State of Ohio
Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of the Blanchard River

Putnam, Hancock, Seneca, Allen, Wyandot, and Hardin Counties, OH

June 28, 2007

Ted Strickland, Governor
Chris Korleski, Director

Biological and Water Quality Study of the Blanchard River and Selected Tributaries 2005

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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

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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:

Division of Surface Water
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4675 Homer Ohio Lane
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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)

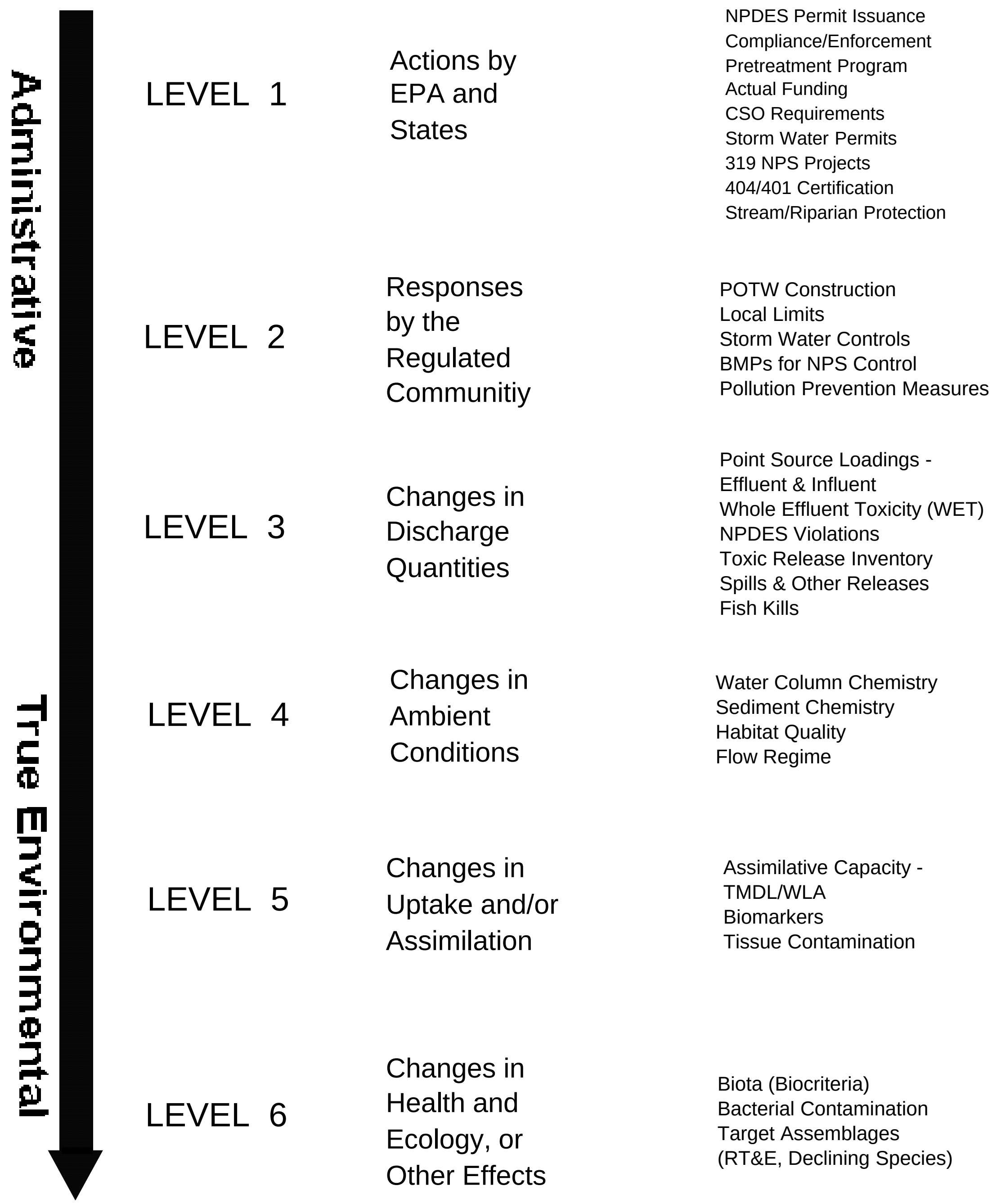

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by the U.S. EPA.

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 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 effect 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 ground water, 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 storm water runoff. Most of this phosphorus is bound tightly to soil particles and enters streams from erosion, although some comes from tile drainage. Urban storm water is more of a concern if combined sewer overflows are involved. The impact from rural storm water 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 25 C) 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 (2005) 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 $\geq$60 μ, silt 5-59 μ, clay $\leq$4 μ), % 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).

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Putnam, Hancock, Seneca, Allen, Wyandot, and Hardin 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 Blanchard River basin from June to October 2005 as part of the five-year basin approach for monitoring, assessment, and issuance of National Pollution Discharge Elimination System (NPDES) permits and to facilitate a Total Maximum Daily Load (TMDL) assessment. This study area included over 100 miles of the Blanchard River beginning in the headwaters and extending to near the confluence with the Auglaize River. Subwatersheds within the study area included Eagle Creek, Ottawa Creek, Cranberry Creek and Riley Creek. To the extent 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 2005 Blanchard River study area;

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

3) Evaluate the influence of the Findlay, Ottawa, Bluffton, 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 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], and 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 (305[b] and 303[d]) Report.

SUMMARY

Aquatic Life Use Attainment Status and Trends

The 2005 Blanchard River study area included six Watershed Assessment Units (WAUs) and a Large River Assessment Unit (LRAU) (Figure 2). The six WAUs were: Blanchard River-headwaters to downstream Potato Run (RM 76.27); Blanchard River-downstream Potato Run to downstream Eagle Creek (RM 76.27 to RM 58.10); Blanchard River- upstream Eagle Creek to upstream Ottawa Creek (RM 58.10 to RM 45.64); Blanchard River- upstream Ottawa Creek to upstream Riley Creek, excluding mainstem greater than 500 mi^2 (RM 45.64 to RM 30.08); Riley Creek; and Blanchard River- downstream Riley Creek to the Auglaize River, excluding the mainstem greater than 500 mi^2 (RM 30.08 to RM 0.00). The LRAU included the Blanchard River mainstem from downstream Dukes Run (RM 35.68) to the confluence with the Auglaize River (mainstem >500 mi^2).

During 2005, fish and/or macroinvertebrate sampling was conducted at 115 locations in the Blanchard River watershed at sites ranging in drainage area from 0.9 mi^2 to 771 $mi^{2.}$ The survey resulted in the assessment of aquatic life use attainment at 84 sites. Fish and macroinvertebrate sampling was planned at each site; however, due to the limitations of resources, timing, and site suitability, a number of locations were sampled for only a single organism group. The Aquatic Life Use Attainment table (Table 1) provides biological index scores/assessments for each of the sampled locations and causes and sources of impairment. Thirty four (40.4%) of the assessed sites fully met the designated or recommended aquatic life use. Twenty (23.8%) of the sites partially met and thirty (35.7%) of the sites were not attaining their designated or recommended use.—Summary statistics related to aquatic life use of each assessment unit are provided in Table 1.

The 2005 biological sampling effort on the Blanchard River mainstem, in large part, replicated sampling conducted in 1983. Upstream from Findlay, partial or non-attainment of WWH ecoregional expectations has persisted. Impacts were similar, in that the combination of habitat modification to the Blanchard River mainstem and tributary streams, nutrient impacts, and organic enrichment related to agriculture, unsewered areas and small WWTPs discharges combined to degrade the Blanchard River mainstem. The severity of the individual impacts likely varied both longitudinally and temporally but the net result was a perpetually depressed resource condition.

The most significant difference in conditions encountered in 2005 versus 1983 was a result of improved water quality downstream from the Findlay WWTP. Construction of a new Findlay WWTP that included relocating the discharge was completed in 2001. Operations at the new plant have reduced ammonia concentrations to the point where it has been nearly undetectable in the effluent for the last 3 years. The macroinvertebrate community in 1983 was impacted for approximately 20 miles. In contrast, the macroinvertebrate community in 2005 produced an ICI in the very good range just 1.2 miles downstream from the discharge. The condition of the fish community, as reflected by the two surveys, also demonstrated an overall increase in resource quality of the Blanchard River mainstem downstream from Findlay in the intervening years (Figure 3). Significant improvements in the fish community that pointed to the improved condition of the resource included the reduced prominence of tolerant fish, a greater proportion of top carnivores and a reduction in the occurrence of deformities, tumors and lesions. The mainstem consistently met ecoregional expectations beginning approximately 6.4 miles downstream from the discharge in 2005.

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.

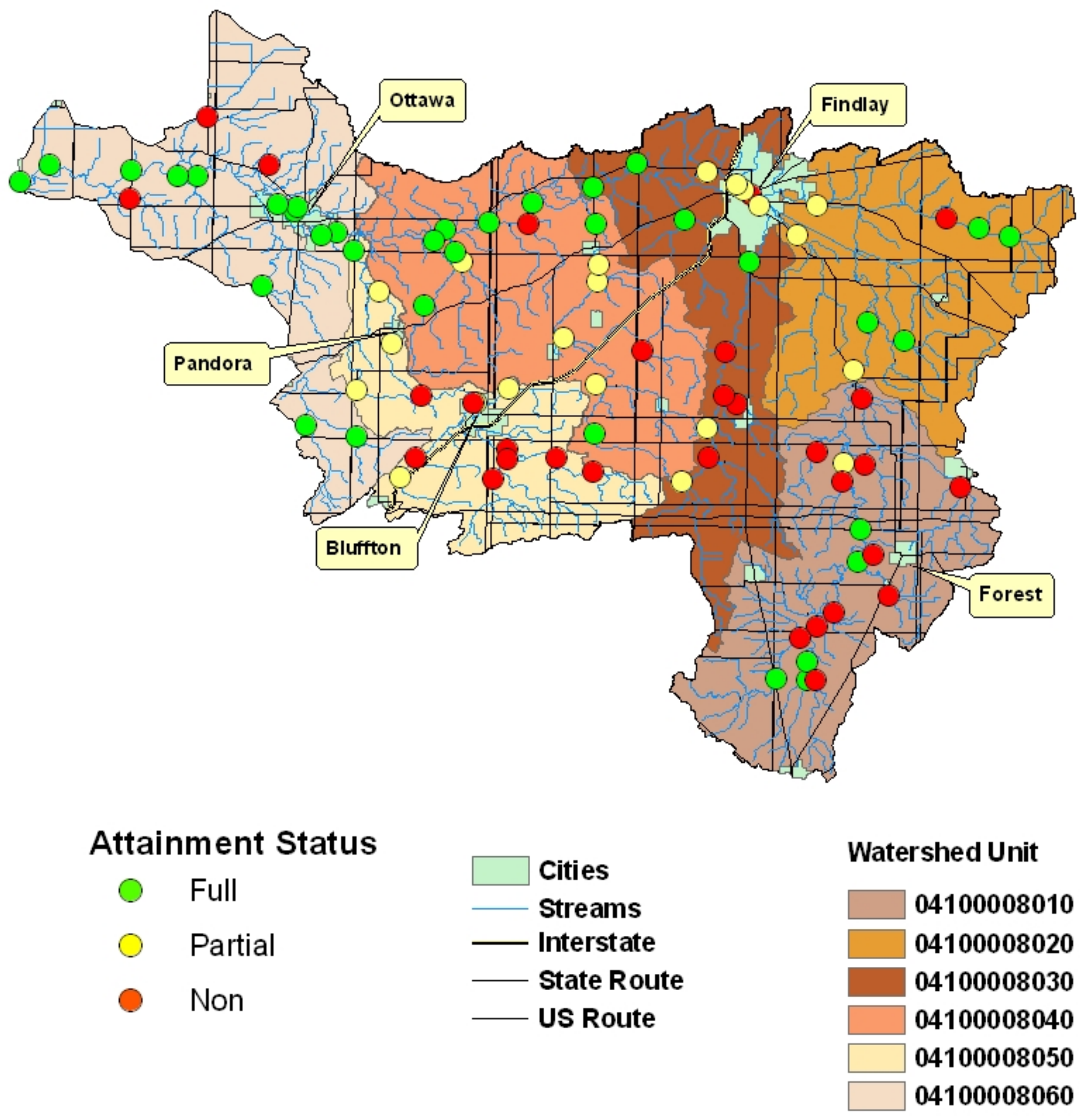


Figure 2. Aquatic Life Use attainment status of sites in the Blanchard River watershed sampled in 2005.

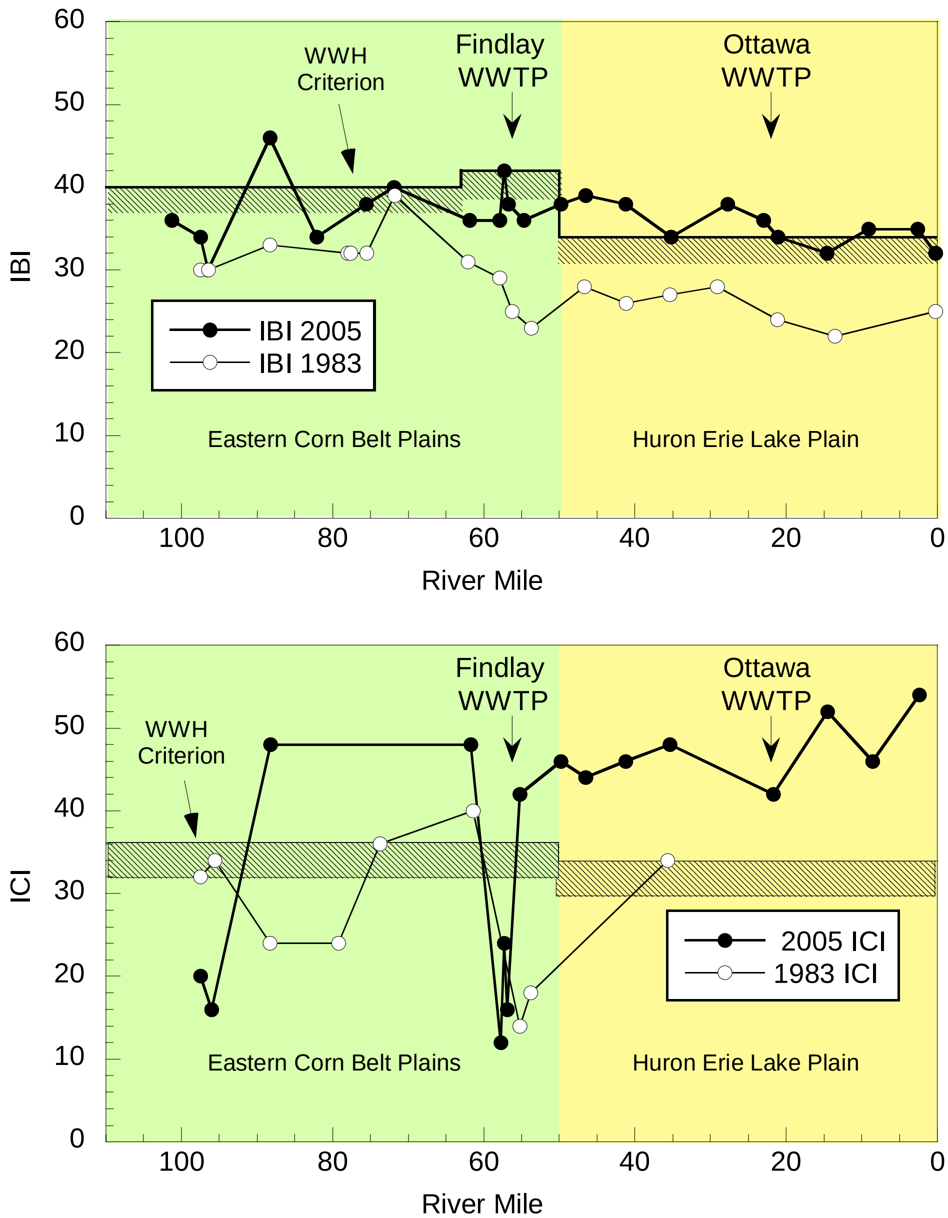


Figure 3. Longitudinal trend of the Index of Biotic Integrity (IBI) and Invertebrate Community Index (ICI) in the Blanchard River in 1983 and 2005.

Table 1A Aquatic life use attainment status for stations sampled in the Blanchard Headwaters assessment unit based on data collected July-September, 2005. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
Blanchard River			*WWH - ECBP Ecoregion*					
101.0/101.3	4.9	36[ns]		G	32.0	Full		
100.1/____	16.2			G				
97.5/97.5	43	34*	9.0	20*	46.0	NON	Direct habitat alteration, nutrients, flow alteration, dissolved oxygen, temperature	Ag related channelization, crop production streambank modification/destabilization
96.0/95.6	61	30*	7.3*	16*	46.0	NON	Direct habitat alteration, organic enrichment/DO	Ag related channelization, crop production, combined sewer overflow (via Shallow Run/ Dunkirk)
88.2/88.3	80	46	9.3	48	55.5	Full		
82.1/82.1	91	34*	8.4	VG	62.5	Partial	Organic enrichment/DO, ammonia, nutrients	Source unknown (ammonia) via Ripley Run, crop production, minor municipal WWTP (Forest)
75.8/75.6	142	38[ns]	7.2*	VG	57.5	Partial	Organic enrichment, nutrients	Crop production
71.9/71.9	145	40	8.7	VG	51.0	Full		
61.7/61.9	238	36[ns]	7.2*	48	62.5	Partial	Organic enrichment, nutrients, thermal modification	Crop production
57.8/57.9	335	36*	9.7	12*	46.0	NON	Thermal modification, organic enrichment/DO, development related direct habitat alteration, siltation	Dam construction, urban runoff, combined sewer overflows
57.3/57.3	336	42	10.1	24*	63.0	Partial	Direct habitat alteration, thermal modification, nutrients, organic enrichment/DO	Upstream impoundment, urban runoff, combined sewer overflows
56.9/56.8	336	38[ns]	9.3	16*	56.5	Partial	Thermal modification, nutrients, development related direct habitat alteration	Upstream impoundment, urban runoff, combined sewer overflows, channelization
55.2/54.7	346	36*	7.6*	42	54.5	Partial	Nutrients, organic enrichment/DO, thermal modification	Upstream impoundment, major municipal point source (Findlay)
			WWH -HELP Ecoregion					
49.8/49.8	378	38	9.7	46	61.5	Full		
46.5/46.5	387	39	9.7	44	65.5	Full		
41.3/41.3	459	38	9.2	46	51.0	Full		

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
35.4/35.2	503	34	9.8	48	53.5	Full		
28.9/27.7	624	38	9.7	VG	60.0	Full		
22.5/23.0	627	36	9.1	MG[ns]	62.0	Full		
21.7/21.1	638	34	9.1	42	51.0	Full		
14.5/ 14.6	703	32[ns]	8.7	52	55.5	Full		
8.6/9.1	744	35	9.6	46	59.0	Full		
2.4/2.6	767	35	8.7	54	48.5	Full		
____/0.2	771	32[ns]	9.1		54.0	(Full)		
Trib. to Blanchard R. (RM 100.38)			*MWH recommended - ECBP Ecoregion*					
0.7/0.7	7.4	<u>26</u>		<u>P</u>*	34.5	NON	Direct habitat alteration, temperature, nutrients Organic enrichment/DO	Ag related channelization, Crop production
Cessna Creek			*WWH recommended - ECBP Ecoregion*					
5.6/____	3.6			G				
3.1/3.1	13.9	40		G	51.0	Full		
0.5/0.5	23.1	32*	8.6	F*	42.0	NON	Direct habitat alteration	Ag related channelization
Shallow Run (Dunkirk)			*WWH - ECBP Ecoregion*					
3.0/____	6.4			<u>VP</u>*			Direct habitat alteration, flow alteration, organic enrichment/DO, nutrients	Ag related channelization, crop production combined sewer overflows
0.9/____	10.8			<u>P</u>*			Direct habitat alteration, flow alteration, organic enrichment/DO, temperature, nutrients	Ag related channelization, crop production combined sewer overflows (Dunkirk)
The Outlet (Blanchard R. RM 90.94)			*WWH recommended - ECBP Ecoregion*					
_____/3.6	9.5	34*			52.5	(NON)	Direct habitat alteration, flow alteration, nutrients	Ag related channelization, crop production
0.3/0.3	12.4	38[ns]		MG[ns]	55.5	Full		
Forest-Simpson Ditch			*WWH - ECBP Ecoregion*					
0.8/0.8	0.9	28*		<u>VP</u>*	62.5	NON	Ammonia, nutrients, organic enrichment/DO	Minor municipal point source (Forest)
Ripley Run			*WWH recommended - ECBP Ecoregion*					
0.1/0.1	5.5	<u>24</u>*		MG[ns]	50.0	NON	Direct habitat alteration, ammonia	Ag related channelization, cause unknown (ammonia)

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
Trib. to Blanchard R. (RM 80.53)			*MWH recommended - ECBP Ecoregion*					
1.8/1.8	6.7	22*		VP*	33.5	NON	Direct habitat alteration, temperature, nutrients, organic enrichment/DO	Ag related channelization, Crop production
Trib. to Blanchard R. (RM 79.75)			*MWH recommended - ECBP Ecoregion*					
2.2/2.2	5.9	20*		HF	40.0	NON	Direct habitat alteration, temperature, nutrients, organic enrichment/DO	Ag related channelization, Crop production
Rickenbach Ditch			*WWH - ECBP Ecoregion*					
1.2/____	3.2			P*			Direct habitat alteration, flow alteration, nutrients	Ag related channelization, crop production
Potato Run			*WWH - ECBP Ecoregion*					
9.6/9.6	12.8	28*		F*	39.0	NON	Direct habitat alteration, nutrients	Ag related channelization, crop production
____/1.8	25	32*	4.3*		63.5	(NON)	Direct habitat alteration, nutrients	Ag related channelization, crop production
0.1/____	28			G				
Buckrun Creek			*MWH recommended - ECBP Ecoregion*					
3.6/____	6.1			HF*			Direct habitat alteration, flow alteration, siltation	Ag related channelization, crop production
Stahl Ditch			*MWH recommended - ECBP Ecoregion*					
7.3/____	6.6			P*			Direct habitat alteration, flow alteration, siltation, nutrients, DO/ organic enrichment	Ag related channelization, crop production
4.4/4.4	12.4	34		MG[ns]	39.5	Full		
Brights Ditch			*MWH recommended - ECBP Ecoregion*					
3.8/____	5.7			P*			Direct habitat alteration, nutrients, DO/ organic enrichment	Ag related channelization, crop production
2.4/____	11.2			P*			Direct habitat alteration, nutrients, DO/ organic enrichment	Ag related channelization, crop production
0.3/____	28.4			G				
The Outlet (Blanchard R. RM 63.63)			*MWH recommended - ECBP Ecoregion*					
7.7/7.7	7	44		G	41.5	Full		
6.1/6.1	16.4	36		HF	17.5	Full		
4.5/4.5	24	42	5.7*	38	39.0	NON	Direct habitat alteration, nutrients	Ag related channelization, crop production
0.5/____	38			44				

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
Lye Creek			*MWH recommended - ECBP Ecoregion*					
9.4/____	7			P*			Direct habitat alteration, flow alteration thermal modification, nutrients, organic enrichment/DO	Ag related channelization, crop production, unsewrered community (Houcktown)
6.7/____	12.2			LF*			Direct habitat alteration, flow alteration thermal modification, nutrients, organic enrichment/DO	Crop production, unsewrered community (Houcktown)
2.6/2.6	26	32	6.4	20*	39.5	Partial	Direct habitat alteration, nutrients, organic enrichment/DO	Ag related channelization, crop production
Hydraulic Ditch			*MWH recommended - ECBP Ecoregion*					
1.5/____	6.6			G				
Flat Branch			*WWH recommended - ECBP Ecoregion*					
1.1/____	6.6			F*			Flow alteration, nutrients	Agricultural related channelization, crop production
0.1/0.1	10.9	26*		MG[ns]	54.0	NON	Flow alteration, nutrients, organic enrichment/DO	Agricultural related channelization, crop production
Buck Run			*WWH - ECBP Ecoregion*					
0.6/0.6	6.5	32*		P*	46.5	NON	Direct habitat alteration, ammonia, nutrients, organic enrichment/DO	Ag related channelization, crop production, minor municipal point source (Arlington)
Eagle Creek			*WWH - ECBP Ecoregion*					
17.7/17.7	12.9	32*		MG[ns]	55.5	Partial	Flow alteration, nutrients	Crop production
14.0/13.9	28	30*	7.0*	32[ns]	66.0	Partial	Flow alteration, nutrients	Crop production
11.6/11.6	39	36[ns]	6.8*	F*	60.5	NON	Flow alteration, nutrients	Crop production
9.1/9.1	48	26*	8.4	MG[ns]	64.5	NON	Flow alteration, nutrients	Crop production
3.7/3.8	57	40	7.8[ns]	MG[ns]	66.0	Full		
0.5/0.5	61	32*	7.4*	G	62.5	Partial	Flow alteration, nutrients, ammonia	Crop production, minor municipal point source (Eagle Creek Utilities)
Aurand Run			*WWH recommended - ECBP Ecoregion*					
____/2.7	10.1	40			63.0	(Full)		
0.5/____	15.1			G				
Higbie-Redick Ditch			*MWH - ECBP Ecoregion*					
0.8/____	6.4			HF				

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
Tiderishi Creek			*MWH recommended - ECBP Ecoregion*					
7.3/7.3	7.2	20*		P*	40.0	NON	Direct habitat alteration, low DO, nutrients, intermittent flow	Ag related channelization, crop production
4.6/____	12.2			P*			Direct habitat alteration, thermal modification, nutrients, , dry channel, pH	Ag related channelization, crop production
			WWH recommended - ECBP Ecoregion					
0.1/0.1	19.4	34*		MG[ns]	58.0	Partial	Direct habitat alteration, nutrients, siltation, organic enrichment/DO	Ag related channelization, crop production
Ottawa Creek			*WWH - ECBP Ecoregion*					
18.5/18.5	6.8	38[ns]		MG[ns]	58.0	Full		
14.7/14.7	11.4	34*		MG[ns]	52.0	Partial	Direct habitat alteration	Ag related channelization, crop production
10.1/10.1	28	38[ns]	7.7*	MG[ns]	62.5	Partial	Direct habitat alteration, siltation, low DO, nutrients	Ag related channelization, crop production
			WWH - HELP Ecoregion					
4.8/4.9	59	36	8.1	F*	67.0	Partial	Direct habitat alteration, siltation, low DO, nutrients	Ag related channelization, Cramer Duck Farm?
____1.8	63	36	7.6		62.5	(Full)		
0.9/____	63			34				
Buck Run			*MWH - ECBP Ecoregion*					
0.2/____	5.6			HF				
Moffitt Ditch			*MWH recommended - HELP Ecoregion*					
2.4/2.4	6.1	38		P*	21.0	NON	Direct habitat alteration, nutrients	Ag related channelization, crop production
0.5/0.5	13.5	32		HF	27.5	Full		
Cartwright Run			*MWH recommended - HELP Ecoregion*					
0.1/____	5.8			HF				
Dukes Run			*WWH recommended - HELP Ecoregion*					
1.9/1.9	7.9	40		F*	48.0	Partial	Direct habitat alteration, siltation	Ag related channelization, pasture land
1.1/1.1	14	34		G	50.0	Full		
Dutch Run			*MWH recommended - HELP Ecoregion*					
5.8/5.8	6.7	24		HF	23.5	Full		

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
			WWH recommended - HELP Ecoregion					
2.7/2.7	12.8	40		G	26.5	Full		
Riley Creek			*MWH recommended - ECBP Ecoregion*					
24.9/24.9	5.8	20*		P*	32.5	NON	Direct habitat alteration, nutrients, siltation, organic enrichment/DO, bacteria (PCR)	Ag related channelization, crop production
22.0/22.6	12.1	26*		P*	37.0	NON	Direct habitat alteration, nutrients, siltation, organic enrichment/DO	Ag related channelization, crop production
			WWH - ECBP Ecoregion					
19.5/19.4	29.4	26*	7.1*	MG[ns]	55.5	NON	Direct habitat alteration, nutrients, siltation, organic enrichment/DO, bacteria (PCR)	Ag related channelization, crop production
15.5/15.5	44.4	34*	7.3*	MG[ns]	61.0	Partial	Organic enrichment/DO, thermal modification, nutrients, bacteria (PCR)	crop production, ground water loadings (low DO), CSO
14.4/____	62			32[ns]				
____/11.5	64	20*	4.3*		52.0	(NON)	Nutrients, siltation, organic enrichment/DO, bacteria (PCR)	crop production, CSO, urban runoff, municipal point sources
7.4/7.6	68	34*	8.0[ns]	MG[ns]	77.5	Partial	Nutrients, organic enrichment/DO, bacteria (PCR)	Crop production
4.4/4.3	70	40	9.3	F*	67.0	Partial	Nutrients, siltation, organic enrichment/DO, thermal modification	Crop production, municipal point sources, low head dam
1.2/1.2	85	42	10.6	40	78.0	Full		
Little Riley Creek (upper)			*WWH recommended- ECBP Ecoregion*					
2.6/2.7	8.5	30*		F*	50.0	NON	Direct habitat alteration, siltation	Ag related channelization, streambank destabilization
1.0/1.0	14.1	28*		F*	53.5	NON	Direct habitat alteration, flow alteration	Ag related channelization, crop production
Marsh Run			*MWH recommended- ECBP Ecoregion*					
1.7/1.8	6.2	24		LF*	33.0	Partial	Direct habitat alteration, nutrients, organic enrichment/DO	Ag related channelization, crop production
Little Riley Creek (lower)			*MWH recommended- ECBP Ecoregion*					
5.4/5.5	5.5	26		P*	25.5	Partial	Direct habitat alteration, siltation	Ag related channelization, crop production
			WWH - ECBP Ecoregion					
4.2/4.3	12.3	24*		F*	64.5	NON	Siltation, flow alteration, nutrients	Crop production
0.1/0.1	16	24*		P*	61.0	NON	Nutrients, organic enrichment/DO, flow alteration, bacteria (PCR)	Urban runoff, CSOs?

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
Cranberry Run			*MWH recommended- HELP Ecoregion*					
6.7/6.7	6.2	28		LF*	31.5	Partial	Direct habitat alteration, nutrients, organic enrichment/DO	Ag related channelization, crop production
1.2/____	11.3			G				
Pike Run			*WWH recommended- ECBP Ecoregion*					
0.7/0.7	5.1	28*		P*	51.0	NON	Organic enrichment/DO, ammonia, nutrients, siltation	Package plant WWTP, Ag related channelization, crop production
Cranberry Creek			*MWH recommended - HELP Ecoregion*					
19.9/19.9	6.4	46		HF	41.0	Full		
			WWH -HELP Ecoregion					
12.9/12.9	25	32	8.1	MG	48.0	Full		
7.8/7.8	30	40	8.6	MG	44.5	Full		
1.8/____	43			46				
Little Cranberry Creek			*MWH recommended – HELP Ecoregion*					
0.8/0.9	7	30		HF	25.0	Full		
Miller City Cut-off			*MWH recommended – HELP Ecoregion*					
0.4/____	9			LF*			Organic enrichment/DO, nutrients, siltation	Ag related channelization, crop production, failed home sewage systems in Miller City
Caton Ditch			*MWH recommended – HELP Ecoregion*					
4.1/____	5.9			P*			Direct habitat alteration, siltation, organic enrichment/DO, nutrients	Ag related channelization, crop production
3.0/3.1	15.5	22*		LF*	48.0	NON	Direct habitat alteration, organic enrichment/DO, flow alteration, nutrients	Ag related channelization, crop production
Bear Creek			*MWH recommended – HELP Ecoregion*					
4.7/____	7.1			P*			Direct habitat alteration, siltation, flow alteration, nutrients, organic enrichment/DO, ammonia	Ag related channelization, crop production, livestock production, failed home sewage systems
____/0.3	12.6	32			26.0	(Full)		
Deer Creek			*MWH recommended – HELP Ecoregion*					
1.6/1.5	7.4	34		VP*	32.0	NON	Direct habitat alteration, nutrients, organic enrichment,/DO, ammonia	Ag related channelization, Country Acres package plant

Ecoregion Biocriteria: Eastern Corn Belt Plain

	IBI			MIwb			ICI		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	40	50	24				36	46	22
Wading	40	50	24	8.3	9.4	4.0	36	46	22
Boat	42	48	24	8.5	9.6	4.0	36	46	22

Ecoregion Biocriteria: Huron Erie Lake Plain

	IBI			MIwb			ICI		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	28	50	20				34	46	22
Wading	32	50	20	7.3	9.4	5.6	34	46	22
Boat	34	48	20	8.6	9.6	5.7	34	46	22

a- MIwb is not applicable to headwater streams with drainage areas ≤ 20 mi^2.

b- A narrative evaluation of the qualitative sample based on attributes such as community composition, EPT taxa richness, and number of sensitive taxa was used when quantitative data were not available or considered unreliable due to current velocities less than 0.3 fps flowing over the artificial substrates.

c- Attainment status based on a single organism group is parenthetically expressed.

d- Causes listed are considered to be a primary influence on water quality, but may not be the only issue leading to impairment. See text for discussion of additional causes that cumulatively have led to impairment.

e- Sources listed are considered to be a primary influence on water quality, but may not be the only source leading to impairment. See text for discussion of additional sources that cumulatively have led to impairment.

ns- Nonsignificant departure from biocriteria (≤4 IBI or ICI units, or ≤0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

Table 1 Summary of Blanchard River assessment unit scoring. The assessment unit score is an average grade of aquatic life use status. 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.

Blanchard Headwaters WAU (04100008 010)	Aquatic Life Attainment Status				Assessment Unit Score
	Total	Full	Partial	NON	
Sites ≤ 50 mi^2 drainage area	13	3	-	10	24
Miles of assessed streams with > 50 mi^2 and < 500 mi^2 drainage area	20.0	6.0	7.0	7.0	

Comments
An additional six sites were sampled that did not meet data requirements to completely evaluate aquatic life status (*i.e.* no fish data and only qualitative macroinvertebrate data). Three sites supported macroinvertebrate assemblages meeting the ecoregional aquatic life expectations. Three other sites had macroinvertebrate assemblages that reflected a poor to very poor resource condition.

The Outlet/Lye Creek WAU (04100008 020)	Aquatic Life Attainment Status				Assessment Unit Score
	Total	Full	Partial	NON	
Sites ≤ 50 mi^2 drainage area	5	3	1	1	53
Miles of assessed streams with > 50 mi^2 and < 500 mi^2 drainage area	3	1	2	-	

Comments
An additional eight sites of less than 50 mi^2 were sampled but did not meet data requirements to completely evaluate aquatic life status (*i.e.* no fish data and only qualitative macroinvertebrate data). Three sites supported macroinvertebrate assemblages reflecting good community quality. Five other sites had macroinvertebrate assemblages that failed to meet ecoregional aquatic life expectations.

Table 1. continued.

Eagle Creek WAU (04100008 030)	Aquatic Life Attainment Status				Assessment Unit Score
	Total	Full	Partial	NON	
Sites ≤ 50 mi^2 drainage area	7	1	2	4	39
Miles of assessed streams with > 50 mi^2 and < 500 mi^2 drainage area	16.5	7.5	8.0	1	
Comments An additional three sites of less than 50 mi^2 were sampled that did not meet data requirements to completely evaluate aquatic life status (*i.e*. no fish data and only qualitative macroinvertebrate data). Two sites supported attaining macroinvertebrate assemblages. One site had macroinvertebrate assemblages that failed to meet ecoregional aquatic life expectations.					

Ottawa Creek WAU (04100008 040)	Aquatic Life Attainment Status				Assessment Unit Score
	Total	Full	Partial	NON	
Sites ≤ 50 mi^2 drainage area	11	5	4	2	54
Miles of assessed streams with > 50 mi^2 and < 500 mi^2 drainage area	14	11	3	-	
Comments An additional four sites of less than 50 mi^2 were sampled that did not meet data requirements to completely evaluate aquatic life status (*i.e*. no fish data and only qualitative macroinvertebrate data). . Two sites supported MWH attaining macroinvertebrate assemblages. Two other site had macroinvertebrate assemblages that failed to meet MWH aquatic life expectations.					

Riley Creek WAU (04100008 050)	Aquatic Life Attainment Status				Assessment Unit Score
	Total	Full	Partial	NON	
Sites ≤ 50 mi^2 drainage area	9	-	3	6	7
Miles of assessed streams with > 50 mi^2 and < 500 mi^2 drainage area	8	1	4	3	

Comments
An additional two sites of less than 50 mi^2 were sampled that did not meet data requirements to completely evaluate aquatic life status (*i.e*. no fish data and only qualitative macroinvertebrate data) but supported WWH attaining macroinvertebrate assemblages.

Cranberry Creek WAU (04100008 060)	Aquatic Life Attainment Status				Assessment Unit Score
	Total	Full	Partial	NON	
Sites ≤ 50 mi^2 drainage area	8	5	-	3	75.0
Miles of assessed streams with > 50 mi^2 and < 500 mi^2 drainage area	-	-	-	-	

Comments
An additional four sites of less than 50 mi^2 were sampled that did not meet data requirements to completely evaluate aquatic life status (*i.e*. no fish data and only qualitative macroinvertebrate data). Two sites supported macroinvertebrate assemblages that met aquatic life use expectations. Two other sites had macroinvertebrate assemblages that were reflective of a poor resource condition.

Blanchard River LRAU (mainstem exceeding 500 mi^2 drainage area) (04100008 00)	Aquatic Life Attainment Status				Assessment Unit Score
	Total	Full	Partial	NON	
Miles with > 500 mi^2 drainage area	35.0	35.0	-	-	100

Comments
An additional site was sampled that did not meet data requirements to completely evaluate aquatic life status (*i.e*. no fish data and only qualitative macroinvertebrate data). The site supported macroinvertebrate assemblage that met ecoregional expectations.

Recreational Use Attainment Status

The safety of waters in the study area for recreational activities was assessed using fecal coliform bacteria as the indicator organism. The presence of these organisms indicates that water has been contaminated by feces from warm blooded animals. Elevated bacteria counts, reported in colony forming units (CFU)/100 ml, increase the risk of illness for people who come in contact with the water.

Recreation use status was determined for each of six WAUs aligned with the 11 digit hydrologic unit, plus the mainstem LRAU. Results from the 2005 survey and a discussion of the test method are summarized in the *Ohio 2006 Integrated Water Quality Monitoring and Assessment Report*. Data that were pooled for statistical analysis included samples from the survey along with any from NPDES permit holders collected during the May 1-October 15 recreation season. The recreation use is considered impaired if either the 75th percentile exceeds 1,000 or the 90th percentile exceeds 2,000. The LRAU was the only assessment unit not considered impaired.

Site specific evaluations of the Primary Contact Recreation use were done in the Blanchard River, Eagle Creek, Ottawa Creek, and Riley Creek. These larger streams were selected for a more detailed evaluation because they are more frequently used for activities like fishing, hunting, and boating. A minimum of 5 samples must be collected within any 30 day period during the recreation season to determine if a site meets the Ohio WQS criteria (OAC, Chapter 3745-1-07, Table 7-13). A site is considered in violation if the fecal coliform geometric mean exceeds 1,000 or more than 10% of the samples exceed 2,000. Recreation is most degraded where violations of the geometric mean criterion are documented since counts are elevated on a consistent basis.

Sanitary conditions were generally good in the Blanchard River mainstem. Only 5 of 23 sites were in violation and 2 of these were because of a single sample that violated the maximum. The 3 geometric mean violations were all located at sites in the headwaters within Hardin County. Eagle Creek was the most degraded of the tributary streams. All 6 sampled sites were in violation of the geometric mean criterion. Riley Creek also exhibited a fair amount of degradation. A total of 6 of 8 sites were in violation, although 2 of these were due to a single sample that violated the maximum. Ottawa Creek was the least degraded of the tributaries. A total of 3 of 5 sites were in violation, including 1 due to a single sample.

Chemical Water Quality

Inorganic water chemistry grab samples and field measurements were collected at 118 sites in the Blanchard River study area at two-week intervals (six times) from mid-July to late September. Samples were analyzed for a variety of parameters including nutrients and metals, and results are presented in Appendix Table A-1. Additional samples for selected organics compounds were collected at 12 of these sites whenever inorganic samples were collected. At the 7 sentinel sites and at the 2 drinking water intake sites, the additional samples were analyzed for the new age pesticides. At 3 sites in the City of Findlay area, the additional samples were analyzed for BNAs and PCBs. Additionally, Datasonde™ continuous monitors were deployed at 36 sites for a 48-hour period near the end of July and early in August. The Datasonde™ continuous monitors were used again in 2006 to conduct additional temperature and dissolved oxygen studies in the headwaters, in the area of the Findlay dams and in Riley Creek. Results from the organics samples and the Datasonde™ surveys are presented in the individual chapters for each Watershed Assessment Unit (WAU).

Exceedences of Water Quality Standards (see WAU-specific WQ exceedence table in each chapter) were principally related to anthropomorphic alterations of the watershed related to agriculture. Hydromodification, principally channelization, affected 44-100% of the impaired stream miles in each of the WAUs. Often riparian vegetation was limited to grasses and low growing brush throughout the Blanchard watershed, but particularly in the tributaries. The combination of exposure to sunlight and elevated nutrients promoted excessive algal growth and wide swings in dissolved oxygen concentrations. Organic enrichment, insufficient dissolved oxygen concentrations, elevated nutrients and high daytime heating were the most significant causes of impairment where physical/chemical factors negatively affected the water resources in the Blanchard River watershed. The effects of channelization often exacerbated these conditions. Flow and habitat modification like the series of dams on Riley Creek and through the urban areas of Findlay also contributed to temperature and dissolved oxygen violations. Beside widespread agricultural runoff, municipal WWTPs are also a major source of nutrients. The newer plants, like the Bluffton and Findlay WWTPs, that treat large volumes of wastewater fairly efficiently still contribute high loadings of nitrate and phosphorus to the river system, by nature of the size of their discharges. Some of the smaller, less advanced WWTPs in the watershed, like the Pandora WWTP, are having a more negative impact on their receiving streams. The lagoon systems in Forest and Arlington are not adequately treating the wastewater before it is discharged, resulting in elevated ammonia levels, organic enrichment, and bacterial contamination as well as excessive nutrient loading. Several unsewered communities in the Blanchard River watershed are also impairing streams with ammonia toxicity, organic enrichment, bacterial contamination and nutrient loading. These include Wharton, Patterson, Mt. Blanchard, Houcktown, and Miller City. CSOs in Dunkirk, Findlay, Pandora and Bluffton are impacting streams in these areas. There are also innumerable single on-lot systems scattered throughout the entire basin, some of which are not functioning properly and are discharging sewage to the streams. On occasion, these cause localized impairments.

Sediment Quality

A total of 30 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.

From a basin-wide perspective, sediment contamination was not a significant concern in the Blanchard River watershed. PAHs, PCBs and insecticides were not commonly detected and metals concentrations were only occasionally above Ohio reference values. Sediment contamination, where present, was principally associated with legacy contaminants related to past practices of industrial facilities in the basin. Contaminant concentrations exceeded probable effect concentrations (PEC) of metals and organics at a few locations (see Sediment Methods discussion, page 29). The Blanchard River sediments near Broad St. (RM 56.83) were contaminated with PAHs, to an extent that some impact on biological communities was likely, and had a relatively high level of PCBs. The site is downstream of an area with oil seepage and CSO discharges from the City of Findlay. Elevated levels of PAHs and lead were collected in sediment at Putnam CR 5-F (RM 35.24), but a source was not readily apparent.

PAHs were also elevated above the PEC in sediment from Riley Creek at Fett Rd. (RM 13.05), downstream from Bluffton. PAHs originate from fossil fuel combustion and are contained in creosote and coal tar. Several have been documented to cause skin cancer in lab animals and are strongly suspected human carcinogens. However, these levels are probably not high enough to warrant a dermal contact advisory to protect human health.

Strontium and arsenic were the elements most frequently documented above reference levels in the lower mainstem Blanchard River, but were likely elevated because of a strong influence from parent geological materials. Chromium and cadmium levels were above reference conditions levels downstream from Ottawa and likely were a remnant of operations at the closed LG Philips Displays TV picture tube plant. Similarly, chromium and nickel concentrations above reference levels were detected in sediment from the Blanchard River at Putnam CR 21-H (RM 2.58), but the source, possibly long since removed, could not be determined.

Fish Tissue

The Ohio Department of Health (ODH) continued a statewide fish consumption advisory in 2006 recommending all persons limit consumption of sport fish caught from all waterbodies in Ohio to one meal per week, unless there is a more restrictive advisory. When the statewide advisory was initially promulgated it was directed at sensitive populations, including women of child bearing age and children under age 15. The advisory was extended to all persons in 2003 due to the statewide/nationwide mercury advisory for sensitive populations and the increasing number of location-specific one meal per week advisories. There are currently no fish consumption advisories that are specific to the Blanchard River watershed. For additional information related to fish consumption advisories, see the 2006 Fish Consumption Advisory report available at http://www.epa.state.oh.us/dsw/fishadvisory/index.html.

The *Ohio 2006 Integrated Water Quality Monitoring and Assessment Report* listed four WAUs in the Blanchard basin and the Large River assessment unit as impaired due to potential human health concerns related to body burden contaminant levels in fish. This report analyzed the risk based on water quality standards for human health. The water quality standards assume that people are eating a certain quantity of different types of fish over time. The report assumes individuals are eating an average of 15 gm/day of fish. The affected assessment units are the Blanchard River-headwaters to downstream Potato Run; Blanchard River- downstream Potato Run to downstream Eagle Creek; Blanchard River- upstream Eagle Creek. to upstream Ottawa Creek; Blanchard River- upstream Ottawa Creek to upstream Riley Creek, excluding mainstem greater than 500 mi^2; and the Blanchard River mainstem only from downstream Dukes Run to the confluence with the Auglaize River (mainstem >500 mi^2). Insufficient information concerning body burden contaminant levels in Riley Creek and Blanchard River- downstream Riley Creek to the Auglaize River, excluding mainstem greater than 500 mi^2 precluded appraisals of fish consumption concerns for these two assessment units. For additional information related to human health concerns due to fish consumption, see the 2006 Integrated Report available at http://www.epa.state.oh.us/dsw/tmdl/2006IntReport/2006OhioIntegratedReport.html#my%20watershed.

RECOMMENDATIONS

Aquatic Life Uses 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.

Previous biological and habitat evaluations of selected streams in the Blanchard River watershed resulted in the application of the WWH aquatic life use for the Blanchard River, Potato Run, Shallow Run, Eagle Creek and Ottawa Creek. Sampling conducted in 2005 confirmed the WWH designation for each of these streams.

Numerous aquatic life use designations changes are being proposed in the Blanchard River/Nettle Creek assessment unit which includes the first 28 miles of the Blanchard River mainstem from its headwaters to just downstream of Potato Run. Cessna Creek, The Outlet (Blanchard R. RM 90.94) and Ripley Run had all been previously designated with a WWH use but without biological verification. The 2005 investigation established the appropriateness of the WWH designation. The WWH use designation for Forest Simpson Ditch was based on limited information gathered in 1983. The stream is severely polluted. Based on the 2005 survey, it is recommended that the WWH designation be continued but that the aquatic life use be reviewed following needed improvements to the Forest WWTP. Three previously undesignated tributaries confluent with to the Blanchard River at RMs 100.37, 80.53 and 79.75 were sampled in 2005. Ohio law stipulates that the WWH use be applied to unassessed waterways; however, the 2005 sampling effort demonstrated that a Modified Warmwater Habitat (MWH) use was the most suitable use. QHEI scores were between 33.5 and 40.0, and the three sites each possessed 4 high influence modified habitat attributes. Rickenbach Ditch (aka Shaefer Ditch) was another stream designated WWH based on limited information from1983. During most of the 2005 survey, flow in Rickenbach Ditch was intermittent. The watercourse was channelized and both instream and riparian habitats were significantly modified. Based on limited habitat and biological potential at RM 1.2, a MWH aquatic life use is recommended for Rickenbach Ditch.

A WWH use had been applied to numerous Blanchard River tributaries in the Outlet/Lye Creek WAU in previous Water Quality Standard rule makings but lacked any biological verification. Buckrun Creek was a previously undesignated and unassessed stream. Ohio law stipulates that the WWH use be applied to unassessed waterways.

The WWH designation was inconsistent with the results of the 2005 sampling effort. All the sampled streams, with the exception of the mainstem, had been subjected to significant alteration to instream habitats and drainage hydrology to facilitate agricultural activities in the watershed. A MWH use is recommended for Buckrun Creek, Stahl Ditch, Brights Ditch, The Outlet (upper) and Lye Creek.

The Eagle Creek WAU included the Blanchard River mainstem and confluent tributaries from upstream from Eagle Creek to upstream Ottawa Creek (RM 58.10 to RM 45.64). Streams for which an aquatic life use was unassigned or unassessed included Hydraulic Ditch, Flat Branch, Buck Run, and Aurand Run. The WWH use designation for Buck Run was based on limited information gathered in 1983. The additional biological and habitat data collected in 2005 clearly categorized Buck Run as a MWH stream. The stream demonstrated a very limited capacity for reestablishment of typical warmwater habitat attributes given the low stream energy and incised nature of the channel. Similarly, a MWH use should also be applied to Hydraulic Ditch. The WWH use is appropriate for Flat Branch and Aurand Run.

The Ottawa Creek WAU includes tributaries to the Blanchard River from above Ottawa Creek (RM 45.64) to above Riley Creek (RM 30.08). Higbie-Rideck Ditch was the only sampled waterway for which the aquatic life use (MWH) had been previously verified. Buck Run had no assigned aquatic life use; the remaining streams included in the 2005 study had an unassessed WWH designation. The WWH use was appropriate for Dukes Run; however, full attainment is contingent on continued recovery of natural stream attributes. Cartwright Run was channelized with primarily gravel substrates. Physical habitat features and limited stream energy makes a MWH aquatic life use applicable. Analysis of biological condition and habitat attributes of Moffitt Ditch were also consistent with a MWH use. QHEI scores were 21.0 and 27.5 at RMs 2.4 and 0.5, respectively, and both sites possessed 4 high influence modified habitat attributes. A MWH use is recommended for Tiderishi Run upstream from the Norfolk and Western railroad crossing (RM 2.90). The WWH should be maintained on Tiderishi Creek downstream from RM 2.90. Habitat was improved somewhat below this point and additional flow benefited aquatic communities. Sampling on Dutch Run involved sites at RMs 5.8 and 1.7. Both locations had been previously channelized, nevertheless, fish and macroinvertebrate sampling results were consistent with a WWH use at RM 1.7 of Dutch Run Biological condition was significantly more limited at RM 5.8. Based on the 2005 results, a MWH use is recommended for Dutch Run upstream from the confluence of Bassinger Ditch (RM 5.26).

Numerous aquatic life use designation changes are being proposed in the Riley Creek assessment unit. The WWH aquatic life use designation for Riley Creek was based on a study conducted in 1991 that began at RM 17.9 and extended downstream to the confluence with the Blanchard River. The 2005 study lengthened the surveyed reach upstream an additional 7 miles. Based on the 2005 results, a MWH use is recommended for Riley Creek upstream from the confluence of Upper Little Riley Creek at RM 20.63. A WWH use had been assigned to Little Riley Creek (upper), Marsh Run and Cranberry Run but never verified. Although much of Little Riley Creek (upper) was channelized, recovery of natural habitat attributes was ongoing. A WWH use should be attainable with continued recovery and controls to limit the input of embedding sediments. Marsh Run was a highly modified watercourse with limited biological communities. It has legal drain status in Hancock County where it is maintained by the SWCD. Habitat features included a straight, shallow channel with little instream cover and minimal water under low flow conditions. The current condition of Marsh Run and minimal likelihood of recovery of natural stream features, necessitates a MWH use. Lower Little Riley Creek was designated with a WWH aquatic life use based on biological sampling conducted in 1991. The sampling involved a survey of conditions beginning at RM 2.4 and extended downstream to the confluence with Riley Creek. The 2005 study lengthened the surveyed reach upstream an additional 3.1 miles. Much of the creek has been channelized and is under petition in Allen County for a drainage project. A MWH use is recommended for Little Riley Creek (lower) from the upper reaches downstream to the confluence of Marsh Run at RM 4.74. Cranberry Run is maintained by the Putnam County SWCD. The upper reach of the stream was channelized and had a predominantly muck substrate. The stream held very little water and was overgrown with grass. Habitat conditions improved as the drainage area increased. Based on conditions encountered in 2005, a MWH use is recommended for Cranberry Run upstream from Riley Township Road 7L (RM 3.05). The WWH should be maintained on Cranberry Run downstream from TR- 7L.

Biological communities were consistent with a WWH use in Cranberry Creek at sampled locations that exceeded 20 mi^2 but the upper portion of the watershed was extensively modified. The MWH use should be applied to Cranberry Creek upstream from the confluence with Little Cranberry Creek. The majority of other headwater sites in the Cranberry Creek WAU were similarly altered. Only Pike Run had habitat characteristics of sufficient quality to support WWH biological communities. Attainment of the use in Pike Run, however, is contingent on limiting sediment and nutrient inputs. Habitat attributes of Little Cranberry Creek, Miller City Cutoff, Caton Ditch, Bear Creek and Deer Creek were consistent with a MWH use. Little Cranberry Creek and the Miller City Cutoff were previously undesignated and unassessed streams. Ohio law stipulates that the WWH use be applied to unassessed waterways; however, the 2005 sampling effort demonstrated that a less stringent MWH use was applicable. No beneficial warmwater habitat features were noted at RM 0.8 on Little Cranberry Creek. The Miller City Cutoff is a man made roadside ditch that diverted the headwaters of South Powell Creek. Caton Ditch and Bear Creek were channelized and dry or nearly dry for much of their length under summer low flow conditions. The channelized streambed of Deer Creek held water throughout the study, but flow was sluggish and much of the riparian vegetation had been removed from the banks.

Table 2 Waterbody use designations for the Blanchard 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 base 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
Blanchard river – at RMs 28.50, 58.72, 62.43, and 65.20		+						+	+	+		+	
- headwaters to Hardin co. rd. 175 (RM 96.2)		+							+	+			+
- all other segments		+							+	+		+	
Deer creek				Δ					Δ	Δ		Δ	
Bear creek				Δ					Δ	Δ		Δ	
Caton ditch				Δ					Δ	Δ		Δ	
Miller City Cutoff				+					+	+		+	
Cranberry creek													
- headwaters to upstream Little Cranberry Creek (RM 17.05)				Δ					Δ	Δ		Δ	
- all other segments		+							+	+		*+	
Little Cranberry Creek				+					+	+		+	
Pike run		*+							*+	*+		*+	
Lammer ditch		*							*	*		*	
Mack Ditch		*							*	*		*	
Tawa run (Blanchard river RM 22.84)							+		*	*			+
Omer Selhorst ditch (Tawa run RM 1.61)							+		*	*			+
Riley creek													
- headwaters to upstream Little Riley creek (upper) (RM 20.63)				Δ					Δ	Δ		Δ	
- all other segments		+							+	+		+	
Cranberry run													
- headwaters to Riley twp. rd. 7L (RM 3.05)				Δ					Δ	Δ		Δ	
- all other segments		*+							*+	*+		*+	
Little Riley creek (lower)													
- headwaters to upstream Marsh run (RM 4.74)				Δ					Δ	Δ		Δ	
- all other segments		+							+	+		+	
Marsh run		*							*	*		*	
May ditch		*							*	*		*	
Marsh run				Δ					*+	*+		*+	
Little Riley creek (upper)		*+							*+	*+		*+	

Water Body Segment	Use Designations												
		Aquatic Life Habitat						Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Cummins ditch		*							*	*		*	
Binkley ditch		*							*	*		*	
Dutch run													
- headwaters to upstream Bassinger ditch (RM 5.26)				Δ					Δ	Δ		Δ	
- all other segments		*+							*+	*+		*+	
Bassinger ditch		*							*	*		*	
Dukes run		*+							*+	*+		*+	
Cartwright run				Δ					*+	*+		*+	
Homer Green ditch		*							*	*		*	
Moffitt ditch				Δ					*+	*+		*+	
Ottawa creek		+							+	+		*	
Tiderishi creek													
- headwaters to upstream Norfolk and Western RR (RM 2.90)				Δ					Δ	Δ		Δ	
- all other segments		*+							*+	*+		*+	
Burket ditch							+		+	+			+
W.B. Moyer ditch (Ottawa creek RM 9.3)				+					+	+			+
Heininger (Hemminger) ditch							+		+	+			+
Higbie-Redick ditch (Ottawa creek RM 14.4)				+					+	+			+
Oil ditch - headwaters to I-75 (RM 1.7)							+		+	+			+
- I-75 to the mouth		+							+	+		*	
Aurand run		+							+	+		+	
Eagle creek		+							+	+		*+	
Buck run		+							+	+			+
Flat branch		*+							*+	*+		*+	
Woodruff ditch		*							*	*		*	
Hydraulic ditch				Δ					*+	*+		*+	
Lye creek		*		Δ					*	*		*	
Silver creek		*							*	*		*	
The outlet		*		Δ					*	*		*	
Brights ditch		*		Δ					*	*		*	
Stahl ditch		*		Δ					*	*		*	
Bacher ditch		*							*	*		*	
Buckrun creek				+					+	+		+	
Potato run		+							+	+		*+	
Rickenbach ditch				Δ					+	+			+
Unnamed tributary (Blanchard river RM 79.75)				+					+	+		+	
Unnamed tributary (Blanchard river RM 80.53)				+					+	+		+	
Ripley run		*+							*+	*+		*+	
Forest Simpson ditch		+							+	+			+
The outlet		*+							*+	*+		*+	

Water Body Segment	Use Designations												
		Aquatic Life Habitat						Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Shallow Run ditch		+							+	+			+
Cessna creek		*+							*+	*+		*+	
Fourmile run		*							*	*		*	
Unnamed tributary (Blanchard river RM 80.53)				+					+	+		+	

Other Recommendations and Future Monitoring Needs

Improvements may be made to water quality throughout the study area by addressing the causes and sources identified within the Aquatic Life Use Attainment table (Table 1). The causes and sources associated with agricultural practices may be addressed by improving riparian buffers, fencing livestock out of streams, proper fertilizer and pesticide application, avoidance of winter land application of manure and ceasing of traditional 'cleaning' of streams. Funding opportunities should be sought to improve agricultural practices and could include any of the above listed improvements. Non-agricultural impairments could be addressed through a combination of regulatory, educational and funding actions including improvements to existing WWTPs (e.g. Forest, Arlington) , the addition of sewers and the construction of new WWTPs (e.g. Wharton, Houcktown, Patterson, Mt. Blanchard), management of failing septic systems, CSO control and/or elimination, and alternatives to traditional stream channelization and riparian removal.

Removal of lowhead dams on the Blanchard River and Riley Creek should be investigated for those structures that no longer serve a useful function. Returning impounded stream reaches to a free flowing condition will facilitate the natural movement of fish and mussel species and improve reaeration and the assimilative capacity of streams.

Tiling of large portions of the watershed has altered the way that ground water augments stream flow in the watershed and may increase the movement of nutrients from the land. Throughout much of the watershed, limited ground water flow during the summer months has reduced stream base flows and increased water temperatures. This situation often worsened the stresses associated with modest nutrient enrichment and habitat simplification. Undoubtedly, tiling has improved the agricultural production but not without an impact upon water resources. An evaluation is needed to assess benefits of tiling of agricultural fields versus the effects of the altered flow regime and the transport of nutrients, particularly phosphorus that ultimately is delivered to Lake Erie.

Nutrients contribute to water resource degradation throughout the watershed. Concentrations of phosphorus and nitrogen well above background reference conditions are common. Areas with depressed dissolved oxygen concentrations have been identified. Generally, reducing the contributions from common sources will improve the condition of the watershed with respect to nutrient enrichment. A variety of sources contribute to the problem: leachate from septic systems, land application of manure, inadequately treated domestic sewage, over application of fertilizer, spills of manure, and inadequate riparian buffers. Accurate identification of and reliable information about activities that contribute nutrients will be critical to taking effective action.

Many of the sampled locations aside from wadable and boatable sites on the larger mainstem and larger tributaries site were affected by past channelization activities that altered the physical habitat. In many altered streams the absence of riparian vegetation and the presence of nutrient intensive activities on adjacent lands leads to the export of excess nutrients. Nutrient management on upland areas, coupled with the reestablishment of wooded riparian buffers, would reduce the severity of this particular impact. An intact riparian canopy would provide shading and transpiration which would maintain lower water temperatures and reduce nuisance algal growth. Vegetation would also stabilize the stream banks. Again, funding should be targeted to provide support for this effort.

Harmful bacteria and viruses are a threat to safely participating in recreational activities such as fishing, wading, and canoeing in the Blanchard watershed. Unfortunately, exceedences of bacteria Water Quality Standards criteria are common throughout the watershed. Ohio EPA has been working with WWTPs to reduce their impacts, but many sources remain: livestock (open access pasturage), land application of manure, inadequately treated wastes from on-lot septic systems. The same BMPs for land application of manure that are used to reduce nutrients can also reduce pathogens (proper manure application rates, timing, buffer strips, etc.) and the facilities could also do additional processing of the manure prior to land application (e.g., composting, digestion). Such actions are required for regulated agricultural facilities; for non-regulated facilities it is voluntary. State and federal agricultural agencies should be able to help develop the appropriate plans.

Additional sampling should be conducted to identify the source of elevated ammonia present in Ripley Run. Reduction of ammonia in the stream should benefit the Blanchard River mainstem and remove this threat to state endangered mussels that have been recorded in the vicinity of the Ripley Run confluence.

METHODS

All physical, chemical, and biological field, laboratory, data processing, and data analysis methodologies and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurances Practices (Ohio Environmental Protection Agency 2006), Biological Criteria for the Protection of Aquatic Life, Volumes I-III (Ohio Environmental Protection Agency 1987a, 1987b, 1989b, 1989c), Manual of Laboratory Operating Procedures. Volumes I,II,III and IV, (Ohio Environmental Protection Agency 2002), The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989, 1995) for aquatic habitat assessment, and the Ohio EPA Sediment Sampling Guide and Methodologies (Ohio EPA 2001). Sampling locations are listed in Table 2.

Determining Use Attainment Status

Use attainment status is a term describing the degree to which environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1). Assessing aquatic use attainment status involves a primary reliance on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-15). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), indices measuring the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Three attainment status results are possible at each sampling location - Full, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails to meet the biocriteria. Non-attainment means that none of the applicable indices meet the biocriteria or one of the organism groups reflects poor or very poor performance. An aquatic life use attainment table (Table 1) is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile, the applicable biological indices, the use attainment status (*i.e.,* full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI), and a sampling location description.

Habitat Assessment

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the habitat characteristics used to determine the QHEI score which generally ranges from 20 to less than 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are *generally* conducive to the existence of warmwater faunas whereas scores less than 45 generally cannot support a warmwater assemblage consistent with the WWH biological criteria. Scores greater than 75 frequently typify habitat conditions which have the ability to support exceptional warmwater faunas.

Sediment and Surface Water Assessment

Fine grain sediment samples were collected in the upper 4 inches of bottom material at each location 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 pans (material for VOC analysis was not homogenized), transferred into glass jars with teflon lined lids, placed on ice (to maintain $4^{o}C$) in a cooler, and shipped to the Ohio EPA Division of Environmental Services. Sediment data is reported on a dry weight basis. Surface water samples were collected, preserved and delivered in appropriate containers to either an Ohio EPA contract lab or the Ohio EPA Division of Environmental Services. Surface water samples were evaluated using comparisons to Ohio Water Quality Standards criteria, reference conditions, or published literature. Sediment evaluations were conducted using guidelines established in MacDonald *et al.* (2000) and Ohio Specific Reference Values (2003).

Macroinvertebrate Community Assessment

Macroinvertebrates were collected from artificial substrates and from the natural habitats. The artificial substrate collection provided quantitative data and consisted of a composite sample of five modified Hester-Dendy multiple-plate samplers colonized for six weeks. At the time of the artificial substrate collection, a qualitative multihabitat composite sample was also collected. This sampling effort consisted of an inventory of all observed macroinvertebrate taxa from the natural habitats at each site with no attempt to quantify populations other than notations on the predominance of specific taxa or taxa groups within major macrohabitat types (e.g., riffle, run, pool, margin). Detailed discussion of macroinvertebrate field and laboratory procedures is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989b).

Fish Community Assessment

Fish were sampled using pulsed DC electrofishing methods. Fish were processed in the field, and included identifying each individual to species, counting, weighing, and recording any external abnormalities. Discussion of the fish community assessment methodology used in this report is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989b).

Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are used to judge aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria, within a weight of evidence framework, has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 1991; Yoder 1995). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, land use data, and biological results (Yoder and Rankin 1995). Thus the assignment of principal causes and sources of impairment in this report represent the association of impairments (based on response indicators) with stressor and exposure indicators. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified, or have been experimentally or statistically linked together. The ultimate measure of success in water resource management is the restoration of lost or damaged ecosystem attributes including aquatic community structure and function. While there have been criticisms of misapplying the metaphor of ecosystem “health” compared to human patient “health” (Suter 1993), in this document we are referring to the process for evaluating biological integrity and causes or sources associated with observed impairments, not whether human health and ecosystem health are analogous concepts.

WATERSHED ASSESSMENT UNIT REPORTS

Blanchard River Headwaters WAU

The Blanchard River Headwaters WAU (04100008-010) covers parts of Hancock, Hardin and Wyandot Counties and drains a total of 140.8 mi^2. The WAU (-010) includes the first 28 miles of the Blanchard River mainstem from its headwaters to just downstream of Potato Run. The larger tributaries to the Blanchard River within this WAU include Cessna Creek, Shallow Run and Potato Run. A map showing principal streams, roads, and urban areas is displayed in Figure 1a. Fish and macroinvertebrate populations and stream habitat conditions were evaluated throughout the WAU. The associated index scores and biological attainment status for each site (full, partial, or non) are summarized in Table 1a. Physical, chemical, and bacterial sampling was done to complement the biological data. Most sites had six sets of samples collected at two week intervals. Bacteria were tested to assess attainment of recreational use. The Blanchard River mainstem had extra sampling done to meet temporal and sample size conditions contained in the rule and evaluate data on a site specific basis. Results from the smaller tributaries were simply compared to the maximum standard. Multi-parameter automatic meters were set at six Blanchard River mainstem sites and three Shallow Run sites to measure physical conditions over a 48 hour period.

Water quality data and biological index scores were evaluated based on Ohio WQS criteria (OAC 3745-1). Target values presented in the *Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999) were used to evaluate nutrient enrichment. Appropriate numerical criteria and target values are often determined by use designation and all data was evaluated based on the current assigned uses of WWH, PCR, AWS, and IWS. Geographic location is an important consideration for biological criteria. All of the WAU (-010) lies in the ECBP ecoregion. Nutrient target values are being used as guidelines in lieu of criteria that are currently under development. Preliminary results support the validity of these target values and the notion that a correlation exists between nutrients, aquatic life attainment status, and drainage area. Criteria will likely be tiered for drainage area at the break between a wadeable stream and a small river (200 mi^2). Therefore, all nutrient samples were evaluated using a phosphorus target of 0.10 mg/L and a nitrate-nitrite target of 1.00 mg/L.

An effort was made to identify the sources of water quality degradation. Ambient water quality is affected by a complex set of biotic and abiotic factors. Water picks up many impurities from the air, land, and ground and gases like oxygen, nitrogen, and carbon dioxide diffuse into water from the atmosphere. Climate, topography, vegetation, and biological activity all influence ambient water quality. Local water quality, though, is usually determined by inputs from anthropogenic sources that are grouped into point and nonpoint categories. The origin of a point source is easy to identify at the end pipe and most are regulated under the NPDES permit system. Individual permits are issued to facilities with unique processes like those summarized in Table 1d. General permits are issued to facilities with similar operations that exert a minimal impact on the environment like those summarized in Table 1e. Continuous discharge point sources have their greatest impact under base flow when chemistry is relatively stable and conditions reflect the ground water that recharges the stream.

Water quality exceedences that were documented are summarized in Table 1b. Some degree of water quality degradation was documented at every site. In most instances, habitat and flow conditions were not adequate enough to overcome an impact to aquatic life and there was widespread impairment. A summary of the dissolved oxygen data obtained from automatic meters deployed in the Blanchard River mainstem and Shallow Run is presented in Table 1c. Minimum dissolved oxygen (DO) values are important because enough DO needs to be present to sustain aquatic life. Criteria that apply to WWH streams are a 24 hour average of 5.0 mg/L and a minimum at any time of 4.0 mg/L. Maximum values are important if they are at supersaturated levels. This phenomenon results in an aquatic life ailment known as gas bubble disease. Initially, it causes gas bubbles to form on external surfaces and blocks the flow of water across the gills. As the disease progresses, it causes bubbles to form behind the eyes (pop-eyed) and in blood. This can restrict or stop blood flow, damage tissues, and eventually cause mortality. Fish mortality can occur when saturation reaches 140% and lesser impacts can happen at levels as low as 104%. There is also mounting evidence that concentrations that fluctuate more than 5 mg/L (minimum/maximum) over a diurnal period have a negative impact on aquatic life. This causes stress to aquatic organisms and is often linked with other changes in the environment like a shift in pH.

Tributary streams in the Blanchard River watershed largely drain cropland and are managed to eliminate excess water with a combination of surface (ditches) and sub surface (tile) drainage systems. Too much water can delay planting, cultivation, or harvest and cause problems with flooding and soil compaction. Some drainage projects are simply done by the landowner, but those that involve multiple landowners and communities fall under county ditch laws. When the interested parties reach a mutual agreement a ditch petition is filed with the Board of County Commissioners. This starts the legal steps required to finance, construct, and maintain a ditch. The County Engineer presents a report at a public hearing and the board votes on the project. If the vote is in favor of the project, the engineer conducts a field survey and prepares plans and a cost estimate. A final hearing is held to re-affirm the decision before work is completed and the County Engineer (or SWCD) becomes responsible for maintenance. Habitat and flow alterations from these drainage projects are considered high magnitude causes of impairment.

The impact from a nonpoint source is a direct function of the surrounding land use and their exact origin is difficult to identify. Pollutants like silt, nutrients, and pesticides are carried in storm water from land used for crop and livestock production. Management practices like channelization, removal of riparian vegetation, and installation of sub surface tile systems result in significant flow and habitat alterations. They contribute to low flow conditions during dry weather periods because they limit ground water recharge by lowering the water table and by increasing evaporation since there is no tree shade. Conversely, these activities contribute to flooding during wet weather periods due to accelerated delivery of runoff. In pasture areas the exclusion of livestock from surface waters is important because of the damage they can cause to habitat and input of nutrients and bacteria. Another type of flow alteration is the impounding of a stream by a low head dam. These dams change stream morphology by flooding riffles, block fish migration, and ultimately change trophic structure. There are no dams in the Blanchard River Headwaters WAU. Pollutants like silt, nutrients, and pesticides are also carried in storm water from urban areas, along with materials like oil and heavy metals that are present in auto exhaust. Combined sewer overflows are also a major source of organic matter and bacteria. Failed home sewage systems can be a problem in areas without central collection and treatment systems. Patterson, Wharton and Mt. Blanchard are examples of these types of areas. Flooding caused by accelerated delivery of runoff is also a problem in urban areas because of impervious surfaces and sources of inflow like down spouts and sump pumps.

Aquatic Life Use Designations

Biological and habitat assessments were conducted at 22 sites in 2005. Aquatic life use attainment status is presented in Table 1a*.*

The Blanchard River is designated as WWH, PCR, AWS, and IWS based on previous field assessments. The mainstem, along with two unnamed headwater tributaries, originates on the north side of Kenton, in Hardin County, flowing to the north and very slightly east. This upper reach has been modified and grass riparian areas are maintained to facilitate agricultural activities in the surrounding watershed. At RM 100.05 the stream is not much more than an open ditch with a drainage area of 16.2 mi^2. Yet, just 4.4 miles downstream (at RM 95.60), after being joined by Cessna Creek and Shallow Run, the Blanchard River is already sizeable stream, with a drainage area of 61 mi^2. This section of the remaining mainstem (about 16-18 miles of the Blanchard River, flowing north to just upstream of Mt. Blanchard) is not maintained for drainage, is sinuous with good riparian zones, and has a rocky substrate. Two negative habitat attributes that occurred consistently within the entire reach were the presence of a moderate to heavy silt layer and significant embeddedness of larger substrates

There is evidence from collections made during 1994-1996 that this section of the Blanchard River supports a diverse population of mussels including two species, the rayed bean (*Villosa fabalis*) and the purple lilliput (*Toxolasma lividus*), which are endangered in the State of Ohio (Hoggarth, et al.) Neither species was among the nine mussel taxa recorded from this reach of the Blanchard River in 2005; however, additional sampling specifically targeting the mussel fauna would be needed to accurately assess the viability of these and other mussels in the watershed.

The Village of Mt. Blanchard is bounded on the west by the Blanchard River mainstem and on the east by Potato Run just about 1-2 miles upstream of where Potato Run flows into the mainstem at the downstream boundary of the Blanchard River Headwaters WAU (-010). Mt. Blanchard has no centralized collection or treatment of residential and commercial sanitary waste. A sampling survey conducted in 1994 indicated that discharges from Mt. Blanchard's combined sewers are having a negative impact on the water quality of the Blanchard River. Mt. Blanchard has an approved plan to build a controlled discharge lagoon wastewater treatment system, but currently remains unsewered.

Three previously unassessed waterways were included in the 2005 survey of the Blanchard Headwater HUC. The unnamed tributaries to the Blanchard River were confluent at RMs 100.38, 80.53 and 79.75. The unnamed tributary to the Blanchard River that is confluent at RM 100.38 is a headwater tributary that originates on the north east side of Kenton. It flows through crop land and is channelized and maintained. The unnamed tributary that is confluent to the Blanchard River at RM 80.53 originates near the point where Hardin, Hancock and Wyandot Counties meet just north of Forest. It is about 5.6 miles long with one tributary within the ECBP ecoregion. It passes through cropland and although much of the stream is channelized, it is not under county maintenance. The unnamed tributary that is confluent to the Blanchard River at RM 79.75 is about 9.2 miles long with one tributary within the ECBP ecoregion. It flows through cropland and is channelized and maintained except for the last 1.4 miles before its confluence with the Blanchard River.

Ohio law stipulates that the WWH use be applied to unassessed waterways; however, the 2005 sampling effort demonstrated that a less stringent use was more appropriate. The streams were channelized with no sinuosity and sparse riparian vegetation. QHEI scores were between 33.5 and 40.0, and the three sites each possessed 4 high influence modified habitat attributes. The 2005 analysis of biological condition and habitat attributes of the waterways were consistent with a MWH use. The recommendation of the MWH use should not be considered a downgrading of aquatic life use; rather, the 2005 survey was the first systematic ambient assessment of appropriate expectations.

Cessna Creek is a tributary of the Blanchard River confluent at RM 98.23 that is only about 5.5 miles in length but has many tributaries, so drains an area of 23.3 mi^2. It is within the ECBP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. The WWH designation had never been verified based on biological sampling prior to the 2005 survey. Fish and macroinvertebrate sampling results were consistent with the WWH use at RM 3.1. Where habitat likely limited the diversity of organisms in the stream, WWH attributes could be recovered, making the use appropriate.

Shallow Run is a tributary of the Blanchard River confluent at RM 96.69 that is about 5.5 miles in length and drains an area slightly greater than 12 mi^2. It is within the ECBP ecoregion and designated as WWH, SCR, AWS, and IWS based on a study done in 1983.

The Outlet (upper) is a tributary of the Blanchard River confluent at RM 90.94 that is about 6.5 miles in length and drains an area of 12.5 mi^2. It is within the ECBP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. The WWH use had never been verified based on biological sampling prior to the

2005 survey. QHEI scores of 52.5 and 55.5 at RMs 3.6 and 0.3 respectively were indicative of a moderate level of habitat alteration. The WWH use was marginally attained at RM 0.3 and with improvement of instream and riparian habitats, a commensurate improvement in the aquatic resources of the stream could be realized. Therefore, the WWH is an appropriate use for The Outlet.

Forest-Simpson Ditch is a tributary of the Blanchard River at RM 89.30 that is only about 2.0 miles in length. It is within the ECBP ecoregion and designated as WWH, SCR, AWS, IWS based on an Ohio EPA study done in 1983 (Ohio EPA 1985). The WWH use designation was rather tenuous compared with current protocols based on a "potential for warmwater faunas, because of the long time span since major vegetation clearing and channel work." In the intervening years, Forest-Simpson Ditch has undergone limited recovery of the characteristics of a typical warmwater stream but continues to be grossly polluted by the effluent from the Forest WWTP lagoons. Water in the stream was pea green (Figure 1i). A QHEI of 62.5 is consistent with a WWH use. Based on the 2005 survey, it is recommended that the WWH designation be continued but that the aquatic life use be reviewed following needed improvements to the Forest WWTP.

Ripley Run is a tributary of the Blanchard River at RM 83.20 that is 4.4 miles in length and drains 5.6 mi^2. It flows from northern Hardin County into southern Hancock County within the ECBP ecoregion and is designated as WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. The WWH use in the 1978 rulemaking for Ripley Run had never been verified based on biological sampling prior to the 2005 survey. The stream is surrounded by cropland and is channelized and maintained. About ½ mile north of the county line, current construction on new U.S. 30 crosses over Ripley Run and two of its tributaries (½ mile south of existing U.S. 30). A QHEI score of 50.0 at RM 0.1 reflected a moderate level of habitat alteration. Nevertheless, high quality substrates were present and recovery from past channelization was occurring. Establishment of more natural channel sinuosity and instream and riparian habitat should result in a commensurate improvement in the aquatic resources of the stream. Therefore, the WWH is an appropriate use.

Potato Run is a tributary of the Blanchard River confluent at RM 76.27 that is about 15 miles long and drains about 28 mi^2. It originates in northern Hardin County, then flows northwest through Wyandot County into Hancock County. Potato Run is in the ECBP ecoregion and is designated as WWH, PCR, AWS, and IWS based on an Ohio EPA study done in 1983. Rickenbach Ditch and Wharton Ditch are tributaries of Potato Run. In 2005, water quality samples were collected upstream and downstream of Rickenbach Ditch (RM 9.65), and at RM 1.84, which is about ¾ miles downstream of a discharge from the unsewered village of Mt. Blanchard. Habitat in the upper reaches of the stream was significantly modified. Most of Potato Run flows through cropland and has been channelized, but at least the lower 6 miles, in Hancock County, are not maintained. As a result, a QHEI score of 63.5 at RM 1.8 reflected a significantly improved habitat compared with conditions encountered at RM 9.6.

Rickenbach Ditch (aka Shaefer Ditch) originates on the north side of Forest and flows northeast to where it meets Potato Run at RM 9.65. It is in the ECBP ecoregion and is designated as WWH, SCR, AWS, and IWS based on an Ohio EPA study done in 1983 (Ohio EPA 1985). The WWH use designation was a rather tenuous compared with current protocols based on a “potential for warmwater faunas, because of the long time span since major vegetation clearing and channel work.” Another factor in assigning the WWH use was continuous flow provided by point source discharges. During most of the 2005 survey, flow in Rickenbach Ditch was intermittent. The watercourse at RM 1.2 was channelized and both instream and riparian habitats were significantly modified. Macroinvertebrate sampling produced a limited assemblage, in part, due to the ditched conditions. Based on habitat and biological impairment seen at RM 1.2, a MWH aquatic life use is recommended.

Aquatic Life Use Attainment Status

Attainment status was determined for sixteen sites in the Blanchard River Headwaters watershed, representing approximately 47 assessed stream miles in the assessment unit. Four sites representing thirteen assessed stream miles, fully met the current or recommended aquatic life use. One site, representative of seven assessed miles, partially met and eleven sites, totaling 25 assessed stream miles, were in non-attainment of the current or recommended aquatic life use.

Biological communities in the Blanchard River Headwaters WAU were impacted by a combination of factors related to agricultural practices in the watershed along with inadequate waste treatment from several of the small communities in the area. Pollution sources from these communities included CSOs, WWTP effluent and releases from unsewered areas. Hydromodification; principally channelization; affected 79% of the impaired stream miles. Instream habitat and natural flow regimes were altered as a result. Often riparian vegetation was limited to grasses and low growing brush. The combination of exposure to sunlight and elevated nutrients promoted the excessive algal growth and wide swings in dissolved oxygen concentrations. An excess of nutrients, and impacts associated with dissolved oxygen/organic enrichment and ammonia were identified as causative factors for 65%, 53%, and 29%, respectively, of the impaired miles. Thermal modification (i.e. elevated temperature) impacted approximately 9% of the impaired miles.

Just three of ten sampled headwater sites (<20 mi^2 drainage area) supported fish assemblages that met the existing or recommended aquatic life uses. Results from seven of fourteen macroinvertebrate collections produced an assemblage that attained ecoregional expectations. Three sites with drainage of less than 20 mi^2 met designated or recommended Aquatic Life Uses and seven sites were nonattaining. Requisite credible data collection requirements were lacking to determine attainment status for five sampled sites in the assessment unit.

Seven wading sites with drainage areas in excess of 20 mi^2 in the Blanchard River Headwaters WAU were also reflective of a largely impaired resource. One location (Blanchard River at RM 88.3) supported a fish community that was in very good condition. The remaining sites had fish assemblages that demonstrated impairment of the WWH use. Three of six macroinvertebrate samples met ecoregional expectations.

Despite a highly modified habitat, the upper site on the Blanchard River (RM 101.0-101.3) supported fish and macroinvertebrates that at least marginally met ecoregional expectations. Requisite credible data collection requirements were lacking to complete an evaluation of the status of use attainment at RM 100.1, but, the site supported a macroinvertebrate community that was consistent with the WWH use. Significant impact to biological resources was documented at further downstream at RMs 97.5 and 96.0. Pollution tolerant bluntnose minnows comprised an inordinately high proportion of the community and the number of mayfly and caddisfly taxa collected from the available habitat declined from 15 at RM 101.0 to no more than seven taxa at RMs 97.5 and 96.0. Habitat alteration related to agricultural was a contributing factor to wide fluctuations in dissolved oxygen and elevated daytime heating of the stream. Additionally, RM 96.0 is downstream from the confluence of Shallow Run. CSOs in the village of Dunkirk have been identified as a source of organic load and elevated nutrients to Shallow Run and, subsequently, the Blanchard River mainstem.

Fish and macroinvertebrate communities were markedly improved at RM 88.2/88.3. Fish community scores were in the very good range and the macroinvertebrate community yielded an ICI score in the exceptional range.

While the macroinvertebrate community continued to exceed minimum ecoregional expectations, the fish community condition declined significantly at RM 82.1 despite an improved habitat (QHEI= 62.5) compared with RM 88.3. It appeared that nutrient inputs from the surrounding watershed were elevated, favoring more pollution tolerant fish species. An IBI score in the fair range at RM 82.1 was due, in large part, to a high abundance of Bluntnose Minnows (*Pimephales* notatus) and a limited diversity of round bodied sucker species. Biological sampling reflected partial attainment of a WWH aquatic life use as a result. Chemical sampling confirmed that nutrients were elevated at this site and diurnal dissolved oxygen levels fluctuated in excess of five mg/l and went below 4.0 mg/l for significant periods of time.

In summary, approximately nine miles of the mainstem Blanchard River met the WWH use. Seven miles partially met ecoregional expectations and nine miles were nonattaining the WWH use. An additional three miles were not fully assessed but did yield a macroinvertebrate assemblage in good condition.

None of the three unnamed tributaries to the Blanchard River met even the modest expectations of the recommended MWH use. One or both of the biological groups were in poor or very poor condition at each of the three sampled locations. Habitat alteration and a commensurate limited capacity to assimilate nutrients related to agricultural production in the surrounding watersheds were the most immediate impacts to the streams. Additional impacts were also likely due to elevated stream temperatures and wide swings in dissolved oxygen concentration.

Requisite credible data collection requirements were lacking to complete an evaluation of the status of the aquatic life use attainment of Cessna Creek at RM 5.6; but, the macroinvertebrate community at the site was consistent with the WWH use. Forty three taxa were collected from the natural substrates including nine pollution sensitive taxa. Macroinvertebrate sampling produced a similar result at RM 3.1 and the fish community IBI score of 40 also met ecoregional expectations. Closer to the mouth of Cessna Creek the fish and macroinvertebrate community condition declined commensurate with a lowering in the habitat quality at the site. The cumulative effects of agricultural related instream and riparian habitat alterations were reflected in fish and macroinvertebrate assemblages at the site. The diversity of macroinvertebrates collected was just slightly more than half the number collected at RM 3.1. Pollution intolerant fish species were absent and simple lithophic fish were present in low abundance. Simple lithophils require clean unembedded substrates for propagation of their eggs. Full attainment of the WWH use at RM 3.1 is an indication that the non-attainment documented at RM 0.5 can be rectified by allowing recovery of typical WWH stream attributes.

Requisite credible data collection requirements were lacking to complete an evaluation of the status of the aquatic life use attainment of Shallow Run, but the macroinvertebrate community at both sites was reflective of an impaired resource. Both sampled locations, at RM 3.0 and 0.9, were predominated by pollution tolerant taxa and were in poor to very poor condition. An earlier investigation of Shallow Run done in 1983 produced similar results. Impacts to the stream included elevated nutrients and ammonia levels downstream from the village of Dunkirk, made worse by the channelized condition of the stream. The physical nature of the stream provided for effective water transport away from adjacent farm fields but negatively impacted the biology of the stream in limiting habitat and increasing the likelihood for elevated water temperatures and wide variation in dissolved oxygen concentrations.

No macroinvertebrate sampling was conducted on the Outlet at RM 3.6 and the fish were in only fair condition. Both organism groups were in marginally good condition at RM 0.3; owing, in part, to more heterogeneous substrates. Variation in the substrates is a benefit to fish and macroinvertebrates communities in that the population is more evenly distributed rather. This is one of the principle impacts that result when streams are maintained primarily to remove excess water from the surrounding landscape. Additional improvement in biological community condition is possible by limiting of organic and nutrient loadings from the unsewered village of Patterson.

Fish and macroinvertebrate assemblages in Forest-Simpson Ditch at RM 0.8 were both in very poor condition, and reflected severely degraded water quality. Pollution tolerant taxa predominated both assemblages and just fifteen fish were collected. Forest-Simpson Ditch has been channelized and continues to be grossly polluted by the effluent from the Forest WWTP lagoons, as originally identified in the 1983 study. The Forest WWTP lagoon discharge upstream from RM 0.8 contributed a high nutrient and organic load that overwhelmed the stream. Water in the stream is pea green (Figure 1i). Chemical sampling documented chronically low dissolved oxygen levels along with elevated ammonia and phosphorus concentrations.

Ripley Run failed to attain a WWH use due to the poor condition of the fish community at RM 0.1. The macroinvertebrate community was in marginally good condition. Unusually high ammonia concentrations were measured on two of six occasions during the summer of 2005, the source of which was undetermined (See water quality discussion). Intermittent toxic levels of ammonia in combination with a somewhat limiting habitat appeared to be the principle causes for non-attainment of the WWH use near the mouth of Ripley Run.

Requisite credible data collection requirements were lacking to complete an evaluation of the status of the aquatic life use of Rickenbach Ditch, but the macroinvertebrate community was reflective of an impaired resource at RM 1.2. The stream was nearly dry for a significant portion of the 2005 sampling period. The site was predominated by pollution tolerant taxa reflecting poor community condition. Impacts to the stream included elevated nutrients contributed by a CSO in the village of Forest along with TDS and metals from the Triumph Thermal Systems discharge. Water quality impacts were likely made worse by the channelized condition of the stream.

Both fish and macroinvertebrate sampling results from Potato Run were in the fair range at RM 9.6 with a limited habitat and nutrient enrichment related to agriculture being the principle causes of non-attainment. Pollution tolerant and pioneering fish comprised a large majority of the population which negatively affected the IBI score. Pioneering species are able to take advantage of unstable and impacted habitats where competition with other species is limited. Correspondingly, pollution tolerant macroinvertebrate taxa comprised a large portion of the community at RM 9.6. The fish community showed continued impairment at RM 1.8 even though habitat at the site was improved. The IBI score remained in the fair range. The MIwb score, which is a measure of fish community structure, was in the very poor range, owing to the predominance of a single tolerant species, *Pimephales notatus* (Bluntnose Minnow). Further downstream at RM 0.1 supported a relatively diverse macroinvertebrate fauna. The results suggested a gradual lessening of water quality impacts with increasing stream size; however, the influence of limited habitat and nutrient inputs in the upper watershed still tended to overwhelm the beneficial attributes of improved habitat at RM 1.8.

Water Quality

The results of dissolved oxygen sampling in the Blanchard River mainstem are presented in Figure 1b. Although there were 4 dissolved oxygen concentrations at or below the OMZA at the first four sites, the median never fell below the OMZA in this WAU (-010). There were also some very high dissolved oxygen levels and in 4 grab samples saturation exceeded 140%. At these sites, there were 4 of 24 grabs that exceeded the OMZM for temperature. The sites are typical of channelized streams with little or no riparian zone, therefore, there is no tree canopy to offer shade from the sun at any time during the day. However, the gradient of the Blanchard River is nearly 9 ft/mi before Cessna Creek joins with it, so in effect the character of the Blanchard River at the first 2 headwater sites is more like a tributary than like the rest of the mainstem. Significant problems with supersaturation and flux were documented by the automatic meters in the Blanchard River headwater sites and the upstream site of Shallow Run. The Village of Mt. Blanchard, which is still unsewered, appears to be impacting the D.O. levels where the Blanchard River flows into the next WAU (-020) downstream of Potato Run.

The results of nitrate-nitrite, total phosphorus and ammonia sampling in the Blanchard River mainstem are presented in Figures 1c, 1d, and 1e. With the exception of the most upstream site, nutrients were also generally within water quality standards at the headwater sites, with the median below the target level for nitrate (1.5 mg/l) at all sites but two, and with the median for phosphorus remaining below the target level (0.10 mg/l) until downstream of Forest-Simpson Ditch. However, ammonia results coupled with the nitrate-nitrite results showed there is one area of particular concern. On 2 of 6 sampling dates, ammonia and nitrate-nitrite levels were apparently high enough in Ripley Run to have affected the levels in the Blanchard River mainstem downstream of this tributary. During at least one of these events ammonia was measured in the Blanchard River at a level above the OMZA. Because high ammonia occurred during only 2 of the sampling events, it did not cause a significant change in the median, but the 75^{th} percentile and, especially, the mean of the ammonia results in Figure 1e show the effect this had on the water quality downstream of Ripley Run. The 2 incidents were almost like spills of some type, as they occurred 4 weeks apart, with a normal sampling event in between. Both samples where high ammonia was detected were not following rain events. The ammonia is unlikely to be from manure or septic system inputs, as the fecal coliform samples collected at the same time showed low counts. The increased nitrogen to the stream did affect the nitrate levels enough to raise the nitrate-nitrite median above the target level in the Blanchard River (Figure 1d). An examination of nitrate-nitrite levels in the tributaries with respect to the mainstem shows how strongly the tributaries are impacting the water quality of the Blanchard River (Figure 1f).

Strontium levels are above the OMZA in more than 62% of the grab samples collected in the Blanchard River mainstem from RM 97.42 downstream to RM 82.10. A high percentage of the tributaries in this geographic region of the WUA also had consistently high strontium levels which can be attributed to the ground water and bedrock in this area. One of the highest contributions of strontium is from the Cessna Creek sub-watershed, which is tributary to the Blanchard River at RM 98.23.

Three sites were sampled on Cessna Creek and water quality is generally good. There were very few exceedences of water quality criteria with the exception of strontium: 17 of 18 grab samples were over the OMZA. Shelly Materials (Hardin Quarry) discharges to a tributary of Cessna Creek and there is a CAFO, Vreba Hoff Dairy, in the headwaters of Cessna Creek.

The Dunkirk WWTP lagoon discharges in the headwaters of Shallow Run. This is a controlled discharge lagoon system and it only discharges for 3-4 days approximately every 3 months. Although the water quality in Shallow Run has improved since Dunkirk constructed its treatment lagoons in 1988, Dunkirk has several CSOs that are still impacting the stream, causing low dissolved oxygen, high ammonia concentrations and high fecal coliform counts in the section of Shallow Run that flows through and downstream of Dunkirk. Phosphorus is also above target in Shallow Run. Downstream of Dunkirk most of the remaining land use is crop production and much of Shallow Run is channelized and maintained. The lack of tree canopy for shade from the sun contributed to exceedences of the OMZM for temperature from RM 4.00 downstream to the mouth on one sampling date. Water quality downstream near the mouth improved somewhat, but there was still evidence of low dissolved oxygen and wide diel variations. Phosphorus was still high, but the median was below target. Strontium was also above the OMZA at most sites. The Hardin Northern School package plant also discharges to a tributary of Shallow Run.

Duff Quarry discharges to the Outlet (upper) at around RM 3.5. The Village of Patterson remains unsewered and continues to impact the water quality at and downstream of RM 3.00 causing low dissolved oxygen, high fecal coliform counts, and phosphorus above target.

Forest-Simpson Ditch has been channelized and continues to be grossly polluted by the effluent from the Forest WWTP lagoons, as originally identified in the 1983 study. Water in the stream is pea green (Figure 1i). Dissolved Oxygen violated the OMZM (minimum) in 5 of 6 grab samples. Ammonia exceeded the OMZA in 5 of 6 grab samples. Phosphorus was more than 10 times the target level. Fecal coliform counts exceeded the site specific maximum in 3 of 6 grab samples.

On 2 of the 6 sampling dates, ammonia concentrations in Ripley Run were extremely high (1 grab sample violated OMZM, the other exceeded the OMZA) and nitrate-nitrite was 25 times target. Total dissolved solids (TDS) in one of the samples was also above the OMZA. On both occasions, samples collected the previous day in the Blanchard River downstream of Ripley Run also showed evidence of the higher ammonia from the tributary. It appears that a large source of ammonia/nitrogen was introduced into Ripley Run on at least 2 occasions during the summer of 2005 (the high ammonia results were not from consecutive sample runs). However, fecal coliform counts were low, therefore the source is not from human or animal waste. The high ammonia and nitrate results were not associated with rainfall or runoff events. Currently the source of this ammonia/nitrogen contamination is undetermined, but of great concern, because Ripley Run flows into and is affecting the Blanchard River in the vicinity of the mussel populations where endangered species have been identified.

Water quality in the unnamed tributary that is confluent to the Blanchard River at RM 80.53 was unusual in that the high levels of total dissolved solids (TDS) and conductivity were more consistent with ground water quality. TDS and strontium were both above OZMA. In one sample, levels of some of the other metals were high also, with aluminum exceeding human health OMZA for non-drinking water, iron exceeding the OMZA for agricultural water supply (AWS), and selenium exceeding the OMZA for WWH. The stream at CR 150 (RM 1.78), where the samples were collected, was always choked with predominantly orange and some bright green colored algae early in the summer, which turned to brown later in the season (Figures 1j, 1k). No sources for these water quality impacts to this tributary were identified.

In the unnamed tributary that is confluent to the Blanchard River at RM 79.75 one of 5 grab samples for dissolved oxygen was below the OMZA, but flow here was low and there was often standing water with no current. There were a few high nitrate-nitrite and phosphorus concentrations, but the medians were below target.

Potato Run phosphorus levels exceeded the target in 100% of the samples collected. Nitrate-nitrite exceeded the target in 38% of the samples, but the median was only above the target at RM 9.95, upstream of Rickenbach Ditch. The lack of tree canopy for shade from the sun contributed to exceedences of the OMZM for temperature at all sites on one sampling date.

Rickenbach Ditch samples from the site at U.S. 30 (RM 1.18) were usually collected in an isolated pool on the upstream side of the bridge because there was no water on the downstream side of the bridge, which resulted in 2 of 6 dissolved oxygen readings being below the OMZM at this site. The other sites sampled on Rickenbach Ditch were collected in the headwaters near Forest, upstream and downstream of the Triumph Thermal Systems discharges. Just upstream of Triumph Thermal Systems is a CSO discharge from the village of Forest. The CSO is likely the source of high phosphorus and nitrate-nitrite which both exceeded target in nearly all the samples at the sites upstream and downstream of Triumph Thermal Systems. Fecal coliform counts also exceeded the site specific maximum at both sites in 2 of 6 grab samples. The effluent from Triumph Thermal Systems is impacting Rickenbach Ditch with total dissolved solids (TDS) which exceeded the OMZA in 100% of the samples collected downstream of the discharge. Copper exceeded the OMZA in 1 of 6 grab samples. Strontium exceeded the OMZA in all samples. The OMZM for temperature was exceeded on one date, probably due to the effluent, as the stream is completely shaded by trees in this section and upstream.

Wharton Ditch is confluent to Potato Run at RM 7.91. During the 1983 Biological and Water Quality Survey of the Blanchard River and Selected Tributaries, Wharton Ditch was not sampled, but Potato Run was sampled at RM 7.90 and the results showed elevated levels of ammonia (12.9 – 26.8 mg/l, median 14.2 mg/l), phosphorus (1.90 – 3.00 mg/l, median 2.75 mg/l), and fecal coliform (3,000 – 100,000 CFU/100ml, median 23,000 CFU/100ml). The cause of these water quality impacts to Potato Run was attributed to the storm sewer effluent from the unsewered Village of Wharton which discharges to Wharton Ditch. During the 2005 survey samples were collected in Wharton Ditch immediately downstream of Wharton's storm sewer discharge. The water here is gray and has a very strong septic odor (Figure 1l). Dissolved oxygen (1.8 – 4.0 mg/l, median 2.35 mg/l) and ammonia (11.0 – 34.4 mg/l, median 28.35 mg/l) violated the OMZM (minimum and maximum, respectively) in 5 of 6 grab samples and exceeded the OMZA in the other. Fecal coliform counts (81,000 - >200,000 CFU/100 ml, median >200,000 CFU/100ml) were above the site specific maximum, phosphorus (2.07 – 5.63 mg/l, median 3.90 mg/l) was above target and TDS (1910 – 3940 mg/l, median 2800 mg/l) was above the OMZA in all samples. Nitrate-nitrite was above target in the one sample where ammonia was slightly lower because some nitrification had occurred. It is clear from these results that the Village of Wharton has continued to have a significant negative impact on the water quality of both Wharton Ditch and Potato Run since the sampling that was conducted 22 years ago.

Nutrient enrichment was the most common type of water quality degradation. Data obtained from grab samples was summarized for phosphorus in Figure 1g and for nitrate-nitrite in Figure 1h to compare sites with similar drainage areas and identify where problems exist. Phosphorus did not meet target in the entire Potato Run drainage, including Rickenbach Ditch. Multiple sources include impacts from the unsewered Village of Wharton, CSOs from Forest, discharges from Triumph Thermal Systems, impacts from the unsewered Village of Mt. Blanchard, discharges from on-lot septic systems, and runoff from farm fields. Phosphorus was also above target in the upstream section of Shallow Run, where the Dunkirk WWTP lagoon and CSOs discharge. The Outlet (upper) did not meet the phosphorus target, most likely because of impacts from the unsewered village of Patterson. Forest-Simpson Ditch was extremely impacted by high phosphorus levels, more than 10 times the target, from the Forest WWTP lagoon discharge. In general, most of the tributaries met target for nitrate-nitrite. Although there were a few high values, all the medians were below target with the exception of Ripley Run. There was an unidentified source of nitrogen to Ripley Run that caused high ammonia and nitrate-nitrite levels on 2 of the 6 sampling dates.

Recreation

People can be exposed to pathogens in water by skin contact and through ingestion. It is because of this that recreation criteria were developed to protect human health. Fecal coliform counts (colony forming units or CFU/100 ml) are used to indicate if water has been contaminated by feces from warm blooded animals. Fecal coliform are harmless in most cases, but there is a potential that the feces contained pathogens or disease producing bacteria (Escherichia, Salmonella, and Shigella), viruses (hepatitis A, Norovirus, and Rotavirus), and parasites (Cryptosporidium, Giardia, and Cyclospora). Reactions to exposure can be as minor as skin rash, sore throat, or ear infection. However, some lead to diarrhea, gastroenteritis, and dysentery or even more serious wide spread epidemic.

An overall determination of the recreation use status was made for the entire WAU. Fecal coliform was used as the test organism because its presence indicates that water has been contaminated by feces from warm blooded animals. If bacteria levels are high enough (colony forming units or CFU/100 ml) there is a chance for people who come in contact with the water to become ill. Data used in the analysis includes samples collected during the May 1-October 15 recreation season obtained from both the 2005 stream survey and monthly operating reports filed by the Dunkirk and Forest WWTPs. Valid results are pooled for statistical analysis and the recreation use is considered impaired if the 75th percentile exceeds 1,000 or the 90th percentile exceeds 2,000. Recreation is considered impaired based on these guidelines because the 75th percentile was 2,700, and 90th percentile was 8,320.

A site specific evaluation of the Primary Contact Recreation (PCR) use was done for the Blanchard River mainstem because it is used for fishing and hunting. To determine if a site meets Ohio WQS criteria, a minimum of 5 samples must be collected within any 30 day period during the May 1-October 15 recreation season. The geometric mean calculated from this set of data should not exceed 1,000 and not more than 10% of the individual results should exceed 2,000. Results for testing done at 6 sites from June 27-July 25 are summarized in Table 1f. Three of these sites violated both the maximum criterion and the geometric mean criterion for primary contact recreation.

A single high fecal coliform sample collected at each of the sites at RM 101.03 and RM 95.60 during high flow accounted for both the site specific maximum and the geometric mean violation, and is likely the result of runoff from the application of manure to surrounding farm fields. The site specific maximum was exceeded in nearly every sample collected at RM 100.05, which also resulted in a violation of the geometric mean at this site. Impacts from high fecal coliform here can be attributed to discharges from nearby on-lot septic systems.

Sediment Quality

Sediment samples were tested for particle size distribution, organic carbon content, % solids, metals, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and organochlorine insecticides. Chemical concentrations are evaluated based on Ohio reference values (Ohio EPA, 2003) and consensus based toxicity guidelines (MacDonald et al, 2000). Ohio reference values are based on an ecoregion reference site approach and considered background concentrations for streams. The MacDonald guidelines consider concentrations below a threshold effect concentration (TEC) to be absent of toxicity and those above a probable effect concentration (PEC) to be toxic to benthic organisms.

Substrate features reflect the glacial origin of the parent materials in the Blanchard River. The stream was characterized by fine materials in the headwaters and in the lower section with some coarser material and bedrock outcrops at the sites in between. Particle size distribution varied from site to site, with the 2 upstream and 2 downstream sites containing mostly silt with no sand and the middle 2 sites containing more than 50% sand. The amount of organic carbon in samples ranged from 2.9 to 4.5%.

There were no PAHs, PCBs or insecticides detected in any of the samples. A summary of metal concentrations in sediment is presented in Table 1g. A few of the concentrations were slightly above Ohio reference values for the ECBP ecoregion, but none were elevated enough to be a concern. Some were also slightly above their respective TEC, but none were near the PEC. No aquatic life impact is expected based on the results.

Pollutant Loadings

There are no major point source dischargers (>1 MGD) in the Blanchard River Headwaters WAU (-010). There are 2 existing and one planned municipal lagoon wastewater treatment systems, 3 extended aeration package plants, 1 industrial wastewater treatment plant and 2 quarry settling pond discharges in the headwaters WAU.

Dunkirk WWTP (permit # 2PB00061) discharges to Shallow Run at RM 4.08. It is a controlled discharge facultative lagoon system located north of SR 81 and E of US 68 in Dunkirk, OH. It was constructed in 1988 with a design discharge flow of 0.137 MGD. Dunkirk has 100% combined sewers and lists 5 CSOs as discharging to Shallow Run in its NPDES Permit:

002 – West of Main St.
003 – Union St.
006 – Patterson St.
007 – Quarry
010 – Pump Station #4 at SR 81
*011 no longer discharges

Dunkirk also has a schedule of compliance in its NPDES Permit to install new separate sewers by November 2015.

No effluent violations have been documented for Outfall 001 since 2 TSS violations were reported in June 2004. Discharges from Outfall 001 occur for 3-4 days approximately every 3 months and were reported in 2005 on the following dates:

March 8-10
April 19-22
June 14-16
Sept 6-8
Dec 6-9

The only recorded discharges from the CSOs occurred on September 26-27, 2005 from 002, 003, 006 and 010.

Forest WWTP (permit # 2PB00044) is located on the south side of Jackson TR 20, east of TR 195, and serves a population of about 1,488. The system was constructed in 1964 and consists of a series of two facultative lagoons with a continuous discharge. When operated in series, a lift station pumps sewage to the west lagoon. It is then pumped to the east lagoon for additional treatment before being discharged through Outfall 001 to Forest-Simpson Ditch at approximately RM 1.3. However, from 1993 through mid-2006, the lagoons were operated in parallel rather than in series. When operated in parallel, the lift station pumps sewage to both lagoons. Then the treated wastewater from each lagoon is pumped back out to a single combined discharge to Forest-Simpson Ditch through Outfall 002 near RM 1.2. While being operated in this manner, the treatment system was not adequately reducing the fecal coliform bacteria levels, so a chlorination/dechlorination system was added prior to the 002 outfall. However, the effluent continued to have difficulty meeting the permit limits for fecal coliform bacteria. So, in mid-2006 Forest WWTP returned to operating the lagoons in series, with the final effluent being discharged from the east lagoon through Outfall 001 to Forest-Simpson Ditch and, the chlorination/dechlorination equipment on Outfall 002 was moved to Outfall 001. The collection system is 60-65% combined sewers and 35-40% separate sewers. Forest has implemented a 3 Phase CSO Control Plan to eliminate their CSOs and completely separate the sewer system. Phase I and Phase II have been completed and Phase III should be completed by December 2010. The remaining CSOs listed in the NPDES Permit are::

003 – Blaine St.	discharge to Rickenbach Ditch
004 – Dixon St.	discharge to Forest-Simpson Ditch
005 – Campbell St.	discharge to Forest-Simpson Ditch

There was an average of 3-4 recorded discharges from these CSOs per month during 2005. NPDES effluent violations at Outfall 001 were documented 9 times for fecal coliform in 2005 and once for TSS.

<u>Mt. Blanchard WWTP</u> (permit # PA00045) is in the final planning stages. Mt. Blanchard currently remains unsewered, but plans construction of a controlled discharge lagoon system, possibly in 2007.

<u>Hardin Northern School</u> (permit # 2PT00043) is located at 11589 SR 81, Dola, OH and its package plant discharges to a tributary of Shallow Run. The school is a facility that operates for only 9 months of the year. The extended aeration package plant is sized to treat 10,000 gpd and was new in 2003.

<u>Riverdale Local School</u> (permit # 2PT00037), located at 20613 SR 37, Mt. Blanchard, OH, houses grades K-12 and serves 1150 students and faculty for 9 months of the year with moderate use in the summer months. The extended aeration package plant has sand filters, chlorination/dechorination and is sized to treat 24,000 gpd. The plant discharges to Potato Run at RM 5.65.

<u>Claradan County Senior Housing Complex</u> (permit # 2PW00008) is a 6 unit apartment complex located at 215C River St., Mt. Blanchard, OH. Claradan has an extended aeration package plant with sand filters and chlorination/dechlorination sized to treat 1800 gpd that discharges to the Blanchard River at RM 77.98.

<u>Triumph Thermal Systems</u> (permit # 2IS00001) [AKA United Aircraft Products/Parker Hannifin], located at 200 Railroad St., Forest, OH, fabricates aircraft fluid and aircraft heat exchangers. There are 4 discharges from the facility to Rickenbach Ditch (aka

Shaefer Ditch). Flow from Outfall 005 can be up to about 8200 gpd from roof drains and subfloor sumps and discharges at about RM 4.97. Outfall 002, at RM 4.94, is the main effluent from the process wastewater treatment plant which discharges intermittently about 51,500 gpd. Outfall 001 discharges up to 1000 gpd of boiler condensate and blowdown and Outfall 003 discharges up to 9500 gpd of noncontact cooling water just downstream of Outfall 002. In the past, Triumph Thermal has had difficulty meeting its permit limits for TSS, hexavalent chromium, fluoride and especially copper. In 2005 the permit limit for fluoride was most often exceeded, with 25 documented permit violations. There were also 6 permit violations each of the limits for hexavalent chromium and TSS, 2 violations of the permit limits for copper and 5 violations of the permit limits for pH in 2005.

Shelly Materials/Hardin Quarry (permit # 2IJ00046) is located at 12484 SR 701 in Pleasant Township. The quarry has 3 discharges to tributaries of Cessna Creek via drainage tiles for a total of 1.1 MGD average daily flow. Outfall 001 (40˚43'40"N 83˚38'36"W) and Outfall 003 (40˚43'48"N 83˚38'36"W) drain storm water runoff, and Outfall 002 (40˚43'40"N 83˚38'38"W) is the effluent from the sedimentation pond.

Shelly Materials/Forest Quarry (permit # 2IJ00022), located at 3798 SR 53, just south of Patterson, is a surface mine stone quarry extracting dolomite. Storm water runoff goes to the settling pond which discharges up to 0.5 MGD via Outfall 002 to a tributary of The Outlet (upper).

Table 1A Aquatic life use attainment status for stations sampled in the Blanchard Headwaters assessment unit based on data collected July-September, 2005. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
Blanchard River			*WWH - ECBP Ecoregion*					
101.0/101.3	4.9	36[ns]		G	32.0	Full		
100.1/____	16.2			G				
97.5/97.5	43	34*	9.0	F*	46.0	NON	Direct habitat alteration, nutrients, flow alteration, ammonia	Ag related channelization, crop production streambank modification/destabilization
96.0/95.6	61	30*	7.3*	F*	46.0	NON	Direct habitat alteration, organic enrichment/DO	Ag related channelization, crop production, combined sewer overflow (via Shallow Run/ Dunkirk)
88.2/88.3	80	46	9.3	48	55.5	Full		
82.1/82.1	91	34*	8.4	VG	62.5	Partial	Organic enrichment/DO, ammonia, nutrients	Cause unknown (ammonia) via Ripley Run, crop production, minor municipal WWTP (Forest)
Trib. to Blanchard R. (RM 100.38)			*MWH recommended - ECBP Ecoregion*					
0.7/0.7	7.4	<u>26</u>		<u>P</u>*	34.5	NON	Direct habitat alteration, temperature, nutrients Organic enrichment/DO	Ag related channelization, Crop production
Cessna Creek			*WWH recommended - ECBP Ecoregion*					
5.6/____	3.6			G				
3.1/3.1	13.9	40		G	51.0	Full		
0.5/0.5	23.1	32*	8.6	F*	42.0	NON	Direct habitat alteration	Ag related channelization
Shallow Run (Dunkirk)			*WWH - ECBP Ecoregion*					
3.0/____	6.4			<u>VP</u>*			Direct habitat alteration, flow alteration, organic enrichment/DO, nutrients	Ag related channelization, crop production combined sewer overflows
0.9/____	10.8			<u>P</u>*			Direct habitat alteration, flow alteration, organic enrichment/DO, temperature, nutrients	Ag related channelization, crop production combined sewer overflows (Dunkirk)
The Outlet (Blanchard R. RM 90.94)			*WWH recommended - ECBP Ecoregion*					

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
_____/3.6	9.5	34*			52.5	(NON)	Direct habitat alteration, flow alteration	Ag related channelization, crop production
0.3/0.3	12.4	38[ns]		MG[ns]	55.5	Full		
Forest-Simpson Ditch			*WWH - ECBP Ecoregion*					
0.8/0.8	0.9	28*		VP*	62.5	NON	Ammonia, nutrients, organic enrichment/DO	Minor municipal point source (Forest)
Ripley Run			*WWH recommended - ECBP Ecoregion*					
0.1/0.1	5.5	24*		MG[ns]	50.0	NON	Direct habitat alteration, ammonia	Ag related channelization, cause unknown (ammonia)
Trib. to Blanchard R. (RM 80.53)			*MWH recommended - ECBP Ecoregion*					
1.8/1.8	6.7	22*		VP*	33.5	NON	Direct habitat alteration, temperature, nutrients, organic enrichment/DO	Ag related channelization, Crop production
Trib. to Blanchard R. (RM 79.75)			*MWH recommended - ECBP Ecoregion*					
2.2/2.2	5.9	20*		HF	40.0	NON	Direct habitat alteration, temperature, nutrients, organic enrichment/DO	Ag related channelization, Crop production
Rickenbach Ditch			*WWH - ECBP Ecoregion*					
1.2/____	3.2			P*			Direct habitat alteration, flow alteration, nutrients	Ag related channelization, crop production
Potato Run			*WWH - ECBP Ecoregion*					
9.6/9.6	12.8	28*		F*	39.0	NON	Direct habitat alteration, nutrients	Ag related channelization, crop production
____/1.8	25	32*	4.3*		63.5	(NON)	Direct habitat alteration, nutrients	Ag related channelization, crop production
0.1/____	28			G				

Ecoregion Biocriteria: Eastern Corn Belt Plain

	IBI			MIwb			ICI		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	40	50	24				36	46	22
Wading	40	50	24	8.3	9.4	4.0	36	46	22
Boat	42	48	24	8.5	9.6	4.0	36	46	22

a- MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.
b- A narrative evaluation of the qualitative sample based on attributes such as community composition, EPT taxa richness, and number of sensitive taxa was used when quantitative data were not available or considered unreliable due to current velocities less than 0.3 fps flowing over the artificial substrates.
c- Attainment status based on a single organism group is parenthetically expressed.
d- Causes listed are considered to be a primary influence on water quality, but may not be the only issue leading to impairment. See text for discussion of additional causes that cumulatively have led to impairment.
e- Sources listed are considered to be a primary influence on water quality, but may not be the only source leading to impairment. See text for discussion of additional sources that cumulatively have led to impairment.
ns- Nonsignificant departure from biocriteria ($\leq$4 IBI or ICI units, or $\leq$0.5 MIwb units).
* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb ^{units}). Underlined scores are in the Poor or Very Poor range.

Table 1b. Exceedences documented in the Blanchard River Headwaters WAU based on Ohio WQS criteria and nutrient target values. Criteria include outside mixing zone minimum or maximum (OMZM) and average (OMZA) values.

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Blanchard River WWH, PCR, AWS, IWS	101.03	WWH	dissolved oxygen	11 of 47 diurnals below OMZM
				1 of 6 grabs > 140% saturation
				diurnal flux > 5 mg/l
			temperature	1 of 6 grabs above OMZM
				11 of 47 diurnals above OMZM
			nitrate-nitrite	5 of 6 grabs and median above target
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum
	100.05	WWH	dissolved oxygen	1 of 48 diurnals below OMZM
				2 of 6 grabs below OMZA
				1 of 6 grabs > 140% saturation
				diurnal flux > 5 mg/l
			temperature	1 of 6 grabs above OMZM
				18 of 48 diurnals above OMZM
			phosphorus	2 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum

Table 1b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Blanchard River WWH, PCR, AWS, IWS	97.42	WWH	dissolved oxygen	1 of 6 grabs below OMZA
				2 of 47 diurnals below OMZM
				1 of 6 grabs >140% saturation
				7 of 47 diurnals >140% saturation
				diurnal flux > 5 mg/l
			temperature	1 of 6 grabs above OMZM
				12 of 47 diurnals above OMZM
			nitrate-nitrite	2 of 6 grabs above target
			phosphorus	1 of 6 grabs above target
			strontium	4 of 6 grabs and median above OMZA
	95.60	WWH	dissolved oxygen	1 of 6 grabs below OMZA
				1 of 6 grabs >140% saturation
				9 of 48 diurnals >140% saturation
				diurnal flux > 5 mg/l
			temperature	1 of 6 grabs above OMZM
				10 of 48 diurnals above OMZM
			phosphorus	1 of 6 grabs above target
			nitrate-nitrite	1 of 6 grabs above target
			strontium	6 of 6 grabs and median above OMZA
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum

Table 1b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Blanchard River WWH, PCR, AWS, IWS	88.27	WWH	phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
			strontium	3 of 6 grabs and median above OMZA
	82.10	WWH	dissolved oxygen	21 of 48 diurnals below OMZM
				diurnal average violated OMZA
				diurnal flux > 5 mg/l
			ammonia	1 of 6 grabs above OMZA
			phosphorus	4 of 6 grabs and median above target
			nitrate-nitrite	3 of 6 grabs and median above target
			strontium	2 of 6 grabs above OMZA
Blanchard River Trib (RM 100.38) WWH, PCR, AWS, IWS	0.66	WWH	temperature	1 of 6 grabs above OMZM
			phosphorus	2 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target
			strontium	1 of 6 grabs above OMZA
		PCR	fecal coliform	1 of 5 grabs above site specific maximum
Cessna Creek WWH, PCR, AWS, IWS	5.60	WWH	strontium	6 of 6 grabs and median above OMZA
	3.11	WWH	dissolved oxygen	1 of 6 grabs >140% saturation
			temperature	1 of 6 grabs above OMZM
			strontium	5 of 6 grabs and median above OMZA
	0.51	WWH	dissolved oxygen	1 of 6 grabs >140% saturation
			temperature	1 of 6 grabs above OMZM
			nitrate-nitrite	1 of 6 grabs above target
			strontium	6 of 6 grabs and median above OMZA

Table 1b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Shallow Run WWH, SCR, AWS, IWS	5.10	WWH	dissolved oxygen	6 of 6 grabs and median below OMZM
			ammonia	3 of 6 grabs above OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	2 of 6 grabs above target
		SCR	fecal coliform	5 of 6 grabs above site specific maximum
	4.70	WWH	dissolved oxygen	4 of 6 grabs and median below OMZM
				1 of 6 grabs below OMZA
			ammonia	1 of 6 grabs violated OMZM
				3 of 6 grabs above OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	2 of 6 grabs above target
			TDS	1 of 6 grabs above OMZA
			strontium	3 of 6 grabs and median above OMZA
		SCR	fecal coliform	4 of 6 grabs above site specific maximum
	4.00	WWH	dissolved oxygen	9 of 47 diurnals below OMZM
				15 of 47 diurnals >140% saturation
				diurnal flux >5 mg/l
			temperature	1 of 6 grabs above OMZM
				16 of 47 diurnals above OMZM
			ammonia	2 of 6 grabs above OMZA
			phosphorus	3 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
			strontium	5 of 6 grabs and median above OMZA

Table 1b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Shallow Run WWH, SCR, AWS, IWS	2.96	WWH	dissolved oxygen	14 of 46 diurnals below OMZM
				diurnal flux <5 mg/l
			temperature	1 of 6 grabs above OMZM
				15 of 46 diurnals above OMZM
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
			strontium	3 of 6 grabs and median above OMZA
		SCR	fecal coliform	1 of 6 grabs above site specific maximum
	0.93	WWH	dissolved oxygen	1 of 6 grabs below OMZA
				2 of 46 diurnals below OMZM
				diurnal flux >5 mg/l
			temperature	1 of 6 grabs above OMZM
				14 of 46 diurnals above OMZM
			phosphorus	3 of 6 grabs above target
			strontium	4 of 6 grabs and median above OMZA
The Outlet (upper) RM 90.94 WWH, PCR, AWS, IWS	3.00	WWH	dissolved oxygen	3 of 6 grabs below OMZA
			phosphorus	5 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
		PCR	fecal coliform	5 of 6 grabs above site specific maximum
	0.28	WWH	phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target

Table 1b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Forest-Simpson Ditch WWH, SCR, AWS, IWS	0.80	WWH	dissolved oxygen	5 of 6 grabs and median below OMZM
			ammonia	5 of 6 grabs above OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
		SCR	fecal coliform	3 of 6 grabs above site specific maximum
Ripley Run WWH, PCR, AWS, IWS	0.03	WWH	dissolved oxygen	1 of 6 grabs below OMZM
				1 of 6 grabs below OMZA
			ammonia	1 of 6 grabs violated OMZM
				1 of 6 grabs above OMZA
			phosphorus	1 of 6 grabs above target
			nitrate-nitrite	3 of 6 grabs and median above target
			TDS	1 of 6 grabs above OMZA
			strontium	2 of 6 grabs above OMZA
Blanchard River Trib (RM 80.53) WWH, PCR, AWS, IWS	1.78	WWH	dissolved oxygen	2 of 6 grabs below OMZA
			TDS	5 of 6 grabs and median above OMZA
			nitrate-nitrite	1 of 6 grabs above target
			strontium	6 of 6 grabs and median above OMZA
			selenium	1 of 6 grabs above OMZA
		HH	aluminum	1 of 6 grabs above OMZA for nondrinking
		AWS	iron	1 of 6 grabs above OMZA
Blanchard River Trib (RM 79.75) WWH, PCR, AWS, IWS	2.22	WWH	dissolved oxygen	1 of 5 grabs below OMZA
			phosphorus	1 of 5 grabs above target
			nitrate-nitrite	2 of 5 grabs above target

Table 1b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Potato Run WWH, PCR, AWS, IWS	9.95	WWH	dissolved oxygen	1 of 4 grabs below OMZM
			temperature	1 of 4 grabs above OMZM
			phosphorus	4 of 4 grabs and median above target
			nitrate-nitrite	3 of 4 grabs and median above target
		HH	aluminum	1 of 4 grabs above OMZA for nondrinking
		AWS	iron	1 of 4 grabs above OMZA
	9.58	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			temperature	1 of 6 grabs above OMZM
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	2 of 6 grabs above target
	1.84	WWH	temperature	1 of 6 grabs above OMZM
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
			strontium	3 of 6 grabs above OMZA
Rickenbach Ditch WWH, SCR, AWS, IWS	4.98	WWH	phosphorus	5 of 6 grabs and median above target
			nitrate-nitrite	5 of 6 grabs and median above target
			strontium	1 of 6 grabs above OMZA
		AWS	iron	1 of 6 grabs above OMZA
		SCR	fecal coliform	2 of 6 grabs above site specific maximum

Table 1b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Rickenbach Ditch WWH, SCR, AWS, IWS	4.93	WWH	temperature	1 of 6 grabs above OMZM
			TDS	6 of 6 grabs and median above OMZA
			copper	1 of 6 grabs above OMZA
			strontium	6 of 6 grabs and median above OMZA
			phosphorus	5 of 6 grabs and median above target
			nitrate-nitrite	6 of 6 grabs and median above target
		SCR	fecal coliform	2 of 6 grabs above site specific maximum
	1.18	WWH	dissolved oxygen	2 of 6 grabs below OMZM
			phosphorus	4 of 6 grabs and median above target
			nitrate-nitrite	2 of 6 grabs above target
		AWS	iron	1 of 6 grabs above OMZA
Wharton Ditch WWH, PCR, AWS, IWS	0.35	WWH	dissolved oxygen	5 of 6 grabs and median below OMZM
				1 of 6 grabs below OMZA
			ammonia	5 of 6 grabs and median violated OMZM
				1 of 6 grabs above OMZA
			TDS	6 of 6 grabs and median above OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
		PCR	fecal coliform	6 of 6 grabs above site specific maximum

Table 1c. Summary of hourly dissolved oxygen measurements (mg/L) recorded by automatic meters deployed in the Blanchard River mainstem and Shallow Run. Highlighted values indicate a WQS violation.

River Mile	Hours	Mean	Median	Minimum	Maximum	Flux
Blanchard River						
101.03	47	5.48	5.07	3.24	8.37	5.13
100.05	48	7.86	6.74	3.82	12.40	8.58
97.42	47	8.11	6.35	3.64	15.00	11.36
95.60	48	8.06	6.71	4.62	16.16	11.54
88.27	49	5.40	5.32	5.06	6.05	0.99
82.10	48	3.76*	5.02	0.07*	5.89	5.82*
Shallow Run						
4.00	47	8.17	6.09	3.13	18.39	15.26
2.96	46	6.49	5.03	2.42	13.67	11.25
0.93	46	7.09	5.89	3.43	12.41	8.98

*Data indicated potential fouling of the electrode during part of sample interval which may have resulted in erroneous low readings.

Table 1d. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Claradan County Senior Housing Complex	2PW00008	Blanchard River	77.98	0.0018 MGD package plant
Mt Blanchard WWTP	2PA00045	Blanchard River		Planned construction in 2007 for controlled discharge lagoons.
Dunkirk WWTP	2PB00061	Shallow Run	4.08	0.137 MGD controlled discharge lagoons
Forest WWTP	2PB00044	Forest-Simpson Ditch	1.50	0.200 MGD controlled discharge lagoons
Hardin Northern School	2PT00043	Shallow Run Trib		0.010 MGD package plant
Shelly Materials (Forest Quarry)	2IJ00046	Drainage tile to Cessna Creek Trib		002 - 1.1 MGD sedimentation pond (ground water) 001, 003 - storm water runoff
Triumph Thermal Systems	2IS00001	Rickenbach Ditch (AKA Schaefer Ditch)	4.97-4.94	001 - 0.001 MGD Boiler blowdown & condensate 002 - 0.0515 MGD WWTP 003 - 0.0095 MGD Non-contact cooling water 005 - 0.0082 MGD: drains, sumps
Duff Quarry	2IJ00022	The Outlet (upper)		0.5 MGD sedimentation pond
Claradan County Senior Housing Complex	2PW00008	Blanchard River	77.98	0.0018 MGD package plant

Table 1e. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Laidlaw Transit Inc	2GR00321	Blanchard River Tributary	Industrial Storm water
Shelly Co	2GG00106	Cessna Creek Tributaries	Industrial Storm water
ES Wagner Co	2GC00796	Ripley Run	Construction Storm water
ES Wagner Co	2GC00797	Ripley Run	Construction Storm water
ES Wagner Co	2GC00958	Unnamed Trib To ODOT Ditch To Blanchard River	Construction Storm water
Hancock County Engineers Office	2GC00847	Blanchard River	Construction Storm water
Vreba Hoff Dairy Development LLC	2GC00277	Cessna Creek Tributary	Construction Storm water

Table 1f. Site specific recreation use assessment in the Blanchard River. Highlighted values indicate an Ohio WQS criteria violation.

Sampling Location	River Mile	Fecal Coliform Count (CFU/100 ml)					
		6/27/05	7/6/05	7/11/05	7/20/05	7/25/05	Geometric Mean
CR 80	101.03	>10,000	1,400	1,000	480	590	1,317
TR 165	100.05	240	>10,000	2,600	4,000	5,000	2,626
TR 56 (Musgrave Rd)	97.42	720	1,400	240	410	870	613
adj CR 183	95.60	>10,000	910	1,100	740	560	1,329
Hardin/Hancock Co Line Rd	88.27	410	790	320	700	590	532
CR 150	82.10	1,300	270	94	1,200	360	427

Table 1g. Metal concentrations (mg/kg) in sediment collected from the Blanchard River. Highlighted values were above either the statewide (*) or ECBP ecoregion sediment reference value (SRV). Values reported as less than were below the quantitation limit.

Parameter	Sampling Location and river mile						
	SRV	CR 80 (101.03)	TR 165 (100.05)	TR 56 (97.42)	adj TR 183 (95.60)	Hardin/ Hancock Co Line Rd (88.27)	CR 150 (82.10)
Aluminum	39,000	26,500	24,600	23,200	23,100	27,400	27,200
Barium	240	132	132	121	105	140	144
Calcium	120,00	44,400	80,200	49,000	23,500	20,100	15,100
Chromium	40	30	28	28	24	29	29
Copper	34	21.8	21.4	15.7	13.4	13.2	20.0
Iron	33,000	28,900	28,900	21,300	18,500	22,600	23,300
Lead	47 *	<21	<20	<22	<22	<27	<30
Magnesiu	35,000	13,400	14,400	13,300	9,140	9,560	7,130
Manganes	780	465	520	396	289	435	475
Nickel	42	29	27	25	<22	<27	<30
Potassium	11,000	7,430	7,460	6,610	5,600	7,100	7,490
Sodium	-	<2,610	<2,520	<2,720	<2,800	<3,370	<3,800
Strontium	390	142	375	498	395	203	259
Zinc	160	97.1	78.7	79.0	64.5	84.6	72.2
Mercury	0.12 *	<0.030	<0.036	<0.034	<0.035	<0.037	<0.043
Arsenic	18	14.0	19.2	10.7	9.57	9.55	8.53
Cadmium	0.90	0.529	0.536	0.452	0.416	0.377	0.453
Selenium	2.3	1.13	<1.01	<1.09	<1.12	<1.35	1.71
Solids (%)	-	58.1%	59.3%	52.5%	57.5%	54.0%	47.8%
TOC (%)	-	3.6%	4.4%	4.5%	2.9%	2.9%	3.4%

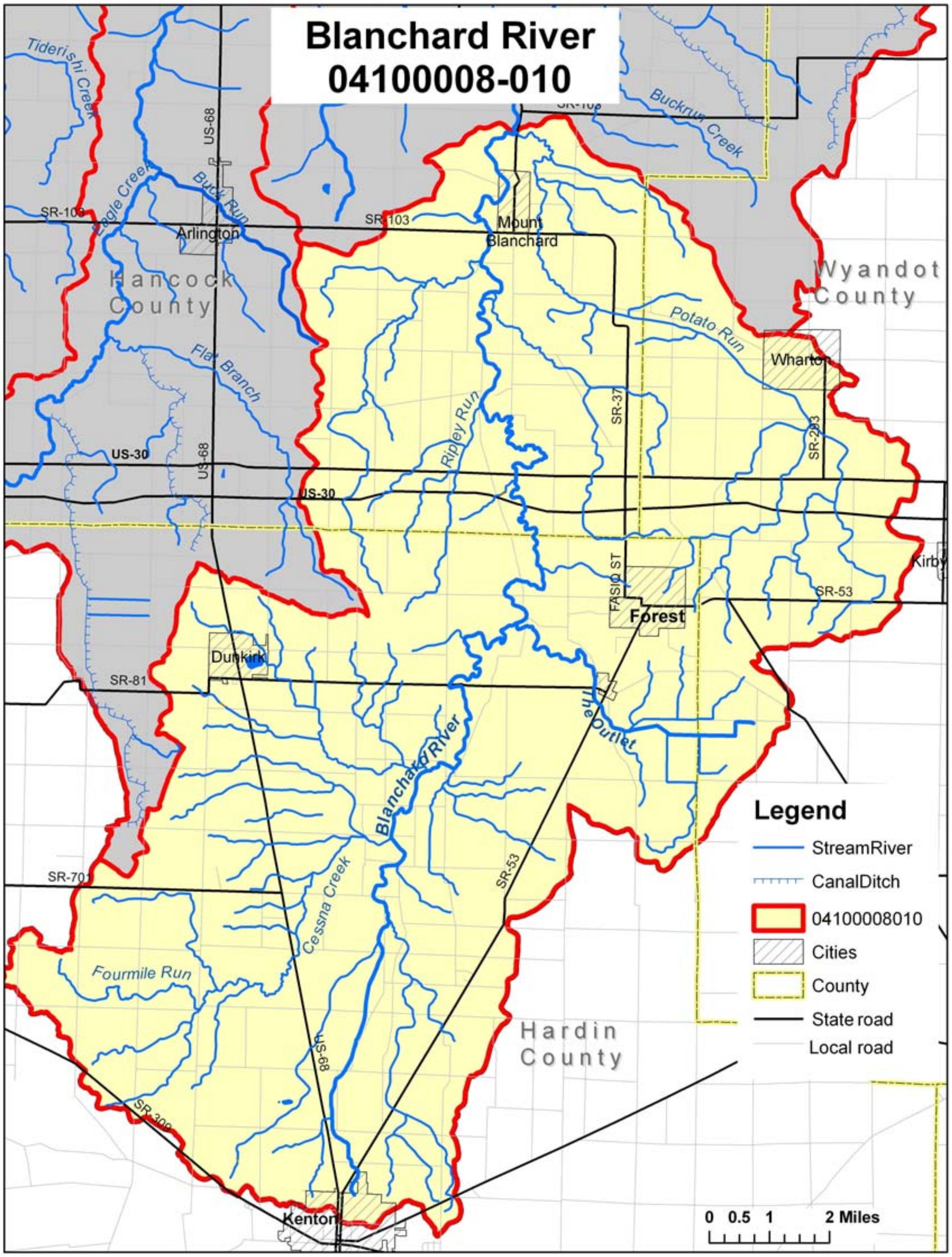


Figure 1a. Map of the Blanchard River Headwaters WAU showing principal streams, urban areas, and roadways.

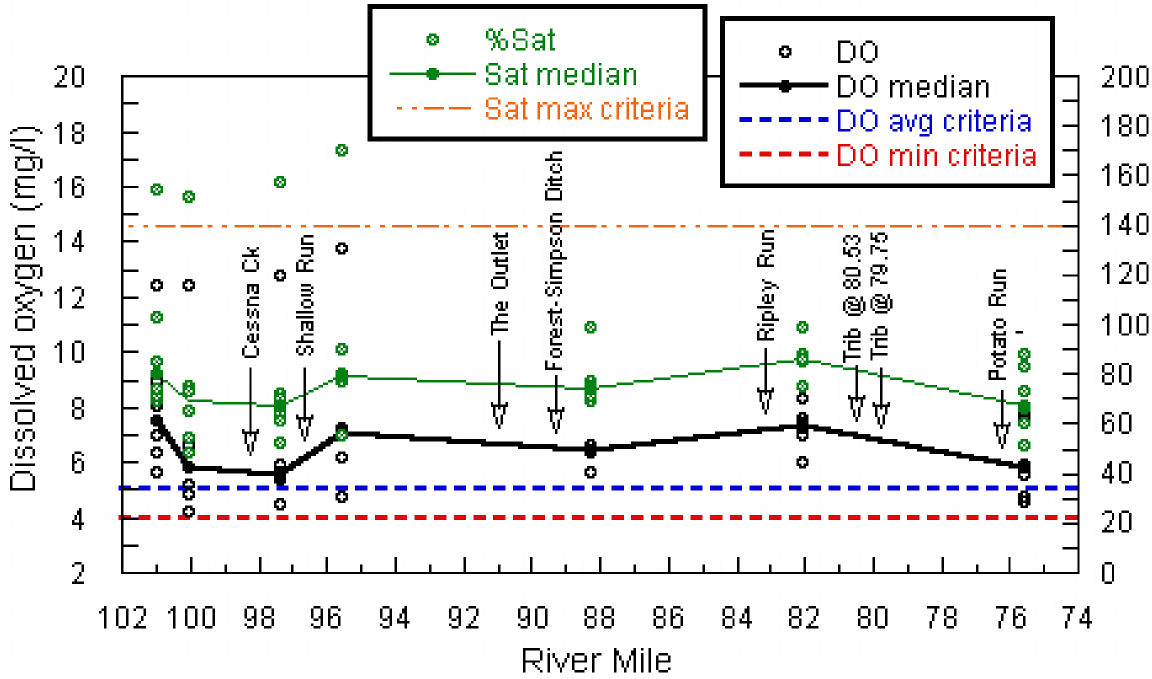


Figure 1b. Summary of dissolved oxygen concentration and saturation measured in daytime grabs from the Blanchard River mainstem plotted against average, minimum and maximum criteria.

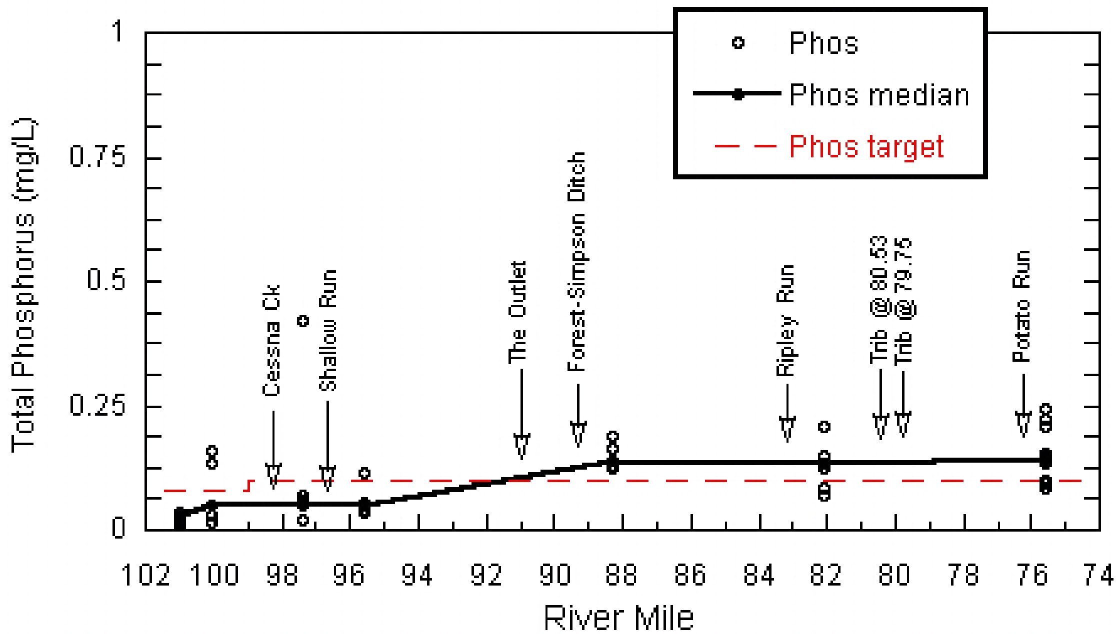


Figure 1c. Summary of phosphorus concentrations measured in grabs from the Blanchard River mainstem plotted against the target level.

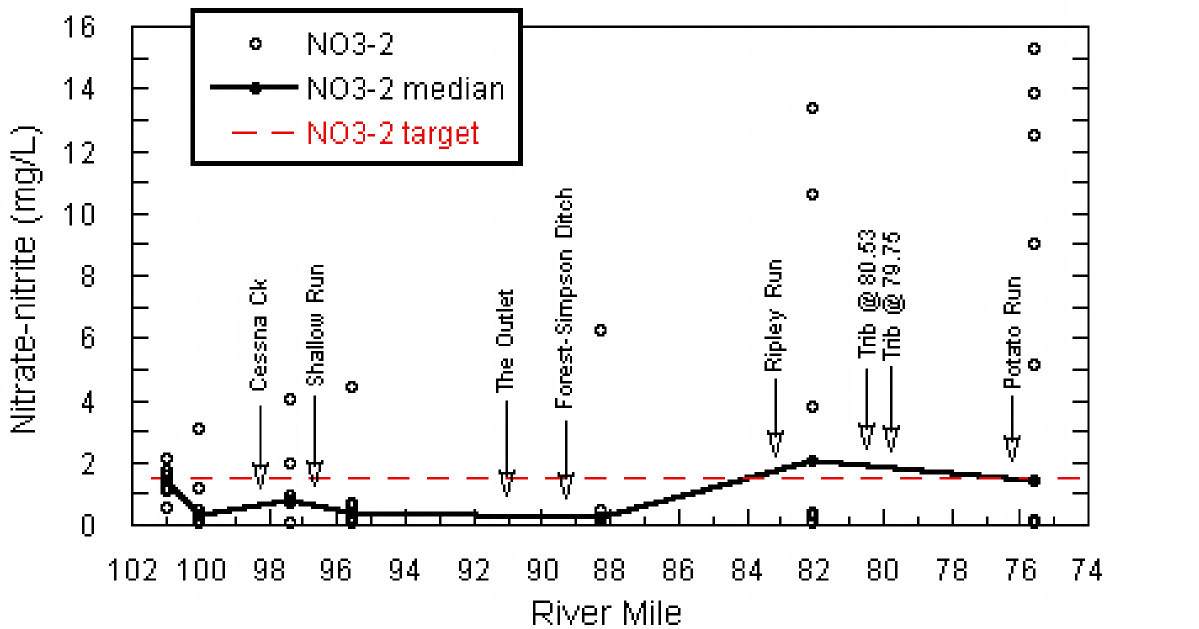


Figure 1d. Summary of nitrate-nitrite concentrations measured in grabs from the Blanchard River mainstem plotted against the target level.

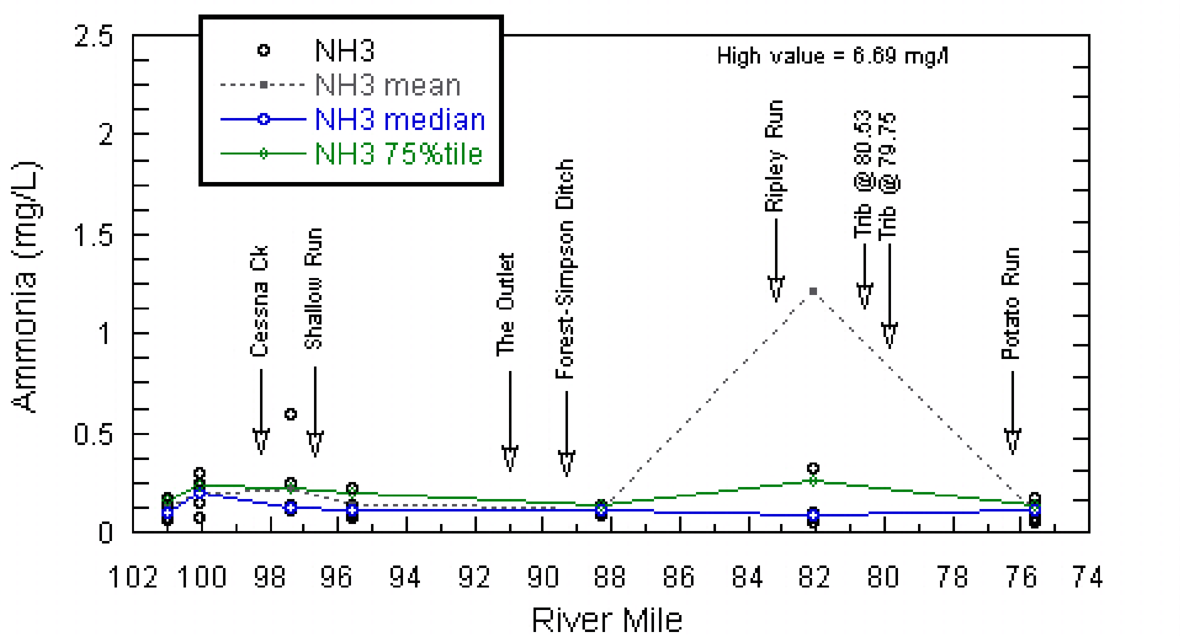


Figure 1e. Summary of ammonia concentrations measured in grabs from the Blanchard River mainstem.

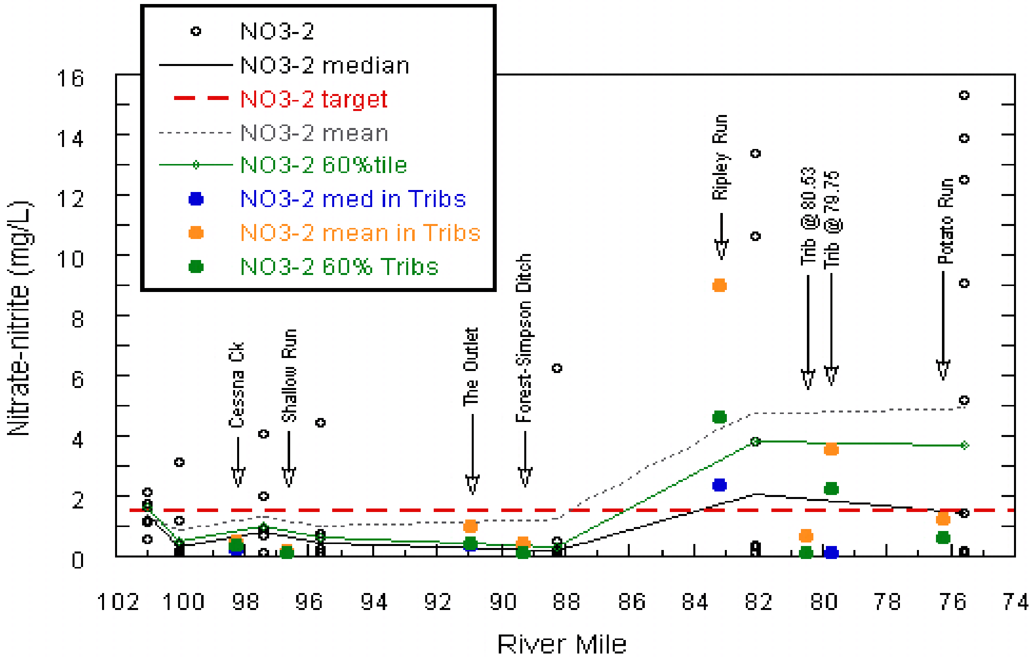


Figure 1f. Summary of nitrate-nitrite concentrations measured in grabs from the Blanchard River mainstem plotted against nitrate-nitrite concentrations measured in grabs from the tributaries and the target level.

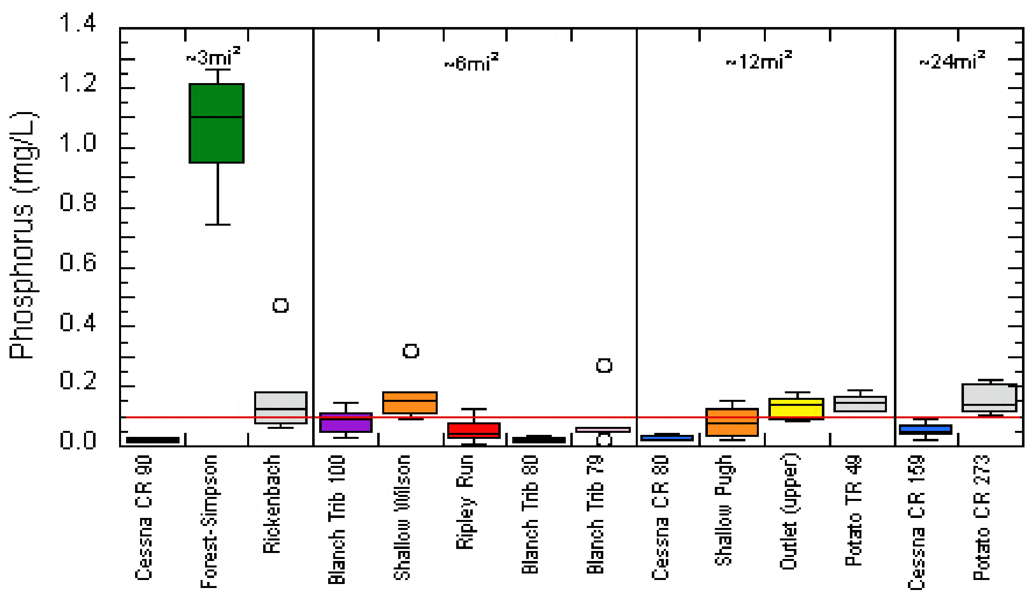


Figure 1g. Summary of phosphorus concentrations measured in grabs from Blanchard River tributary sites plotted against the target level. Sites are loosely grouped based on similar drainage areas of 3, 6, 12, and 24 mi^2. The box contains 50% of the data points and the line represents the median value.

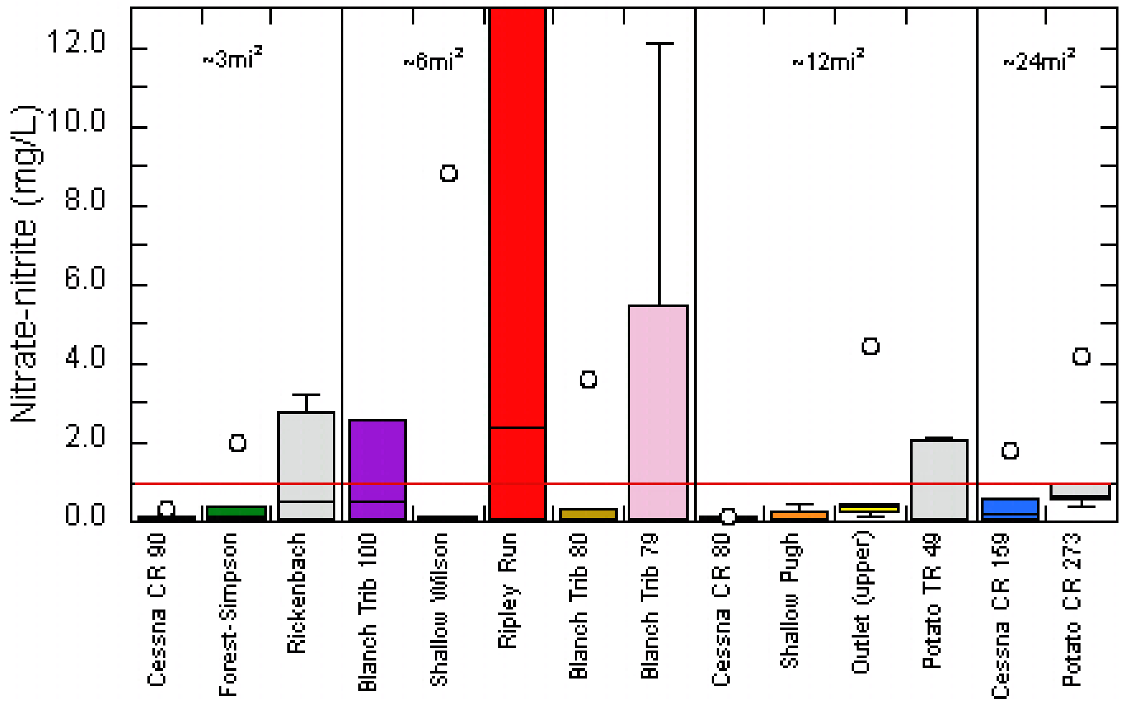


Figure 1h. Summary of nitrate-nitrite concentrations measured in grabs from Blanchard River tributary sites plotted against the target level. Sites are loosely grouped based on similar drainage areas of 3, 6, 12, and 24 mi^2. The box contains 50% of the data points and the line represents the median value.

Figure 1i. Forest-Simpson Ditch at TR 195 downstream of Forest WWTP lagoons.

Figures j,k. Blanchard River Tributary (80.53) at CR 150 choked with algae on surface and through water column.

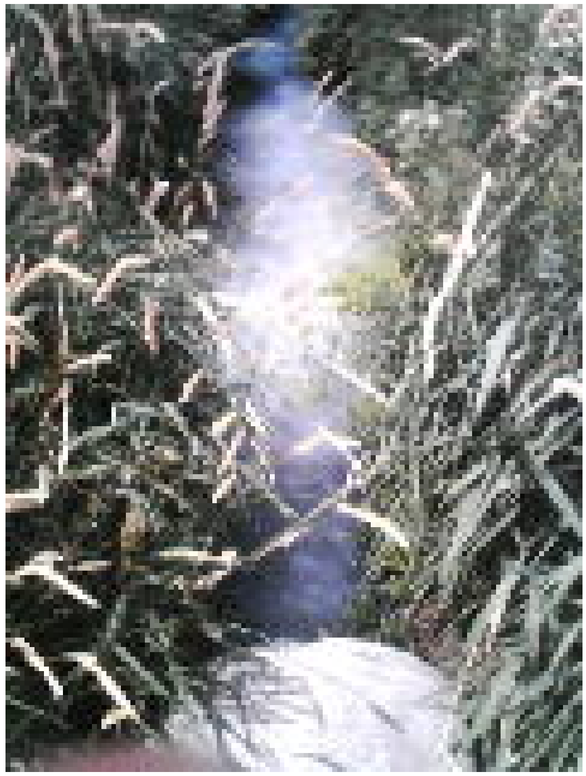


Figure 1l. Wharton Ditch downstream of Wharton's storm sewer discharge.

The Outlet/Lye Creek WAU

The Outlet/Lye Creek WAU (04100008-020) is almost entirely contained in Hancock County except for the upper headwater reaches of some of the tributaries which extend into western Wyandot County and the southwest corner of Seneca County. The WAU (-020) also includes 18.2 miles of the Blanchard River mainstem from downstream of Potato Run, to downstream of Lye Creek (just upstream of Eagle Creek). The Outlet (lower) is 9.2 miles long, draining 38.2 mi^2, and it is at a point just downstream of its confluence with the Blanchard River (RM 63.63) where the mainstem first exceeds a 200 mi^2 drainage area. A map showing principal streams, roads, and urban areas is displayed in Figure 2a. Fish and macroinvertebrate populations and stream habitat conditions were evaluated throughout the WAU. The associated index scores and biological attainment status for each site (full, partial, or non) are summarized in Table 2a. Physical, chemical, and bacterial sampling was done to complement the biological data. Most sites had six sets of samples collected at two week intervals. Bacteria were tested to assess attainment of recreational use. The Blanchard River mainstem had extra sampling done to meet temporal and sample size conditions contained in the rule and evaluate data on a site specific basis. Results from the smaller tributaries were simply compared to the maximum standard. Multi-parameter automatic meters were set at three Blanchard River mainstem sites in 2005 to measure physical conditions over a 48 hour period. Additional sites were monitored using the automatic meters in 2006 as part of a follow-up survey on the Blanchard River mainstem through the City of Findlay. The 2006 survey included sites in both the Outlet/Lye Creek WAU (-020), and overlapped downstream into the Eagle Creek WAU (-030).

Water quality data and biological index scores were evaluated based on Ohio WQS criteria (OAC 3745-1). Target values presented in the *Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999) were used to evaluate nutrient enrichment. Appropriate numerical criteria and target values are often determined by use designation and all data was evaluated based on the current assigned uses of WWH, PCR, AWS, and IWS. Geographic location is an important consideration for biological criteria. All of The Outlet/Lye Creek WAU lies in the ECBP ecoregion. Nutrient target values are being used as guidelines in lieu of criteria that are currently under development. Preliminary results support the validity of these target values and the notion that a correlation exists between nutrients, aquatic life attainment status, and drainage area. Criteria will likely be tiered for drainage area at the break between a wadeable stream and a small river (200 mi^2). Therefore, nutrient samples from all tributaries to the Blanchard River in this WAU (-020) and from the mainstem upstream of The Outlet (lower) were evaluated using a phosphorus target of 0.10 mg/L and a nitrate-nitrite target of 1.00 mg/L. However, a phosphorus target of 0.17 mg/L and a nitrate-nitrite target of 1.5 mg/L were used to evaluate nutrient samples from the Blanchard River mainstem downstream of The Outlet (lower).

An effort was made to identify the sources of water quality degradation. Ambient water quality is affected by a complex set of biotic and abiotic factors. Water picks up many impurities from the air, land, and ground and gases like oxygen, nitrogen, and carbon dioxide diffuse into water from the atmosphere. Climate, topography, vegetation, and biological activity all influence ambient water quality. Local water quality, though, is usually determined by inputs from anthropogenic sources that are grouped into point and nonpoint categories. The origin of a point source is easy to identify at the end pipe and most are regulated under the NPDES permit system. Individual permits are issued to facilities with unique processes like those summarized in Table 2d. General permits are issued to facilities with similar operations that exert a minimal impact on the environment like those summarized in Table 2e. Continuous discharge point sources have their greatest impact under base flow when chemistry is relatively stable and conditions reflect the ground water that recharges the stream.

Water quality exceedences that were documented are summarized in Table 2b. Some degree of water quality degradation was documented at every site. In most instances, habitat and flow conditions were not adequate enough to overcome an impact to aquatic life and there was widespread impairment. A summary of the dissolved oxygen data obtained from automatic meters deployed in the Blanchard River mainstem is presented in Table 2c. Minimum dissolved oxygen (DO) values are important because enough DO needs to be present to sustain aquatic life. Criteria that apply to WWH streams are a 24 hour average of 5.0 mg/L and a minimum at any time of 4.0 mg/L. Maximum values are important if they are at supersaturated levels. This phenomenon results in an aquatic life ailment known as gas bubble disease. Initially, it causes gas bubbles to form on external surfaces and blocks the flow of water across the gills. As the disease progresses, it causes bubbles to form behind the eyes (pop-eyed) and in blood. This can restrict or stop blood flow, damage tissues, and eventually cause mortality. Fish mortality can occur when saturation reaches 140% and lesser impacts can happen at levels as low as 104%. There is also mounting evidence that dissolved oxygen concentrations that fluctuate more than 5 mg/L (minimum/maximum) over a diurnal period have a negative impact on aquatic life. This causes stress to aquatic organisms and is often linked with other changes in the environment like a shift in pH.

Most tributary streams drain cropland and are managed to eliminate excess water with a combination of surface (ditches) and sub surface (tile) drainage systems. Too much water can delay planting, cultivation, or harvest and cause problems with flooding and soil compaction. Some drainage projects are simply done by the landowner, but those that involve multiple landowners and communities fall under county ditch laws. When the interested parties reach a mutual agreement a ditch petition is filed with the Board of County Commissioners. This starts the legal steps required to finance, construct, and maintain a ditch. The County Engineer presents a report at a public hearing and the board votes on the project. If the vote is in favor of the project, the engineer conducts a field survey and prepares plans and a cost estimate. A final hearing is held to re-affirm the decision before work is completed and the County Engineer (or SWCD) becomes responsible for maintenance. Habitat and flow alterations from these drainage projects are considered high magnitude causes of impairment.

The impact from a nonpoint source is a direct function of the surrounding land use and their exact origin is difficult to identify. Pollutants like silt, nutrients, and pesticides are carried in storm water from land used for crop and livestock production. Management practices like channelization, removal of riparian vegetation, and installation of sub surface tile systems result in significant flow and habitat alterations. They contribute to low flow conditions during dry weather periods because they limit ground water recharge by lowering the water table and by increasing evaporation since there is no tree shade. Conversely, these activities contribute to flooding during wet weather periods due to accelerated delivery of runoff. In pasture areas the exclusion of livestock from surface waters is important because of the damage they can cause to habitat and input of nutrients and bacteria. A type of flow alteration is the impounding of a stream by a low head dam. These dams change stream morphology by flooding riffles, block fish migration, and ultimately change trophic structure. Several of these structures are located on the Blanchard River above and through Findlay. Three are located within The Outlet/Lye Creek WAU at RM 58.77, 62.40, and 65.17. The dam at RM 62.4 is there for the purpose of impounding water for the City of Findlay's primary drinking water intake, used to fill the City's adjacent water supply reservoirs. Failed home sewage systems can be a problem in areas without central collection and treatment systems. Houcktown is and example of one of these areas. Pollutants like silt, nutrients, and pesticides are also carried in storm water from urban areas, along with materials like oil and heavy metals that are present in auto exhaust. Combined sewer overflows are also a major source of organic matter and bacteria. The sewage collection system in Findlay has 2 of its 24 CSOs present in The Outlet/Lye Creek WAU. Flooding caused by accelerated delivery of runoff is also a problem in urban areas because of impervious surfaces and sources of inflow like down spouts and sump pumps.

Aquatic Life Use Designations

The Blanchard River is designated as WWH, PCR, AWS, and IWS based on previous field assessments. The Blanchard River mainstem enters The Outlet/Lye Creek WAU (-020) just downstream of Potato Run and Mt. Blanchard, flowing almost directly north through 12-13 miles of rural area, mostly cropland. At SR 37 (RM 75.57), just downstream from Mt. Blanchard, the drainage area is 142 mi^2. Buckrun Creek (9 mi^2 drainage area) enters at RM 69.84 and Brights Ditch (28.6 mi^2 drainage area) enters at RM 65.85. The first impoundment on the mainstem, a low head dam, is at RM 65.17, just east of the Findlay reservoirs, where the old drinking water intake was once located. The mainstem makes a 90° bend to the west at RM 63.63, its confluence with The Outlet (38.5 mi^2 drainage area), and continues to flow west for 5 more miles into the City of Findlay where it enters the Eagle Creek WAU (-030). It is just downstream of The Outlet where the drainage area of the Blanchard River mainstem becomes >200 mi^2, which is the criteria defining a small river (vs. a wadeable stream), and different nutrient targets begin to apply. The second mainstem impoundment is at RM 62.40, on the north side of the Findlay reservoirs, where the main water intake for the City of Findlay is located. Several small tributaries drain developing areas from the north, east of Findlay, to the mainstem. The next in the series of mainstem impoundments through the Findlay area, known as the Riverside Dam, is in Riverside Park at RM 58.77, which the City of Findlay maintains for their backup water intake. Lye Creek (28.6 mi^2 drainage area) enters the Blanchard River from the south in the City of Findlay at RM 58.38 just before the mainstem enters into the Eagle Creek WAU (-030). The three sites sampled on the mainstem in The Outlet/Lye Creek WAU were at SR 37 (RM 75.57), at Jackson TR 166 (RM 71.85), and at Pumphouse #2 - Findlay water intake (RM 62.40).

Analysis of the physical habitat of the Blanchard River within the assessment unit confirmed the appropriateness of the WWH. QHEI scores of three sampled locations within this reach of the mainstem, extending from downstream from Potato Run to upstream from Eagle Creek, ranged from 51.0 to 62.5. An increase in the number of positive WWH attributes coincided with increasing drainage area and likely reflected a partial attenuation of the impact from agricultural related habitat modification and nutrient enrichment in the headwaters of the Blanchard River. Efforts directed at improving instream habitat, such as providing additional cover and limiting entrainment of sediment, may help to further offset the effects of nutrient enrichment within this reach of the mainstem.

Buckrun Creek is a tributary of the Blanchard River confluent at RM 69.84 that is 7.5 miles long and drains an area of about 10 mi^2. It has been channelized and is being maintained by the Hancock Co. Engineer. Stream habitat was limited with a predominance of fine grained sediments and a modified channel bordered with maintained grass-lined banks. Buckrun Creek was a previously undesignated and unassessed stream. Ohio law stipulates that the WWH use be applied to unassessed waterways; however, the 2005 sampling effort demonstrated that a less stringent use was more appropriate. The 2005 investigation of biological condition and habitat attributes of the stream was consistent with a MWH use. The recommendation of the MWH use should not be considered a downgrading of aquatic life use; rather, the 2005 survey was the first systematic ambient assessment of appropriate expectations.

All of the remaining tributaries were designated WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. However, none of these streams had been evaluated using biological and habitat data prior to the 2005 survey. Analysis of habitat features and biological performance provided ample evidence that the WWH use was not a realistic expectation for these streams. A modified warmwater habitat (MWH) use more accurately reflects an achievable expectation of biological performance given the altered condition of the streams. The MWH use recommendation should not be considered a downgrading of aquatic life use. Rather, the 2005 survey accomplished the first systematic ambient assessment of the appropriate use.

Brights Ditch is tributary to the Blanchard River at RM 65.85, near the southeast corner of Findlay Reservoir. It is only 6.2 miles long, but has several tributaries, including Stahl Ditch, so it drains a total area of about 28.6 mi^2. As the names imply, both Brights Ditch and Stahl Ditch have been channelized and are being maintained by the Hancock Co. Engineer. At RM 7.3, Stahl Ditch was nearly dry; but downstream, the stream acquired significant ground water and had good flow at RM 4.4. A QHEI score of 39.5 was recorded at RM 4.4 on Stahl Ditch and modified habitat attributes exceeding typical warmwater features by a ratio of 6:3. Overall, Brights Ditch offered limited habitat for the development of typical fish and macroinvertebrate communities. The upper two sites (RMs 3.8 and 2.4) had no discernable flow with emergent aquatic vegetation filling much of the waterway. A significant ground water contribution (via Stahl Ditch) provided increased flow near the confluence with the mainstem (RM 0.3) but the stream was channelized for its entire length. Based on the condition of the two streams and limited potential for significant habitat improvement, a MWH use is recommended for Brights Ditch and Stahl Ditch.

The Outlet (lower) is a tributary to the Blanchard River that originates just north of Carey and is confluent at RM 63.63. It is about 11 miles long and has a drainage area of about 38.5 mi^2. The watershed drains an area of peat soil which was unique for the study area. Some of its tributaries are channelized and maintained by the Hancock Co. Engineer, and although it appears to have been channelized in the past, The Outlet (lower) is not currently being maintained. The stream functions primarily as a mechanism to facilitate agricultural drainage of adjacent peat soils. QHEI scores of three sites at RM 7.7, 6.1 and 4.5 ranged between 17.5 and 41.5 and modified habitat attributes greatly outnumbered typical warmwater features at each site. The limiting effect of modified habitat was somewhat ameliorated by a high base flow with relatively good water quality. Consequently, the macroinvertebrate community was in relatively good condition and the diversity of fish species resulted in IBI scores that met WWH expectations. However, a MIwb score at RM 4.5 in the poor range reflected an imbalanced fish community resulting from the monotonous habitat. Consequently, based on the condition of the stream and limited potential for significant habitat improvement, a MWH use is recommended for The Outlet.

Lye Creek is tributary to the Blanchard River at RM 58.38, the very downstream edge of The Outlet/Lye Creek WAU (-020). Lye Creek, and its tributary, Silver Creek, are within the ECBP ecoregion and are designated WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. The stream also had not been evaluated using biological and habitat data prior to the 2005 survey. Limited recovery from past channelization had occurred at RMs 9.4 and 6.7. Nearer to the mouth, the stream was extensively modified. A QHEI score of 39.5 was recorded at RM 2.6 and modified habitat attributes exceeded typical warmwater features by a ratio of 8:3. It is unlikely that significant additional improvement in the habitat will occur given the need to maintain drainage and the low gradient nature of Lye Creek. The physical condition of the stream limited biological performance and negated the WWH use. Therefore, a modified warmwater habitat use is recommended.

Aquatic Life Use Attainment Status

Attainment status was determined for eight sites in the Outlet/Lye Creek WAU, representing approximately 33 assessed stream miles in the watershed. Limited sampling of an additional eight sites allowed for a determination of aquatic life use designation but credible data requirements negated a complete evaluation of attainment status. Four sites representing eighteen assessed stream miles, fully met the current or recommended aquatic life use. Three sites, representative of eleven assessed miles, partially met and one site, totaling four assessed stream miles, was in non-attainment of the current or recommended aquatic life use.

Biological communities in the Outlet/Lye Creek WAU were impacted primarily by factors related to agricultural practices in the watershed. Elevated nutrients, and impacts associated with dissolved oxygen/organic enrichment were identified as causative factors for 100%, and 53%, respectively, of the impaired miles. Hydromodification, principally channelization, affected 47% of the impaired stream miles. Instream habitat and natural flow regimes were altered as a result. Often riparian vegetation was limited to grasses and low growing brush. The combination of exposure to sunlight and elevated nutrients promoted excessive primary productivity.

Three headwater sites (<20 mi^2 drainage area) received both fish and macroinvertebrate sampling. All three met the recommended MWH aquatic life use. Just one of six additional headwater sites where qualitative macroinvertebrate sampling only was conducted produced assemblages that were consistent with a MWH use. Overall the sampling results were typical for headwater sized streams throughout the entire Blanchard River watershed, in that impacts were evident principally as a result of agricultural practices in the watershed.

Five wadable streams sites with drainage areas in excess of 20 mi^2 in the Outlet/Lye Creek WAU also demonstrated impacts to significant portions of the assessed miles. Only one location (Blanchard River at RM 71.9) supported both fish and macroinvertebrate communities that met ecoregional expectations. Two additional sites supported good to very good macroinvertebrate communities but lacked fish sampling results needed to provide a complete evaluation of aquatic life use status.

The community condition of fish and macroinvertebrates in the mainstem reach of the Blanchard River in the Outlet/Lye Creek WAU (04100008-020) was reflective of the interaction between nutrient levels and the assimilative capacity of the stream. The macroinvertebrate community condition was rated very good to exceptional at the three sampled locations (RMs 75.8, 71.9 and 61.7). Each site supported a good diversity of mayfly and caddisfly taxa. IBI scores were reflective of a fish community that structurally, at least, marginally met with ecoregional expectations even though pollution sensitive species were not well represented. However, MIwb scores, which are reflective of the relative proportionality of species within the fish community, were more variable. MIwb ecoregional expectations were not met at RMs 75.6 and 61.9. This imbalance was due largely to a predominance of pollution tolerant bluntnose minnows (*Pimephales notatus*). Their occurrence was an indicator of an abundant food source in the form of suspended organic matter and phytoplankton. Agriculture related nutrient enrichment was frequently encountered in water quality sampling within this reach of the mainstem. Additionally, elevated water temperatures were a concern at RM 61.9.

The depression expressed in the MIwb scores at RMs 75.6 and 61.9 corresponded with elevated nutrients documented in the chemical sampling results. The site at RM 75.6 was in partial attainment of ecoregional expectations, due to the nutrient load from the upper watershed. The mainstem then meanders through rural areas and woodlands for about 10 miles with only one significant but small tributary, Buckrun Creek (drainage area less than 10 mi^2), before receiving any other inputs. Relatively good quality habitat and flow conditions in this stretch of the mainstem help to assimilate the nutrient load so that the biological criteria were in full attainment at RM 71.9. Additional nutrients are contributed in flow from Brights Ditch and The Outlet upstream from RM 61.9. Flow altering impoundments are located downstream of each of these tributaries. Consequently, the segment of the mainstem that includes the site at RM 61.9 was again reduced to partial attainment.

Requisite credible data collection requirements were lacking to complete an evaluation of the status of the aquatic life use of Buckrun Creek but, qualitative macroinvertebrate sampling marginally met expectations of the recommended MWH use. Macroinvertebrate community condition rated a high fair evaluation. Ten EPT taxa were recorded but only four sensitive taxa were collected. The sampled reach was primarily pooled and predominated by the pollution tolerant snail, *Helisoma anceps*. The cumulative effects of agricultural related instream and riparian habitat alteration and a commensurate limited capacity to assimilate nutrients were the most immediate causes of impact to Buckrun Creek. Additional impacts were also likely due to elevated stream temperatures and wide swings in dissolved oxygen concentration given the physical nature of the stream.

Qualitative macroinvertebrate sampling of Stahl Ditch at RM 7.3 produced a largely pollution tolerant community. Only 21 taxa were collected including just one sensitive taxon. The sampling results reflected an enriched water quality condition and proclivity for wide variation in dissolved oxygen concentration. Phosphorus concentrations were elevated. Possible sources included fertilizer and/or manure application applied to surrounding agricultural fields and improperly functioning onsite septic systems. The poor macroinvertebrate community at RM 7.3 was a less than goal result; however, status in the upper reaches of the stream was not fully assessed due to incomplete data quality requirements. The macroinvertebrate community was improved at RM 4.4 compared to RM 7.3 owing to the contribution of ground water to the steam flow. Fifty taxa were collected including 9 sensitive taxa. Fish sampling at RM 4.4 yielded an IBI score of 34, which is in the fair range. Taken together, biological sampling results were consistent with the recommended MWH use at RM 4.4.

Requisite credible data requirements were not met for the sampled sites on Brights Ditch so a complete evaluation of aquatic life status was not done. However, macroinvertebrate sampling results were illustrative of the effects of a limited habitat. Macroinvertebrate sampling was conducted at three locations. The macroinvertebrate condition at RMs 3.8 and 2.4 was poor; well below minimum expectations of the proposed MWH aquatic life use, but was much improved at RM 0.3, rating a good narrative evaluation. Pollution tolerant organisms predominated in the headwaters and no sensitive macroinvertebrate taxa were collected at either of the two upstream sites versus twelve that were identified at RM 0.3. The significant improvement in community condition noted near the mouth reflected an improved habitat. Beneficial habitat attributes at RM 0.3 included ground water contributed flow and large sized substrates. In addition to the habitat related limitations, agricultural practices in the watershed also contributed to elevated nutrients and low dissolved oxygen concentrations recorded in water chemistry results during the 2005 sampling period.

Flow contributed by ground water in The Outlet (lower) produced a volume that was significantly higher than similarly sized ECBP streams and supported fish assemblages more typical of a much larger stream. The net result was that no typical headwater fish species were recorded at either of the headwater sized sites (RM s 7.7 and 6.1). The diversity of fish taxa at RMs 7.7, 6.1 and 4.5 produced IBI scores that attained WWH expectations. Still, the effects of the monotonous habitat (QHEI= 39.0) at RM 4.5 were manifest in a fish assemblage predominated by pollution tolerant creek chubs and yielded a MIwb score in the poor range (MIwb = 5.7). The macroinvertebrate sampling results met or exceeded expectations of the recommended MWH use. The collected assemblages reflected marginally attaining to nearly exceptional conditions. In modified watercourses, significant variability in the macroinvertebrate condition is relatively common given microhabitat differences between the various sites as long as the chemical water quality is acceptable. Overall, the water quality in The Outlet was fairly good except for extremely high levels of nitrate-nitrite.

Sampling of Lye Creek at RMs 9.4 and 6.7 was for macroinvertebrates only. Despite relatively good substrates at the sites, neither was supporting macroinvertebrate communities that were consistent with the recommended MWH use. High phosphorus levels attributed to the unsewered community of Houcktown and runoff from adjacent agricultural fields contributed a significant nutrient load to this reach of Lye Creek. Limited overhead canopy combined in combination with elevated nutrients produced an enriched water quality condition with wide swings in dissolved oxygen concentration and elevated daytime heating. As a result, pollution tolerant taxa comprised a large portion of the total taxa collected. An ICI score of 20 verified that macroinvertebrate community condition was no better at RM 2.6. Pollution tolerant oligochaetes accounted for nearly 80% of the organisms collected from the artificial substrates and the result of natural substrate sampling was similar to the previous sites. IBI and MIwb scores met expectations for a MWH use at RM 2.6 but the fish community also reflected significant enrichment in the predominance of bluntnose minnows (*Pimephales notatus*) among the 25 taxa collected. In all, pollution tolerant fish comprised 73% of the total catch. The net result of sampling at RM 2.6 was partial attainment of the recommended MWH aquatic life use. Attainment status of the upstream sites could not be fully evaluated due to the lack of fish sampling results; nevertheless, significant impacts related to agricultural practices and the unsewered community of Houcktown were evident.

Water Quality

Although the Blanchard River site at SR 37 is geographically located in The Outlet/Lye Creek WAU (-020), it is a reference site that was selected to model the water quality of the Blanchard River Headwaters WAU (-010). This first segment of the mainstem in The Outlet/Lye Creek WAU was in partial attainment, with high levels of nutrients, reflecting conditions from the Headwaters WAU. Nitrate-nitrite exceeded the target level in 7 of 12 grab samples and total phosphorus exceeded the target in 9 of 12 grabs, with both medians also above the target levels. The mainstem then meanders through more remote rural areas and woodlands for about 10 miles with only one tributary, Buckrun Creek (drainage area less than 10 mi^2), before receiving any other inputs. Some fairly good quality habitat and flow conditions in this stretch of the mainstem help to assimilate the nutrient load from upstream enabling this segment to reach full attainment. However, both Brights Ditch and The Outlet contribute high loads of nitrate-nitrite to the mainstem, and flow altering impoundments are located downstream of each of these tributaries. It is also just downstream of the confluence with The Outlet that the drainage area of the Blanchard River becomes >200 mi^2 (small river vs. wadeable stream). This is the point where the target values used for phosphorus and nitrate increase from 0.10 to 0.17 mg/l and from 1.0 to 1.5 mg/l, respectively. Despite the increased flow and the higher targets, nitrate-nitrite in this segment, which includes the Findlay water intake at RM 62.40, still exceeded the target level in 5 of 6 grab samples, and correspondingly, this segment of the mainstem has again been reduced to partial attainment. Figure 2b shows these changes in the levels of nitrate-nitrite in the

Blanchard River mainstem from upstream to downstream in The Outlet/Lye Creek WAU (-020). Strontium was also above the OMZA at RM 62.40 in 5 of 6 grab samples. Because this segment of the mainstem within 500 yds of the Findlay water intake is also designated as Public Water Supply, human health criteria for drinking water apply here. The human health criteria for manganese in drinking water was exceeded in 6 of 6 grab samples collected here. Other samples collected at the drinking water intake were analyzed for pesticides. Table 2f lists the compounds that were detected in the samples, indicating an impact from agriculture. No insecticides were detected, but several herbicides were detected.

Results from the multi-parameter automatic meters in 2006 indicate that the combination of impoundments, increasing development upstream, and urban landuse within the City of Findlay may be causing the violations of temperature and dissolved oxygen measured in the Blanchard River mainstem from upstream of Findlay (in this WAU -020) to downstream of Findlay (in the Eagle Creek WAU -030). Figures 2c and 2d show the statistical distribution of temperature and dissolved oxygen measurements, respectively, at each site in the mainstem through both WAUs, taken over a 24 hour period using the automatic meters. All of the meters were set about a foot off the bottom, so these measurements were taken down in the water column and not at the surface.

Figure 2d shows how the impounded flow affected temperatures, with mean temperatures exceeding the average temperature criterion at nearly every site, except for the very deepest sites upstream of the dams, and one affected by the WWTP discharge. At sites in the more urbanized area of Findlay (where there was little or no riparian habitat, thus no shading from trees and more urban runoff) and at sites downstream, temperatures increased and there were violations of the maximum temperature criterion as well.

The effects of the impoundments on dissolved oxygen (DO) are evident in the steep drop in DO levels in the most pooled areas of the river upstream of the 2 Findlay dams (Figure 2e). The minimum DO criterion was violated for the full 24 hours at the site just upstream of each of the Riverside and the Liberty St. Dams. At the Riverside Dam, the next upstream site also violated both minimum and 24 hr. average DO criteria for most of the measurement period.

The dam at RM 62.40, which is used by Findlay's Drinking Water Reservoir, does not appear to be having as severe an impact on the water quality of the Blanchard River as the dams within the City of Findlay. The Riverside Dam (WAU -020) and the Liberty St. Dam (WAU -030) are located in developed areas where there is little to no riparian zone. The dams create essentially large ponds where flow stagnates, water is exposed to excessive daytime heating, and nutrients from upstream sources promote algal growth in the impounded reach. Add to this the runoff from heated asphalt and concrete surfaces in the surrounding urban area and temperatures soar while dissolved oxygen levels plummet in these stagnant, ponded impoundments, affecting both the surface water behind the dam and the mainstem flow immediately downstream. The results of the diurnal oxygen and temperature measurements conducted in 2006 delineated an even greater impact associated with the Riverside Dam impoundment, because sediment has filled in much of the volume behind the dam, making the stagnant pooled segment of the river upstream of this dam shallow as well.

Nutrient enrichment was the most common type of water quality degradation, primarily due to agricultural practices in the watershed and untreated or poorly treated sewage, and mostly being carried to the mainstem by the tributaries. Low dissolved oxygen and high nitrate-nitrite are the primary impacts to Brights Ditch. Low dissolved oxygen was a problem at the upstream site on Stahl Ditch, but high phosphorus was the cause of nutrient enrichment there. Strontium levels were above the OMZA in both Brights Ditch and Stahl Ditch, reflecting the contribution of ground water flow, and mercury was detected above the OMZA for the protection of human health in “non-drinking” water in 1 grab at each site on Stahl Ditch (Table 2b). Overall, the water quality in The Outlet was fairly good except for extremely high nitrate-nitrite (Figure 2c). The unsewered Village of Houcktown discharges untreated sewage to Lye Creek near Hancock CR 26 (RM 9.44-9.45). Lye Creek is impaired here by high fecal coliform counts, high ammonia levels, phosphorus levels above target, and fluctuating and often supersaturated dissolved oxygen levels. The phosphorus levels remained elevated nearly 7 miles downstream, but by RM 2.63, had declined enough for the median to drop below target.

Data obtained from grab samples was summarized for phosphorus in Figure 2f and nitrate-nitrite in Figure 2g to compare sites with similar drainage areas and identify where problems exist. Phosphorus levels were well below target in most of the tributaries in this WAU (-020). The exceptions were the most upstream site in Stahl Ditch at TR 199 (RM 7.27), where all 6 samples and the median were well above the phosphorus target, and Lye Creek, where high phosphorus levels can be attributed to discharges from the unsewered village of Houcktown and persist downstream. In Stahl Ditch, the high phosphorus levels at TR 199, along with lower dissolved oxygen, higher fecal coliform and some higher ammonia results, indicate that runoff from fertilizers and manure application is a possible source, or water quality at the sample location may have been locally affected by the discharge of failed septic systems nearby. More investigation is needed to positively identify the source. Phosphorus levels at all sites on Stahl Ditch and Brights Ditch downstream of TR 199 (Stahl Ditch RM 7.27) are below target. In Lye Creek, phosphorus levels downstream of Houcktown decreased but never fully recovered, although, by RM 2.63 (nearly 7 miles downstream from Houcktown), the median phosphorus level eventually dropped to below target. Nitrate-nitrite levels were also highest in the vicinity of the Houcktown discharges, but nitrate-nitrite medians in Lye Creek were always below target. However, nitrate-nitrite levels in

Brights Ditch and the Outlet were quite high at nearly all the sites. There is a small lagoon WWTP with a controlled discharge and a package plant discharge in the headwaters of Brights Ditch, but for the most part the only other surrounding land use on these streams is rural and cropland.

Recreation

An overall determination of the recreation use status was made for the entire WAU. Fecal coliform was used as the test organism because its presence indicates that water has been contaminated by feces from warm blooded animals. If bacteria levels are high enough (colony forming units or CFU/100 ml) there is a chance for people who come in contact with the water to become ill. Data used in the analysis includes samples collected during the May 1-October 15 recreation season obtained from both the 2005 stream survey and monthly operating reports filed by the Vanlue WWTP. Valid results are pooled for statistical analysis and the recreation use is considered impaired if the 75th percentile exceeds 1,000 or the 90th percentile exceeds 2,000. The 75th percentile was only 542, but the recreation use is considered impaired based on these guidelines because the 90th percentile was 4,110.

A site specific evaluation of the Primary Contact Recreation (PCR) use was done for the Blanchard River mainstem because it is used for fishing and hunting. To determine if a site meets Ohio WQS criteria, a minimum of 5 samples must be collected within any 30 day period during the May 1-October 15 recreation season. The geometric mean calculated from this set of data should not exceed 1,000 and not more than 10% of the individual results should exceed 2,000. Results for testing done at 3 sites from June 27-July 25 are summarized in Table 2g. None of the sites violated the geometric mean and there was only one violation of the site specific maximum.

Sediment Quality

Sediment samples were tested for particle size distribution, organic carbon content, % solids, metals, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and organochlorine insecticides. Chemical concentrations are evaluated based on Ohio reference values (Ohio EPA, 2003) and consensus based toxicity guidelines (MacDonald et al, 2000). Ohio reference values are based on an ecoregion reference site approach and considered background concentrations for streams. The MacDonald guidelines consider concentrations below a threshold effect concentration (TEC) to be absent of toxicity and those above a probable effect concentration (PEC) to be toxic to benthic organisms.

Particle size progressed from upstream to downstream going from mostly silt and no sand at SR 37 to about 43% sand and 34% silt at TR 166, then finally to 73% sand and only 19% silt at the Pumphouse #2 site. There were no PAHs, PCBs or insecticides detected in any of the samples. A summary of metal concentrations in sediment is presented in Table 2h. A few of the concentrations were slightly above Ohio reference values for the ECBP ecoregion, but none were elevated enough to be a concern. Some were also slightly above their respective TEC, but none were near the PEC. No aquatic life impact is expected based on the results.

Pollutant Loadings

Vanlue WWTP (permit # 2PA00016) is located at TR 197, Vanlue and serves a population of about 400. The 3 cell controlled discharge lagoon system was constructed in 1978 with a design flow of 0.070 MGD and a hydraulic capacity of 0.118 MGD. The plant usually discharges to Brights Ditch (RM 3.87) for 3-5 one month periods between October and June. In 2005, Vanlue WWTP discharged during the months of January and March. There was no discharge from the WWTP during the survey period.

Heritage Springs Campgrounds (permit # 2PR00182) is located at 13891 TR 199, Vanlue and has an extended aeration package plant with sand filter and disinfection (chlorination and dechlorination). It discharges up to 12,500 gpd via a field tile to a headwater tributary of Brights Ditch seasonally from the last weekend in April to the last weekend in October.

Public Lakes and Reservoirs

The monitoring and assessment of “lakes”, including natural lakes and man made impounded or upground reservoirs, is an important compliment to the study of stream ecosystems. Lakes act as watershed sinks for the upstream loading of nutrients, sediment, and pesticides. Thus, their assessment may be the best indicator of the combined effects that both point and nonpoint pollution sources have on surface water quality. Lakes serve as the primary drinking water and recreation source for millions of citizens in Ohio.

The City of Findlay has two upground reservoirs that were built to provide drinking water. Both are constructed of earthen dikes approximately 12 ft. wide at the top with 2:1 side slopes. The insides of the dikes are covered with limestone riprap to protect them from wind and wave erosion. Reservoir #1 was completed in 1950 and has a surface area of 186 acres. Reservoir #2 was completed in 1970 and has a surface area of 650 acres. They share a common dike and are connected by a system of pipes. Both reservoirs are open to public fishing, but swimming is not allowed. Gasoline outboard motors with a maximum of 9.9 hp are permitted on Reservoir #2 and electric motors only are permitted on Reservoir #1. Fish management activities include routine stocking, population monitoring, and angler harvest studies.

The Blanchard River serves as source water for the reservoirs through an intake located at river mile 62.40 (pump house #2). Water is pumped from the Blanchard River into Reservoir #2 and flows by gravity into Reservoir #1. It is then pumped from Reservoir #1 to the water treatment plant. If necessary, it is also possible to pump water from Reservoir #2 to the treatment plant. An intake located at river mile 65.18 (pump house #1) was used before Reservoir #2 was built, but it is no longer in service. The flow augmentation line is located here and water can be pumped from the reservoirs into the river either during low flow periods or when water levels in the reservoirs are too high. A back-up intake for the water treatment plant is located in the Blanchard River at river mile 58.80 (Riverside Park), but this line goes directly to the plant.

Findlay Reservoir #2 was assessed by the Ohio EPA during the 2005 field season and all work was done from the deepest part of the lake within the conservation pool. During each of three sampling events a temperature, dissolved oxygen, pH, and conductivity profile was recorded at 1 meter intervals and the secchi transparency depth was measured. Samples for lab analysis were collected from the water column at ½ meter below the surface and ½ meter above the bottom. Additional samples were collected to determine chlorophyll a concentration and a vertical tow net was used to collect phytoplankton and zooplankton specimens. A sediment sample was also collected during one of the sampling events.

A variety of parameters were tested in the water column samples, including physical attributes, oxygen demand, nutrients, metals, and pesticides. Results were compared to applicable Ohio Water Quality Standards and Drinking Water Standards. Statewide Water Quality Criteria (3745-1-07) are established for the protection of aquatic life and Lake Erie Basin Criteria (3745-1-33) are established for the protection of human health and wildlife. Primary Drinking Water Standards (OAC 3745-81) are set for pollutants with serious human health implications and are usually expressed as maximum contaminant levels (MCLs). Some of these pollutants include metals, nitrate, pesticides, and organic disinfection byproducts. Secondary Contaminant Standards (OAC 3745-82) are set for pollutants associated with aesthetic constituents like taste, odor, and color. Some of these pollutants include sulfates, iron, and manganese.

Water quality in Findlay Reservoir #2 was good based on results from the three sampling events. A thermocline never developed during the summer, indicating that wind and wave action keep the water column mixed. Dissolved oxygen levels at bottom depths in the summer fell below the statewide average criteria for warmwater habitat streams of 5.0 mg/L, but never fell below the minimum criteria of 4.0 mg/L. Nutrients are a concern in lakes because excessive levels trigger nuisance algae blooms. Nutrient criteria for lakes in Ohio are currently under development, but federal criteria based on regional reference sites are available in the interim (U.S. EPA, 2000). Criteria for lakes in aggregate ecoregion VI include; total phosphorus- 37.5 µg/L, total nitrogen- 0.78 mg/L, chlorophyll a- 8.59 µg/L, and secchi depth- 1.356 meters. Results showed that nutrient levels exceeded criteria in the spring and this ultimately led to algae blooms in the summer as water temperatures warmed. Summer chlorophyll a concentrations increased from 9.11 µg/L in August to 48.35 µg/L in September and secchi depth decreased from 2.60 m to 0.75 m, respectively. Reducing nutrients contained in spring runoff from the upper watershed would be of great benefit to water quality in the reservoir by eliminating these late summer algae blooms. Levels of secondary contaminants like iron and manganese were above drinking water standards at times, but these values were usually at bottom depths near the sediment interface.

The trophic state index (Carlson, 1977) is a means of classifying lakes by predicting algal biomass. The index can be calculated using either secchi depth, chlorophyll a, or phosphorus measurements. The table below summarizes trophic state index (TSI) values calculated for Findlay Reservoir #2 in 2005. Since the parameters in the calculations are used to predict algal biomass, chlorophyll a is the best predictor. When secchi depth over predicts biomass water transparency is probably affected by small particles suspended in the water column such as silt and clay. When phosphorus concentration under predicts biomass it is likely the limiting growth nutrient.

Date	TSI chlorophyll a	TSI secchi depth	TSI phosphorus
May 25	41	51	58
August 6	52	46	27
September 21	69	64	27

Lakes with values ≤ 37 are considered oligotrophic, 38-47 mesotrophic, 48-66 eutrophic, and ≥ 67 hypereutrophic. This information is useful for managers because lakes that fall within a particular trophic state exhibit certain characteristics. For example, at TSI values <30 the water is very clear, the hypolimnion has oxygen throughout the year, and Salmonid fisheries dominate. However, at TSI values > 60 the water is turbid, the hypolimnion becomes anoxic, blue greens dominate the algal community causing taste and odor problems, and warmwater fisheries (i.e. bass) dominate. A reliable method for determining the final TSI of a lake is to average summer chlorophyll a and spring phosphorus values. Using this formula places Findlay Reservoir #2 in a eutrophic state with a final TSI of 60.

Sediment is an important parameter to evaluate in lakes because it has an impact on storage capacity, recreation, and aquatic life. Loss of water storage capacity due to sedimentation can reduce the useful life of a lake and make costly dredging necessary. Generally, a volume loss > 40% is considered excessive. Field results published in the

Impact of Nonpoint Pollution On Lakes In Ohio (U.S. Soil Conservation Service, 1990) indicate that Findlay Reservoir #2 has exhibited a 0% volume loss since it was constructed. A sediment sample was collected by dredge on Sept. 21, 2005 to test for physical attributes and chemical quality. The sample was found to consist of 33% solids and 2.8% organic carbon and particle size was distributed as 38.6% medium/coarse silt, 28.6% fine/very fine silt, 17.6% medium/coarse clay, and 15.2% fine clay. Chemical quality of sediment is important if dermal contact occurs during recreation because certain chemicals, such as Polynuclear Aromatic Hydrocarbons (PAHs), can cause skin cancer. No organic compounds of any kind were detected in the sample, so this issue should not be a problem. Sediment chemistry can also affect both water quality and the function of aquatic life communities. Nutrients released into the water column can stimulate algae blooms, while some compounds are toxic to aquatic life and bioaccumulate in the food chain. Consensus based sediment toxicity guidelines (MacDonald et al, 2000) identify two benchmarks that can be used to predict responses from benthic organisms. Levels below the threshold effect concentration (TEC) are considered absent of toxicity and those above the probable effect concentration (PEC) are likely toxic. Concentrations of chromium, copper, zinc, and arsenic were above their respective TEC values, but all were well below the PEC.

Table 2a Aquatic life use attainment status for stations sampled in the Outlet/Lye Creek WAU assessment unit based on data collected July-September, 2005. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
Blanchard River			*WWH - ECBP Ecoregion*					
75.8/75.6	142	38[ns]	7.2*	VG	57.5	Partial	Organic enrichment, nutrients	Crop production
71.9/71.9	145	40	8.7	VG	51.0	Full		
61.7/61.9	238	36[ns]	7.2*	48	62.5	Partial	Organic enrichment, nutrients, thermal modification	Crop production
Buckrun Creek			*MWH recommended - ECBP Ecoregion*					
3.6/____	6.1			HF*			Direct habitat alteration, flow alteration, siltation	Ag related channelization, crop production
Stahl Ditch			*MWH recommended - ECBP Ecoregion*					
7.3/____	6.6			P*			Direct habitat alteration, flow alteration, siltation, nutrients, DO/ organic enrichment	Ag related channelization, crop production
4.4/4.4	12.4	34		MG[ns]	39.5	Full		
Brights Ditch			*MWH recommended - ECBP Ecoregion*					
3.8/____	5.7			P*			Direct habitat alteration, nutrients, DO/ organic enrichment	Ag related channelization, crop production
2.4/____	11.2			P*			Direct habitat alteration, nutrients, DO/ organic enrichment	Ag related channelization, crop production
0.3/____	28.4			G				
The Outlet (Blanchard R. RM 63.63)			*MWH recommended - ECBP Ecoregion*					
7.7/7.7	7	44		G	41.5	Full		
6.1/6.1	16.4	36		HF	17.5	Full		
4.5/4.5	24	42	5.7*	38	39.0	NON	Direct habitat alteration, nutrients	Ag related channelization, crop production
0.5/____	38			44				
Lye Creek			*MWH recommended - ECBP Ecoregion*					
9.4/____	7			P*			Direct habitat alteration, flow alteration thermal modification, nutrients, organic enrichment/DO	Ag related channelization, crop production, unsewrered community (Houcktown)
6.7/____	12.2			LF*			Direct habitat alteration, flow alteration thermal modification, nutrients, organic enrichment/DO	Crop production, unsewrered community (Houcktown)
2.6/2.6	26	32	6.4	20*	39.5	Partial	Direct habitat alteration, nutrients, organic enrichment/DO	Ag related channelization, crop production

Ecoregion Biocriteria: Eastern Corn Belt Plain

	IBI			*MIwb*			*ICI*		
Site Type	*WWH*	*EWH*	*MWH*	*WWH*	*EWH*	*MWH*	*WWH*	*EWH*	*MWH*
Headwaters	*40*	*50*	*24*				*36*	*46*	*22*
Wading	*40*	*50*	*24*	*8.3*	*9.4*	*4.0*	*36*	*46*	*22*
Boat	*42*	*48*	*24*	*8.5*	*9.6*	*4.0*	*36*	*46*	*22*

a- MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.
b- A narrative evaluation of the qualitative sample based on attributes such as community composition, EPT taxa richness, and number of sensitive taxa was used when quantitative data were not available or considered unreliable due to current velocities less than 0.3 fps flowing over the artificial substrates.
c- Attainment status based on a single organism group is parenthetically expressed.
d- Causes listed are considered to be a primary influence on water quality, but may not be the only issue leading to impairment. See text for discussion of additional causes that cumulatively have led to impairment.
e- Sources listed are considered to be a primary influence on water quality, but may not be the only source leading to impairment. See text for discussion of additional sources that cumulatively have led to impairment.
ns- Nonsignificant departure from biocriteria ($\leq$4 IBI or ICI units, or $\leq$0.5 MIwb units).
* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

Table 2b. Exceedences documented in The Outlet/Lye Creek WAU based on Ohio WQS criteria and nutrient target values. Criteria include outside mixing zone minimum or maximum (OMZM) and average (OMZA) values.

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Blanchard River WWH, PCR, AWS, IWS	75.57	WWH	dissolved oxygen	2 of 10 grabs below OMZA
			nitrate-nitrite	7 of 12 grabs and median above target
			phosphorus	9 of 12 grabs and median above target
			strontium	3 of 12 grabs above OMZA
	71.85	WWH	nitrate-nitrite	2 of 5 grabs above target
			phosphorus	2 of 5 grabs above target
			strontium	1 of 5 grabs above OMZA
		PCR	fecal coliform	violated site specific maximum
PWS	62.60	WWH	temperature	4 of 53 diurnals above OMZM*
				28 of 53 diurnals above OMZA*
	62.40	WWH	nitrate-nitrite	5 of 6 grabs and median above target
			strontium	5 of 6 grabs and median above OMZA
		PWS (HH)	manganese	6 of 6 grabs and median above maximum
			TDS	1 of 6 grabs above OMZA for drinking
	61.90	WWH	temperature	2 of 47 diurnals above OMZM*
				25 of 47 diurnals above OMZA*
	60.25	WWH	temperature	9 of 42 diurnals above OMZM*
				18 of 42 diurnals above OMZA*
	59.40	WWH	dissolved oxygen	31 of 46 diurnals below OMZA*
	59.00	WWH	dissolved oxygen	46 of 46 diurnals below OMZA*

*Data collected in 2006

Table 2b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Blanchard River WWH, PCR, AWS, IWS	58.30	WWH	dissolved oxygen	1 of 44 diurnals >140% saturation*
			temperature	13 of 44 diurnals above OMZM*
				31 of 44 diurnals above OMZA*
Buckrun Creek WWH, PCR, AWS, IWS	3.57	WWH	dissolved oxygen	2 of 6 grabs below OMZA
			nitrate-nitrite	1 of 6 grabs above target
			phosphorus	1 of 6 grabs above target
		PCR	fecal coliform	2 of 6 grabs above site specific maximum
Brights Ditch WWH, PCR, AWS, IWS	3.85	WWH	dissolved oxygen	2 of 5 grabs below OMZM
				1 of 5 grabs below OMZA
				1 of 5 grabs >140% saturation
			nitrate-nitrite	3 of 5 grabs and median above target
			strontium	5 of 5 grabs and median above OMZA
	2.41	WWH	dissolved oxygen	3 of 6 grabs below OMZM
				1 of 6 grabs below OMZA
			nitrate-nitrite	2 of 6 grabs above target
			strontium	6 of 6 grabs and median above OMZA
		PCR	fecal coliform	1 of 6 grabs above site specific maximum
	0.24	WWH	dissolved oxygen	1 of 6 grabs >140% saturation
			nitrate-nitrite	6 of 6 grabs and median above target
			strontium	6 of 6 grabs and median above OMZA
		PCR	fecal coliform	1 of 6 grabs above site specific maximum

*Data collected in 2006

Table 2b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Stahl Ditch WWH, PCR, AWS, IWS	7.27	WWH	dissolved oxygen	2 of 6 grabs below OMZM
				2 of 6 grabs below OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
			strontium	6 of 6 grabs and median above OMZA
		HH	mercury	1 of 6 grabs above OMZA for nondrinking
		PCR	fecal coliform	1 of 6 grabs above site specific maximum
	4.35	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			phosphorus	1 of 6 grabs above target
			nitrate-nitrite	1 of 6 grabs above target
			strontium	5 of 6 grabs and median above OMZA
		HH	mercury	1 of 6 grabs above OMZA for nondrinking
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	1 of 6 grabs above site specific maximum

Table 2b. Continued

The Outlet (lower) RM 63.63 WWH, PCR, AWS, IWS	7.68	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			nitrate-nitrite	6 of 6 grabs and median above target
		PCR	fecal coliform	1 of 6 grabs above site specific maximum
	6.05	WWH	phosphorus	1 of 6 grabs above target
			nitrate-nitrite	6 of 6 grabs and median above target
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	2 of 6 grabs above site specific maximum
	4.47	WWH	phosphorus	1 of 6 grabs above target
			nitrate-nitrite	6 of 6 grabs and median above target
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	1 of 6 grabs above site specific maximum
	0.51	WWH	phosphorus	2 of 6 grabs above target
			nitrate-nitrite	6 of 6 grabs and median above target
			strontium	1 of 6 grabs above OMZA
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	3 of 6 grabs above site specific maximum
Lye Creek WWH, PCR, AWS, IWS	9.45	WWH	dissolved oxygen	1 of 6 grabs >140% saturation
			phosphorus	4 of 6 grabs and median above target
			nitrate-nitrite	3 of 6 grabs above target
			strontium	4 of 6 grabs and median above OMZA
		PCR	fecal coliform	4 of 6 grabs above site specific maximum

Table 2b. Continued

Lye Creek WWH, PCR, AWS, IWS	9.44	WWH	ammonia	3 of 6 grabs above OMZA
			phosphorus	4 of 6 grabs and median above target
			nitrate-nitrite	2 of 6 grabs above target
		PCR	fecal coliform	6 of 6 grabs above site specific maximum
	6.66	WWH	phosphorus	3 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
			strontium	5 of 6 grabs and median above OMZA
		PCR	fecal coliform	2 of 6 grabs above site specific maximum
	2.63	WWH	dissolved oxygen	2 of 6 grabs >140% saturation
			phosphorus	2 of 6 grabs above target
			nitrate-nitrite	1 of 6 grabs above target
			strontium	3 of 6 grabs above OMZA
		PCR	fecal coliform	1 of 6 grabs above site specific maximum
Lye Creek WWH, PCR, AWS, IWS	0.50	WWH	dissolved oxygen	15 of 55 diurnals below OMZA*
				diurnal flux >5 mg/l*
			temperature	26 of 55 diurnals above OMZM*
				9 of 55 diurnals above OMZA*

*Data collected in 2006

Table 2c. Summary of hourly dissolved oxygen measurements (mg/L) recorded by automatic meters deployed in the Blanchard River. Highlighted values indicate a WQS violation.

River Mile	Hours	Mean	Median	Minimum	Maximum	Flux
Blanchard River						
75.57	48	5.55	5.57	5.15	6.02	0.87
71.85	48	5.68	5.69	5.37	5.95	0.58
62.60*	53*	6.87*	6.86*	6.35*	7.26*	0.91*
61.90	48	6.00	6.00	5.77	6.14	0.37
61.90*	47*	7.00*	6.50*	5.75*	9.36*	3.61*
60.25*	42*	6.20*	5.88*	4.50*	8.27*	3.77*
59.40*	46*	3.58*	3.50*	2.07*	5.26*	3.19*
59.00*	46*	2.73*	2.62*	1.73*	3.97*	2.24*
58.30*	44*	7.17*	6.86*	5.71*	10.44*	4.73*
Lye Creek						
0.50	55*	5.99*	6.40*	3.24*	9.02*	5.78*

*Data collected in 2006.

Table 2d. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Vanlue WWTP	2PA00016	Brights Ditch	3.87	0.070 MGD controlled discharge lagoon system
Heritage Springs Camp Grounds	2PR00182	Brights Ditch Trib		0.0125 MGD package plant

Table 2e. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Createc Corp	2GR00546	City of Findlay MS4 to Blanchard River	Industrial Storm water
Filtech Inc	2GR00503	City of Findlay MS4 to Blanchard River	Industrial Storm water
Findlex Corp	2GR00165	City of Findlay MS4 to Blanchard River	Industrial Storm water
Hilltop Energy Inc	2GR00095	Brights Ditch	Industrial Storm water
Hisan Inc	2GR00197	City of Findlay MS4 to Blanchard River	Industrial Storm water
Kuss Filtration	2GR00576	City of Findlay MS4 to Blanchard River	Industrial Storm water
Pieco Inc DBA Superior Trim	2GR00599	City of Findlay MS4 to Blanchard River	Industrial Storm water
United Parcel Service	2GG00225	Blanchard River Tributary	Industrial Storm water
Arcadia Point Development	2GC00404	Regional Retention Pond For Brookstone	Construction Storm water
Best Construction	2GC00375	Lye Ck	Construction Storm water
Best Construction	2GC00538	Lye Ck	Construction Storm water
Best Construction	2GC00914	Lye Ck	Construction Storm water
Birchaven Estates At Eastern Woods Ltd	2GC00638	Blanchard River	Construction Storm water

Build Covington Greens LLC	2GC00337	City of Findlay MS4 to Blanchard River	Construction Storm water

Table 2e. Continued.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
CCA Inc	2GC00911	Blanchard River	Construction Storm water
Darden Restaurant	2GC00327	Blanchard River Tributary	Construction Storm water
Findlay One LLC	2GC00592	Retention Pond	Construction Storm water
First Federal	2GC00041	City of Findlay MS4 to Blanchard River	Construction Storm water
FMT Inc	2GC00087	Blanchard River	Construction Storm water
Hancock County Engineers Office	2GC00853	Lye Creek, Blanchard River	Construction Storm water
Kohl's Dept Stores Inc	2GC00417	Blanchard River Tributary	Construction Storm water
ODOT District 1	2GC00255	Blanchard River	Construction Storm water
Owens Community College	2GC00245	County Storm Sewer	Construction Storm water
Patriot Ctr LLC Co/ Rudolph Libbe Properties	2GC00535	City Of Findlay Storm Sewer	Construction Storm water
Paul Ballinger	2GC01086	Blanchard River	Construction Storm water
Petti Construction	2GC00544	Blanchard River	Construction Storm water
Timberstone Construction Inc	2GC00323	Blanchard River Tributary	Construction Storm water
Timberstone Construction Inc	2GC00392	Blanchard River Tributary	Construction Storm water
Weinko Inc	2GC00882	Blanchard River Tributary	Construction Storm water
Weinko Inc	2GC00883	Blanchard River Tributary	Construction Storm water
Winkoe	2GC00260	Ditch	Construction Storm water

Table 2f. Summary of herbicides (µg/L) detected in the Blanchard River at the Findlay WTP Pumphouse #2 (RM 62.40). Values reported as less than were below the quantitation limit.

Compound (Trade Name)	6/13/05	6/27/05	7/11/05	7/25/05	8/08/05	8/22/05
Acetochlor (Harness)	<0.23[UJ]	<0.21[UJ]	0.82	0.46[J]	<0.22[UJ]	<0.21
Atrazine (AAtrex)	<0.23[UJ]	<0.21[UJ]	4.33	1.07[J]	0.43[J]	0.35
Metolachlor (Dual)	0.36[J]	<0.21[UJ]	0.76	1.01[J]	0.33[J]	0.26
Simazine (Princep)	<0.23[UJ]	<0.21[UJ]	0.44	0.22[J]	<0.22[UJ]	<0.21

[J] The compound was positively identified, but the associated value is estimated.
[UJ] The compound was not detected above the quantitation limit and the quantitation limit is estimated.

Table 2g. Site specific recreation use assessment in the Blanchard River. Highlighted values indicate an Ohio WQS criteria violation.

Sampling Location	River Mile	Fecal Coliform Count (CFU/100 ml)					
		6/27/05	7/6/05	7/11/05	7/20/05	7/25/05	Geometric Mean
SR 37	75.57	390	270	210	1600	790	489
TR 166	71.85	290	210	270	2500	370	433
Findlay WTP Pumphouse #2	62.40	330	1900	650	1600	470	789

Table 2h. Metal concentrations (mg/kg) in sediment collected from the Blanchard River. Highlighted values were above either the statewide (*) or ECBP ecoregion sediment reference value (SRV). Values reported as less than were below the quantitation limit.

Element	Sampling Location and river mile			
	SRV	SR 37 (75.57)	TR 166 (71.85)	Pumphouse #2 (62.40)
Aluminum	39.000	29.900	37.700	18.200
Barium	240	164	207	108
Calcium	120.000	22.500	13.100	15.600
Chromium	40	35	41	22
Copper	34	22.8	23.3	12.6
Iron	33.000	25.400	29.400	17.100
Lead	47 *	<31	<33	<22
Magnesium	35.000	9.670	8.300	6.460
Manganese	780	348	740	318
Nickel	42	<31	36	<22
Potassium	11.000	8.110	10.400	4.440
Sodium	-	<3.900	<4.080	<2.730
Strontium	390	305	258	418
Zinc	160	109	116	70.6
Mercury	0.12 *	<0.043	<0.052	<0.030
Arsenic	18	10.7	12.8	6.95
Cadmium	0.90	0.544	0.529	0.332
Selenium	2.3	<1.56	1.71	<1.09
Solids (%)	-	45.8%	44.5%	59.0%
TOC (%)	-	3.9%	3.4%	3.2%

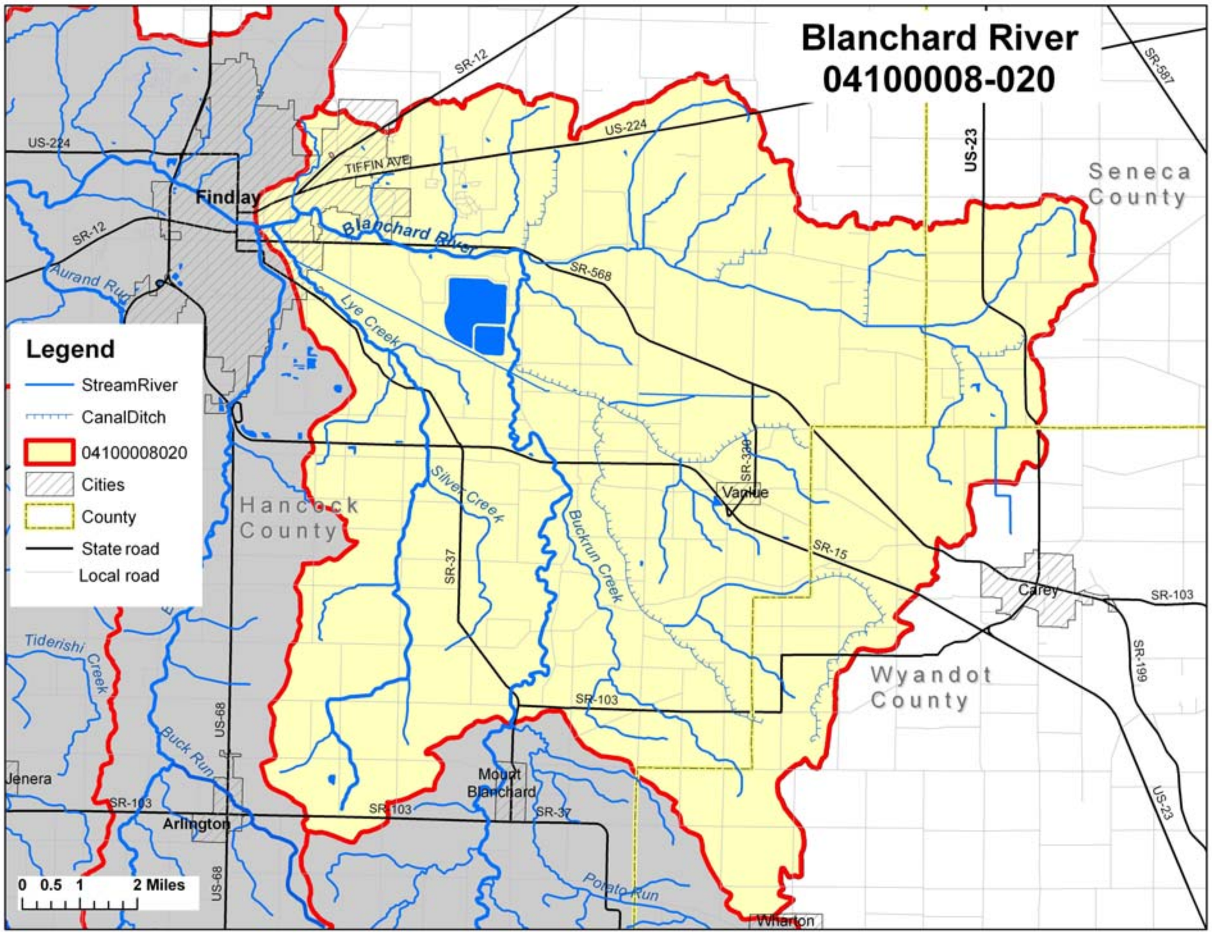


Figure 2a. Map of the The Outlet/Lye Creek WAU showing principal streams, urban areas, and roadways.

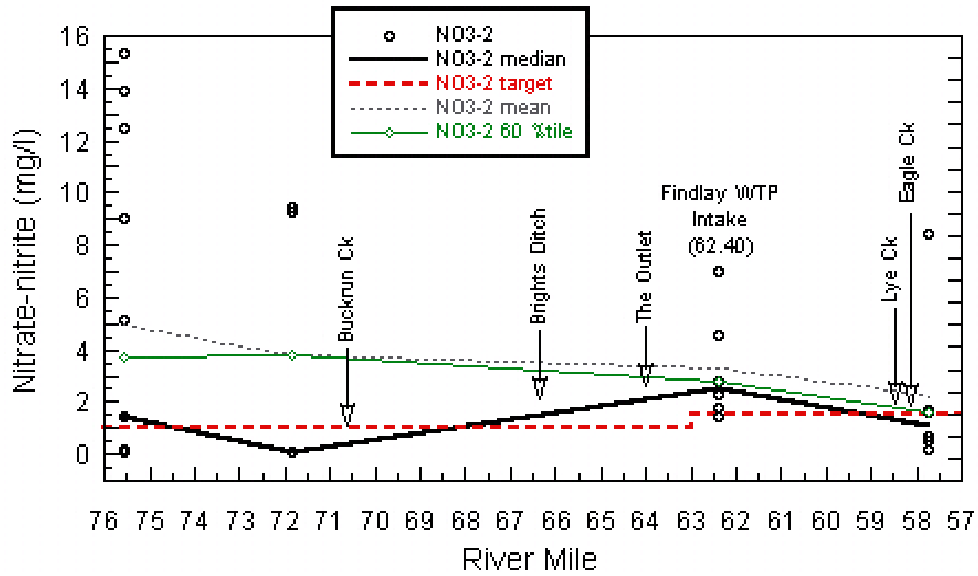


Figure 2b. Summary of nitrate-nitrite concentrations measured in grabs from the Blanchard River mainstem plotted against the target level.

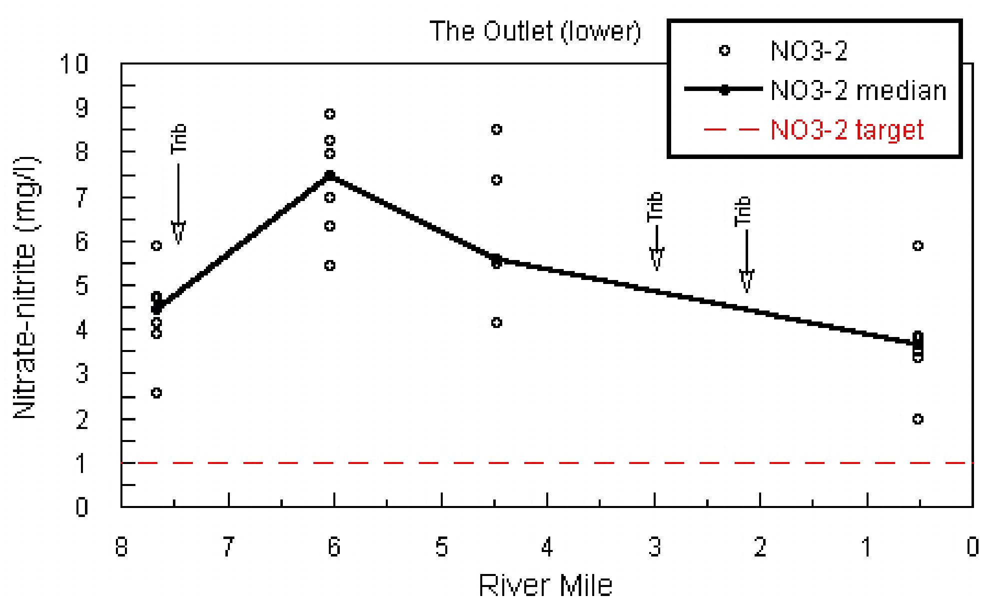


Figure 2c. Summary of nitrate-nitrite concentrations measured in grabs from The Outlet (lower - RM 63.63) plotted against the target level.

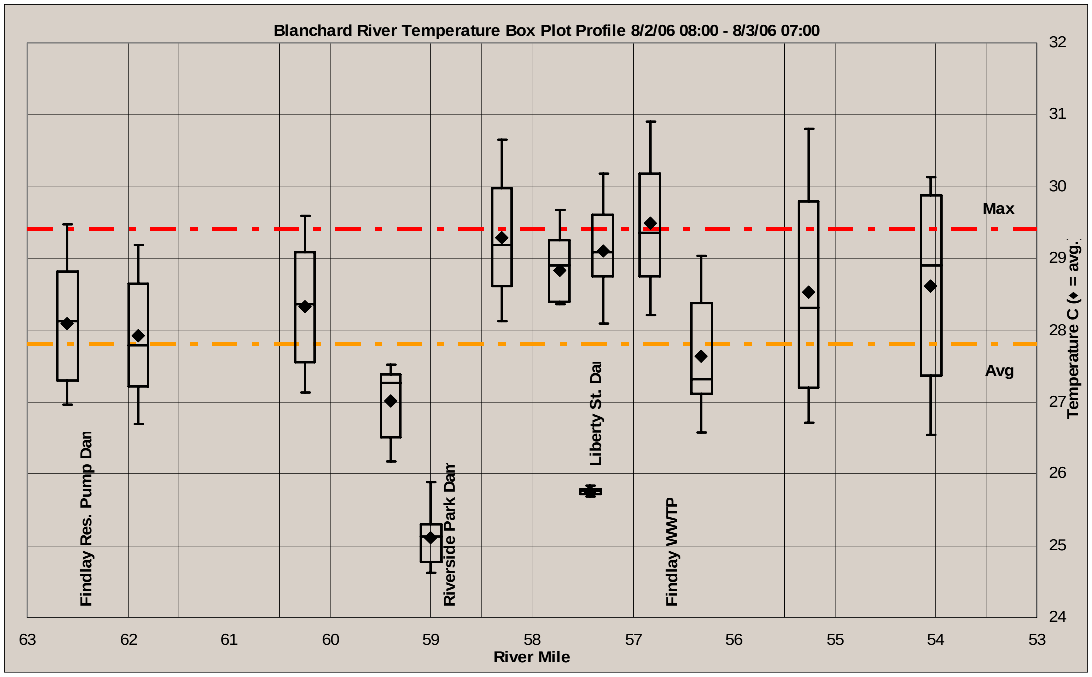


Figure 2d. Temperature profile of Blanchard River mainstem measured hourly over a 24 hr. period using multi-parameter automatic meters, plotted against average and maximum temperature criteria.

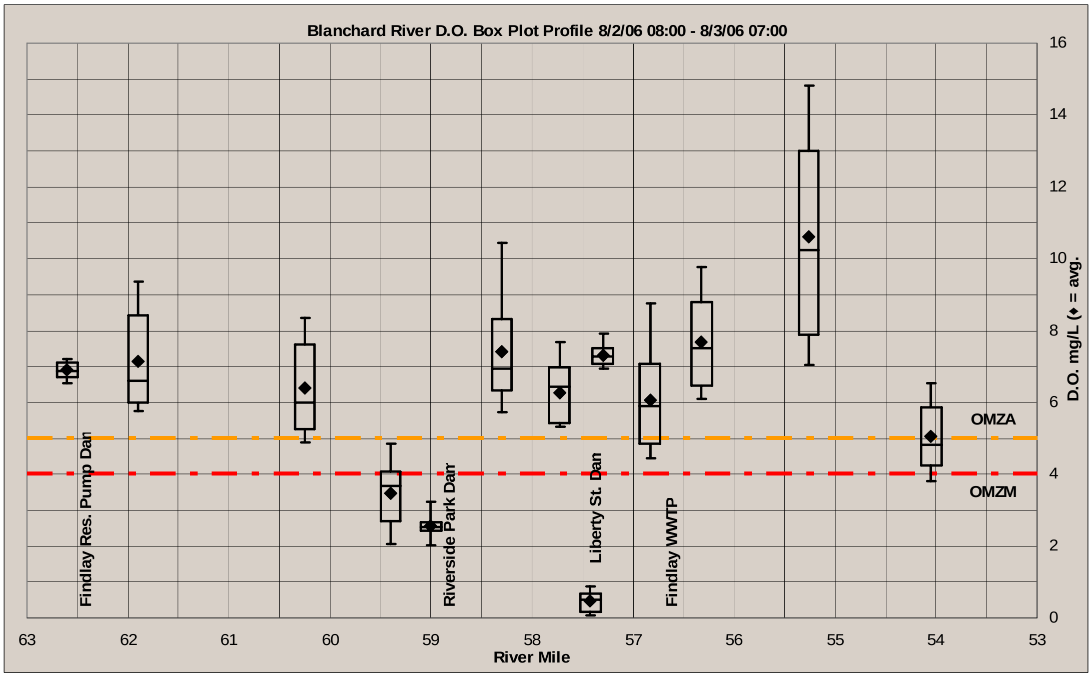


Figure 2e. Dissolved oxygen profile of Blanchard River mainstem measured hourly over a 24 hr. period using multi-parameter automatic meters, plotted against average (OMZA) and minimum (OMZM) dissolved oxygen criteria.

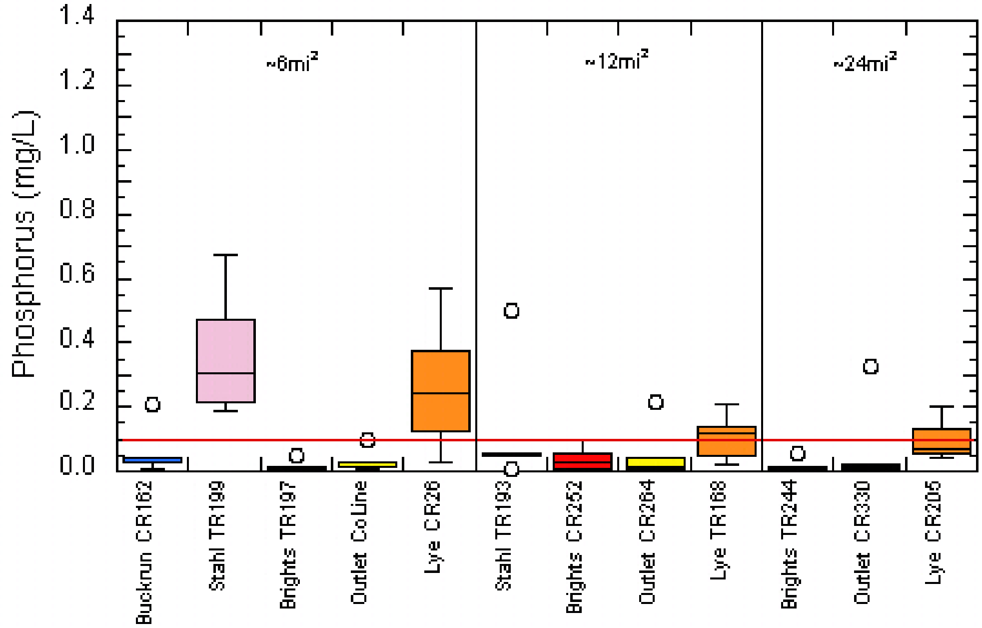


Figure 2f. Summary of phosphorus concentrations measured in grabs from Blanchard River tributary sites plotted against the target level. Sites are loosely grouped based on similar drainage areas of 6, 12, and 24 mi^2. The box contains 50% of the data points and the line represents the median value.

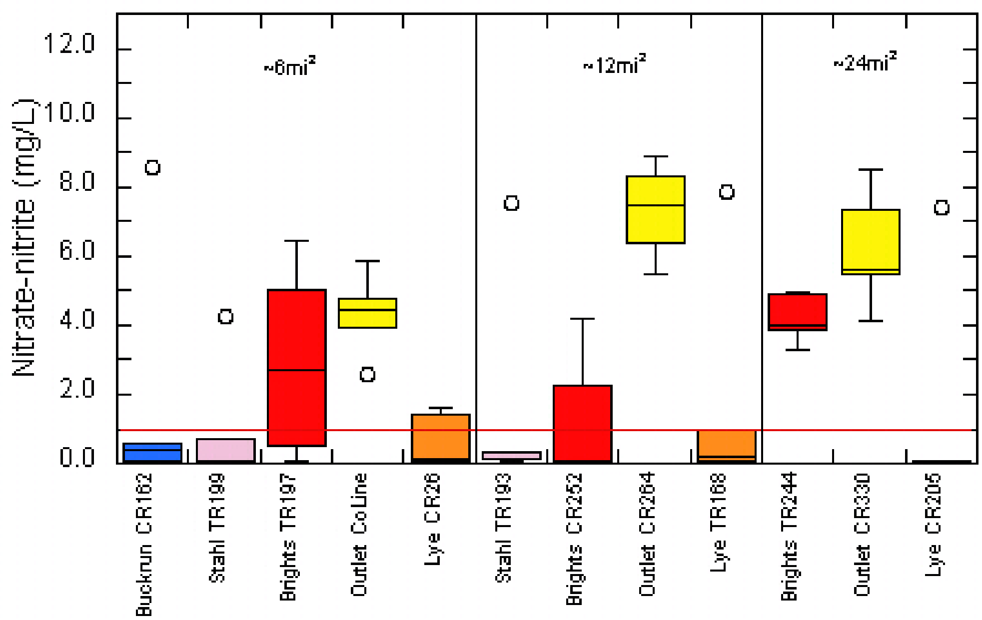


Figure 2g. Summary of nitrate-nitrite concentrations measured in grabs from Blanchard River tributary sites plotted against the target level. Sites are loosely grouped based on similar drainage areas of 6, 12, and 24 mi^2. The box contains 50% of the data points and the line represents the median value.

Eagle Creek WAU

The Eagle Creek WAU (04100008-030) is almost entirely contained in Hancock County except for the very upper reaches of the Eagle Creek headwaters which extend into northern Hardin County. The WAU (-030) also includes 12.5 miles of the Blanchard River mainstem from upstream of Eagle Creek, through the City of Findlay, to upstream of Ottawa Creek. Eagle Creek alone drains an area of about 61.4 mi^2 and flows through the southern half of the City of Findlay before meeting the Blanchard River. A map showing principal streams, roads, and urban areas is displayed in Figure 3a. Fish and macroinvertebrate populations and stream habitat conditions were evaluated throughout the WAU. The associated index scores and biological attainment status for each site (full, partial, or non) are summarized in Table 3a. Physical, chemical, and bacterial sampling was done to complement the biological data and an effluent sample was collected at the Findlay WWTP. Most sites had six sets of samples collected at two week intervals. Bacteria were tested to assess attainment of recreational use. Eagle Creek and the Blanchard River mainstem had extra sampling done to meet temporal and sample size conditions contained in the rule and evaluate data on a site specific basis. Results from the smaller tributaries were simply compared to the maximum standard. Multi-parameter automatic meters were set at six Blanchard River mainstem sites and one Eagle Creek site in 2005 to measure physical conditions over a 48 hour period. However, the data were compromised by an extremely high flow rain event during the week of sampling. Seven Blanchard River sites (in the Eagle Creek WAU) and selected tributary sites were monitored using the automatic meters in 2006 as part of a follow-up survey on the Blanchard River mainstem through the City of Findlay. The 2006 survey included sites in both the Eagle Creek WAU (-030) and overlapped upstream into the Outlet/Lye Creek WAU (-020), to include a total of 13 Blanchard River sites.

Water quality data and biological index scores were evaluated based on Ohio WQS criteria (OAC 3745-1). Target values presented in the *Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999) were used to evaluate nutrient enrichment. Appropriate numerical criteria and target values are often determined by use designation and all data was evaluated based on the current assigned uses of WWH, PCR, AWS, and IWS. Geographic location is an important consideration for biological criteria. Nearly all of the Eagle Creek WAU lies in the ECBP ecoregion. Just a short section of the Blanchard River mainstem crosses into the HELP ecoregion about 5 miles upstream of the next WAU (-040). Nutrient target values are being used as guidelines in lieu of criteria that are currently under development. Preliminary results support the validity of these target values and the notion that a correlation exists between nutrients, aquatic life attainment status, and drainage area. Criteria will likely be tiered for drainage area at the break between a wadeable stream and a small river (200 mi^2). Therefore, nutrient samples from Eagle Creek and other tributaries to the Blanchard River were evaluated using a phosphorus target of 0.10 mg/L and a nitrate-nitrite target of 1.00 mg/L. However, a phosphorus target of 0.17 mg/L and a nitrate-nitrite target of 1.5 mg/L were used to evaluate nutrient samples from the Blanchard River mainstem in this WAU.

An effort was made to identify the sources of water quality degradation. Ambient water quality is affected by a complex set of biotic and abiotic factors. Water picks up many impurities from the air, land, and ground and gases like oxygen, nitrogen, and carbon dioxide diffuse into water from the atmosphere. Climate, topography, vegetation, and biological activity all influence ambient water quality. Local water quality, though, is usually determined by inputs from anthropogenic sources that are grouped into point and nonpoint categories. The origin of a point source is easy to identify at the end pipe and most are regulated under the NPDES permit system. Individual permits are issued to facilities with unique processes like those summarized in Table 3d. General permits are issued to facilities with similar operations that exert a minimal impact on the environment like those summarized in Table 3e. Continuous discharge point sources have their greatest impact under base flow when chemistry is relatively stable and conditions reflect the ground water that recharges the stream.

Water quality criteria exceedences that were documented are summarized in Table 3b. Some degree of water quality degradation was documented at every site. In most instances, habitat and flow conditions were not adequate enough to overcome an impact to aquatic life and there was widespread impairment. A summary of the dissolved oxygen data obtained from the automatic meters deployed in the Blanchard River and 2 tributaries in 2006 is presented in Table 3c. Minimum dissolved oxygen (DO) values are important because enough DO needs to be present to sustain aquatic life. Criteria that apply to WWH streams are a 24 hour average of 5.0 mg/L and a minimum at any time of 4.0 mg/L. Maximum values are important if they are at supersaturated levels. This phenomenon results in an aquatic life ailment known as gas bubble disease. Initially, it causes gas bubbles to form on external surfaces and blocks the flow of water across the gills. As the disease progresses, it causes bubbles to form behind the eyes (pop-eyed) and in blood. This can restrict or stop blood flow, damage tissues, and eventually cause mortality. Fish mortality can occur when saturation reaches 140% and lesser impacts can happen at levels as low as 104%. There is also mounting evidence that concentrations that fluctuate more than 5 mg/L (minimum/maximum) over a diurnal period have a negative impact on aquatic life. This causes stress to aquatic organisms and is often linked with other changes in the environment like a shift in pH.

Most tributary streams drain cropland and are managed to eliminate excess water with a combination of surface (ditches) and sub surface (tile) drainage systems. Too much water can delay planting, cultivation, or harvest and cause problems with flooding and soil compaction. Some drainage projects are simply done by the landowner, but those that involve multiple landowners and communities fall under county ditch laws. When the interested parties reach a mutual agreement a ditch petition is filed with the Board of County Commissioners. This starts the legal steps required to finance, construct, and maintain a ditch. The County Engineer presents a report at a public hearing and the board votes on the project. If the vote is in favor of the project, the engineer conducts a field survey and prepares plans and a cost estimate. A final hearing is held to re-affirm the decision before work is completed and the County Engineer (or SWCD) becomes responsible for maintenance. Habitat and flow alterations from these drainage projects are considered high magnitude causes of impairment. None of the streams in the Eagle Creek Sub-watershed (Eagle Creek and its tributaries) are currently being maintained by Hancock County with the exception of one mile-long ditch just north of CR 26 and a few short tiles.

The impact from a nonpoint source is a direct function of the surrounding land use and their exact origin is difficult to identify. Pollutants like silt, nutrients, and pesticides are carried in storm water from land used for crop and livestock production. Management practices like channelization, removal of riparian vegetation, and installation of sub surface tile systems result in significant flow and habitat alterations. They contribute to low flow conditions during dry weather periods because they limit ground water recharge by lowering the water table and by increasing evaporation since there is no tree shade. Conversely, these activities contribute to flooding during wet weather periods due to accelerated delivery of runoff. In pasture areas the exclusion of livestock from surface waters is important because of the damage they can cause to habitat and input of nutrients and bacteria. A type of flow alteration is the impounding of a stream by a low head dam. These dams change stream morphology by flooding riffles, block fish migration, and ultimately change trophic structure. Several of these structures are located on the Blanchard River above and through Findlay and there is one on Eagle Creek. Of the dams on the Blanchard River mainstem, only the Liberty St. Dam, is located within The Eagle Creek WAU at RM 57.42. Pollutants like silt, nutrients, and pesticides are also carried in storm water from urban areas, along with materials like oil and heavy metals that are present in auto exhaust. Combined sewer overflows are also a major source of organic matter and bacteria. The sewage collection system in Findlay has 22 of its 24 CSOs present in the Eagle Creek WAU. Failed home sewage systems can be a problem in areas without central collection and treatment systems. Dola and Williamstown are examples of these types of areas. Flooding caused by accelerated delivery of runoff is also a problem in urban areas because of impervious surfaces and sources of inflow like down spouts and sump pumps.

Aquatic Life Use Designations

The Blanchard River mainstem enters the Eagle Creek WAU (-030) just upstream of the confluence with Eagle Creek in the City of Findlay at RM 58.10. It flows to the west and for the next 2 miles it is still within the City of Findlay where it passes over the Liberty St.

Dam at RM 57.42, and receives discharges from 22 of Findlay's 24 combined sewer overflows (CSOs), some via Eagle Creek, Howard Run or other tributaries, and the discharge from the Findlay WWTP at RM 56.42. Figure 3b is a schematic of the streams showing the approximate location of the dischargers in the Eagle Creek WAU. In the past, the Blanchard River mainstem would receive pollutant loads from industrial dischargers in the City of Findlay as far downstream of Findlay as RM 54.00 via discharges to Oil Ditch, but most of those discharges have since been eliminated or reduced to storm water runoff (i.e. no longer contain process wastewater). Now, as the Blanchard River continues west out of Findlay downstream of the WWTP, for 10.5 miles more before reaching the next WAU, the only additional point sources are a storm water discharge and a quarry discharge to Oil Ditch (confluence at RM 54.00), and a quarry discharge to Aurand Run (confluence at RM 52.17).

The Blanchard River reach in the Eagle Creek WAU extending from upstream of Eagle Creek to upstream Ottawa Creek (RM 58.10 to RM 45.64) crosses the boundary between the ECBP and HELP ecoregions. Sites at RMs 49.8 and 46.5 are in the HELP ecoregion. The river is designated as WWH, PCR, AWS, and IWS based on an Ohio EPA study done in 1983. Analysis of the physical habitat of the Blanchard River within the assessment unit confirmed the appropriateness of the WWH use designation. QHEI scores of six sampled locations within this reach of the mainstem, ranged from 46.0 to 65.5. All of the sites had a moderate to heavy silt layer and limited pool/riffle/run development but benefited from having significant instream cover and areas of relatively deep pools. One significant obstacle to fully attaining the WWH aquatic life use was the Liberty Street dam (RM 57.42).

Eagle Creek is the dominant tributary in this WAU (-030), confluent with the Blanchard River at RM 58.10. Eagle Creek is about 21.5 miles long and drains nearly 62 mi^2. It flows mostly north and just slightly northwest from northwest of Dola, along the west side of Arlington and through the south side of Findlay before reaching the Blanchard River. Eagle Creek is entirely within the ECBP ecoregion and is designated as WWH, PCR, AWS, and IWS based on an Ohio EPA study done in 1983. The stream bottom is mostly bedrock and there is not much sediment, although there is often a fine layer of silt covering the rock, especially in the more modified upper reaches of Eagle Creek. Although no part of Eagle Creek is currently maintained some headwater sections appear to have been channelized in the recent past.

The most upstream tributary to Eagle Creek is Hydraulic Ditch, a highly modified stream that flows north from Dola to join Eagle Creek at RM 18.05. Flat Branch is confluent with Eagle Creek at RM 15.65. The headwaters of Eagle Creek, Hydraulic Ditch, Flat Branch and Woodruff Ditch (a tributary of Flat Branch) all flow through the area where new U.S. 30 is under construction ½ mile south of existing U.S. 30. Also, both the Villages of Dola and Williamstown (located between Woodruff Ditch and Flat Branch) are currently unsewered. However, no discharges from the villages to these Eagle

Creek tributaries had been identified at the time of this survey. Farther downstream on Eagle Creek, Buck Run flows west through the Village of Arlington before joining Eagle Creek at RM 11.78. The Arlington WWTP discharges to Buck Run. Arlington's WTP and the Sycamore Springs Golf Course package plant both discharge to Cottner Ditch, which is confluent to Eagle Creek at RM 9.55. The University of Findlay has a large equestrian facility along Eagle Creek at CR 40. Eagle Creek then continues north through Camp Berry, a Boy Scout camp, where there is a package plant discharge and a low head dam at RM 6.58. Downstream from the U.S. 68 and SR 15 intersection and Main St. at the south edge of Findlay, the Eagle Creek Utilities WWTP discharges to Eagle Creek. Eagle Creek then flows northeast through the southern half of the City of Findlay, where it receives the discharges from several CSOs before its confluence with the Blanchard River in the center of Findlay at RM 58.10.

Hydraulic Ditch is a tributary of Eagle Creek confluent at RM 18.05 that basically has the characteristics of an 8.5 mile long channelized ditch draining about 8 mi^2. However, at least the last 2.6 miles of it that are in Hancock County are not being maintained. Hydraulic Ditch is entirely in the ECBP ecoregion and is designated WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. Hydraulic Ditch had not been evaluated using biological and habitat data prior to the 2005 survey. Significant modified habitat attributes included limited pool depths and a predominance of sand and silt substrate. Even though the macroinvertebrate assemblage was in good condition, it appeared unlikely that full attainment of the WWH use could be consistently met. Rather, a modified warmwater habitat use is recommended. The MWH use recommendation should not be considered a downgrading of aquatic life use for Hydraulic Ditch. Rather, the 2005 survey accomplished the first systematic ambient assessment of the appropriate use. Additional fish sampling is needed to definitively determine the appropriate aquatic life use.

Flat Branch is a tributary of Eagle Creek confluent at RM 15.65. It is 7.4 miles long and drains about 11 mi^2. Flat Branch is entirely in the ECBP ecoregion and, along with its tributary, Woodruff Ditch at RM 0.9, is designated WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. Flat Branch was designated as a WWH in the previous rulemaking but the use had never been verified based on biological sampling. Results of the 2005 survey included sites at RM 1.1 and 0.1. Both locations were previously channelized. Limited beneficial habitat features and nearly interstitial flow were noted at the upper site (RM 1.1). The lower site had recovered a largely natural sinuosity with relatively heterogeneous instream habitats. The QHEI score of 54.0 at RM 0.1 reflected a moderate level of habitat alteration. Nutrient enrichment was noted at both sampling locations that likely impacted biological communities. WWH is an attainable use with improvements to water quality; however, alteration of the stream hydrology which benefits agricultural production will likely continue to impinge on the diversity of fish and macroinvertebrate taxa that the stream is able to support.

Buck Run is a mostly channelized tributary of Eagle Creek that flows through the Village of Arlington, confluent at RM 11.78. The stream is about 4.5 miles long with a drainage area of about 7 mi^2. It is in the ECBP ecoregion and is designated WWH, SCR, AWS, IWS based on an Ohio EPA study done in 1983. Buck Run received a WWH designation based on previous work done in the Blanchard River watershed and documented in "Biological and Water Quality Study of the Blanchard River and Selected Tributaries" January, 1985. The report did not include any biological or habitat measurements. Rather the justification for the WWH use was based on the presence of perennial flow downstream of Arlington's outfall (RM 0.75 to 0.0) and that "(Buck Run) possessed more diverse aquatic habitat, and thus the potential for warmwater faunas, because of the long time span since major vegetation clearing and channel work." The work done in 2005 included both QHEI and biological assessments of Buck Run. The results made it apparent that continued recovery of WWH attributes and biological communities had not occurred in the intervening period since 1985. The stream at RM 0.6 was characterized as a grass-lined ditch. A QHEI score of 46.5 was recorded and modified habitat attributes exceeded typical warmwater attributes by a ratio of 6:3. Biological sampling results reflected a fair fish condition and a poor macroinvertebrate community. Even with elimination of nutrient and organic loadings, it appeared unlikely that Buck Run could meet a WWH aquatic life use. The MWH use is a more appropriate designation based on the 2005 data.

Aurand Run is a tributary of the Blanchard River confluent at RM 52.17. It is in the ECBP ecoregion, originating south of Findlay and flowing northwest for 9 miles until it reaches the Blanchard River, draining an area of about 16 mi^2. It flows through an area where there are several quarries operating and receives the discharge from one, as well as industrial storm water discharges from at least 2 other stone related operations (Tables 3d and 3e). Aurand Run was a previously undesignated and unassessed stream. Ohio law stipulates that the WWH use be applied to unassessed waterways. The 2005 sampling effort affirmed the WWH use. The stream was channelized but beneficial habitat attributes; such as varied substrates, limited substrate embeddedness, and the presence of instream cover, yielded a QHEI score of 63.0 at RM 2.7. Generally, a score in excess of 60.0 is considered sufficient to expect typical WWH biological communities. Fish and macroinvertebrate sampling results were consistent with the recommended WWH use.

Aquatic Life Use Attainment Status

Attainment status was determined for fifteen sites in the Eagle Creek WAU, representing approximately 34.5 assessed stream miles in the watershed. Limited sampling of three additional sites allowed for a determination of aquatic life use designation but credible data requirements negated a complete evaluation of attainment status. Four sites representing 10.5 assessed stream miles, fully met the current or recommended aquatic life use. Six sites, representative of thirteen assessed miles, partially met and five sites, totaling eleven assessed stream miles, were in non-attainment of the current or recommended aquatic life use.

Biological communities in the Eagle Creek WAU were impacted primarily by factors related to agricultural practices in the watershed. Elevated nutrients, and impacts associated with dissolved oxygen/organic enrichment were identified as causative factors for 92%, and 40%, respectively, of the impaired miles. Flow alteration, principally to facilitate agricultural activities, affected 64% of the impaired stream miles. Instream habitat and natural flow regimes were altered as a result. Impacts within the Findlay urban area included elevated stream temperature and widely fluctuating dissolved oxygen concentrations that were attributed to the Liberty Street dam, CSOs and urban runoff.

The impoundment formed behind the Liberty Street Dam had a significant impact on fish and macroinvertebrate assemblages in the Blanchard River. The change from a free flowing stream to a pond like environment alone can limit the diversity of typical WWH communities. Additionally the impoundment acted as a sink, collecting silt and pollutants from area CSOs and contained in storm water runoff. Water temperatures were often elevated and wide swings in dissolved oxygen concentrations were documented during the summer sampling period. As a result, poor habitat and degraded water quality combine to impact biological communities. Fish and macroinvertebrate community conditions were rated as fair and poor, respectively within the Liberty Street dam pool (RM 57.8/57.9).

The proliferation of plankton within the impoundment had an effect downstream from the dam (RM 57.3). The now food rich water released over the dam produced an immediate increase in facultative and pollution tolerant macroinvertebrate taxa that consumed the plankton. Total organism density of nearly 4500 organisms per square foot was recorded on the artificial substrate samplers and a similar high density was noted on the natural substrates. Fish sampling results met ecoregional expectations but the macroinvertebrate community was in only fair condition despite relatively good habitat.

Water quality downstream of the dam appeared to be within Water Quality Criteria, based on the grab samples collected during the 2005 survey year. However, the water quality and sediment sampling conducted downstream from the Liberty Street Dam in April 2005 found PAHs (Polycyclic Aromatic Hydrocarbons) in the sediments at levels above the Water Quality Criteria for the protection of human health, and benzo(a)pyrene, one of the PAHs, was also detected in the water at levels above the Water Quality Criteria (Hull & Assoc.). The suspected source was the former Brandman Tire Facility. There are also 7 CSOs within 300 yards upstream or downstream of the Liberty St. Dam. The most downstream of these CSOs, at RM 57.11, has a history of problems with oil seepage. Some evidence of oil seepage was observed along the bank in the area upstream of Broad St. during sediment collection in October 2005.

The site on the Blanchard River upstream from Broad Street (RM 57.9) was in a reach with low gradient and a wide modified channel. The fish community marginally attained WWH expectations but the macroinvertebrate community was in only fair condition owing primarily to a lack of current at the site. An overriding habitat influence negated the identification of any impact associated with nearby industrial sites and CSO releases, nevertheless, sediments near Broad St. (RM 56.83) were contaminated with PAHs and PCBs.

The Findlay WWTP discharged an average of about 12 MGD during 2005 and is a major source of nutrient loading to the Blanchard River. A significant increase in the levels of nitrate-nitrite and phosphorus from below target to well above target occurred downstream of the Findlay WWTP. There also appeared to be a slight depression in dissolved oxygen concentrations approximately 10 miles downstream of the WWTP discharge (Figure 3g) based on the surface grab samples.

Partial attainment downstream from the Findlay WWTP (RM 54.7) resulted from widely differing fish index scores recorded in the initial sampling pass on June 11 versus the subsequent sampling conducted October 14. An IBI score of 28 was recorded in June and increased to 44 in October. Similarly, MIwb scores were 7.0 and 8.2 in June and October, respectively. The averaged IBI and MIwb scores were in the fair range. The disparate results suggest an impaired community condition possibly due to an upset in the operation of the Findlay WWTP followed by a reestablishment of the warmwater fish community in the intervening period between sampling passes. The macroinvertebrate community produced a very good ICI score of 42 at RM 55.2. The community structure was indicative of moderate to high enrichment but, given the conditions upstream from the Findlay WWTP, an influence from the discharge on the macroinvertebrate community could not be directly correlated.

The remaining two Blanchard River sites (RMs 49.8 and 46.5) in the Eagle Creek WAU were located within the HELP ecoregion. The river took on characteristics typical of the ecoregion with a predominance of silt/sand substrates and limited riffle/run development. The channel was incised and accumulations of woody debris and sand provided areas where flow velocity was increased to a moderate level. Despite the changes in the nature of the river, habitat measurements were consistent with the WWH use. Biological sampling results exceeded minimum ecoregional expectations at both locations with index scores in the good to exceptional range. Pollution sensitive macroinvertebrate taxa were well represented. MIwb scores of 9.7 at both sites (in the exceptional range) were markedly improved over the fair result recorded downstream from the Findlay WWTP, and indicative ofa much more balanced and stable fish assemblage.

Out of 12.5 assessed stream miles of the Blanchard River in the Eagle Creek WAU, 4.5 miles fully met WWH ecoregional expectations. Seven miles partially met and one mile was in non-attainment.

One or both organism groups sampled at five of six sampling locations on Eagle Creek failed to meet ecoregional expectations. Out of 13 assessed stream miles, just one mile fully met WWH ecoregional expectations. Six miles partially met and six miles were in non-attainment. The results generally reflected a chronic widespread impact from agricultural practices in the watershed; principally alteration of the natural flow regimen via tile drainage and the addition of nutrients to the system. The site downstream from Buck Creek (RM 11.6) was the only location where both fish and macroinvertebrate communities were in a less than goal condition. Biological performance at this site coincided with an increase in phosphorus and ammonia attributable to the village of Arlington WWTP discharge. The fish community showed additional decline at RM 9.1 and was reflected in an IBI score in the poor range. The only site where full attainment was documented was at RM 3.7. The remaining sites had marginally good to good macroinvertebrate communities but one or both of the fish index scores were in the fair range.

Requisite credible data collection requirements were lacking to complete an evaluation of the status of the aquatic life use of Hydraulic Ditch at RM 1.5, but the macroinvertebrate community was rated in good condition. Thirty-eight taxa were collected from the natural substrates including thirteen EPT taxa (ephemeroptera, plecoptera, trichoptera). The results suggested adequate water quality that enabled the establishment of a relatively diverse macroinvertebrate community. It is important to note that these organisms can often be found in areas with overall monotonous habitat as long as suitable substrate is sporadically present. Often, a single piece of woody debris or an occasional rock located in sufficient current allows for the establishment of low density populations of relatively pollution sensitive taxa. Chemical sampling results indicated that nutrient levels (ammonia, nitrate-nitrite and phosphorus) were at least occasionally elevated.

Tiling of the surrounding agricultural areas likely exacerbated the limited dry weather flow of Flat Branch. Elevated nutrients were also a concern. Phosphorus levels at both RMs 1.1 and 0.1 were consistently elevated in grab samples collected during the summer sampling period. The nitrogen parameters were also occasionally elevated. The macroinvertebrate community was in fair condition at RM 1.1. The assemblage was reasonably diverse; 37 taxa were collected, but only two were considered pollution sensitive. A lack of sufficient water in the stream negated fish sampling at the site. Biological sampling at RM 0.1 yielded a marginally good macroinvertebrate assemblage and a fish result in the poor range (IBI= 26). Over the course of the summer, the stream at RM 0.1 became intermittent. As a result, fish sampling was conducted along a reach of disconnected pools. The fish community was moderately diverse, twelve species were recorded, but pollution tolerant creek chubs (*Semotilus atromaculatus*) predominated. Non-attainment of the WWH aquatic life use was attributed to nutrient enrichment and flow alteration to facilitate row crop agriculture along with frequently low dissolved oxygen levels.

Buck Run failed to meet ecoregional expectations. The Arlington WWTP discharge has consistently exceeded the design capacity of 0.168 MGD. Organic loading and elevated ammonia levels had a significant impact on biological communities, as a result. The impact was likely exacerbated by the channelized nature of the stream. Significant accumulations of organic sediment were noted along the stream margins. Qualitative macroinvertebrate sampling produced a limited diversity of taxa, none of which were considered pollution sensitive. The macroinvertebrate community was indicative of a poor resource condition. The fish community was in marginally better condition and yielded an IBI score in the fair range. A relatively diverse assemblage was collected, but pollution tolerant and omnivorous species (*i.e.*, bluntnose minnows and white suckers) predominated.

The fish community of Aurand Run at RM 2.7 was in good condition. Relatively pollution sensitive darter and sculpin species were well represented and pollution tolerant and pioneering fishes were not overly abundant, suggesting that the community was in stable, balanced condition. An IBI score of 40, in the good range, resulted. Commensurate macroinvertebrate sampling at RM 0.5 also yielded an assemblage that was indicative of good community condition. Thirty nine taxa were collected in moderate to low density, eleven of which are consider pollution sensitive. It was also noted that enrichment did not appear to be excessive even though nitrogen and phosphorus data indicated that there may have been a localized source of untreated sewage upstream. The fecal coliform data also supported this theory.

Water Quality

Water quality in the Blanchard River as it enters the Eagle Creek WAU (-030) is affected by the location of 2 dams: the Riverside Dam at RM 58.77 upstream of Lye Creek in The Outlet/Lye Creek WAU (-020), and the Liberty St. Dam at RM 57.42 downstream of Eagle Creek and Main Street. Upstream of the Riverside Dam the Blanchard River is in partial attainment of WWH biocriteria in part due to the increased loading of nitrate-nitrite from 2 upstream tributaries (WAU 020) which has been compounded by flow alteration (a dam downstream of each tributary). At Main St, downstream of the Riverside Dam, but now in the Liberty St. Dam pool, nitrate-nitrite levels have decreased so that the medians are below target even though there are still a few high results. However, the impoundment within the City of Findlay is larger, deeper and more pond-like than those created by the lowhead dams farther upstream. This condition is compounded by a lack of quality riparian zone because this segment of the river is in an urbanized section of Findlay, which means there is no tree canopy to provide shade from the sun. The growth of algae in the deeper still water at Main St. is promoted by extended exposure to sunlight during the day and can lead to widely fluctuating diurnal dissolved oxygen levels, particularly near the surface. Grab samples from the surface measured for D.O. at mid-day during the 2005 survey were often >140% saturation, but the diurnals measured deeper in the water column by the automatic meters in both 2005 and 2006 were always below the minimum criterion of 4.0 mg/l. Water temperature also exceeded the OMZM (outside the mixing zone maximum criterion) at Main St. and at the next 2 downstream sites in surface water grabs on one date during the 2005 survey due to the sun exposure, high air temperature and slow moving water. There are also 8 CSOs discharging to this impounded segment of the Blanchard River which can contribute nutrients, bacteria and other pollutants associated with urban runoff.

As shown for The Outlet/Lye Creek WAU -020, results from the multi-parameter automatic meters in 2006 indicate that the combination of impoundments, increasing development upstream, and urban landuse within the City of Findlay may be causing the violations of temperature and dissolved oxygen measured in the Blanchard River mainstem from upstream of Findlay (The Outlet/Lye Creek WAU -020) to downstream of Findlay (in this WAU -030). Figures 3c and 3d show the statistical distribution of temperature and dissolved oxygen measurements, respectively, at each site in the mainstem through both WAUs, taken over a 24 hour period using the automatic meters. All of the meters were set about a foot off the bottom, so these measurements were taken down in the water column and not at the surface.

Figure 3c shows how the impounded flow affected temperatures, with mean temperatures exceeding the average temperature criterion at nearly every site, except for the very deepest sites upstream of the dams, and one affected by the WWTP discharge. At sites in the more urbanized area of Findlay (where there was little or no riparian habitat, thus no shading from trees and more urban runoff) and at sites downstream, temperatures increased and there were violations of the maximum temperature criterion as well.

The effects of the impoundments on dissolved oxygen (DO) are evident in the steep drop in DO levels in the most pooled areas of the river upstream of the 2 Findlay dams (Figure 3d). The minimum DO criterion was violated for the full 24 hours at the site just upstream of each of the Riverside and the Liberty St. Dams. At the Riverside Dam, the next upstream site also violated both minimum and 24 hr. average DO criteria for most of the measurement period.

The Dam at RM 62.40, which is used by Findlay's Drinking Water Reservoir, does not appear to be having as severe an impact on the water quality of the Blanchard River as the dams within the City of Findlay. The Riverside Dam (WAU -020) and the Liberty St.

Dam (WAU -030) are located in developed areas where there is little to no riparian zone. The dams create essentially large ponds where flow stagnates, water is allowed time to bake in the sun, and algae fed by nutrients from upstream sources proliferate. Add to this the runoff from heated asphalt and concrete surfaces in the surrounding urban area and temperatures soar while dissolved oxygen levels plummet in these stagnant, ponded impoundments.

The Blanchard River is re-aerated as it passes over the Liberty St. Dam, and except for some high nitrate levels, the water quality downstream of the dam appears to be within Water Quality Criteria, based on the grab samples collected during the 2005 survey year. However, the former Brandman Tire Facility, a brownfield site currently owned by the City of Findlay, is immediately adjacent to the river along the north bank next to the dam. Water quality and sediment sampling conducted in the river adjacent to this facility in April 2005 found PAHs (Polycyclic Aromatic Hydrocarbons) in the sediments at levels above the Water Quality Criteria for the protection of human health, and benzo(a)pyrene, one of the PAHs, was also detected in the water at levels above the Water Quality Criteria (Hull & Assoc.). In addition, there are 7 CSOs within 300 yards upstream or downstream of the Liberty St. Dam. The most downstream of these CSOs, at RM 57.11, has a history of problems with oil seepage to the Blanchard River. The suspected source of the oil is material buried in the Rawson Park area. The CSO line runs through Rawson Park, and it is thought that oil has been migrating and leaching along the buried sewer line to the river. Some evidence of oil seepage was observed along the bank in the area upstream of Broad St. during sediment collection in October 2005.

The old Findlay WWTP used to discharge to the Blanchard River upstream of Broad St. at RM 56.82, but the new plant was constructed in 2000-2001 on the west side of Broad St. and the discharge point was moved to RM 56.42. The Findlay WWTP discharged an average of about 12 MGD during 2005 and is a major source of nutrient loading to the Blanchard River. Figures 3e and 3f illustrate the dramatic increase in the levels of nitrate-nitrite and phosphorus from below target to well above target downstream of the Findlay WWTP. There also appears to be slight D.O. sag occurring within 10 miles downstream of the WWTP discharge (Figure 3g) based on the surface grab samples.

The pattern of high strontium values in the Blanchard River mainstem samples appears to be directly related to the location of quarry operations on tributaries in the Eagle Creek WAU (-030), and to the regional geology as it is generally associated with areas of shallow bedrock and/or ground water influence throughout the Blanchard River Watershed.

Fluctuating dissolved oxygen levels in the headwaters of Eagle Creek reflected the modified state of this section of the stream, no riparian zone and little shade from the sun, resulting in some grabs with >140% saturation while others had D.O. levels below the OMZA. However, in most of the rest of Eagle Creek the substrate is essentially bedrock and in many places it is functionally comparable to a concrete slab. There are several quarry operations in the areas near Eagle Creek especially on the southwest side of Findlay because the bedrock is so close to the surface, although none discharge to Eagle Creek. There is silt deposition in the headwaters, but as you move downstream the silt is deposited only in a fine layer on the bedrock or in isolated pockets, until finally it becomes difficult to locate or identify any sediment component of the substrate. With the stream functioning more like a conduit, water quality in Eagle Creek is the composite of the water quality in its tributaries and the direct discharges to Eagle Creek before it has a chance to assimilate the pollutants that are being introduced along the way. For example, Figures 3h and 3i show the effects the ammonia and phosphorus loads from Buck Run have on Eagle Creek. With ammonia, there was some assimilation of the sudden initial higher load from Buck Run, but not enough to prevent the cumulative additional ammonia loading from downstream sources from increasing the overall ammonia concentration in the stream, particularly after the Eagle Creek Utilities WWTP discharge. With phosphorus, Eagle Creek also initially assimilates much of the extremely high level of phosphorus coming from Buck Run, but with additional downstream sources to Eagle Creek, phosphorus medians remain above target all the way to the mouth.

Nutrient enrichment is still the most common type of water quality degradation in this WAU (-030). Data obtained from grab samples was summarized for phosphorus in Figure 3r and for nitrate-nitrite in Figure 3s to compare sites with similar drainage areas and identify where problems exist. Phosphorus was just above target at both sites in Flat Branch, a tributary of Eagle Creek, but it greatly exceeded the phosphorus target in Buck Run, the Eagle Creek Tributary that receives the discharge from the Arlington WWTP. Since there are no other tributaries in this WAU (-030) that attain a 24 mi^2 drainage area for comparison with the more downstream Eagle Creek sites, only the most upstream Eagle Creek site could be used in this comparison, in the 12 mi^2 drainage area group. The Eagle Creek site, Hydraulic Ditch (a tributary of Eagle Creek), and Aurand Run (a tributary of the Blanchard River) are all within the phosphorus target. Nitrate-nitrite was above target in Buck Run and Aurand Run. There were some high nitrate-nitrite values at the 6 mi^2 drainage area site in Flat Branch, but the median was below target.

Hydraulic Ditch, Flat Branch, Buck Run, and Cottman Ditch are all tributaries of Eagle Creek. The Arlington WWTP, Arlington WTP, Sycamore Springs Golf Course, Camp Berry, Eagle Creek Utilities, and City of Findlay CSOs are all point sources under permit to discharge to Eagle Creek and its tributaries. Eagle Creek does not appear able to assimilate the cumulative load of ammonia or phosphorus from the multiple dischargers in the watershed. Fecal coliform levels were also consistently a problem in Eagle Creek, particularly in Findlay.

Hydraulic Ditch flows along the east side of the unsewered village of Dola, and although no discharges of untreated sanitary waste from Dola to Hydraulic Ditch were specifically identified during this survey, it does not preclude the potential that one or more exist. Only one site was sampled on Hydraulic Ditch at RM 1.5, which is 3.5 miles downstream from Dola. Three of the 6 grab samples tested for fecal coliform exceeded the PCR maximum. Based on the data, there is a source of ammonia, nitrate-nitrite, and phosphorus upstream that on one sampling date resulted in levels of nitrate-nitrite and phosphorus exceeding target at this site (ammonia levels were also slightly increased on that date, which coincided with a high fecal coliform count).

The unsewered community of Williamstown is situated about equidistant between Flat Branch and Woodruff Ditch. Although no discharges to either stream from the Williamstown area were specifically identified during this survey, it does not preclude the potential that one or more exist. Two sites were sampled in Flat Branch, upstream (RM 1.11) and downstream (RM 0.06) of Woodruff Ditch. Data suggests there may be a source of ammonia, nitrate-nitrite and phosphorus upstream of each of the sites. Phosphorus levels at both sites were consistently above target. Nitrate-nitrite levels exceeded target occasionally, but ammonia levels never became exceedingly high. Dissolved oxygen levels at the site near the mouth were frequently below OMZA (and once below OMZM), but this occurred only twice at the upstream site. In the samples tested, there were no fecal coliform levels that exceeded the PCR maximum.

The Arlington WWTP discharges to Buck Run at RM 0.75 and has a significant impact on the water quality in Buck Run and Eagle Creek downstream of Buck Run. Three of 6 ammonia samples were above the OMZA and the phosphorus median was 18 times the target level. Four of the 6 nitrate-nitrite samples were also above target. Only 1 D.O. grab was below the OMZA. No fecal coliform levels exceeded the SCR maximum (the PCR maximum – which does not apply here, but does apply downstream in Eagle Creek – was exceeded in only 2 of the 6 samples).

Cottner Ditch is a very small tributary (about 2 miles long) of Eagle Creek confluent at RM 9.43, downstream from Buck Run. It is in the ECBP ecoregion and is currently undesignated. The Brinkman Turkey Farm used to have a seasonal discharge to this stream at RM 0.95, but this discharge was eliminated in 1997. The Sycamore Springs Golf Course has a package plant that discharges to Cottner Ditch and the Arlington WTP discharges its filter backwash water to Cottner Ditch. The Arlington WTP discharge frequently has difficulty meeting the Water Quality OMZA for chloride in Cottner Ditch, so alternatives for meeting the chloride limit are being evaluated. Currently the favored option is to send the WTP discharge to the Arlington WWTP for treatment.

Howard Run is one of the few tributaries of the Blanchard River that flows in from the north. It begins with several of its own very small headwater tributaries on the northeast side of Findlay, flowing in along the east side of Main St. (behind Dow Chemical) before turning west through the City of Findlay, then joining the Blanchard River at RM 56.80, just upstream of the Findlay WWTP. It is only about 4 miles long and receives the discharge from 2 City of Findlay CSOs, one right at the mouth. Howard Run is in the ECBP ecoregion and is undesignated.

Oil Ditch is a tributary of the Blanchard River at RM 54.00. It is in the ECBP ecoregion and from its headwaters to I-75 Oil Ditch is designated LRW, SCR, AWS and IWS (small drainageway maintenance), then from I-75 to the mouth it is designated WWH, PCR, AWS and IWS based on a biological and water quality study done on Oil Ditch in 1987, despite that study's recommendation that the aquatic life use designation of the downstream segment (downstream of RM 1.7, from I-75 to the mouth) be changed from WWH to MWH (OEPA, 1988). While most of the process discharges that used to impact Oil Ditch have been eliminated, there are still some industrial storm water discharges and a quarry with NPDES Discharge Permits. Currently Centrex is also being requested by Ohio EPA to determine and eliminate the source of oil that has been intermittently leaking to Oil Ditch from that facility.

Aurand Run is a tributary of the Blanchard River confluent at RM 52.17. It is in the ECBP ecoregion, originating south of Findlay and flowing northwest for 9 miles until it reaches the Blanchard River, draining an area of about 16 mi^2 and is currently undesignated. It flows through an area where there are several quarries operating and receives the discharge from one, as well as industrial storm water discharges from at least 2 other stone related operations (Tables 3d and 3e). In all of the surface water grab samples collected in Aurand Run, strontium levels exceeded the OMZA and were 2-5 times higher than the levels in other streams in this WAU. Sampling during the survey had to be split between 2 sites because the first sampling site was torn up for reconstruction halfway through the survey period. This made some conclusions more difficult to formulate, but the nitrogen and phosphorus data from the 2 sites seem to indicate that there may be a localized source of untreated sewage somewhere upstream of both. The fecal coliform data also support this theory.

Recreation

An overall determination of the recreation use status was made for the entire WAU. Fecal coliform was used as the test organism because its presence indicates that water has been contaminated by feces from warm blooded animals. If bacteria levels are high enough (colony forming units or CFU/100 ml) there is a chance for people who come in contact with the water to become ill. Data used in the analysis includes samples collected during the May 1-October 15 recreation season obtained from both the 2005 stream survey and monthly operating reports filed by the Findlay WWTP. Valid results are pooled for statistical analysis and the recreation use is considered impaired if the 75^{th} percentile exceeds 1,000 or the 90^{th} percentile exceeds 2,000. Recreation is considered impaired based on these guidelines because the 75th percentile was 1,800, and 90th percentile was 4,600.

A site specific evaluation of the PCR use was done for Eagle Creek, as well as the Blanchard River mainstem within in the Eagle Creek WAU, because it is used for fishing and hunting. To determine if a site meets Ohio WQS criteria, a minimum of 5 samples must be collected within any 30 day period during the May 1-October 15 recreation season. The geometric mean calculated from this set of data should not exceed 1,000 and not more than 10% of the individual results should exceed 2,000. Results for fecal coliform testing done at 6 sites on the mainstem from June 27-July 25, and at 6 sites on Eagle Creek from June 30-July 28, are summarized in Table 3g. None of the Blanchard River sites violated WQS criteria, but all of the Eagle Creek sites exceeded 2,000 CFU/100 ml in at least 2 of 5 samples (40% or more) and the geometric means at all Eagle Creek sites exceeded 1,000 CFU/100 ml.

At most of the Eagle Creek sites the high fecal coliform samples were associated with high flow conditions following rain events. However, the fecal coliform levels in Eagle Creek at CR 27, the most upstream site, and at Lincoln St, the most downstream site, consistently violated the WQS criteria throughout the survey. At the upstream site, the source could be local septic tank discharges upstream that were not identified. The Lincoln St. site is downstream of the Eagle Creek Utility discharge and several City of Findlay CSOs; which are all contributing to high fecal coliform levels in Eagle Creek.

Sediment Quality

Sediment samples were tested for particle size distribution, organic carbon content, % solids, metals, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and organochlorine insecticides. Chemical concentrations are evaluated based on Ohio reference values (Ohio EPA, 2003) and consensus based toxicity guidelines (MacDonald et al, 2000). Ohio reference values are based on an ecoregion reference site approach and considered background concentrations for streams. The MacDonald guidelines consider concentrations below a threshold effect concentration (TEC) to be absent of toxicity and those above a probable effect concentration (PEC) to be toxic to benthic organisms.

Sediment sampling was conducted during low flow in October 2005, and no sediment was located in the Blanchard River mainstem downstream of the Liberty St. Dam until downstream at Broad St. The substrates upstream of Broad St. were too rocky or too sandy to provide a good sediment sample. However, an oily material was observed seeping from the bank in the area upstream of Broad St. Sediment samples had been collected in this stretch of the mainstem between the dam and Broad St. during April 2005 as part of the Brandman Tire Environmental Property Assessment (Hull & Assoc., 2005.), however, river flows at that time were much higher, and parts of the banks and sides of the channel would have been under water and considered sediment under those conditions. As the sample at Broad St. was being collected in October 2005, an oily sheen appeared on the water surface when the sediments were disturbed. Four sediment samples were collected in the Blanchard River mainstem between Broad St. and the next WAU (-040).

As stated in an earlier section, there is sediment deposition in the headwaters of Eagle Creek, but in most of the rest of the stream the substrate is essentially bedrock and in many places it is functionally comparable to a concrete slab. As you move downstream the silt is deposited only in a fine layer on the bedrock or in isolated pockets, until finally it becomes difficult to locate or identify any sediment component of the substrate. Only two samples were collected from Eagle Creek. The most upstream sample, at TR 32, was a sample of sediments mostly concentrated in one area in a pocket on the surface of the bedrock. As would be expected, these sediments were very fine, consisting entirely of silt and clay, with no sand. The other sample, although farther downstream, was collected in an area where there seemed to be a little more deposition, possibly because it was just downstream of the confluence with Buck Run. In contrast, this sample was about 69% sand, based on particle size. No sediment was located in Eagle Creek from Lincoln St. downstream to the mouth.

A summary of the organic compounds detected in the Blanchard River mainstem sediment samples collected in October 2005 is presented in Table 3h. Some of the results from the sediment samples collected in conjunction with the Brandman Tire Facility Property Assessment farther upstream in April 2005 are also included in this table for comparison. However, it should be noted that the Brandman Tire samples were analyzed by a different lab using lower detection limits, so several compounds that were detected in these samples, if present in the TMDL samples at the same level, would have gone undetected (any compound present at levels below about 0.6-0.8 mg/kg in the TMDL samples would have been undetected).

The Blanchard River sediments near Broad St. (RM 56.83) were contaminated with PAHs and PCBs. Six of the PAH compounds were detected at levels above the PECs, and this sample also likely exceeds the PEC guideline for total PAHs (it is within 0.66 mg/kg) given the higher detection limit of these samples. The Broad St. site is downstream of all the oil seepage and all the CSO discharges from the City of Findlay. It is more contaminated than any of the sites that were sampled adjacent to the Brandman Tire Facility. It was the only site with a relatively high level of PCBs detected in the sample; however the total concentration of PCBs found was still below the PEC guideline for aquatic life. A total of 6 PAH compounds were detected in the sediments downstream at CR 140, but at lower levels, and none exceeded the PECs. No organic compounds were detected in sediments further downstream within this WAU (-030). No PAHs or PCBs were detected in any of the Eagle Creek sediment samples. There was a low level (near the detection limit) of the pesticide 4,4'-DDE detected in the sediment sample collected from Eagle Creek at CR 24 (RM 11.57).

A summary of metal concentrations in sediment is presented in Table 3i. A few of the concentrations were slightly above Ohio reference values for the ECBP ecoregion, but none were elevated enough to be a concern. Some were also slightly above their respective TEC, but none were near the PEC. No aquatic life impact is expected based on the results.

Pollutant Loadings

Findlay WWTP (permit # 2PD00008) is the only major point source (>1 MGD) within the Eagle Creek WAU (-030). It is located at 1201 S. River Rd., and serves a population of about 42,300, along with industrial users that contribute about 1.029 MGD of process water. The plant was first modified in 1988, but then a major modification/reconstruction in 2000-2001 moved the treatment processes—consisting of 4 oxidation ditches, 5 secondary clarifiers, and UV disinfection—and the discharge to the west side of Broad St. The plant has an average design flow of 15 MGD with a planned peak flow of 40 MGD and currently discharges to the Blanchard River at RM 56.42. There are also 24 CSOs (Table 3f) discharging to the Blanchard River, Eagle Creek, Howard Run and Haggerman Run. Only the first 17 are listed in the current permit. The rest were discovered since the permit was issued and will be added when the permit is renewed; however, they have been numbered and are being monitored as part of the required Combined Sewer Operational Plan.

Although the changes made to the WWTP when it was re-built in 2001 have greatly improved the quality of the discharge, it remains a major source of nutrients, particularly nitrate-nitrite and phosphorus, to the Blanchard River. Figures 3j-3m show the effects that changes to the plant have had on the annual loadings of ammonia, nitrate-nitrite, and TSS. Improved treatment to remove ammonia has the consequence of increasing nitrate-nitrite in the effluent. This is considered a better alternative than discharging elevated levels of ammonia, though, because of its acute toxicity to aquatic life. Modifications in 1988 substantially reduced ammonia loadings (Figure 3j), but the new plant built in 2001 further reduced ammonia to the point where it has been nearly undectable in the effluent for the last 3 years. Figure 3k presents the same data as in Figure 3j, only scaled for the lower loading levels of ammonia in more recent years. It is difficult to see the relative effect on nitrate-nitrite in comparison over the entire historical time period, as self-monitoring of nitrate-nitrite was not required in the NPDES Permit for part of this time (Figure 3l), so there is a gap in the data.

Annual TSS loads have continued to decrease steadily over time even as flows have increased slightly (Figure 3m). Annual BOD_5 loads decreased dramatically as a result of the plant modifications in 1988 and remained low (Figure 3n). Figure 3o shows the annual loading of phosphorus to the Blanchard River from the Findlay WWTP. While phosphorus loadings were also decreased by the 1988 modifications, they appear to have been increasing again very slightly since 1998.

The Findlay WWTP reported only 4 violations of their NPDES permit during 2005. In January 2005, they reported 2 unexplained violations of the permit limits for mercury. However, as the result of a requested permit modification, mercury limits were later removed from the permit and replaced with only monitoring requirements. On 2 separate dates in July 2005, the plant also reported violations of the permit limits for fecal coliform bacteria with sample numbers “too numerous to count”.

Ohio EPA has conducted four whole effluent 48-hr screening bioassays of the Findlay WWTP Outfall 001 effluent since the plant was rebuilt in 2001. The bioassays were conducted on January 7-8 and February 4-5, 2002 and on June 6-7 and July 18-19, 2005. Screening bioassays using *Pimephales promelas* and *Ceriodaphnia dubia* as test organisms are routinely conducted as part of a toxics evaluation in conjunction with permit reissuance. The screening bioassays are utilized to determine if an effluent is acutely toxic to the test organisms and to indicate if more extensive bioassays should be conducted to estimate median lethal concentrations or persistence of toxicity.

In the January 2002 bioassay, the effluent was found to be acutely toxic to *Ceriodaphnia dubia*, but in all 3 bioassays that have been conducted since, the effluent was not acutely toxic to either test organism.

Arlington WWTP (permit # 2PA00050) is located on Fellowship Dr., Arlington and serves a population of about 1,500. The 3 lagoon system was constructed in 1975 and treatment consists of aeration, settling and chlorination/dechlorination. The plant has a continuous discharge to Buck Run at RM 0.75. Design flow is 0.168 MGD, but the plant has had an average annual discharge of 0.16-0.30 MGD between 2001-2005 and it has averaged >0.2 MGD in 3 of those 5 years. The Arlington WWTP reported no numeric violations of its NPDES Permit in 2005.

A history of pollutant loadings at the WWTP was evaluated using monthly operating report data. Annual loadings for ammonia and total phosphorus are displayed in Figures 3p and 3q. The 2005 loadings of ammonia and phosphorus to Buck Run from the Arlington WWTP discharge, which are among the lowest in recent years, are responsible for the sudden increase in those pollutants in Eagle Creek downstream of Buck Run mentioned in the water quality discussion above (Figures 3h and 3i).

Eagle Creek Utility (permit # 2PU00004) is located at the SR 15/US 68 intersection, Findlay and serves about 150 homes. Treatment consists of 2-stage oxidation lagoons with a controlled discharge to Eagle Creek at RM 3.37.

Camp Berry (permit # 2PR00146) is located at 11716 CR 40, Arlington and operates an extended aeration package plant designed to treat 15,000 gpd with settling, sand filters and chlorination/dechlorination. Discharge is to Eagle Creek. When the camp gets the most use during June-July the average flow through the plant is 1000 gpd. In the remaining months, flow is about 82 gpd on the weekends and there is only limited flow on the weekdays.

Sycamore Springs Golf Course (permit # 2PR00098) is located at 11492 TR 25, Arlington and operates 4000 gpd package plant. The wastewater discharges at RM 0.7 of Cottner Ditch, a tributary to Eagle Creek at RM 9.55.

Arlington WTP (permit # 2IZ00000) is located on Fellowship Dr., Arlington and discharges backwash water from 3 ion exchange softeners via an 18" tile to Cottner Ditch, a tributary to Eagle Creek at RM 9.55, at a rate of about 13,000 gpd. The discharge currently receives no treatment, but has not been meeting the Water Quality OZMA for chloride in Cottner Ditch. The WTP plant is evaluating alternative plans for bringing the discharge into compliance with this criterion. Some alternatives that have been considered include: 1) rerouting the discharge to Buck Run or Eagle Creek downstream of the WWTP discharge; 2) treatment options; 3) storage and controlled discharge. Another more likely alternative is to eliminate the discharge entirely by sending the backwash water to the WWTP. Upon acceptance, the plan will be incorporated into the NPDES Permit.

EnelCo, Inc. (AKA Tarbox-McCall Stone) Quarry (permit # 2IJ00064) is located at 852 Western Ave., Findlay and discharges 1 MGD of ground water and storm water after treatment by settling in a sedimentation pond. The quarry discharges to Oil Ditch at RM 2.80.

National Lime & Stone (permit # 2IJ00081) is located at 9840 CR 313, Findlay and discharges 1.5 MGD of ground water and storm water after treatment by settling in a sedimentation pond. The quarry discharges to Aurand Run.

BP Oil Findlay Bulk Plant (permit # 2IN00176) is located at 620 Western Ave., Findlay. Outfall 001 discharges storm water, after treatment by an oil/water separator, to a railroad ditch that is tributary to the Blanchard River. The design flow is 151 gpd, however, it discharges very infrequently.

Table 3A Aquatic life use attainment status for stations sampled in the Eagle Creek WAU assessment unit based on data collected July-September, 2005. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
Blanchard River			WWH - ECBP Ecoregion					
57.8/57.9	335	36*	9.7	12*	46.0	NON	Thermal modification, organic enrichment/DO, development related direct habitat alteration, siltation	Dam construction, urban runoff, combined sewer overflows
57.3/57.3	336	42	10.1	24*	63.0	Partial	Thermal modification, nutrients, organic enrichment/DO	Upstream impoundment, urban runoff, combined sewer overflows
56.9/56.8	336	38[ns]	9.3	16*	56.5	Partial	Thermal modification, nutrients, development related direct habitat alteration	Upstream impoundment, urban runoff, combined sewer overflows, channelization
55.2/54.7	346	36*	7.6*	42	54.5	Partial	Nutrients, organic enrichment/DO, thermal modification	Upstream impoundment, major municipal point source (Findlay)
			WWH -HELP Ecoregion					
49.8/49.8	378	38	9.7	46	61.5	Full		
46.5/46.5	387	39	9.7	44	65.5	Full		
Hydraulic Ditch			MWH recommended - ECBP Ecoregion					
1.5/____	6.6			G				
Flat Branch			WWH recommended - ECBP Ecoregion					
1.1/____	6.6			F*			Flow alteration, nutrients	Agricultural related channelization, crop production
0.1/0.1	10.9	26*		MG[ns]	54.0	NON	Flow alteration, nutrients, organic enrichment/DO	Agricultural related channelization, crop production
Buck Run			WWH - ECBP Ecoregion					
0.6/0.6	6.5	32*		P*	46.5	NON	Direct habitat alteration, ammonia, nutrients, organic enrichment/DO	Ag related channelization, crop production, Minor municipal point source (Arlington)
Eagle Creek			WWH - ECBP Ecoregion					
17.7/17.7	12.9	32*		MG[ns]	55.5	Partial	Flow alteration, nutrients	Crop production
14.0/13.9	28	30*	7.0*	32[ns]	66.0	Partial	Flow alteration, nutrients	Crop production
11.6/11.6	39	36[ns]	6.8*	F*	60.5	NON	Flow alteration, nutrients	Crop production
9.1/9.1	48	26*	8.4	MG[ns]	64.5	NON	Flow alteration, nutrients	Crop production
3.7/3.8	57	40	7.8[ns]	MG[ns]	66.0	Full		
0.5/0.5	61	32*	7.4*	G	62.5	Partial	Flow alteration, nutrients, ammonia	Crop production, minor municipal point source (Eagle Creek Utilities)
Aurand Run			WWH recommended - ECBP Ecoregion					
____/2.7	10.1	40			63.0	(Full)		

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
0.5/____	15.1			G				

Ecoregion Biocriteria: Eastern Corn Belt Plain

	IBI			MIwb			ICI		
Site Type	*WWH*	*EWH*	*MWH*	*WWH*	*EWH*	*MWH*	*WWH*	*EWH*	*MWH*
Headwaters	*40*	*50*	*24*				*36*	*46*	*22*
Wading	*40*	*50*	*24*	*8.3*	*9.4*	*4.0*	*36*	*46*	*22*
Boat	*42*	*48*	*24*	*8.5*	*9.6*	*4.0*	*36*	*46*	*22*

Ecoregion Biocriteria: Huron Erie Lake Plain

	IBI			MIwb			ICI		
Site Type	*WWH*	*EWH*	*MWH*	*WWH*	*EWH*	*MWH*	*WWH*	*EWH*	*MWH*
Headwaters	*28*	*50*	*20*				*34*	*46*	*22*
Wading	*32*	*50*	*20*	*7.3*	*9.4*	*5.6*	*34*	*46*	*22*
Boat	*34*	*48*	*20*	*8.6*	*9.6*	*5.7*	*34*	*46*	*22*

a- MIwb is not applicable to headwater streams with drainage areas ≤ 20 mi^2.
b- A narrative evaluation of the qualitative sample based on attributes such as community composition, EPT taxa richness, and number of sensitive taxa was used when quantitative data were not available or considered unreliable.
c- Attainment status based on a single organism group is parenthetically expressed. ID = insufficient data to meet credible data requirements.
d- Causes listed are considered to be a primary influence on water quality, but may not be the only issue leading to impairment. See text for discussion of additional causes that cumulatively have led to impairment.
e- Sources listed are considered to be a primary influence on water quality, but may not be the only source leading to impairment. See text for discussion of additional sources that cumulatively have led to impairment.
ns- Nonsignificant departure from biocriteria (≤4 IBI or ICI units, or ≤0.5 MIwb units).
** - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.*

Table 3b. Exceedences documented in the Eagle Creek WAU based on Ohio WQS criteria and nutrient target values. Criteria include outside mixing zone minimum or maximum (OMZM) and average (OMZA) values.

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Blanchard River WWH, PCR, AWS, IWS	57.73	WWH	dissolved oxygen	3 of 6 grabs > 140% saturation
			temperature	1 of 6 grabs above OMZM
				3 of 43 diurnals above OMZM*
				1 of 6 grabs above OMZA
				40 of 43 diurnals above OMZA*
			nitrate-nitrite	3 of 6 grabs above target
			strontium	3 of 6 grabs and median above OMZA
	57.42	WWH	dissolved oxygen	37 of 37 diurnals below OMZM*
	57.30	WWH	temperature	1 of 6 grabs above OMZA
				8 of 27 diurnals above OMZM*
				19 of 27 diurnals above OMZA*
			nitrate-nitrite	3 of 6 grabs above target
			strontium	2 of 6 grabs above OMZA
	56.83	WWH	temperature	2 of 6 grabs above OMZA
				12 of 41 diurnals above OMZM*
				29 of 41 diurnals above OMZA*
			nitrate-nitrite	3 of 6 grabs above target
			strontium	3 of 6 grabs above OMZA
	56.32	WWH	temperature	15 of 46 diurnals above OMZA*

*Data collected in 2006

Table 3b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Blanchard River WWH, PCR, AWS, IWS	55.26	WWH	dissolved oxygen	1 of 18 grabs below OMZA
				17 of 48 diurnals >140% saturation*
				Diurnal flux >5 mg/l*
			temperature	14 of 48 diurnals above OMZM*
				10 of 48 diurnals above OMZA*
			nitrate-nitrite	20 of 20 grabs and median above target
			phosphorus	15 of 20 grabs and median above target
	54.05	WWH	dissolved oxygen	9 of 46 diurnals below OMZM*
			temperature	13 of 46 diurnals above OMZM*
				12 of 46 diurnals above OMZA*
	49.78	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			nitrate-nitrite	6 of 6 grabs and median above target
			phosphorus	6 of 6 grabs and median above target
			strontium	5 of 6 grabs and median above OMZA
	46.49	WWH	dissolved oxygen	1 of 6 grabs below OMZM
				1 of 6 grabs below OMZA
			nitrate-nitrite	6 of 6 grabs and median above target
			phosphorus	6 of 6 grabs and median above target
			strontium	3 of 6 grabs and median above OMZA
Hydraulic Ditch WWH, PCR, AWS, IWS	1.50	WWH	phosphorus	1 of 6 grabs above target
			nitrate-nitrite	1 of 6 grabs above target
		PCR	fecal coliform	3 of 6 grabs above maximum

*Data collected in 2006

Table 3b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Flat Branch WWH, PCR, AWS, IWS	1.11	WWH	dissolved oxygen	1 of 6 grabs below OMZM
				1 of 6 grabs below OMZA
			phosphorus	5 of 6 grabs and median above target
			nitrate-nitrite	2 of 6 grabs above target
	0.06	WWH	dissolved oxygen	1 of 5 grabs below OMZM
				3 of 5 grabs below OMZA
			phosphorus	5 of 5 grabs and median above target
			nitrate-nitrite	1 of 5 grabs above target
Buck Run WWH, SCR, AWS, IWS	0.56	WWH	dissolved oxygen	1 of 6 grabs below OMZM
			ammonia	3 of 6 grabs above OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	4 of 6 grabs and median above target
			strontium	3 of 6 grabs and median above OMZA
Eagle Creek WWH, PCR, AWS, IWS	17.69	WWH	dissolved oxygen	1 of 6 grabs below OMZA
				1 of 6 grabs > 140% saturation
			phosphorus	1 of 6 grabs above target
			nitrate-nitrite	1 of 6 grabs above target
			strontium	4 of 6 grabs and median above OMZA
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum

Table 3b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Eagle Creek WWH, PCR, AWS, IWS	13.94	WWH	dissolved oxygen	3 of 6 grabs below OMZA
			phosphorus	3 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum
	11.57	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	4 of 6 grabs and median above target
			strontium	3 of 6 grabs above OMZA
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum
	9.12	WWH	dissolved oxygen	1 of 6 grabs below OMZM
				1 of 6 grabs below OMZA
			phosphorus	5 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
			strontium	5 of 6 grabs and median above OMZA
		HH	aluminum	1 of 6 grabs above OMZA
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum

Table 3b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Eagle Creek WWH, PCR, AWS, IWS	3.75	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			phosphorus	5 of 6 grabs and median above target
			nitrate-nitrite	2 of 6 grabs above target
			strontium	3 of 6 grabs above OMZA
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum
	0.45	WWH	dissolved oxygen	1 of 10 grabs below OMZM
				4 of 10 grabs below OMZA
			phosphorus	11 of 12 grabs and median above target
			nitrate-nitrite	3 of 12 grabs above target
			strontium	1 of 12 above OMZA
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum
Aurand Run WWH, PCR, AWS, IWS	0.50-1.96	WWH	dissolved oxygen	1 of 5 grabs below OMZM
			phosphorus	1 of 5 grabs above target
			nitrate-nitrite	3 of 5 grabs and median above target
			strontium	5 of 5 grabs and median above OMZA
		PCR	fecal coliform	2 of 6 grabs above site specific maximum

Table 3c. Summary of hourly dissolved oxygen measurements (mg/L) recorded by automatic meters deployed at sites in the Blanchard River mainstem and tributaries in 2006. Highlighted values indicate a WQS violation.

River Mile	Hours	Mean	Median	Minimum	Maximum	Flux
Blanchard River						
57.73	43	6.12	6.43	4.49	7.67	3.18
57.42	37	0.62	0.66	0.06	1.47	1.41
57.30	27	7.28	7.16	6.77	7.90	1.13
56.83	41	5.87	5.79	4.43	8.77	4.34
56.32	46	7.58	7.29	6.09	9.78	3.69
55.26	48	10.09	9.76	6.59	14.82	8.23
54.05	46	4.91	4.74	3.65	6.55	2.90
Howard Run						
0.18	44	5.68	5.52	5.02	6.71	1.69
Blanchard River Tributary (RM 54.30)						
0.05	41	5.85	5.79	5.35	6.40	1.05

Table 3d. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Findlay WWTP	2PD00008	Blanchard River	56.42	15.0 MGD Oxidation ditches, secondary clarifiers and UV disinfection
National Lime & Stone	2IJ00081	Aurand Run		1.5 MGD Sedimentation pond
Enelco, Inc. (Tarbox-McCall Stone) Quarry	2IJ00064	Oil Ditch	2.80	1.0 MGD Sedimentation pond
BP Oil Findlay Bulk Plant	2IN00176	RR ditch to Blanchard R		151 gpd Oil/water separator
Eagle Creek Utility Co.	2PU00004	Eagle Creek	3.37	2-stage oxidation lagoons with controlled discharge; plans to tie-in to Findlay WWTP?
Camp Berry	2PR00146	Eagle Creek		0.015 MGD package plant
Arlington WWTP	2PA00050	Buck Run Creek	0.75	0.168 MGD continuous discharge lagoon system
Arlington WTP	2IZ00000	Cottner Ditch to Eagle Creek		Backwash water from ion exchange softeners - no treatment; evaluating alternatives
Sycamore Springs Golf Course	2PR00098	Cottner Ditch to Eagle Creek	0.70	0.004 MGD package plant

Table 3e. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Ball Metal Beverage Container Corp	2GG00050	Howard Run	Industrial Storm water
Centrex Corp	2GR00204	Oil Ditch	Industrial Storm water
Centrex Corp	2GR00205	Oil Ditch	Industrial Storm water
Centrex Corp	2GR00207	City of Findlay Storm Sewers	Industrial Storm water
Centrex Corp	2GR00208	Oil Ditch	Industrial Storm water
Centrex Corp	2GR00210	Oil Ditch	Industrial Storm water
Cooper Tire & Rubber Co	2GG00078	Oil Ditch	Industrial Storm water
Dow Chemical Co	2GR00261	Howard Run	Industrial Storm water
Dukes Transportation Services Inc	2GR00100	Aurand Run	Industrial Storm water
Garner Trucking Inc	2GG00143	Aurand Run	Industrial Storm water
Hancor Inc	2GR00034	Eagle Creek	Industrial Storm water
Hancor Inc	2GR00035	Eagle Creek Tributary	Industrial Storm water
Hyway Trucking Company	2GG00031	Blanchard River Trib	Industrial Storm water
National Lime & Stone Co	2GR00068	Aurand Run	Industrial Storm water
Owens Brockway Plastic Products Inc	2GG00286	Oil Ditch	Industrial Storm water
Owens Brockway Plastic Products Inc	2GR00299	Oil Ditch	Industrial Storm water
Remington Arms Co Inc	2GR00398	Eagle Creek	Industrial Storm water
Spectrulite Consortium Inc	2GR00092	Blanchard River Trib	Industrial Storm water
Stoneco Inc	2GR00478	Aurand Run	Industrial Storm water
Waste Management Of Ohio Inc	2GG00254	Oil Ditch	Industrial Storm water
Waste Management Of Ohio Inc	2GR00160	Oil Ditch	Industrial Storm water

Table 3e. Continued.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Werk Brau Company Inc	2GR00289	City of Findlay Storm Sewers	Industrial Storm water
Whirlpool Corp	2GR00258	City of Findlay Storm Sewers?	Industrial Storm water
Wyandot Dolomite Inc	2GG00047	Aurand Run	Industrial Storm water
Blanchard Valley Health Assoc	2GC00551	City of Findlay Storm Sewers	Construction Storm water
Blanchard Valley Health Assoc	2GC00998	Blanchard River Trib	Construction Storm water
Brookview Homes Inc	2GC01242	Blanchard River Trib	Construction Storm water
C-International	2GC00111	Howard Run	Construction Storm water
City Of Findlay	2GC00055	Blanchard River	Construction Storm water
Compass Environmental Inc	2GC00510	Oil Ditch	Construction Storm water
ES Wagner Co	2GC00785	Eagle Creek	Construction Storm water
ES Wagner Co	2GC00788	Eagle Creek	Construction Storm water
ES Wagner Co	2GC00795	Hydraulic Ditch	Construction Storm water
ES Wagner Co	2GC00799	Flat Branch	Construction Storm water
ES Wagner Co	2GC00800	Flat Branch	Construction Storm water
Findlay 75 LLC	2GC00088	Blanchard River Trib	Construction Storm water
Findlay Professional Park LLC	2GC00399	Lake Cascades	Construction Storm water
Flag City Development Ltd	2GC00146	County Storm Sewer	Construction Storm water
Gateway Church	2GC00464	Aurand Run	Construction Storm water
Hancock Co Engrs Office	2GC01276	Howard Run	Construction Storm water
Hancock Co Engrs Office	2GC00514	Eagle Creek	Construction Storm water
Hancock Co Engrs Office	2GC00556	Blanchard River	Construction Storm water
Jim Baker	2GC00418	Aurand Run	Construction Storm water

Table 3e. Continued.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Marathon Ashland Pipe Line LLC	2GC00959	City of Findlay Storm Sewer to Blanchard River	Construction Storm water
Nigh Properties LLC	2GC00940	Storm Sewer to Eagle Ck	Construction Storm water
ODOT District 1	2GC00203		Construction Storm water
ODOT District 1	2GC00506	Riley Ck Tribs, Eagle Ck, Flat Branch, Blanchard R	Construction Storm water
ODOT District 1	2GC00637	Aurand Run	Construction Storm water
ODOT District 1	2GC00656	Blanchard River	Construction Storm water
ODOT District 1	2GC00695	Blanchard River	Construction Storm water
ODOT District 1	2GC01137	Blanchard River	Construction Storm water
RG Properties Inc	2GC00541	Blanchard River	Construction Storm water
Speedway Superamerica LLC	2GC00385	City Of Findlay MS4	Construction Storm water
Westend Properties Ltd	2GC00813	State Storm Sewer To Blanchard River Trib	Construction Storm water
Whitson Properties	2GC01133	Blanchard River Trib	Construction Storm water
Wick's Construction Co Inc	2GC00458	Ditch to Blanchard R	Construction Storm water
Wick's Construction Co Inc	2GC00803	Ditch to Blanchard R	Construction Storm water
BP Oil Company	2GU00030	Dalzell Ditch	Petroleum Corrective Action
Petroleum Systems Inc	2GU00014	Oil Ditch	Petroleum Corrective Action
Petroleum Systems Inc	2GU00041	Storm Sewer to Eagle Ck	Petroleum Corrective Action

Table 3f. City of Findlay List of Known Combined Sewer Overflows

CSO #	Description	Receiving Stream
002	End of Edinborough Drive	Dalzell Ditch
003	Mouth of Howard Run at river	Howard Run
004	East of WWTP	Blanchard River
005	Northwest Street and High Street	Blanchard River
006	North side of Liberty Street Dam	Blanchard River
007	Liberty Street	Blanchard River
008	South End of Taylor Street	Blanchard River
009	East Front and East Street	Blanchard River
010	Hancock Street	Eagle Creek
011	Bank and First Street	Eagle Creek
012	South Main Street and Sixth	Eagle Creek
013	East Sandusky and Blanchard Street	Eagle Creek
014	South West and West Front Street	Blanchard River
015	Shinkle and Findlay Street	Blanchard River
016	Northwest of Hull and Milton	Blanchard River
017[a]	Bolton and Prentiss	Dalzell Ditch
018	East end of Tioga Avenue	Howard Run
019	North Cory at Walnut Street alley	Blanchard River
020	East Pearl at alley east of Main Street	Eagle Creek
021	Marshall south of Findlay Street	Blanchard River
022	West Front and Main Street	Blanchard River
023	East Street and East Sandusky	Blanchard River
024	Washington Street and Marshall	Blanchard River
025	Park Street and First Street	Eagle Creek
026	Fairway and Greendale	Haggerman Run

[a] Overflow 017 was removed in spring 2003.

Table 3g. Site specific recreation use assessment in the Blanchard River mainstem and Eagle Creek. Highlighted values indicate an Ohio WQS criteria violation.

Sampling Location	River Mile	Fecal Coliform Count (CFU/100 ml)					
Blanchard River		6/27/05	7/6/05	7/11/05	7/19/05	7/25/05	Geometric Mean
Main St	57.73	34	1,200	200	1,000	300	300
Dst Liberty St Dam	57.30	200	1,200	270	1,200	470	516
Ust Broad St	56.83	230	1,400	270	1,300	430	546
CR 140	55.26	710	1,200	1,300	1,000	650	914
CR 128	49.78	250	400	180	2,000	330	412
SR 235	46.49	150	620	140	1,000	470	361
Eagle Creek		6/30/05	7/7/05	7/14/05	7/21/05	7/28/05	Geometric Mean
TR 27	17.69	3,400	4,000	3,000	130,000	4,000	8,309
TR 32	13.94	960	890	1,800	2,400	5,000	1,792
CR 24	11.57	1,000	260	1,200	9,000	3,400	1,570
CR 26	9.12	2,200	520	1,200	9,400	6,000	2,387
Main St	3.75	2,500	1,600	150	7,400	5,100	1,866
Lincoln St	0.45	>10,000	4,200	>10,000	6,000	1,900	5,445

Table 3h. Organic compounds detected in sediments collected from the Blanchard River and Eagle Creek. Values in Bold exceed Concensus-Based Sediment Quality Guideline Probable Effect Concentrations (PECs).

COMPOUND (mg/kg) except where noted	Sampling Location and River Mile							
	Blanchard River – TMDL Survey (August - November 2005)				Blanchard River – Brandman Tire Facility Assessment (April 2005)		Eagle Creek – TMDL Survey (November 2005)	
	SR 235 (46.49)	CR 128 (49.78)	CR 140 (55.26)	Broad St (56.83)	Downstream Liberty St Dam[1]	Upstream Liberty St Dam[2]	CR 24 (11.57)	TR 32 (13.94)
Acenaphthene	-	-	-	-	0.105	0.0605	-	-
Acenaphthylene	-	-	-	-	0.0365	0.0201	-	-
Anthracene	-	-	-	-	0.188	0.125	-	-
Benz[a]anthracene	-	-	-	1.35	0.896	0.754	-	-
Benzo[a]pyrene	-	-	0.83	1.75	0.782	0.677	-	-
Benzo[b]fluoranthene	-	-	1.18	1.88	1.19	1.08	-	-
Benzo[g,h,i]perylene	-	-	-	1.54	0.551	0.493	-	-
Benzo[k]fluoranthene	-	-	-	1.72	0.342	0.291	-	-
Chrysene	-	-	1.12	2.00	0.933	0.792	-	-
Fluoranthene	-	-	2.10	4.75	1.92	1.51	-	-
Fluorene	-	-	-	-	0.162	0.0828	-	-
Indeno[1,2,3-cd]pyrene	-	-	0.86	1.73	0.458	0.414	-	-
2-Methylnaphthalene	-	-	-	-	0.0224	0.0367	-	-
Naphthalene	-	-	-	-	0.0202	-	-	-
Phenanthrene	-	-	0.80	1.90	1.41	0.926	-	-
Pyrene	-	-		3.52	1.94	1.56	-	-
Total PAHs (mg/kg)	-	-	8.46	22.14	10.95	8.82	-	-
PCB-1254 (ug/kg)	-	-	-	318	0.237	-	-	-
PCB-1260 (ug/kg)	-	-	-	74.1	-	-	-	-
Total PCBs (ug/kg)	-	-	-	392.1	0.237	-	-	-
4,4'-DDE (ug/kg)	-	-	-	-	-	-	8.4	-

[1]Values presented are the greatest level of the compound detected at any of the 3 locations sampled downstream of the Liberty St. Dam.

[2]Values presented are the greatest level of the compound detected at any of the 3 locations sampled upstream of the Liberty St. Dam.

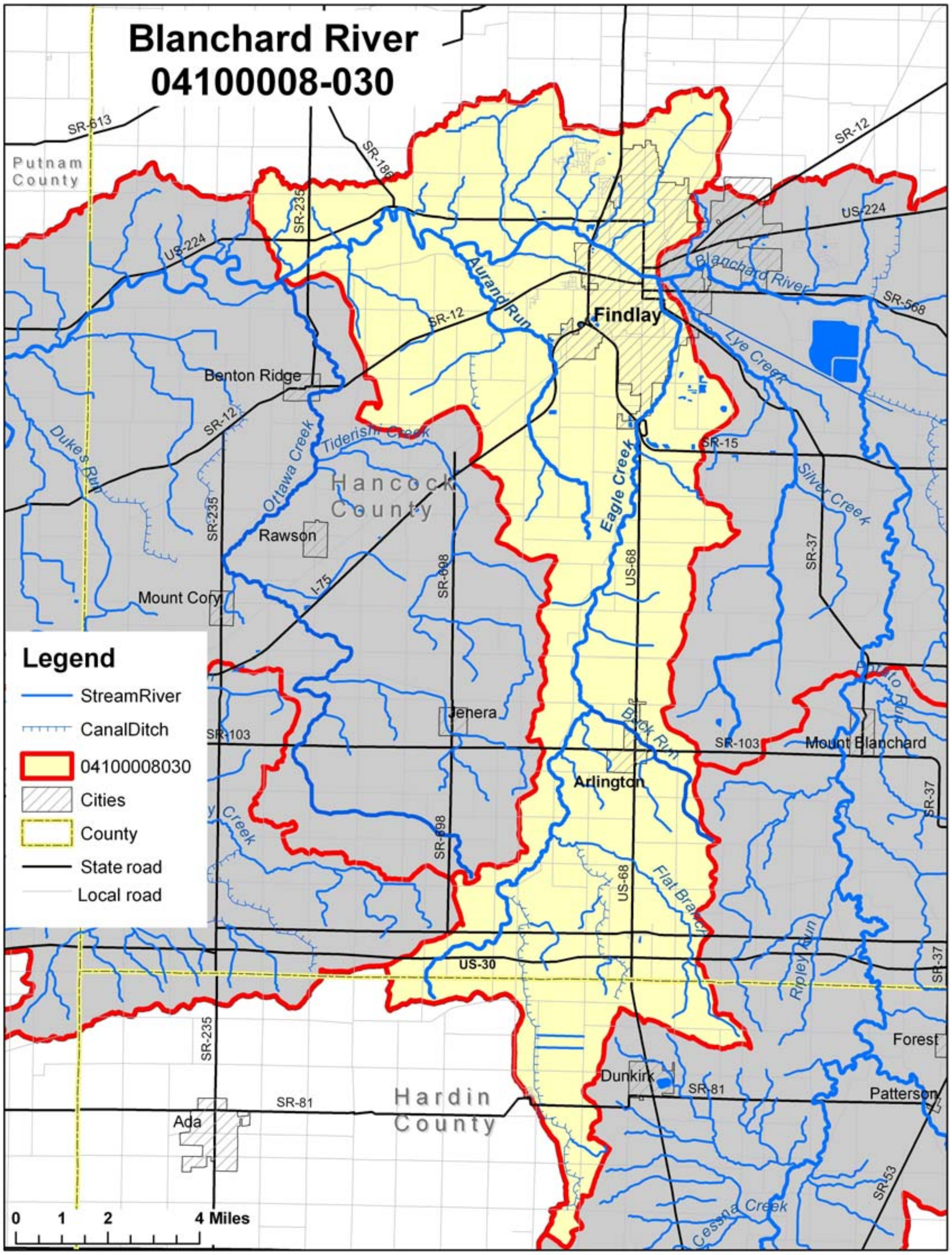
Table 3i. Metal concentrations (mg/kg) in sediment collected from the Blanchard River and Eagle Creek. Highlighted values were above either the statewide (*) or appropriate ecoregion sediment reference value (SRV). Values reported as less than were below the quantitation limit.

Element	Sampling Location and river mile							
	SRV		Blanchard River				Eagle Creek	
	HELP	ECBP	SR 235 (46.49)	CR 128 (49.78)	CR 140 (55.26)	Broad St (56.83)	TR 32 (13.94)	CR 24 (11.57)
Aluminum	42,000	39,000	21,200	22,800	31,300	16,100	29,700	18,600
Barium	210	240	114	122	164	101	160	104
Calcium	110,000	120,000	19,200	19,100	29,400	44,500	26,500	19,500
Chromium	51	40	26	29	37	26	34	23
Copper	42	34	13.6	15.8	26.8	23.9	19.7	15.2
Iron	44,000	33,000	18,200	19,500	22,200	16,600	24,400	17,000
Lead	47 *	47 *	28	31	<31	<28	<31	<24
Magnesium	29,000	35,000	8,530	8,860	13,100	17,700	9,380	7,720
Manganese	1,000	780	366	382	370	320	468	282
Nickel	36	42	<22	<31	<31	<28	<31	<24
Potassium	12,000	11,000	5,840	6,000	7,930	4,470	8,820	5,540
Sodium	-	-	<2,690	<3,870	<3,880	<3,490	<3,910	<3,000
Strontium	250	390	183	250	266	262	196	177
Zinc	190	160	103	121	154	142	79.6	61.9
Mercury	0.12 *	0.12 *	0.113	0.071	0.120	0.064	<0.047	<0.038
Arsenic	11	18	8.03	7.87	9.08	7.70	10.7	5.74
Cadmium	0.96	0.90	0.376	0.416	0.630	0.651	0.412	0.362
Selenium	1.4	2.3	<1.08	<1.55	<1.55	<1.40	1.56	<1.20
Solids (%)	-	-	64.0	50.7	49.5	54.0	48.3	58.5
TOC (%)	-	-	4.1	4.5	4.6	5.6	3.2	3.3

Table 3j. Summary of herbicides (µg/L) detected in the Eagle Creek WAU. Values reported as less than (<) were below the lab quantitation limit.

Blanchard River at CR 140 (RM 55.26)						
Compound (Trade Name)	6/13/05	6/27/05	7/11/05	7/25/05	8/8/05	8/22/05
Acetochlor (Harness)	<0.21[UJ]	<0.22	0.44	0.62[J]	<0.21	<0.21
Atrazine (AAtrex)	<0.21[UJ]	0.73	2.08	1.39[J]	0.69	0.48
Metolachlor (Dual)	<0.21[UJ]	0.27	0.64	1.25[J]	0.36	0.25
Metribuzin (Sencor)	<0.21[UJ]	<0.22	<0.21	<0.21[UJ]	<0.21	<0.21
Simazine (Princep)	<0.21[UJ]	0.25[J]	0.33	0.22[J]	<0.21	<0.21
Eagle Creek at Lincoln St (RM 0.45)						
Compound (Trade Name)	6/16/05	6/30/05	7/14/05	7/28/05	8/11/05	8/25/05
Acetochlor (Harness)	<0.21	<0.20[UJ]	<0.21	0.34[J]	<0.21	<0.21
Atrazine (AAtrex)	0.89	0.77[J]	0.54	0.85[J]	0.48	0.29
Metolachlor (Dual)	0.28	0.25[J]	0.23	0.69[J]	0.34	0.24
Metribuzin (Sencor)	<0.21	<0.20[UJ]	<0.21[UJ]	<0.20[UJ]	<0.21	<0.21
Simazine (Princep)	0.21	<0.20[UJ]	<0.21	0.24[J]	<0.21	<0.21

[J] The compound was positively identified, but the associated value is estimated.
[UJ] The compound was not detected above the quantitation limit and the quantitation limit is estimated.


Blanchard River
04100008-030
Legend
StreamRiver
CanalDitch
04100008030
Cities
County
State road
Local road
0 1 2 4 Miles
Putnam County
Hancock County
Hardin County
Findlay
Benton Ridge
Rawson
Mount Cory
Jenera
Arlington
Mount Blanchard
Dunkirk
Ada
Forest
Patterson
Blanchard River
Aurand Run
Lye Creek
Tiderishi Creek
Ottawa Creek
Duke's Run
Eagle Creek
Silver Creek
Potato Run
Buck Run
Flat Branch
Ripley Run
Cessna Creek
SR-613
SR-186
SR-12
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SR-53

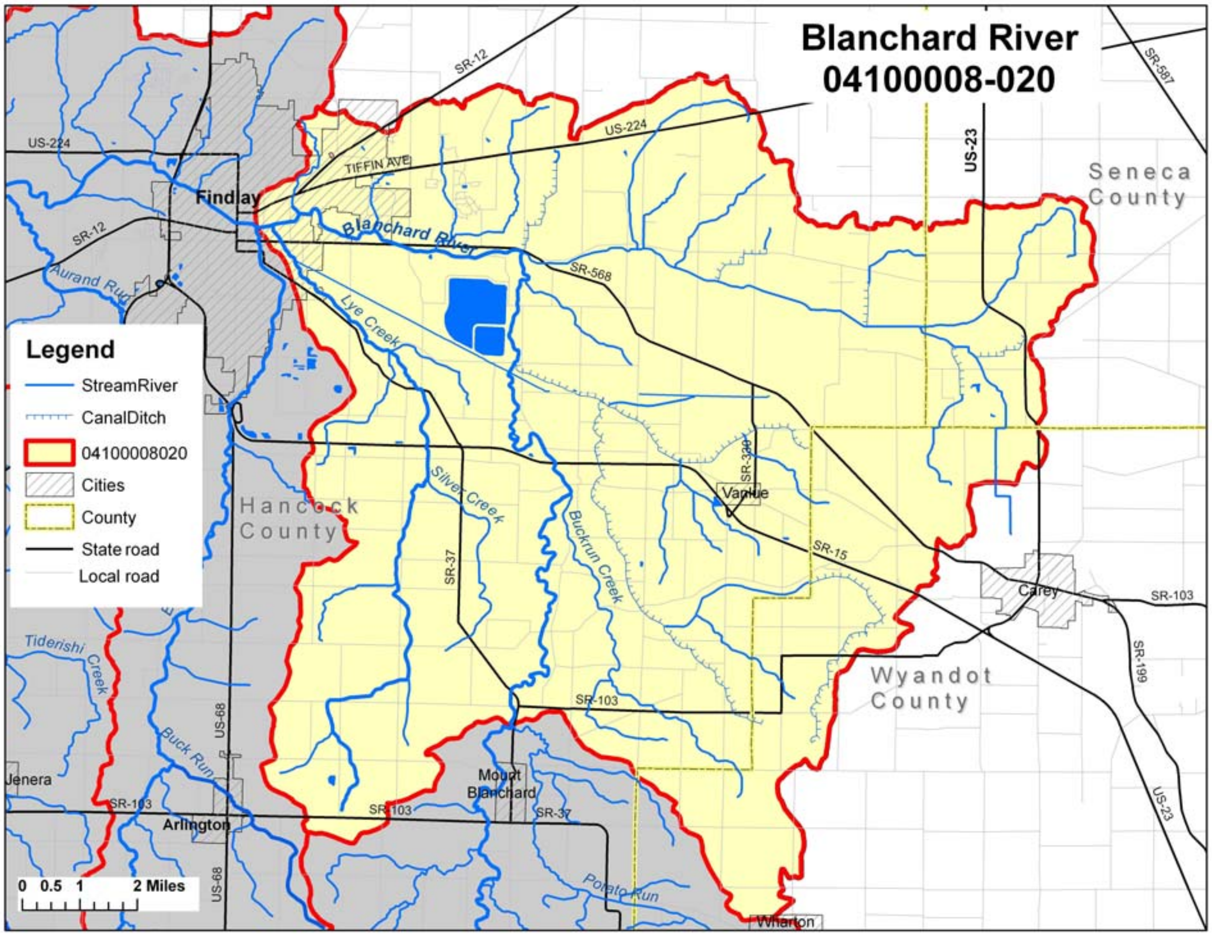

Figure 3a. Map of the Eagle Creek WAU showing principal streams, urban areas, and roadways.

HUC 04100008 030

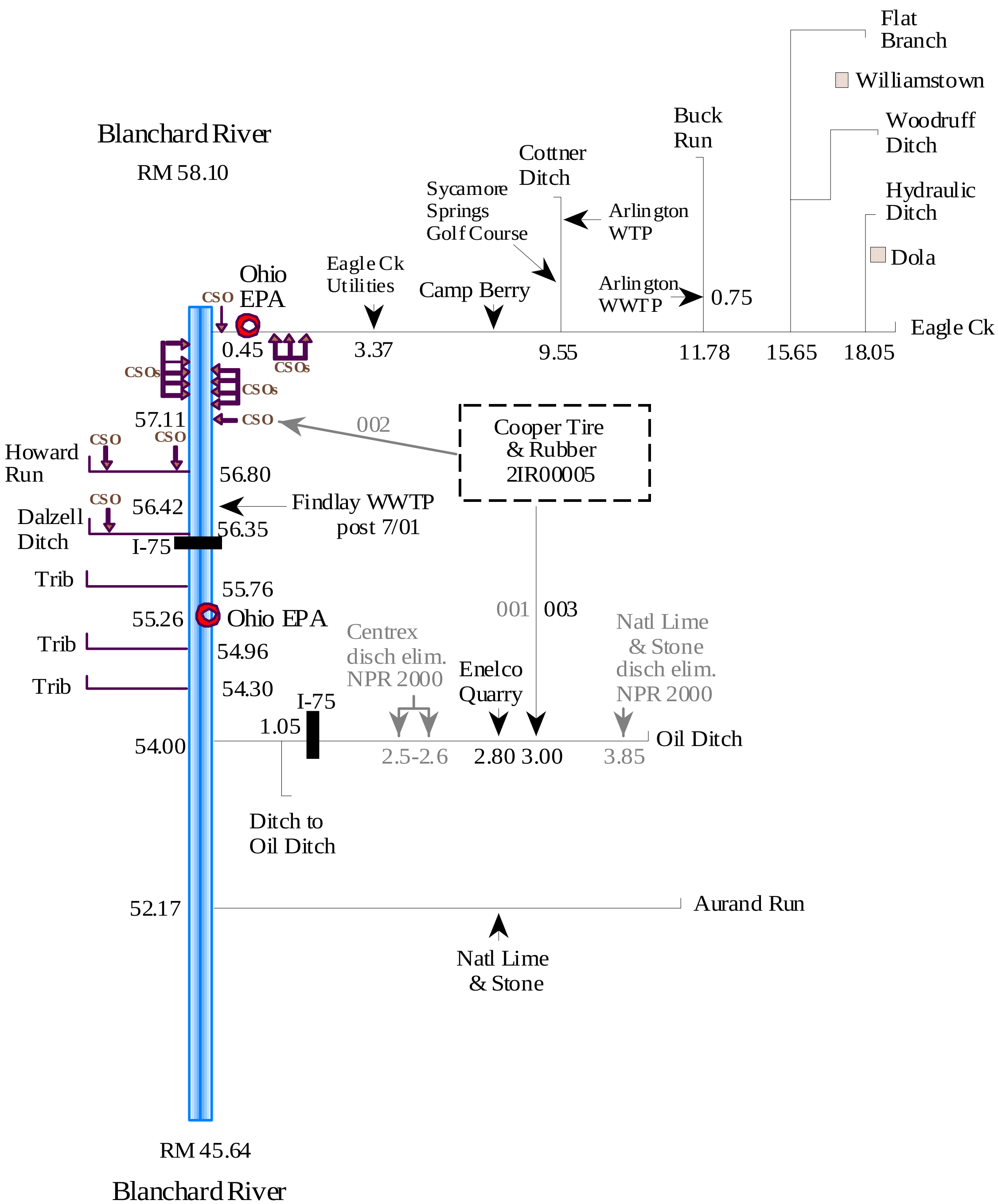

Figure 3b. Schematic of the Eagle Creek WAU (-030).

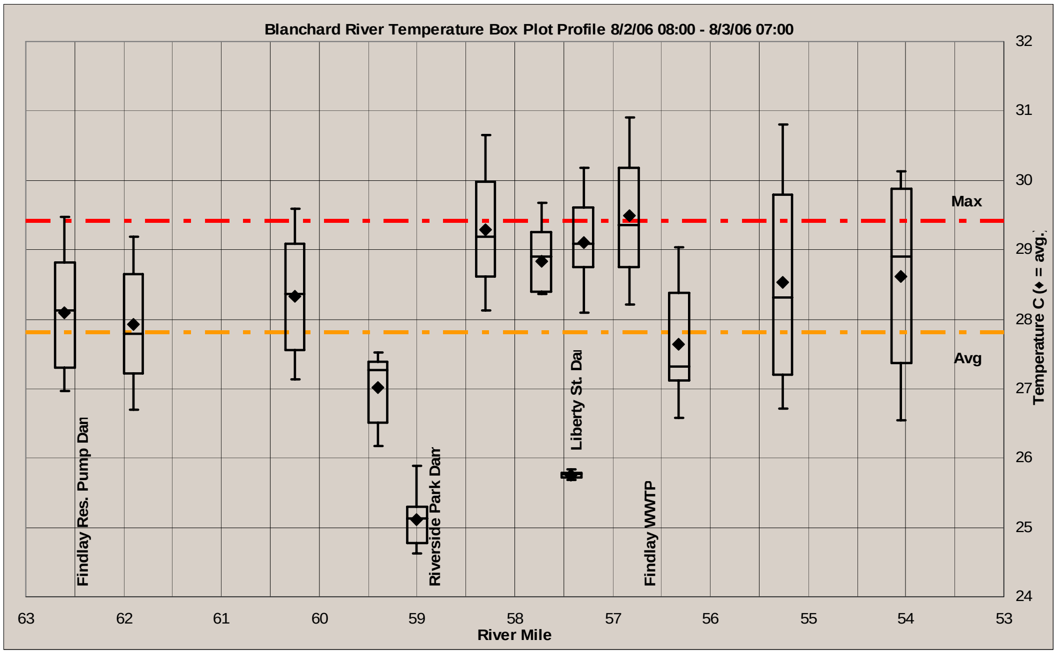

Figure 3c. Temperature profile of Blanchard River mainstem measured hourly over a 24 hr. period using multi-parameter automatic meters, plotted against average and maximum temperature criteria.

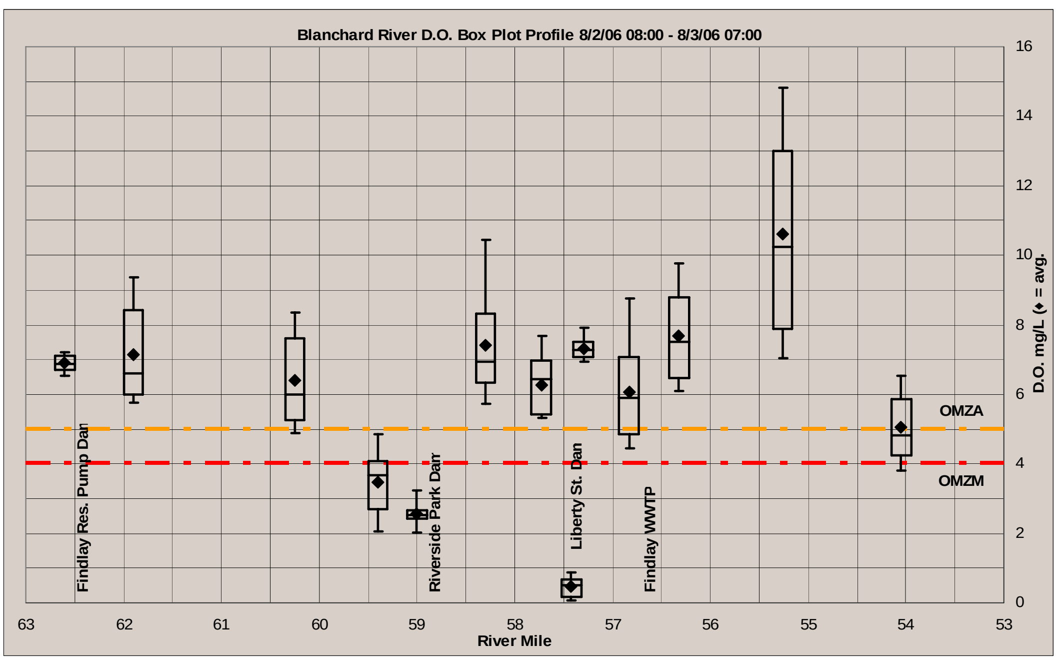

Figure 3d. Dissolved oxygen profile of Blanchard River mainstem measured hourly over a 24 hr. period using multi-parameter automatic meters, plotted against average (OMZA) and minimum (OMZM) dissolved oxygen criteria.

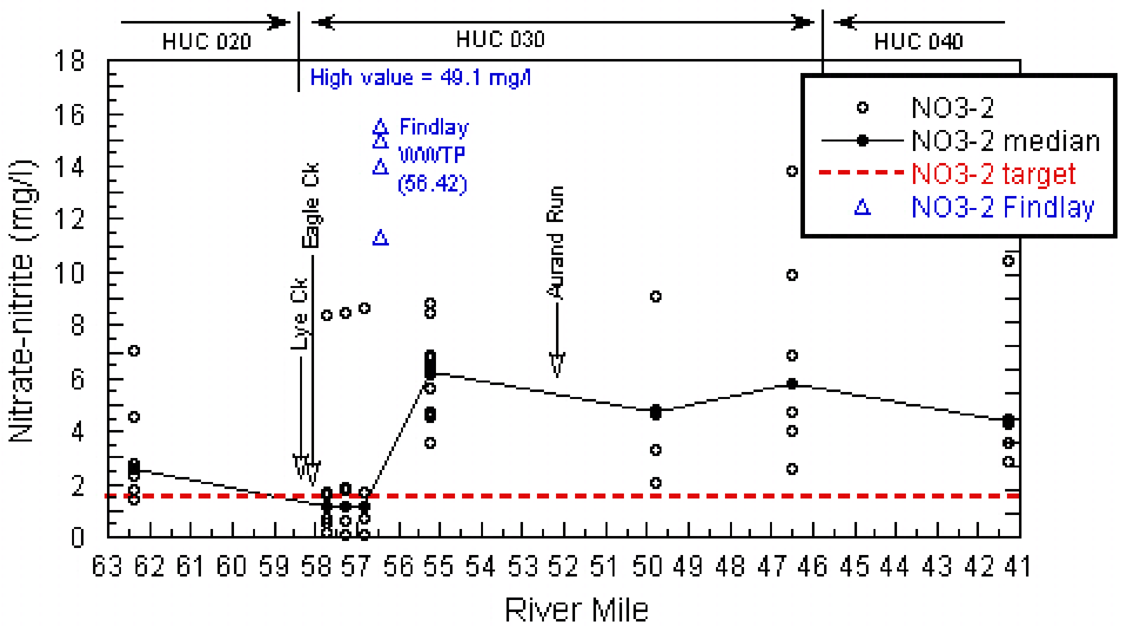

Figure 3e. Summary of nitrate-nitrite concentrations measured in grabs from the Blanchard River mainstem plotted against the target level.

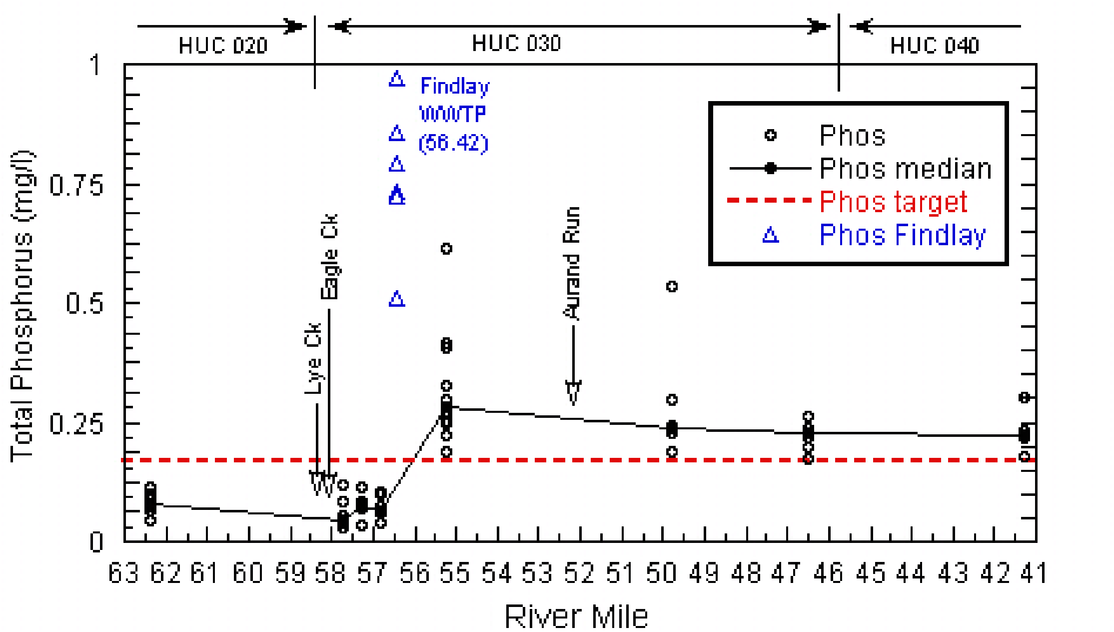

Figure 3f. Summary of total phosphorus concentrations measured in grabs from the Blanchard River mainstem plotted against the target level.

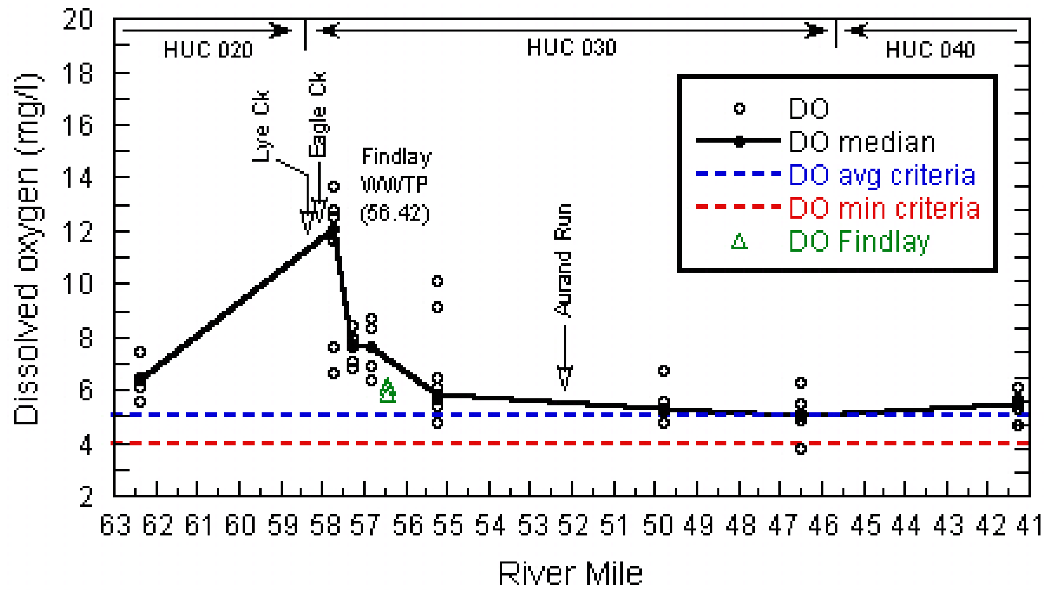

Figure 3g. Summary of dissolved oxygen concentrations measured in daytime grabs from the Blanchard River mainstem plotted against average and minimum criteria.

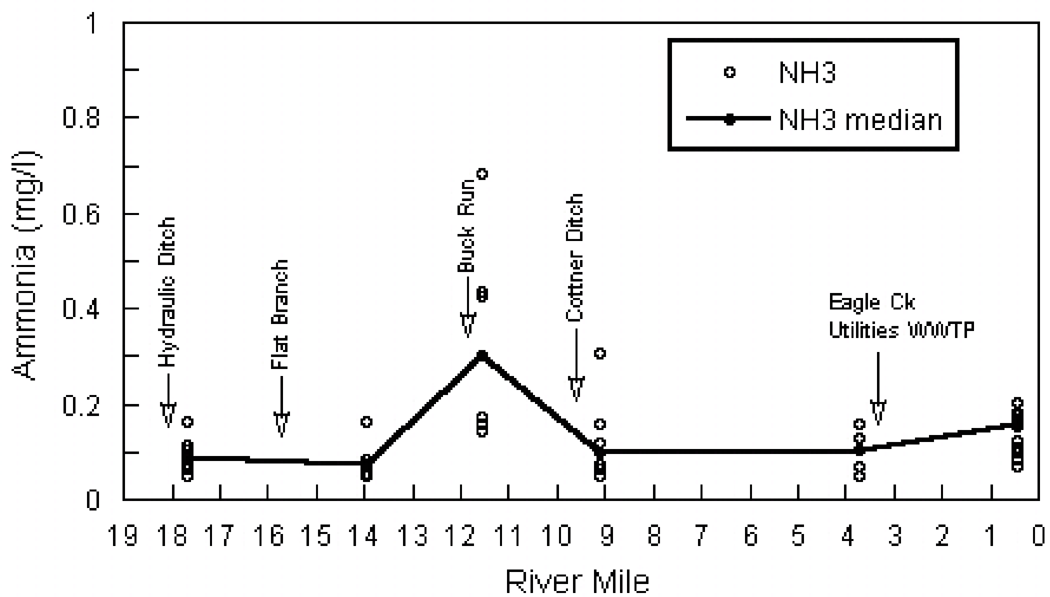

Figure 3h. Summary of ammonia concentrations measured in daytime grabs from the Eagle Creek mainstem.

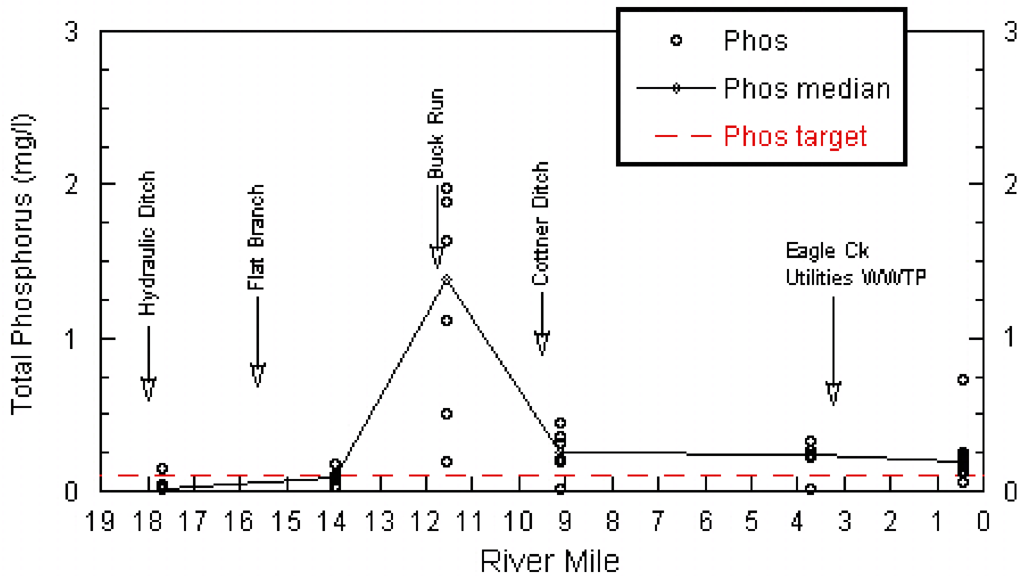

Figure 3i. Summary of total phosphorus concentrations measured in grabs from the Eagle Creek mainstem plotted against the target level.

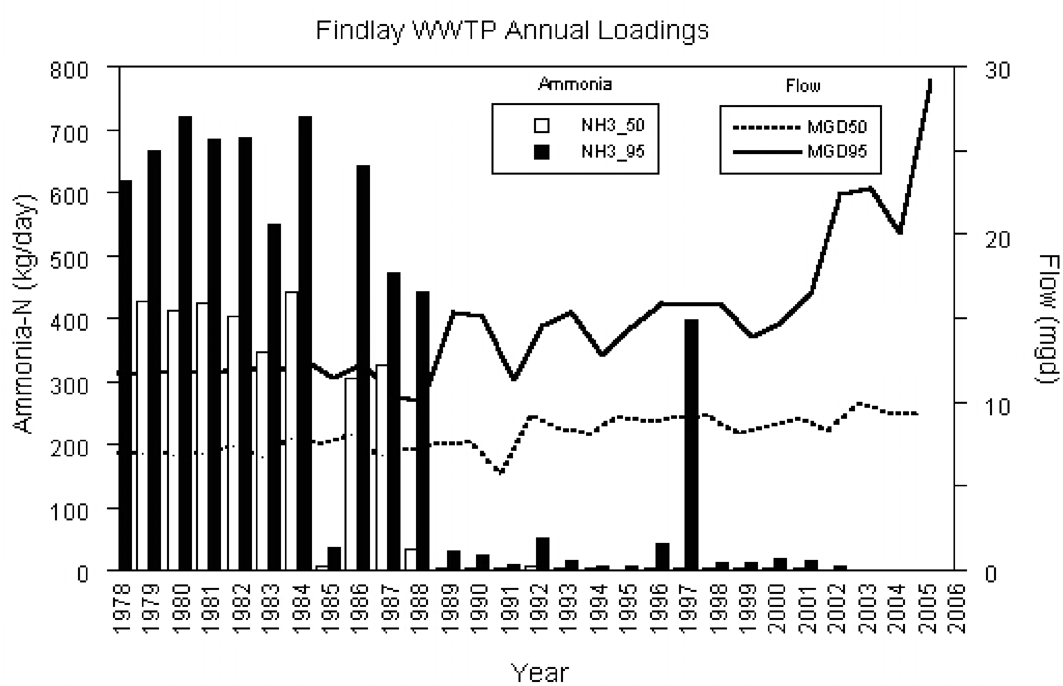

Figure 3j. Annual summary of MOR data for ammonia collected at the Findlay WWTP.

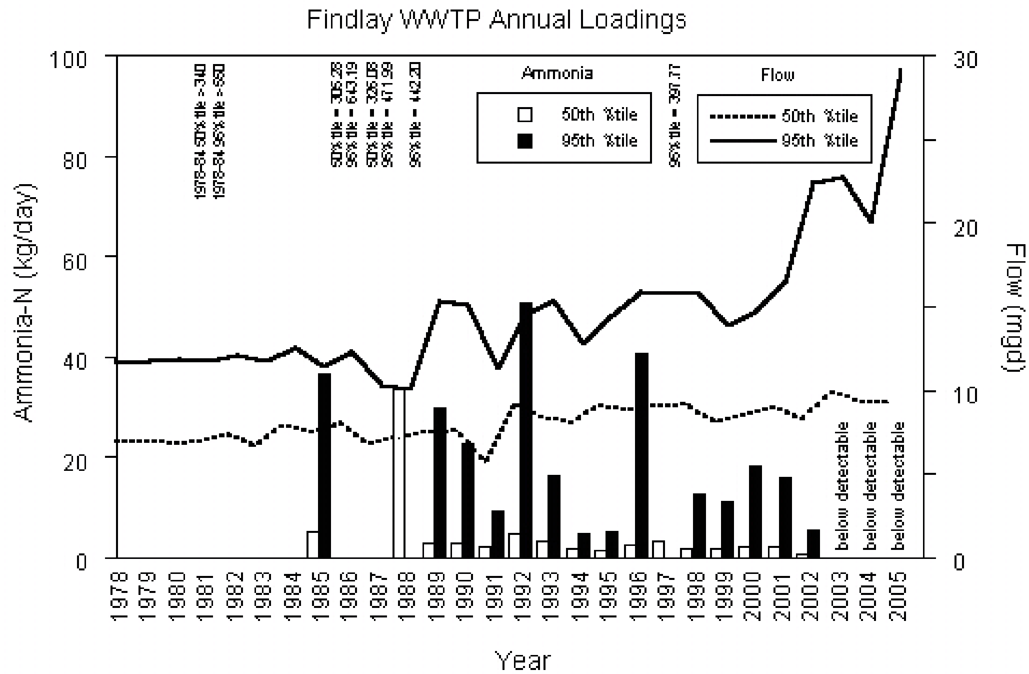

Figure 3k. Annual summary of MOR data for ammonia collected at the Findlay WWTP.

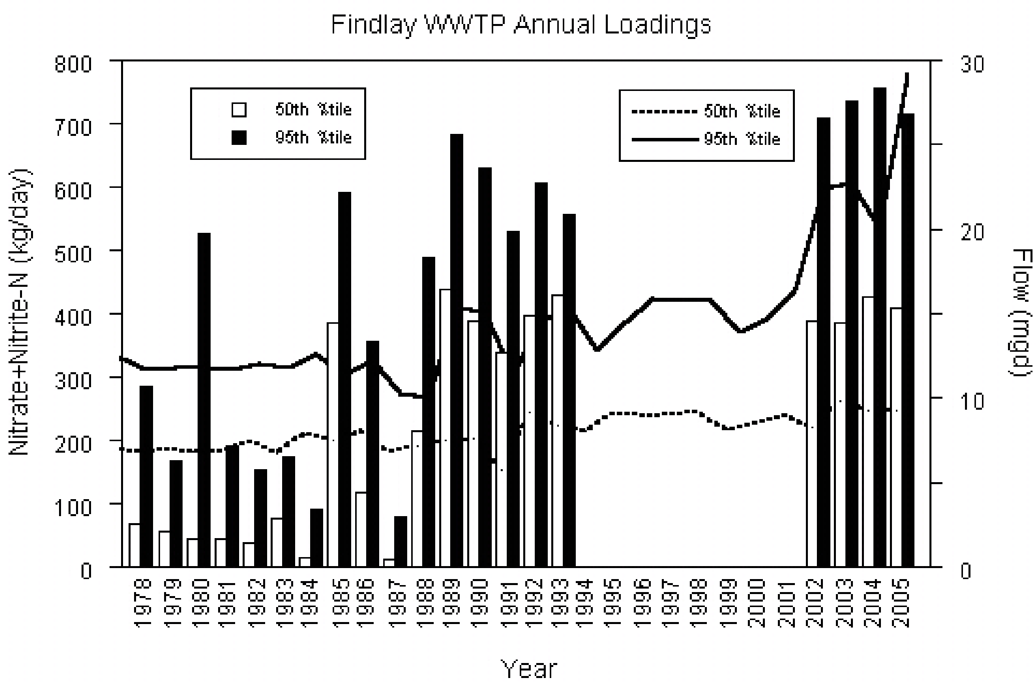

Figure 3l. Annual summary of MOR data for nitrate-nitrite collected at the Findlay WWTP.

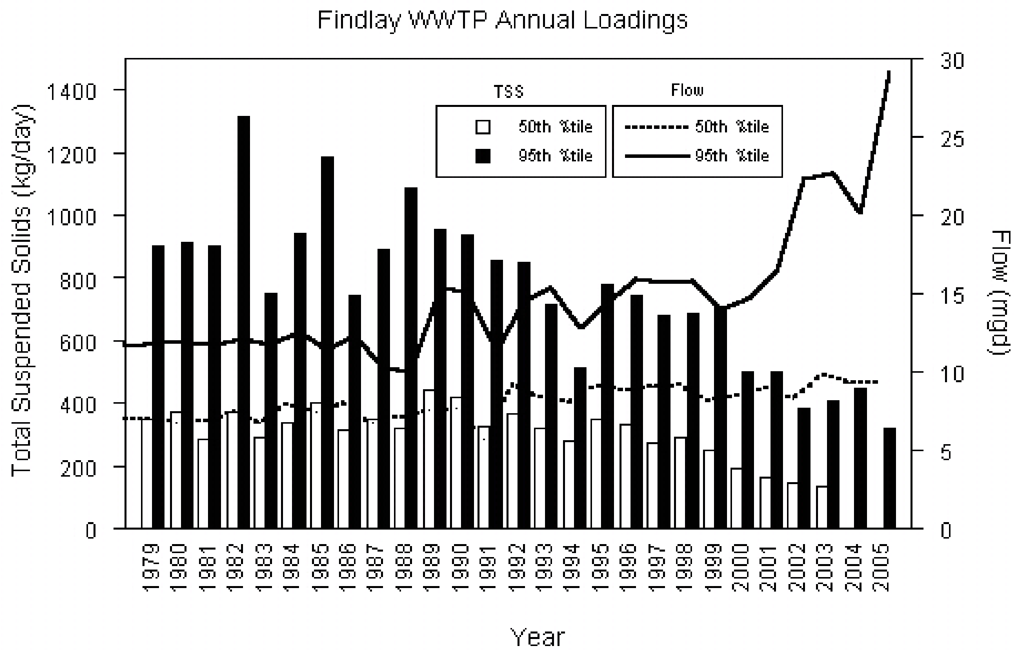

Figure 3m. Annual summary of MOR data for Total Suspended Solids (TSS) collected at the Findlay WWTP.

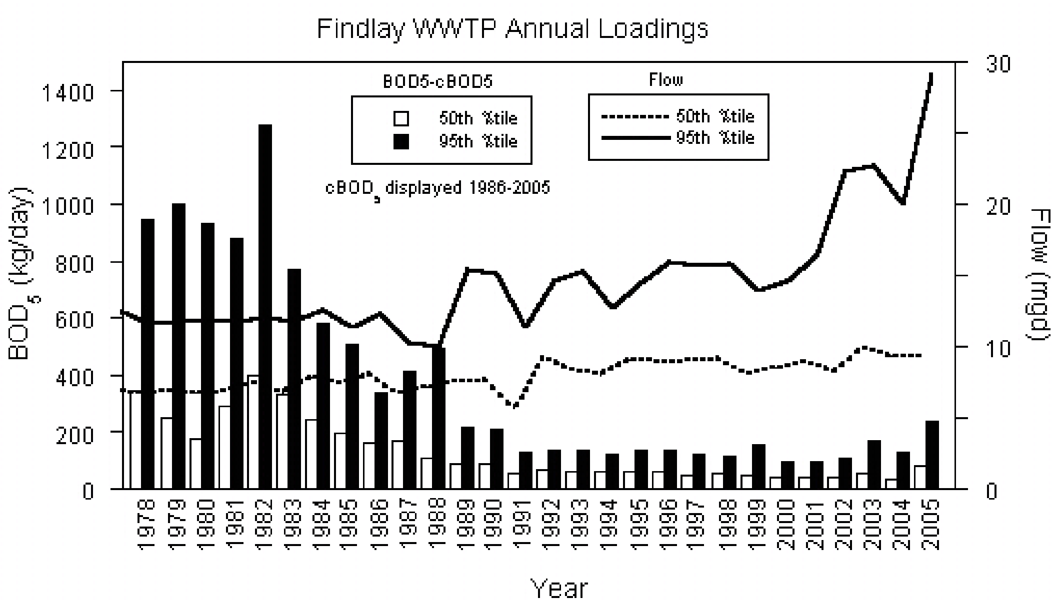

Figure 3n. Annual summary of MOR data for BOD_5 collected at the Findlay WWTP.

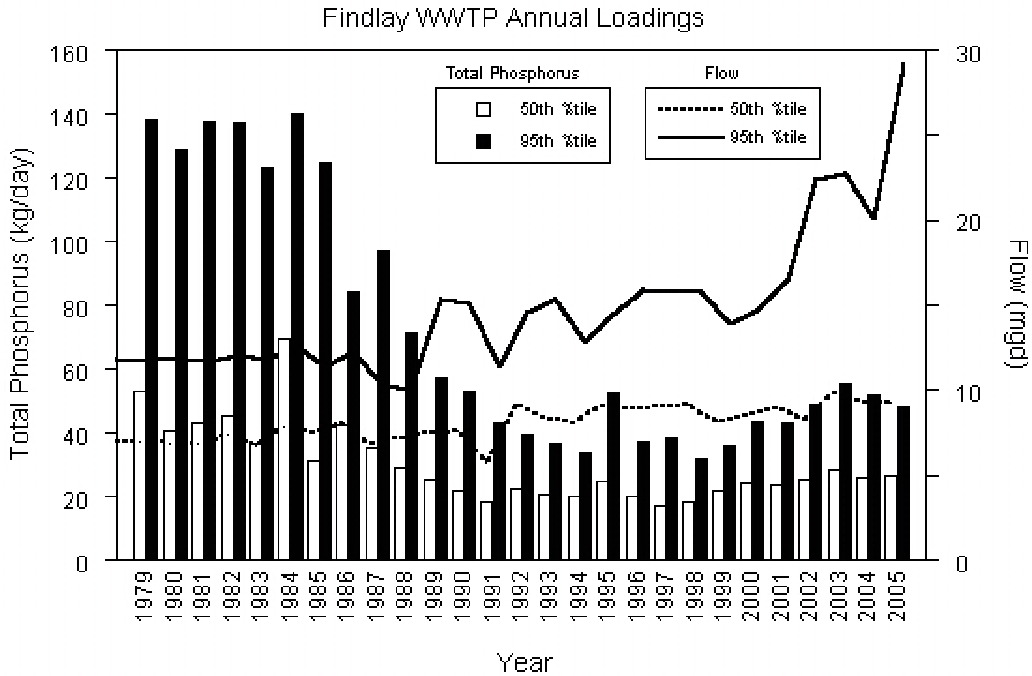

Figure 3o. Annual summary of MOR data for total phosphorus collected at the Findlay WWTP.

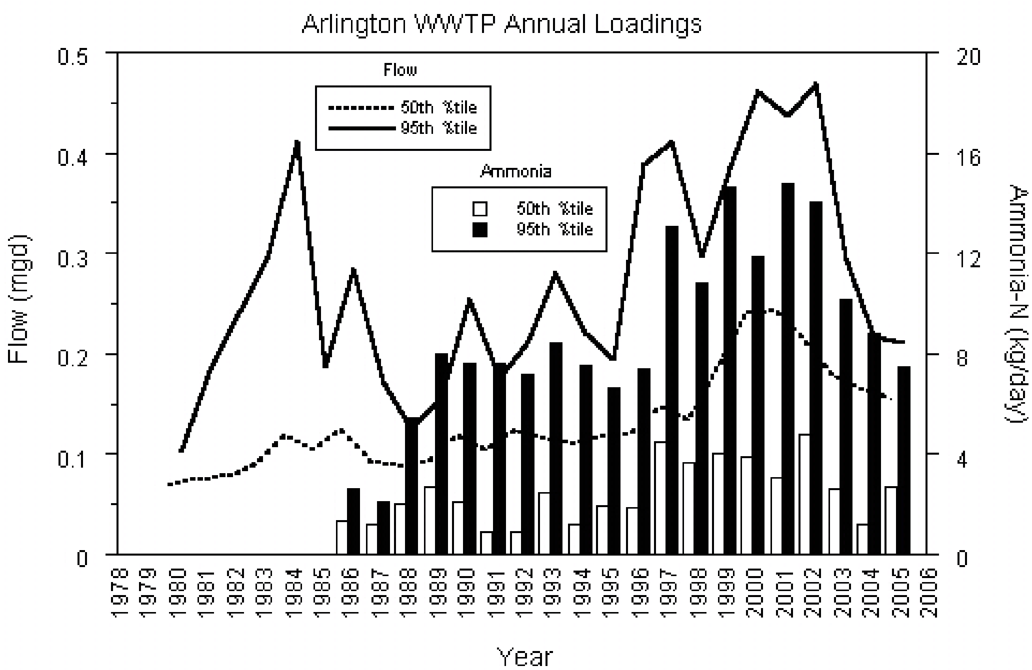

Figure 3p. Annual summary of MOR data for ammonia collected at the Arlington WWTP.

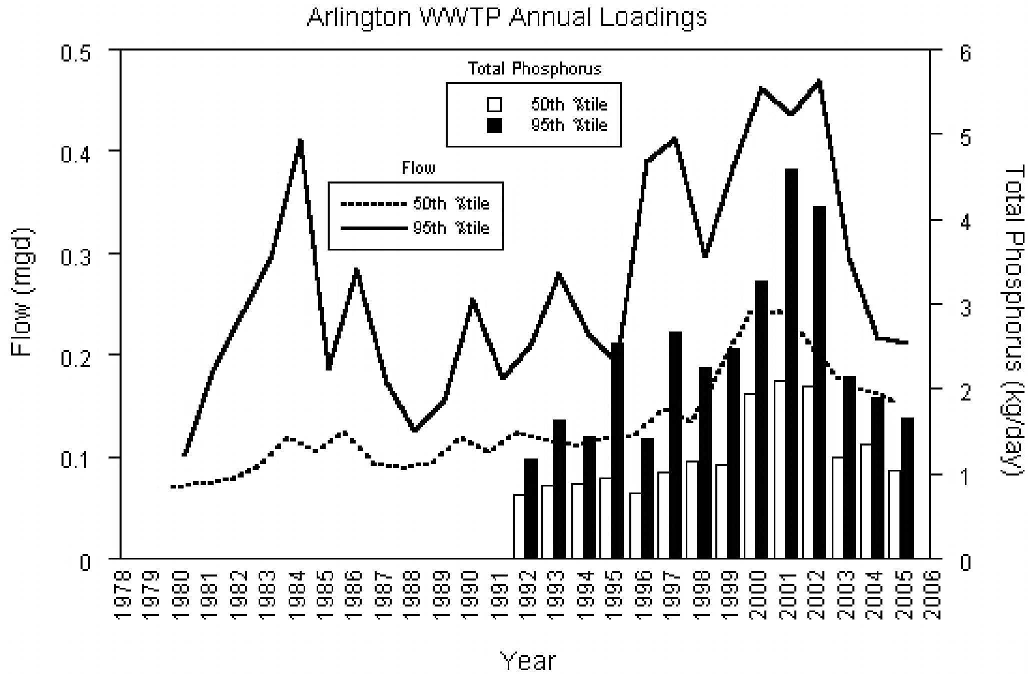

Figure 3q. Annual summary of MOR data for total phosphorus collected at the Arlington WWTP.

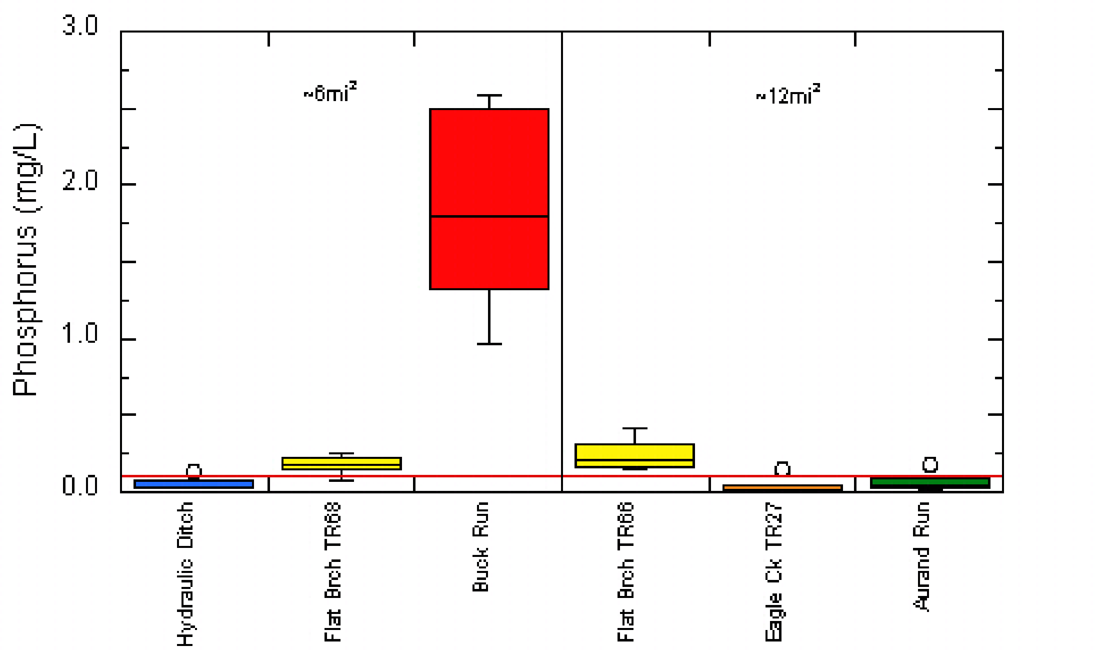

Figure 3r. Summary of phosphorus concentrations measured in grabs from Blanchard River/Eagle Creek tributary sites plotted against the target level. Sites are loosely grouped based on similar drainage areas of 6 and 12 mi^2. The box contains 50% of the data points and the line represents the median value.

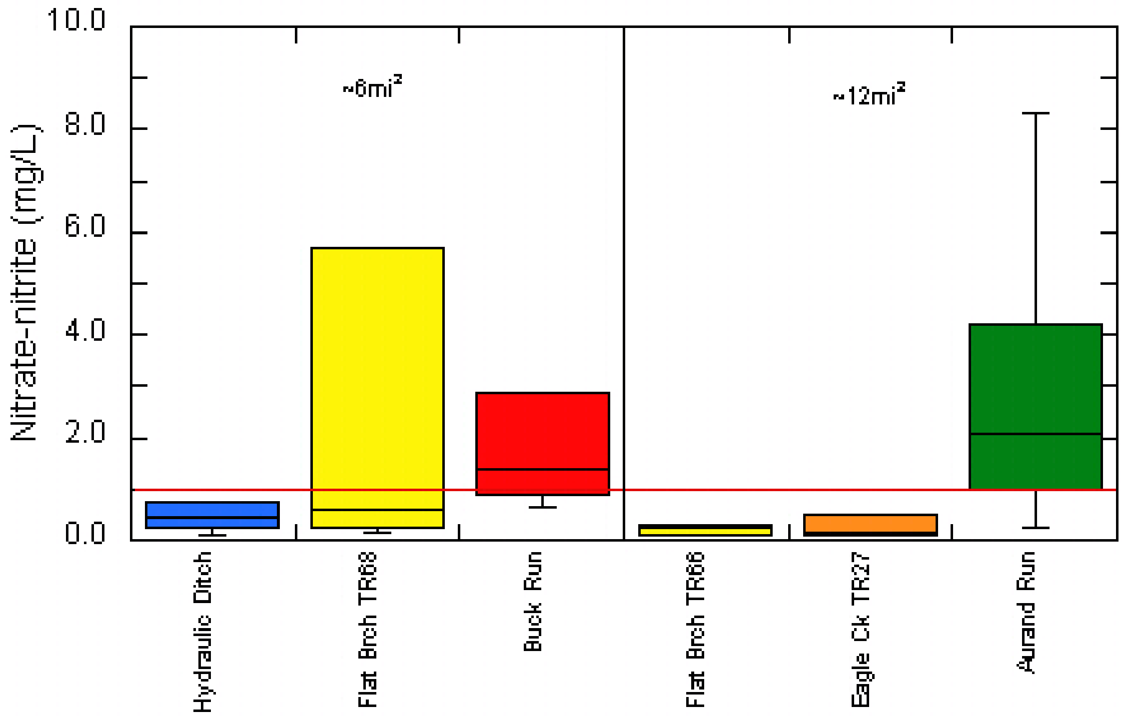

Figure 3s. Summary of nitrate-nitrite concentrations measured in grabs from Blanchard River/Eagle Creek tributary sites plotted against the target level. Sites are loosely grouped based on similar drainage areas of 6 and 12 mi^2. The box contains 50% of the data points and the line represents the median value.

Ottawa Creek WAU

The Ottawa Creek WAU (04100008-040) covers the Blanchard River above Ottawa Creek (RM 45.64) to above Riley Creek (RM 30.08) and drains about 148.9 mi^2. The Blanchard River below Dukes Run (RM 35.65) is excluded because it meets the definition of a large river (> 500 mi^2) and is evaluated separately. A map showing principal streams, roads, and urban areas is displayed in Figure 4a. Fish and macroinvertebrate populations and stream habitat conditions were evaluated throughout the WAU. The associated index scores and biological attainment status for each site (full, partial, or non) are summarized in Table 4a. Physical, chemical, and bacterial testing was done to complement the biological data. Most sites had six sets of samples collected at two week intervals. Bacteria were tested to assess recreation and the Blanchard River and Ottawa Creek had extra sampling done to meet temporal and sample size conditions contained in the rule and evaluate them on a site specific basis. Results from the small tributaries were simply compared to the maximum standard.

Water quality data and biological index scores were evaluated based on Ohio WQS criteria (OAC 3745-1). Target values presented in the *Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999) were used to evaluate nutrient enrichment. Appropriate numerical criteria and target values are often determined by use designation and all data was evaluated based on current assigned uses. Geographic location is also an important variable for determining criteria. Most of the WAU is within the HELP ecoregion, except Ottawa Creek originates in the ECBP and transitions around RM 9.2. Nutrient target values are being used as guidelines in lieu of criteria that are currently under development. Preliminary results support the validity of these target values and the notion that a correlation exists between nutrients, aquatic life attainment status, and drainage area. Criteria will likely be tiered for drainage area at the break between a wadeable stream and a small river (200 mi^2). Based on this assumption, nutrient samples from tributaries in the WAU were evaluated using a phosphorus target of 0.10 mg/L and a nitrate-nitrite target of 1.00 mg/L. Samples from the Blanchard River were evaluated using a phosphorus target of 0.17 mg/L and a nitrate-nitrite target of 1.50 mg/L. Water quality exceedences that were documented are summarized in Table 4b.

An effort was made to identify the sources of water quality degradation. Ambient water quality is affected by a complex set of biotic and abiotic factors. Water picks up many impurities from the air, land, and ground and gases like oxygen, nitrogen, and carbon dioxide diffuse into water from the atmosphere. Climate, topography, vegetation, and biological activity all influence ambient water quality. Local water quality, though, is usually determined by inputs from anthropogenic sources that are grouped into point and nonpoint categories. The origin of a point source is easy to identify at the end of the pipe and most are regulated under the NPDES permit system. Individual permits are issued to facilities with unique processes like those summarized in Table 4c. General permits are issued to facilities that have similar operations and exert a minimal impact on the environment like those summarized in Table 4d. Construction storm water permits are included only for projects done in 2005. Continuous discharge point sources have their greatest impact under base flow when chemistry is relatively stable and conditions reflect the ground water that recharges the stream.

Tributary streams in the Blanchard River watershed largely drain cropland and are managed to eliminate excess water with a combination of surface (ditches) and sub surface (tile) drainage systems. Too much water can delay planting, cultivation, or harvest and cause problems with flooding and soil compaction. Some drainage projects are simply done by the landowner, but those that involve multiple landowners and communities fall under county ditch laws. When the interested parties reach a mutual agreement a ditch petition is filed with the Board of County Commissioners. This starts the legal steps required to finance, construct, and maintain a ditch. The County Engineer presents a report at a public hearing and the board votes on the project. If the vote is in favor of the project, the engineer conducts a field survey and prepares plans and a cost estimate. A final hearing is held to re-affirm the decision before work is completed and the County Engineer (or SWCD) becomes responsible for maintenance. Habitat and flow alterations from these drainage projects are considered high magnitude causes of impairment.

The impact from a nonpoint source is a direct function of the surrounding land use and their exact origin is difficult to identify. Pollutants like silt, nutrients, and pesticides are carried in storm water from land used for crop and livestock production. Management practices like channelization, removal of riparian vegetation, and installation of sub surface tile systems result in significant flow and habitat alterations. They contribute to low flow conditions during dry weather periods because they limit ground water recharge by lowering the water table and by increasing evaporation since there is no tree shade. Conversely, these activities contribute to flooding during wet weather periods due to accelerated delivery of runoff. In pasture areas the exclusion of livestock from surface waters is an issue because of the damage they cause to habitat and increase the input of nutrients and bacteria. Another type of flow alteration is the impounding of a stream by a low head dam. These dams change stream morphology by flooding riffles, block fish migration, and ultimately change trophic structure. An example of this is a small dam on Ottawa Creek at CR 313 (RM 11.1) near Mt. Cory. Pollutants like silt, nutrients, and pesticides are also carried in storm water from urban areas, along with materials like oil and heavy metals that are present in auto exhaust. Failed home sewage systems can be a problem in areas without central collection and treatment systems. This has been a problem in much of the WAU until recently. The Rawson WWTP was constructed in 2001 and Mt. Cory is connected to the system, but sewers in Benton Ridge have yet to be installed and plans are still under development for the Jenera WWTP. Flooding caused by accelerated delivery of runoff is also a problem in urban areas because of impervious surfaces and sources of inflow like down spouts and sump pumps.

Aquatic Life Designations

Biological and habitat assessments were conducted at 19 sites in 2005. Aquatic life use attainment status is presented in Table 4a.

The Blanchard River at CR 53 (RM 41.31) was the only mainstem site within this WAU. It is designated as WWH, PCR, AWS, and IWS based on previous field assessments. Habitat conditions at CR 53 (RM 41.3) were similar to other sites downstream from Findlay. Low gradient and an incised channel were significant impediments to the development of a more diverse habitat by limiting channel sinuosity and keeping sediment confined within the river channel. Mid channel areas contained significant rubble substrates but heavy siltation was noted in areas that were out of direct current flow.

Dutch Run is a tributary of the Blanchard River confluent at RM 33.00 that is about 14 miles in length and drains an area of 14.8 mi^2. It is within the HELP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. It is channelized and has legal drain status in Putnam County where it is maintained by the SWCD. Most riparian vegetation has been removed from the banks except the lower three miles which has a narrow wooded corridor. The channel held water throughout the study, but flow was often stagnant at TR O (RM 5.79). The stream was designated as a WWH in a previous rulemaking but the use had never been verified based on biological sampling. The 2005 survey included sites at RM 5.8 and 1.7. Both locations were previously channelized. QHEI values recorded at RM 5.8 and 1.7 on Dutch Run of were 23.5 and 26.5, respectively and reflected the highly modified nature of the stream. Nevertheless, fish and macroinvertebrate sampling results were consistent with a WWH use at RM 1.7. Based on the 2005 results, a MWH use is recommended for Dutch Run upstream from the confluence of Bassinger Ditch (RM 5.26) along with continuing the WWH use downstream from Bassinger Ditch to the confluence with the Blanchard River.

Dukes Run is a tributary of the Blanchard River confluent at RM 35.65 that is about 9 miles in length and drains an area of 14.7 mi^2. It is within the HELP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. It is channelized, under petition in Putnam County, and has legal drain status in Hancock County where it is maintained by the SWCD (a.k.a. Moyer Ditch). Most riparian vegetation has been removed from the banks except the lower two miles which has a narrow wooded corridor. The channel held water throughout the study, but flow was often stagnant at CR M (RM 1.90).

Dukes Run was designated as a WWH in a previous rulemaking but the use had never been verified based on biological sampling. Results of the 2005 survey included sites at RM 1.9 and 1.1. Both locations were previously channelized; however, the downstream site had recovered a largely natural sinuosity that increased the heterogeneity of instream habitat. QHEI scores of 48 and 50 at RM 1.9 and 1.1 do not singularly identify the suitability of a WWH use. However, biological communities fully met the use at RM 1.1. The upper site (RM 1.9) was impacted by unobstructed cattle access and interstitial flow which limited the macroinvertebrate community. A WWH is an attainable use with continued recovery of natural stream attributes; however, alteration of the stream hydrology which benefits agricultural production will likely continue to impinge on the diversity of fish and macroinvertebrate taxa that the stream is able to support.

Cartwright Run is a tributary of Dukes Run confluent at RM 1.82 that is about 4.5 miles in length and drains an area of 5.8 mi^2. It is within the HELP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. It is channelized and has legal drain status in Putnam County where it is maintained by the SWCD (a.k.a. Snavely Ditch). Virtually all riparian vegetation has been removed from the banks. The channel held water throughout the study, but flow was often stagnant at CR M (RM 0.02). Physical habitat features and limited stream energy makes a MWH aquatic life use for Cartwright Run applicable.

Moffitt Ditch is a tributary of the Blanchard River confluent at RM 37.44 that is about 8 miles in length and drains an area of 15.8 mi^2. It is within the HELP ecoregion and is designated as WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS.

Moffitt Ditch was designated as a WWH in a previous rulemaking but the use had never been verified based on biological sampling. However, analysis of biological condition and habitat attributes of the waterway were consistent with a MWH use. The 2005 survey included sites at RM 2.4 and 0.5. The stream is channelized, essentially a canal, with no sinuosity or riparian vegetation. The channel held water throughout the study, but flow was often stagnant at CR 53 (RM 2.37). QHEI scores were 21.0 and 27.5 at RM 2.4 and 0.5, respectively, and both sites possessed 4 high influence modified habitat attributes. The recommendation of the MWH use should not be considered a downgrading of aquatic life use for Moffitt Ditch. Rather, the 2005 survey accomplished the first systematic ambient assessment of the appropriate use.

Buck Run is a tributary of Moffitt Ditch confluent at RM 1.46 that is about 5 miles in length and drains an area of 5.6 mi^2. It is within the HELP ecoregion and does not have assigned use designations. It is channelized and has legal drain status in Hancock County where it is maintained by the SWCD. Virtually all riparian vegetation has been removed from the banks and it is essentially a canal with no sinuosity. The stream bottom consisted of primarily fine grained substrates. The channel held water throughout the study, but flow was often stagnant at TR 20 (RM 0.18). Physical habitat features and limited stream energy makes a MWH aquatic life use an appropriate use for Buck Run.

Ottawa Creek is a tributary of the Blanchard River confluent at RM 45.64 that is about 23 miles in length and drains an area of 64.3 mi^2. It originates in the ECBP ecoregion and transitions into the HELP ecoregion at about RM 9.2 and is designated as WWH, PCR, AWS, and IWS based on a study done in 1993. The channel in the upper half of the creek has been extensively modified and cleared of riparian vegetation. Flow is more natural in the lower half and woodlots are more common. The channel held water throughout the study, but flow was stagnant at times in the headwaters.

Ottawa Creek was designated with a WWH use based on biological/ water quality survey conducted in 1993. The 2005 survey confirmed the appropriateness of the use based on current habitat conditions and biological performance. Even though the stream lacked areas of fast current and had limited riffle/run/pool development, QHEI scores of five sites on Ottawa Creek ranged from 52.0 to 67.0. Beneficial attributes included relatively abundant instream cover and a diversity of substrates sizes. .

Tiderishi Creek is a tributary of Ottawa Creek confluent at RM 5.88 that is about 12 miles in length and drains an area of 19.4 mi^2. It is within the ECBP ecoregion and is designated PCR, AWS, and IWS based on the 1978 Ohio WQS. Most of the stream is channelized and it is maintained by the Hancock County SWCD above TR 64 (RM 9.5). Riparian corridors are narrow if present, except for where the creek flows through isolated woodlots. Lack of water in the channel was a problem during much of the study period. Flow was intermittent at CR 26 (RM 7.28) and the creek was actually dry at TR 44 (RM 4.57) during two of the sampling events as shown in Figure 4k. No fish sampling was conducted at TR 44. Water flow was continual near the mouth of Tiderishi Creek (RM0.1).

Tiderishi Creek had not been evaluated using biological and habitat data prior to the 2005 survey. A WWH use was assigned to the stream in the 1978 and 1985 water quality standards but never verified. The stream at RM 7.3 was little more than a conveyance for drainage of runoff from the surrounding agricultural fields. A QHEI score of 40 was recorded with modified habitat attributes exceeding typical warmwater features by a ratio of 9:2. Similar conditions were encountered at RM 4.6. Based on conditions encountered in 2005, a MWH use is recommended for Tiderishi Creek upstream from the Norfolk and Western railroad crossing (RM 2.90). The WWH should be maintained on Tiderishi Creek downstream from RM 2.90. Habitat was improved somewhat below this point and additional flow benefited aquatic communities. A QHEI score of 58.0 was recorded at RM 0.1 and fish and macroinvertebrate sampling reflected partial attainment of the WWH use. Habitat conditions in the lower reach make WWH attainment a reasonable expectation with a lessening of nutrient inputs to Tiderishi Creek.

Higbie-Redick Ditch is a tributary of Ottawa Creek confluent at RM 14.37 that is about 5 miles in length and drains an area of 7.0 mi^2. It is within the ECBP ecoregion and designated as MWH, SCR, AWS, and IWS based on a study done in 1993. It was channelized in 1951 and has shown little recovery even though it is not formally maintained. There is virtually no riparian vegetation except for a grass buffer strip in the lower two miles and a narrow wooded corridor above this point. The channel held water throughout the study due to shallow bedrock and subsequent ground water recharge and there was usually a slow current velocity at TR 59 (RM 0.76).

Aquatic Life Attainment Status

The Blanchard River mainstem from above Ottawa Creek (RM 45.64) to below Dukes Run (RM 35.65), the point at which drainage area exceeds 500 mi^2, fully met the designated WWH Aquatic Life use. Attainment status of the reach is based on sampling done at RM 41.3 in conjunction with documented attainment at sites located upstream from Ottawa Creek and in the Large River Assessment Unit downstream from Dukes Run. Even though low dissolved oxygen and elevated nutrients were documented, the macroinvertebrate community yielded a large number of sensitive taxa and an ICI score in the exceptional range at RM 41.3. The fish results performed at a lower level but still reflected relatively good resource condition with index scores in the good range (IBI=38, MIwb=9.2).

Attainment status was determined for fifteen sites on Blanchard River tributaries, representing approximately 32 assessed stream miles. It is important to note that the attainment status on four of the sites was based on a MWH use; so expectations, while more realistic, were significantly less than those required to meet a WWH use. Six sites, representing 12 assessed stream miles, fully met the current or recommended aquatic life use. Five sites, totaling 15 assessed miles, partially met and two sites, totaling five assessed stream miles, were in non-attainment of the current or recommended aquatic life use. The nonattaining sites were on streams with a MWH use designation.

Biological communities in this portion of the Blanchard River study area were impacted by a combination of factors related to agricultural practices in the watershed. Hydromodification; principally channelization, flow modification and removal of riparian vegetation; affected all 20 impaired stream miles where fish and/or macroinvertebrates did not fully meet ecoregional expectations. An excess of dissolved oxygen/organic enrichment, nutrients, and siltation were identified as causative factors for 70%, 60%, and 20 %, respectively, of the impaired miles.

Five headwater sites (less than 20 mi^2 drainage area) fully met designated or recommended Aquatic Life Uses; two sites failed to meet existing or recommended ecoregional biocriteria and three sites partially met. Requisite credible data collection requirements were lacking to determine attainment status for three sites in the assessment unit.

Fish and macroinvertebrate community condition at the three wadable sites resulted in two sites that partially met and one that was fully meeting ecoregional expectations.

Even though the habitat in Dutch Run was modified, both fish and macroinvertebrate sampling results were consistent with a WWH use at RM 1.7. An IBI score of 40 was recorded and qualitative sampling netted eleven pollution sensitive macroinvertebrate taxa. Biological condition was more limited at RM 5.8 but the recommended MWH use was met. Fish sampling resulted in an IBI score of 24, and just four sensitive macroinvertebrate taxa were collected.

Portions of Cartwright Run lacking sufficient canopy were algae choked; suggesting a high likelihood for wide swings in dissolved oxygen related to the photosynthetic activity. Qualitative macroinvertebrate sampling at RM 0.2 yielded a largely facultative assemblage, and included eight EPT taxa. Community condition was rated high fair. The evaluation is consistent with MWH expectations; however credible data requirements were not completed in order to fully assess attainment status.

While IBI scores from Moffitt Ditch were consistent with a MWH at both sampled locations, the macroinvertebrate community at RM 2.4 was in poor condition. Half of the 30 taxa collected were pollution tolerant and aquatic beetles and water boatmen predominated. The macroinvertebrate community marginally met the MWH use at RM 0.5.

Buck Run contained a large amount of algae indicating significant nutrient enrichment. Qualitative macroinvertebrate sampling at RM 0.2 yielded a largely facultative assemblage, predominated by riffle beetles and heptageniid mayflies. The community condition was rated high fair. The evaluation is consistent with a MWH expectation; however credible data requirements were not completed in order to fully assess attainment status.

Overall, biological resources in Ottawa Creek were in fair to good condition. The fish community, based on the IBI results, was improved compared to sampling results from 1993 (Figure 4b). Fish and macroinvertebrate communities in the upper watershed and within the lower couple of miles of the stream met ecoregional expectations. The intervening reach of approximately thirteen miles partially met the WWH use. Impacts to the stream where the aquatic life use was not fully meeting were related to alteration of stream hydrology and a moderate to heavy silt/sand bedload that limited the availability of interstitial spaces between larger substrates. Additionally, water chemistry results demonstrated an excess of nutrients and a dissolved oxygen deficit which likely contributed to reduced numbers of pollution sensitive fish and/or macroinvertebrates within the middle reach of Ottawa Creek.

Fish and macroinvertebrate communities in Tiderishi Creek were reflective of an impaired aquatic resource. Poor fish and macroinvertebrate assemblages were present in the recommended MWH reach of Tiderishi Creek. Decomposing cornstalks and other plant debris in the stream at RM 7.3 likely contributed a significant oxygen demand and the channelized habitat presented significant obstacles for the attainment of even a MWH use. Prior to becoming dry, a small volume of water moved over exposed bedrock at RM 4.6. Nutrient enrichment promoted the growth of nuisance algae and exposure to sunlight led to high daytime temperatures. Fish and macroinvertebrate communities were in poor condition where flow was limited. Just a single pollution sensitive macroinvertebrate taxon was collected from RMs 7.3 and 4.6. Fish sampling at RM 7.3 yielded seven species. Pollution tolerant fish comprised over 90% of the total collected. No fish sampling was conducted at RM 4.6 because the stream was dry on the date the site was visited. Sampling near the mouth of Tiderishi Creek produced a fair fish and marginally good macroinvertebrate result. Fourteen fish species were recorded with tolerant fish comprising 47% of the total number collected. Biological community structure at RM 0.1 was reflective of an excess of nutrients and a dissolved oxygen deficit in combination with historical stream modifications to benefit row crop agricultural activities.

Higbie-Redick Ditch at RM 0.8 was channelized with a predominantly sand/silt substrate. Macroinvertebrate sampling yielded a high diversity of organisms; 50 taxa were identified. Seventeen of the collected taxa were pollution tolerant versus four sensitive taxa. Requisite credible data collection requirements were lacking to complete an evaluation of the status of the use; but, the macroinvertebrate community was consistent with the MWH use.

Recreation Use Attainment

People can be exposed to pathogens in water by skin contact and through ingestion. It is because of this that recreation criteria were developed to protect human health. Fecal coliform counts (colony forming units or CFU/100 ml) are used to indicate if water has been contaminated by feces from warm blooded animals. Fecal coliform bacteria are harmless in most cases, but there is a potential that the feces contained pathogens or disease producing bacteria (*Escherichia*, *Salmonella*, and *Shigella*), viruses (hepatitis A, Norovirus, and Rotavirus), and parasites (*Cryptosporidium*, *Giardia*, and *Cyclospora*). Reactions to exposure can be as minor as skin rash, sore throat, or ear infection. However, some lead to diarrhea, gastroenteritis, and dysentery or even a more serious wide spread epidemic.

Recreation was evaluated overall for the WAU and on a site specific basis for the Blanchard River and Ottawa Creek. Site specific evaluations were done on the larger streams because they are popular sport fishing destinations. The overall assessment was done by pooling data obtained from the 2005 stream survey and NPDES permit monthly operating reports for samples that were collected during the recreation season (May 1-October 15). The recreation use is then considered impaired if either the 75th percentile exceeds 1,000 CFU/100 ml or the 90th percentile exceeds 2,000 CFU/100 ml. Based on these guidelines, the recreation use for the WAU is considered impaired because the values were 1,600 CFU/100 ml and 5,400 CFU/100 ml, respectively.

The Blanchard River and Ottawa Creek are both designated as PCR. To determine if a specific site meets Ohio WQS criteria a minimum of 5 samples must be collected within any 30 day period during the recreation season. The geometric mean from this data set should not exceed 1,000 CFU/100 ml and not more than 10% of the individual results should exceed 2,000 CFU/100 ml. The Blanchard River at CR 53 (RM 41.31) had 5 samples collected June 27-July 25. The geometric mean calculated was 302 CFU/100 ml and the maximum count was 1,400 CFU/100 ml, so this site meets PCR criteria. Sites in Ottawa Creek had 5 samples collected June 28-July 26 and the results are summarized in Table 4f. The site at CR 12 in Orange Township (RM 18.52) violated the maximum criteria, while the sites at CR 12 in Union Township (RM 14.67) and TR 79 (RM 4.82) violated both the geometric mean and maximum. Potential sources in the area include the Rawson WWTP, home sewage systems, and livestock. The Rawson plant is a lagoon system with a controlled discharge to Ottawa Creek at RM 7.2. It presently serves the villages of Rawson and Mt. Cory and construction of sewers is underway to connect Benton Ridge. The plant did not discharge during the study period and the only flow reported in 2005 was 5.48 million gallons in November. Another potential source is manure settling ponds at the Cramer duck farm located on CR 54. It is not known if these ponds have overflows, but they probably get washed out during high water since they are in the floodplain.

Water Quality

Nutrient enrichment was the most common water quality degradation in the WAU. Data obtained from tributaries was summarized to compare sites with similar drainage areas and to pinpoint problem areas. Sites that drain approximately 6 mi^2 are summarized for phosphorus in Figure 4d and nitrate-nitrite in Figure 4e and sites that drain 12, 24, and 48 mi^2 are summarized for phosphorus in Figure 4f and nitrate-nitrite in Figure 4g. Phosphorus concentrations were generally consistent within a site and tended to be highest in the upper part of the WAU (Tiderishi Creek, Ottawa Creek, and Higbie Redick Ditch). Nitrate-nitrite concentrations varied considerably and tended to be the highest in the lower part of the WAU (Moffitt Ditch and Buck Run). Nitrate levels were high early in the study period (June) close to the time of fertilizer applications and then steadily decreased as the nutrient was assimilated. A spike in concentration usually followed rainstorms because nitrate passes through soil and is discharged through field tiles.

Water quality of the Blanchard River at CR 53 (RM 41.31) was degraded by low dissolved oxygen and nutrient enrichment. The majority of low dissolved oxygen values were measured by an automatic meter. A graph showing temperature and dissolved oxygen data from this unit is displayed in Figure 4c. All of the dissolved oxygen values (n=47) were below the OMZA of 5.0 mg/L and the average concentration of 4.11 mg/L is considered a WQS criteria violation. Of these values, 17 (36%) were below the OMZM of 4.0 mg/L and are also considered a WQS criteria violation. All 6 of 6 grab samples and the median value (0.221 mg/L) for phosphorus and all 6 of 6 grab samples and the median value (4.35 mg/L) for nitrate-nitrite were above respective targets. Water chemistry during base flow at this site is greatly influenced by effluent from the Findlay WWTP (RM 56.42). Based on monthly operating report and USGS flow data the amount of effluent in the river at Hancock CR 140 (RM 55.26) was approximately 26.2% in June, 9.4% in July, and 28.8% in August. Agricultural runoff and CSOs contribute to the nutrient load during storm events.

Dutch Run was degraded by low dissolved oxygen as a result of the poor flow conditions and concentration was below 5.0 mg/L in 7 of 12 grabs collected at two sites. Nutrient enrichment is not a serious problem based on the survey data. A few grabs were above target, but all median values met their respective target levels.

Water quality of Dukes Run was degraded by fecal coliform counts elevated above the PCR maximum in 6 of 10 grabs collected at two sites. Livestock with access to the stream from a pasture at CR M are the probable source, since cows were observed wading in the water on several occasions during the study period. This activity also increases turbidity and siltation problems. The highest suspended solids concentration measured in the WAU (394 mg/L) was collected here when cows were wading. Runoff from the nearby Northwest Ohio Recycling scrap metal facility on TR 2 might be a concern too because a spike in metals was also detected in this sample. Nutrient enrichment is not a serious problem based on the survey data. A few grabs were above target, but all median values met their respective target levels.

Water quality of Cartwright Run was degraded by low dissolved oxygen as a result of the poor flow conditions. The dissolved oxygen concentration was below 5.0 mg/L in 2 of 6 grabs. Several grabs had nutrients above target, but the median values met their respective target levels. Fecal coliform counts were above the PCR maximum in 2 of 5 samples.

Moffitt Ditch was mainly degraded by nutrient enrichment, especially nitrate-nitrite. The median values at both sites and 9 of 12 grab samples were above the target level. This enrichment was also evident in the nuisance levels of algae present. Fecal coliform counts were above the PCR maximum in 3 of 9 samples at the two sites tested.

Buck Run was mainly degraded by nutrient enrichment, especially nitrate-nitrite. The median value and 4 of 6 grab samples were above the target level. The poor flow conditions resulted in dissolved oxygen below 5.0 mg/L in 2 of 6 grabs. Fecal coliform counts were above the PCR maximum in 2 of 5 samples.

Most water quality problems in Ottawa Creek were in the lower segment where several pollution sources are located. This is also where the stream transitions from the ECBP ecoregion to the HELP ecoregion. As a result, lower stream gradient limits reaeration from the atmosphere and reduces assimilative capacity. Nearly half of the dissolved oxygen levels measured at TR 79 (RM 4.82) and CR 86 (RM 0.90) were below 5.0 mg/L

(Figure 4h). A significant increase in nutrient enrichment coincides with the low dissolved oxygen readings. Nearly all grab samples (16 of 18) and both median values for phosphorus were above target (Figure 4i). Similar results were obtained for nitrate-nitrite, with 12 of 18 grab samples and both median values above target (Figure 4j). Major sources of nutrients in this area include the Rawson WWTP, Cramer Duck Farm, failed home sewage treatment systems in Benton Ridge, and the Tawa Ridge Estates package plant. The Rawson lagoon system is controlled and did not discharge during the study period. The Tawa Ridge Estates package plant is a small system designed to treat 2,800 gpd and only serves about 4 homes. Since the completion of the survey, Benton Ridge completed construction of sanitary sewers and tied into the Rawson WWTP in July 2006. The Cramer Duck farm has several manure settling ponds. It does not have a nutrient management plan and is not regulated under the NPDES program, so little is known about the fate of this waste. Another source that needs to be addressed is a septic discharge found flowing from a field tile just downstream from CR 86 that probably originates from nearby failed home sewage treatment systems.

Other results of interest in Ottawa Creek included high levels of strontium, indicating a strong influence from groundwater recharge. Fecal coliform counts violated both the site specific maximum and geometric mean at two locations and one of these was at TR 79 downstream from the Cramer Duck Farm. The site at CR 86 was tested for levels of pesticides. No insecticides were detected in any of the samples, but the herbicides Atrazine and Metolachlor were routinely present. A summary of the compounds that were detected is presented in Table 4e..

Limited flow, coupled with nutrient enrichment, nuisance levels of algae, and lack of tree shade resulted in water quality degraded by low dissolved oxygen and elevated temperature and pH in Tiderishi Creek. There was always moderate to high current velocity at the mouth (RM 0.01) because of ground water springs that recharge the stream and this greatly improved water quality. The ground water influence is evident in the high levels of strontium found in the samples. Not enough fecal coliform samples were collected to do site specific evaluations, but only 2 of 12 tested at the three sites exceeded the PCR maximum. There is one point source under permit that discharges to the creek. The Ohio DOT operates twin 0.01 MGD package plants that serve the I-75 rest areas south of Findlay (Park #1-26). Treated effluent from the north bound plant is pumped across the interstate and combines with effluent from the south bound plant. This then flows south through a tile and discharges to Tiderishi Creek at RM 3.82. These plants have a history of poor operation and maintenance and numerous permit violations have been documented in recent years. Conditions deteriorated to the point that the rest areas were closed in October 2005 for several months to correct water and wastewater issues. Some of the improvements completed in 2006 included de-chlorination facilities and new sand filter media. Runoff from livestock production areas is another source of impairment in Tiderishi Creek. A manure spill at the Boehm Dairy farm on TR 25 was investigated on October 11, 2005. It was determined that milk house waste overflowed from a holding tank into a field tile and entered the creek at around RM 7.5. The spill resulted in a small fish kill.

A ground water influence in Higbie-Redick Ditch was evident in the high levels of strontium found in the samples. The ditch flows through Jenera where failed home sewage systems discharge through storm sewers approximately 1.5 miles upstream from the sampling site. This village has a population of about 260 and intends to construct a controlled discharge lagoon system to treat sewage, but at this time there is not an approved general plan. Water quality was degraded mainly by nutrient enrichment.

Sediment Quality

Characteristics of stream sediment usually reflect the glacial origin of parent materials. Most of the Ottawa Creek WAU is within the HELP ecoregion, which is a remnant of the Great Black Swamp and dominated by soft silt and muck. This proved to be true in the field, where fine sediment deposits for sample collection were abundant. Samples were tested for particle size, % organic carbon, % solids, metals, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and organochlorine insecticides. The Ohio EPA evaluates sediment quality based on ecoregion reference values (Ohio EPA, 2003) and consensus based toxicity guidelines (MacDonald et al, 2000). Sediment reference values (SRV) are considered representative of background concentrations in Ohio streams. The toxicity guidelines identify pollutant concentrations that trigger a response from benthic organisms. Levels below the threshold effect concentration (TEC) are absent of toxicity and those above the probable effect concentration (PEC) are toxic.

Contaminated sediment is probably not a cause of impairment in the WAU. However, since only three samples were collected, there may be isolated problems that were not discovered. Samples generally consisted of a 50/50 blend of sand mixed with finer silt and clay and organic carbon ranged from 3.0-4.6%. There were no PCBs, PAHs, or insecticides detected and a summary of metals concentrations is presented in Table 4g. Virtually all of these levels were below their respective SRV.

Table 4A Aquatic life use attainment status for stations sampled in the Ottawa Creek assessment unit based on data collected July-September, 2005. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
Blanchard River			*WWH - HELP Ecoregion*					
41.3/41.3	459	38	9.2	46	51.0	Full		
Higbie-Redick Ditch			*MWH - ECBP Ecoregion*					
0.8/____	6.4			HF				
Tiderishi Creek			*MWH recommended - ECBP Ecoregion*					
7.3/7.3	7.2	20*		P*	40.0	NON	Direct habitat alteration, low DO, nutrients, intermittent flow	Ag related channelization, crop production
4.6/____	12.2			P*			Direct habitat alteration, thermal modification, nutrients, dry channel, pH	Ag related channelization, crop production
			WWH recommended - ECBP Ecoregion					
0.1/0.1	19.4	34*		MG[ns]	58.0	Partial	Direct habitat alteration, nutrients, siltation, organic enrichment/DO	Ag related channelization, crop production
Ottawa Creek			*WWH - ECBP Ecoregion*					
18.5/18.5	6.8	38[ns]		MG[ns]	58.0	Full		
14.7/14.7	11.4	34*		MG[ns]	52.0	Partial	Direct habitat alteration	Ag related channelization, crop production
10.1/10.1	28	38[ns]	7.7*	MG[ns]	62.5	Partial	Direct habitat alteration, siltation, low DO, nutrients	Ag related channelization, crop production
			WWH - HELP Ecoregion					
4.8/4.9	59	36	8.1	F*	67.0	Partial	Direct habitat alteration, siltation, low DO, nutrients	Ag related channelization, Cramer Duck Farm?
____1.8	63	36	7.6		62.5	(Full)		
0.9/____	63			34				
Buck Run			*MWH - ECBP Ecoregion*					
0.2/____	5.6			HF				
Moffitt Ditch			*MWH recommended - HELP Ecoregion*					
2.4/2.4	6.1	38		P*	21.0	NON	Direct habitat alteration,nutrients	Ag related channelization, crop production
0.5/0.5	13.5	32		HF	27.5	Full		
Cartwright Run			*MWH recommended - HELP Ecoregion*					
0.1/____	5.8			HF				
Dukes Run			*WWH recommended - HELP Ecoregion*					

River Mile Invertebrate/ Fish	MI^2	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
1.9/1.9	7.9	40		F*	48.0	Partial	Direct habitat alteration, siltation	Ag related channelization, pasture land
1.1/1.1	14	34		G	50.0	Full		
Dutch Run			*MWH recommended - HELP Ecoregion*					
5.8/5.8	6.7	24		HF	23.5	Full		
			WWH recommended - HELP Ecoregion					
2.7/2.7	12.8	40		G	26.5	Full		

Ecoregion Biocriteria: Eastern Corn Belt Plain

	IBI			MIwb			ICI		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	40	50	24				36	46	22
Wading	40	50	24	8.3	9.4	4.0	36	46	22
Boat	42	48	24	8.5	9.6	4.0	36	46	22

Ecoregion Biocriteria: Huron Erie Lake Plain

	IBI			MIwb			ICI		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	28	50	20				34	46	22
Wading	32	50	20	7.3	9.4	5.6	34	46	22
Boat	34	48	20	8.6	9.6	5.7	34	46	22

a- MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.
b- A narrative evaluation of the qualitative sample based on attributes such as community composition, EPT taxa richness, and number of sensitive taxa was used when quantitative data were not available or considered unreliable due to current velocities less than 0.3 fps flowing over the artificial substrates.
c- Attainment status based on a single organism group is parenthetically expressed.
d- Causes listed are considered to be a primary influence on water quality, but may not be the only issue leading to impairment. See text for discussion of additional causes that cumulatively have led to impairment.
e- Sources listed are considered to be a primary influence on water quality, but may not be the only source leading to impairment. See text for discussion of additional sources that cumulatively have led to impairment.
ns- Nonsignificant departure from biocriteria ($\leq$4 IBI or ICI units, or $\leq$0.5 MIwb units).
* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

Table 4b. Exceedences documented in the Ottawa Creek WAU based on Ohio WQS criteria and nutrient target values. Criteria include outside mixing zone minimum or maximum (OMZM) and average (OMZA) values.

Stream	River	Use	Parameter	Water Quality Degradation
Blanchard River WWH, PCR, AWS, IWS	41.31	WWH	dissolved oxygen	17 of 47 diurnals below OMZM
				30 of 47 diurnals below OMZA
				24-hour average below OMZA
				1 of 6 grabs below OMZA
			temperature	2 of 47 diurnals above OMZA
			strontium	3 of 6 grabs above OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	6 of 6 grabs and median above target
Dutch Run WWH, PCR, AWS, IWS	5.79	WWH	dissolved oxygen	3 of 6 grabs below OMZM
				2 of 6 grabs below OMZA
			phosphorus	1 of 6 grabs above target
			nitrate-nitrite	1 of 6 grabs above target
		PCR	fecal coliform	1 of 5 grabs above maximum
	2.71	WWH	dissolved oxygen	1 of 6 grabs below OMZM
				1 of 6 grabs below OMZA
			phosphorus	1 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target
Dukes Run WWH, PCR, AWS, IWS	1.90	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			phosphorus	2 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	4 of 5 grabs above maximum

Table 4b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Dukes Run WWH, PCR, AWS, IWS	1.10	WWH	phosphorus	1 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target
		PCR	fecal coliform	2 of 5 grabs above maximum
Cartwright Run WWH, PCR, WAS, IWS	0.02	WWH	dissolved oxygen	1 of 6 grabs below OMZM
				1 of 6 grabs below OMZA
			phosphorus	2 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target
		PCR	fecal coliform	2 of 5 grabs above maximum
Moffitt Ditch WWH, PCR, AWS, IWS	2.37	WWH	dissolved oxygen	1 of 6 grabs below OMZM
			phosphorus	1 of 6 grabs above target
			nitrate-nitrite	5 of 6 grabs and median above target
		PCR	fecal coliform	2 of 4 grabs above maximum
	0.53	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			phosphorus	1 of 6 grabs above target
			nitrate-nitrite	4 of 6 grabs and median above target
		PCR	fecal coliform	1 of 5 grabs above maximum
Buck Run	0.18	WWH	dissolved oxygen	1 of 6 grabs below OMZM
				1 of 6 grabs below OMZA
			phosphorus	1 of 6 grabs above target
			nitrate-nitrite	4 of 6 grabs and median above target
		PCR	fecal coliform	2 of 5 grabs above maximum

Table 4b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Ottawa Creek WWH, PCR, AWS, IWS	18.52	WWH	phosphorus	5 of 6 grabs and median above target
			strontium	5 of 6 grabs above OMZA
		PCR	fecal coliform	violated site specific maximum
	14.67	WWH	phosphorus	1 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum
	10.13	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			strontium	1 of 6 grabs above OMZA
			phosphorus	2 of 6 grabs above target
			nitrate-nitrite	1 of 6 grabs above target
	4.82	WWH	dissolved oxygen	3 of 6 grabs below OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	5 of 6 grabs and median above target
			strontium	5 of 6 grabs above OMZA
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum
	0.90	WWH	dissolved oxygen	4 of 10 grabs below OMZA
			phosphorus	10 of 12 grabs and median above target
			nitrate-nitrite	7 of 12 grabs and median above target
			strontium	10 of 12 grabs above OMZA

Table 4b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Tiderishi Creek WWH, PCR, AWS, IWS	7.28	WWH	dissolved oxygen	3 of 6 grabs below OMZA
			phosphorus	5 of 6 grabs and median above target
			nitrate-nitrite	3 of 6 grabs above target
			strontium	3 of 6 grabs above OMZA
		PCR	fecal coliform	1 of 4 grabs above maximum
	4.57	WWH	dissolved oxygen	1 of 4 grabs below OMZM
			temperature	1 of 4 grabs above OMZM
				1 of 4 grabs above OMZA
			ammonia	1 of 4 grabs above OMZA
			phosphorus	2 of 4 grabs and median above target
			nitrate-nitrite	1 of 4 grabs above target
			strontium	2 of 4 grabs above OMZA
			pH	2 of 4 grabs above OMZA
	0.01	WWH	nitrate-nitrite	2 of 6 grabs above target
			strontium	5 of 6 grabs above OMZA
		PCR	fecal coliform	1 of 5 grabs above maximum
Higbie Redick Ditch MWH, SCR, AWS, IWS	0.76	MWH	phosphorus	1 of 6 grabs above target
			nitrate-nitrite	3 of 6 grabs above target
			strontium	4 of 6 grabs above OMZA

Table 4c. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Tawa Ridge Estates	2PW00003	Ottawa Creek	3.28	0.0028 MGD package plant
Ohio DOT I-75 Rest Area	2PP00019	Tiderishi Creek	3.82	0.01 MGD package plant
Rawson WWTP	2PA00039	Ottawa Creek	7.20	0.152 MGD lagoon system with a controlled discharge
Cory Rawson High School	2PT00031	Ottawa Creek	10.80	0.0125 MGD package plant

Table 4d. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Nelson Manufacturing Co.	2GR00433	Blanchard Tributary (30.81)	Industrial Storm water
Putnam County Airport	2GC01002	Blanchard Tributary (32.31)	Construction Storm water
Ohio DOT (US Rt. 224)	2GC00400	Blanchard Tributary (35.35)	Construction Storm water
Ohio DOT (State Rt. 235)	2GC00214	Moffitt Ditch, Ottawa Creek Tributary (0.4)	Construction Storm water

Table 4e. Summary of herbicides (µg/L) detected in Ottawa Creek at Hancock CR 86 (RM 0.90). Values reported as less than were below the quantitation limit.

Compound (Trade Name)	6/14/05	6/28/05	7/12/05	7/26/05	8/9/05	8/23/05
Acetochlor (Harness)	<0.22[UJ]	<0.22[UJ]	<0.21[UJ]	0.32[J]	<0.21	0.22[J]
Atrazine (AAtrex)	<0.22[UJ]	1.39[J]	<0.21[UJ]	1.32[J]	0.44	0.66[J]
Metolachlor (Dual)	<0.22[UJ]	0.27[J]	<0.21[UJ]	0.72[J]	0.50	0.32[J]
Simazine (Princep)	<0.22[UJ]	<0.22[UJ]	<0.21[UJ]	0.22[J]	<0.21	0.21[UJ]

[J] The compound was positively identified, but the associated value is estimated.
[UJ] The compound was not detected above the quantitation limit and the quantitation limit is estimated.

Table 4f. Site specific recreation use assessment in Ottawa Creek. Highlighted values indicate an Ohio WQS criteria violation.

Sampling Location	River Mile	Fecal Coliform Count (CFU/100 ml)					
		6/28/05	7/7/05	7/12/05	7/18/05	7/26/05	Geometric Mean
CR 12	18.52	>10,000	560	310	850	280	838
CR 12	14.67	2,200	850	1,200	1,800	990	1,319
TR 38	10.13	190	360	280	980	1,400	483
TR 79	4.82	820	1,000	230	>10,000	1,400	1,214
CR 86	0.90	640	350	590	1,700	480	641

Table 4g. Metal concentrations (mg/kg) in sediment collected from the Ottawa Creek WAU. Highlighted values were above either the statewide (*) or HELP ecoregion sediment reference value (SRV). Values reported as less than (<) were below the quantitation limit.

Element	Sampling Location and river mile			
	SRV	Blanch CR 53 41.31	Ottawa CR86 0.90	Dukes TR L-2 1.10
Aluminum	42,000	21,600	22,600	26,500
Barium	210	116	103	144
Calcium	110,000	37,800	21,100	25,200
Chromium	51	29	22	30
Copper	42	21.7	18.4	16.1
Iron	44,000	23,200	20,300	20,800
Lead	47 *	<29	<26	<26
Magnesium	29,000	13,100	9,020	8,070
Manganese	1,000	437	286	431
Nickel	36	<29	<26	<26
Potassium	12,000	6,230	5,320	7,060
Sodium	-	<3,560	<3,230	<3,180
Strontium	250	225	307	103
Zinc	190	107	84.3	85.5
Mercury	0.12 *	0.050	<0.033	0.042
Arsenic	11	11.0	6.83	10.0
Cadmium	0.96	0.404	0.349	0.497
Selenium	1.4	<1.43	<1.29	<1.27

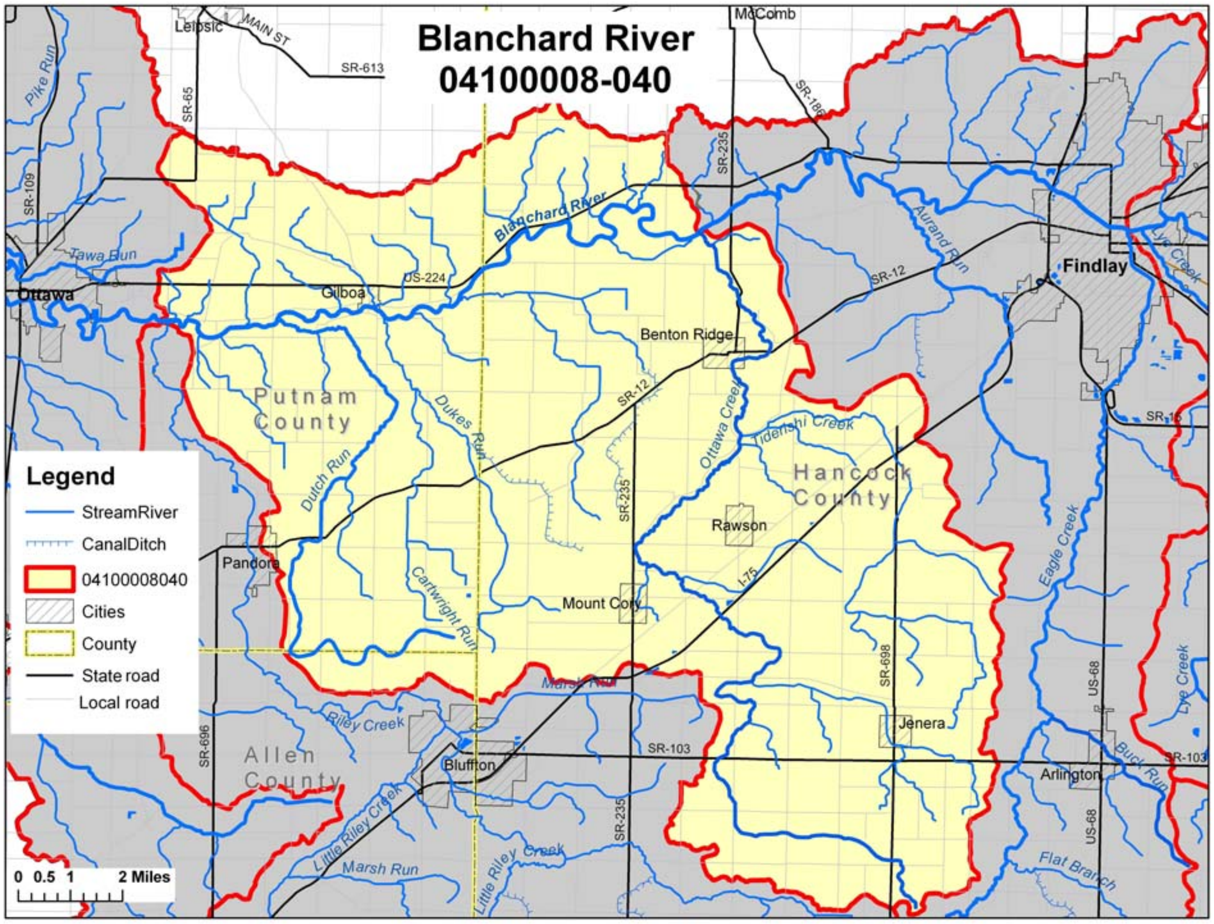

Figure 4a. Map of the Ottawa Creek WAU showing principal streams, roads, and urban areas. The Blanchard River below Dukes Run is excluded and evaluated separately as a Large River Assessment Unit.

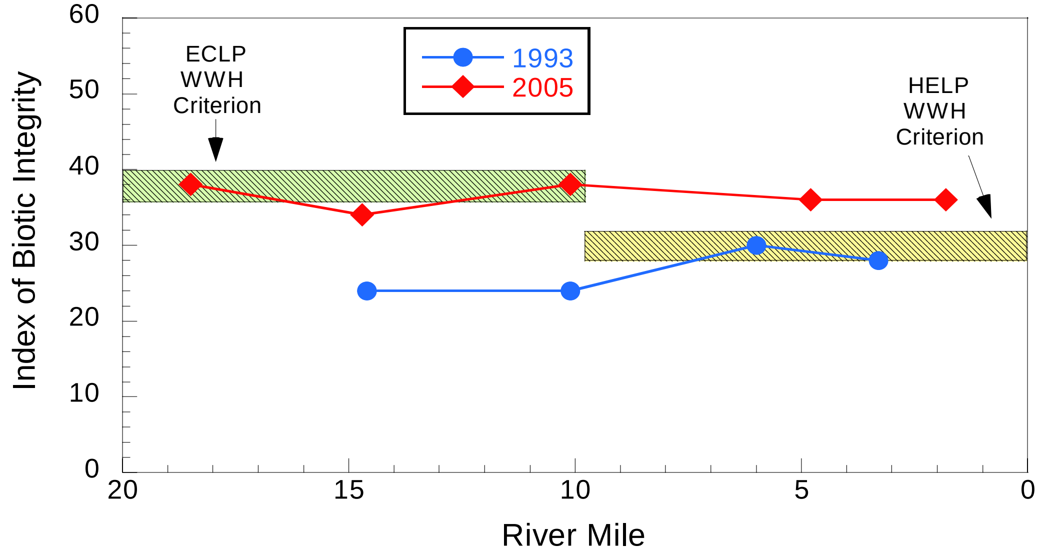

Figure 4b. Longitudinal trend of the Index of Biotic Integrity in Ottawa Creek, 1993 and 2005.

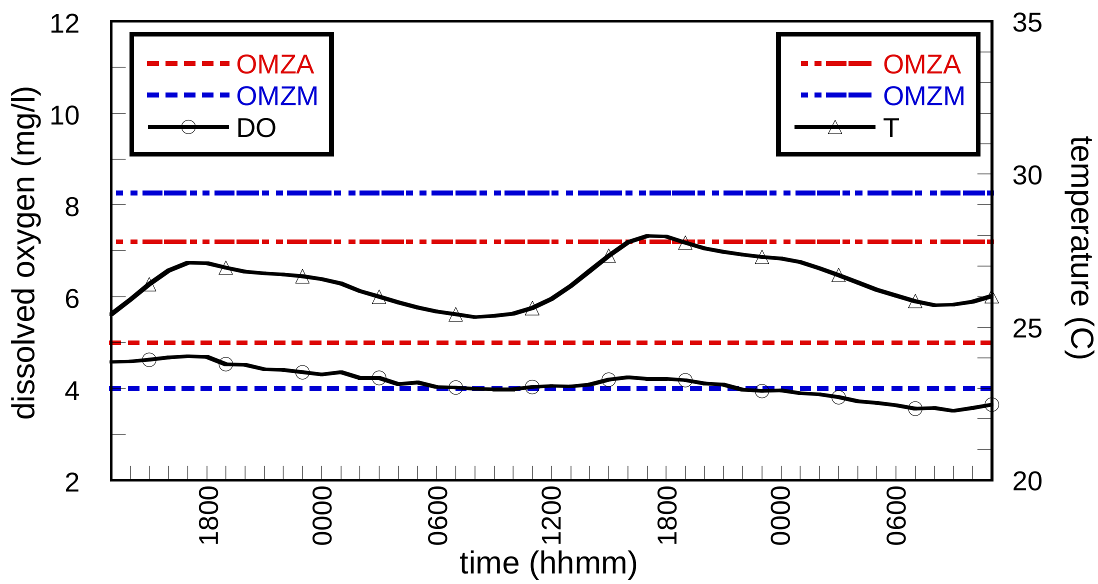

Figure 4c. Hourly readings of dissolved oxygen and temperature measured in the Blanchard River at Hancock CR 53 plotted against respective average and minimum/maximum criteria.

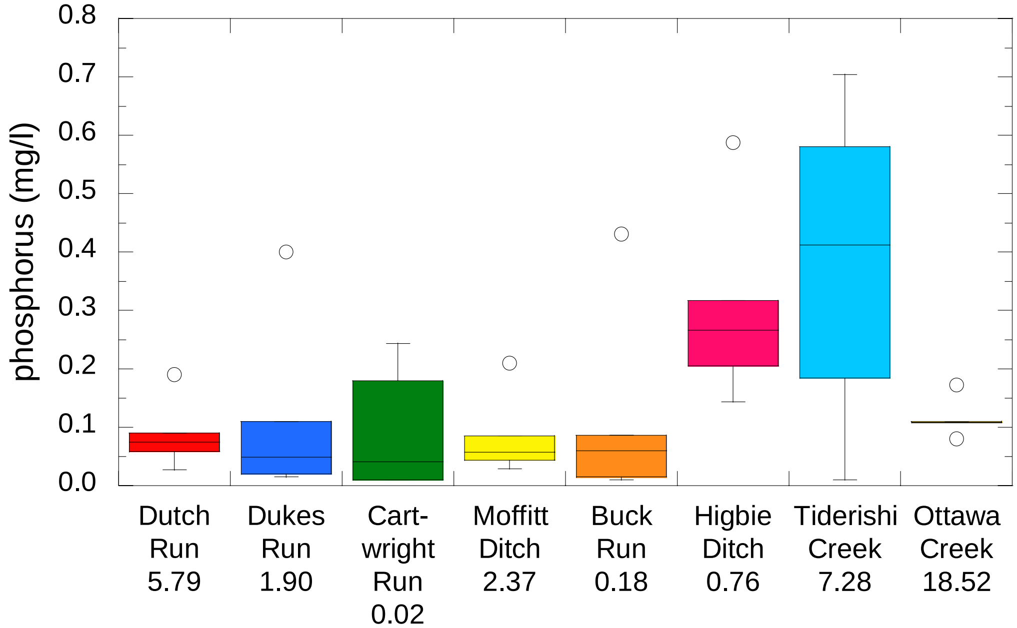

Figure 4d. Summary of phosphorus concentrations measured in grabs from tributary sites with a drainage area of approximately 6 mi2. The box contains 50% of the data points and the line represents the median value.

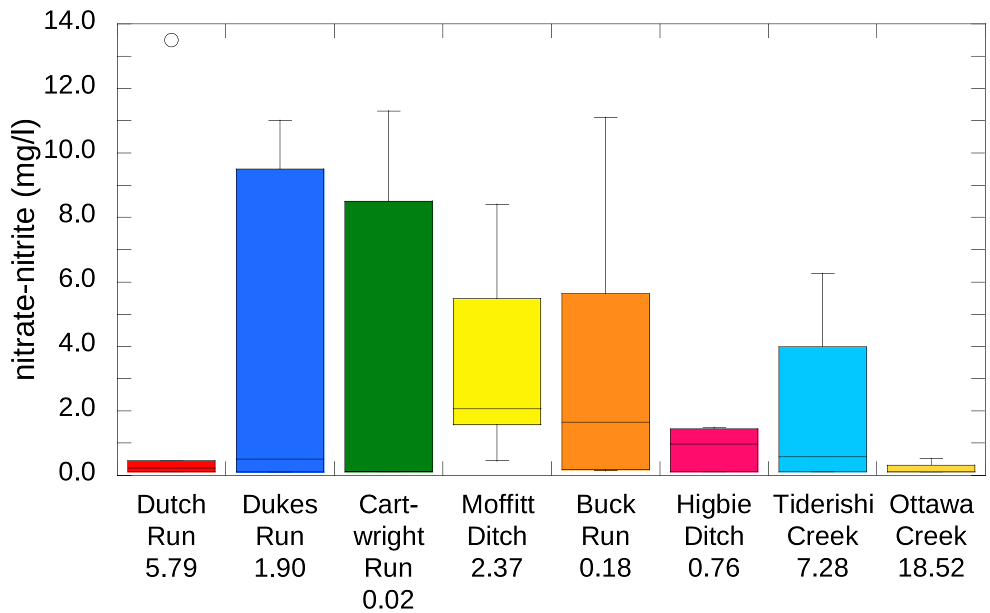

Figure 4e. Summary of nitrate-nitrite concentrations measured in grabs from tributary sites with a drainage area of approximately 6 mi^2. The box contains 50% of the data points and the line represents the median value.

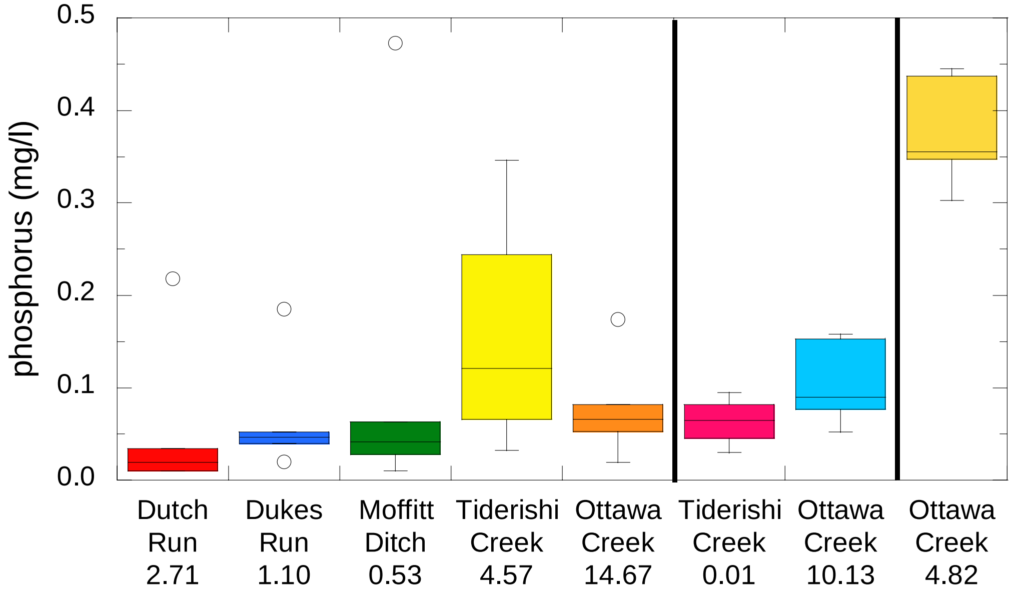

Figure 4f. Summary of phosphorus concentrations measured in grabs from tributary sites. Sites are loosely grouped based on similar drainage areas of 12, 24, and 48 mi^2. The box contains 50% of the data points and the line represents the median value.

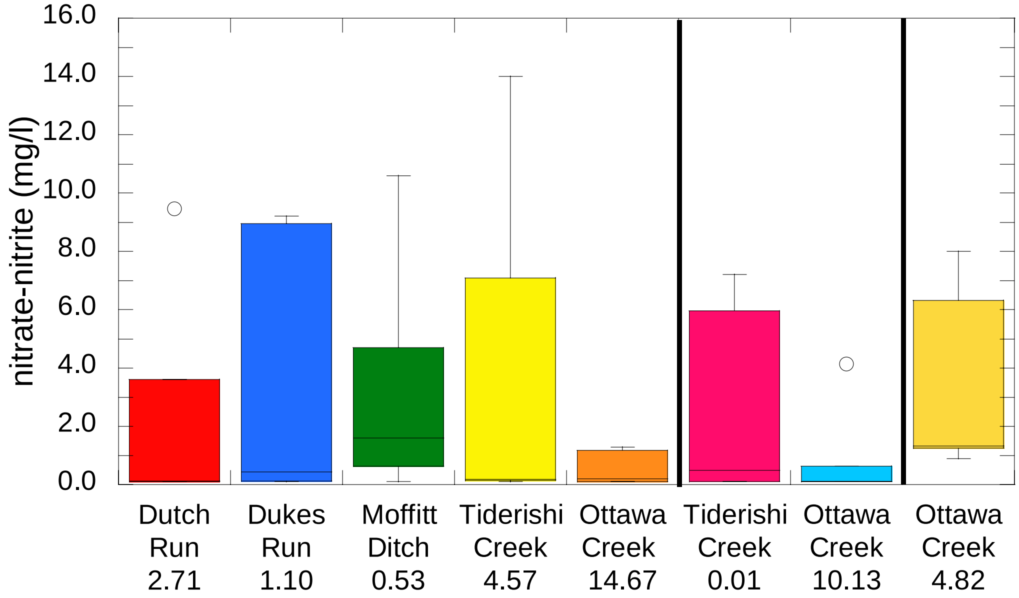

Figure 4g. Summary of nitrate-nitrite concentrations measured in grabs from tributary sites. Sites are loosely grouped based on similar drainage areas of 12, 24, and 48 mi^2. The box contains 50% of the data points and the line represents the median value.

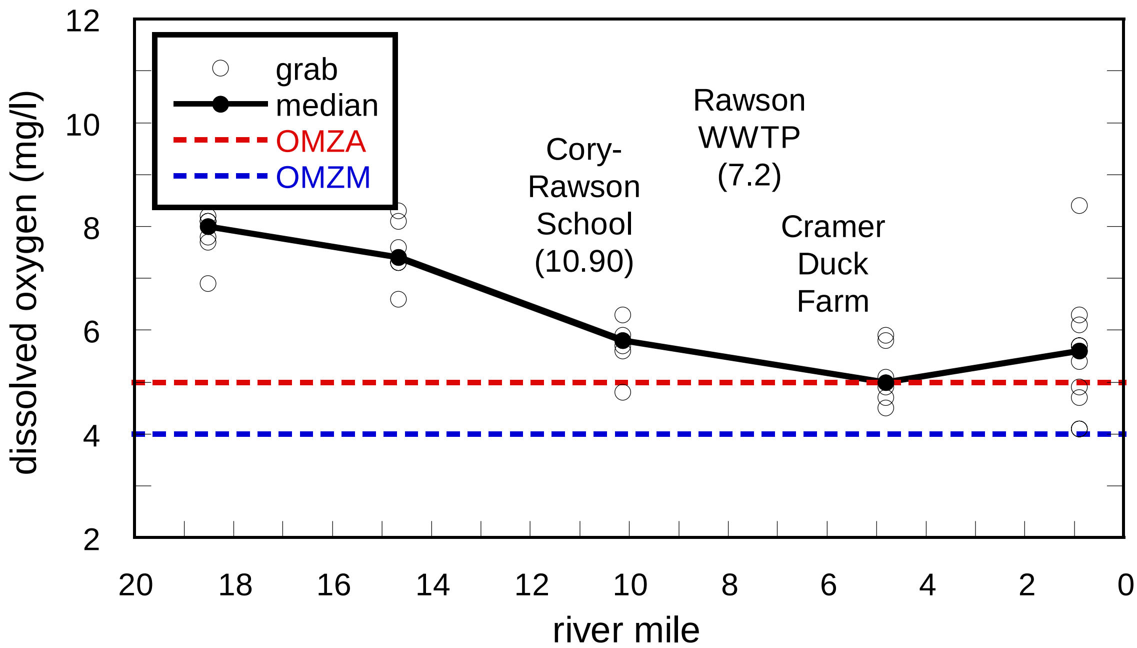

Figure 4c. Dissolved oxygen concentrations measured in daytime grabs from the Ottawa Creek mainstem plotted against the average and minimum criteria.

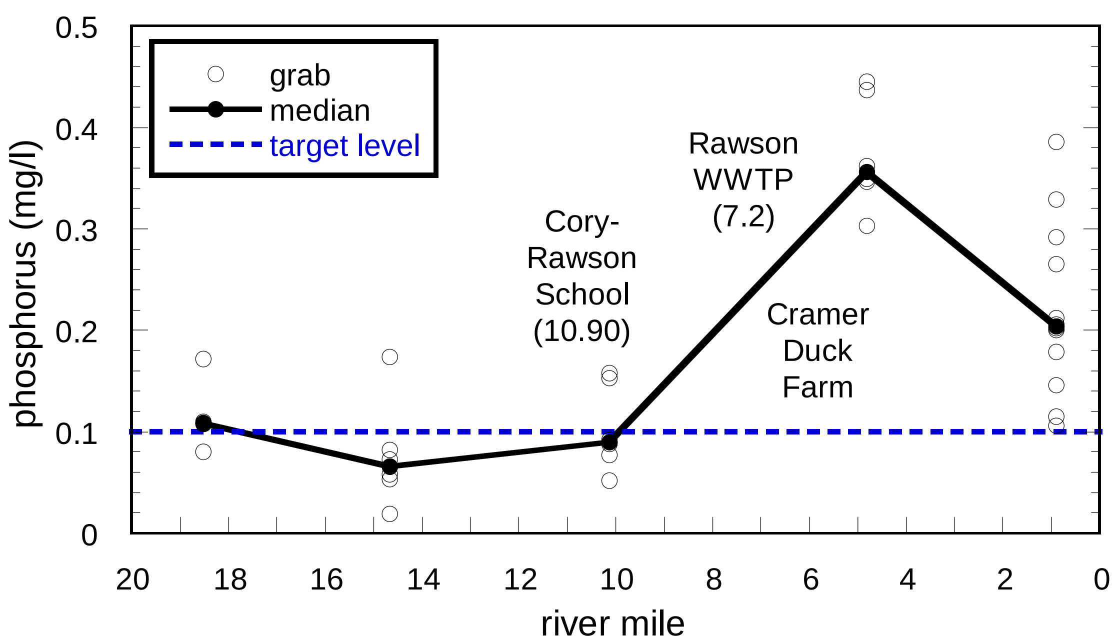

Figure 4d Phosphorus concentrations measured in grabs from the Ottawa Creek mainstem plotted against the target level.

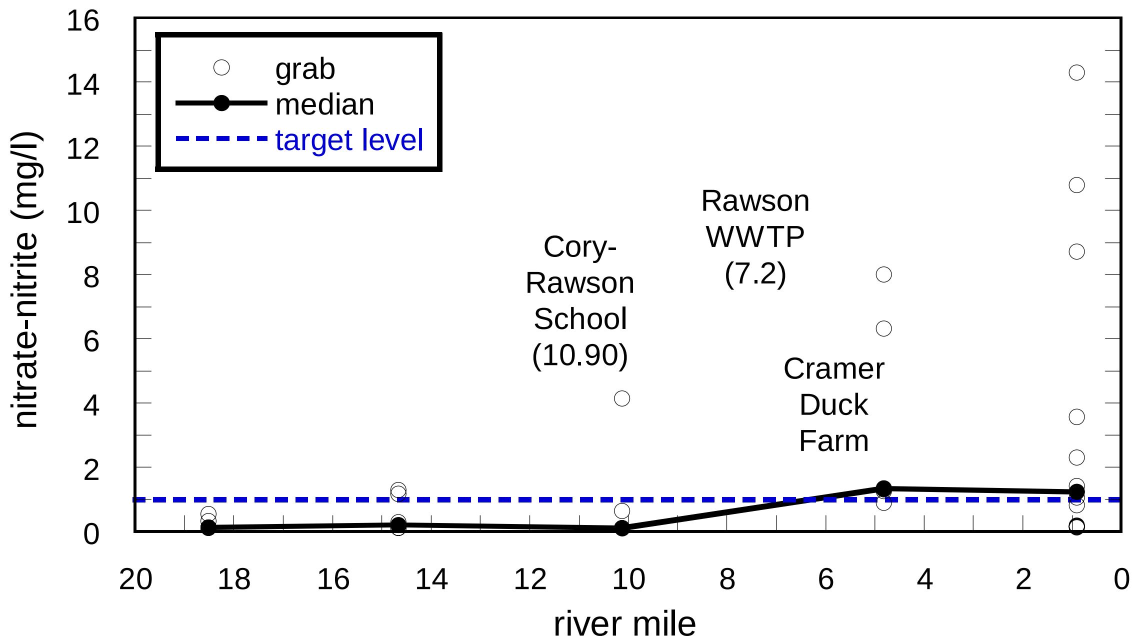

Figure 4e. Nitrate-nitrite concentrations measured in grabs from the Ottawa Creek mainstem plotted against the target level.

Figure 4f. Dry creek bed found in Tiderishi Creek at Eagle TR 44 (RM 4.57) on August 23.

Riley Creek WAU

The Riley Creek WAU (04100008-050) covers parts of four counties and drains about 88.2 mi^2. A map showing principal streams, roads, and urban areas is displayed in Figure 5a. Fish and macroinvertebrate populations and stream habitat conditions were evaluated throughout the WAU. The associated index scores and biological attainment status for each site (full, partial, or non) are summarized in Table 5a. Physical, chemical, and bacterial sampling was done to complement the biological data and an effluent sample was collected at the Bluffton WWTP. Most sites had six sets of samples collected at two week intervals. Bacteria were tested to assess recreation and Riley Creek had extra sampling done to meet temporal and sample size conditions contained in the rule and evaluate data on a site specific basis. Results from the small tributaries were simply compared to the maximum standard. Multi parameter automatic meters were set at six Riley Creek sites to measure physical conditions over a 48 hour period.

Water quality data and biological index scores were evaluated based on Ohio WQS criteria (OAC 3745-1). Target values presented in the *Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999) were used to evaluate nutrient enrichment. Appropriate numerical criteria and target values are often determined by use designation and all data was evaluated based on the current assigned uses of WWH, PCR, AWS, and IWS. Geographic location is an important consideration for biological criteria. Riley Creek originates in the ECBP ecoregion and crosses into the HELP ecoregion below Bluffton at RM 15.0. Nutrient target values are being used as guidelines in lieu of criteria that are currently under development. Preliminary results support the validity of these target values and the notion that a correlation exists between nutrients, aquatic life attainment status, and drainage area. Criteria will likely be tiered for drainage area at the break between a wadeable stream and a small river (200 mi^2). Therefore, nutrient samples from the WAU were evaluated using a phosphorus target of 0.10 mg/L and a nitrate-nitrite target of 1.00 mg/L.

Water quality exceedances that were documented are summarized in Table 5b. Some degree of water quality degradation was documented at every site. In most instances, habitat and flow conditions were not adequate enough to overcome an impact to aquatic life and there was widespread impairment. A summary of the dissolved oxygen data obtained from automatic meters deployed in Riley Creek is presented in Table 5c. Minimum dissolved oxygen values are important because enough needs to be present to sustain aquatic life. Criteria that apply to WWH streams are a 24 hour average of 5.0 mg/L and a minimum at any time of 4.0 mg/L. Maximum values are important if they are at supersaturated levels. This phenomenon results in an aquatic life ailment known as gas bubble disease. Initially, it causes gas bubbles to form on external surfaces and blocks the flow of water across the gills. As the disease progresses, it causes bubbles to form behind the eyes (pop-eyed) and in blood. This can restrict or stop blood flow, damage tissues, and eventually cause mortality. Fish mortality can occur when saturation reaches 140% and lesser impacts can happen at levels as low as 104%. There is also mounting evidence that concentrations that fluctuate more than 5 mg/L (minimum/maximum) over a diurnal period have a negative impact on aquatic life. This causes stress to aquatic organisms and is often linked with other changes in the environment like a shift in pH. Significant problems with supersaturation and flux were documented by the automatic meters.

An effort was made to identify the sources of water quality degradation. Ambient water quality is affected by a complex set of biotic and abiotic factors. Water picks up many impurities from the air, land, and ground and gases like oxygen, nitrogen, and carbon dioxide diffuse into water from the atmosphere. Climate, topography, vegetation, and biological activity all influence ambient water quality. Local water quality, though, is usually determined by inputs from anthropogenic sources that are grouped into point and nonpoint categories. The origin of a point source is easy to identify at the end pipe and most are regulated under the NPDES permit system. Individual permits are issued to facilities with unique processes like those summarized in Table 5d. General permits are issued to facilities with similar operations that exert a minimal impact on the environment like those summarized in Table 5e. Continuous discharge point sources have their greatest impact under base flow when chemistry is relatively stable and conditions reflect the ground water that recharges the stream.

Most tributary streams drain cropland and are managed to eliminate excess water with a combination of surface (ditches) and sub surface (tile) drainage systems. Too much water can delay planting, cultivation, or harvest and cause problems with flooding and soil compaction. Some drainage projects are simply done by the landowner, but those that involve multiple landowners and communities fall under county ditch laws. When the interested parties reach a mutual agreement a ditch petition is filed with the Board of County Commissioners. This starts the legal steps required to finance, construct, and maintain a ditch. The County Engineer presents a report at a public hearing and the board votes on the project. If the vote is in favor of the project, the engineer conducts a field survey and prepares plans and a cost estimate. A final hearing is held to re-affirm the decision before work is completed and the County Engineer (or SWCD) becomes responsible for maintenance. Habitat and flow alterations from these drainage projects are considered high magnitude causes of impairment.

The impact from a nonpoint source is a direct function of the surrounding land use and their exact origin is difficult to identify. Pollutants like silt, nutrients, and pesticides are carried in storm water from land used for crop and livestock production. Management practices like channelization, removal of riparian vegetation, and installation of sub surface tile systems result in significant flow and habitat alterations. They contribute to low flow conditions during dry weather periods because they limit ground water recharge by lowering the water table and by increasing evaporation since there in no tree shade. Conversely, these activities contribute to flooding during wet weather periods due to accelerated delivery of runoff. In pasture areas the exclusion of livestock from surface waters is an issue because of the damage they cause to habitat and increase the input of nutrients and bacteria. Livestock were observed wading in Riley Creek on several occasions and this activity was documented in the photograph shown in Figure 5b. A type of flow alteration is the impounding of a stream by a low head dam. These dams change stream morphology by flooding riffles, block fish migration, and ultimately change trophic structure. One of these structures is located on Riley Creek near Pandora and is shown in Figure 5c. Pollutants like silt, nutrients, and pesticides are also carried in storm water from urban areas, along with materials like oil and heavy metals that are present in auto exhaust. Combined sewer overflows are also a major source of organic matter and bacteria. Sewage collection systems in Bluffton and Pandora both have CSOs present. Flooding caused by accelerated delivery of runoff is also a problem in urban areas because of impervious surfaces and sources of inflow like down spouts and sump pumps.

Aquatic Life Use Designations

Biological and habitat assessments were conducted at 17 sites in 2005 and aquatic life use attainment status is presented in Table 5a.

Cranberry Run is a tributary of Riley Creek confluent at RM 3.37 that is about 10 miles in length and drains an area of 11.7 mi^2. It is within the HELP ecoregion and designated as PCR, AWS, and IWS based on the 1978 Ohio WQS. The stream is maintained by the Putnam County SWCD. A QHEI score of 31.5 was recorded at Cool Road (RM 6.7) on Cranberry Run which was channelized and had a predominantly muck substrate. The stream held very little water and was overgrown with grass. Modified habitat attributes outnumbered warm water attributes by a margin of 10:1. Habitat conditions were improved at RM 1.2. The lower site (RM 1.2) had more heterogeneous substrates, additional flow volume and supported a relatively good macroinvertebrate community; consistent with a WWH use. A package plant that serves the Ridge Road mobile home park is the only point source under permit and it discharges at RM 4.0. Water quality was generally good except that levels of nitrate-nitrite were elevated at times.

Cranberry Run had not been evaluated using biological and habitat data prior to the 2005 survey. A WWH use was assigned to the streams in the 1978 and 1985 water quality standards but never verified. Based on conditions encountered in 2005, a MWH use is recommended for Cranberry Run upstream from Riley Township Road 7L (RM 3.05). The WWH use should be maintained on Cranberry Run downstream from TR-7L.

Lower Little Riley Creek is a tributary of Riley Creek confluent at RM 15.30 that is about 9.5 miles in length and drains an area of 15.8 mi^2. It is within the ECBP ecoregion and designated as PCR, AWS, and IWS based on a study done in 1991. Most land is used for crop production except for commercial and residential developments in Beaverdam and Bluffton. Several regulated point sources are in the basin, including the Beaverdam WWTP. This is a controlled lagoon system and it did not discharge during the study period. Small package plants that serve a truck stop, nursing home, and subdivision are also present. Water quality was poor and degraded by low dissolved oxygen, elevated nutrients, and bacteria. Dissolved oxygen was below the OMZA in 8 of 16 samples, and 6 of these violated the OMZM. Phosphorus was above the target level in 16 of 16 samples and the median values were 4 to 8 times the target. Not enough fecal coliform samples were collected to do site specific evaluations, but 10 of 16 tested at the three sites exceeded the PCR maximum.

Lower Little Riley Creek was designated with a WWH aquatic life use based on biological sampling conducted in 1991. The sampling involved a survey of conditions beginning at RM 2.4 and extended downstream to the confluence with Riley Creek. The 2005 study lengthened the surveyed reach upstream an additional 3.1 miles. Sampling at RMs 4.3 and 5.5 was the first occasion to adequately assess the applicability of aquatic life uses in the upper reaches of the stream using a standardized biological evaluation. The channel held very little water at Swaney Road (RM 5.50), had good flow at Hillville Road (RM 4.30), and was dry at Riley Street (RM 0.03) late in the summer. It is suspected that water seeps into fractures in the bedrock here. Much of the creek is channelized and it is under petition in Allen County for a drainage project. Based on the 2005 results, a MWH use is recommended for Lower Little Riley Creek from the upper reaches downstream to the confluence of Marsh Run at RM 4.74. This portion was highly modified; yielding a QHEI score of 25.5. Habitat structure at RM 4.3 was much improved resulting in a QHEI score of 64.5.

Marsh Run is a tributary of Riley Creek confluent at RM 15.61 that is about 4.5 miles in length and drains an area of 7.6 mi^2. It is within the ECBP ecoregion and designated as PCR, AWS, and IWS based on the 1978 Ohio WQS. Marsh Run had not been evaluated using biological and habitat data prior to the 2005 survey. A WWH use was assigned to the stream in the 1978 and 1985 water quality standards but never verified. Marsh Run was a highly modified watercourse with limited biological communities. It has legal drain status in Hancock County where it is maintained by the SWCD. At TR 51 (RM 1.8), major habitat features included a straight, shallow channel with little instream cover and minimal water under low flow conditions. Modified habitat attributes outnumbered warm water attributes by a margin of 11:1 and netted a QHEI score of 33.0. A MWH use is recommended for Marsh Run. Poor habitat conditions and low dissolved oxygen are the likely causes of biological impairment.

Upper Little Riley Creek is a tributary of Riley Creek confluent at RM 20.63 that is about 6.5 miles in length and drains an area of 14.9 mi^2. It is within the ECBP ecoregion and designated as PCR, AWS, and IWS based on the 1978 Ohio WQS. Storm water from Marshall's Import Cars and Parts (permit # 2GR00150) is a source at TR 27 (RM 2.64). In addition, the bridge was replaced here during the study and a landowner was clearing riparian vegetation. Water quality was degraded mainly by low dissolved oxygen and siltation. One of the samples at TR 51 (RM 1.00) had 0.031 µg/L of mercury detected, which is above the OMZA for human health. Runoff from the auto scrap yard is a possible source since mercury is commonly used in auto switches.

Upper Little Riley Creek had not been evaluated using biological and habitat data prior to the 2005 survey. A WWH use was assigned to the stream in the 1978 and 1985 water quality standards but never verified. Although much of Upper Little Riley Creek was formally channelized it is not under county maintenance. Remnant impacts of channelization were in evidence but recovery of more natural habitat attributes was ongoing. QHEI scores at RM 2.7and 1.0 of 50 and 53.5, respectively, do not singularly identify the suitability of a WWH use. However, only one high influence modified habitat attribute was noted (no sinuosity at RM 2.7). A WWH should be an attainable use with continued recovery and controls to limit the input of embedding sediments.

Riley Creek is a tributary of the Blanchard River confluent at RM 30.08 that is about 27.5 miles in length and drains an area of 88.2 mi^2. Geographically, it transitions from the ECBP to the HELP ecoregion at about RM 15.0, but maintains many habitat characteristic of the ECBP. Additionally the stream is designated as WWH, PCR, AWS, and IWS based on a study done in 1991. It is not maintained for drainage, but has a history of habitat and flow alterations. Channelization and removal of riparian vegetation are practiced in the headwaters and there are some areas where limestone bedrock was mined from the stream bed. Low head dams located at RM 7.5, 7.3, 4.6, and 1.3 have resulted in impounded sections. There are also small concrete dams at RM 6.0 and 5.0, but they do not alter flow much. Some degree of water quality and habitat degradation was documented at every site; which translated into biological impairment in most instances. Fish were in attainment in the lower 7.6 miles, but scores were generally poor to very poor above that point.

The WWH aquatic life use designation was based on biological sampling conducted in 1991 that began at RM 17.9 and extended downstream to the confluence with the Blanchard River. The 2005 study lengthened the surveyed reach upstream an additional 7 miles. Sampling at RMs 24.9, 22.6 and 19.4 was the first occasion to adequately assess the applicability of aquatic life uses in the upper reaches of the stream using a standardized biological approach. Based on the 2005 results, a MWH use is recommended for Riley Creek upstream from the confluence of Upper Little Riley Creek at RM 20.63. This portion was highly modified, yielding a QHEI score of 32.5 at RM 24.9 and 37.0 at RM 22.6 with three high influence modified habitat attributes and a

10:2 ratio of modified to warmwater attributes. Habitat structure at RM 19.4 was improved. No high influence modified attributes were noted and the QHEI score increased to 55.5.

Aquatic Life Use Attainment Status

Sampled headwater sites in the Riley Creek WAU offer a good example of how similar sites within the entire Blanchard River watershed are affected by agricultural practices in the basin. The upper reaches of the watershed have been subjected to extensive alteration of the physical habitat and hydrology. Given a generally low gradient; recovery of warmwater habitat attributes in these small streams is a lengthy process and often interrupted by maintenance activities to facilitate drainage. Habitat needed to support typical WWH fish communities was severely compromised, as a result. Additionally nutrient enrichment promoted the growth of algae and wide fluctuations in dissolved oxygen levels which affected both organism groups.

Most tributary streams drain cropland and are managed to eliminate excess water with a combination of surface (ditches) and sub surface (tile) drainage systems. Too much water can delay planting, cultivation, or harvest and cause problems with flooding and soil compaction. Some drainage projects are simply done by the landowner, but those that involve multiple landowners and communities fall under county ditch laws. When the interested parties reach a mutual agreement a ditch petition is filed with the Board of County Commissioners. This starts the legal steps required to finance, construct, and maintain a ditch. The County Engineer presents a report at a public hearing and the board votes on the project. If the vote is in favor of the project, the engineer conducts a field survey and prepares plans and a cost estimate. A final hearing is held to re-affirm the decision before work is completed and the County Engineer (or SWCD) becomes responsible for maintenance. Habitat and flow alterations from these drainage projects are considered high magnitude causes of impairment.

Attainment status was determined for fourteen sites in the Riley Creek watershed, representing approximately 36 assessed stream miles in the WAU based. One site representing two assessed stream miles, fully met the current or recommended aquatic life use. Six sites, totaling thirteen assessed miles, partially met and eight sites, totaling 21 assessed stream miles, were in non-attainment of the current or recommended aquatic life use.

Biological communities in the Riley Creek WAU were impacted by a combination of factors related to agricultural practices in the watershed along with CSOs and urban runoff in the vicinity of the city of Bluffton. Hydromodification; principally channelization, flow modification and removal of riparian vegetation; affected 44% of the impaired stream miles. An excess of nutrients, dissolved oxygen concentrations/organic enrichment and siltation were identified as causative factors for 72%, 58%, and 53%, respectively, of the impaired miles. Thermal modification (i.e. elevated temperature) impacted approximately 22% of the assessed miles.

Two of nine headwater sites (<20 mi^2 drainage area) supported fish assemblages that met the existing or recommended aquatic life uses. Results from just one of ten macroinvertebrate collections (Cranberry Run at RM 1.2) produced an assemblage that attained ecoregional expectations. The limited ability of headwater streams in the Riley Creek WAU to support reasonably diverse biological communities is made even more apparent in that five of the low performing sites were on reaches with less than WWH expectations, having been recommended for a MWH use. Impacts included excessive nutrients, low DO, habitat alteration and siltation. Six sites with drainage of less than 20 mi^2 failed to meet designated or recommended Aquatic Life Uses and three sites partially met. Requisite credible data collection requirements were lacking to determine attainment status for one site in the assessment unit.

Seven wading sites (>20 mi^2 drainage area) on Riley Creek were also reflective of a largely impaired resource. The 2005 results were a consistent with a similar survey conducted in 1991. Biological community condition was associated with habitat quality and basin wide agricultural practices more closely than proximity to discharges from the Bluffton or Pandora WWTPs. The fish community, in particular, closely followed a pattern of low IBI scores at sub par habitat sites with improved results as the QHEI score increased at the three most downstream sites. Excessive nutrients and an impact from sedimentation were evidenced by the near absence of pollution intolerant fish species and low numbers of simple lithophilic fish. Simple lithophils require clean unembedded substrates for propagation of their eggs. The macroinvertebrate community was in slightly better condition within this reach, however, enrichment and to a lesser degree, sedimentation negatively affected the community. Only the most downstream site met WWH expectations. This was the only site in the Riley Creek WAU that supported both typical warmwater fish and macroinvertebrate communities.

Water Quality

Nutrient enrichment was the most common type of water quality degradation. Data obtained from grab samples was summarized for phosphorus in Figure 5q and nitrate-nitrite in Figure 5r to compare sites with similar drainage areas and identify where problems exist. In general, phosphorus met target in all tributaries except Lower Little Riley Creek and although nitrate-nitrite levels were high at times, all median values were below target. These are related to spring runoff and summer storm events.

Water quality in Riley Creek was degraded by several aspects pertaining to dissolved oxygen, including low levels, supersaturated levels, and levels that fluctuate widely over a diurnal period. Field readings for dissolved oxygen are summarized for grab samples in Figure 5e and for automatic meters in Figure 5f. Low dissolved oxygen was mainly a problem in the headwaters. Results at the three upstream sites were below the OMZA in 16 of 18 grab samples and the automatic meter set at TR 51 (RM 19.40) had 13 of 48 readings (27%) below the OMZA. Several factors likely contribute to this problem. Water levels were usually quite low because the drainage area is small and sub surface tile systems limit ground water recharge. Water was low enough on August 24 that flow was intermittent at CR 28 (RM 22.62). A moderate stream gradient (6.3 ft/mi) and channelization result in placid conditions and limit reaeration of the stream from the atmosphere. Low dissolved oxygen was also documented upstream from the Bluffton WWTP discharge. The automatic meter set at Spring Street (RM 15.41) had 27 of 49 readings (55%) below the OMZA. This condition might be influenced by ground water discharged from the Bluffton Stone quarry at RM 17.19. Ground water is typically low in oxygen and the facility discharges an annual average of 1.5 MGD (2.32 cfs). The problem is probably compounded by organic matter discharged from a CSO at Jefferson Street (RM 16.00) since bacteria that decompose the material consume oxygen in the process. Water temperature was higher than normal in this part of the creek too because of shallow water and bedrock substrate that absorbs heat from the sun. A graph showing dissolved oxygen and temperature data from the automatic meter at Spring Street is displayed in Figure 5g. Temperature was above the OMZA criteria in 18 of 49 readings (37%). Oxygen saturation in water is inversely proportional to temperature, so less oxygen is soluble as temperature increases.

High water temperature is also a concern in the lower part of Riley Creek, although it did not seem to translate into dissolved oxygen problems. Temperature was consistently high enough that averages calculated from automatic meter data at TR Q (RM 7.52) and CR 6 (RM 4.36) are violations of the OMZA. A significant number of these readings also violated the OMZM at each site. Graphs showing these results are displayed in Figures 5h and 5i, respectively. At TR Q (RM 7.52) the creek is wide and shallow with bedrock substrate and there is no tree canopy to provide shade from the sun. The creek is impounded by a low head dam upstream from CR 6 (RM 4.36) and this retains the water long enough for sunlight to have an effect. A low head dam upstream from TR K-6 (RM 1.20) has a similar impact, but not quite as severe. This is probably because ground water discharged from the Putnam Stone quarry at RM 1.94 is cool enough to minimize the effect.

Dissolved oxygen supersaturation is a concern at Fett Road (RM 13.05) below the Bluffton WWTP. A graph that shows dissolved oxygen concentration and % saturation at this site is displayed in Figure 5j. Some of the readings actually exceeded the 20 mg/L concentration and 200% saturation range limits. Algae blooms were common at this site and their photosynthetic activity is what causes the extremely high dissolved oxygen levels. This process also increases the pH level because the assimilation of carbon dioxide disrupts the calcium carbonate equilibrium and releases hydroxide ions. This phenomenon was especially noticed at CR 6 (RM 4.36), where an automatic meter measured 6 of 48 (12%) pH readings above the OMZA. This segment is influenced by a dam pool and effluent from the Pandora WWTP (RM 5.35).

The negative aquatic life impacts exerted by variables like dissolved oxygen and pH are often in response to algae blooms. Nuisance levels of algae can develop rapidly when nitrogen and phosphorus are abundant and factors like sunlight and temperature are not limiting. Nutrients rarely approach levels that are toxic to aquatic life, but the responses they stimulate damage stream aesthetics and taint drinking water. Drinking water problems range from simple taste and odor problems to serious human health concerns like methemoglobinemia (blue babies). Ammonia from the Bluffton WWTP was identified as a high magnitude cause of impairment during the study done in 1991. However, this is no longer the case since the plant has been replaced with a new facility. All effluent samples collected during the study were either at or below the 0.05 mg/L detection limit. Bacteria in the aeration tanks are very efficient at converting ammonia into nitrate (nitrification). The trade off with eliminating ammonia toxicity, though, is dealing with nitrate enrichment downstream from the outfall.

The main sources of nutrients in Riley Creek are agricultural runoff and effluent from the Bluffton (RM 15.40) and Pandora WWTPs (RM 5.35). Results from grab samples collected in the creek are summarized for phosphorus in Figure 5k and nitrate-nitrite in Figure 5l. The median phosphorus values at the three upstream sites were about 2 times the target level and then declined sharply to below target from TR 51 (RM 19.40) to Fett Road (RM 13.05). Subsequent downstream sites had median values about 1.5 times the target level. Nitrate-nitrite values exhibited a much different pattern. Median values were below the target level at all sites except Fett Road (RM 13.05), where the median was nearly 4 times the target. Effluent samples collected from the Bluffton WWTP during the survey had median phosphorus and nitrate-nitrite values of 0.581 mg/L and 29.1 mg/L, respectively. The response from these nutrient loadings was an algae bloom that persisted most of the summer at Fett Road.

An impact from agricultural runoff was evident in samples tested for pesticides. Six sets of samples were collected at TR K-6 (RM 1.20) and a summary of the compounds that were detected is presented in Table 5f. No insecticides were detected in any of the samples and Atrazine and Metolachlor were the most commonly detected herbicides. This information is important because the drinking water intake on the Blanchard River for Ottawa is only 2.78 miles away.

Most tributary streams drain cropland and are managed to eliminate excess water with a combination of surface (ditches) and sub surface (tile) drainage systems. Too much water can delay planting, cultivation, or harvest and cause problems with flooding and soil compaction. Some drainage projects are simply done by the landowner, but those that involve multiple landowners and communities fall under county ditch laws. When the interested parties reach a mutual agreement a ditch petition is filed with the Board of

County Commissioners. This starts the legal steps required to finance, construct, and maintain a ditch. The County Engineer presents a report at a public hearing and the board votes on the project. If the vote is in favor of the project, the engineer conducts a field survey and prepares plans and a cost estimate. A final hearing is held to re-affirm the decision before work is completed and the County Engineer (or SWCD) becomes responsible for maintenance. Habitat and flow alterations from these drainage projects are considered high magnitude causes of impairment.

Nutrient enrichment was the most common type of water quality degradation. Data obtained from grab samples was summarized for phosphorus in Figure 5q and nitrate-nitrite in Figure 5r to compare sites with similar drainage areas and identify where problems exist. In general, phosphorus met the target value in all tributaries except Lower Little Riley Creek and although nitrate-nitrite levels were high at times, all median values were below target. These are related to spring runoff and summer storm events.

Pollutant Loadings

Bluffton WWTP (permit # 2PC00005) is the only major point source (>1 MGD) within the Riley Creek WAU. It is located at 450 North Spring Street and serves a population of about 3,896, along with three categorical industrial users that contribute about 0.137 MGD of process water. The original plant was replaced with a new system that went on line in October 2003 and it significantly increased treatment capacity and improved effluent quality. Raw sewage from the collection system is filtered with bar screens to remove large debris and accumulates in a wet well. Centrifugal pumps then lift the sewage so it can flow by gravity into the rest of the plant. A grit chamber removes sand and other coarse material. Biological treatment is performed in conventional activated sludge aeration tanks. This flows to settling tanks where polymer and ferric chloride is added to enhance phosphorus removal. The treated wastewater is disinfected with ultraviolet light and aerated before being discharged to Riley Creek from Outfall 001 at RM 15.40. The plant is designed to treat 1.9 MGD and has a peak capacity of 6.2 MGD, with an annual average discharge of about 0.9 MGD. Sludge is treated with aerobic digesters, de-watered in a belt press, and eventually land applied at agronomic rates. The collection system consists of 95% separate sewers and contains 5 lift stations and 2 CSOs. Infiltration and inflow into the collection system is estimated at 0.318 MGD.

Bluffton has made a considerable effort to meet the conditions of their permit. A history of pollutant loadings at the WWTP was evaluated using monthly operating report data. These graphs show that effluent quality has improved significantly since the new plant went on line. Annual loadings for $cBOD_5$, phosphorus, and ammonia displayed in Figures 5m, 5n and 5o, respectively, all exhibit decreasing trends. Conversely, loadings of nitrate-nitrite displayed in Figure 5p have increased because of improved nitrification within the plant. The unfortunate consequence of this is nuisance algae blooms, which were documented in Riley Creek at Fett Road (RM 13.05) downstream from the WWTP. This is considered a better alternative than discharging elevated levels of ammonia, though, because of its acute toxicity to aquatic life.

The Ohio EPA renews NPDES permits every five years and also conducts annual compliance inspections at majors. An inspection was done at the Bluffton WWTP in June 2005 and the plant was in good operational order. Much progress has been made eliminating CSOs through sewer separation and reduction of infiltration and inflow, but the lack of CSO monitoring was noted as a deficiency. There have been 20 CSOs eliminated from the collection system since 2003 and two are still remaining. They are located at the intersection of Spring Street and Riley Street (Outfall 021- RM 15.39) and at Jefferson Street (Outfall 023- RM 16.00). Outfall 023 is scheduled to be eliminated by September 2006 and Outfall 021 by September 2007. The following effluent limit violations were documented in 2005;

Jan. - maximum TSS, cBOD, and P loading (1 of 4)
April - average P concentration and maximum P loading (1 of 4)
Sept. - average and maximum P concentration (3 of 4)
Dec. - average and maximum P concentration (1 of 4) and maximum P loading (1 of 4)

These permit violations typically occur during periods of wet weather when the plant operator attempts to treat the maximum amount of storm water. The plant is capable of handling these increased storm flows since the expansion was completed. However, this technique reduces the retention time required for adequate treatment and makes it difficult to feed enough chemicals to precipitate phosphorus. Even so, this alternative is preferred over releasing untreated sewage from CSOs.

<u>Pandora WWTP</u> (permit # 2PB00029) is located on Putnam CR 6 about 1 mile north of State Rt. 12 and serves a population of about 1,188, along with two categorical industrial users that contribute about 0.001 MGD of process water. The system was completed in 1972 and consists of a series of two facultative lagoons with a continuous discharge. Cell I holds about 8.2 million gallons and it provides primary treatment with a detention time of 33 days. It previously had aerators to help treat cannery waste, but this facility is now closed and the pumps were removed. Cell II holds about 7.8 million gallons and it provides secondary treatment with a detention time of 31 days. A rock filter was added in 1988 to provide tertiary treatment and remove solids. Final effluent is discharged to Riley Creek from Outfall 001 at RM 5.35. The plant is designed to treat 0.22 MGD and has an annual average discharge of about 0.27 MGD. The collection system consists of combined sewers and an interceptor that directs flows to a wet well where a lift station pumps sewage to the lagoons through a force main. Infiltration and inflow into the collection system is estimated at 0.17 MGD. The wet well has an overflow (Outfall 013) and as many as 11 CSOs were once active (Outfalls 002-011). A five phase project is planned to install new sanitary sewers and eliminate overflows.

Outfall 006 was previously eliminated by a project done in 1979. Phase I in 1996 eliminated Outfalls 011 and 012, Phase II in 2000 eliminated Outfalls 009 and 010, and Phase III is underway and should eliminate Outfalls 005, 007, and 008. Pandora is under Findings and Orders signed on July 25, 2003 to complete Phase III by July 2006, Phase IV by July 2008, and Phase V by December 2010.

The Pandora WWTP has a long history of permit violations. Treatment is poor because the system handles more waste than it was designed to treat. This is mainly caused by the combined sewers and excessive sources of infiltration and inflow. At times septic conditions in the rock filter have degraded effluent quality too by decreasing dissolved oxygen and increasing ammonia concentrations. Completion of the separation project should alleviate overloading and the system might gain enough detention time to convert to a controlled discharge. It is also possible that the lagoons are filling in with sediment, so it might be necessary to pump sludge to increase capacity.

Pandora Manufacturing is located at 501 S. Basinger Road, Pandora, OH. On March 21, 2006 there was a spill at the facility that resulted in the release of about 960 gallons of a floor wax compound into the village storm sewer system. This material ultimately escaped into Riley Creek and led to a clean up by federal, state, and county emergency response crews.

Recreation

People can be exposed to pathogens in water by skin contact and through ingestion. It is because of this that recreation criteria were developed to protect human health. Fecal coliform counts (colony forming units or CFU/100 ml) are used to indicate if water has been contaminated by feces from warm blooded animals. Fecal coliform are harmless in most cases, but there is a potential that the feces contained pathogens or disease producing bacteria (*Escherichia*, *Salmonella*, and *Shigella*), viruses (hepatitis A, Norovirus, and Rotavirus), and parasites (*Cryptosporidium*, *Giardia*, and *Cyclospora*). Reactions to exposure can be as minor as skin rash, sore throat, or ear infection. However, some reactions lead to diarrhea, gastroenteritis, and dysentery or even more serious wide spread epidemic.

Recreation was evaluated overall for the WAU and on a site specific basis for Riley Creek. The site specific evaluations were done because Riley Creek is a popular sport fishing destination. The overall assessment was done by pooling data obtained from the 2005 stream survey and NPDES permit monthly operating reports filed by Bluffton and Pandora for samples that were collected during the recreation season (May 1-October 15). The overall recreation use is considered impaired if either the 75^{th} percentile exceeds 1,000 CFU/100 ml or the 90^{th} percentile exceeds 2,000 CFU/100 ml. Based on these guidelines, the recreation use for the WAU is considered impaired because the values were 2,200 CFU/100 ml and 7,600 CFU/100 ml, respectively.

To determine if a specific site meets Ohio WQS criteria, a minimum of 5 samples must be collected within any 30 day period during the May 1-October 15 recreation season. The geometric mean calculated from this set of data should not exceed 1,000 and not more than 10% of the individual results should exceed 2,000. Results for testing done at 8 sites from June 29-July 27 are summarized in Table 5g. Six of these sites violated the maximum criterion and three of those violated the geometric mean criterion.

An impact from home sewage systems and possibly runoff from livestock is evident at TR 51 (RM 19.40). This was the first site that violated the geometric mean criterion. The highest levels were documented at Spring Street (RM 15.41) just above the Bluffton WWTP. The source here is probably the Jefferson Street CSO, since there were several rainstorms during July that were heavy enough to trigger an overflow. These overflows were also identified as a major problem during the 1991 study, but Bluffton has made major collection system improvements since that time. The last site to violate the geometric mean criterion was outside Bluffton at Fett Road (RM 13.05) and this is probably a lingering impact from CSOs.

Sediment Quality

Sediment samples were tested for particle size distribution, organic carbon content, % solids, metals, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and organochlorine insecticides. Chemical concentrations are evaluated based on Ohio reference values (Ohio EPA, 2003) and consensus based toxicity guidelines (MacDonald et al, 2000). Ohio reference values are based on an ecoregion reference site approach and considered background concentrations for streams. The MacDonald guidelines consider concentrations below a threshold effect concentration (TEC) to be absent of toxicity and those above a probable effect concentration (PEC) to be toxic to benthic organisms.

Substrate features reflect the glacial origin of the parent materials in Riley Creek. The creek was characterized by fine materials in the headwaters and coarse materials with bedrock outcrops in the lower section. As a result, sediment was not very common, especially in areas with bedrock outcrops or intact floodplains. A total of four samples were collected, but two were very thin layers found on top of bedrock below low head dams. Deep sediment was found in the headwaters where the stream is channelized and below the Bluffton urban area. Particle size distribution varied from site to site, but most samples contained at least 50% sand. The amount of organic carbon in samples ranged from 2.8-5.5%.

There were no PCBs or insecticides detected in any of the samples. The only one with any PAHs detected was collected at Fett Road (RM 13.05). A total of 11 different compounds had a sum concentration of 25.81 mg/kg, which is above the PEC of 22.8

mg/kg. Some response from benthic organisms is likely at this level. They might simply avoid the contamination or exhibit reduced growth, reproduction, or mortality. PAHs originate from fossil fuel combustion and are contained in creosote and coal tar. Several have been documented to cause skin cancer in lab animals and are strongly suspected human carcinogens. However, these levels are probably not high enough to warrant a dermal contact advisory to protect human health.

A summary of metal concentrations in sediment is presented in Table 5h. A few of the concentrations were slightly above Ohio reference values for the ECBP ecoregion, but none were elevated enough to be a concern. Some were also slightly above their respective TEC, but none were near the PEC. No aquatic life impact is expected based on the results.

Table 5A Aquatic life use attainment status for stations sampled in the Riley Creek assessment unit based on data collected July-September, 2005. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
Riley Creek			*MWH recommended - ECBP Ecoregion*					
24.9/24.9	5.8	20*		P*	32.5	NON	Direct habitat alteration, nutrients, siltation, organic enrichment/DO, bacteria (PCR)	Ag related channelization, crop production
22.0/22.6	12.1	26*		P*	37.0	NON	Direct habitat alteration, nutrients, siltation, organic enrichment/DO	Ag related channelization, crop production
			WWH - ECBP Ecoregion					
19.5/19.4	29.4	26*	7.1*	MG[ns]	55.5	NON	Direct habitat alteration, nutrients, siltation, organic enrichment/DO, bacteria (PCR)	Ag related channelization, crop production
15.5/15.5	44.4	34*	7.3*	MG[ns]	61.0	Partial	Organic enrichment/DO, thermal modification, nutrients, bacteria (PCR)	crop production, ground water loadings (low DO), CSO
14.4/____	62			32[ns]				
____/11.5	64	20*	4.3*		52.0	(NON)	Nutrients, siltation, organic enrichment/DO, bacteria (PCR)	crop production, CSO, urban runoff, municipal point sources
7.4/7.6	68	34*	8.0[ns]	MG[ns]	77.5	Partial	Nutrients, organic enrichment/DO, bacteria (PCR)	Crop production
4.4/4.3	70	40	9.3	F*	67.0	Partial	Nutrients, siltation, organic enrichment/DO, thermal modification	Crop production, municipal point sources, low head dam
1.2/1.2	85	42	10.6	40	78.0	Full		
Little Riley Creek (upper)			*WWH recommended- ECBP Ecoregion*					
2.6/2.7	8.5	30*		F*	50.0	NON	Direct habitat alteration, siltation	Ag related channelization, streambank destabilization
1.0/1.0	14.1	28*		F*	53.5	NON	Direct habitat alteration, flow alteration	Ag related channelization, crop production
Marsh Run			*MWH recommended- ECBP Ecoregion*					
1.7/1.8	6.2	24		LF*	33.0	Partial	Direct habitat alteration, nutrients, organic enrichment/DO	Ag related channelization, crop production
Little Riley Creek (lower)			*MWH recommended- ECBP Ecoregion*					
5.4/5.5	5.5	26		P*	25.5	Partial	Direct habitat alteration, siltation	Ag related channelization, crop production
			WWH - ECBP Ecoregion					
4.2/4.3	12.3	24*		F*	64.5	NON	Siltation, flow alteration, organic enrichment/DO, nutrients	Crop production
0.1/0.1	16	24*		P*	61.0	NON	Nutrients, organic enrichment/DO, flow alteration, bacteria (PCR)	Urban runoff, CSOs?
Cranberry Run			*MWH recommended- HELP Ecoregion*					
6.7/6.7	6.2	28		LF*	31.5	Partial	Direct habitat alteration, nutrients, organic enrichment/DO	Ag related channelization, crop production

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
			WWH recommended- ECBP Ecoregion					
1.2/____	11.3			G				

Ecoregion Biocriteria: Eastern Corn Belt Plain

	IBI			MIwb			ICI		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	40	50	24				36	46	22
Wading	40	50	24	8.3	9.4	4.0	36	46	22
Boat	42	48	24	8.5	9.6	4.0	36	46	22

Ecoregion Biocriteria: Huron Erie Lake Plain

	IBI			MIwb			ICI		
Site Type	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Headwaters	28	50	20				34	46	22
Wading	32	50	20	7.3	9.4	5.6	34	46	22
Boat	34	48	20	8.6	9.6	5.7	34	46	22

a- MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.
b- A narrative evaluation of the qualitative sample based on attributes such as community composition, EPT taxa richness, and number of sensitive taxa was used when quantitative data were not available or considered unreliable due to current velocities less than 0.3 fps flowing over the artificial substrates.
c- Attainment status based on a single organism group is parenthetically expressed.
d- Causes listed are considered to be a primary influence on water quality, but may not be the only issue leading to impairment. See text for discussion of additional causes that cumulatively have led to impairment.
e- Sources listed are considered to be a primary influence on water quality, but may not be the only source leading to impairment. See text for discussion of additional sources that cumulatively have led to impairment.
ns- Nonsignificant departure from biocriteria ($\leq$4 IBI or ICI units, or $\leq$0.5 MIwb units).
* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

Table 5b. Exceedences documented in the Riley Creek WAU based on Ohio WQS criteria and nutrient target values. Criteria include outside mixing zone minimum or maximum (OMZM) and average (OMZA) values.

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Riley Creek WWH, PCR, AWS, IWS	24.94	WWH	dissolved oxygen	5 of 6 grabs below OMZM
				1 of 6 grabs below OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
		PCR	fecal coliform	violated site specific maximum
	22.62	WWH	dissolved oxygen	2 of 6 grabs below OMZM
				4 of 6 grabs below OMZA
			phosphorus	5 of 6 grabs and median above target
	19.40	WWH	dissolved oxygen	1 of 6 grabs below OMZM
				3 of 6 grabs below OMZA
				9 of 48 diurnals below OMZM
				4 of 48 diurnals below OMZA
				diurnal flux > 5 mg/L
				diurnal saturation > 140%
			phosphorus	3 of 6 grabs above target
			nitrate-nitrite	3 of 6 grabs above target
		AWS	iron	1 of 6 grabs above OMZA
		PWS	fecal coliform	violated site specific geometric mean
				violated site specific maximum

Table 5b. Continued

Stream	River	Use	Parameter	Water Quality Degradation
Riley Creek WWH, PCR, AWS, IWS	15.41	WWH	dissolved oxygen	21 of 49 diurnals below OMZM
				6 of 49 diurnals below OMZA
				diurnal flux > 5 mg/L
			temperature	6 of 49 diurnals above OMZM
				12 of 49 diurnals above OMZA
			phosphorus	1 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum
	13.05	WWH	dissolved oxygen	diurnal flux > 5 mg/L
				diurnal saturation > 140%
			phosphorus	2 of 6 grabs above target
			nitrate-nitrite	6 of 6 grabs and median above target
		PCR	fecal coliform	violated site specific geometric mean
				violated site specific maximum
	7.52	WWH	dissolved oxygen	1 of 47 diurnals below OMZA
				diurnal flux > 5 mg/L
			temperature	17 of 47 diurnals above OMZM
				violated OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	2 of 6 grabs above target
		PCR	fecal coliform	violated site specific maximum

Table 5b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Riley Creek WWH, PCR, AWS, IWS	4.36	WWH	dissolved oxygen	4 of 48 diurnals below OMZA
				diurnal saturation > 140%
			temperature	16 of 48 diurnals above OMZM
				violated OMZA
				diurnal flux > 5 mg/L
			pH	6 of 48 diurnals above OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	2 of 6 grabs above target
	1.20	WWH	dissolved oxygen	diurnal flux > 5 mg/L
				diurnal saturation > 140%
			temperature	17 of 47 diurnals above OMZA
			phosphorus	8 of 12 grabs and median above target
			nitrate-nitrite	3 of 12 grabs above target
		PCR	fecal coliform	violated site specific maximum
Cranberry Run WWH, PCR, AWS, IWS	6.67	WWH	nitrate-nitrite	3 of 6 grabs above target
		PCR	fecal coliform	1 of 6 grabs above maximum
	1.22	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			phosphorus	2 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target
		PCR	fecal coliform	1 of 6 grabs above maximum

Table 5b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Lower Little Riley Creek WWH, PCR, AWS, IWS	5.50	WWH	dissolved oxygen	1 of 6 grabs below OMZM
				1 of 6 grabs below OMZA
			ammonia	1 of 6 grabs above OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
		PCR	fecal coliform	2 of 6 grabs above maximum
	4.30	WWH	dissolved oxygen	3 of 6 grabs below OMZM
				1 of 6 grabs below OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	2 of 6 grabs above target
		PCR	fecal coliform	4 of 6 grabs above maximum
	0.03	WWH	dissolved oxygen	2 of 4 grabs below OMZM
			phosphorus	4 of 4 grabs and median above target
			nitrate-nitrite	2 of 4 grabs above target
		PCR	fecal coliform	4 of 4 grabs above maximum
Marsh Run WWH, PCR, AWS, IWS	1.74	WWH	dissolved oxygen	3 of 6 grabs below OMZA
			strontium	1 of 6 grabs above OMZA
			phosphorus	2 of 6 grabs above target
			nitrate-nitrite	3 of 6 grabs above target
		PCR	fecal coliform	2 of 6 grabs above maximum

Table 5b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Upper Little Riley Creek WWH, PCR, AWS, IWS	2.64	WWH	dissolved oxygen	3 of 6 grabs below OMZA
			phosphorus	2 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	2 of 6 grabs above maximum
	1.00	WWH	dissolved oxygen	2 of 6 grabs below OMZA
			phosphorus	2 of 6 grabs above target
			nitrate-nitrite	3 of 6 grabs and median above target
		AWS	iron	1 of 6 grabs above OMZA
		HH	mercury	1 of 6 grabs above OMZA
		PCR	fecal coliform	2 of 6 grabs above maximum

Table 5c. Summary of hourly dissolved oxygen measurements (mg/L) recorded by automatic meters deployed in Riley Creek. Highlighted values indicate a WQS violation.

River Mile	Hours	Mean	Median	Minimum	Maximum	Flux
19.40	48	7.71	6.70	2.76	14.15	11.39
15.41	49	5.33	4.30	3.13	9.87	6.74
13.05	48	12.35	10.66	5.44	20.00	14.56
7.52	48	10.22	10.44	4.96	14.81	9.85
4.36	48	8.89	8.81	4.79	14.98	10.19
1.20	47	8.92	8.47	5.57	13.60	8.03

Table 5d. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Putnam Stone	2IJ00057	Riley Creek	1.94	0.15 MGD sedimentation pond
Pandora WWTP	2PB00029	Riley Creek	5.35	0.335 MGD continuous discharge lagoon system
Bluffton WWTP	2PC00005	Riley Creek	15.40	1.9 MGD activated sludge plant
Bluffton Stone	2IJ00018	Riley Creek	17.19	1.5 MGD sedimentation pond
Ridge Road MHP	2PY00046	Cranberry Run	4.0	0.0035 MGD package plant
Mast Estates	2PG00038	Lower Little Riley Creek	3.6	0.009 MGD package plant
Beaverdam WWTP	2PB00018	Lower Little Riley Creek Tributary (5.55)	0.4	0.10 MGD controlled discharge lagoon system
Richland Manor	2PR00199	Lower Little Riley Creek Tributary (5.69)	0.1	0.0186 MGD package plant
Speedway Super America # 3547	2PR00109	Lower Little Riley Creek	6.2	0.015 MGD package plant

Table 5e. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
Gerken Materials, Plant #5	2GG00241	Riley Creek	Industrial Storm water
DTR Industries	2GG00035	Riley Creek	Industrial Storm water
Gerken Materials, Plant #3	2GG00239	Riley Creek	Industrial Storm water
Gerken Materials, Plant #10	2GG00243	Riley Creek	Industrial Storm water
Tower Automotive	2GR00488	Marsh Run	Industrial Storm water
Mid Bus, Inc.	2GR00119	Riley Creek	Industrial Storm water
Bluffton Septic Tank Co.	2GR00118	Lower Little Riley Creek	Industrial Storm water
Marshall’s Import Cars and Parts	2GR00150	Upper Little Riley Creek	Industrial Storm water
Clemens Development Systems	2GC00125	Riley Creek	Construction Storm water
Village of Beaverdam	2GC00654	May Ditch	Construction Storm water
Allen County Engineers	2GC00084	Riley Creek	Construction Storm water
Allen County Engineers	2GC00008	Riley Creek	Construction Storm water
Ohio DOT	2GC00506	Binkley Ditch, Cummins Ditch, Riley Creek, Upper Little Riley Creek	Construction Storm water

Table 5f. Summary of herbicides (µg/L) detected in Riley Creek at Ottawa TR K-6 (RM 1.20). Values reported as less than were below the quantitation limit.

Compound (Trade Name)	6/15/05	6/29/05	7/13/05	7/27/05	8/10/05	8/24/05
Acetochlor (Harness)	1.37	<0.21[UJ]	<0.21[UJ]	<0.40[UJ]	<0.21	<0.21[UJ]
Atrazine (AAtrex)	3.18	1.35[J]	<0.21[UJ]	0.60[J]	0.49	0.38[J]
Metolachlor (Dual)	0.66	0.35[J]	<0.21[UJ]	1.02[J]	0.23	0.27[J]
Simazine (Princep)	0.23	0.31[J]	<0.21[UJ]	<0.40[UJ]	<0.21	<0.21[UJ]

[J] The compound was positively identified, but the associated value is estimated.

[UJ] The compound was not detected above the quantitation limit and the quantitation limit is estimated.

Table 5g. Site specific recreation use assessment in Riley Creek. Highlighted values indicate an Ohio WQS criteria violation.

Sampling Location	River Mile	Fecal Coliform Count (CFU/100 ml)					
		6/29/05	7/7/05	7/13/05	7/18/05	7/27/05	Geometric Mean
CR 12	24.94	190	68	150	2,800	2,400	420
CR 28	22.62	1,400	100	620	1,000	1,600	674
TR 51	19.40	4,800	2,500	260	1,900	1,600	1568
Spring St	15.41	9,800	2,000	1,000	2,200	10,000	3365
Fett Road	13.05	1,400	1,000	620	1,800	8,800	1689
TR Q	7.52	690	210	620	1,000	4,600	838
CR 6	4.36	130	8	24	560	1,800	120
TR K-6	1.20	430	150	130	680	7,600	534

Table 5h. Metal concentrations (mg/kg) in sediment collected from Riley Creek. Highlighted values were above either the statewide (*) or ECBP ecoregion sediment reference value (SRV). Values reported as less than were below the quantitation limit.

Element	Sampling Location and river mile				
	SRV	TR 51 19.40	Fett Rd. 13.05	CR 6 4.36	TR K-6 1.20
Aluminum	39,000	44,000	16,900	11,000	39,900
Barium	240	248	80.8	60.4	215
Calcium	120,000	45,000	39,100	20,800	39,500
Chromium	40	48	22	15	45
Copper	34	21.0	14.6	10.0	25.5
Iron	33,000	30,900	15,500	10,100	30,800
Lead	47 *	<43	<21	<20	<34
Magnesium	35,000	10,000	15,300	7,370	15,400
Manganese	780	729	243	160	676
Nickel	42	<43	<21	<20	34
Potassium	11,000	12,400	4,990	2,860	11,200
Sodium	-	<5,350	<2,670	<2,450	<4,290
Strontium	390	334	144	96	271
Zinc	160	126	69.0	41.6	143
Mercury	0.12 *	0.068	<0.029	<0.036	0.081
Arsenic	18	13.3	7.80	3.77	11.6
Cadmium	0.90	0.623	0.427	0.231	0.720
Selenium	2.3	<2.14	<1.07	<0.98	<1.72

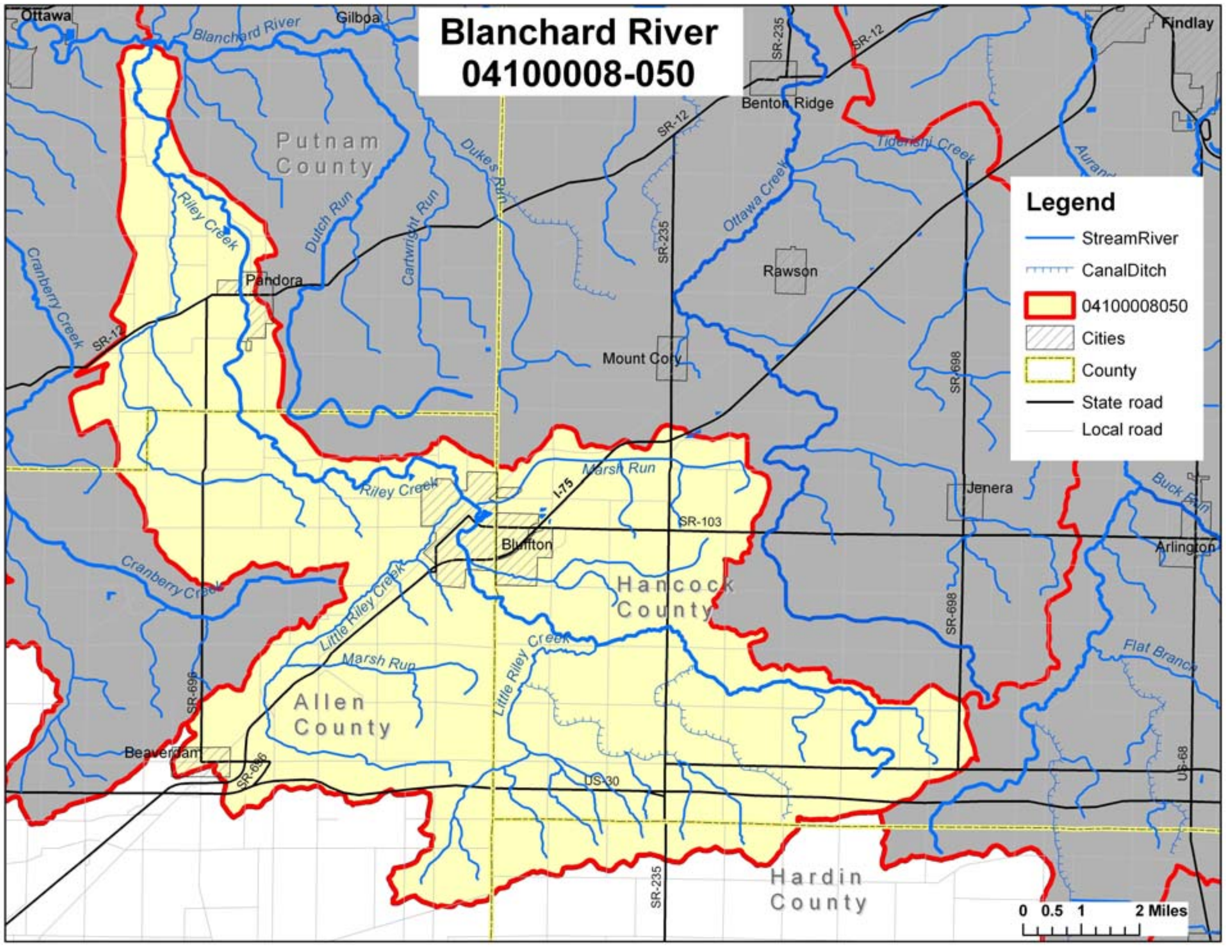

Figure 5a. Map of the Riley Creek WAU showing principal streams, urban areas, and roadways.

Figure 5b. Unrestricted livestock showed wading in Riley Creek at Riley TR Q (RM 7.52).

Figure 5c. Low head dam on Riley Creek below the Village of Pandora near Putnam CR 6.

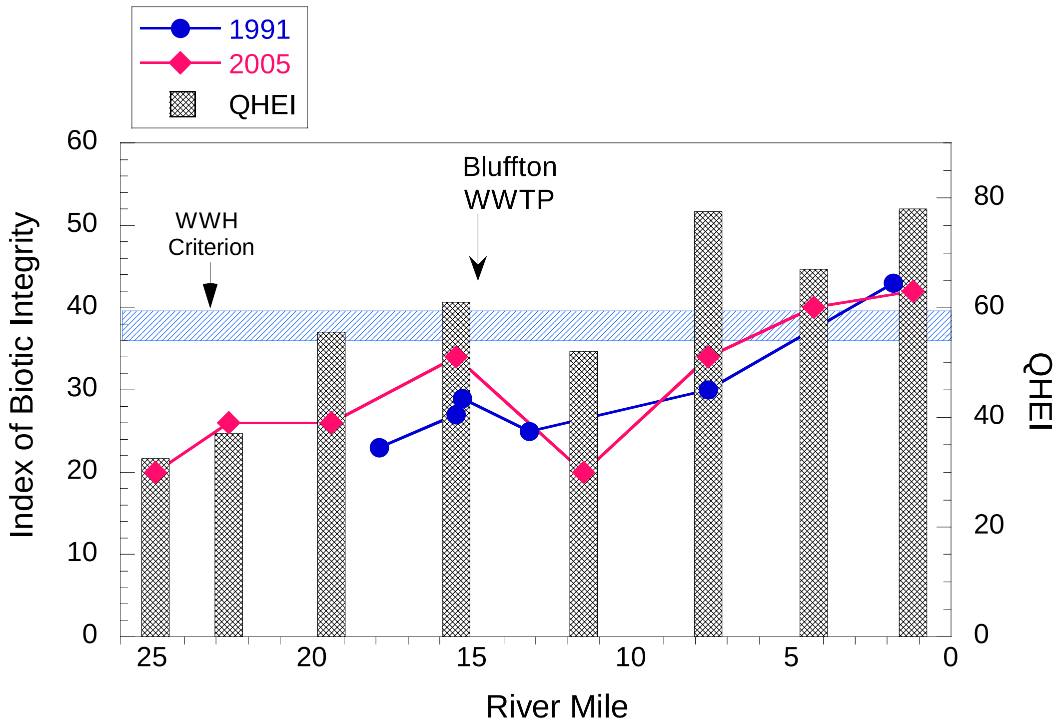

Figure 5d Longitudinal trend of the Index of Biotic Integrity (IBI), 1991 and 2005, and 2005 QHEI scores in Riley Creek demonstrating the relationship between fish community condition and habitat quality.

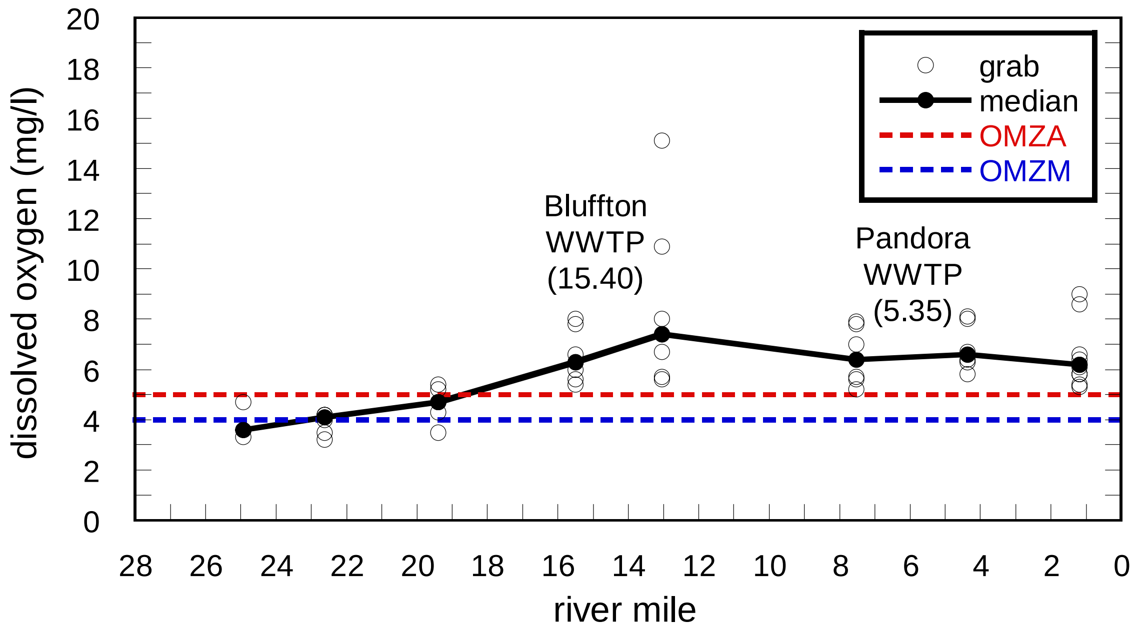

Figure 5e. Summary of dissolved oxygen concentrations measured in daytime grabs from Riley Creek plotted against average and minimum criteria.

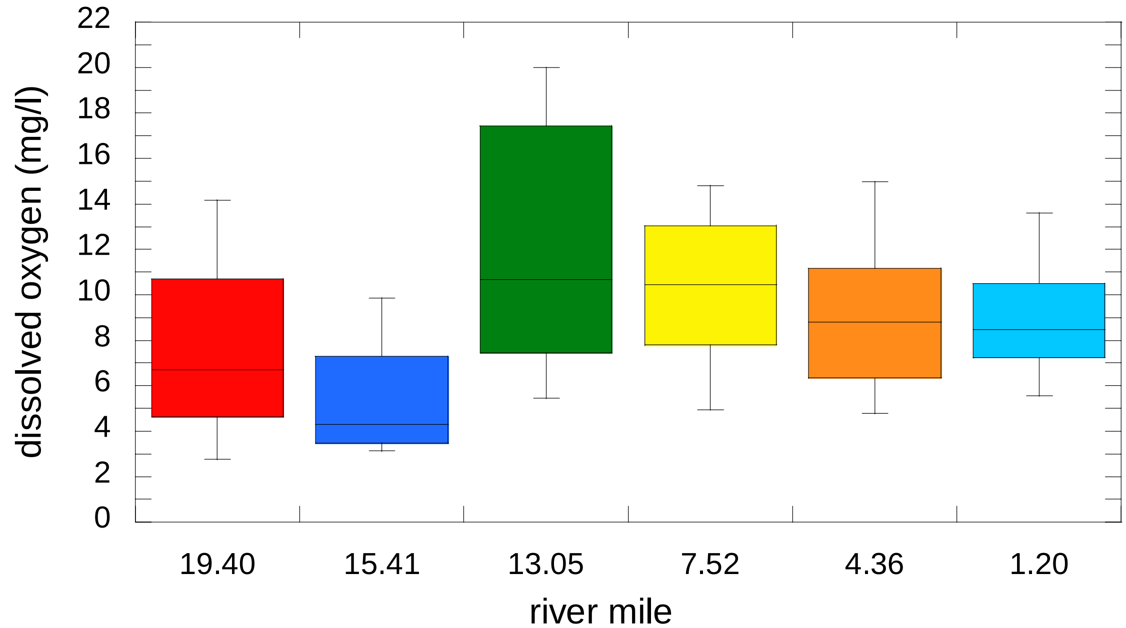

Figure 5f. Summary of dissolved oxygen concentrations measured hourly for 48 hours by continuous monitors deployed in Riley Creek on August 2, 2005. The box contains 50% of the data points and the line represents the median value.

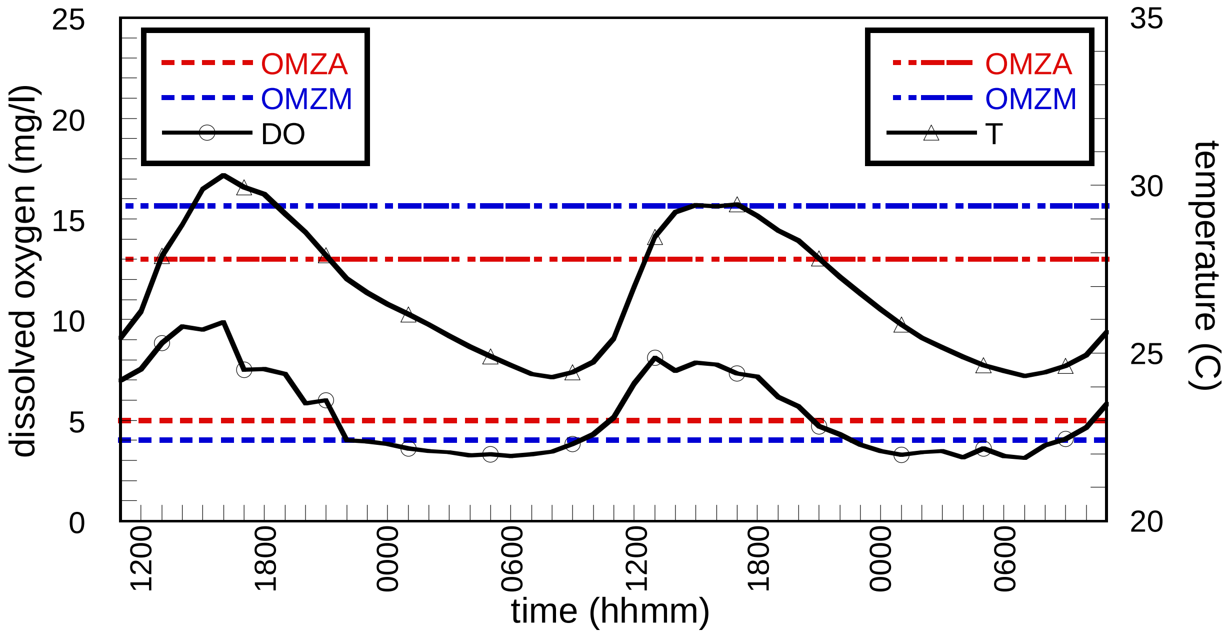

Figure 5g. Hourly readings of dissolved oxygen and temperature measured in Riley Creek at Spring Street plotted against respective average and minimum/maximum criteria.

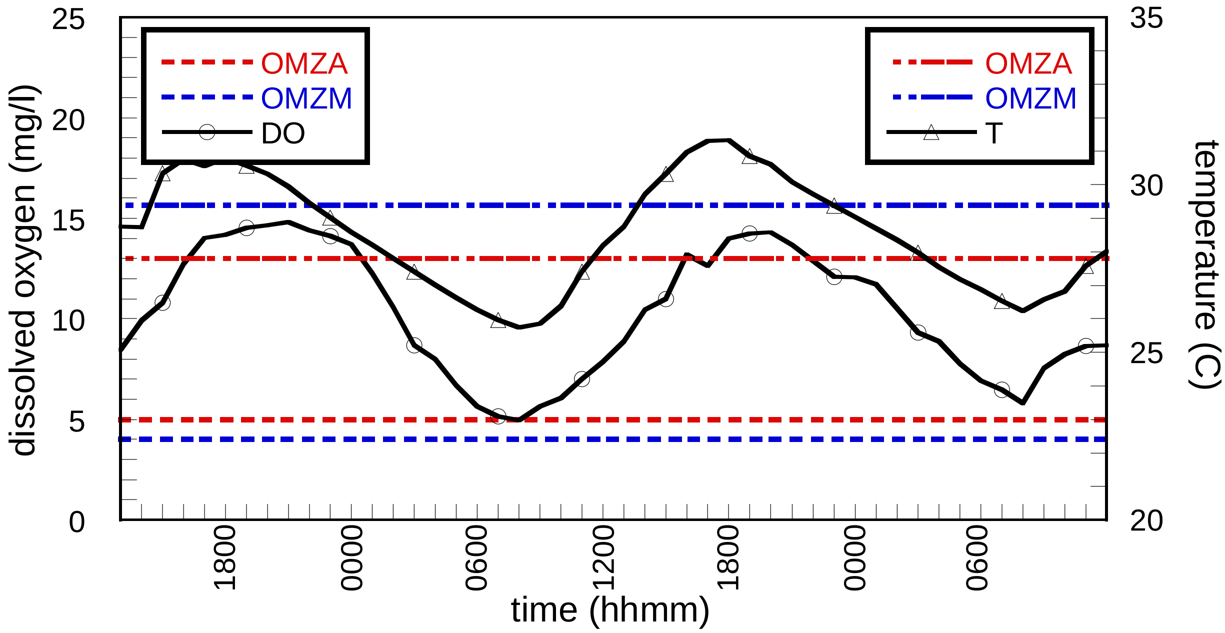

Figure 5h. Hourly readings of dissolved oxygen and temperature measured in Riley Creek at Riley TR Q plotted against respective average and minimum/maximum criteria.

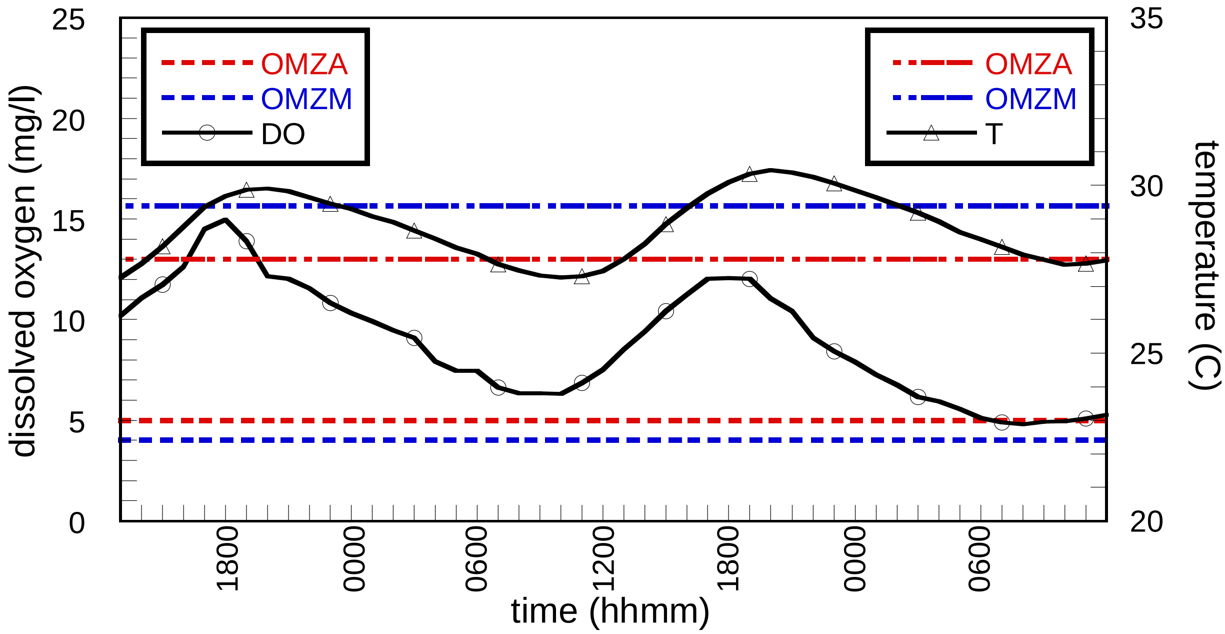

Figure 5i. Hourly readings of dissolved oxygen and temperature measured in Riley Creek at Putnam CR 6 plotted against respective average and minimum/maximum criteria.

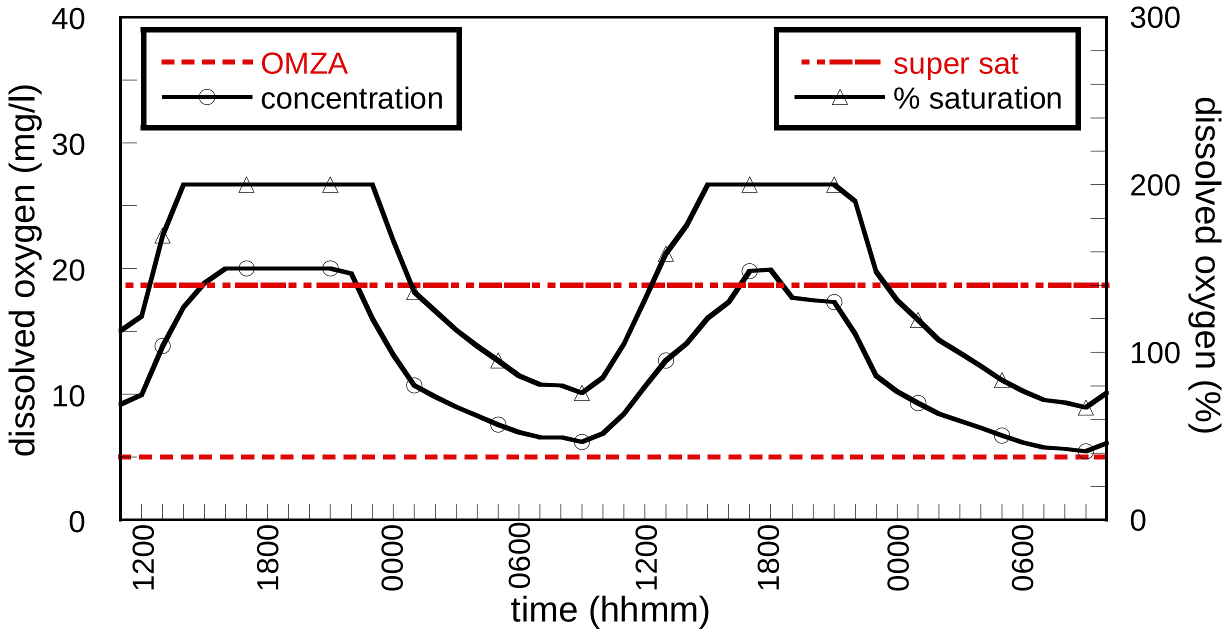

Figure 5j. Hourly readings of dissolved oxygen concentrations and % saturation measured in Riley Creek at Fett Road plotted against the average criteria and supersaturation level.

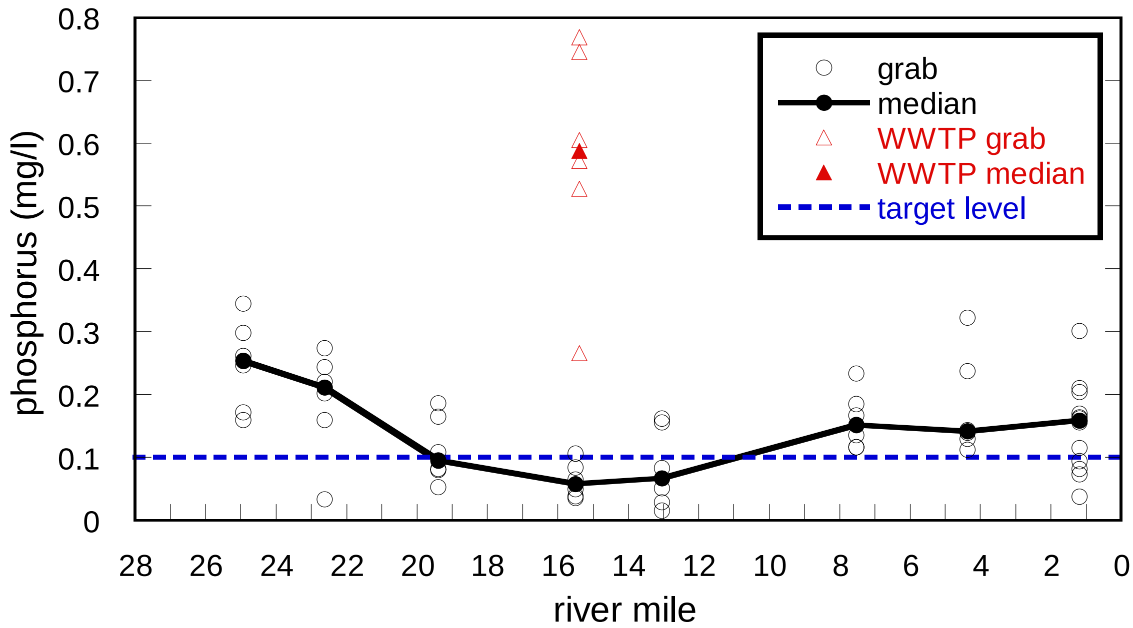

Figure 5k. Summary of phosphorus concentrations measured in grabs from Riley Creek and Bluffton WWTP effluent plotted against the target level.

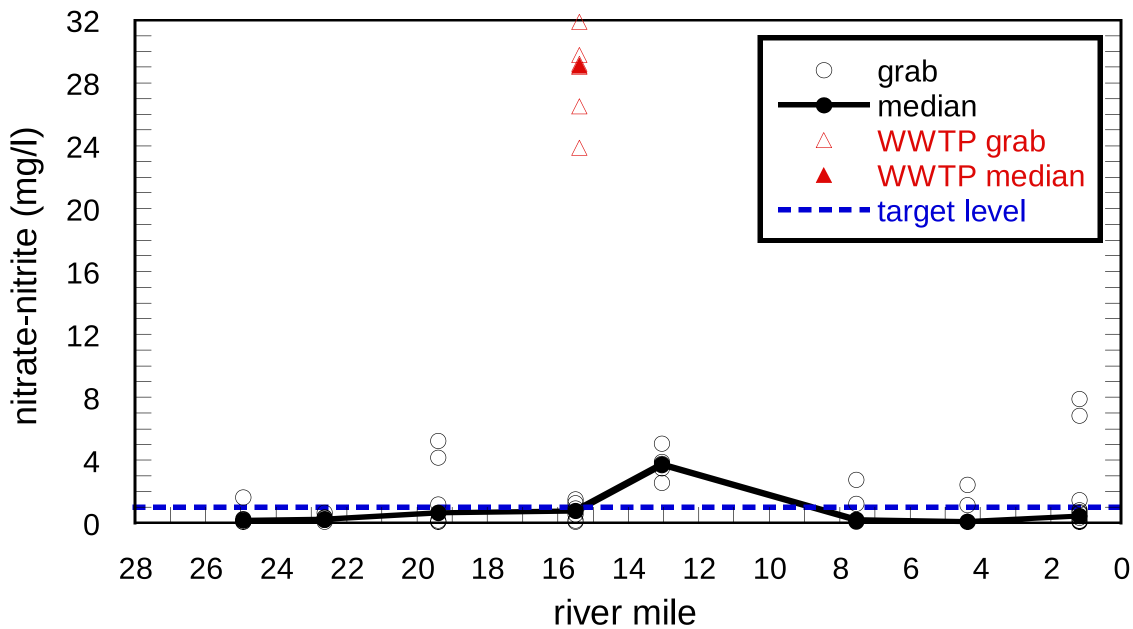

Figure 5l. Summary of nitrate-nitrite concentrations measured in grabs from Riley Creek and Bluffton WWTP effluent plotted against the target level.

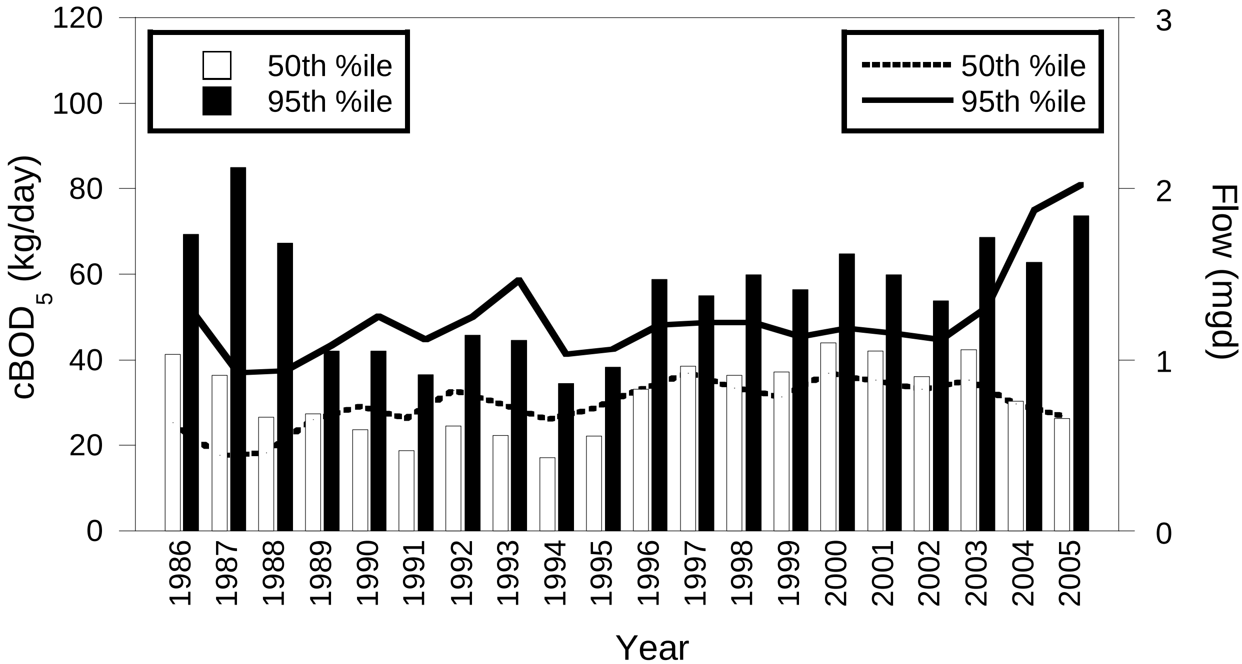

Figure 5m. Annual summary of MOR data for 5-day cBOD collected at the Bluffton WWTP.

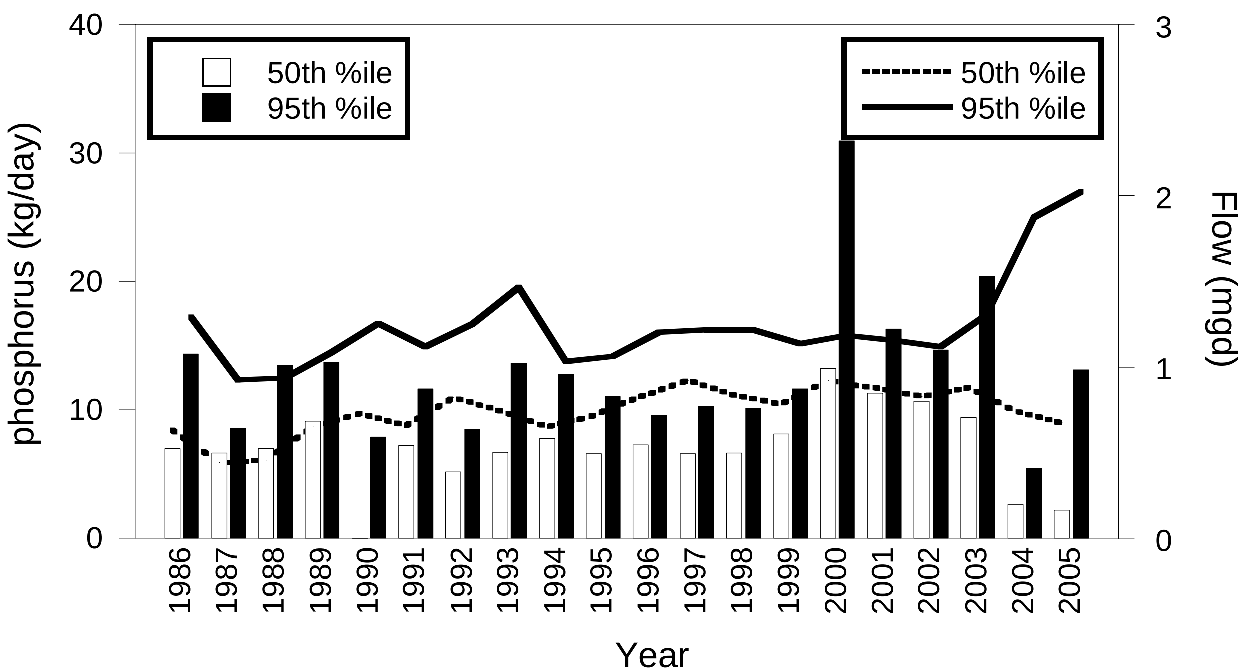

Figure 5n. Annual summary of MOR data for phosphorus collected at the Bluffton WWTP.

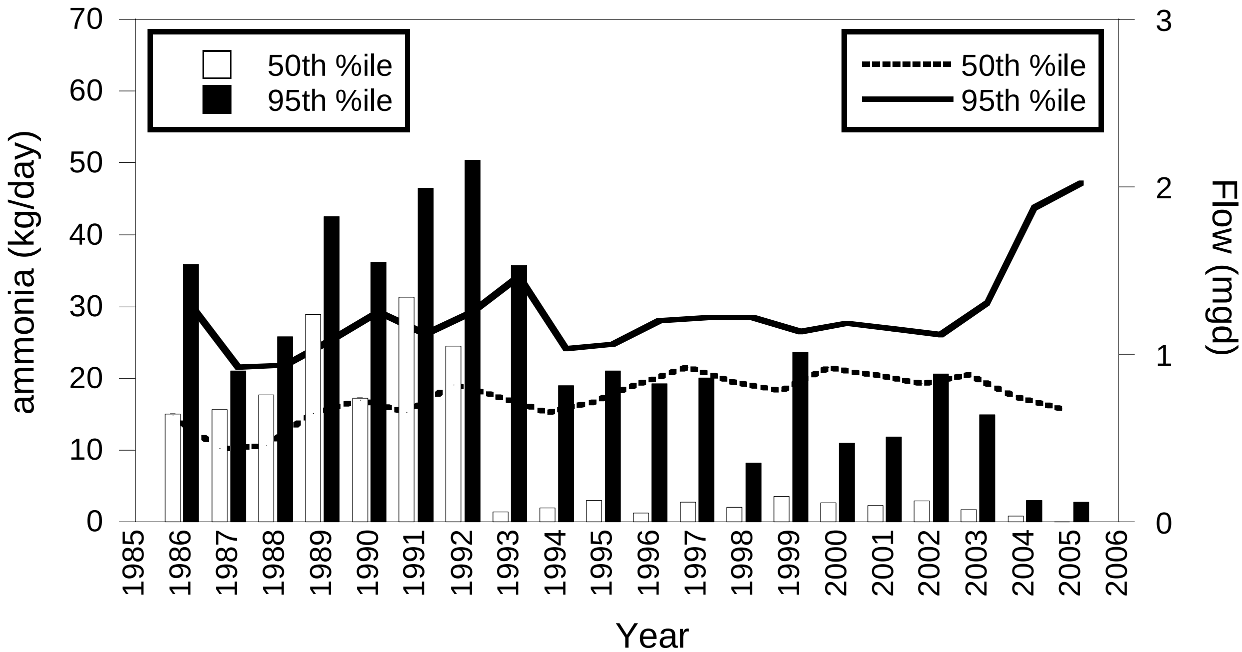

Figure 5o. Annual summary of MOR data for ammonia collected at the Bluffton WWTP.

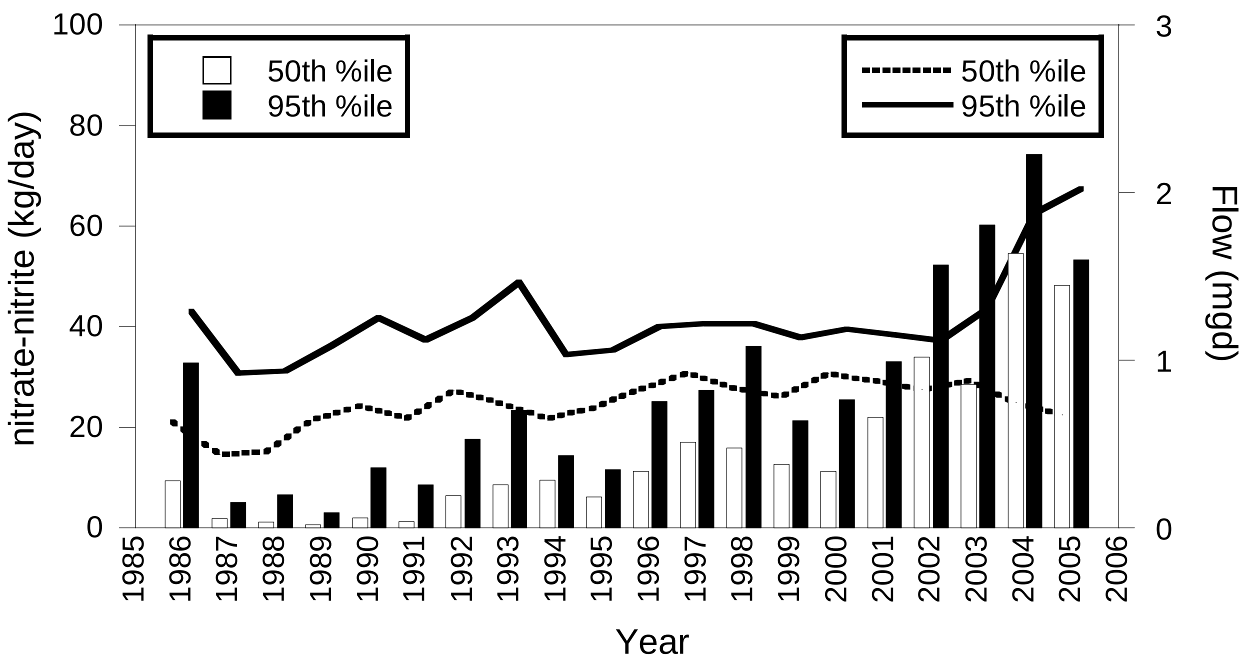

Figure 5p. Annual summary of MOR data for nitrate-nitrite collected at the Bluffton WWTP.

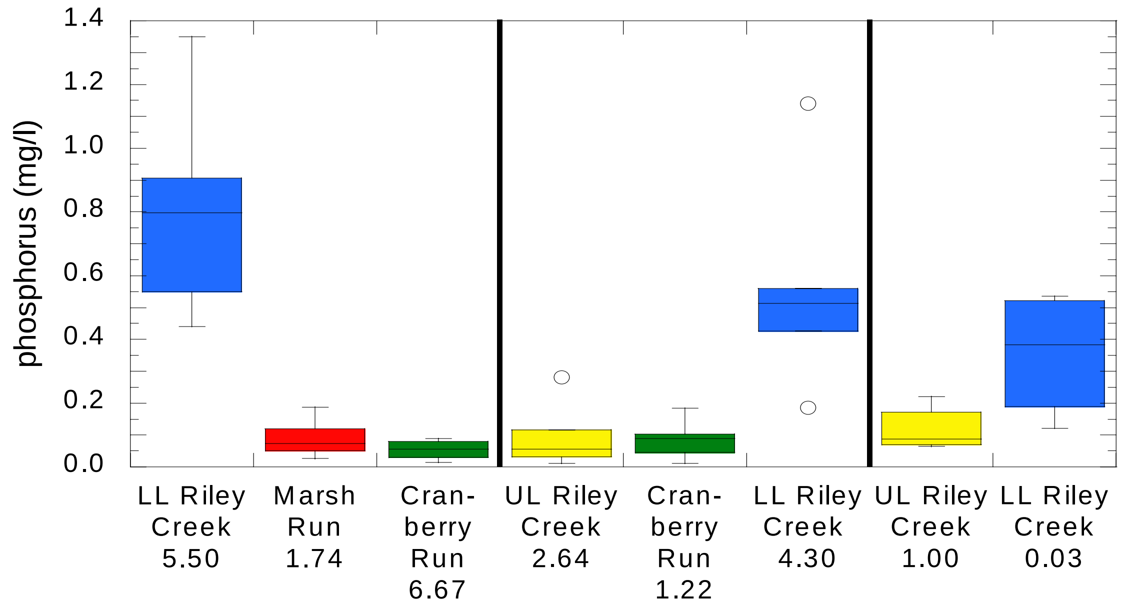

Figure 5q. Summary of phosphorus concentrations measured in grabs from Riley Creek tributary sites. Sites are loosely grouped based on similar drainage areas of 6, 12, and 24 mi^2. The box contains 50% of the data points and the line represents the median value.

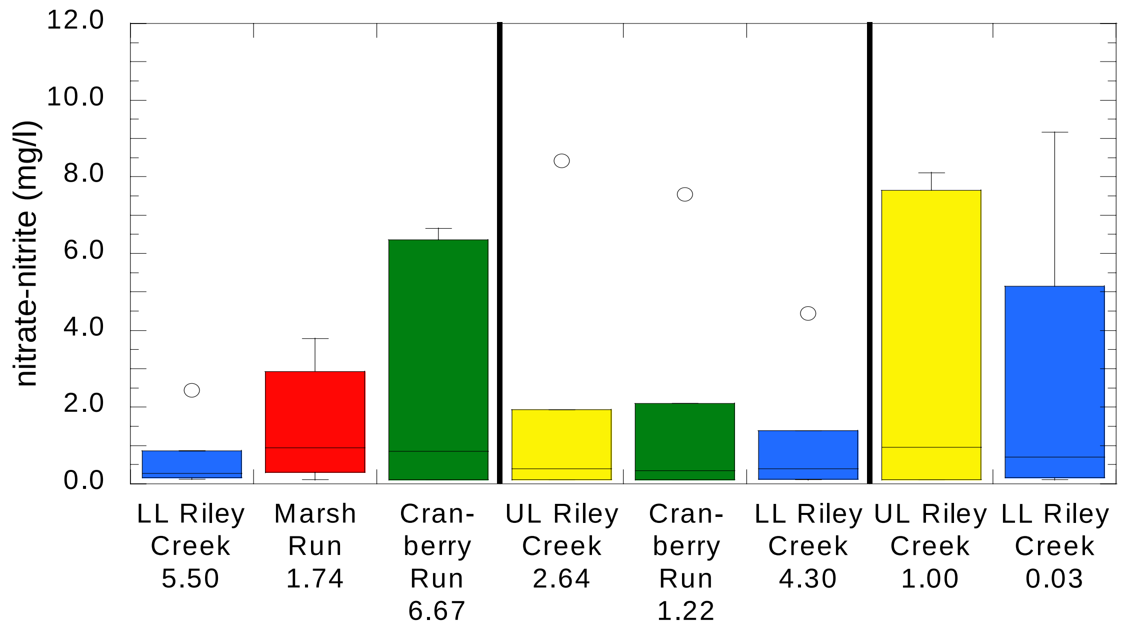

Figure 5r. Summary of nitrate-nitrite concentrations measured in grabs from Riley Creek tributary sites. Sites are loosely grouped based on similar drainage areas of 6, 12, and 24 mi^2. The box contains 50% of the data points and the line represents the median value.

Cranberry Creek WAU

This WAU (04100008-060) drains a total of 147.3 mi^2 and covers the Blanchard River below Riley Creek (RM 30.08) to the mouth (RM 0.0). The Blanchard River mainstem is excluded since it meets the definition of a large river in this segment and is evaluated separately. A map showing principal streams, roads, and urban areas is displayed in Figure 6a. Fish and macroinvertebrate populations and stream habitat conditions were evaluated throughout the WAU. The associated index scores and biological attainment status for each site (full, partial, or non) are summarized in Table 6a. Physical, chemical, and bacterial testing was done to complement the biological data. Most sites had six sets of samples collected at two week intervals.

Water quality data and biological index scores were evaluated based on Ohio WQS criteria (OAC 3745-1). Target values presented in the *Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999) were used to evaluate nutrient enrichment. Appropriate numerical criteria and target values are often determined by use designation and all data was evaluated based on current assigned uses. Geographic location is also an important variable for determining criteria and the entire WAU is within the HELP ecoregion. Nutrient target values are being used as guidelines in lieu of criteria that are currently under development. Preliminary results support the validity of these target values and the notion that a correlation exists between nutrients, aquatic life attainment status, and drainage area. Criteria will likely be tiered for drainage area at the break between a wadeable stream and a small river (200 mi^2). Based on this assumption, nutrient samples in the WAU were evaluated using a phosphorus target of 0.10 mg/L and a nitrate-nitrite target of 1.00 mg/L. Water quality exceedences that were documented are summarized in Table 6b.

An effort was made to identify the sources of water quality degradation. Ambient water quality is affected by a complex set of biotic and abiotic factors. Water picks up many impurities from the air, land, and ground and gases like oxygen, nitrogen, and carbon dioxide diffuse into water from the atmosphere. Climate, topography, vegetation, and biological activity all influence ambient water quality. Local water quality, though, is usually determined by inputs from anthropogenic sources that are grouped into point and nonpoint categories. The origin of a point source is easy to identify at the end pipe and most are regulated under the NPDES permit system. Individual permits are issued to facilities with unique processes like those summarized in Table 6c. General permits are issued to facilities that have similar operations and exert a minimal impact on the environment like those summarized in Table 6d. Construction storm water permits are included only for projects done in 2005. Continuous discharge point sources have their greatest impact under base flow when chemistry is relatively stable and conditions reflect the ground water that recharges the stream.

The impact from a nonpoint source is a direct function of the surrounding land use and their exact origin is difficult to identify. Pollutants like silt, nutrients, and pesticides are carried in storm water from land used for crop and livestock production. Management practices like channelization, removal of riparian vegetation, and installation of sub surface tile systems result in significant flow and habitat alterations. They contribute to low flow conditions during dry weather periods because they limit ground water recharge by lowering the water table and by increasing evaporation since there in no tree shade. Conversely, these activities contribute to flooding during wet weather periods due to accelerated delivery of runoff. In pasture areas the exclusion of livestock from surface waters is an issue because of the damage they cause to habitat and input of nutrients and bacteria. Another type of flow alteration is the impounding of a stream by a low head dam. These dams change stream morphology by flooding riffles, block fish migration, and ultimately change trophic structure. Pollutants like silt, nutrients, and pesticides are also carried in storm water from urban areas, along with materials like oil and heavy metals that are present in auto exhaust. Failed home sewage systems can be a problem in areas without central collection and treatment systems. Miller City is an example of one of these areas. Flooding caused by accelerated delivery of runoff is also a problem in urban areas because of impervious surfaces and sources of inflow like down spouts and sump pumps.

Aquatic Life Use Designations

Deer Creek is a tributary of the Blanchard River confluent at RM 7.28 that is about 4 miles in length and drains an area of 10.9 mi^2. It is within the HELP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. The appropriateness of the WWH use, however, had not been investigated. Conditions encountered in 2005 demonstrated that a less stringent use was more appropriate. It is channelized and has legal drain status above State Rt. 694 (RM 2.8) where it is maintained by the Putnam County SWCD (a.k.a. Erhart Ditch). Most riparian vegetation has been removed from the banks except the lower 1.5 miles is wooded. The channel held water throughout the study, but flow was occasionally stagnant at State Rt. 115 (RM 1.57). A QHEI score of 32.0 was recorded at RM 1.6. Typically, WWH streams have no more than one high influence modified attribute and a variety of typical warmwater attributes. Evaluation of habitat at the site recorded five high influence modified habitat attributes and zero typical warmwater habitat attributes. The physical condition of the stream negated a WWH use, rather, a modified warmwater habitat use (MWH) is recommended. The recommendation of the MWH use should not be considered a downgrading of the aquatic life use; rather, the 2005 survey was the first systematic ambient assessment of appropriate expectations.

Bear Creek is a tributary of the Blanchard River confluent at RM 12.50 that is about 7.5 miles in length and drains an area of 13.2 mi^2. It is within the HELP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. It is channelized and under petition for legal drain status in Putnam County. Virtually the entire stream is devoid of riparian vegetation. Ohio law stipulates that the WWH use be applied to unassessed waterways; however, the 2005 sampling effort demonstrated that a less stringent use was more appropriate. The channel was often dry above CR K (RM 4.70) where the stream is essentially a roadside ditch and flow was intermittent as far downstream as TR I-14 (RM 0.32). A QHEI score of 26.0 was recorded at RM 0.4 and modified habitat attributes eclipsed typical warm water features by a ratio of 11:1. The physical condition of the stream limited biological performance and negated the WWH use, rather, a modified warmwater habitat use is recommended. The MWH use recommendation should not be considered a downgrading of aquatic life use. Rather, the 2005 survey accomplished a first time systematic assessment to establish the appropriate use.

Caton Ditch is a tributary of the Blanchard River confluent at RM 13.23 that is about 8 miles in length and drains an area of about 17.8 mi^2. It is within the HELP ecoregion and designated as WWH, PCR, AWS, and IWS in the 1978 Ohio WQS. The appropriateness of the WWH use, however, had not been investigated. Conditions encountered in 2005 demonstrated that a less stringent use was more appropriate. The watercourse was channelized many years ago and has shown little recovery even though it is not under a county maintenance program. Most riparian vegetation has been removed from the banks except the lower 4 miles has a narrow wooded corridor. A QHEI score of 48.0 was recorded at RM 0.3. A principle feature that precluded a WWH aquatic life use was the modification of the drainage area hydrology to facilitate agricultural activities. The channel was often dry at CR 13 (RM 4.11) and, at times, flow was intermittent at State Rt. 108 (RM 3.02). The recommendation of the MWH use should not be considered a downgrading of aquatic life use; rather, the 2005 survey was a first time systematic assessment to determine appropriate expectations.

The Miller City Cutoff is a tributary of Caton Ditch confluent at RM 3.13 that is about 4.5 miles in length and drains an area of 9.0 mi^2. It is within the HELP ecoregion and does not have assigned aquatic life and recreation use designations. Ohio law stipulates that the WWH use be applied to unassessed waterways such as Miller City Cutoff; however, the 2005 sampling effort demonstrated that a less stringent use was more appropriate. The watercourse is a man-made roadside ditch that diverted the headwaters of South Powell Creek from the Auglaize River watershed into the Blanchard River watershed. The 2005 investigation of biological condition and habitat attributes of the stream was consistent with the MWH use. The recommendation of the MWH use should not be considered a downgrading of aquatic life use; rather, the 2005 survey was a first time systematic assessment to determine appropriate expectations.

Cranberry Creek is a tributary of the Blanchard River confluent at RM 17.30 that is about 24.5 miles in length and drains an area of about 45.0 mi^2. It is located within the HELP ecoregion and designated as WWH, PCR, AWS, and IWS based on a previous field assessment conducted in 1983. The stream is channelized and jointly maintained by the Putnam County SWCD and Allen County Engineers. A flood abatement project was recently completed that included cutting and clearing of trees from the mouth to State Rt. 12 and reconstruction and widening of the channel from State Rt. 12 to the Village of Rockport. The stream held water throughout the study, but flow was occasionally stagnant in low gradient areas and became intermittent in the headwaters. Flows measured during the study period at CR J (RM 1.64) ranged from 0.5-5.6 cfs, with a median value of 1.5 cfs.

The WWH use on Cranberry Creek was based on previous work done in the Blanchard River watershed in and documented in "Biological and Water Quality Study of the Blanchard River and Selected Tributaries" January, 1985. The 1985 report did not include any biological or habitat measurements. The work done in 2005 included both QHEI and/or biological assessments of four sites on Cranberry Creek. The majority of the stream supported biological communities consistent with a WWH use for the HELP ecoregion, but the upper portion of the watershed was extensively modified. A QHEI score of 41.0 at RM 19.9 was not much lower than scores recorded at RMs 12.9 and 7.8 but four high influence modified attributes were noted and modified attributes exceeded typical warmwater features by a ratio of 9:2. Based on the 2005 results, at least marginal attainment of the WWH use was possible where sufficient drainage area size assured continual flow but a MWH use is more appropriate for the headwaters of Cranberry Creek. The MWH use should be applied to Cranberry Creek upstream from the confluence of Little Cranberry Creek.

Little Cranberry Creek is a tributary of Cranberry Creek confluent at RM 17.05 that is about 4.2 miles in length, drains an area of 7.0 mi^2 and was a previously undesignated and unassessed stream. Ohio law stipulates that the WWH use be applied to unassessed waterways; however, the 2005 sampling effort demonstrated that a less stringent use was more appropriate. Little Cranberry Creek was channelized around 1948 and some maintenance has been done by landowners since then. A flood abatement project is currently being drafted by the Allen County SWCD. A QHEI score of 25.0 was recorded at RM 0.8 and no beneficial warmwater habitat features were noted. The physical condition of the stream limited biological performance and negated the WWH use, rather, a modified warmwater habitat use is recommended. The MWH use recommendation should not be considered a downgrading of aquatic life use. Rather, the 2005 survey accomplished the first systematic ambient assessment the appropriate use.

Pike Run is a tributary of the Blanchard River confluent at RM 18.62 that is about 4.5 miles in length and drains an area of 5.5 mi^2. It is within the HELP ecoregion and designated as WWH, PCR, AWS, and IWS based on the 1978 Ohio WQS. The aquatic life use for Pike Run had not been evaluated using biological and habitat data prior to the 2005 survey. The WWH use was assigned to the stream but never verified. The stream is channelized and has legal drain status above TR F-6 where it is maintained by the Putnam County SWCD. A QHEI score of 51.0 was recorded at RM 0.7 and modified habitat attributes moderately exceeded typical warmwater features by a ratio of 7:5. The stream possessed relatively natural functioning channel with coarse substrates. A major limiting factor was a moderate to heavy silt cover and significant embeddedness. The physical condition of the stream was such that, with needed water quality and habitat improvements, a commensurate increase in fish and macroinvertebrate community condition is likely; making the a WWH use the appropriate designation.

Aquatic Life Use Attainment Status

Attainment status was determined for eight sites in the Cranberry Creek WAU, representing approximately 22 assessed stream miles in the watershed. Limited sampling of four additional sites allowed for a determination of aquatic life use designation but credible data requirements negated a complete evaluation of attainment status. Five sites representing 19 assessed stream miles, fully met the current or recommended aquatic life use. Three sites, totaling three assessed stream miles, were in non-attainment of the current or recommended aquatic life use. Three of four sites in the Cranberry Creek WAU that received macroinvertebrate sampling only were also reflective of an impaired resource.

Fish community sampling of Deer Creek produced an IBI score of 34, in the fair range, which exceeded the recommended MWH expectations. The community was predominated by blackstripe topminnows (*Fundulus notatus*) and green sunfish (*Lepomis cyanellus*). Their occurrence likely was due in part to the ponded nature of the stream as it bisects the Country Acres Golf Club immediately upstream of the sampled location. The Country Acres Golf Club figured prominently in the condition of the macroinvertebrate community, as well. Poorly treated effluent from the golf course WWTP was discharged at RM 1.6. Septic sludge coated that stream bottom from which rattailed maggots (*Eristalsis* sp.) were collected. Rattailed maggots are one of the most tolerant macroinvertebrates and are only collected from streams that are grossly polluted by organic matter. Pollution tolerant midges (*Chironomus* sp.) and lunged snails (*Physella* sp.) predominated and a total of sixteen taxa were collected. Documented water quality impacts included nutrient enrichment, low dissolved oxygen, elevated ammonia, elevated dissolved solids, and pathogens. Improvement in the operation of the WWTP should result in a commensurate increase in condition of the Deer Creek.

No fish results were recorded for Bear Creek at RM 4.7 because the stream was dry when sampling was attempted. The macroinvertebrate community at the site was in poor condition due to multiple factors related to both habitat and water quality. Qualitative sampling produced just twenty one taxa, two thirds of which were considered pollution tolerant. No sensitive taxa were recorded at the site. The stream was admirably suited as a conveyance of water to facilitate agriculture but the trapezoidal channel confined silt and offered no benefit to aquatic communities. Additionally, elevated nutrients, and ammonia concentrations and low dissolved oxygen levels were documented in water quality samples collected at the site. Fish sampling that was accomplished near the mouth of Bear Creek at RM 0.3 yielded an IBI score in the fair range (32) that met MWH ecoregional expectations. Nutrient levels remained elevated at RM 0.4. Chemical water quality impairments were attributed to poorly functioning residential septic systems and runoff associated with livestock and crop production in the watershed.

No fish results were recorded for Caton Ditch at RM 4.1 because the stream was dry when sampling was attempted. The macroinvertebrate community at the site was in poor condition due to multiple factors related to both habitat and water quality. Qualitative sampling produced just nineteen taxa and pollution tolerant lunged snails (*Physella* sp.) taxa predominated. A silty, channelized condition and minimal flow were significant impediments to development of stable biological communities. Additionally, elevated nutrients and low dissolved oxygen levels were reflected in the composition of the macroinvertebrate community and confirmed in water quality samples collected at the site. The macroinvertebrate community reflected a minimally improved resource condition at RM 3.0 owing primarily to the increased drainage area at the site and shading riparian that limited the effects of nutrient enrichment on primary productivity at the site. Degraded water quality was still evident; nutrient concentrations remained elevated and low dissolved oxygen levels were documented. The macroinvertebrate community received a low fair evaluation which still did not meet the recommended MWH use. The fish community at RM 3.1 was in poor condition. Pollution tolerant bluntnose minnows and creek chubs predominated. Attainment of the recommended MWH use is largely contingent on limiting the transfer of nutrients from the surrounding agricultural areas and maintaining perennial flow.

No fish results were recorded for the Miller City Cutoff because the stream was nearly dry when sampling was attempted. A silty, channelized condition was seen as the primary impediment to biological communities; additionally, elevated nutrients and an excessive organic load were documented. While credible data requirements preclude a complete assessment of attainment status, the macroinvertebrate results were not meeting even the limited expectations of a recommended MWH aquatic life use. The cutoff at RM 0.4 supported a macroinvertebrate fauna predominated by pollution tolerant and facultative midges. A total of 30 taxa were collected; fourteen of which were considered pollution tolerant. Failed home septic systems and effluent from the Miller City High School WWTP were believed to be the principle sources of pollutants to the stream.

Despite documented nutrient enrichment and significant habitat alteration throughout the Cranberry Creek watershed, biological sampling results were consistent with existing or recommended aquatic life uses in Cranberry Creek. The stream channel was predominantly wide and shallow. Much of the water surface was exposed to direct sunlight, resulting in extensive growths of algae and aquatic plants (i.e. Elodea sp.). The site at RM 19.9 supported a surprisingly diverse fish community and scored an IBI of 46, in the very good range, even though the streamflow was intermittent on the sampling date (29 Aug., 2005). It is likely that a couple of comparatively deep pools at the site were serving as refugia for fish in the stream. The macroinvertebrates collected at the site were, contrastingly, predominated by pollution tolerant taxa and were rated in high fair condition. The sampling of sites at RM 12.9 and 7.8 produced fish assemblages that were typical for HELP ecoregion streams and macroinvertebrates that were in marginally good condition. No fish sampling was conducted at RM 1.8 but quantitative macroinvertebrate samplers yielded an ICI score in the exceptional range, suggesting that conditions were of sufficient quality to meet the WWH expectations even though moderate enrichment was indicated.

Biological communities in Little Cranberry Creek met expectations of the recommended MWH. Both communities were reflective of the channelized nature and some evidence of nutrient enrichment was noted. Facultative and tolerant macroinvertebrate taxa predominated but relatively pollution sensitive taxa were also present (*Helicopsyche borealis*). The fish community included a predominance of gizzard shad (*Dorsoma cepadianum*) which are not commonly collected in headwater sized streams. Their presence was evidence of an unbalanced, unstable assemblage of fishes at the site. Tolerant and pioneering fish species were present in acceptable numbers but no obligate high quality headwater species were collected. The resultant fish assemblage produced an IBI score of 30, reflective of a fair fish community condition and within the acceptable range of scores for a MWH designated stream. Nutrient concentrations were highest early in the sampling period; which was attributed to runoff from surrounding agricultural areas.

The macroinvertebrate community of Pike Run was in poor condition at RM 0.7. Qualitative macroinvertebrate sampling produced a largely pollution tolerant community. Only 24 taxa were collected including just one sensitive taxon. The macroinvertebrate sampling results reflected an enriched water quality condition and suggested wide swings in day-night oxygen concentration. The fish community was in marginally better condition and generated an IBI in the fair range (IBI = 28). Pollution tolerant creek chubs (*Semotilus atromaculatus*) predominated and only one simple lithophilic species was recorded. Significant water quality impacts attributed to an unidentified source of sewage were documented at RM 0.7.

Water Quality

This WAU is comprised almost entirely of small headwater streams. The lone exception is Cranberry Creek, which is considered wadeable. All of the streams that were evaluated have been channelized in the past and most are maintained and under legal drain status. The most common cause of water quality degradation documented was nutrient enrichment. This was especially true for phosphorus in streams outside of the Cranberry Creek basin, where 35 of 40 (87.5%) grab samples and site specific median values were above the 0.10 mg/L target level. Although phosphorus was not a problem in the Cranberry Creek basin, nitrate-nitrite was more frequently above target. This is probably due to sub-surface tile drainage associated with crop production, since nitrate passes through soil instead of being bound by surface electrical charges. To compare nutrient levels at sites with similar drainage areas, the results were sorted and plotted for phosphorus in Figure 6b and nitrate-nitrite in Figure 6c. Deer Creek had by far the highest nutrient levels measured in the WAU due to the close proximity of the Country Acres package plant. This facility was operating very poorly during the study period. Areas affected by nutrient enrichment typically had nuisance growths of algae present.

Another common cause of water quality degradation documented in the WAU was low levels of dissolved oxygen. Dissolved oxygen is necessary to sustain aquatic life and criteria that apply to WWH streams are a 24 hour average of 5.0 mg/L and a minimum at any time of 4.0 mg/L. Every site tested had at least one value that was below the average criterion. Some of the low readings were due to poor flow conditions and low gradient, which limit reaeration from the atmosphere. Sites with the poorest conditions were affected by organic enrichment, which causes oxygen to be consumed by decomposition. This was the case in Deer Creek, where the Country Acres package plant discharges poorly treated effluent. Failed home sewage treatment systems are sources in Miller City Cutoff and the upper part of Bear Creek. Runoff from a livestock farm is a likely source in the lower part of Bear Creek. The source in Pike Run was not positively identified, but the Glandorf Rod and Gun Campground is a likely candidate. All of these areas often had a characteristic septic odor.

Elevated ammonia and dissolved solids were measured where sewage was a problem in Deer Creek, Bear Creek and Pike Run. The ammonia test measures the amount of ammonium ion (NH_4^+) and ammonium hydroxide (NH_4OH) in water. Under normal conditions, most is present as the dissociated ammonium ion, which is almost harmless to aquatic life. Alkaline pH levels shifts the equilibrium to undissociated ammonium hydroxide, which is extremely toxic. This form easily diffuses through gills and disrupts membrane processes by displacing the potassium ion (K^+). Mortality occurs when diffusion into the blood is faster than excretion. The dissolved solids test measures the amount of organic and inorganic material in solution. Elevated levels can reduce egg survival in fish and disrupt osmoregulation.

A site on Cranberry Creek at CR J was tested for levels of pesticides. No insecticides were detected in any of the samples, but the herbicides Atrazine and Metolachlor were routinely present. A summary of the compounds that were detected is presented in Table 6e.

Recreation

People can be exposed to pathogens in water by skin contact and through ingestion. It is because of this that recreation criteria were developed to protect human health. Fecal coliform counts (colony forming units or CFU/100 ml) are used to indicate if water has been contaminated by feces from warm blooded animals. Fecal coliform are harmless in most cases, but there is a potential that the feces contained pathogens or disease producing bacteria (*Escherichia*, *Salmonella*, and *Shigella*), viruses (hepatitis A, Norovirus, and Rotavirus), and parasites (*Cryptosporidium*, *Giardia*, and *Cyclospora*). Reactions to exposure can be as minor as skin rash, sore throat, or ear infection. However, some lead to diarrhea, gastroenteritis, and dysentery or even more serious wide spread epidemic.

An overall evaluation of the recreation use for the WAU was done by pooling a total of 70 bacteria counts from samples collected during the recreation season (May 1-October 15) at 12 stream survey sites. The recreation use is considered impaired if either the 75^{th} percentile exceeds 1,000 CFU/100 ml or the 90^{th} percentile exceeds 2,000 CFU/100 ml. Based on these guidelines, the recreation use is impaired because the values were 2,400 CFU/100 ml and 9,280 CFU/100 ml, respectively.

Sediment Quality

Cranberry Creek at CR J (RM 1.64) was the only site where sediment was collected within the WAU. It was tested for particle size distribution, organic carbon content, % solids, metals, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and organochlorine insecticides. All results were evaluated based on Ohio reference values (Ohio EPA, 2003) and consensus based toxicity guidelines (MacDonald et al, 2000). Ohio reference values are based on an ecoregion reference site approach and considered background concentrations for streams. The MacDonald guidelines consider concentrations below a threshold effect concentration (TEC) to be absent of toxicity and those above a probable effect concentration (PEC) to be toxic to benthic organisms.

The sample consisted of a 50/50 blend of sand mixed with silt and clay and contained 4.0% organic carbon. No PAHs, PCBs, or insecticides were detected in the sample. All of the metal concentrations were below respective Ohio reference values for the HELP ecoregion. Nickel and arsenic were slightly above their respective TEC, but well below the PEC. No impact to aquatic life is expected from contaminated sediment based on these results.

Table 6a Aquatic life use attainment status for stations sampled in the Cranberry Creek WAU assessment unit based on data collected July-September, 2005. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community.

River Mile Invertebrate/ Fish	MI[2]	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
Pike Run			*WWH recommended- ECBP Ecoregion*					
0.7/0.7	5.1	28*		P*	51.0	NON	Organic enrichment/DO, ammonia, nutrients, siltation	Package plant WWTP, Ag related channelization, crop production
Cranberry Creek			*MWH recommended - HELP Ecoregion*					
19.9/19.9	6.4	46		HF	41.0	Full		
			WWH -HELP Ecoregion					
12.9/12.9	25	32	8.1	MG	48.0	Full		
7.8/7.8	30	40	8.6	MG	44.5	Full		
1.8/____	43			46				
Little Cranberry Creek			*MWH recommended – HELP Ecoregion*					
0.8/0.9	7	30		HF	25.0	Full		
Miller City Cut-off			*MWH recommended – HELP Ecoregion*					
0.4/____	9			LF*			Organic enrichment/DO, nutrients	Ag related channelization, crop production, failed home sewage systems in Miller City
Caton Ditch			*MWH recommended – HELP Ecoregion*					
4.1/____	5.9			P*			Direct habitat alteration, siltation, organic enrichment/DO, nutrients	Ag related channelization, crop production
3.0/3.1	15.5	22*		LF*	48.0	NON	Direct habitat alteration, organic enrichment/DO, flow alteration	Ag related channelization, crop production
Bear Creek			*MWH recommended – HELP Ecoregion*					
4.7/____	7.1			P*			Direct habitat alteration, siltation, flow alteration, nutrients, organic enrichment/DO, ammonia	Ag related channelization, crop production, livestock production, failed home sewage systems
____/0.3	12.6	32			26.0	(Full)		
Deer Creek			*MWH recommended – HELP Ecoregion*					
1.6/1.5	7.4	34		VP*	32.0	NON	Direct habitat alteration, nutrients, organic enrichment,/DO, ammonia	Ag related channelization, Country Acres package plant

Ecoregion Biocriteria: Huron Erie Lake Plain									
	IBI			*MIwb*			*ICI*		
Site Type	*WWH*	*EWH*	*MWH*	*WWH*	*EWH*	*MWH*	*WWH*	*EWH*	*MWH*
Headwaters	*28*	*50*	*20*				*34*	*46*	*22*
Wading	*32*	*50*	*20*	*7.3*	*9.4*	*5.6*	*34*	*46*	*22*
Boat	*34*	*48*	*20*	*8.6*	*9.6*	*5.7*	*34*	*46*	*22*

a- MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.

b- A narrative evaluation of the qualitative sample based on attributes such as community composition, EPT taxa richness, and number of sensitive taxa was used when quantitative data were not available or considered unreliable due to current velocities less than 0.3 fps flowing over the artificial substrates.

c- Attainment status based on a single organism group is parenthetically expressed.

d- Causes listed are considered to be a primary influence on water quality, but may not be the only issue leading to impairment. See text for discussion of additional causes that cumulatively have led to impairment.

e- Sources listed are considered to be a primary influence on water quality, but may not be the only source leading to impairment. See text for discussion of additional sources that cumulatively have led to impairment.

ns- Nonsignificant departure from biocriteria ($\leq$4 IBI or ICI units, or $\leq$0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

Table 6b. Exceedences documented in the Cranberry Creek WAU based on Ohio WQS criteria and nutrient target values. Criteria include outside mixing zone minimum or maximum (OMZM) and average (OMZA) values.

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Deer Creek WWH, PCR, AWS, IWS	1.57	WWH	dissolved oxygen	3 of 6 grabs below OMZM
			ammonia	2 of 6 grabs above OMZM
				2 of 6 grabs above OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	4 of 6 grabs and median above target
			dissolved solids	4 of 6 grabs above OMZA
			conductivity	4 of 6 grabs above OMZA
			aluminum	1 of 6 grabs above OMZA
			strontium	1 of 6 grabs above OMZA
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	4 of 6 grabs above maximum

Table 6b. Continued

Bear Creek WWH, PCR, AWS, IWS	4.70	WWH	dissolved oxygen	1 of 6 grabs below OMZM
			ammonia	1 of 6 grabs above OMZM
				2 of 6 grabs above OMZA
			phosphorus	5 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
			dissolved solids	3 of 6 grabs above OMZA
			conductivity	3 of 6 grabs above OMZA
			barium	1 of 6 grabs above OMZA
			strontium	1 of 6 grabs above OMZA
		PCR	fecal coliform	3 of 6 grabs above maximum
	0.32	WWH	dissolved oxygen	1 of 6 grabs below OMZM
			phosphorus	4 of 6 grabs and median above target
			nitrate-nitrite	1 of 6 grabs above target
			aluminum	1 of 6 grabs above OMZA
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	1 of 6 grabs above maximum

Table 6b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Caton Ditch WWH, PCR, AWS, IWS	4.11	WWH	dissolved oxygen	1 of 4 grabs below OMZA
			phosphorus	4 of 4 grabs and median above target
			nitrate-nitrite	1 of 4 grabs above target
			aluminum	1 of 4 grabs above OMZA
			barium	1 of 4 grabs above OMZA
		AWS	iron	3 of 4 grabs above OMZA
		PCR	fecal coliform	3 of 4 grabs above maximum
	3.02	WWH	dissolved oxygen	2 of 6 grabs below OMZA
			phosphorus	5 of 6 grabs and median above target
			nitrate-nitrite	3 of 6 grabs above target
Miller City Cutoff Ditch	0.37	WWH	dissolved oxygen	2 of 6 grabs below OMZM
				1 of 6 grabs below OMZA
			phosphorus	6 of 6 grabs and median above target
			nitrate-nitrite	3 of 6 grabs above target
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	1 of 6 grabs above maximum

Table 6b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Cranberry Creek WWH, PCR, AWS, IWS	19.94	WWH	dissolved oxygen	1 of 6 grabs below OMZM
			nitrate-nitrite	1 of 6 grabs above target
		PCR	fecal coliform	1 of 6 grabs above maximum
	12.87	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			phosphorus	1 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target
	7.76	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			nitrate-nitrite	2 of 6 grabs above target
		PCR	fecal coliform	3 of 6 grabs above maximum
	1.64	WWH	dissolved oxygen	2 of 10 grabs below OMZM
				2 of 10 grabs below OMZA
			phosphorus	2 of 12 grabs above target
			nitrate-nitrite	5 of 12 grabs and median above target
			temperature	1 of 10 grabs above OMZA
		PCR	fecal coliform	1 of 6 grabs above maximum
Little Cranberry Creek	0.83	WWH	dissolved oxygen	1 of 6 grabs below OMZM
			phosphorus	1 of 6 grabs above target
			nitrate-nitrite	2 of 6 grabs above target

Table 6b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Degradation
Pike Run WWH, PCR, AWS, IWS	0.72	WWH	dissolved oxygen	4 of 6 grabs below OMZM
			ammonia	1 of 6 grabs above OMZA
			phosphorus	5 of 6 grabs and median above target
			nitrate-nitrite	2 of 6 grabs above target
			aluminum	1 of 6 grabs above OMZA
		AWS	iron	1 of 6 grabs above OMZA
		PCR	fecal coliform	2 of 6 grabs above maximum

Table 6c. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Country Acres	2PG00083	Deer Creek	1.58	0.03 MGD package plant
Miller City High School	2PT00025	Miller City Cutoff	1.1	0.008 MGD package plant
Putnam County Landfill	2IN00122	Wolfe Run	0.7	storm water sedimentation pond
Putnam County Board of MRDD	2PG00112	Blanchard Tributary (15.2)	0.6	0.01 MGD package plant

Table 6d. Facilities regulated by a general NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	Description
WC Wood Company, Inc.	2GG00055	Cranberry Tributary (4.76)	Industrial Storm water
Kahle&Langhals Ready Mix	2GG00099	Pike Run	Industrial Storm water
LG Phillips Displays	2GR00417	Tawa Run	Industrial Storm water
Touchstone CMP	2GC00120	Blanchard Tributary (21.52)	Construction Storm water
Van Ham Dairy LLC	2GC00303	Blanchard Tributary (2.21)	Construction Storm water
Village of Ottawa	2GC00574	Selhorst Ditch	Construction Storm water
Ohio DOT	2GC00252	Miller City Cutoff	Construction Storm water
Ohio DOT	2GC00465	Tawa Run	Construction Storm water

Table 6e. Summary of herbicides (µg/L) detected in Cranberry Creek at Putnam CR J (RM 1.64). Values reported as less than were below the quantitation limit.

Compound (Trade Name)	6/16/05	6/30/05	7/14/05	7/28/05	8/11/05	8/25/05
Acetochlor (Harness)	0.29	<0.21 UJ	<0.21 UJ	<0.40 UJ	<0.21	<0.21
Atrazine (AAtrex)	1.20	1.14 J	<0.21 UJ	<0.40 UJ	0.43	0.37
Metolachlor (Dual)	0.39	0.32 J	<0.21 UJ	0.68 J	0.30	0.27
Simazine (Princep)	0.27	0.30 J	<0.21 UJ	<0.40 UJ	<0.21	<0.21

J The compound was positively identified, but the associated value is estimated.
UJ The compound was not detected above the quantitation limit and the quantitation limit is estimated.

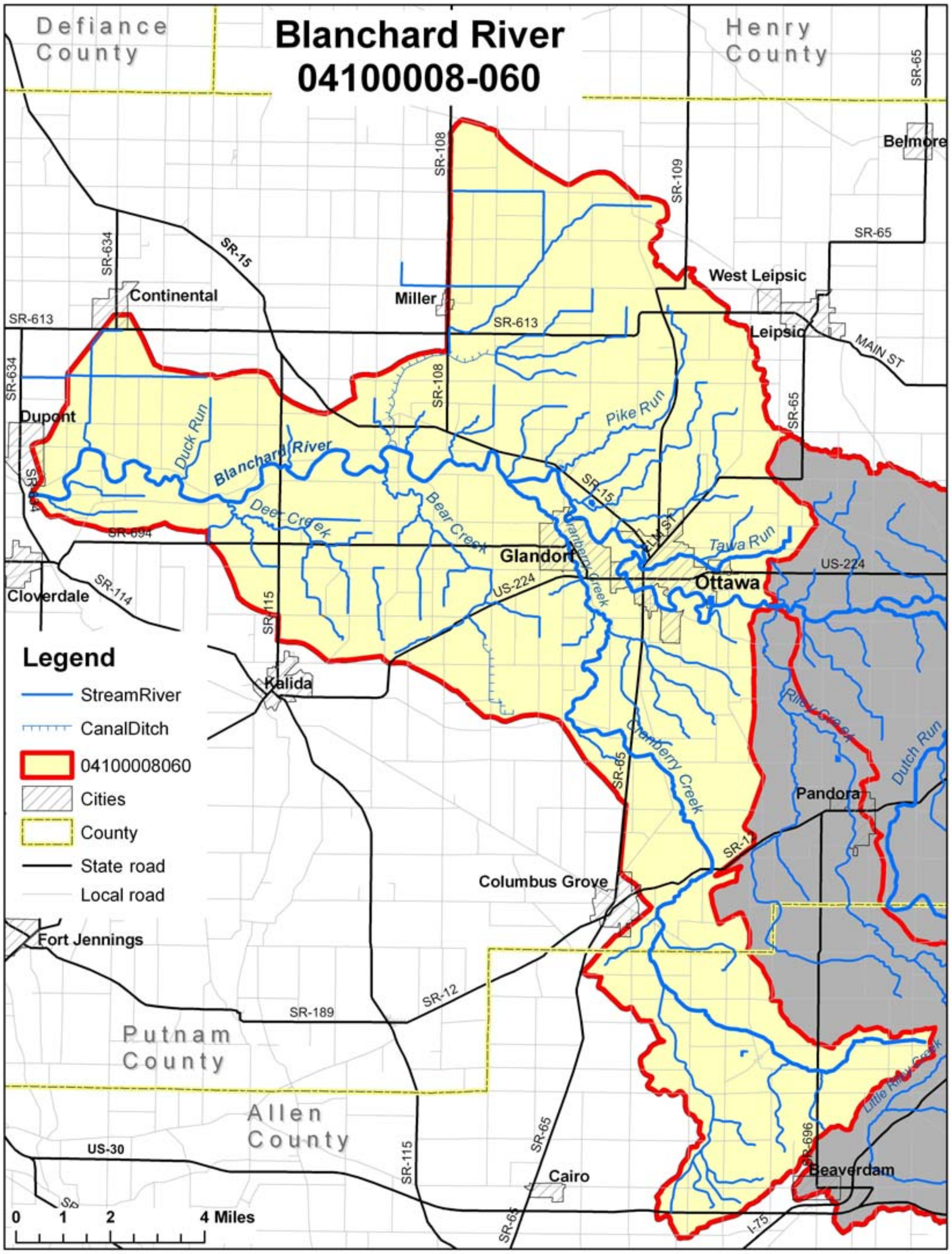

Figure 6a. Map of the Cranberry Creek WAU showing principal streams, roads, and urban areas. The Blanchard River is excluded and evaluated separately as a Large River Assessment Unit.

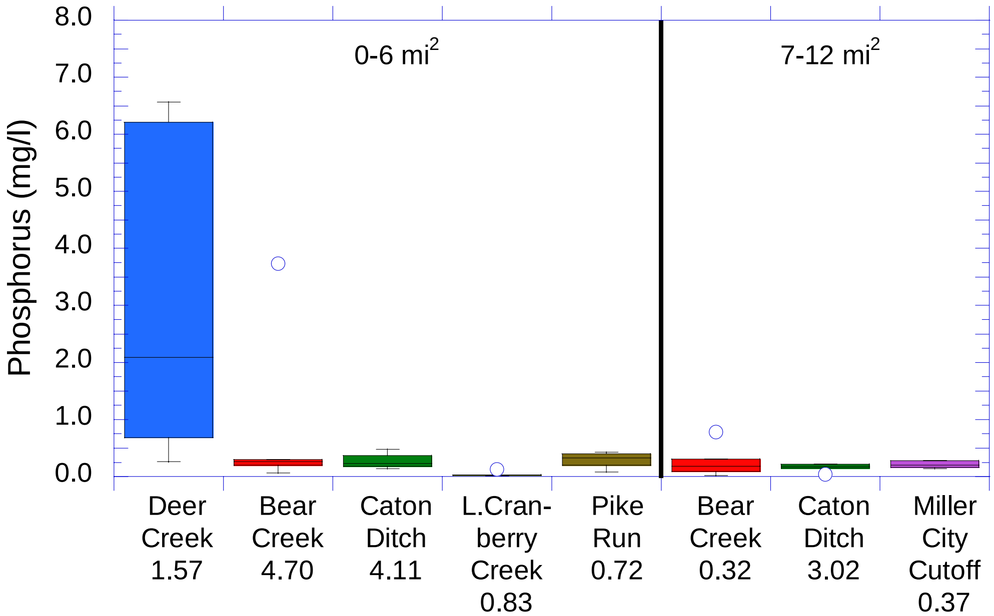

Figure 6b. Summary of phosphorus concentrations measured in grabs from tributary sites loosely grouped based on similar drainage areas of 6 and 12 mi^2. The box contains 50% of the data points and the line represents the median value.

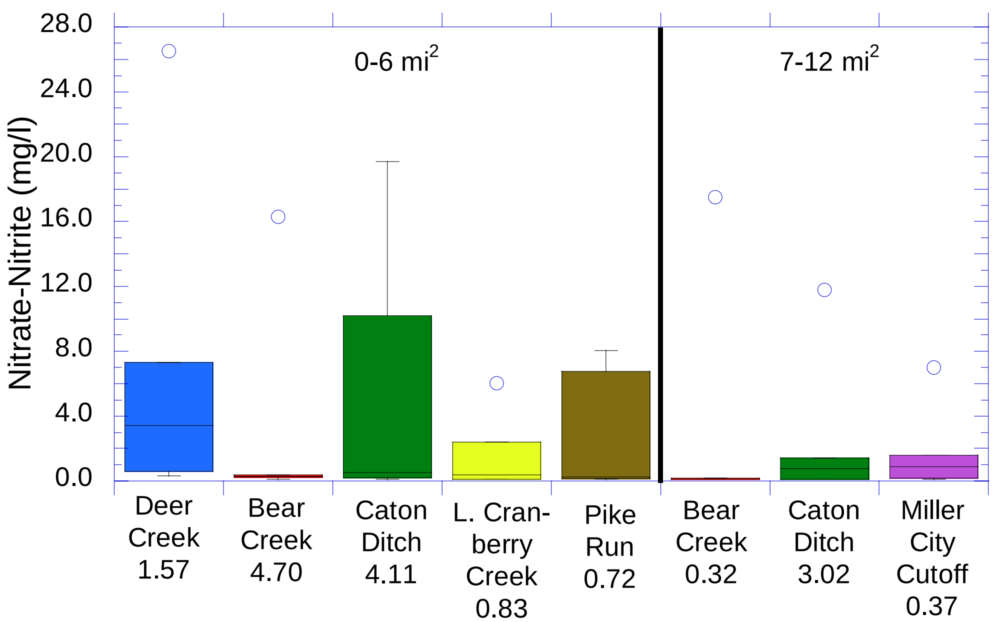

Figure 6c. Summary of nitrate-nitrite concentrations measured in grabs from tributary sites loosely grouped based on similar drainage areas of 6 and 12 mi^2. The box contains 50% of the data points and the line represents the median value.

Blanchard River LRAU

The Blanchard River large river assessment unit (LRAU 04100008 001) encompasses the mainstem from downstream Dukes Creek (RM 35.65) to the confluence with the Auglaize 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. Fish and macroinvertebrate populations and stream habitat conditions were evaluated throughout the LRAU. The associated index scores and attainment status for each site (full, partial, or non) are summarized in Table 7a. Physical, chemical, and bacterial sampling was done to complement the biological data and an effluent sample was collected at the Ottawa WWTP. Most sites had six sets of samples collected at two week intervals. Additional bacteria sampling was done so site specific recreation use evaluations could be done. Multi parameter automatic meters were set at eight sites to measure physical conditions over a 48 hour period.

Water quality data and biological index scores were evaluated based on Ohio WQS criteria (OAC 3745-1). Target values presented in the *Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999) were used to evaluate nutrient enrichment. Appropriate numerical criteria and target values are often determined by use designation and all data was evaluated based on the current assigned uses of WWH, PCR, AWS, IWS, and PWS (RM 28.50). Geographic location is also an important variable for determining criteria. The LRAU is within the HELP ecoregion, much of which is a remnant of the Great Black Swamp that has been extensively deforested and drained for cropland. The local terrain is nearly level and the river is downcut about 20 feet into the glacial lake bed, which results in a very narrow floodplain. Nutrient target values are being used as guidelines in lieu of criteria currently under development. Preliminary results support the validity of these target values and the notion that a correlation exists between nutrients, aquatic life attainment status, and drainage area. Criteria will likely be tiered for drainage area at the break between a wadeable stream and a small river (200 mi^2). Therefore, nutrient samples from the LRAU were evaluated using a phosphorus target of 0.17 mg/L and a nitrate-nitrite target of 1.50 mg/L.

Water quality exceedences that were documented are summarized in Table 7b. Some degree of water quality degradation was documented at every site, but habitat and flow conditions were adequate enough to overcome an impact to aquatic life. A statistical summary of the dissolved oxygen data from automatic meters is presented in Table 7c. Minimum values are important because enough oxygen needs to be present to sustain aquatic life. Criteria that apply to WWH streams are a 24 hour average of 5.0 mg/L and a minimum at any time of 4.0 mg/L. Maximum values are important if they are at supersaturated levels. This phenomenon results in an aquatic life ailment known as gas bubble disease. There is also mounting evidence that concentrations that fluctuate more than 5 mg/L (minimum/maximum) over a diurnal period have a negative impact on aquatic life. This causes stress to aquatic organisms and is often linked with other changes in the environment like a shift in pH. No problems with supersaturation or flux were documented by the automatic meters.

An effort was made to identify the sources of water quality degradation. Ambient water quality is affected by a complex set of biotic and abiotic factors. Water picks up many impurities from the air, land, and ground and gases like oxygen, nitrogen, and carbon dioxide diffuse into water from the atmosphere. Climate, topography, vegetation, and biological activity all influence ambient water quality. Local water quality, though, is usually determined by inputs from anthropogenic sources that are grouped into point and nonpoint categories. The origin of a point source is easy to identify at the end pipe and most are regulated under the NPDES permit system. Individual permits are issued to facilities with unique processes like those summarized in Table 7d. Continuous discharge point sources have their greatest impact under base flow when chemistry is relatively stable and conditions reflect the ground water that recharges the stream. There are presently no facilities regulated by a General permit in the LRAU, but several located in the Ottawa Industrial Park may need to apply for industrial storm water coverage. These include Ottawa Foods, Steel Technologies, Tawa Tree Service, D4 Industries, and Silgan Plastic. Some facilities in the area discharge to tributary streams and are listed in the Cranberry Creek WAU. The American Weather Seal plant in Ottawa holds an industrial storm water permit, but the plant is now closed.

The impact from a nonpoint source is a direct function of the surrounding land use and their exact origin is difficult to identify. Pollutants like silt, nutrients, and pesticides are carried in storm water from land used for crop and livestock production. Management practices like channelization, removal of riparian vegetation, and installation of sub surface tile systems result in significant flow and habitat alterations. They contribute to low flow conditions during dry weather periods because they limit ground water recharge by lowering the water table and by increasing evaporation since there in no tree shade. Conversely, these activities contribute to flooding during wet weather periods due to accelerated delivery of runoff. Pollutants like silt, nutrients, and pesticides are also carried in storm water from urban areas, along with materials like oil and heavy metals that are present in auto exhaust. Combined sewer overflows are also a major source of organic matter and bacteria. Flooding caused by accelerated delivery of runoff is also a problem in urban areas because of impervious surfaces and sources of inflow like down spouts and sump pumps.

Aquatic Life Uses

Biological and habitat assessments were conducted at ten sites in 2005 and aquatic life use attainment status is presented in Table 7a.

Stream habitat of the Blanchard River in the LRAU was reflective of the combination of a predominantly agricultural land use, silty soils and widespread drainage improvements in the surrounding watershed. Flow is confined within steep banks that trap sediment within the stream channel. Drainage improvements in the watershed speeds the flush of water into the mainstem which increases the erosive force of storm flows; destabilizing stream banks. This was particularly apparent at RM 8.6 where recent loss of streambank soil had created a gravel bar immediately downstream. The bar restricted the flow under low flow conditions and provided a more heterogeneous substrate that benefited the macroinvertebrate community at the site. Overall, a mixture of beneficial and modified habitat attributes was present in the LRAU. The mainstem was not affected directly by channelization and mid channel areas contained significant boulder/cobble substrates. Conversely, little instream cover was observed and a moderate to heavy silt cover was noted. The low gradient nature of the topography precluded significant areas of fast current and led to fair to poor ruffle/run/pool development. QHEI scores ranged from 48.5 to 62.0, values that were in line with WWH attainability and reflected the landscape alteration and limitations to greater habitat diversity inherent to HELP ecoregion.

This reach of stream was designated with a WWH aquatic life use based on a previous biological survey. Sampling in 2005 of fish and macroinvertebrates revealed assemblages that while not particularly diverse, were consistent with a WWH use. The fish community sampling of eight sites produced, at best, one sensitive species, a low occurrence of round bodied suckers and a predominance of omnivores. IBI scores were in the marginally good to good range and MIwb values were in the good to exceptional range. Similarly, the assortment of macroinvertebrate taxa documented exhibited a level of diversity and community structure consistent with a WWH use. Macroinvertebrate sampling of seven sites between RM 35.4 and RM 2.4 produced communities that reflected marginally good to exceptional resource condition. A moderate diversity of pollution sensitive taxa was collected at each site and suggested acceptable water quality conditions even though habitat conditions were less than ideal. No impact attributed to the Ottawa WWTP discharge was apparent in the performance of the fish and macroinvertebrate assemblages. Siltation and generally slow current velocity appeared be principle determinants of macroinvertebrate and fish community structure in the Blanchard River LRAU.

Water Quality

Organic enrichment has been identified as a high magnitude cause of impairment in the past, but there is no evidence of such based on the 2005 grab sample data. Virtually all results for biochemical oxygen demand, chemical oxygen demand, and kjeldahl nitrogen were below background levels. Low dissolved oxygen has also been identified as a cause of impairment in the past and may still be a threat to aquatic life use attainment. A summary of grab sample measurements collected during the daytime is presented in Figure 7a. None of the values violated the OMZM and only 3 (6.5%) were below the OMZA. However, low dissolved oxygen during dark periods is a significant issue. A summary of automatic meter measurements collected over a 48 hour period is presented in Figure 7b. A total of 56 (15.1%) were below the OMZA and the mean at Putnam CR 15 (RM 13.37) of 4.2 mg/L is considered a WQS violation. This was the only site that had readings recorded below the OMZM. All of the low readings were during dark periods that coincide with algal respiration, indicating that the problem is induced by nutrient enrichment. Diurnal dissolved oxygen and temperature readings exhibit similar patterns at all of the sites evaluated. Typical results are displayed for Putnam CR 5-F (RM 35.24) in Figure 7c and Putnam CR 21-H (RM 2.58) in Figure 7d.

Several factors influence dissolved oxygen concentration in the LRAU. Diffusion from the atmosphere is a major source of oxygen in water and turbulence at the surface is an important part of this process because it increases surface area. This segment has little turbulence because stream gradient is low and there is some impounding of the river from a small dam located at RM 25.42. This dam was built to create a water supply for the former Buckeye Sugar Plant. Dissolved oxygen solubility is inversely proportional to temperature and warmer than normal water was measured during the study. Even though grab samples were collected early in the day (0900-1300 hours), a total of 12 (26.1%) temperature readings were above the OMZA. Several temperatures above the OMZM were measured by automatic meters. This problem can be attributed in part to the hot summer weather and to the open canopy and lack of tree shade to limit thermal input from the sun. Plant photosynthesis is another major source of oxygen in water. Algae blooms are common in this assessment unit as evidenced by the green water color and levels of chlorophyll $_a$ measured at Putnam CR 8 (RM 28.88). Excessive blooms result in low readings at nighttime during periods of respiration. Decay of organic matter consumes oxygen and influences concentration in the water column. Sources include leaves and woody debris, as well as fecal matter of both human and animal origin.

There is strong evidence of nutrient enrichment based on the 2005 data. Phosphorus is of most concern because it often limits plant growth and there is a significant correlation with biological index scores (Ohio EPA, 1999). A summary of phosphorus concentrations measured in grab samples is presented in Figure 7e and a total of 25 of 48 (52.1%) exceeded the target level. Most median values are near the target value, so the river is already at or slightly above its assimilative capacity. The correlation between nitrate-nitrite and biological index scores is not as strong. A summary of nitrate-nitrite concentrations measured in grab samples is presented in Figure 7f and a total of 37 of 48 (77.1%) exceeded the target level. Most median values are two times the target level and maximum concentrations were about six times the target value.

Sources of nutrients in surface water include wastewater, combined and separate storm overflows in urban areas, runoff containing organic and inorganic fertilizer in agricultural areas, and home sewage systems. Even though most of the LRAU is located in rural areas, it is still heavily influenced by urban nutrient sources originating as far away as 20 miles. Based on monthly operating report data, the Findlay WWTP (RM 56.42) discharged an average effluent volume of 7.45 MGD in June, 11.08 MGD in July, and 8.94 MGD in August. This equates to an average of 26.2%, 9.4%, and 28.8%, respectively, of the total flow in the river using USGS gage station data at Hancock CR 140 (RM 55.26). Certain chemical constituents can also be used to narrow down the origin of nutrients. High levels of parameters like sodium and chloride in surface water are an indication of point sources because they are present in cleaning products and water softening salts and usually elevated in wastewater effluent. Their concentrations in the river are controlled by dilution and evaporation and not affected by biological processes. Background levels in the Blanchard River at the Findlay WTP intake (RM 62.40) were a median value of 16 mg/L for sodium and 34 mg/L for chloride. Median values in the Blanchard River at CR 140 were 42 mg/L for sodium and 65 mg/L for chloride. Levels steadily decreased in the river as wastewater is assimilated and the river is diluted by tributary streams. Median values in the Blanchard River at Putnam CR 8 (RM 28.88) were 38 mg/L for sodium and 62 mg/L for chloride. An idea of the origin of phosphorus can be determined by the ratio of soluble (dissolved) to total phosphorus. Most phosphorus contained in point source effluent is soluble and most in nonpoint runoff is attached to soil and in particulate form. Therefore, % soluble reactive phosphorus (SRP) values in the 95% range are usually associated with point sources and values in the 10-20% range are associated with nonpoint sources (Baker, 1996). The median SRP ratio (range in parenthesis) at CR 140 was 83.8% (69.8-97.3), at CR 8 was 74.6% (29.1-89.0), and at State Route 115 (RM 9.05) was 68.4% (40.8-79.6). These results suggest that most phosphorus in this part of the river comes from the Findlay WWTP and a long distance is required for it to be assimilated.

Pollutant Loadings

The Ottawa WWTP (2PD00028) is the only major point source (discharge >1 MGD) in the LRAU. It is located at 1371 North Defiance Avenue and serves a population of about 5,890. Sewage collection and treatment has been provided since 1953 and the plant was converted from activated sludge aeration to contact stabilization in 1968. Preliminary treatment consists of a raw pump station with comminutors and an aerated grit tank. Before biological treatment, there is a splitter capable of diverting flow to a 2.8 million gallon equalization basin during periods of high flow. Wastewater is then treated in an oxidation ditch and alum is added to aid with phosphorus removal, followed by final settling tanks and ultraviolet disinfection. Treated effluent is discharged to the Blanchard River at RM 22.07 from outfall 001. The system is designed to treat 3.0 MGD and has a hydraulic capacity of 5.0 MGD. Flows above the hydraulic capacity are bypassed from the EQ basin from outfall 002. Sludge is treated in aerobic digesters, dewatered in drying beds, and land applied at agronomic rates. The collection system consists of 100% separate sewers, has 8 lift stations, and a force main serving the Village of Glandorf. Infiltration and inflow into the collection system is estimated at 0.366 MGD.

Pollutant loadings at the Ottawa WWTP were evaluated using monthly operating report data. Significant improvements have been made to the plant over the years. The grit, aeration, and settling tanks were upgraded in 1985 and UV disinfection was installed in 1989. Most recently, an expansion was done in 1999 that significantly increased treatment capacity. Another important change recently was the closing of the Philips Displays plant in town because it discharged a significant amount of process water to the sanitary sewer. Trends in $cBOD_5$ and ammonia loadings from outfall 001 are displayed in Figures 7g and 7h, respectively. The expansion completed in 1999 was extremely successful at improving effluent quality. The closing of the Philips Displays plant is also noted by the significant decrease in median flow rates since 2002.

The Ohio EPA renews NPDES permits on a five year rotation and conducts annual compliance inspections at major facilities. An inspection was done at the Ottawa WWTP in 2005 and a review of monthly operating report data was done at this time. Violations of ammonia and phosphorus limits were documented in May. These occurred because sludge was not hauled due to unfavorable weather and there was an excessive amount of solids in the plant. A plant bypass in February of 2005 was also noted and deemed necessary to relieve basement flooding. This happened during a major flood when Ottawa was declared a national disaster area. The Ohio EPA also conducts screening bioassays to evaluate effluent toxicity in conjunction with permit renewal at major facilities. Samples are evaluated using *Pimephales promelas* (fathead minnow) and *Ceriodaphnia dubia* (freshwater invertebrate) as test organisms. Two bioassays each were completed in support of this process in 1996, 2001, and 2005. No acute toxicity to either organism was documented in any of these tests.

Public Water Supply

The Ottawa WTP is a public utility located at 1972 Agner Street that produces and distributes potable water. The facility pumps water from the Blanchard River via an intake at RM 28.50 into a 20 acre upground reservoir for storage and subsequent treatment. This storage capability makes it possible to selectively pump water from the river when pollutant concentrations are at their lowest. Ottawa is classified as a community public water system by the Ohio EPA Division of Drinking and Ground Waters (DDAGW). Drinking water standards and monitoring requirements are defined in the Safe Drinking Water Act and Ohio Public Drinking Water Standards. All community public water systems are required to prepare and distribute an annual Consumer Confidence Report that summarizes finished water quality. No violations were documented by Ottawa in the 2004 report, indicating that a good quality product is distributed.

Primary Drinking Water Standards (OAC 3745-81) are set for pollutants with serious human health implications and are usually expressed as maximum contaminant levels (MCLs). Some of these pollutants include metals, nitrate, pesticides, and organic disinfection byproducts. Mercury is one metal of concern because exposure to high levels can damage the brain, kidneys, and developing fetus. High nitrate can cause oxygen starvation in tissues if it is fed to pregnant women or babies and can result in a potentially fatal condition known as methemoglobinemia (blue babies). Certain pesticides are suspected human carcinogens and some have been shown to retard fetal growth and cause premature birth in lab animals. Trihalomethane compounds are also suspected human carcinogens and they form when chlorine is added to water that contains organic matter. Secondary Contaminant Standards (OAC 3745-82) are set for pollutants associated with aesthetic constituents like taste, odor, and color. Some of these pollutants include dissolved solids, iron, and manganese.

The PWS use in the Blanchard River was evaluated based on Lake Erie basin human health criteria (OAC 3745-1-33) using six sets of grab samples collected at Putnam CR 8 (RM 28.88). These criteria are designed to protect source waters to the extent that public water systems would meet MCLs for finished water using conventional treatment only. The criteria apply within 500 yards (0.28 mile) of an intake and, even though sampling was done at 0.38 mile from the intake, results are still representative of source water at the intake and can provide useful information. The river contains high amounts of minerals and, as a result, criteria for several secondary pollutants were exceeded. All results for iron, all but one result for manganese, and one result for dissolved solids were above respective OMZA values. Both the MCL and PWS criteria for nitrate are 10.0 mg/L. None of the survey results were above this level and concentrations ranged from 1.65-8.34 mg/L, with a median value of 3.44 mg/L. Ottawa is required to test their drinking water for nitrate once per month. Results for treated water samples tested through July 2005 ranged from 0.23-1.40 mg/L.

Samples for herbicide and insecticide analysis were collected at Putnam CR 8 (RM 28.88) and again at State Rt. 115 (RM 9.05). No insecticides were detected in any of the samples and a summary of herbicides that were detected is presented in Table 7e. The most commonly detected, with trade name in parenthesis, were Atrazine (AAtrex) in 8 of 12 samples and Metolachlor (Dual) in 12 of 12 samples. Both of these are extensively used in crop production areas for selective weed control in corn and soybeans. There is also a frequently used mixture of Atrazine and Metolachlor marketed under the trade name of Bicep. Concentrations were considerably higher at State Rt. 115 due to the increase in drainage area and amount of land used for crop production. These results indicate that runoff in agricultural areas is a source of herbicides in the river and that they persist in the environment. Ottawa is required to test for Alachlor, Atrazine, and Simazine monthly during the summer and quarterly the rest of the year. Treated water samples tested through July 2005 detected Atrazine in one sample, but it was well below the MCL.

Excessive algae blooms are common in the Blanchard River near Ottawa because of nutrient enrichment. These blooms cause taste and odor problems and are linked to the formation of disinfection byproducts. It is suspected that algae cells are the major source of organic matter in Trihalomethane formation when chlorine is added for disinfection. Certain blue green algae have been shown to emit micocystins that can cause liver damage. Samples from the Blanchard River were filtered and analyzed for chlorophyll $_a$ content to quantify the amount of algae in Ottawa's source water. Results varied somewhat during the study period and concentrations ranged from 6.79-20.06 µg/L, with a median value of 12.04 µg/L. The US EPA recently developed water quality criteria that include a 2.70 µg/L chlorophyll $_a$ limit for streams and rivers in the Corn Belt Ecoregion. The State of Oklahoma is proposing a 10.0 µg/L chlorophyll $_a$ criterion for all surface waters used as water supplies (Oklahoma Water Resources Board, 2005).

Recreation

An overall determination of the recreation use status in the LRAU was made using fecal coliform as the test organism. Their presence indicates that water has been contaminated by feces from warm blooded animals. If levels are high enough (colony forming units or CFU/100 ml) there is chance for people who come in contact with the water to become ill. Data used in the analysis includes samples from stream surveys and monthly operating reports filed by NPDES permit holders that were collected during the May 1-October 15 recreation season. All valid results are pooled and the recreation use is considered impaired if either the 75^{th} percentile exceeds 1,000 or the 90^{th} percentile exceeds 2,000. In the Blanchard River LRAU the geometric mean was 290, 75^{th} percentile 408, and 90^{th} percentile 992. The recreation use is considered in attainment based on these results.

A site specific evaluation of the PCR use designation was done because the Blanchard River is commonly used for fishing, hunting, and canoeing. To determine if a site meets the Ohio WQS criteria for PCR, a minimum of 5 samples must be collected within any 30 day period during the recreation season. Criteria for PCR require that the fecal coliform geometric mean from this data set should not exceed 1,000 and not more than 10% of the individual results should exceed 2,000. Results for fecal coliform testing done June 27-July 25 are summarized in Table 7f. No results from the site specific sampling violated the geometric mean criterion. Only 1 sample violated the 30 day maximum criterion at Putnam CR 15 (RM 13.37) on July 19. Counts at all sites tended to be higher than normal on this date. A likely reason is that there were heavy rainstorms several days before the sampling event. These storms tend to increase the impact from sewage bypasses, CSOs, and runoff in livestock production areas.

Sediment Quality

Substrate features reflect the glacial origin of the parent materials in the LRAU. The glacial lake bed of the HELP ecoregion is characterized by soft silt and muck. Other factors in the LRAU like low gradient, downcut channel, and narrow floodplain keep sediment contained in the river. Stream bank erosion is more of a problem here too because of the instability of the channel and bank materials. This was found to be the case in the field as fine sediment deposits for sample collection were abundant in the river. Samples were tested for particle size distribution, organic carbon content, % solids, metals, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and organochlorine insecticides. Chemical concentrations are evaluated based on Ohio reference values (Ohio EPA, 2003) and consensus based toxicity guidelines (MacDonald et al, 2000). Ohio reference values are based on an ecoregion reference site approach and considered background concentrations for streams. The MacDonald guidelines consider concentrations below a threshold effect concentration (TEC) to be absent of toxicity and those above a probable effect concentration (PEC) to be toxic to benthic organisms.

All of the samples consisted of at least 50% fine particles, four were about a 50/50 blend of sand mixed with fines and three were virtually all silt and clay. No PCBs or insecticides were detected in any of the samples. The only one with any PAHs detected was collected at Putnam CR 5-F (RM 35.24). A total of 10 different compounds had a sum concentration of 18.59 mg/kg. This level does not exceed the PEC of 22.8 mg/kg, but it is above the TEC of 1.61 mg/kg, so the potential for an impact exists. PAHs originate from fossil fuel combustion and are contained in creosote and coal tar. Several have been documented to cause skin cancer in lab animals and are strongly suspected human carcinogens. If enough contamination is present a contact advisory might be needed to protect human health, but these levels are probably not high enough for such action.

A summary of metal concentrations in sediment is presented in Table 7g. The elements strontium and arsenic were the most frequently documented above reference levels, but they probably do not pose much of a problem to aquatic life. They are likely elevated because of a strong influence from parent materials. The sample at Putnam CR 5-F (RM 35.24) had a lead concentration of 76 mg/kg, which is significantly above the statewide reference value of 47 mg/kg. This is the same site that had PAHs detected and the two probably come from the same source. The sample at Ottawa TR I-9 (RM 21.02) had chromium and cadmium concentrations above reference levels. This is downstream from Ottawa and there are several potential industrial sources, most notably the closed LG Philips Displays TV picture tube plant. Neither of the concentrations exceeded their respective PEC levels, but both were above the TEC. The sample at Putnam CR 21-H (RM 2.58) had chromium and nickel concentrations above reference levels, but the source is unknown. The nickel concentration of 45 mg/kg is near the PEC level of 48.6 mg/kg.

Table 7A. Aquatic life use attainment status of the Blanchard River large river assessment unit (LRAU: 5080001 003), June- October, 2005. 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.

River Mile Invertebrate/ Fish	MI^2	IBI	MIwb[a]	ICI[b]	QHEI	Attainment[c]	Causes[d]	Sources[e]
Blanchard River			*WWH - ECBP Ecoregion*					
35.4/35.2	503	34	9.8	48	53.5	Full		
28.9/____	624			VG				
____/27.7	625	38	9.7		60.0	(Full)		
22.5/23.0	627	36	8.9	MG[ns]	62.0	Full		
21.7/21.1	638	34	9.1	42	51.0	Full		
14.5/ 14.6	703	32[ns]	8.7	52	55.5	Full		
8.6/9.1	744	35	9.6	46	59.0	Full		
2.4/2.6	767	35	8.7	54	48.5	Full		
____/0.2	771	32[ns]	9.1		54.0	(Full)		

Ecoregion Biocriteria: Huron Erie Lake Plain (HELP)

INDEX - Site Type	LRW	MWH channel modified	WWH	EWH
IBI Headwater -Boat	18	24	34	48
MIwb -Boat	4.0	5.8	8.5	9.6
ICI	8	22	34	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 Use attainment status based on one organism group is parenthetically expressed.

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

Table 7b. Summary of exceedences documented in the LRAU based on Ohio WQS criteria and nutrient target values. Criteria include outside mixing zone minimum or maximum (OMZM) and average (OMZA) values.

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Exceedence
Blanchard River WWH, PCR, AWS, IWS, and PWS (RM 28.50)	35.24	WWH	dissolved oxygen	4 of 47 diurnals below OMZA
			temperature	5 of 47 diurnals above OMZM
				12 of 47 diurnals above OMZA
				1 of 6 grabs above OMZA
			strontium	2 of 6 grabs above OMZA
			phosphorus	3 of 6 grabs above target
			nitrate-nitrite	5 of 6 grabs and median above target
	28.88	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			temperature	4 of 49 diurnals above OMZM
				18 of 49 diurnals above OMZA
				1 of 6 grabs above OMZA
			phosphorus	5 of 6 grabs and median above target
			nitrate-nitrite	6 of 6 grabs and median above target
		PWS	dissolved solids	1 of 6 grabs above OMZA
			iron	6 of 6 grabs above OMZA
			manganese	5 of 6 grabs above OMZA

Table 7b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Exceedence
Blanchard River WWH, PCR, AWS, IWS, and PWS (RM 28.50)	24.20	WWH	dissolved oxygen	1 of 6 grabs below OMZA
			temperature	2 of 48 diurnals above OMZM
				12 of 48 diurnals above OMZA
				2 of 6 grabs above OMZA
			phosphorus	3 of 6 grabs above target
			nitrate-nitrite	4 of 6 grabs and median above target
	21.02	WWH	dissolved oxygen	1 of 6 grabs below OMZA
				7 of 46 diurnals below OMZA
			temperature	1 of 6 grabs above OMZA
				11 of 46 diurnals above OMZA
			phosphorus	3 of 6 grabs and median above target
			nitrate-nitrite	5 of 6 grabs and median above target
	13.37	WWH	dissolved oxygen	16 of 48 diurnals below OMZM
				violated OMZA
			temperature	2 of 6 grabs above OMZA
				8 of 48 diurnals above OMZA
			phosphorus	3 of 6 grabs above target
			nitrate-nitrite	4 of 6 grabs and median above target
		PCR	fecal coliform	violated site specific maximum

Table 7b. Continued

Stream (Use Designations)	River Mile	Use	Parameter	Water Quality Exceedence
Blanchard River WWH, PCR, AWS, IWS, and PWS (RM 28.50)	9.05	WWH	temperature	2 of 9 grabs above OMZA
			phosphorus	5 of 11 grabs above target
			nitrate-nitrite	9 of 11 grabs and median above target
	6.75	WWH	temperature	5 of 47 diurnals above OMZA
	2.58	WWH	dissolved oxygen	2 of 47 diurnals below OMZA
			temperature	3 of 6 grabs above OMZA
				6 of 47 diurnals above OMZA
			phosphorus	3 of 7 grabs above target
			nitrate-nitrite	5 of 7 grabs and median above target
	0.20	WWH	temperature	17 of 47 diurnals above OMZA

Table 7c. Summary of hourly dissolved oxygen measurements (mg/L) recorded by automatic meters deployed in the LRAU. Highlighted values indicate a WQS violation.

River Mile	Hours	Mean	Median	Minimum	Maximum	Flux
35.24	47	6.16	5.87	4.91	7.97	3.06
28.88	49	6.54	6.36	5.52	8.04	2.52
24.20	48	6.24	6.22	5.79	6.92	1.13
21.02	46	5.36	5.34	4.89	6.07	1.18
13.37	48	4.25	4.27	3.40	5.26	1.86
6.75	47	6.36	6.23	5.35	7.71	2.36
2.58	47	5.68	5.51	4.97	6.50	1.53
0.20	46	6.55	6.46	5.44	8.02	2.58

Table 7d. Facilities regulated by an individual NPDES permit.

Facility Name	Ohio EPA Permit No.	Receiving Stream	River Mile	Description
Ottawa WWTP	2PD00028	Blanchard River	22.16	3.0 MGD contact stabilization
Ottawa WTP	2IW00222	Blanchard River	27.1	0.5 MGD sludge lagoon system with a controlled discharge

Table 7e. Summary of herbicides (µg/L) detected in the LRAU. Values reported as less than (<) were below the lab quantitation limit. Qualified data are defined as; J- positively identified but the value is estimated and UJ- not positively identified but the quantitation limit is estimated.

Compound (Trade Name)	6/13/05	6/27/05	7/11/05	7/25/05	8/8/05	8/22/05
Blanchard River at Putnam CR 8 (RM 28.88)						
Acetochlor (Harness)	0.40^{J}	<0.21	$<0.21^{UJ}$	0.67^{J}	0.22^{J}	<0.21
Atrazine (AAtrex)	$<0.22^{UJ}$	0.79	$<0.21^{UJ}$	1.17^{J}	0.81^{J}	0.48
Metolachlor (Dual)	0.53^{J}	0.34	0.65^{J}	1.02^{J}	0.42^{J}	0.35
Metribuzin (Sencor)	0.23^{J}	<0.21	$<0.21^{UJ}$	$<0.21^{UJ}$	$<0.22^{UJ}$	<0.21
Simazine (Princep)	$<0.22^{UJ}$	0.22^{J}	$<0.21^{UJ}$	$<0.21^{UJ}$	$<0.22^{UJ}$	<0.21
Blanchard River at State Rt. 115 (RM 9.05)						
Acetochlor (Harness)	1.52	<0.21	$<0.21^{UJ}$	0.61^{J}	0.27	<0.21
Atrazine (AAtrex)	5.72	1.16	$<0.21^{UJ}$	$<0.21^{UJ}$	0.98	0.48
Metolachlor (Dual)	2.42	0.46	0.93^{J}	0.82^{J}	0.48	0.34
Metribuzin (Sencor)	0.25	<0.21	$<0.21^{UJ}$	$<0.21^{UJ}$	<0.21	<0.21
Simazine (Princep)	0.84	0.25^{J}	$<0.21^{UJ}$	$<0.21^{UJ}$	<0.21	<0.21

Table 7f. Site specific recreation use assessment in the LRAU. Highlighted values indicate an Ohio WQS criteria violation.

Sampling Location	River Mile	Fecal Coliform Count (CFU/100 ml)					
		6/27/05	7/6/05	7/11/05	7/19/05	7/25/05	Geometric Mean
CR 5-F	35.24	250	260	200	690	210	285
CR 8	28.88	220	270	120	720	330	279
US 224	24.20	260	370	180	1000	530	391
TR I-9	21.02	220	260	200	1900	530	410
CR 15	13.37	240	190	110	7900	370	430
SR 115	9.05	250	110	150	1800	310	297
CR 21-H	2.58	230	230	80	1400	210	262

Table 7g. Metal concentrations (mg/kg) in sediment collected from the Blanchard River. Highlighted values were above either the statewide (*) or HELP ecoregion sediment reference value (SRV). Values reported as less than (<) were below the quantitation limit.

Element	Sampling Location and river mile							
	SRV	CR 5-F 35.24	CR 8 28.88	US 224 24.20	TR I-9 21.02	CR 15 13.37	SR 115 9.05	CR 21-H 2.58
Aluminum	42,000	37,200	34,200	38,200	30,100	39,100	35,300	49,900
Barium	210	205	166	189	173	187	184	272
Calcium	110,000	85,800	32,400	30,100	30,300	37,500	30,400	36,400
Chromium	51	45	40	42	56	43	41	59
Copper	42	34.6	30.4	29.7	26.6	22.6	25.2	34.8
Iron	44,000	30,300	29,600	29,400	26,100	29,700	28,200	37,800
Lead	47 *	76	<38	<39	<27	<27	<32	<39
Magnesium	29,000	36,000	12,700	12,800	11,600	15,400	11,200	15,200
Manganese	1,000	634	597	550	560	604	600	704
Nickel	36	<36	<38	<39	31	35	34	45
Potassium	12,000	10,900	8,910	10,200	9,000	10,800	10,700	15,700
Sodium	-	<4,470	<4,720	<4,830	<3,350	<3,370	<3,980	<4,820
Strontium	250	399	362	319	237	202	226	275
Zinc	190	174	146	147	141	107	122	152
Mercury	0.12 *	0.086	0.050	0.091	0.074	0.050	0.058	0.078
Arsenic	11	13.7	11.8	11.6	10.5	11.1	12.0	15.1
Cadmium	0.96	0.633	0.566	0.642	2.16	0.586	1.00	0.959
Selenium	1.4	1.99	<1.89	<1.93	<1.34	<1.35	<1.59	<1.93

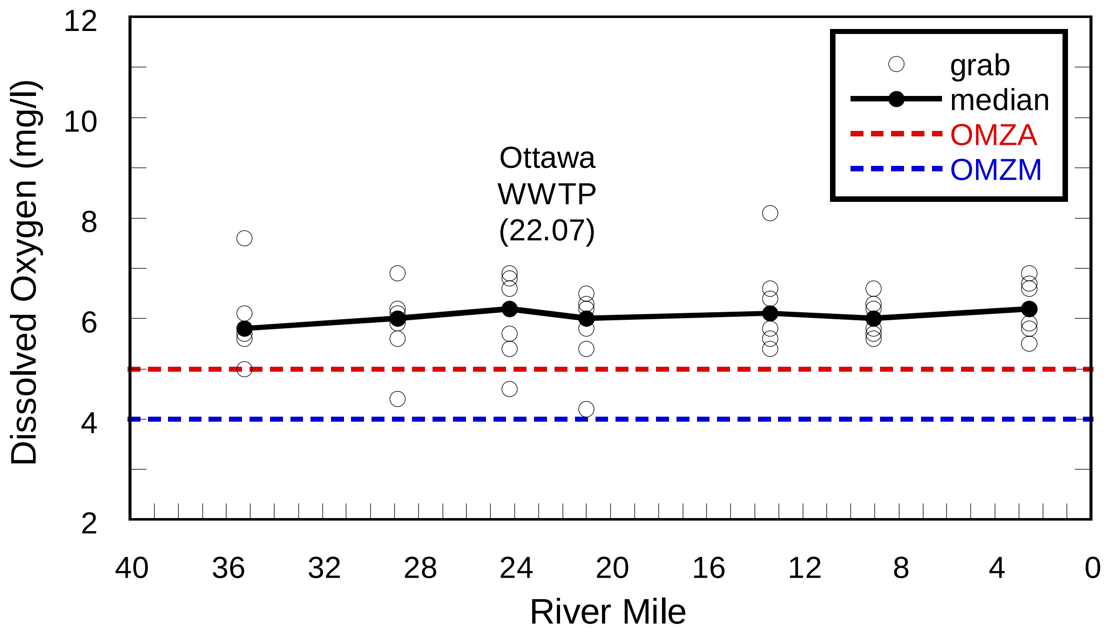

Figure 7a. Summary of dissolved oxygen concentrations measured in daytime grabs from the Blanchard River plotted against average and minimum criteria.

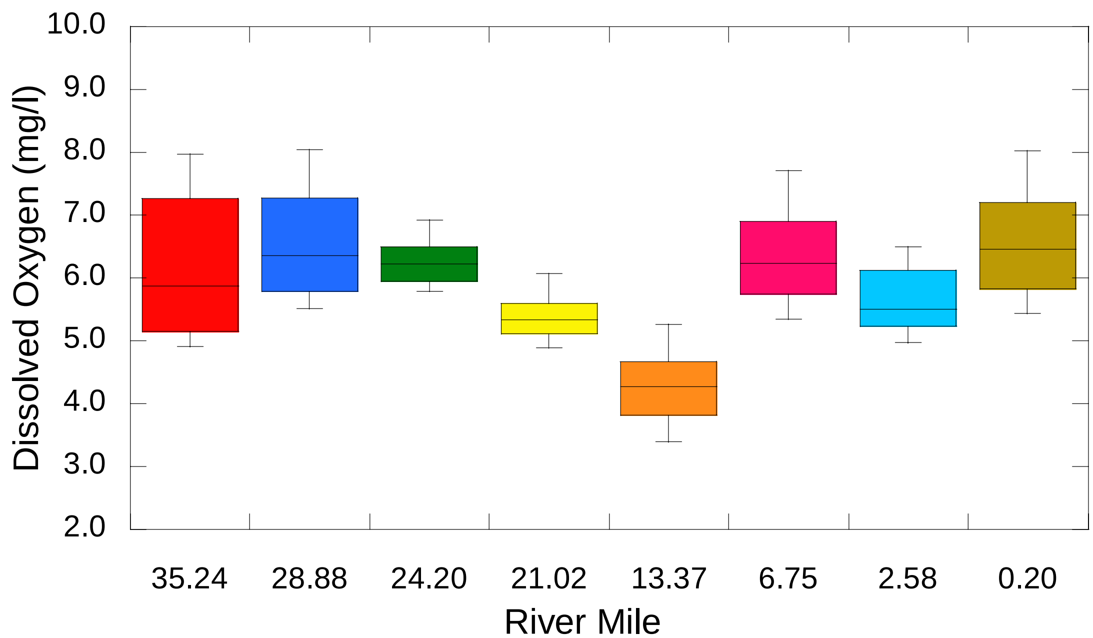

Figure 7b. Summary of dissolved oxygen concentrations measured hourly for 48 hours by continuous monitors deployed in the Blanchard River on August 2, 2005. The box contains 50% of the data points and the line represents the median value.

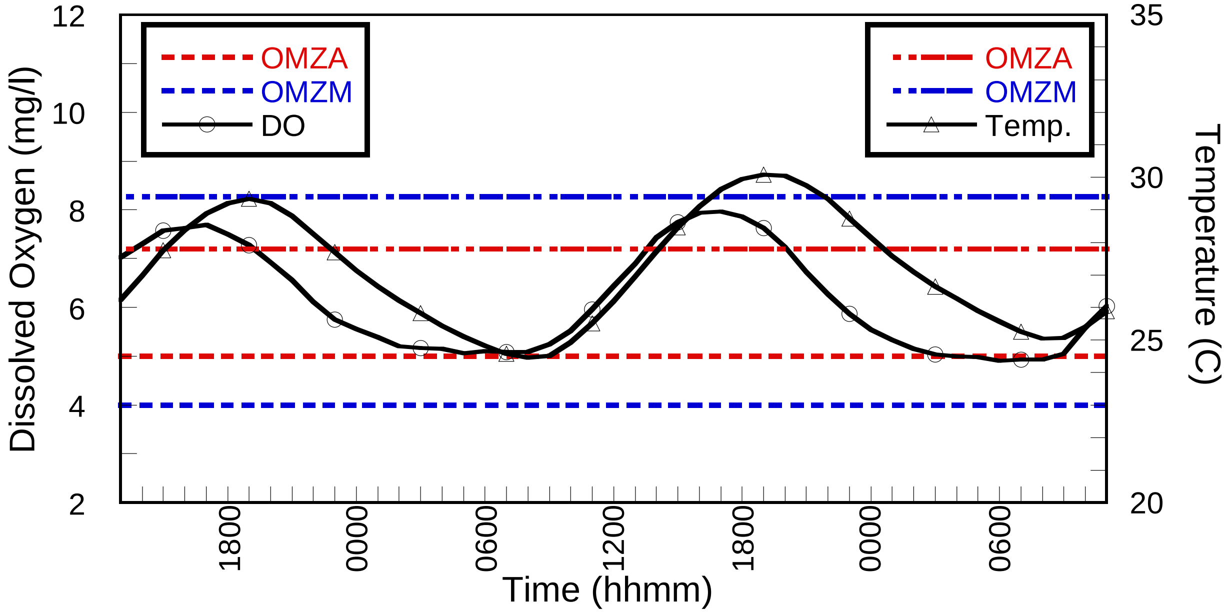

Figure 7c. Hourly readings of dissolved oxygen and temperature measured in the Blanchard River at Putnam CR 5-F plotted against respective average and minimum/maximum criteria.

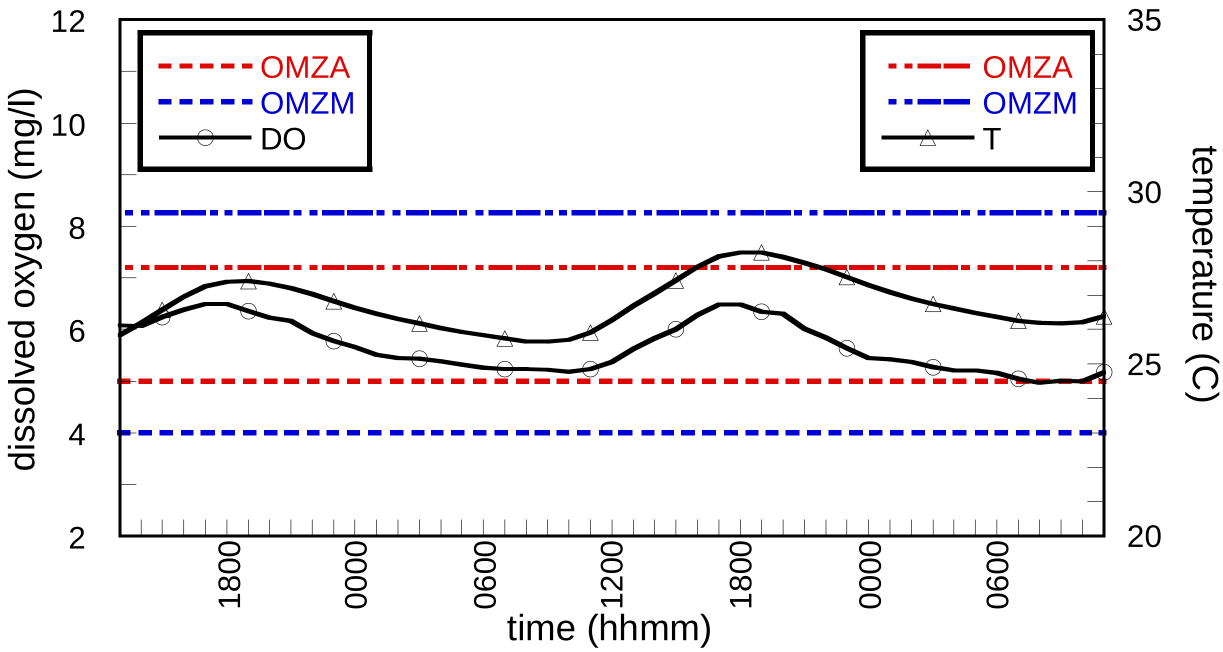

Figure 7d. Hourly readings of dissolved oxygen and temperature measured in the Blanchard River at Putnam CR 21-H plotted against respective average and minimum/maximum criteria.

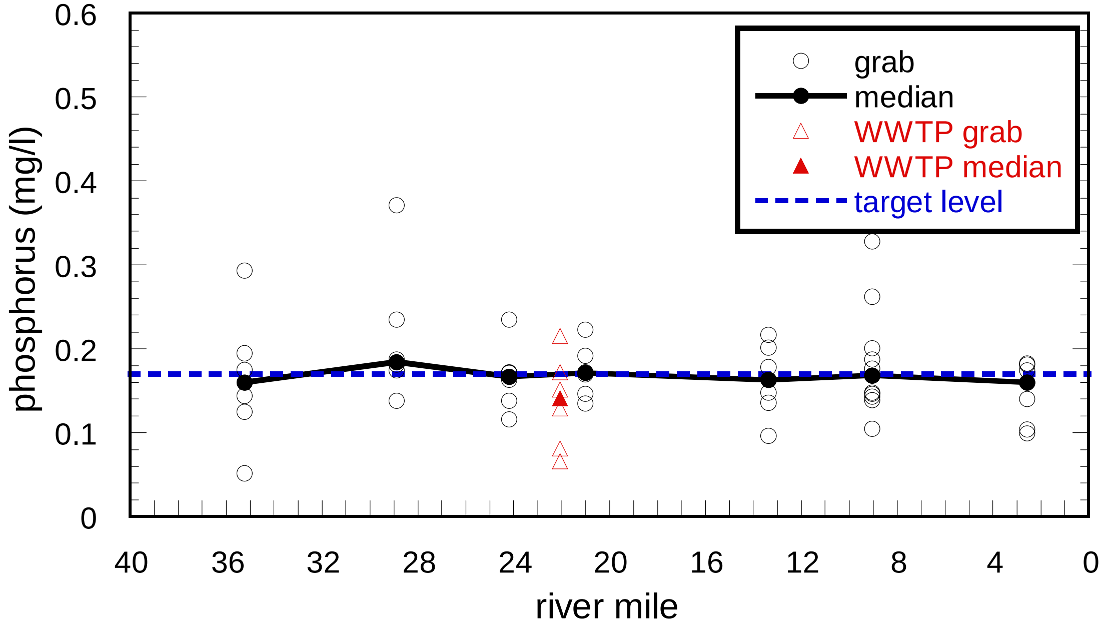

Figure 7d. Summary of phosphorus concentrations measured in grabs from the Blanchard River and Ottawa WWTP plotted against the target level (0.17 mg/l).

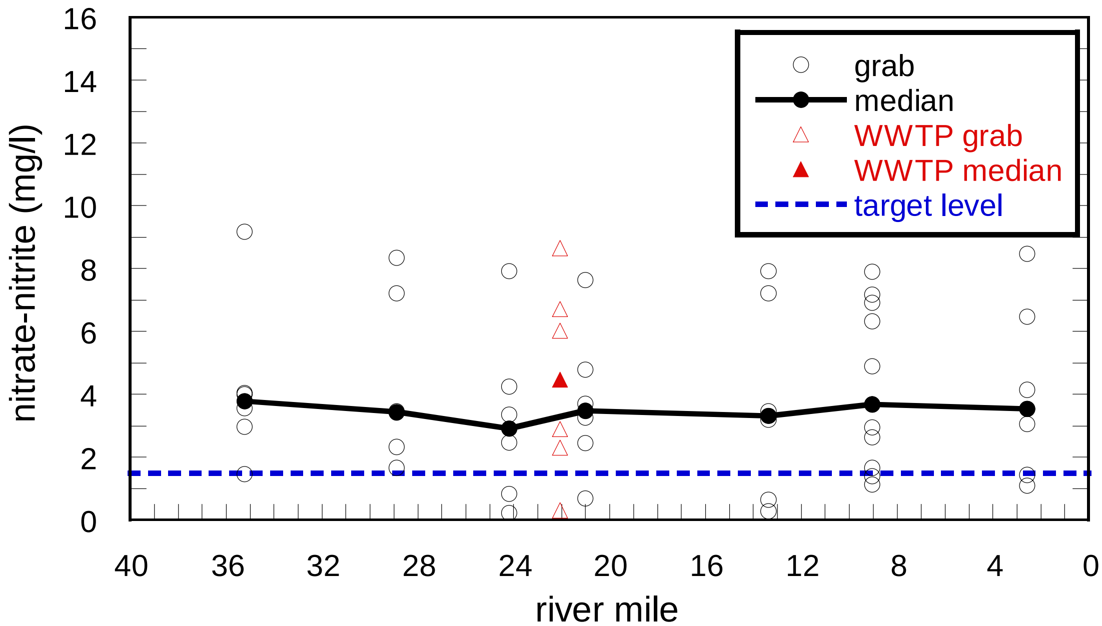

Figure 7e. Summary of nitrate-nitrite concentrations measured in grabs from the Blanchard River and Ottawa WWTP plotted against the target level (1.50 mg/l).

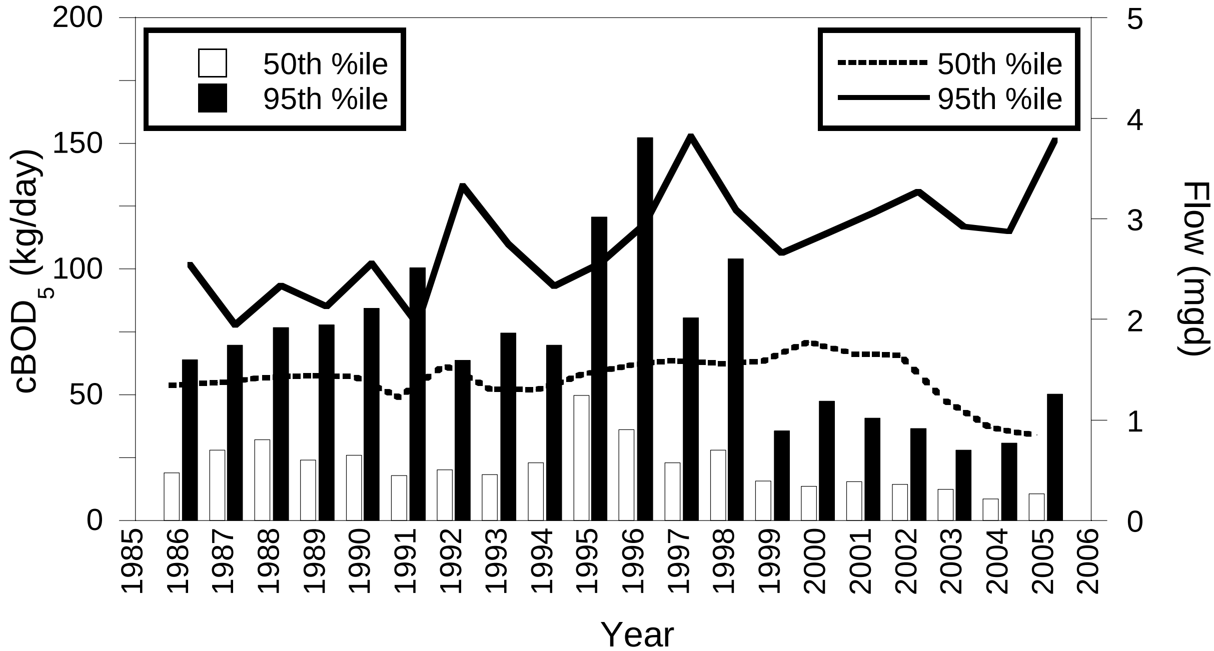

Figure 7f. Annual summary of MOR data for 5-day cBOD collected at the Ottawa WWTP.

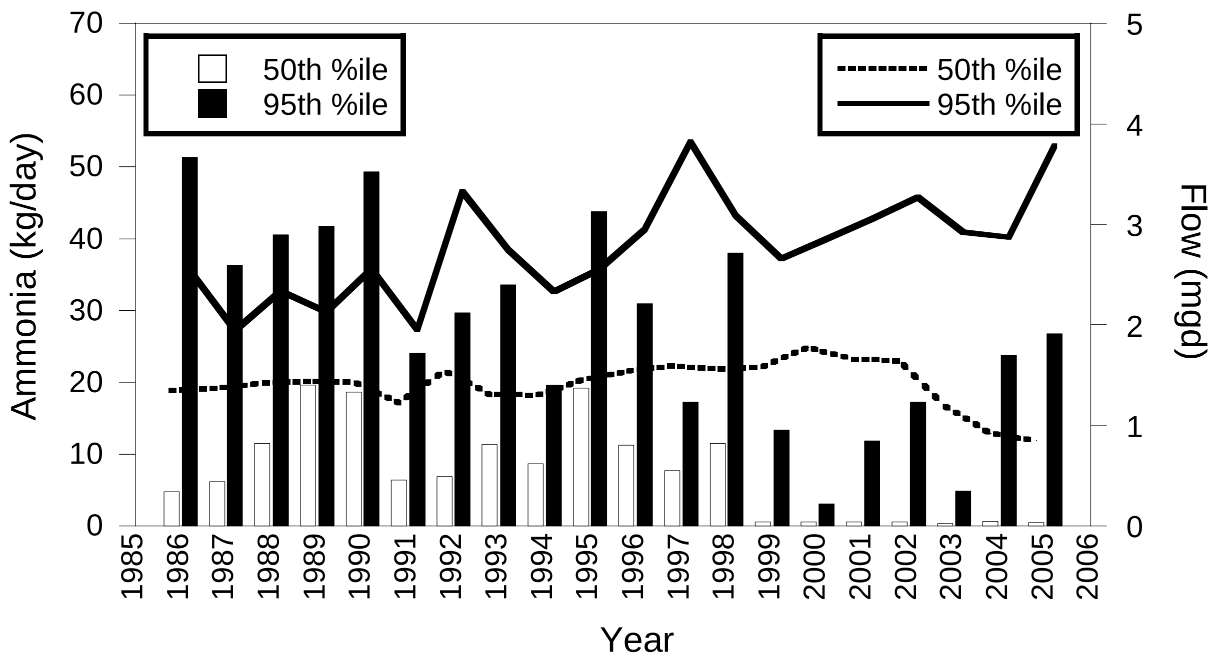

Figure 7g. Annual summary of MOR data for ammonia collected at the Ottawa WWTP.

REFERENCES:

DeShon, J.D. 1995. Development and application of Ohio EPA's invertebrate community index (ICI), *in* W.S. Davis and T. Simon (eds.). Biological assessment and criteria: tools for risk-based planning and decision making. CRC Press/Lewis Publishers, Ann Arbor.

Hull & Assoc, Inc., 2005. Phase II Environmental Property Assessment. Prepared for Findlay/Brandman Clean Ohio Revitalization Fund Application to Ohio EPA.

Hoggarth, M.A., D.L. Rice, and T.L. Groove. 2000. The correlation of mussels with fish in the upper Blanchard River in Hardin and Hancock counties, Ohio, with special regard to the rayed bean (*Villosa fabalis*). In: R.A. Tankersly, D. Warmolts, G.T. Watters, and B. Armitage (editors). Freshwater Mollusk Symposium Proceedings, Part I: Proceedings of the Conservation, Captive Care, and Propagation of Freshwater Mussels Symposium, Columbus, Ohio, March, 1998.MacDonald, D., C. Ingersoll, T. Berger. 2000. *Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems*. Arch. Environ. Contam. Toxical.: Vol.39, 20-31.

Ohio Department of Natural Resources. Division of Water. *Gazetteer of Ohio Streams*. 1960. Columbus, Ohio.

Ohio Department of Natural Resources. Division of Water. Drainage Areas of Ohio Streams (Supplement to Gazetteer of Ohio Streams). 1967. Columbus, Ohio.

Ohio Environmental Protection Agency. 1988. Biological and Water Quality Study of Oil Ditch, Hancock County, Ohio, 1987. Doc. OEPA 04-224. Columbus, OH.

___ 1989. Addendum to biological criteria for the protection of aquatic life: Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Planning and Assessment, Surface Water Section, Columbus, Ohio.

___ 1989c. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Planning and Assessment, Columbus, Ohio.

___ 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

___ 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

___ 1988. Biological and Water Quality Study of Oil Ditch, Hancock County, Ohio, 1987. Doc. OEPA 04-224. Columbus, OH.

___ 1999. Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams. Technical Bulletin MAS/1999-1-1.

___ 2001. Sediment sampling guide and methodologies, 2nd edition. Nov. 2001. Division of Surface Water, Columbus, Ohio.

___ 2002. Manual of Laboratory Operating Procedures. Volumes I,II,III and IV. Division of Environmental Services.Services, Columbus, Ohio.

___ 2005. Division of Emergency and Remedial Response. Site Inspection Southwestern Portland Cement Landfill Number 1. U.S. EPA ID:OHD000508693

___ 2005. *Ecological risk assessment guidance manual*. Feb. 2005. Division of Emergency and Remedial Response, Columbus, Ohio.

___ 2006. *Ohio EPA manual of surveillance methods and quality assurance practices, updated edition*. Division of Environmental Services, Columbus, Ohio.

Ohio State University Extension Data Center. Population by Government Units 2000. Retrieved January 27, 2005 http://www.osuedc.org/profiles/

Omernik, J.M. 1988. Ecoregions of the conterminous United States. Ann. Assoc. Amer. Geogr. 77(1): 118-125.

Persaud, D., J. Jaagumayi, and A. Hayton. 1994. *Guidelines for the protection and management of aquatic sediment quality in Ontario*. Ministry of the Environment, Public Information Centre, Toronto, Ontario.

United States Department of the Interior-U.S. Geological Survey. 2004. Water Resources Data-Ohio Water Year 2005. *Volume 1. Ohio River Basin Excluding Project Data*. Water-Data report OH-03-1. 383 pp.

___ 2000. *Low Flow Characteristics of Streams in Ohio through Water Year 1997*. Report 01-4140. 421 pp.

United State Army Corps of Engineers Electronic references. Retrieved October 4, 2004 from http://www.lrl.usace.army.mil/cjbl/

United States Census Bureau. Population Division. Release Date: July 10, 2005. Table SUB-EST2002-07-39-Ohio Incorporated Place Population Estimates, Sorted Alphabetically: April 1, 2000 to July 1, 2002.

University of Cincinnati, Department of Geography. Robert Frohn, Richard Beck, Lin Liu, and Xinhao Wang. Project #01 (h)EPA-06, "Statewide Land Use Classification and Validation in Ohio"; Project start date 12/01/01; project end date 4/2005.

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. 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.

___ 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.

___ 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.