/l) were also the highest in the survey.

Daytime grab dissolved oxygen concentrations dropped below the WWH WQS criterion on two occasions at RM 5.03 in Mud Creek, downstream from the Gifford Apartment Complex WWTP. Field crews frequently reported murkiness and sewage odor at this site. (In September 2004, the Ohio EPA received revisions to a permit to install (PTI) application for sanitary sewer extensions to connect the Gifford Apartment Complex as well as the Village of Donnelsville and Tecumseh Local School District in WAU 05080001 180 to the Clark County Southwest Regional sewerage collection system.

Seventy-eight percent (78%) of ammonia-N concentrations in the assessment unit were less than the laboratory detection limit of 0.05 mg/l. Concentrations above applicable ECBP reference values occurred at several locations on August 28 after precipitation. While an overall nitrate-nitrite-N median of 4.15 mg/l was measured for all samples collected in the assessment unit, site medians ranged from 0.975 mg/l in Dry Lick Run to 7.45 mg/l in Clear Creek (RM 0.50). Field notes mention cattle in a pasture upstream from the Clear Creek sampling location. Phosphorus concentrations were low with an overall median of 0.038 mg/l and 95% of values well below reference background levels. The highest median phosphorus concentrations were measured in Lilly Creek (0.1 mg/l) and Clear Creek (0.09 mg/l).

Nine organic compounds were detected in the water column during the survey (Table 28, Appendix Table A-3). Atrazine and metolochlor, the most frequently detected compounds, accounted for 21% and 18%, respectively, of the total detections. Dieldrin exceeded the non-drinking water human health WQS criterion in Lilly Creek in the August sampling.

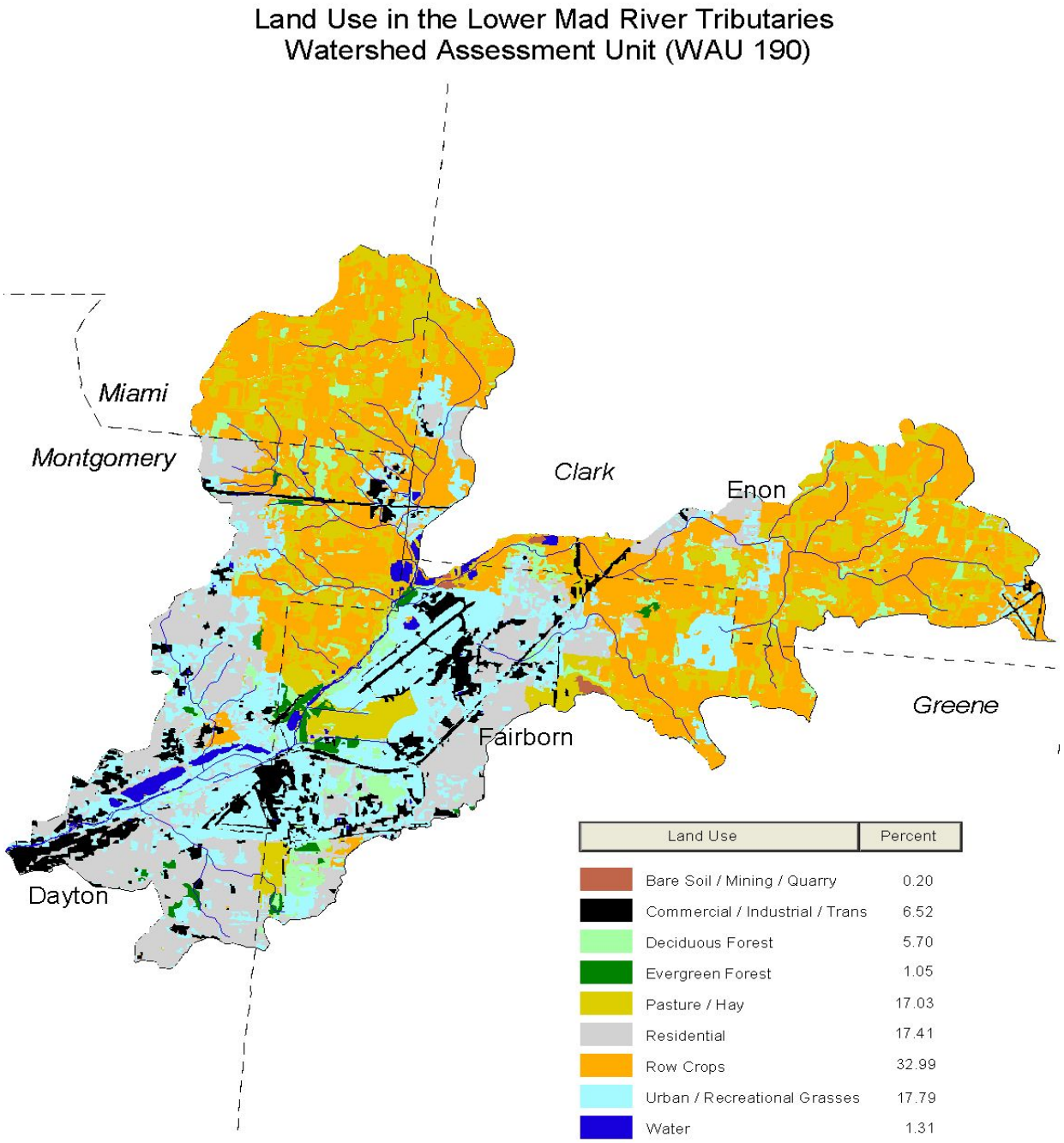


Figure 44. Land Use in the Lower Mad River Tributaries Watershed Assessment Unit (WAU 05080001 190); (University of Cincinnati, 2001).

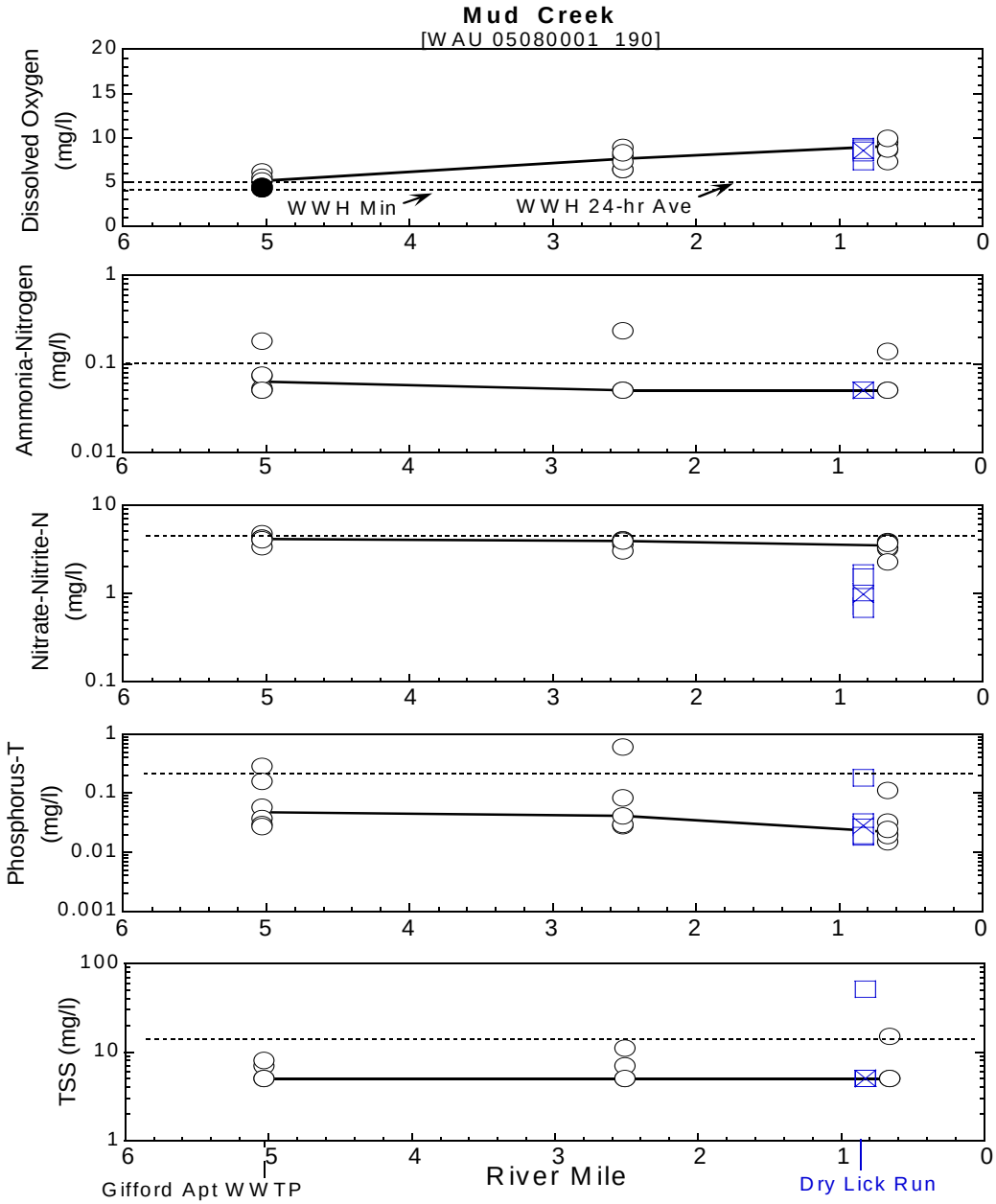


Figure 45. Longitudinal plots of water chemistry daytime grabs in Mud Creek (circles) and Dry Lick Run RM 1.62 (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in Mud Creek while an 'X' depicts the median in Dry Lick Run. WQS criteria are shown in the dissolved oxygen plot. (Values below criteria are shown as solid circles or squares.) Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

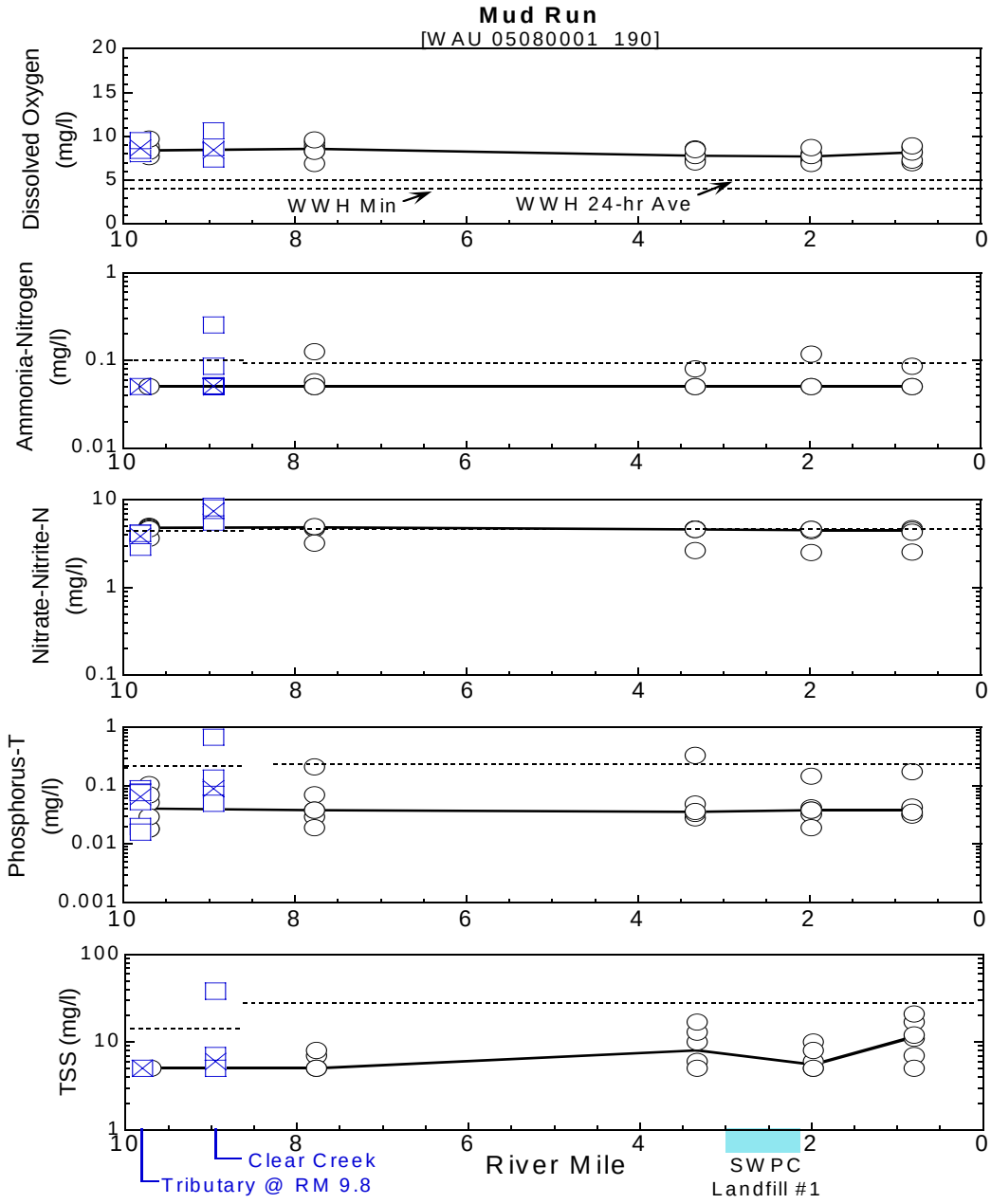


Figure 46. Longitudinal plots of water chemistry daytime grabs in Mud Run (circles), an unnamed tributary RM 0.70 (squares), and Clear Creek RM 0.50 (squares) during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled in Mud Run while an 'X' depicts the median in the tributary and Clear Creek. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

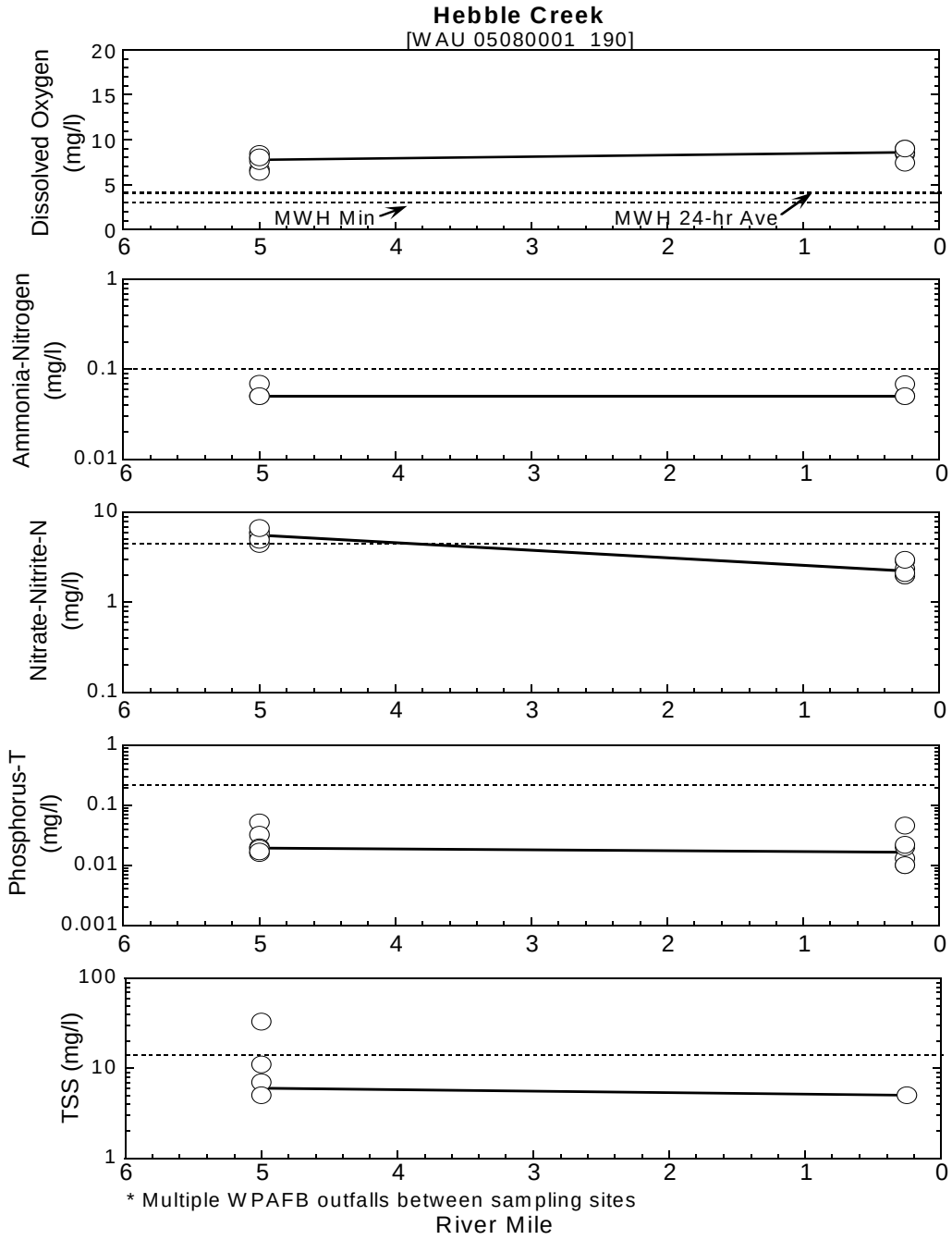


Figure 47. Longitudinal plots of water chemistry daytime grabs in Hebble Creek during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

Chemical Sediment Quality

Sediment quality was evaluated at six sites in WAU 05080001 190 (Table 19 and Table 20). Mud Run was sampled at three locations to bracket the old Southwest Portland Cement Landfill No. 1. Previously, the Ohio EPA conducted a Preliminary Assessment/Site Investigation (PA/SI) at the former Southwestern Portland Cement Landfill No. 1 on May 19-20, 2003. This cement kiln dust landfill covers 180 acres and has two leachate seeps forming two small unnamed tributaries draining to Mud Run at RM 2.13 and RM 2.55. the Ohio EPA's PA/SI documented leachate containing elevated pH (>12), selenium, arsenic, nickel and lead. As water discharges from on-site seeps and migrates toward Mud Run, soluble metals begin to precipitate from solution. This is reflected by the whitish color of sediment along the bottom of the unnamed tributaries.

A total of six sediment samples, including a background sample, were collected during the PA/SI. Five samples were collected from Mud Run, and one sample was collected from the Seep No. 1 area. None of the Mud Run and unnamed tributary No. 1 sediment samples exceeded the MacDonald TEC or PEC for numerous metals and polycyclic aromatic hydrocarbon (PAH) compounds. Two inorganic parameters, calcium and selenium, exceeded the Ohio SRV values, with the highest selenium value recorded at the background site. Chemical results reflected noncontaminated sediment conditions in Mud Run and unnamed tributary No. 1.
No samples were taken in tributary No.2.

Sediment sampling of Mud Run conducted during the 2003 Mad River survey confirmed results of the PA/SI. Mud Run samples at RM 9.7 and RM 3.33 were upstream from the seeps at RM 2.13 and RM 2.55. No metals above the Ohio SRV guidelines were detected. The insecticide methoxychlor (1.080 mg/kg) was detected at RM 9.7. There is no sediment guideline for this insecticide. Both upstream sites had sediment ammonia at levels above the Ontario sediment disposal guideline (100 mg/kg).

Sediment results from Mud Run RM 1.98, downstream from the seeps, documented zinc (162 mg/kg) over the Ohio SRV and between MacDonald TEC and PEC. No other metal or organic compounds were above the MacDonald TEC or the Ohio SRV. At all sites on Mud Run, the laboratory contaminant acetone was detected.

Lilly Creek (RM 0.1) was one of the more contaminated sediment sites in the survey. Complaints about contamination in the creek at Woodman and Airway Roads (RM 1.34) have been documented since 1983. Sediment samples taken during 1987 in this area detected naphtha, toluene, trichlorethylene, tetrachlorethylene, and PAH compounds. Many sources were suspected but no one was observed discharging.

In 2003, no metal results were detected over the MacDonald TEC or the Ohio SRV in Lilly Creek sediments. Eleven different PAH compounds were detected totaling 41.25 mg/kg. Seven individual PAH compounds were over the MacDonald PEC, adverse effects upon benthic

organisms are likely to occur. Sediment ammonia (200 mg/kg) was above the Ontario sediment disposal guideline (100 mg/kg).

Six different pesticides were detected in Lilly Creek sediments. Total chlordane (0.153 mg/kg) was detected over the MacDonald PEC. 4, 4'-DDT and heptachlor were between the MacDonald TEC and PEC, meaning adverse affects frequently occur. Methoxychlor (0.053 mg/kg) and trans-nonachlor (0.045 mg/kg) were also detected but no sediment guidelines are developed for these pesticides.

Mud Creek at RM 5.03 is downstream from two commercial nurseries south of New Carlisle and a failed package plant serving an apartment quadplex. The pesticide degradation byproduct, 4, 4'-DDE, was detected between the MacDonald TEC and PEC. Sediment ammonia (750 mg/kg) was the second highest level recorded during the survey. Sewage sludge was a major component of the sediment sample. All metals were below the MacDonald TEC and the Ohio SRV.

Hebble Creek (RM 0.25) was a clean sample. No metals were detected over the MacDonald TEC or the Ohio SRV. No sediment organics were detected.

Watershed Protection Efforts

There have been no formal watershed projects covering all of the Lower Mad River Tributaries (WAU 05080001 190) and mainstem (LRAU 05080001 003), but a cooperative effort between the City of Dayton, the Miami Valley Regional Planning Commission, and others (the Watershed Enhancement Project) calls for partnering with entities for watershed and wellhead protection.

Table 19. Concentrations (mg/kg) of metals and nutrients in sediment samples collected in the Lower Mad River Tributaries watershed assessment unit (WAU 05080001 190) during 2003. Parameter concentrations were evaluated based on Ohio EPA sediment metal reference sites (2003), MacDonald (2000) Sediment Quality Guidelines (SQG) and Persuad (1993). Values above guidelines are highlighted.

Parameter	Site Location (RM)							
	Mud Creek US 40 RM 5.03	**Mud Run** Hagan Rd RM 9.70	**Mud Run** Spangler Rd RM 3.33	**Mud Run** Haddix Rd RM 1.98	**Hebble Creek** Hebble Creek Rd. RM 0.25	**Lilly Creek** near mouth RM 0.10	***Reference***	
							Ohio	**MacD**
Al-T [O]	14800	19800	19500	19100	19100	12800	39000	*
As-T [OM]	7.90	6.86	6.91	7.32	5.48	7.43	18	9.79-33
Ba-T [O]	104	151	155	166	107	103	240	*
Ca-T [O]	51300	53700	50500	67800	31100	72000	120000	*
Cd-T [OM]	0.311	0.325	0.36	0.349	0.372	0.417	0.9	0.99-4.98
Cr-T [OM]	<22	23	21	<25	22	20	40	43.4-111
Cu-T [OM]	13.4	12.7	14.7	16.9	11.4	18.3	34	31.6-149
Fe-T [O]	13500	16900	16500	17400	16100	13200	33000	*
Hg-T [OM]	0.054	<0.036	<0.044	0.035	<0.028	0.044	0.12	0.18-1.06
K-T [O]	3000	3720	3730	3790	4150	3290	11000	*
Mg-T [O]	18100	15200	14200	16100	11600	22400	35000	*
Mn-T [O]	306	370	362	435	265	294	780	*
Na-T *	<3630	<3420	<3480	<4140	<2840	<3270	*	*
Ni-T [OM]	<29	<27	<28	<33	<23	<26	42	22.7-48.6
Pb-T [OM]	31	<27	<28	<33	<23	26	47	35.8-128
Se-T [O]	<1.45	<1.37	<1.39	<1.66	<1.14	<1.31	2.3	*
Sr-T [O]	87	47	47	58	41	64	390	*
Zn-T [OM]	72.1	74.1	88.2	162+#	73.4	116	160	121-459
							Ohio	**Pers.**
NH_3-N [P]	750 [L]	210 [L]	120 [L]	82	73	200 [L]	*	100
TOC [P]	5.2%	5.6%	5.6%	5.6%	2.5%	4.5%	*	10.0%
pH *	7.6	7.4	7.6	7.7	7.6	7.5	*	*
P-T [P]	602	955	755	1060	740	944	*	2000
%FGM [O]	38.0%	50.5%	59.5%/52.2%	44.1%	51.5%	36.8%	30.0%	*
COD*	107000	108000	67100	123000	41000	92600	*	*

↘ Below the goal of 30% Fine Grain Material in sample
%FGM Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)
NA Compound not analyzed. * Not evaluated
[O] Evaluated by Ohio EPA (2003) [M] Evaluated by MacDonald (2000) [P] Evaluated by Persuad (1993)

Ohio SRV Guidelines (2003)
+ above background for this area

Ontario Sediment Guidelines (Persuad (1993)
L > Open Water Disposal Guidelines; equivalent to the Lowest Effect Level (LEL)-applicable to NH_3-N only.
• > severe effect level (disturbance in benthic community can be expected)

MacDonald (2000) Sediment Quality Guidelines (SQG)
TEC-PEC Threshold effect concentration (TEC) - Probable effect concentration (PEC)
Above which adverse effects frequently occur
■ **>PEC** Probable effect concentration (PEC) -Above which adverse effects usually or always occur

Table 20. Sediment concentrations of organic compounds (priority pollutant scan) detected in the Lower Mad River Tributaries watershed assessment unit (WAU 05080001 190) during 2003. Individual compounds were evaluated by the MacDonald Sediment Quality Guidelines (2000).

River / Landmark	**Analysis Performed**	**Compound Detected**	**Result** mg/kg unless noted
Mud Creek RM 5.03 U.S. 40 TOC 5.2 % Fine Grained Material =38.0%	1) VOC 2) BNA 3) Pesticides 4) PCB	Acetone 4,4'-DDE	0.097 * BDL 0.0092 # BDL
Mud Run RM 9.70 Hagan Road TOC 5.6 % Fine Grained Material =50.5%	1) VOC 2) BNA 3) Pesticides 4) PCB	Acetone Methoxychlor	0.139 * BDL 1.080 * BDL
Mud Run RM 3.33 Spangler Road TOC 5.6 % Fine Grained Material =52.2% 59.5%	1) VOC 2) BNA 3) Pesticides 4) PCB	Acetone	0.125 * BDL BDL BDL
Mud Run RM 1.98 Haddix Road TOC 5.6 % Fine Grained Material = 44.1%	1) VOC 2) BNA 3) Pesticides 4) PCB	Acetone	0.148 * BDL BDL BDL
Hebble Creek RM 0.25 Hebble Creek Road TOC 2.5 % Fine Grained Material =51.5%	1) VOC 2) BNA 3) Pesticides 4) PCB		BDL BDL BDL BDL

Table 20. Continued.

River / Landmark	Analysis Performed	Compound Detected	Result mg/kg unless noted
Lilly Creek RM 0.10	1) VOC	Acetone	0.138 *
Near mouth	2) BNA	Anthracene	0.97 ■
TOC 4.5 %		Benz(a)anthracene	2.71 ■
Fine Grained Material =36.8%		Benzo(a) pyrene	3.12 ■
		Benzo(b)fluoranthene	3.11 *
		Benzo[g,h,i]perylene	2.69 *
		Benzo(k)fluoranthene	3.35 *
		Chrysene	3.83 ■
		Fluoranthene	7.62 ■
		Indeno[1,2,3-cd]pyrene	2.70 *
		Phenanthrene	5.16 ■
		Pyrene	5.99 ■
		Total PAH	**41.25** ■
		bis(2-Ethylhexyl)phthalate	2.58 *
		3&4 Methylphenol	2.06 *
	3) Pesticides	4,4'-DDT	0.0089 #
		Heptachlor	0.0089 *
		Methoxychlor	0.0533 *
		alpha-chlordane	0.0652 *
		gamma-chlordane	0.088 *
		Total chlordane	0.1532 ■
		trans-nonachlor	0.0458 *
	4) PCB		BDL

* Not evaluated NA Compound not analyzed BDL Below Detection Limit TOC Total Organic Carbon

1) Volatile Organic Compounds (VOC) U.S. EPA Method 8260B
2) Base Neutral & Acid Extractibles (BNA) U.S. EPA Method 8270
3) Pesticides U.S. EPA Methods 8082A
4) Polychlorinated biphenyls (PCBs) U.S. EPA Method 8082A

Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)

MacDonald (2000) Sediment Quality Guidelines (SQG)

TEC-PEC Threshold effect concentration (TEC) - Probable effect concentration (PEC) Above which adverse effects frequently occur

■ **>PEC** Probable effect concentration (PEC) -Above which adverse effects usually or always occur

Point Source Evaluations

Greenon High School – unnamed tributary (RM 0.65) to Mud Run (RM 9.2)
Permit # - 1PT00014
Lat.: $39^0$52'13"; Long.: $83^0$53'29"

Greenon High School is located in Clark County at 3950 South Tecumseh Road, Springfield. An NPDES permit became effective on January 2, 2003 for a new wastewater treatment plant. A PTI (No. 05-2915) was issued on December 23, 2004. The new plant was completed in August 2004, serving 750 students and 40 staff members. The wastewater treatment plant consists of a trash trap, flow equalization tank, an extended aeration package plant with a settling tank, dosing chamber, two slow surface sand filters, chlorination/dechlorination tank with post aeration, and a sludge holding tank. The average effluent flow is 16,000 gpd. Prior to the installation of a new wastewater treatment plant, there were two sewage systems that served the school that were installed in the 1960s and 1970s. One system consisted of a septic tank, dosing tank and two slow surface sand filters and the second system consisted of a trash trap, an extended aeration package plant and a settling tank. The system was upgraded to meet BADCT limits

Numeric violations of NPDES permit limits were evaluated from 2003 to 2004. NPDES violations, reported through SWIMS, revealed a total of 67 violations for Greenon High School. For the nearly two years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included dissolved oxygen, TSS and $cBOD_5$ reported with the greatest frequency. Final effluent limitation violations have not occurred since the new wastewater treatment plant became operational in 2004.

Huber Mobile Home Park - unnamed tributary (RM 0.5) to the Mad River (RM 7.25)
Permit # - 1PV00088
Lat.: $39^0$48'45"; Long.: $84^0$05'16"

Huber Mobile Home Park is located in Greene County at 4311 Kitridge Rd, Dayton. The wastewater facility was built in the 1950s, and modified in 1992 and 2001. This facility serves approximately 120 mobile homes and 30 RV sites. The upgrade in 1992 converted this facility into an activated sludge, extended aeration facility. The treatment system consists of an equalization basin, comminutor, extended aeration plant, clarifier, fixed media clarifier, post aeration tank, dosing chamber, slow surface sand filters, post-aeration tank, a sludge holding tank and ultraviolet disinfection. The discharge enters an unnamed tributary and probably infiltrates into the ground during low flow periods. During wet weather, the discharge has the potential of entering the Mad River.

Numeric violations of NPDES permit limits were evaluated from 2000 to 2004. NPDES violations, reported through SWIMS, revealed a total of 12 violations for the Huber MHP. For the nearly five years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included $cBOD_5$, TSS and ammonia-N (NH3-N)

reported with the greatest frequency. Sixty-seven percent of the violations occurred in 2003 and no seasonal patterns were observed. Eight Frequency Violations (sampling frequency) have been documented by the Ohio EPA for 2003 and 2004. Eighty-seven percent (87) of the violations were noted as having occurred in the spring and summer.

Hustead Elementary School - unnamed tributary (RM 1.50) to Mud Run (RM 9.8)
Permit # - 1PT00069
Lat.: $39^0$50'32"; Long.: $83^0$53'6"

Hustead Elementary School is located in Clark County at 3600 Hustead Rd, Springfield. An NPDES permit became effective on January 2, 2003. A PTI (No. 05-2916) was issued on June 2, 2004 for an extended aeration treatment system serving 371 students and staff (when in session). This facility produces an average effluent flow of 5,200 gpd. Prior to the installation of a new wastewater treatment plant, the sewage system consisted of a septic tank, dosing tank and two slow surface sand filters. The new wastewater treatment plant was completed in August 2004. The wastewater treatment plant consists of a trash trap, flow equalization tank, an extended aeration package plant with a settling tank, two slow surface sand filters, chlorination/dechlorination tank with post aeration and a sludge holding tank to meet BADCT limits.

Numeric violations of NPDES permit limits were evaluated from 2003 to 2004. During the period from January 2003 through August 2004, Hustead Elementary was in violation of their NPDES permit for not obtaining and analyzing samples of their final effluent. NPDES violations reported for the remainder of the period through SWIMS, revealed four for Hustead Elementary School. In September, 2004, the 30-day limit for TSS was violated and in October 2004, the 30-day limit for average fecal coliform bacteria was violated. During this period, there were two frequency violations reported.

West Enon Estates

In October 2001, the Ohio EPA investigated the development of West Enon Estates and found evidence of unsanitary conditions. Many of the residences and businesses were served by failing on-lot wastewater disposal systems which discharged raw or partially treated sewage to ditches and storm sewers that flowed into an unnamed tributary of the Mad River. Sampling of the ditches and storm sewer revealed elevated levels of fecal coliform and *E. coli* bacteria in excess of Ohio Water Quality Standards, which constituted a public health nuisance. On February 13, 2002, the Ohio EPA issued a PTI (No. 05-11917) for the installation of sanitary sewer extensions to serve the West Enon Estates subdivision. As of May 24, 2004, 139 of the 214 properties in the West Enon Estates and vicinity had connected to the sanitary sewer system. The Clark County Southwest Regional wastewater treatment plant treats the sewage for this area.

Wright Patterson Air Force Base (WPAFB) is located in southwest Ohio between the cities of Dayton and Fairborn in Greene and Montgomery Counties. The 88th Air Base Wing is the host organization at WPAFB. The WPAFB is the headquarters for the Material Command, whose primary function is national defense as well as research and development, testing, and aircraft maintenance. The base has multiple stormwater and noncontact cooling water outfalls to Hebble Creek, other tributaries to the Mad River in WAU 05080001 190 and several other outfalls that discharge directly to the mainstem of the Mad River in WAU 05080001 003. All of these outfalls are covered under NPDES permit 1I000001. Discussions of all outfalls from Wright Patterson AFB are included in this section of the document.

WPAFB - Hebble Creek, Mad River, Bass Lake, Trout Creek, and tributaries
Permit # - *1I000001* – Stormwater and noncontact cooling waters
Outfalls – 001 through 023

Wright Patterson AFB has 23 discharge points (Table 21) to the Mad River watershed. Outfalls are geographically numbered with 001 furthest south (northeast of Riverside) and generally working northwest with outfall 023 north of Bass Lake. Five outfalls (016-020) discharge directly to the Mad River. Several outfalls (006-013) discharge to Hebble Creek. A Storm Water Pollution Prevention Plan has been developed for the entire base.

During a 2003 inspection by Ohio EPA, it was noted that a study at WPAFB documented approximately 200 cross connections within the storm sewer network. Also identified was concern of the coal storage area from Building 20770 posing a stormwater runoff threat to local tributaries. During an Ohio EPA inspection in 2004, finely crushed coal from the 770 heating plant at 2711 Kauffman Ave. was documented migrating to tributary banks of an unnamed tributary to the Mad River.

A spill summary in WPAFB files from 1995-1998 involved primarily WPAFB NPDES outfall numbers 002, 003, 005, and 018 respectively. The Ohio EPA has recorded chronic complaints from outfalls 003 and 004 on Springfield St. near Area B. Contaminated contact cooling water from Building 18, which houses the Test Fuel Research Center, was determined to be the source of the spills. The cooling water from Buildng 18 becomes contaminated with water that comes in contact with fuel during engine cell tests. The fuels are emulsified which hinders the oil/water separators ability to capture the fuel.

Table 21. Outfalls regulated under NPDES permit 1I000001 for Wright Patterson AFB in Greene and Montgomery Counties in WAU 05080001 190 and 05080001 003.

NPDES Outfall #	Historical WPAFB Outfall #	Lat/Long	Description
001	2	39° 46'59" 84°07'13"	Stormwater runoff from the hazardous waste TSD facility, museum hanger, and avionic laboratory. Noncontact cooling water. Cooling tower blowdown (Area B. Bldg 20620). Also receives discharge from vapor extraction remediation treatment of contaminated groundwater. Discharge to an unnamed tributary of the Mad River Harshman Rd (west side)
002	3	39°47'25" 84°06'25"	Noncontact cooling water blowdown from cooling tower, Area B. Bldg 20022B. Discharge is to a metal flapped outfall the Mad River off of Springfield St after RR overpass.
003	4	39°47'28" 84°06'18"	Stormwater runoff from scrap metal, and material testing. Noncontact cooling water. Motor vehicle refueling station (Area A Bldg 20464), floor drains from numerous buildings, several o/w separators and aircraft testing and component testing (Area B, Bldg 20094). Discharge is to Springfield St after RR Pass to culvert "1918" to the Mad River.
004	includes outfalls: 5-13	39°47'37" 84°05'50"	Stormwater runoff from Vehicle Maintenance Shop in Area B, Bldg 20038 and steam plant in Area B, Bldg 20128 discharge to the Mad River.
005	17,18,19	39°47'36" 84°04'22"	Stormwater runoff from the CE grounds and the DRMO scrap yard, noncontact cooling water discharge to an unnamed tributary, cooling tower drain and other equipment involves Bldgs 20741, 20745, and 20451 discharge to Hebble Creek. Bioslurper discharge also to Hebble Creek.
006	20	39°47'43" 84°03'16"	Stormwater runoff Motor Vehicle refueling station in Area A, Bldg 10293 discharge to an unnamed tributary to Hebble Creek.
007		39°48'02" 84°03'22"	Stormwater runoff and condensate from Entomology shop-pesticides and herbicides in Area A, -3 pipes under the roadway discharge to Hebble Ck
008		39°48'08" 84°03'13"	Stormwater runoff from the west-central section of Area A, Bldgs. 10876, 10877, 10280, and 10281 discharge to Hebble Ck.
009		39°48'21" 84°02'45"	Stormwater runoff from the eastern section of Area A Medical center and Residential Housing to Hebble Creek
010		39°48'31" 84°02'49"	Stormwater runoff from the northwest section of Area A. Residential housing and golf course discharge to Hebble Ck
011		39°48'45" 84°02'40"	Stormwater runoff from Area A and C near Skeel and Wright Avenues Residential housing, gym, Officers Club and golf course (Areas A and C) discharge to Hebble Ck

Table 21. Continued.

NPDES Outfall #	Historical WPAFB Outfall #	Lat/Long	Description
012		39°48'52" 84°02'35"	Stormwater runoff from vehicle maintenance area in Area C, Bldg 30060, hobby shop, Kitty Hawk swimming pool, shipping/receiving, warehouses, and noncontact cooling water discharge to Hebble Creek.
013		39°48'54" 84°02'32"	Stormwater runoff from East Ramp area of a aircraft staging zone (fueling repairs, deicing), motor vehicle refueling station generating wash water (Area C, Bldg 30119) and outdoor aircraft Maintenance operations (Area C, Bldg 30013 and 30256) discharge enters Hebble Ck
014		39°48'25" 84°03'49"	Stormwater runoff from fueling and deicing operations discharges to Trout Creek via a stormwater sewer pipe.
015		39°48'38" 84°04'03"	Stormwater runoff (Area C, East Ramp) from fueling and deicing operations discharge to Ditch # 5 to Trout Creek via a stormwater sewer pipe.
016		39°49'31" 84°03'31"	Stormwater runoff from aircraft fueling, maintenance and deicing operations discharge to unnamed tributaries of the Mad River via stormwater sewer.
017		39°49'42" 84°03'10"	Stormwater runoff from aircraft fueling, maintenance, storage facility, floor drain (Bldg 30017), aircraft washing (Bldg 30153), and deicing operations discharge to an unnamed tributary of the Mad River via stormwater sewer.
018		39°49'57" 84°02'48"	Stormwater runoff from Aircraft Refueling (Area C, West Ramp , deicing operations (Area C, West Ramp) discharge to Bass Lake via stormwater sewer then to the Mad River.
019		39°50'04" 84°02'57"	Stormwater runoff Petroleum Ops Bldg with one o/w separator (Bldg 34033) discharge to Bass Lake then to the Mad River.
020		39°50'18" 84°03'05"	Stormwater runoff from aircraft support operations and cooling tower (Bldg 34012), discharge to tributary of the Mad River
021		39°48'35" 84°01'54"	Final effluent from coal pile runoff treatment facility (Area C Bldg 31240) discharge to unnamed tributaries of Hebble Ck. Ultimate discharge to outfall 012.
022		39°47'42" 84°04'51"	Final effluent from coal pile runoff treatment facility (Area C Bldg 20770) discharge to unnamed tributaries of Hebble Creek. Ultimate discharge to outfall 005
023		39°47'00" 84°05'51"	Stormwater runoff from aircraft survivability test area after the oil/water separator discharge to an unnamed tributary of the Mad River.

WPAFB - Mad River (WAU 05080001 003), West Twin Lakes
Permit # -*1IN00156* - Groundwater Remediation
Outfalls – 001 (Mad River @ storm sewer west of Harshman Rd.) and 003 (Mad River @ RM 5.03) - Wastewater from Vapor Phase Extraction of VOC Groundwater Remediation
Outfall 001 - $39^0$48'29"; $84^0$05'08"
Outfall 003 - $39^0$48'29"; $84^0$05'00"

Wright Patterson AFB's groundwater remediation/wastewater treatment facility is located at Prairie and Riverview Roads in Area C of the base. This treatment system intercepts, removes and treats a groundwater plume contaminated with a volatile organic compound. The treated water is released into the storm sewers that discharge through outfalls 001 and 003.

WPAFB
Permit # - *1IN00274* - Bioslurper

The WPAFB Bioslurper is a groundwater remediation mobile wastewater treatment works located at the POL Tank Farm in Greene County in Area C. The Bioslurper previously operated for nine months in Area B under a Petroleum Corrective Action Permit. Under this permit the system monitored for flow rate, pH, total lead, benzene, toluene, ethyl benzene, total xylene, total oil and grease, and quarterly polycyclic aromatic hydrocarbons (PAHs). The system treats 28,000 gpd of contaminated groundwater wastewater associated with petroleum products. Treatment consists of an oil/water separator, followed by liquid phase carbon columns, and then discharge. The system is permitted and capable of operating continuously, but currently it is inoperable. Since this is mobile unit, its location can change. Each time the unit is moved, a new permit must be issued.

Springfield-Beckley Municipal Airport and **Ohio Air National Guard** facilities both have discharges into this watershed assessment unit. The complete descriptions of these outfalls are contained in the "Point Source Evaluations" section in WAU 180.

Lower Mad River Large River Assessment Unit (LRAU 05080001 003)
This large river assessment unit exclusively covers the lower Mad River mainstem from the Donnels Creek confluence (RM 18.38) to the mouth. The aquatic life and recreation use designations in effect are Warmwater Habitat (WWH) and Primary Contact Recreation (PCR). While the upper portion of the river flows through predominately agricultural land, riparian land use in the lower reaches is generally more urban (Figure 36 and Figure 44) (University of Cincinnati, 2001).

The river flows through Huffman MetroPark (283 acres) in Greene County and Eastwood MetroPark (437 acres) in Montgomery County (Five Rivers MetroPark, 2005). Huffman Dam (RM 6.0), part of a system of five earthen flood control dams managed by the Miami Conservancy District (MCD), was built after the flood of 1913. The 65-ft tall dam, built to temporarily store floodwater and allow normal water flow to pass, has no gates or permanent dam pool. Completed in 1972, Eastwood Lake, a mile-long, 185-acre lake created as a by-product of gravel mining operations, is located in Eastwood MetroPark within Dayton city limits. In addition to providing water recreation, the lake is part of a system of ponds, lakes and lagoons that serve as artificial charge basins for nearby City of Dayton well fields.

Two major municipal wastewater facilities, Clark County Southwest Regional WWTP (RM 13.3) and the Fairborn WWTP (RM 9.62), discharge to the Mad River mainstem in this assessment unit. Martin Marietta-Fairborn Gravel discharges at RM 10.62. The river is also the receiving stream for multiple stormwater and noncontact cooling water discharges from Wright Patterson Air Force Base (Outfall 004-RM 5.58, Outfall 003-RM 5.03, Outfall 002-RM 4.90, and Outfall 001 through storm sewers west of Harshman Rd). Under a separate NPDES permit (1IN00156), WPAFB also discharges treated groundwater at RM 6.88. (WPAFB also has multiple outfalls in WAU 05080001 190). Additionally, BP Oil (treated groundwater), Gem City Chemical (treated groundwater), and Dayton Phoenix (noncontact cooling water and stormwater) discharge to the river through a storm sewer on the north side of the Mad River at Findlay Street (RM 1.63), while Flowserve Corporation (noncontact cooling water and stormwater) discharges to the river via a storm sewer outfall on the opposite (south) side. The City of Dayton Lime Reclamation Facility (Dayton WTP) discharges to the Mad River at RM 1.5 (Outfall 002) and at RM 1.0 (Outfall 001).

Table 22. Aquatic life use attainment status of the Mad River large river assessment unit (LRAU: 5080001 003), June- October, 2003. The Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb) and Invertebrate Community Index (ICI) scores are based on the performance of fish (IBI, MIwb) and macroinvertebrate (ICI) communities. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities.

Stream River Mile Invertebrate/Fish	Attainment Status	IBI	MIwb	ICI/ narrative	QHEI	Drainage Area
LRAU: 5080001 003						
Mad River			*WWH*			
17.5/17.5	Partial	34*	8.4[ns]	G	77.5	527
13.1/13.1	Full	41[ns]	9.2	G	83.5	554
11.5/11.5	Full	38[ns]	9	46	83	554
9.0/8.6	Full	40[ns]	9.2	G	81.5	617
6.0/6.0	Full	43	8.7	40	77.5	622
4.0/4.0	Full	52	10.1	42	76.5	642
1.6/1.6	Full	52	9.7	G	74	654
0.3/0.3	Full	50	9.5	G	61	657

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)

INDEX - Site Type	LRW	MWH channel modified	CWH	WWH	EWH
IBI Headwater - Wading/ Boat	18/18	24/24	40	40/ 42	50
MIwb Wading/ Boat	4.0/4.0	6.2/5.8	-/6.6	8.3/ 8.5	9.4/ 9.6
ICI	8	22	36	36	46

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns Nonsignificant departure from biocriterion (<4 IBI or ICI units; <0.5 MIwb units).
a Narrative evaluation used in lieu of ICI (E=Exceptional; G=Good; MG=Marginally Good; F=Fair; P=Poor).
b Use attainment status based on one organism group is parenthetically expressed.
N/A Not Applicable. The MIwb is not applicable to headwater sites.

Aquatic Life Uses

The Mad River large river assessment unit (LRAU 5080001 003) encompasses the mainstem from downstream Donnels Creek (RM 18.4) to the confluence with the Great Miami River. This portion of the mainstem has a drainage area in excess of the 500 mi^2 limit used in delineating assessment units with multiple water courses. Consequently, this reach is considered separately from smaller drainages within the basin when reporting on attainment status. Biological and habitat assessments were conducted at eight sites in 2003 and aquatic life use attainment status is presented in Table 22. Surface water assessments were conducted at the same eight sites.

Eight sites were sampled in 2003. The WWH aquatic life use applies to this reach of stream. Seven sites were in full attainment of the WWH use. Depressed fish index scores at one site

(RM 17.5) resulted in partial attainment of ecoregional expectations. The LRAU overall attainment score was 83.7 (Table 1).

The WWH use was reflected in the reduced number of coldwater macroinvertebrate taxa compared to the CWH reach upstream from Buck Creek. However, the fish community continued to maintain characteristics that were more typical of headwater (brook fauna) streams. In particular, limited diversity of sunfish species and an abundance of white suckers depressed the IBI scores at the four sites exceeding 500 mi^2 drainage area between RM 17.5 and RM 9.0. However, only the IBI at RM 17.5 was below WWH ecoregional expectations. Still, marginally attaining IBI scores resulted at the other three sites as remnant headwater community characteristics persisted. Macroinvertebrate community condition was in the good to exceptional range throughout the assessment unit. The four sites between RM 6.0 and the confluence with the Great Miami River fully met the WWH aquatic life use and supported fish and macroinvertebrate assemblages reflective of good water quality and acceptable habitat. These results occurred despite potential impacts from urban runoff, upstream point sources and habitat modifications.

No lingering impacts attributed to the Springfield WWTP discharge were apparent in the performance of the fish and macroinvertebrate assemblages in this reach. Nor were there any differences in the stream biota related to the Southwest Regional or Fairborn WWTPs.

Recreational Uses

Typical of the entire study area, the PCR use designation was not attained (Table 27, Figure 10, and Appendix Table A-2) with elevated bacteria values occurring on high flow days.

Chemical Water Quality

Inorganic water chemistry grab samples and field measurements were collected at nine sites in this assessment unit at two-week intervals (six times) from mid-July to late September (Table 25) and analyzed for a variety of parameters including nutrients and metals (Figure 50, Appendix Table A-1). Six of these sites were also sampled for organic compounds twice during the survey (Table 28, Appendix Table A-3), and five sites were sampled for bacteria (fecal coliform and E. coli) five times within a thirty day period in order to determine PCR use attainment (Table 27, Appendix Table A-2). Additionally, Datasonde™ continuous monitors were deployed at six sites for a 48-hour period in July and again in September (Figure 8).

Mean daily flows from May through September 2003 measured by the USGS gage station in the Mad River near Dayton upstream from Huffman Dam (Figure 48) were above normal with 54% of flows exceeding the 10% duration exceedence flow of 864 cfs (USGS 2004 and 2000). On water chemistry sampling days the gage recorded a mean daily low of 580 cfs on August 28 and a mean daily high of 886 cfs on July 17. Flows were also elevated above the 10% duration exceedence flow on three of the five days when sites were sampled for bacteria. Total

precipitation of 14.84 inches was recorded at Huffman Dam (MCD 2003) from July through September 2003, a departure of 4.89 inches above normal for the period (Figure 49).

Water chemistry grab sample results which exceeded State of Ohio Water Quality Standards criteria (WQS) are presented in Table 26 and Table 27.

Datasonde™ values were generally stable throughout this assessment unit with the exception of July dissolved oxygen (DO) levels at RM 6.28 upstream from Hebble Creek. Forty of the 47 hourly DO measurements at this site fell below the minimum WWH criterion of 4 mg/l. This site is downstream from multiple WPAFB outfalls. Field notes indicated elevated flows and turbidity. Additionally, Huffman Dam precipitation records indicate the area received 1.45 inches of rain the day before the Datasonde™ was deployed and an additional 0.3 inches during deployment (MCD 2003).

Eighty-one percent (81%) of ammonia-N concentrations in the assessment unit were less than the laboratory detection limit of 0.05 mg/l. Nitrate-nitrite-N and total phosphorus levels also remained low with respective overall medians of 3.39 mg/l and 0.13 mg/l, repectively.

Twelve organic compounds were detected in the water column during the survey (Table 28, Appendix Table A-3). Similar to much of the Mad River watershed, the most frequently detected compounds were the herbicides metolochlor and Atrazine with each accounting for 18% of detections. Concentrations of heptachlor epoxide exceeded the non-drinking water human health WQS criterion in the June sampling at all sites sampled. Heptachlor is used in termite control. Heptachlor epoxide is not produced commercially, but rather is formed by the chemical and biological transformation of heptachlor in the environment. Additionally, June concentrations of aldrin exceeded the non-drinking water human health WQS criterion at two sites (RMs 13.10 and RM 1.63) while dieldrin exceeded the non-drinking water human health criterion at RM 8.60.

The Miami Conservancy District (MCD) collected water samples downstream from Huffman Dam (RM 6.0) during 2003 at eight-hour increments and analyzed for several parameters including nutrients, TSS, chloride, and sulfate (Ekberg, 2003). A comparison of these parameters versus discharge flow from July 14 through September 30, 2003, is provided in Figure 51. Total phosphorus generally correlated directly with river discharge, ranging from 0.119 mg/l to 0.796 mg/l with a median of 0.167 mg/l. As expected, TSS concentrations (median 30.6 mg/l) also increased as flows increased. Nitrate-nitrite-N concentrations ranged from 1.05 mg/l to 4.06 mg/l (median 3.00 mg/l) while ammonia-N ranged from 0.019 mg/l to 0.397 mg/l (median 0.054 mg/l) with 78% of ammonia-N values less than or equal to the ECBP 90th percentile reference concentration of 0.074 mg/l. Concentrations of chloride (median 33 mg/l) and sulfate (median 51 mg/l) appeared to be inversely correlated to river discharge, decreasing during periods of runoff.

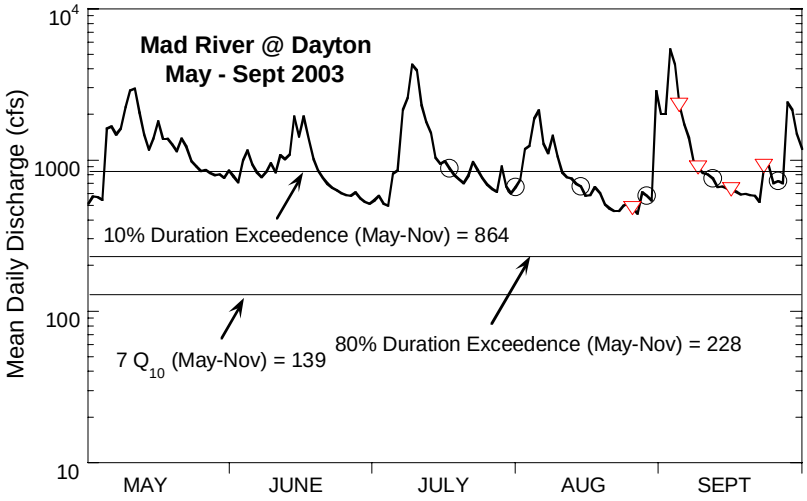
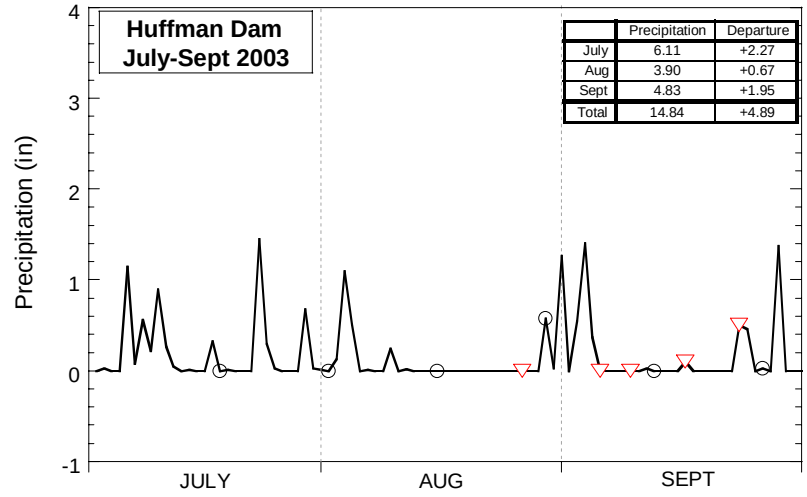


Figure 48.

May through September, 2003 flow hydrograph for the Mad River near Dayton. Low flow conditions ($7Q_{10}$), 10% and 80% duration exceedence flows are based on USGS station #03270000 (period of record 1914-1921, 1924-1997). Open circles indicate river discharge on water chemistry sampling days. Triangles indicate river discharge on bacteriological sampling days.



	Precipitation	Departure
July	6.11	+2.27
Aug	3.90	+0.67
Sept	4.83	+1.95
Total	14.84	+4.89

*Rain gages are read every morning at or near 8:00 am. Therefore, these readings reflect the previous 24 hour catch.

Figure 49.

Daily precipitation recorded at Huffman Dam from July through September (MCD, 2003). Open circles represent conventional water chemistry sampling days. Triangles represent bacteriological sampling days in the watershed assessment unit

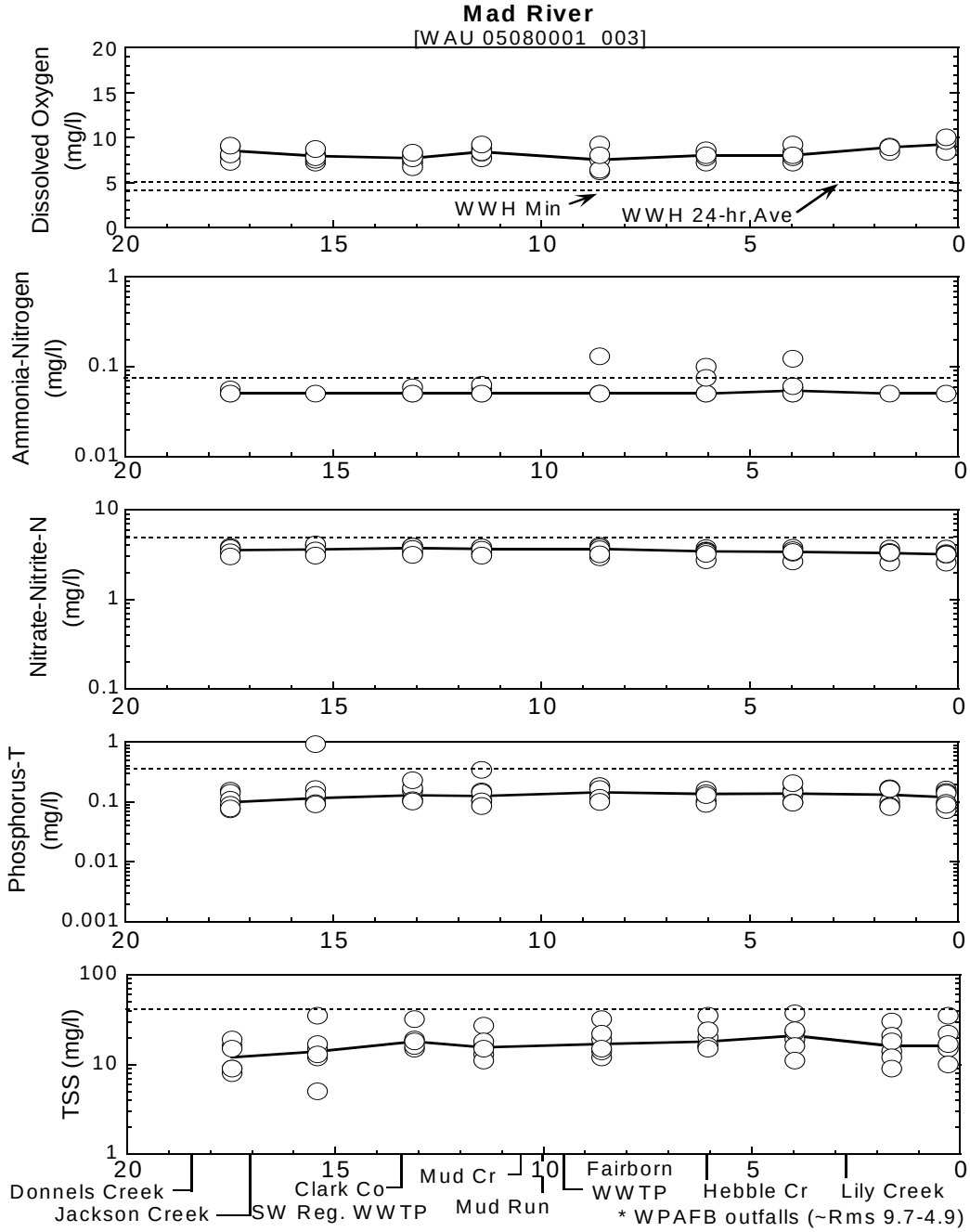


Figure 50. Longitudinal plots of water chemistry daytime grabs in the Mad River during the 2003 survey. Top to bottom: dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-nitrogen, total phosphorus, and total suspended solids (TSS). The solid line depicts the median value at each river mile sampled. WQS criteria are shown in the dissolved oxygen plot. Dotted lines in the other plots represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

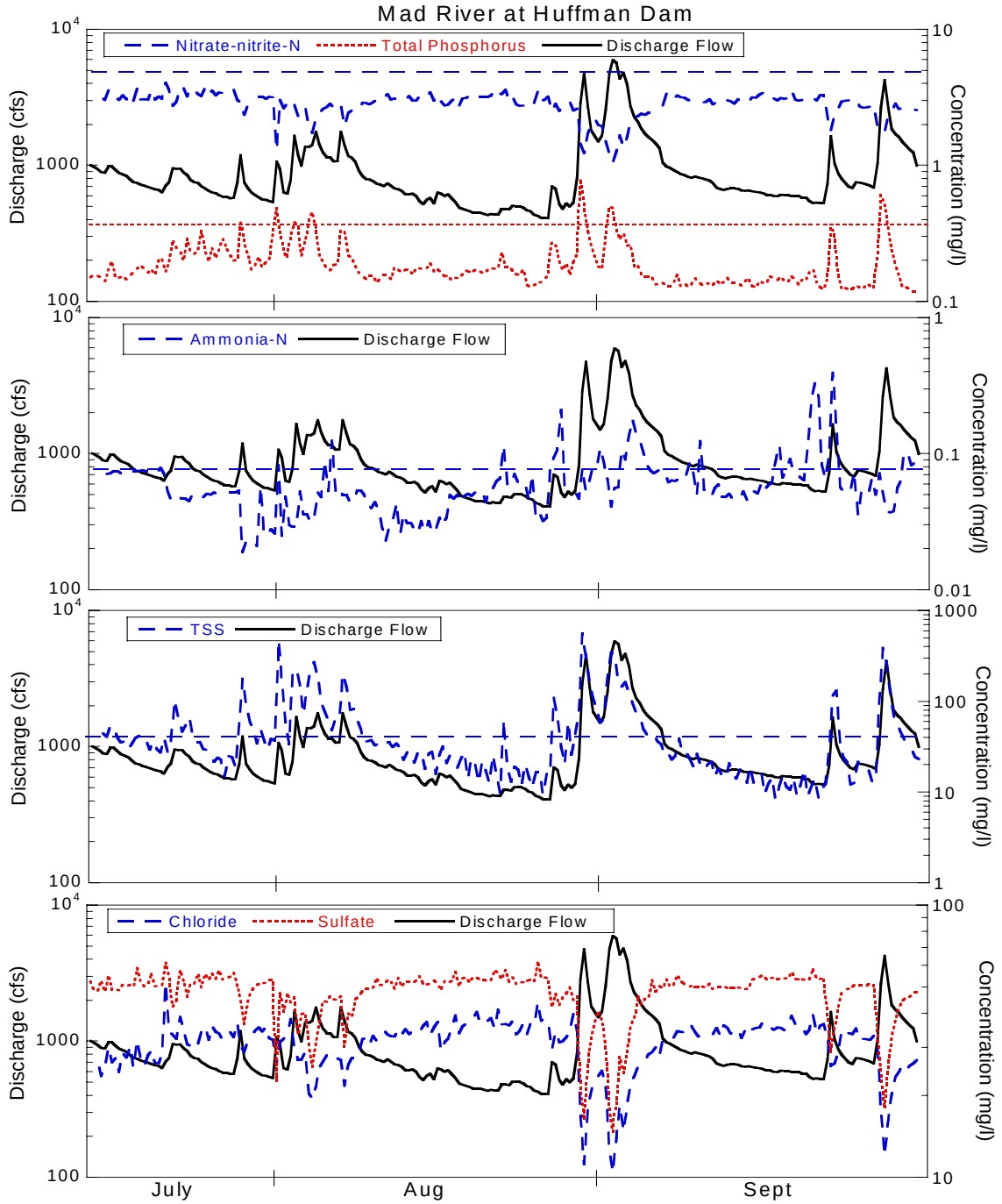


Figure 51. Mad River @ Huffman Dam July 14-September 30, 2003. Top to bottom: Discharge flow versus total phosphorus and nitrate-nitrite-N, discharge flow versus ammonia-N, discharge flow versus total suspended solids (TSS), and discharge flow versus chloride and sulfate. (All data per Ekberg, MCD 2003.) Dotted horizontal lines represent the 90th percentile concentration (75th percentile concentration for TSS) from reference sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

Chemical Sediment Quality

Sediment quality was evaluated at six sites in LRAU 05080001 003 (Table 23 and Table 24). All sites are on the Mad River mainstem and reach from the I-70 bridge in Clark County to RM 0.28, upstream from the confluence with the Great Miami River in Montgomery County. The watershed lies in Mad River and Bethel townships of Clark County, Bath Township in Greene County and Wayne and Mad River townships in Montgomery County.

Rural land use dominates the northern part of the watershed (Clark County). In Greene County, the Mad River originally flowed through wetlands that have since been converted to gravel mining operations. General land use becomes more urban as the river passes the Fairborn WWTP (RM 8.6), but a riparian corridor exists along the edge of Wright Patterson AFB. The river has a buffer area as it travels through Huffman Dam Metropark, City of Dayton Rohrs Island well field, and Eastwood Metropark.

Sediments in the lower reaches of the Mad River (RM 13.1 to RM 0.28) were relatively uncontaminated with metals. Lead and calcium were detected above the Ohio SRVs at the Findlay Street bridge in Dayton (RM 1.63). Lead levels were also between the MacDonald TEC and PEC, meaning adverse effects to benthic organisms frequently occur

Low levels of acetone were found in five of six sediment samples. It is believed that acetone was a laboratory contaminant and not representative of the actual conditions.

The Mad River at RM 13.10 is downstream from the Clark County Regional WWTP and is subject to runoff from I-70. No sediment metals were detected above the Ohio sediment reference values. The PAH, fluoranthene (0.78 mg/kg), was detected between the MacDonald TEC and PEC. The legacy pesticide methoxychlor and the wood preservative 3&4 methylphenol were also detected. There is no sediment guideline for methoxychlor or 3&4 methylphenol.

The Mad River at RM 8.6 is downstream from the Fairborn WWTP. Fluoranthene (0.98 mg/kg) was detected between the MacDonald TEC and PEC. The wood preservative 3&4 methylphenol was detected at 4.59 mg/kg.

The Mad River downstream from Hebble Creek (RM 6.1) flows through an urban neighborhood and had experienced historical spills of oil from the 1970s. Four different PAHs were detected in sediments for a total of 4.55 mg/kg. This is between the MacDonald TEC and PEC. The legacy pesticide methoxychlor (0.01 mg/kg) and the wood preservative 3&4 methyl phenol (2.67 mg/kg) were also detected. There are no sediment guidelines for methoxychlor or 3&4 methylphenol.

Sediment samples from the Mad River at Harshman Road (RM 4.0) detected two PAH compounds (fluoranthene and pyrene) totaling 2.01 mg/kg. This amount of total PAH in sediment is between the MacDonald TEC and PEC, meaning adverse effects to benthic

organisms frequently occur. The wood preservative 3&4 methyl phenol was detected at 2.62 mg/kg.

The Mad River at Findlay Street (RM 1.63) enters the older industrial part of Dayton. The river bed is made up of extensive sand and gravel deposits interspersed with old metal parts and other urban refuse. Five different PAHs compounds were detected in sediments for a total of 4.67 mg/kg. This is between the MacDonald TEC and PEC and adverse effects to benthic organisms frequently occur

The Mad River (RM 0.28) is in the heart of the old industrial corridor of Dayton. Abandoned industries and factories are in the immediate watershed. The area is part of a large Brownfield project. The sampling site is located adjacent to the former Delphi Harrison Thermal Systems facility. This facility covers the land between Webster and Keowee Streets and is adjacent to the Mad River. Numerous unreported releases and 23 documented spills from the 1970s to 1994 have contaminated the site. This property is under the RCRA RFI/voluntary corrective action program. Most significant contamination resulted from a July 31, 1975 release of 1000 gallons of perchloroethylene (PCE) that is still found in the upper aquifer leaving the site. In addition, free product PCBs at levels up to 1330 ppm are found on top of the aquifer on the site.

Historical reports document PCB contaminated oil and chlorinated solvents entering the Mad River via a 72 inch City of Dayton storm sewer, immediately upstream from the confluence with the Great Miami River. A sheet pile barrier was installed along the Mad River to prevent PCBs from traveling off site and a "pump and treat" remediation of groundwater is ongoing for removal of free product PCBs and chlorinated solvents. Storm sewers feeding the 72 inch culvert have been cleaned of contaminated sediment.

Ten different PAH compounds were detected in sediments at RM 0.28sampled in 2003 to 2004. Total PAH concentrations were 14.06 mg/kg, which is above the MacDonald PEC, adverse affects to benthic organisms usually or always occur. The wood preservative 3&4 methylphenol was detected at 1.88 mg/kg. No PCBs or chlorinated solvents were detected. No study has been conducted of historical sediments in the vicinity, and should be done under the RCRA corrective action.

Watershed Protection Efforts

There have been no formal watershed projects covering all of the Lower Mad River Tributaries (WAU 05080001 190) and mainstem (LRAU 05080001 003). A cooperative effort between the City of Dayton, the Miami Valley Regional Planning Commission, and others (Watershed Enhancement Project) calls for partnering with entities for watershed and wellhead protection.

Table 23. Concentrations (mg/kg) of metals and nutrients in sediment samples collected in the Lower Mad River Mainstem watershed assessment unit (WAU 05080001 003) during 2003. Parameter concentrations were evaluated based on Ohio EPA sediment metal reference sites (2003), MacDonald (2000) Sediment Quality Guidelines (SQG) and Persuad (1993). Values above guidelines are highlighted.

Parameter	Site Location (RM)							
	Mad River I-70 RM 13.10	**Mad River** Dst Fairborn WWTP RM 8.60	**Mad River** Dst Hebble Creek RM 6.05	**Mad River** Dst Harshman Rd RM 3.97	**Mad River** Findlay St RM 1.63	**Mad River** Webster St RM 0.28	***Reference***	
							Ohio	**MacD**
Al-T [O]	13400	12200	9140	7580	6190	8130	39000	*
As-T [OM]	6.80	8.53	5.29	5.47	5.24	5.06	18	9.79-33
Ba-T [O]	135	174	96.5	122	81.3	104	240	*
Ca-T [O]	87300	93400	58600	85600	122000+	76600	120000	*
Cd-T [OM]	0.490	0.520	0.438	0.354	0.317	0.462	0.9	0.99-4.98
Cr-T [OM]	19	<30	<17	<16	13	<19	40	43.4-111
Cu-T [OM]	13.8	20.0	14.5	12.4	10.8	23.2	34	31.6-149
Fe-T [O]	12700	16400	11200	11000	9560	11100	33000	*
Hg-T [OM]	0.064	0.072	0.056	0.037	0.033	0.060	0.12	0.18-1.06
K-T [O]	2740	2360	1880	1450	1410	1680	11000	*
Mg-T [O]	20600	22600	16600	16600	29600	20400	35000	*
Mn-T [O]	438	699	403	380	312	314	780	*
Na-T *	<2750	<4940	<2780	<2730	<2080	<3150	*	*
Ni-T [OM]	<22	<40	<22	<22	<17	<25	42	22.7-48.6
Pb-T [OM]	<22	<40	27	<22	75+#	<25	47	35.8-128
Se-T [O]	<1.10	<1.98	<1.11	<1.09	<0.83	<1.26	2.3	*
Sr-T [O]	166	195	93	169	156	128	390	*
Zn-T [OM]	76.6	128	73.7	65.8	48.8	110	160	121-459
							Ohio	**Pers.**
NH_3-N [P]	68	65	<12	33	<11	44	*	100
TOC [P]	5.6%	6.4%	5.2%	5.4%	4.1%	6.5%	*	10.0%
pH *	7.6	7.9	7.7	7.7	7.6	7.5	*	*
P-T [P]	992	1130	654	893	503	701	*	2000
%FGM [O]	28.8 %ú	59.5%	42.9%	45.8%	20.0 %ú	43.1%/47.2%	30.0%	*
COD*	124000	102000	106000	82000	70900	73600	*	*

↘ Below the goal of 30% Fine Grain Material in sample
%FGM Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)
NA Compound not analyzed. * Not evaluated
[O] Evaluated by Ohio EPA (2003) [M] Evaluated by MacDonald (2000) [P] Evaluated by Persuad (1993)

Ohio SRV Guidelines (2003)
+ above background for this area

Ontario Sediment Guidelines (Persuad (1993)
L > Open Water Disposal Guidelines; equivalent to the Lowest Effect Level (LEL)-applicable to NH_3-N only.
• > severe effect level (disturbance in benthic community can be expected)

MacDonald (2000) Sediment Quality Guidelines (SQG)
TEC-PEC Threshold effect concentration (TEC) - Probable effect concentration (PEC)
Above which adverse effects frequently occur
■ **>PEC** Probable effect concentration (PEC) -Above which adverse effects usually or always occur

Table 24. Sediment concentrations of organic compounds (priority pollutant scan) detected in the Lower Mad River Mainstem watershed assessment unit (WAU 05080001 003) during 2003. Individual compounds were evaluated by the MacDonald Sediment Quality Guidelines (2000).

River / Landmark	Analysis Performed	Compound Detected	Result mg/kg unless noted
Mad River RM 13.10 I-70 TOC = 5.6 % Fine Grained Material =28.8 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone Fluoranthene 3&4 Methylphenol Methoxychlor	0.118 * 0.78 # 1.12 * 0.0233 * BDL
Mad River RM 8.60 Dst. Fairborn WWTP TOC = 6.4% Fine Grained Material = 59.5%	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone Fluoranthene 3&4 Methylphenol	0.158 * 0.98 # 4.59 * BDL BDL
Mad River RM 6.05 Dst. Hebble Creek TOC = 5.2% Fine Grained Material =42.9 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone Benzo(b)fluoranthene Chrysene Fluoranthene Pyrene **Total PAH** 3&4 Methylphenol Methoxychlor	0.132 * 0.92 * 0.88 # 1.49 # 1.26 # **4.55 #** 2.67 * 0.01 * BDL
Mad River RM 3.97 Harshman Road TOC = 5.4% Fine Grained Material =45.8 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	Acetone Fluoranthene Pyrene **Total PAH** 3&4 Methylphenol	0.133 * 1.11 # 0.90 # **2.01 #** 2.62 * BDL BDL
Mad River RM 1.63 Findlay Street TOC = 4.1% Fine Grained Material =20.0 %	1) VOC 2) BNA 3) Pesticides 4) PCBs	 Benzo(k)fluoranthene Chrysene Fluoranthene Phenanthrene Pyrene **Total PAH**	BDL 0.60 * 0.69 # 1.46 # 0.70 # 1.22 # **4.67 #** BDL BDL

Table 24. Continued.

River / Landmark	**Analysis Performed**	Compound Detected	**Result** mg/kg unless noted
Mad River RM 0.28	1) VOC	Acetone	0.160 *
Webster St		Toluene	0.127 *
TOC = 6.5%	2) BNA	Benz(a)anthracene	0.98 #
Fine Grained Material =43.1%		Benzo(a) pyrene	1.02 #
47.2%		Benzo(b)fluoranthene	1.41 *
		Benzo[g,h,i]perylene	1.08 *
		Benzo(k)fluoranthene	1.01 *
		Chrysene	1.41 ■
		Fluoranthene	2.59 ■
		Indeno[1,2,3-cd]pyrene	1.14 *
		Phenanthrene	1.34 ■
		Pyrene	2.08 ■
		Total PAH	**14.06 #**
		3&4 Methylphenol	1.88 *
	3) Pesticides		BDL
	4) PCBs		BDL

* Not evaluated NA Compound not analyzed BDL Below Detection Limit TOC Total Organic Carbon

1) Volatile Organic Compounds (VOC) U.S. EPA Method 8260B
2) Base Neutral & Acid Extractibles (BNA) U.S. EPA Method 8270
3) Pesticides U.S. EPA Methods 8082A
4) Polychlorinated biphenyls (PCBs) U.S. EPA Method 8082A

Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)

MacDonald (2000) Sediment Quality Guidelines (SQG)

TEC-PEC Threshold effect concentration (TEC) - Probable effect concentration (PEC)
Above which adverse effects frequently occur

■ **>PEC** Probable effect concentration (PEC) -Above which adverse effects usually or always occur

Point Source Evaluation
Clark County Southwest Regional WWTP - Mad River (RM 13.3)
Permit # -1PK00013
Lat.: $39^0$52'04"; Long.: $84^0$01'08"

The Clark County Southwest Regional WWTP is located at 3990 Woodbury Rd, Medway, Ohio. The facility was built in 1980, with a subsequent upgrade/expansion in 1993. The plant was expanded to a design flow of 2 million gallons per day (MGD), with a proposed expansion to 4 MGD by 2006-2007. Wastewater treatment consists of a coarse bar screen, automatic screen, aerated grit chamber, 2 primary clarifiers, 3 oxidation ditches, 2 secondary clarifiers, 4 tertiary sand filters, chlorination, and dechlorination. Southwest Regional WWTP receives waste from the communities of Enon, Medway, Park Layne, Crystal Lake, and the Center Point Industrial Park. There are 33 industries and commercial facilities which send waste to the treatment plant. Two of these facilities are regulated by the Ohio EPA's Pretreatment Program- Alpha Mold (Milloq) and Metokote Industries. The collection system contains 22 lift stations which are reported as having no overflow potential. The facility has primary treatment bypass capability or options of utilizing the primary clarifiers as equalization basins. The Southwest Regional WWTP has a backup generator that can supply electricity to all process areas of the facility.

Sludge is land applied on three 40-acre tracts at Milton-Carlisle Rd. and Ansbaugh Rd. in New Carlisle. An unnamed tributary exists nearby and should runoff occur it would migrate toward the Jackson Creek Watershed.

Ohio EPA personnel inspection reports since 2002 have noted that the refrigeration of samples collected and stored by the entity (in the composite sampler) has remained above the required 4 degrees Celsius. Due to these storage practices, the validity of the data associated with the samples is compromised.

The Ohio EPA conducted bioassays of the Southwest Regional WWTP outfall 001 effluents, upstream and mixing zone waters were conducted in 1994, 1998, 1999 and 2003. The toxicity endpoints were mixed for the five tests. Two acute bioassay events, conducted by the Ohio EPA in spring and summer of 1994 indicated toxicity in the June of 1994 samples however the April sample was inconclusive. The 1998 effluents were acutely toxic to the daphnid *Ceriodaphnia. dubia*. In March of 1999, testing detected acute toxicity to *C. dubia* in the effluent. The fall 2003 test demonstrated no toxicity to either test organism (fathead minnow and daphnids) in any of the samples.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed a total of ten for Southwest Regional WWTP. For the nearly six years of data evaluated, constituents violating permit limits were mostly conventional wastewater components and included DO, $cBOD_5$, and chlorine reported with the greatest frequency. The NPDES violations occurred mostly in 2002 and 2004.

Fairborn Water Reclamation Facility (Fairborn WWTP) - Mad River (RM 9.62)
Permit # - 1PD00002
Lat.: $39^0$50'45"; Long.: $84^0$03'15":

The Fairborn WWTP is located in Montgomery County at 6920 Upper Valley Pike, Huber Heights. The plant is a secondary treatment facility utilizing an oxidation ditch treatment system with a design flow of 5.5 MGD. The original facility was constructed in 1958 with subsequent upgrades in 1974, 1986, 1993, 1999 and 2002. Current treatment consists of influent pumping, screening grit removal, 4 oxidation ditches, secondary clarifiers, ultraviolet disinfection, aerobic sludge digestion and a belt filter press. In 2001, expansion discussions began to increase the design flow to 11 MGD. The majority of service area is sewered and is separate with no overflows or bypasses. Facility operations are being converted into a selector mode of operation (can treat 6.0 MGD) in which a percentage of waste activated solids are returned to aeration to improve nutrient removal efficiency.

Upgrades began in 1999 and included removal of a bottle neck into oxidation ditch #4 with the addition of a 36" pipe, and repairs to the baffles in oxidation ditch #4 to eliminate short circuiting, new mixers and diffusers to the sludge holding tank, new flow diversion sluice gates for the oxidation ditchs, new flights and chains in one of the grit channels, and new disks on the oxidation ditches aerators.

The N-Vitro Advanced Alkaline Stabilization System (lime stabilization) was added in 1999. Fairborn began processing digested biosolids into N-Vitro Soil (classified as exceptional quality biosolids) by meeting limits for metals, pathogens and pH. Dry beds became full by December 1999, as a backlog of class A solids was stored at the facility while a customer base for the solids was being developed. The city is currently hauling Envirosoil to Southdown Cement Company as part of project overseen by the Bureau of Mines and Reclamation for its restoration requirements.

In 2002, upgrades included a new pump in the southeast lift station, rehabilitation of grit chamber #1, addition of a flow proportioned composite sampler on the influent, surface mixers and bubble diffusers to the aerobic sludge digester, and a replacement alkaline feed augur on the Enviro processing system.

The City of Fairborn continues to investigate and eliminate sources of I/I and, as of 2002, the work was 60% complete. Eight neighborhoods were screened for I/I by camera, smoke testing and dye testing.

Ohio EPA bioassays of the Fairborn WWTP outfall 001 effluents, upstream and mixing zone waters were conducted in 1994, 1998 and 2004. The effluents were not acutely toxic to either test organism (fathead minnows and daphnids) in any of the samples.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed none for the Fairborn WWTP.

B.P Exploration & Oil Inc., Dayton Terminal - City of Dayton storm sewer to the Mad River (RM 1.63)
Permit # -1IN00147
Outfall 001 - Lat.:39^{0}47'07"; Long.:84^{0}09'41" - discharge from catch basin prior to entering storm sewer
Outfall 002 - Lat.:39^{0}47'10"; Long.:84^{0}09'35" (at manhole) - air stripper and discharge (at a manhole on Brandt Pike) from ground water treatment system prior to entering storm sewer

BP Exploration & Oil Inc. of Dayton is located in Montgomery County at 621 Brandt Pike, Dayton, Ohio. BP Exploration receives petroleum products from pipelines originating in Toledo and Lima, Ohio. These petroleum materials are subsequently stored on site for later truck distribution. Fuel oil, aircraft fuel, and diesel gasoline are then delivered to retail marketing.

An Ohio EPA inspection in 2004 addressed issues such as air stripper cleaning, sampling frequency, and reporting. Stormwater from within the diked tank farm is routed through a rope-type oil skimmer and composited with the treated groundwater. The stormwater then travels to an oil/water separator and then to a lift station which pumps to a City of Dayton storm sewer to the Mad River. The groundwater remediation system also discharges by gravity flow to the City of Dayton storm sewer. Historically, the stormwater flowed into a lined retention pond which overflowed to an infiltration area to the south.

Another oil company, Sun Oil Company near BP Exploration, has a groundwater remediation program under NPDES 1GU00024 and combines flow with BP Oil downstream from the BP sampling location. An Ohio EPA inspection in 2001 rendered a satisfactory rating for this facility.

Numeric violations of NPDES permit limits were evaluated from 2001 to 2004. NPDES violations, reported through SWIMS, revealed a total of five for BP Oil-Dayton Terminal. For the approximate year of data evaluated, constituents violating permit limits were pH and benzenes, reported with the greatest frequency. Most of the violations occurred in 2004.

Dayton Phoenix Group – City of Dayton Storm Sewer to the Mad River (RM 1.63)
Permit # -1IS00014
All Outfalls – Lat.:39^{0}47'30"; Long.: 84^{0}10'00"
Outfall 001 – formerly called 002
Outfall 002 - stormwater prior to discharging into the storm sewer to the Mad River
Outfall 003 - stormwater prior to discharging into the storm sewer to the Mad River
Outfall 004 - stormwater prior to discharging into the storm sewer to the Mad River
Outfall 005 - noncontact cooling water prior to discharging into the storm sewer to the Mad River

The Dayton Phoenix Group is located in Montgomery County at 1619 Kuntz Rd, Dayton, Ohio.

Dayton Phoenix manufactures motors and compressors for locomotives. The wastewaters discharged under their permit are noncontact (once-through) cooling water from an annealing oven and air compressor, and are conveyed to the Mad River through the City of Dayton Storm Sewer. An NPDES renewal package was received in February of 2001. The facility has removed noncontact cooling water from all of its outfalls except for outfall 005. In 2001, an Ohio EPA inspection during a rain event noted the absence of any sheen on the surface of their discharge water. Process water and sanitary flow that are generated on-site are discharged in the sanitary sewer and treated at the City of Dayton WWTP.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004. NPDES violations, reported through SWIMS, revealed one (pH) for Dayton Phoenix Group Inc.

Flowserve Corporation (Dayton Foundry) - storm sewer to the Mad River (RM 1.63)
Permit # -1IN00034
001-Lat.: $39^0$46'21"; Long.: $84^0$09'33"

Flowserve Corporation is located in Montgomery County at 450 North Findlay St., Dayton. This permit holder is a manufacturer of iron and steel castings and pump manufacturing, utilizing raw materials such as cadmium, chromium and nickel. There is one discharge point for stormwater and noncontact cooling water to the City of Dayton storm sewer. Flowserve's process wastewater (~60,000 gpd) discharges to the sanitary collection system of the City of Dayton WWTP for treatment. Frequency of the discharges depends on a failure of the recirculating system which historically has been approximately two times a year. The cooling system failure results in chlorinated city water used in a once-through manner. This permitee also holds an Ohio EPA Stormwater Pollution Prevention Plan. An unresolved enforcement case from 2002 will be addressing the proper disposal of an intermittent or "emergency" discharge of chlorinated noncontact cooling water.

Numeric violations of NPDES permit limits were evaluated from 2002 to 2004. NPDES violations, reported through SWIMS, revealed a total of nine for Flowserve. For the nearly three years of data evaluated, constituents violating permit limits were mostly chlorine and oil and grease reported with the greatest frequency. Seasonal patterns indicated that violations were not observed in the winter months. In 2003, Flowserve eliminated the chlorine from the storm sewer by adding a closed loop water return system and dechlorinating filters. Other potential sources of chlorinated water were under investigation in 2004.

Gem City Chemicals Incorporated - storm sewer to the Mad River (RM 1.63)
Permit # - 1IN00134
Lat.: $39^0$47'15"; Long.: $84^0$10'31"

Gem City Chemical is located in Montgomery County at 1287 Air City Avenue, Dayton. Gem City is a chemical distribution, blending and repackaging facility employing approximately 13 people on a nine-hour shift. A Crown Model 6 H-300 groundwater recovery system/air stripper

was installed in 1992 due to the presence of contaminated groundwater discovered on the property. This treated water is discharged through outfall 001 at an approximate volume of 0.432 MGD.

Numeric violations of NPDES permit limits were evaluated from 2001 to 2004. NPDES violations, reported through SWIMS, revealed a total of 16 for Gem City Chemicals Inc. For the nearly four years of data evaluated, constituents violating permit limits were volatile organic compounds including C-1,2-Dichloroethene and Toluene. All years had the same approximate number of violations. Violations were attributed to the reduced efficiency of the air stripper created by a buildup of minerals on the packing media.

Dayton Water Treatment Plant - Mad River (RM 1.5 and RM1.0)
Permit # - 1IW00030
Outfall 001 – Lat.: $39^0$46'17"; Long. : $84^0$10'5" - Mad River (RM 1.0)
Outfall 002 – Lat.: $39^0$46'89"; Long.: $84^0$09'43"-storm sewer to Mad River (RM 1.5)

The City of Dayton Water Treatment Plant is located in Montgomery County at 1048 Ottawa Street. This facility produces potable drinking water by using two lime softening water treatment plants. The lime softening residuals are pumped from the water treatment plants to the Lime Recalculation Facility (LRF). Once through the treatment process, the remaining solids are thickened and discharged into the L-shaped lagoon that ultimately discharges through outfall 001. When the LRF is out-of-service for maintenance, the lime softening residuals are diverted to the lagoon located along State Route 4 that ultimately discharges through outfall 002 to the Mad River. However, this outfall has the potential to continuously discharge, especially during precipitation events. During an inspection in January, 2003, a whitish-grey precipitant ("quick" lime) was noted immediately beneath outfall 001 for approximately 35 feet downstream. This facility produces a "quick" lime from its water softening process which ultimately flows to the lagoons. The current operations of this discharger reported an average effluent flow of 271,000 gpd for each outfall. Parameters monitored are pH, TSS and total residual chlorine.

Numeric violations of NPDES permit limits were evaluated from 1999 to 2004 for outfalls 001 and 002. NPDES violations, reported through SWIMS, revealed a total of 46 for chlorine and TSS for both outfalls.

Wright Patterson Air Force Base has several outfalls that also discharge into this LRAU. The complete descriptions of all the outfalls for Wright Patterson are included in the "Point Source Evaluations" section for WAU 190.

Table 25. Sampling locations for the Mad River study area, 2003. M - macroinvertebrate sample (artificial substrate sample), M_{ql} - macroinvertebrate sample (natural substrate qualitative sample only), F - fish sample (2 passes), F_{1X} - fish sample (1 pass), C - conventional water chemistry parameters (6 runs), Bac - bacteria (5 runs), S - sediment sample (conventional and organics), D-Datasonde™ monitor, O-organic water chemistry (2 runs). [Latitude/longitude coordinates are provided in WGS84 datum.]

Stream RM	Sample Type	Latitude/Longitude (DD)	Location	USGS Quad
WAU: 05080001150				
Mad River (mainstem)				
61.23	C,O,Bac,S,M_{ql},F_{1x}	40.3499/83.6742	Co. Rd. 5 (reference); Dst Kamp-a-Lott	Zanesfield
57.23	C,M,F	40.3053/83.7029	Co. Rd. 29	Zanesfield
53.21	C,O,Bac,S,M,F	40.2672/83.7513	Twp. Rd. 173 (reference)	Bellefontaine
52.05	C,M,F	40.2522/83.7493	St. Rt. 245	Zanesfield
51.10	C,M,F	40.2454/83.7634	Ust. W. Liberty WWTP	Northville
50.98	C,Bac,D,M,F,S	40.2434/83.7643	Pimtown Rd; Dst. W. Liberty WWTP	Northville
49.08	C,M,F	40.2225/83.7732	Upper Valley Pike	Northville
43.90	C,M,F,S	40.1572/83.7871	Ust. Kings Creek	Northville
Sugar Creek				
1.0	F_{1x}	40.3520/83.6546	private lane	Zanesfield
Peters Ditch				
0.1	F_{1x}	40.3209/83.6798	near mouth	Zanesfield
Macochee Creek				
6.16	C,M_{ql},F_{1x}	40.2656/83.6586	Co. Rd. 28	Zanesfield
3.70	C,M_{ql},F_{1x}	40.2685/83.7026	Twp. Rd. 166	Zanesfield
2.95	C,O,Bac,S,M_{ql},F_{1x}	40.2589/83.7045	St. Rt. 287 (reference)	Zanesfield
1.41	C,M_{ql},F_{1x}	40.2501/83.7292	McClain Rd. (Twp Rd 47)	Zanesfield
0.04	C,M_{ql},F_{1x}	40.2487/83.7532	near mouth	Northville
Macochee Ditch				
0.66	C,M_{ql},F_{1x}	40.1941/83.7876	Lippincott Rd.	Northville
Glady Creek				
4.17	C,O,Bac,S,M_{ql},F_{1x}	40.2184/83.8284	Sullivan Rd.	Northville
Kings Creek				
6.13	C,M_{ql},F_{1x}	40.1693/83.6880	Ludlow Rd.	Kingscreek
3.90	C,M,F	40.1606/83.7256	Kennard-Kings Creek Rd	Kingscreek
0.09	C,M,F,S	40.1569/83.7855	St. Rt. 290, near mouth	Northville
Tributary to Kings Creek (RM 4.99/3.18)				
1.00	C,M_{ql},F_{1x}	40.2033/83.6876	Kennard North Rd.	Kingscreek
Tributary to Kings Creek (RM 0.46)				
0.49	C,M_{ql},F_{1x}	40.1563/83.7718	farm lane	Northville
WAU: 05080001160				
Mad River (mainstem)				
41.58	C,M,F	40.1300/83.8093	Millerstown Rd	Northville
39.89	C,O,Bac,S,D,M,F	40.1074/83.7992	U.S. Rt. 36; Upstream Urbana WWTP	Urbana West
38.35	C,O,Bac,S,D,M,F	40.0856/83.8012	Old Troy Pike; Dst Urbana WWTP	Urbana West
32.68	C,Bac,M,F	40.0073/83.8231	Tremont City Rd.	Urbana West
Muddy Creek				
6.24	C,M_{ql},F_{1x}	40.2059/83.8375	Ust Church Rd.; Dst tributary	Northville
0.10	C,M,F	40.1337/83.8101	near mouth	Northville

Table 25. Continued.

Stream RM	Sample Type	Latitude/Longitude (DD)	Location	USGS Quad
WAU: 05080001160 (Continued)				
Spring Run				
0.62	C,O,Bac,S,M_{ql},F_{1x}	40.1775/83.8267	Woodville Pike	Northville
Dugan Run				
3.99	C,M_{ql},F_{1x}	40.1256/83.7400	Dellinger Rd	Kingscreek
0.95	C,O,Bac,S,M_{ql},F_{1x}	40.1041/83.7815	Muzzys Rd.	Urbana West
Nettle Creek				
8.23	C,M_{ql},F_{1x}	40.1430/83.9107	Adj. Nettle Creek Rd (reference)	St. Paris
7.07	C,M_{ql},F_{1x}	40.1340/83.8924	Kite Rd.	St. Paris
4.49	C,O,Bac,S,M_{ql},F_{1x}	40.1083/83.8632	Runkle Rd. (reference)	Urbana West
2.50	C,M_{ql},F_{1x}	40.0922/83.8375	St. Rt. 560	Urbana West
0.01	C,M	40.0706/83.8108	at mouth	Urbana West
Tributary to Nettle Creek (aka St. Paris Tributary)				
2.66	C,Bac,M_{ql},F_{1x}	40.1341/83.9491	Ust. St. Paris WWTP; Ust. Huffman Dr	St. Paris
2.64	C,Bac,D,S, M_{ql},F_{1x}	40.1344/83.9489	Dst. St. Paris WWTP; Dst. Huffman Dr	St. Paris
Owens Creek				
0.10	C,M_{ql},F_{1x}	40.0912/83.8376	St. Rt. 560	Urbana West
Anderson Creek				
5.90	C,M_{ql},F_{1x}	40.1477/83.8339	Kiser Rd.	Northville
3.67	C,M_{ql},F_{1x}	40.1223/83.8248	Dst. Stickley Rd; Dst Russell Creek	Urbana West
1.03	C,M_{ql},F_{1x}	40.0865/83.8158	Old Troy Pike	Urbana West
Hog Creek				
0.60	C,M_{ql},F_{1x}	40.1518/83.8524	Eris Rd.	Northville
Russell Creek				
0.01	C,M_{ql}	40.1233/83.8260	at mouth	Urbana West
Harban Creek				
0.10	C,F_{1x}	40.1338/83.8401	at mouth	Northville
Bull Branch				
0.40	C,M_{ql},F_{1x}	40.0538/83.8221	Dallas Rd.	Urbana West
Stony Creek				
0.70	C,M_{ql},F_{1x}	40.0433/83.8318	Upper Valley Pike	Urbana West
Storms Creek				
3.14	C,M_{ql},F_{1x}	40.0449/83.8683	Willow Dale Rd.	Urbana West
0.70	C,M_{ql},F_{1x}	40.0284/83.8335	Upper Valley Pike	Urbana West
Chapman Creek				
10.11	C,M_{ql},F_{1x}	40.0806/83.9503	Conrad Rd.	Thackery
6.92	C,M_{ql},F_{1x}	40.0540/83.9200	St. Rt. 55	Thackery
4.00	C,O,Bac,S,M_{ql},F_{1x}	40.0241/83.8894	Snyder Domer Rd;Ust Tremont City landfill	Thackery
0.77	C,O,Bac,S,D,M,F	40.0107/83.8352	Upper Valley Pike;Dst Tremont City landfill	Urbana West
Blacksnake Creek				
0.42	C,M_{ql},F_{1x}	40.0481/83.9194	Donnelsville Rd.	Thackery
Deer Creek				
0.60	C,M_{ql},F_{1x}	40.0332/83.9098	Zerkle Rd.	Thackery

Table 25. Continued.

Stream RM	Sample Type	Latitude/Longitude (DD)	Location	USGS Quad
WAU: 05080001170				
Buck Creek				
19.50	C,M_{ql}	40.0812/83.6521	St. Rt. 29	Urbana East
17.53	C,M_{ql},F_{1x}	40.0578/83.6667	Pisgah Rd.	Urbana East
13.13	C,M,F	40.0104/83.6989	St. Rt. 4	Urbana East
6.50	C,O,Bac,S,M,F	39.9469/83.7583	Adj. Old Reid Park; Ust Beaver Creek	Springfield
0.60	C,O,Bac,S,D,M,F	39.9307/83.8467	Adj. Snyder Park	Springfield
Dugan Ditch				
2.16	C,M_{ql},F_{1x}	40.0638/83.6940	Pisgah Rd.	Urbana East
East Fork Buck Creek				
5.02	C,M_{ql},F_{1x}	40.0485/83.6338	Number Ten Rd.	Urbana East
0.28	C,M,F	40.0062/83.6934	Baldwin Lane	Urbana East
Tributary to tributary of East Fork Buck Creek (RM 1.00/1.33)				
0.94	C	40.0004/83.6465	Vernon Asbury Rd.	Urbana East
Tributary to East Fork Buck Creek (RM 1.00)				
2.30	M_{ql},F_{1x}	39.9906/83.6478	Vernon Asbury Rd., Dst Catawba WWTP	New Moorefield
Beaver Creek				
10.16	C,M_{ql},F_{1x}	39.9126/83.6113	St. Rt. 54	Vienna
4.50	C,M,F	39.9268/83.6965	Meenach Rd; Ust Sinking Creek	New Moorefield
0.67	C,O,Bac,S,M,F	39.9405/83.7490	Croft Rd. (reference); Dst Sinking Creek	New Moorefield
Sinking Creek				
4.60	C,M_{ql},F_{1x}	39.9472/83.6814	Mahar Rd.	New Moorefield
WAU: 05080001180				
Mad River (mainstem)				
29.55	C,O,Bac,S,M,F	39.9643/83.8316	St. Paris Pike	Springfield
27.00	C,M,F	39.9338/83.8515	First road ust. US 68 (fishing lake entrance)	Springfield
25.57	D	39.9180/83.8492	Ust Springfield WWTP	Springfield
25.43	C,O,Bac,S,M,F	39.9201/83.8474	Ust Springfield WWTP	Springfield
24.13	C,O,Bac,S,D,M,F	39.9224/83.8693	Lower Valley Pike; Dst Springfield WWTP	Springfield
Moore Run				
4.10	C,O,S,M_{ql},F_{1x}	40.0264/83.7921	Countyline Rd; Ust International Truck	Urbana West
2.46	C,O,S,D,M_{ql},F_{1x}	40.0053/83.8036	Tremont City Rd; Dst International Truck	Urbana West
0.79	C,M_{ql},F_{1x}	39.9900/83.8175	River Rd; Dst Kenton Creek	Springfield
Kenton Creek				
0.30	C,M_{ql},F_{1x}	39.9926/83.8112	U.S. Rt. 68	Springfield
Pondy Creek				
1.14	C,M_{ql},F_{1x}	39.9697/83.8381	Baker Rd.	Springfield
Dry Run				
0.22	C,M_{ql},F_{1x}	39.9755/83.8426	Upper Valley Pike	Springfield
Mill Creek				
3.24	C,Bac,M_{ql},F_{1x}	39.8767/83.8424	Springfield-Xenia Rd.	Springfield
0.01	C,O,M_{ql},F_{1x},S	39.9149/83.8519	at mouth	Springfield
Rock Run				
0.10	C,M_{ql},F_{1x}	39.9231/83.8694	driveway near mouth	Springfield
Miller Creek				
0.01	C,M_{ql},F_{1x}	39.9411/83.8773	Shrine Rd.	Donnelsville

Table 25. Continued.

Stream RM	Sample Type	Latitude/Longitude (DD)	Location	USGS Quad
WAU: 05080001180 (Continued)				
Donnels Creek				
7.50	C,M_{ql},F_{1x}	39.9638/83.9521	Detrick Jordan Pike	Donnelsville
3.70	C,O,Bac,M,F	39.9269/83.9449	Hampton Rd. (Upstream Donnelsville)	Donnelsville
1.87	C,Bac,M_{ql},F_{1x}	39.9070/83.9534	Hampton Rd. (Downstream Donnelsville)	Donnelsville
East Fork Donnels Creek				
2.91	C,M_{ql},F_{1x}	39.9500/83.9293	Folk-Ream Rd.	Donnelsville
0.01	C,M_{ql},F_{1x}	39.9272/83.9430	at mouth	Donnelsville
Jackson Creek				
3.80	C,M_{ql},F_{1x}	39.9310/83.9720	Milton-Carlisle Rd.	Donnelsville
0.90	C,O,Bac,S,M_{ql},F_{1x}	39.8983/83.9727	Lower Valley Pike	Donnelsville
WAU: 05080001190				
Mud Creek				
5.03	C,M_{ql},F_{1x},S	39.9088/84.0356	US 40	New Carlisle
2.51	C,M_{ql},F_{1x}	39.8792/84.0436	Gerlaugh Rd.	New Carlisle
0.66	C,M_{ql},F_{1x}	39.8556/84.0527	Lower Valley Pike	Fairborn
Dry Lick Run				
1.62	C,M_{ql},F_{1x}	39.8669/84.0818	Shull Rd	Fairborn
Mud Run				
9.70	C,M_{ql},F_{1x},S	39.8517/83.9081	Hagan Rd.	Yellow Springs
7.77	C,M,F	39.8559/83.9384	Hunter Rd.	Yellow Springs
3.33	C,O,S,M,F	39.8541/83.9974	Spangler Rd. (Upstream Landfill #1)	Yellow Springs
1.98	C,O,Bac,S,M,F	39.8544/84.0187	Haddix Rd. (Downstream Landfill #1)	Fairborn
0.80	C,M,F	39.8450/84.0365	Medway Rd	Fairborn
Tributary to Mud Run (RM 9.8)				
0.70	C,M_{ql},F_{1x}	39.8484/83.8999	Fairfield Pike	Yellow Springs
Clear Creek				
0.50	C,M_{ql},F_{1x}	39.8488/83.9222	Fairfield Pike	Yellow Springs
Hebble Creek				
5.00	C,M_{ql},F_{1x}	39.8227/84.0142	Dayton Ave.	Fairborn
0.25	C,O,Bac,S,D,M_{ql},F_{1x}	39.7985/84.0846	Hebble Creek Rd.	Fairborn
Lilly Creek				
0.10	C,O,Bac,S,M_{ql}	39.7800/84.1414	near mouth	Dayton North
LRAU: 05080001003				
Mad River				
17.48	C,M,F	39.8857/83.9665	Snider Rd.	Donnelsville
15.43	C,O	39.8753/83.9951	Spangler Rd.	Donnelsville
13.10	C,O,Bac,D,M,F,S	39.8645/84.0184	I-70 ; Dst Clark County SW Regional WWTP	Fairborn
11.44	C,D,M,F	39.8495/84.0362	Osborne -Medway Rd	Fairborn
9.7	D	39.8383/84.0574	Ust Fairborn WWTP	Fairborn
8.60	C,O,Bac,D,M,F,S	39.8273/84.0625	Dst Fairborn WWTP	Fairborn
6.28	D	39.8011/84.0898	Ust Huffman Dam; Ust Hebble Creek	Fairborn
6.05	C,O,Bac,S,M,F	39.7978/84.0897	Ust Huffman Dam; Dst Hebble Creek	Fairborn
3.97	C,O,Bac,D,S,M,F	39.7885/84.1233	Harshman Rd	Fairborn
1.63	C,O,Bac,S,M,F	39.7749/84.1600	Findlay St. (reference)	Dayton North
0.28	C,S,M,F	39.7683/84.1835	Webster St.	Dayton North

Table 26. Exceedences of Ohio EPA WQS criteria (OAC 3745-1) (and other chemicals not codified for which toxicity data is available) for chemical/physical water parameters measured in grab samples taken from the Mad River study area during 2003 (units are Fg/l for metals and organics, #colonies/100 ml for fecal coliform and *E. coli*, SU for pH, and mg/l for all other parameters). (Strontium exceeded Tier II limits in 183 samples and is not included in the table.[b])

Stream (*use designation* [a]) River Mile	Parameter [c] (value)
WAU: 05080001150	
Mad River *(SRW, CWH, PCR, AWS, IWS)*	
61.23	Heptachlor epoxide (0.0031[#]) Fecal coliform (1900[" JL]) *E. coli* (230["], 190[" JL], 740[""])
53.21	Fecal coliform (1500[" JL]) *E. coli* (250["], 160[" JL], 130[" JL], 260["], 660[""])
50.98	Fecal coliform (18000["" JL]) *E. coli* (200["], 140[" JL], 190[" JL], 420[""], 4600[""])
Macochee Creek *(CWH, PCR, AWS, IWS)*	
6.16	Dissolved oxygen (5.60[‡‡])
2.95	Fecal coliform (2600[""], 2500[""], 5300[""]) *E. coli* (800[""], 310[""], 1370["" JL], 620[""], 350[""])
Glady Creek *(SRW, CWH, PCR, AWS, IWS)*	
4.17	Dissolved oxygen (5.70[‡‡],6.30[‡], 6.30[‡]) Aldrin (0.0028[#]) Dieldrin (0.0044[#]) Fecal coliform (2200[""]) *E. coli* (360[""], 480[""], 790[""])
WAU: 05080001160	
Mad River *(SRW, CWH, PCR, AWS, IWS)*	
39.89	Fecal coliform (1800[" JL]) *E. coli* (150[" JL], 140[" JL], 190[" JL], 360[""])
38.35	Heptachlor epoxide (0.0038[#]) *E. coli* (160[" JL])
32.68	Fecal coliform (1700[" JL]) *E. coli* (280["], 140[" JL], 400[""])
Spring Run *(SRW, CWH, PCR, AWS, IWS)*	
0.62	Fecal coliform (1300[" JL]) *E. coli* (250["], 210["], 550[""], 340[""])

Table 26. Continued.

Stream (*use designation* [a]) River Mile	Parameter [c] (value)
WAU: 05080001160 (continued)	
Dugan Run *(WWH, PCR, AWS, IWS)*	
3.99	Dissolved oxygen (4.40‡)
0.95	Fecal coliform (4000"", 28000"") *E. coli* (160" JL, 700"", 5900"")
Nettle Creek *(RM 8.23 to mouth: CWH, SCR, AWS, IWS; all other segments: WWH, SCR, AWS, IWS)*	
4.49	Heptachlor epoxide (0.0035#) *E. coli* (1040"" JL)
Tributary to Nettle Creek (aka St. Paris Tributary) *(WWH, SCR, AWS, IWS)*	
2.66	Fecal coliform (9000"" JL, 18000"" JL) *E. coli* (1010"" JL, 3100"", 6700"")
2.64	Fecal coliform (14000"" JL) *E. coli* (1000"" JL, 6200"")
Anderson Creek *(CWH, PCR, AWS, IWS)*	
3.67	Dissolved oxygen (5.00‡‡, 5.90‡‡, 6.60‡, 6.20‡, 5.60‡‡)
Russell Creek *(SRW, CWH, PCR, AWS, IWS)*	
0.01	Dissolved oxygen (6.00‡, 5.70‡‡, 5.80‡‡, 4.10‡‡)
Storms Creek (*SRW, CWH, PCR, AWS, IWS)*	
0.70	Dissolved oxygen (4.80‡‡)
Chapman Creek (*CWH, PCR, AWS, IWS)*	
6.92	Dissolved oxygen (4.80‡‡) Iron-T (7610[4])
4.00	Fecal coliform (1700", 3100"", 2700"") *E. coli* (200", 890"" JL, 1060"" JL, 570"")
0.77	Fecal coliform (4100"") *E. coli* (270", 300"" JL, 600"", 750"")
Deer Creek (*SRW, CWH, PCR, AWS, IWS)*	
0.60	Dissolved oxygen (6.40‡)

Table 26. Continued.

Stream (*use designation* [a]) River Mile	Parameter [c] (value)
WAU: 05080001170	
Buck Creek ***(Park boundaries between C.J. Brown Reservoir and mouth: SRW, WWH, PCR, AWS, IWS; Headwaters to C.J. Brown Reservoir (~RM 11.2): CWH, PCR, AWS, IWS; all other segments: WWH, PCR, AWS, IWS)***	
19.50	Dissolved oxygen (6.20‡)
6.50	Aldrin (0.0034#) Fecal coliform (7200"" JL) *E. coli (*2000"")
0.60	Lead-T (15.1*) Aldrin (0.0042#) Fecal coliform (25000"" , 93000"" JL) *E. coli* (620"", 780"", 13000"" JL)
Tributary to tributary of East Fork Buck Creek (RM 1.00/1.33) ***(Undesignated)***	
0.94	Dissolved oxygen (3.30‡‡) Copper-T (21*) Lead-T (11.1*) Iron-T (16600[4])
Beaver Creek ***(Sinking Creek (RM 2.8) to mouth:WWH, PCR, AWS, IWS; all other segments: CWH, PCR, AWS, IWS)***	
0.67	Fecal coliform (1800" JL, 5900"") *E. coli* (930"" JL, 1200"" JL)
WAU: 05080001180	
Mad River ***(SRW, CWH, PCR, AWS, IWS to Buck Creek confluence–RM 26.15; SRW, WWH, PCR, AWS, IWS from Buck Creek confluence to Eastwood Park (RM 2.7))***	
29.55	Fecal coliform (29000"") *E. coli* (200", 8300"" JL)
25.43	Heptachlor epoxide (0.0049#) Fecal coliform (2300"", 91000"" JL) *E. coli* (290", 170" JL, 300"" JL, 22000"")
24.13	Heptachlor epoxide (0.0052#) Fecal coliform (2100"", 92000"" JL) *E. coli* (54000"", 370"", 310"")
Moore Run (***WWH, PCR, AWS, IWS)***	
4.10	Heptachlor epoxide (0.0037#)
2.46	Heptachlor epoxide (0.0048#)

Table 26. Continued.

Stream (*use designation* [a]) River Mile	Parameter (value)
WAU: 05080001180 (continued)	
Pondy Creek (*SRW, CWH, PCR, AWS, IWS)*	
1.14	Ammonia-N (0.52*)
Dry Run (*SRW, CWH, PCR, AWS, IWS)*	
0.22	pH (9.05[)])
Mill Creek *(WWH, PCR, AWS, IWS)*	
3.24	Fecal coliform (1300[" JL], 18000[" " JL]) *E. coli* (190[" JL], 450[" "], 6700[" "])
Rock Run *(WWH, PCR, AWS, IWS)*	
0.10	Iron-T (12200[4])
Donnels Creek *(EWH, PCR, AWS, IWS)*	
3.70	Fecal coliform (1500[" JL], 7200[" " JL]) *E. coli* (510[" "], 550[" "], 310[" "], 440[" "], 3900[" "])
1.87	Fecal coliform (1500[" JL], 11100[" " JL]) *E. coli* (160[" JL], 230[" JL], 660[" "], 490[" "], 7700[" "])
Jackson Creek *(EWH, PCR, AWS, IWS)*	
0.90	Fecal coliform (1200[" JL], 4200[" "]) *E. coli* (150[" JL], 1400[" "], 590[" "], 590[" "])
WAU: 05080001190	
Mud Creek *(Undesignated)*	
5.03	Dissolved oxygen (4.50[‡], 4.20[‡])
Mud Run *(WWH, PCR, AWS, IWS)*	
1.98	Fecal coliform (3000[" " JL], 8000[" " JL]) *E. coli* (140[" JL], 1800[" " JL], 3600[" "])
Hebble Creek *(MWH, SCR, IWS)*	
0.25	Fecal coliform (18000[" " JL]) *E. coli* (7800[" "])
Lilly Creek *(Undesignated)*	
0.10	Dieldrin (0.0022[#]) Fecal coliform (19000[" " " JL],67000[" " " JL]) *E. coli* (2100[" " "], 1900[" " " JL], 27000[" " "])

Table 26. Continued.

Stream (*use designation* [a]) River Mile	Parameter [c] (value)
LRAU: 05080001003	
Mad River ***(SRW, WWH, PCR, AWS, IWS to Eastwood Park (RM 2.7); WWH, PCR, AWS, IWS from 2.7 to mouth***	
13.10	Heptachlor epoxide (0.0053[#]) Aldrin (0.0029[#]) Fecal coliform (1300[" JL]) *E. coli* (200["], 150[" JL], 140[" JL], 480[""])
8.60	Heptachlor epoxide (0.0038[#]) Dieldrin (0.0028[#]) Fecal coliform (1220[" JL], 2600[""]) *E. coli* (150[" JL], 500[""], 560[""])
6.05	Heptachlor epoxide (0.0049[#]) Fecal coliform (1900[" JL], 24000[""]) *E. coli* (200["], 310[""], 6200[""])
3.97	Heptachlor epoxide (0.0052[#]) Fecal coliform (2300[""], 2300[""]) *E. coli* (130[" JL], 340[""], 490[""])
1.63	Heptachlor epoxide (0.0036[#]) Aldrin (0.0028[#]) Fecal coliform (2300[""], 8800[""JL]) *E. coli* (250["], 150[" JL], 1500[""JL])

a Use designations:

SRW - State Resource Water

Aquatic Life Habitat	Water Supply	Recreation
WWH - warmwater habitat	IWS - industrial water supply	PCR - primary contact
EWH - exceptional warmwater habitat	AWS - agricultural water supply	SCR - secondary contact
CWH - coldwater habitat		
MWH - modified warmwater habitat		
Undesignated		

. [WWH biocriteria apply to 'undesignated' surface waters.]

Table 26. Continued.

Stream (*use designation* [a]) River Mile	Parameter [c] (value)

b Higher strontium concentrations are typically associated with outwash from glacial deposits high in celestite ($SrSO_4$).

WAU	**% of Strontium values above Tier II criteria**
05080001150	17 % (20 of 120 values)
05080001160	45 % (86 of 191 values)
05080001170	32 % (25 of 77 values)
05080001180	44 % (52 of 118 values)
05080001190	0 % (0 of 180 values)
05080001003	0 % (0 of 53 values)

c Bacteriological data (fecal coliform, *E. coli*) are shown to gauge the potential for impacts to receiving waters. See also Table 27.

* exceedence of numerical criteria for prevention of chronic toxicity (CAC).
** exceedence of numerical criteria for prevention of acute toxicity (AAC).
*** exceedence of numerical criteria for prevention of lethality (FAV).
) exceedence of the pH criteria (6.5-9.0).
exceedence of numerical criteria for the protection of human health (non-drinking—protective of people against adverse exposure to chemicals via eating fish).
4 exceedence of agricultural water supply criterion.
‡ value is below the CWH minimum 24-hour average D.O criterion (7.0 mg/l) or value is below the EWH minimum 24-hour average D.O criterion (6.0 mg/l) or value is below the WWH minimum 24-hour average D.O criterion (5.0 mg/l) or value is below the MWH minimum 24-hour average D.O criterion (4.0 mg/l) as applicable.
‡‡ value is below the CWH minimum at any time D.O. criterion (6.0 mg/l) or value is below the EWH minimum at any time D.O. criterion (5.0 mg/l) or value is below the WWH minimum at any time D.O. criterion (4.0 mg/l) or value is below the MWH minimum at any time D.O. criterion (3.0 mg/l) as applicable.
" value is above the average PCR criteria (fecal coliform 1000/100ml; *E. coli* 126/100ml)
"" value is above the maximum PCR criteria (fecal coliform 2000/100ml; *E. coli* 298/100ml) or value is above the maximum SCR criteria (fecal coliform 5000/100ml; *E. coli* 576/100ml) as applicable.
"""" value is above maximum criteria applicable to all waters (fecal coliform 5000/100ml; *E. coli* 576/100ml). [Requirements associated with the maximum criteria applicable to all waters include: samples must be collected during steady state flow representative of dry weather conditions; at least two or more samples must exceed criteria when five or fewer samples are collected, or criteria must be exceeded in more than twenty percent of the samples when more than five samples are taken.]
P The reported result is estimated because the sample was not analyzed within the required holding time.
JL The reported result is estimated because it has been computed using a colony count that is not within the acceptable counting range.

Table 27. Exceedences of Ohio EPA bacteriological water quality criteria (OAC 3745-1-07) during 2003 in the Mad River study area by watershed assessment unit (WAU). Five samples were collected from select sites from August 25 - September 22. At least one of the two bacteriological standards (fecal coliform or *E. coli*) must be met. (Values above criteria are highlighted in red.)

	Watershed Assessment Unit (5080001_ _ _)					
	150 (5 sites)	**160** (10 sites)	**170** (3 sites)	**180** (7 sites)	**190** (3 sites)	**003** (5 sites)
Primary Contact Recreation (Fecal coliform): Geometric mean fecal coliform content based on not less than five samples within a thirty-day period shall not exceed 1000 per 100 ml, *and* fecal coliform content shall not exceed 2000 per ml in more than ten percent of the samples taken during any thirty-day period.						
Geometric mean (#colonies/100ml)	717	765	591	**1157**	**1349**	532
% > max	**20%**	**20%**	**27%**	**26%**	**40%**	**24%**
n =	25	50	15	35	15	25
Primary Contact Recreation (*E. coli*): Geometric mean *E. coli* content based on not less than five samples within a thirty-day period shall not exceed 126 per 100 ml, *and E. coli* content shall not exceed 298 per 100 ml in more than ten percent of the samples taken during any thirty-day period.						
Geometric mean (#colonies/100ml)	**294**	**213**	**159**	**429**	**388**	**147**
% > max	**48%**	**40%**	**40%**	**54%**	**40%**	**32%**
n =	25	50	15	35	15	25

Table 28. Frequency of organic compounds detected in water samples collected in the Mad River study area during 2003 by watershed assessment unit (WAU) (number of WQS criteria exceedences/number of detections). Samples were collected at select sites twice during the survey.

	Watershed Assessment Unit [05080001_ _ _] (Number of Organic Sites in WAU)						
Parameter	**150** (4)	**160** (7)	**170** (3)	**180** (8)	**190** (4)	**003** (6)	**TOTAL** (32)
Acetochlor*	*/1	-/-	*/3	*/1	*/2	*/5	*/12
Aldrin	1/1	-/-	2/2	-/-	-/-	2/2	5/5
Atrazine*	*/5	*/11	*/6	*/10	*/6	*/11	*/49
alpha-Hexachlorocyclohexane	-/-	-/-	-/1	-/3	-/3	-/1	-/8
delta-Hexachlorocyclohexane*	*/1	*/1	*/1	*/4	-/-	*/5	*/12
gamma-Hexachlorocyclohexane(Lindane)	-/-	-/-	-/-	-/1	-/-	-/-	-/1
bis(2-Ethylhexyl)adipate*	*/5	*/5	*/3	*/3	*/3	*/6	*/25
bis(2-Ethylhexyl)phthalate	-/2	-/5	-/2	-/8	-/4	-/6	-/27
Chloroform	-/-	-/4	-/3	-/6	-/1	-/2	-/16
Dieldrin	1/1	-/-	-/-	-/-	1/1	1/1	3/3
1,4-Dichlorobenzene	-/1	-/-	-/-	-/-	-/-	-/-	-/1
Endosulfan I	-/1	-/-	-/1	-/-	-/-	-/-	-/2
Endosulfan II	-/1	-/-	-/-	-/-	-/-	-/-	-/1
Heptachlor epoxide	1/1	2/2	-/-	4/4	-/-	5/5	12/12
Metolachlor*	*/4	*/11	*/6	*/11	*/5	*/11	*/48
Simazine*	*/5	*/5	*/5	*/7	*/3	*/5	*/30
TOTAL	3/29	2/44	2/33	4/58	1/28	8/60	20/252

* No applicable WQS criteria available for parameter.

Table 29. Dischargers in the Mad River watershed.

WAU	Facility Name	Ohio EPA Permit No.	Receiving Stream	Mainstem River Mile	Description
150	Rockin' Ridge Resort	1PR00101	Trib to Mad River	63	wastewater treated by package plant
150	Kamp-a-Lott	1PZ00109	Trib to Mad River	61.41	wastewater treated by package plant
150	Indian Hills MHP	1PV00108	Trib to Mad River	59	wastewater treated by package plant
150	Kirkmont Center	1PZ00069	Trib to trib to Mad River	58.8	wastewater treated by package plant
150	West Liberty WWTP	1PC00012	West Liberty Tributary	51.06	secondary treatment
150	West Liberty Salem School	1PT00066	Macochee Ditch	46.09	extended aeration facility
150	Freshwater Farms of Ohio	1IN00167	Trib to trib to Kings Ck	43.82	discharge from the fish hatchery to an unnamed tributary of Kings Creek. Retail wastewater is collected in a septic tank and hauled to local WWTP.
150	Royal Coach MHP	-	Lagoon nr Mad R	-	extended aeration to an infiltration lagoon
160	Fox River Paper Company	1IA00003	Trib to Dugan Run	39.43	sends approximately 200,000 gpd to a spray field. The remainder of the wastestream is sent to the City of Urbana WWTP.
160	International Fiber Corp	1IH00020	Dugan Run	39.43	process wastewater and stormwater discharge
160	Johnson Welded Products	1IS00000	Trib to Dugan Run	39.43	noncontact cooling water
160	ORBIS-001	1PB00039	Dugan Run	39.43	noncontact cooling water/stormwater
160	ORBIS-002	1PB00039	Drainage to Dugan Run	39.43	noncontact cooling water/stormwater
160	ORBIS-003	1PB00039	Drainage to Dugan Run	39.43	noncontact cooling water/stormwater
160	Urbana WWTP	1PD00011	Mad River	39.15	conventional activated sludge wastewater treatment facility
160	Graham High School	1PT00088	Trib to Nettle Cr	37.18	wastewater treated by package plant
160	St. Paris WWTP	1PB00029	St. Paris tributary to Nettle Cr to Mad	37.18	secondary treatment
160	Lakewood Swim Club	-	Stony Cr	35.05	no permit
160	Urbana Local Elem. School	1PT00100	Trib of Bogles Run	34.95	extended aeration facility
160	Valley View MHP	1PY00002	dry wells - Bogles Run watershed	34.95	extended aeration facility with no tertiary treatment
160	Graham South Elem. School	1PT00089	Chapman Cr	32.58	extended aeration facility
160	Econolodge	-	Dry wells - Bogles Run watershed	-	dry wells/no permit

Table 29. Continued.

WAU	Facility Name	Ohio EPA Permit No.	Receiving Stream	Mainstem River Mile	Description
170	All Seasons Resorts Tomorrow's Star RV Resorts	1PX00043	Beaver Cr to Buck Cr	26.15	wastewater treated by package plant
170	Beaver Valley Resort & CG	1PX00042	Beaver Cr to Buck Cr	26.15	wastewater treated by package plant
170	BP Oil #09771	1GU00107	Stormwater sewer to Buck Cr	26.15	oil/water separator tank, transfer tank and particulate filters, activated carbon filtration
170	BP Oil Spfld Bulk Plant	1lN00256	Discharge to surface of ground	-	oil/water separator is to a lined pond
170	Bridgewood MHP	1PV00112	Trib to Beaver Cr to Buck Cr	26.15	wastewater treated by package plant
170	Brookside Village MHP	1PV00097	Sinking Cr	26.15	wastewater treated by package plant
170	Cascade Corp.	1lS00020	Trib of Mill Run to Buck Creek	26.15	stormwater (outfall 001) and discharge from an air stripper/lime treatment system associated with groundwater remediation activities (002).
170	Catawba WWTP	1PA00020	Trib to East Fork Buck Cr	26.15	wastewater discharge is a controlled lagoon discharging
170	Harmony Estates MHP	1PV00007	Trib to Beaver Cr	26.15	wastewater treated by package plant
170	Northeastern H.S.	1PT00033	Sinking Cr	26.15	wastewater treated by package plant
170	O.S. Kelly Company	1lS00023	Buck Cr	26.15	noncontact cooling water
170	Ports Petroleum (Fuel Mart 764)	1PZ00092	Trib to trib to Beaver Cr	26.15	stormwater to catch basins and oil/water separators
170	South Vienna WWTP	1PA00021	Beaver Cr	26.15	secondary treatment
180	Harvest Square MHP	1PV00082	Moore Run	30.75	wastewater treated by package plant
180	International Truck and Engine (Navistar)-001	1lN00022	Trib to Moore Run	30.75	industrial waste includes equalization, oil/water separation, coagulation, clarification, filtration and pH adjustment. Combined industrial and sanitary wastewater is biologically treated which entails aeration, clarification, chlorination and stabilization
180	International Truck and Engine (Navistar)-002	1lN00022	Trib to Moore Run	30.75	non contact cooling water and storm water outfall chlorinated before discharge

Table 29. Continued.

WAU	Facility Name	Ohio EPA Permit No.	Receiving Stream	Mainstem River Mile	Description
180	KTK Industrial Park	1PZ00003	Moore Run	30.75	extended aeration facility
180	Rolling Hills MHP	1PV00047	Trib to Moore Run	30.75	wastewater treated by package plant
180	Country Air MHP-001	-	Drainage to trib to Pondy Cr	28.67	No permit
180	Country Air MHP-002	-	Drainage to trib to Pondy Cr	28.67	No permit
180	Country Air MHP-003	-	Drainage to trib to Pondy Cr	28.67	No permit
180	Fink Meats	1IH000101	Trib to Pondy Cr	28.67	extended aeration facility
180	Springfield WWTP	1PE00007	Mad River	25.34	
180	BP Oil #09760	1GU00019	Trib to trib of Mill Creek	25.3	oil/water separator
180	Competition Accessories	-	Trib to trib to Mill Cr	25.3	wastewater treated by package plant-offline in March, 2004.
180	Ohio Air National Guard-Outfall 002	1lO00000	Trib to Mill Cr	25.3	discharge of storm water associated with air field activities, oil/water separator
180	Ohio Air National Guard-Outfall 003	1lO00000	Trib to Mill Cr	25.3	discharge of storm water associated with air field activities, oil/water separator
180	Springfield-Beckley Municipal Airport-Outfalls 001-005	1PS00009	Mill Creek	25.3	extended aeration system
180	Clearview MHP	1PV00098	Trib to Mad River	24.98	wastewater treated by package plant
180	Greenlawn Village Condo	-	Miller Cr	24.12	no permit
180	Rockway Elementary School	-	Rock Run	24.12	wastewater treated by package plant
180	Rolling Terrace MHP	1PV00058	Miller Cr	24.12	wastewater treated by package plant
180	Westwind Properties L.L.C.	1PW00036	Trib to Miller Cr	24.12	wastewater treated by package plant
180	Boone Station	-	Trib to Mad River	23.2	no permit
180	Edgewood MHP	1PV00100	Trib to Mad River	22.8	wastewater treated by package plant

Table 29. Continued.

WAU	Facility Name	Ohio EPA Permit No.	Receiving Stream	Mainstem River Mile	Description
180	Tecumseh Court MHP	1PV00126	Trib to Mad River	21.93	wastewater treated by package plant-no permit
180	Enon Heights MHP	1PV00106	Trib to Mad River	21.1	wastewater treated by package plant
180	Enon WTP	1IX00032	Mad River	19.62	
180	BP Oil (Ison Residence)	1GU00096	Donnels Cr	18.38	groundwater recovery system/air stripper
180	Chateau Estates MHP	1PV00056	East Fork Donnels Cr	18.38	wastewater treated by package plant
180	North Hampton WTP	1lZ00110	Donnels Cr	18.38	connected to sanitary sewers-2004
180	Northwestern H.S.	1PT00012	Trib to East Fork Donnels Cr	18.38	wastewater treated by package plant
180	Tecumseh H.S.	1PT00042	Drainage to Jackson Cr	17.04	wastewater treated by package plant
180	Pleasant Valley MHP	1PV00105	Warden Ditch to Smith Ditch to Mad River	12.28	wastewater treated by package plant
180	Moyno Industries	1lS00019	Trib of Mad River thru storm sewers	unk	noncontact cooling water
180	Sunset Terrace MHP	1PV00118	Currently to GW--proposed direct to Moore Run	--	wastewater treated by package plant
190	Gifford Apartment Complex (aka Hackworth Apartments)	-	Mud Cr	10.54	wastewater treated by package plant
190	Ohio Air National Guard-Outfall 001	1I000000	Trib to Mud Run	10.07	stormwater
190	Springfield-Beckley Municipal Airport-Outfalls 006-007	1PS00009	Trib to Mud Run	10.07	wastewater/stormwater
190	Greenon High School	1PT00014	Trib to a trib to Mud Run	10.07	wastewater treated by package plant
190	Hustead Elementary School	1PT00069	Trib to Mud Run	10.07	wastewater treated by package plant
190	WPAFB-Outfall 020	1I000001	Trib to Mad River	9.64	stormwater and noncontact cooling water

Table 29. Continued.

WAU	Facility Name	Ohio EPA Permit No.	Receiving Stream	Mainstem River Mile	Description
190	WPAFB-Outfalls 016-019	1I000001	Bass Lake or Trib	8.27	stormwater
190	Huber MHP	1PV00088	Trib to Mad River	7.25	wastewater treated by package plant
190	WPAFB-Outfalls 014-015	1I000001	Trib to Mad River	6.88	stormwater
190	WPAFB-Outfalls 005-013. 021, 022	1I000001	Hebble Creek	6.07	stormwater/cooling water
190	WPAFB Outfall 001	1IN00274	unknown	mobile	stormwater/cooling water
003	Clark Co. SW Regional	1PK00013	Mad River	13.3	secondary treatment
003	Martin-Marietta Fairborn	1lJ00026	Mad River	10.62	Gravel washwater/stormwater
003	Fairborn WWTP	1PD00002	Mad River	9.62	secondary treatment facility
003	WPAFB Outfall 001	1IN00156	Mad River	6.88	groundwater recovery system/air stripper
003	WPAFB Outfall 004	1I000001	Mad River	5.58	stormwater runoff from the vehicle maintenance area but prior to discharge to the Mad River. Hebble Ck Rd toward Twin Lakes-Vehicle Maintenance Shop (Area B, Bldg 20038), steam plant
003	WPAFB Outfall 003	1I000001	Mad River	5.03	groundwater recovery system/air stripper
003	WPAFB Outfall 002	1I000001	Mad River	4.9	Noncontact cooling water/ Cooling tower blowdown
003	WPAFB Outfall 001	1I000001	Subsurface storm sewer to Mad River	~3.3-3.8	groundwater recovery system/air stripper
003	BP Oil	1lN00147	via storm sewer to Mad River	1.63	oil/water separator/groundwater recovery system/air stripper
003	Dayton Phoenix	1lS00014	via storm sewer to Mad River	1.63	noncontact (once-through) cooling water from an annealing oven and air compressor
003	Flowserve Corp.	1IN00034	via storm sewer to Mad River	1.63	storm water and noncontact cooling water
003	Gem City Chemical	1lN00134	via storm sewer to Mad River	1.63	groundwater recovery system/air stripper
003	Dayton WTP-002	1lW00030	Mad River	1.55	lagoon that ultimately discharges through outfall
003	Dayton WTP-001	1lW00030	Mad River	1.00	lagoon that ultimately discharges through outfall
003	WPAFB Outfall 003	1IN00156	to Twin Lakes-no outlet	-	groundwater recovery system/air stripper

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