Lower Alum Creek Watershed Action Plan

Published by:

The Friends of Alum Creek & Tributaries

In partnership with
The Alum Creek Action Plan Steering Committee &
The Lower Alum Creek Watershed Community

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Dear Readers,

The Friends of Alum Creek & Tributaries (FACT) formed in 1998 with a mission to preserve and protect Alum Creek as a community resource. As we began work on this document, our discussions with many residents helped us learn something we hadn't fully realized about ourselves: people are drawn towards water's ability to enchant.

FACT is in turn sharing a vision of the great potential that this resource holds. We ask you to join us in opening your senses to the beauty of Alum Creek as it exists now, and opening your imagination to its potential as we come together to face challenges. The action plan presents steps that we can all take to preserve and restore the health of our river.

Thank you to the dozens of people who made the creation of this document possible, and to those yet to come! To learn more or get involved, please contact FACT with the information provided below.

Sincerely,

The Friends of Alum Creek & Tributaries

Acknowledgements

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ACRONYMS

BMP	Best Management Practice
CFS	Cubic Feet per Second
CRPD	Columbus Recreation and Parks Department
CWA	Clean Water Act
DERR	Division of Emergency and Remedial Response (Ohio EPA)
DHD	Delaware Health District
DNR	Department of Natural Resources
DO	Dissolved Oxygen
DOSD	Division of Sewerage and Drainage (Columbus Public Utilities Department)
DSW	Division of Surface Water (Ohio EPA)
DSWCD	Delaware Soil and Water Conservation District
EPA	Environmental Protection Agency
FCBH	Franklin County Board of Health
FACT	Friends of Alum Creek & Tributaries
FSWCD	Franklin Soil and Water Conservation District
HSTS	Home Sewage Treatment System
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
LCD	Local Health Department
MIwb	Modified Index of Well Being
MGD	Million Gallons per Day
MORPC	Mid-Ohio Regional Planning Commission
NPDES	National Pollution Discharge Elimination System
NPS	Nonpoint Source (pollution)
ODH	Ohio Department of Health
QHEI	Qualitative Habitat Evaluation Index
RM	River Mile
SWAP	Source Water Assessment & Protection
TMDL	Total Maximum Daily Load
TSD	Technical Support Document
WPRD	Westerville Parks and Recreation Department
WWH	Warmwater Habitat

I. INTRODUCTION

Nonpoint source (NPS) pollution has emerged as a major source of water quality problems nationwide. It occurs as rain water or snow melt washes pollutants off of the surrounding landscape and into streams and rivers. The other major category of pollution, point sources, originate from discrete locations, such as the end of a pipe, and have been the focus of natural resource management agencies since the Clean Water Act was passed in 1972. Reduction of point sources in Alum Creek improved water quality dramatically in the 1980's early 1990's, but water quality has again declined in recent years as a result of NPS pollution.

The purpose of this action plan is to identify and restore impaired reaches of Alum Creek and tributaries through reducing NPS pollution (although point sources will also be taken into consideration). Protecting areas that are currently meeting water quality standards is an equally important component. The plan strives to incorporate the vision of local communities for improving neighborhoods as they relate to water quality, and improving the capacity of local government officials to address NPS pollution through stronger collaborations. This plan presents an analysis of the underlying environmental, economic, and social factors related to the impaired areas and outlines strategies for restoration and preservation.

The process of creating the action plan began in 1999 when the newly formed Friends of Alum Creek & Tributaries (FACT) applied for funds to facilitate planning with local communities. Leaders in local government, natural resources protection, interested citizens, and many others participated in authoring the plan and have already begun the implementation process.

A. The Lower Alum Creek Watershed

The Alum Creek watershed is located in central Ohio, running through portions of Morrow, Delaware, and Franklin Counties. The watershed basin drains 199 square miles along Alum Creek's 55.8 miles. The focus of this document, however, is the lower Alum Creek watershed, which extends from the Alum Creek Lake Reservoir in southern Delaware County to the creek's mouth and confluence with Big Walnut and Blacklick Creeks in southeastern Franklin County (Figure 1).

The lower Alum Creek watershed drains 100 square miles and contains almost 27 miles of Alum Creek. It includes two 14-digit Hydrologic Unit Code (HUC's) subwatersheds, as defined by the U.S. Geological Survey: the Upper Subwatershed HUC (05060001160010) and the Lower Subwatershed HUC (05060001160010). The two 14-digit HUC subwatersheds and their boundaries are shown in Figure 1. Along the mainstem of Alum Creek, the boundary between the upper and lower subwatershed falls near Schrock Road in Westerville.

The Friends of Alum Creek & Tributaries (FACT), who sponsored coordination and funding of the planning process, focused planning solely on the lower Alum Creek watershed for several reasons. The group has historically focused on this portion of the watershed due to resource limitations and the vastly differing land use and water quality conditions found in the two sections. These differences are exaggerated by the Alum Creek Lake Reservoir, which spatially separates the segments and acts as a buffer between them. Lastly, results of other watershed planning projects have shown that a smaller scale approach is more likely to be successful in targeting and reducing impairment.

Six tributary streams are addressed within this document:

- Unnamed Tributary at Alum Creek river mile 25.50 (Delaware County – OH38 4.6)
- Unnamed Tributary at Alum Creek river mile 23.47 (Delaware County – OH38 4.5)
- Spring Run (Franklin/Delaware County – OH38 2.3)
- Spring Run West (Franklin County – OH38 2.1)
- Kilbourne Run (Franklin County – OH38 2.7)
- Bliss Run (Franklin County)

While numerous other tributaries exist, these six are the only ones for which water quality data exists (OEPA, 2003a). While actions in Section IV will apply to the entire watershed, other tributaries were not specifically included because planners were unable to assess their water quality status or form a basis for measuring results of planning efforts.

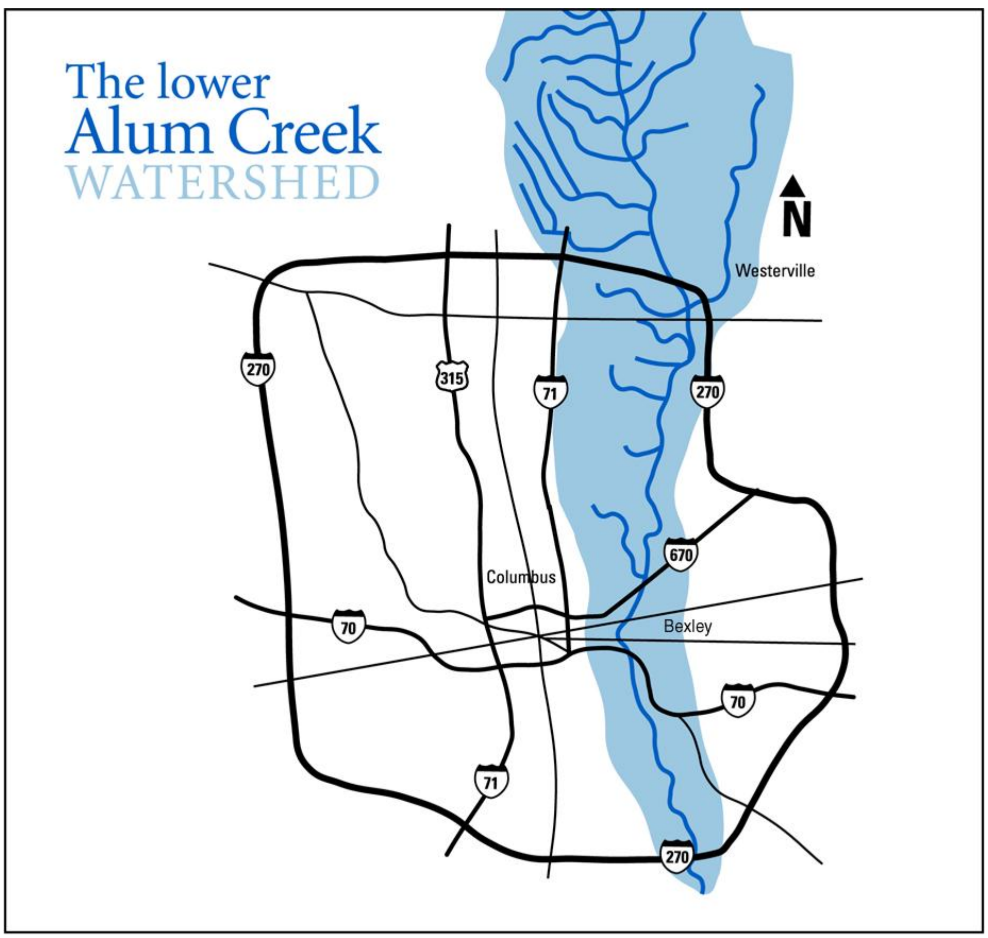


Figure 1: The Lower Alum Creek Watershed

B. Lower Alum Creek Demographics

The lower Alum Creek watershed contains portions of 13 political jurisdictions (listed below) and a population of 257,000 people. According to the 2000 census, 62% of the watershed population is White, 32% is African American, and the remaining 6% is American Indian, Asian, Hispanic, or Other. These numbers reflect that the Alum Creek watershed is home to many minority communities; 38% of residents within the watershed consider themselves "non-white," compared to 24% in Franklin County as a whole. Census data show similar percentages between the lower Alum Creek watershed and Franklin County for home ownership and median per capita income, although education levels in the watershed are somewhat lower.

It is interesting to note that the watershed contains not only an ethnically diverse population, but diverse neighborhoods in terms of history, density, and land use. For instance, areas in the northern end of the lower watershed have experienced vast land use changes in the last decade as agricultural lands have been converted to suburbs, while the City of Bexley was established almost 200 years ago and retains little open land for new development.

Lower Alum Creek Watershed Political Jurisdictions	
Counties / Townships	Delaware County / Genoa, Orange Franklin County / Sharon, Blendon, Clinton, Mifflin, Madison
Cities	Westerville, Columbus, Bexley
Villages	Minerva Park

C. Other Watershed Management Activities

Alum Creek Greenways Plan

The Franklin County Greenways Initiative, housed within the Mid-Ohio Regional Planning Commission (MORPC), created a Greenways Plan for Franklin County in early 1997. Alum Creek was chosen as the first watershed for local application of the plan, and so "Greenways – A Plan for Alum Creek" was completed in 1999 (MORPC, 1999). Strategies such as surveys of creek-side residents, a "Getting to Know You" stream walk and canoe float series, and a community planning forum were used to involve the public in the development of the plan.

The Greenways Plan established seven goals:
1) Increase awareness
2) Improve access
3) Create a 'Friends of Alum Creek' community group
4) Provide a safe environment
5) Protect and enhance the natural greenway
6) Improve water quality for recreational use and biological diversity, and
7) Develop a multi-use trail

As both a goal within the plan and a result of new networks established among individuals, natural resource managers, and environmental groups during the planning process, the Friends of Alum Creek & Tributaries were formed in 1998. Many other greenway plan goals have been achieved since then, while others that were more costly or complex are included in the action plan and will receive the benefit of staff time dedicated to their implementation and further grant funding. The Greenways Initiative and numerous other partnering organizations continue to lend support to FACT and have been extensively involved in the development of this action plan.

The protection and enhancement of a natural greenway along Alum Creek for both active and passive recreation continues to be a primary goal of local parks and recreation departments. In addition to pre-existing park land, significant portions of the riparian corridor have been purchased or placed under conservation easement to accommodate a 27 mile multi-use trail along the creek. Several components are already finished, and the trail is scheduled to be fully completed by 2007.

Big Walnut Basin Total Maximum Daily Load (TMDL) Study

As the action plan was going to print, the Ohio EPA released a draft Total Maximum Daily Load (TMDL) restoration plan for the Big Walnut Creek Watershed basin, which includes Alum Creek, Big Walnut Creek, and Blacklick Creek (Ohio EPA, 2004). The Ohio EPA must develop TMDL's for impaired waters to determine the extent of pollution reduction necessary for a given stream to regain ecological health (i.e., achieve full use attainment). This is accomplished by identifying pollutant sources, estimating their load contributions, and then determining appropriate load reductions.

In the Alum Creek watershed, TMDL's were developed for sediment, pathogens, and habitat. Although the action plan was developed primarily during 2003 and 2004 prior to the release of the draft TMDL, data and targets from the TMDL were incorporated while final revisions were being made to the action plan in early 2005. The ease of this transition was made possible by efforts of action planners and the TMDL team to maintain communication during the planning process. For example, the TMDL development team helped design the format and focus of the planning effort and plan goals (see Section II). Priority status has been given to actions that will help address TMDL parameters. Please see Section IV for more details.

Westerville Source Water Assessment & Protection

The Ohio EPA conducted a "Drinking Water Source Assessment" for the City of Westerville in 2003 in accordance with the state and federal Source Water Assessment and Protection program (SWAP) (OEPA, 2003b). Assessments are conducted to ensure the long term availability of drinking water through identifying protection areas and ways to reduce the risk of contamination. Alum Creek surface water is the primary source of Westerville's public water system. The report identified development activities and spills as potential sources of contamination, and protective strategies such as controlling storm water runoff and coordinating with local emergency response agencies. Local protection planning to achieve these strategies is already underway via stormwater control efforts described in this action plan and a source water assessment and protection plan currently being drafted by Westerville.

II. PLAN DEVELOPMENT

A. The Friends of Alum Creek & Tributaries

The Friends of Alum Creek & Tributaries (FACT) were formed in 1998 as a result of a regional planning agency initiative to create a greenways plan for Alum Creek (see Section I). The organization's mission is to improve and protect the ecological health of Alum Creek and its use as a resource by local communities. FACT is a non-profit organization and comprised of members from the local watershed community, including residents, local governments, businesses, and clubs. A Board of Directors governs the organization; please see Appendix 1 for a summary of the organization's structure and bylaws.

Recognizing poor water quality conditions in some portions of the creek and vulnerability to further degradation in others, FACT applied for funds from the Ohio EPA Division of Surface Water 319 grant program in 2000. This grant program originated from section 319 of the Clean Water Act, which targets nonpoint source pollution. Using these funds, FACT hired a staff person in 2001 to continue the group's public outreach efforts and coordinate the creation of a watershed action plan for Alum Creek.

FACT formed the **Alum Creek Action Plan Steering Committee** in 2002 to guide the planning process, with the goal of promoting diverse and effective stakeholder involvement. Representatives from FACT, local resource agencies, governments, environmental groups, and universities comprised the committee, which met monthly throughout 2002 and periodically thereafter. This committee will continue to play a vital role in evaluating and updating the plan as it is implemented.

The steering committee developed the planning process with two major components to encourage broad community participation. The "technical" track focused on water quality solutions and stakeholders who would be more directly involved in policy implementation. The "community" track focused on the values and vision of community members for their neighborhoods as they relate to Alum Creek. Please see Appendix 2 to view a list of action planning participants.

Technical Planning Track

The first meeting of the technical track was held on January 15th, 2003, and was attended by sixty people. Participation remained strong throughout 2003, with between 20 and 40 people attending monthly sessions. A wide array of community members were invited to participate, from representatives of various city departments to land owners to interested watershed residents. Special attention was paid to recruiting individuals and organizations with the skills, knowledge, and decision-making authority that would be needed to implement specific portions the plan.

The decision-making process selected for this effort was a "structured decision-making" approach. Participants in multi-stakeholder planning efforts often experience frustration with the quality of recommendations that result from more common consensus-based planning processes. These tend to promote management alternatives that are familiar and uncontroversial and that may or may not effectively address water quality impairments. Ohio State University Extension became involved at the beginning of the planning process to help participants critically analyze the problem, and generate and evaluate a broad range of management alternatives using both technical data and stakeholder values.

Prior to stakeholder meetings, a small group comprised of representatives from FACT, state agencies, and the Ohio EPA Total Maximum Daily Load (TMDL) development team met to develop focus areas for the plan that would fit well with TMDL outcomes and provide a viable structure for stakeholder participation (see Section I for more information on the TMDL). Through examining known causes and sources of impairment and likely TMDL parameters, the group outlined four action planning work groups. These groups met concurrently during monthly stakeholder meetings to focus on various impairment issues:

- <u>Land Use:</u> zoning, regulations, comprehensive community plans
- <u>Stormwater & Construction</u>: stormwater runoff quantity and quality, during and after construction.
- <u>Hydromodification & Habitat</u>: hydromodification (dams, levees, channelizations), riparian preservation, and recreation.
- <u>Organic Enrichment & Human Health</u>: nutrient and organic enrichment, pathogens, and toxic pollutants.

Community Planning Track

The action plan steering committee also created a second planning component to facilitate participation from a wider range of community members. Water quality was an obvious focus of the action plan, but the committee realized that residents at large would have greater interest in participating if they were given the opportunity to relate to the watershed on their own terms. A community planning track with a focus on what residents valued about living near Alum Creek was created to compliment the technical track. Ohio State University Extension again provided assistance, this time employing an approach termed "Appreciative Inquiry.[1]"

Appreciate inquiry was seen as a way of creating change in the Alum Creek watershed communities by having members of that community take an in-depth look at what is working and how they could support and expand what was working toward the creation of an ideal future. There are four phases of an Appreciative Inquiry Process:

[1] Appreciative Inquiry began in the field of organizational development with the work of David Cooperrider in the early 1980's when he discovered that the members of an organization are more energized and motivated to change when they focus on what is working in the organization than when they focus on what is wrong or needs fixing. This basic principle - that members of an organization can create a more desirable future by focusing on the positive and creative forces that give life to the organization - has more recently been applied to larger groups, including whole communities, to address vital aspects of community life, including economic development, health and safety, and the environment.

- Discover
- Dream
- Design
- Deliver

An Appreciative Inquiry typically begins with the selection of an area of community life that participants wish to improve. Once the topic area has been selected, a core group of community members are led through a process of **discovery** to explore what they appreciate and value most about their community in relation to the topic area. During the discovery phase, the core group will often interview residents and encourage them to share stories about moments when things worked well, when they felt most excited, inspired, and successful. These stories become the basis for the next phase: dreaming.

During the **dreaming** phase, participants in the inquiry are encouraged to envision what is possible for the community in relation to the topic area. This vision for the future must be grounded in reality, but because participants have been focusing on those moments when the community was at it's best, they naturally look beyond what they may have believed possible before the inquiry began.

Once a shared vision of the desired state is created, a larger cross-section of the community is invited to participate in **designing** projects that will lead to the creation of the ideal. Rather than starting from scratch, these projects are meant to build on existing efforts in the community through new linkages, additional support, broader delivery of services, or some other expansion of what is already working.

Finally, participants in the process commit to **deliver** on the projects they have created to move the community toward the shared vision for the future. Appreciative Inquiry is not a linear process with a beginning and an end, so even after projects are completed, the process of creation continues with the continual inquiry into what is working and the creation of new and innovative ways to move toward the desired future.

The appreciative inquiry process for the Alum Creek action plan began with FACT volunteers conducting interviews with over 100 watershed residents to learn what they appreciated about living near Alum Creek. Responses were used to help structure a community meeting at Franklin Park Conservatory on March 15th, 2003. The Alum Creek watershed is unique in encompassing a very diverse population; about forty residents representing neighborhoods throughout the watershed attended.

Participants interviewed each other to again build a sense of what they valued about living near Alum Creek, what was working in their neighborhoods, and their vision for building on that foundation. One theme that emerged was the value of abundant greenspace along Alum Creek, which creates a rare haven for relaxation, mental rejuvenation, and quietness. Greenspace and opportunities for recreation were also viewed as assets in terms of building a sense of community and neighborhood pride. Many people were concerned about recent losses of greenspace and the decline in abundance of wildlife.

Based on the interviews and exercises at the meeting, five areas of interest were established:

- Education and awareness
- Greenspace
- Water quality
- Recreation
- Litter control

Workshop attendees then developed projects relating to each theme. Eight projects were developed in total, and are listed at the end of Section IV. These projects are a tremendous starting point for building public outreach campaigns because they are based entirely on the values of watershed residents. Some goals and projects, such as reducing litter, fit easily into the technical action planning section. Implementation of other projects, such as naming tributaries, will be pursued as opportunities are found to work within watershed communities with local partners.

Public comment

Comment on this action plan was solicited while the plan was still in draft form by both technical and community planning participants. Both groups were contacted with opportunities to comment in November and December 2003, and the community planning group was also invited to a public meeting on January 8th, 2004. This meeting provided an opportunity for FACT members, community planning participants, and the general public to hear a presentation on the plan, receive copies, and submit written comments. The meeting and completion of the draft was publicized on the FACT website, through press releases to local papers, at libraries, and to targeted civic associations in the watershed.

B. Outline of Plan Content

The first two sections of this plan (including the current section) are dedicated to describing the watershed and planning process. Section III includes a comprehensive resource inventory that describes the physical and social conditions of the watershed. It also contains an assessment of water quality, including causes and sources of water quality impairment. Section IV consists of water quality goals, recommended actions, and implementation strategies. This section is structured by stream segments (two 14-digit HUC subwatersheds and six tributary streams), which will allow actions to be targeted to critical stream reaches. Section V describes how the plan will be evaluated and revised.

C. Endorsement & Adoption

Several levels of commitment from local stakeholders are possible, including formal and informal commitments, the existence of an interested party that will pursue an action, or no commitment but willingness of at least one party to continue research. At the time this document was printed, all levels of commitment were present in the plan and described where possible. Endorsement of the plan by local partners is described in Section IV through statements of commitment found at the head of every action table. After the plan has been fully endorsed by the Ohio EPA and Ohio DNR, FACT will seek resolutions of support from active stakeholders, including the following:

City of Columbus
City of Bexley
City of Westerville
Franklin County
Delaware County
Orange Township, Delaware County
Genoa Township, Delaware County
Northeast Area Commission, Columbus
North Central Area Com., Columbus
Mid-Ohio Regional Planning Commission
Franklin Soil & Water Conservation District
Delaware Soil & Water Conservation District
Franklin County Metro Parks
Sierra Club, Central Ohio Chapter
Audubon, Columbus Chapter
Ohio Environmental Council
Columbus Outdoor Pursuits
Delaware Friends of the Trail
St. Mary's of the Springs

D. Information & Education

Education and information needs were identified by planning committees for nearly every major issue being addressed in the plan, from home sewage treatment to the value of natural greenways. These needs are integrated with and targeted towards the implementation of actions throughout Section IV. Please see Appendix 3 for a list of all education actions. Coordination with Phase I and Phase II communities regarding Nonpoint Source (NPS) pollution education will be a major focus of educational efforts by FACT. The FACT education and outreach committee will provide a platform for implementation of some education programs.

Projects generated during community action planning will also be used as a starting point for education and outreach efforts. While they tend to be less directly oriented towards water quality, they have a large potential for creating public support in the interest of watershed protection because they address community values identified by residents.

Publicity of the completion of the plan and its goals was undertaken in the first half of 2004 through print media and a special event to recognize stakeholders and celebrate the plan's completion. Seeking endorsement of the plan from political jurisdictions and other stakeholders will also present an opportunity to publicize the plan.

E. Implementation

After the planning phase is completed, action plan participants will continue to be invited to collaborate with FACT as implementation partners. The level of involvement will depend on the stakeholder and plan priorities, but all participants will be invited to quarterly action plan meetings. The meetings will promote active involvement in implementation by providing stakeholders with an opportunity to share progress, new opportunities, challenges, and a basis for the plan to remain a "living document." Any individuals or organizations that wish to join the planning or implementation effort may do so by contacting the Friends of Alum Creek & Tributaries at (614) 409-0511 or visiting FACT online at www.friendsofalumcreek.org.

F. Funding Strategy for Friends of Alum Creek & Tributaries

The long-term viability of FACT as an organization is an important factor in the successful implementation of the watershed action plan. With the completion of the initial draft of the plan in early 2004, the organization was able to dedicate more attention to organizational development and building its capacity for fundraising. Several important steps were made in that year, including expanding the board of directors to create a more formal fundraising committee and the creation and implementation of a diverse fundraising plan with items such as expanded membership recruitment, special events, and foundation grants. Please see Appendix 4 to view FACT's 2005 Fundraising Plan.

FACT will continue to seek grants from the Ohio EPA and Ohio DNR as a major source of revenue. In May 2004, FACT applied for an Ohio EPA Section 319 Implementation Grant, which will likely be received in late 2005. FACT also utilizes an Ohio DNR Watershed Coordinator grant to fund FACT's single staff position at a declining rate over six years (from 2003 to 2009). The declining percentage of the position funded by the grant is meant to encourage grant recipients to establish local funding sources. FACT will create annual fundraising plans to continue to meet this and other budgetary needs. Expanded membership from individuals, business, and political jurisdictions within the watershed will continue to be a major focus of the plan, as will special events and foundation grants.

III. WATERSHED INVENTORY

A. INTRODUCTION

Alum Creek is 55.8 miles long, flowing north to south through portions of Morrow, Delaware, and Franklin Counties. Its watershed, or area of land that drains into Alum Creek, covers 199 square miles (shown in blue in the figure below). At its terminus in southeastern Franklin County, Alum Creek flows into Big Walnut Creek, and from there into the Scioto River and eventually the Ohio River.

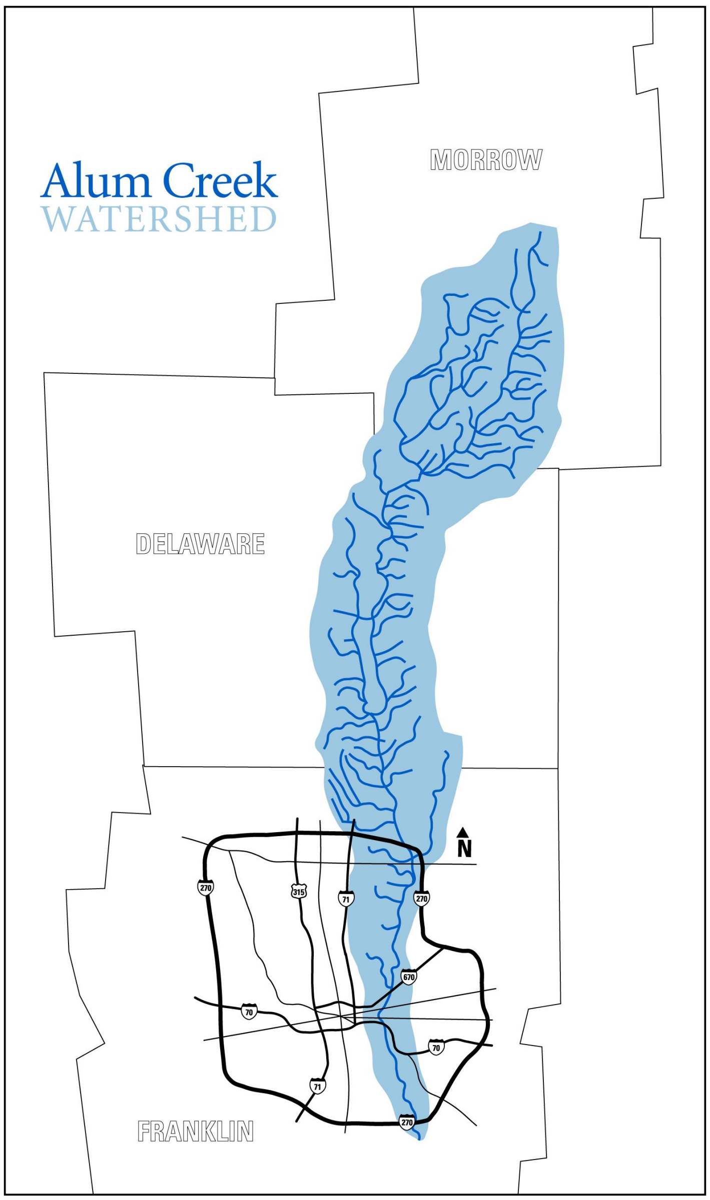


Figure 2: The Alum Creek Watershed. Image created by OSU Extension

The watershed is located within the Eastern Cornbelt Ecoregion, an area of level, glaciated plains traversed by broad, low, linear hills. Central Ohio was heavily forested prior to European settlement, after which land use was converted predominately to agriculture. Suburban and urban land uses have come to dominate the southern portion of the watershed over the last fifty years.

Alum Creek's headwater elevation in Morrow County is 1120 feet above mean sea level, and drops on average 7.4 feet per mile to an elevation of 715 feet at its mouth. The gradient, however, is less steep in the southern half of the watershed. Stream bed elevation at the outlet of Alum Creek Lake Reservoir is 822 feet, and falls an average of only 4 feet per mile between the reservoir and its mouth (ODNR, 2001).

In addition to major land use changes, the watershed has been significantly altered by the creation of the 10 ½ mile long Alum Creek Lake reservoir in 1974. Built in south-central Delaware County, it covers 3,387 acres and effectively divides the watershed into two distinct segments: the upper watershed (north of the reservoir dam) remains largely agricultural, while the majority of the lower watershed is now urban and suburban. This difference in land use also results in the presence of different sets of water quality issues in the two segments.

This document focuses on the **Lower Alum Creek Watershed**, which includes 27 miles of Alum Creek from the reservoir dam in southern Delaware County south to the creek's mouth in southeastern Franklin County. In addition to two counties, it flows through three cities (Westerville, Columbus, and Bexley), seven townships (Orange and Genoa in Delaware County, and Sharon, Blendon, Clinton, Mifflin, and Madison in Franklin County), and one village (Minerva Park).

B. GEOLOGY

Glacial and Bedrock Geology

The lower Alum Creek watershed lies generally within the Glacial Till Plain ecoregion. The entire area was covered by glaciers at least twice in the most recent Wisconsinian glacial era and at least once in the next most recent Illinoian era. The ice-related movement and deposition of materials has notably affected current landforms and soils.

The nature of the underlying bedrock plays a role in the expression of landforms in the surface geology. In the Alum Creek watershed, the Ohio Shale formation, a silt/clay related formation of Upper Devonian age, comprises the upper most layers of bedrock. (This bedrock is, however, buried under glacial till which averages 50 feet thick). This shale provided the most local source of material carried and eroded by the glaciers. It is composed of (and weathers readily back into) clay and silt, which is a major component of local soils. It is probably not mere coincidence that the sedimentary shale beds, which are inclined dipping gradually to the east, have north-south orientated layers which strike near the surface and run parallel to the basic path of Alum Creek (Figure 3). Bedrock outcroppings have been noted in a few places along Alum Creek, such as north of Morse Road.

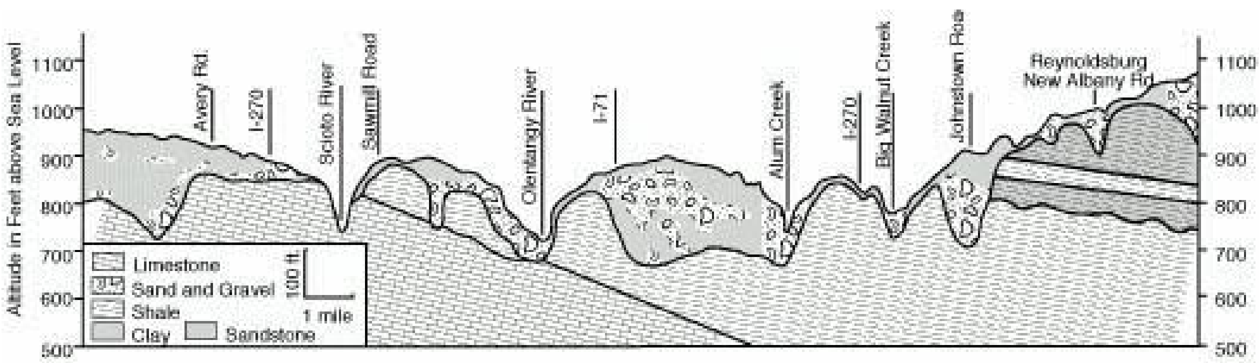


Figure 3: Generalized cross section of Franklin County, Ohio (adapted from Ground-Water Resources of Franklin County map, J. J. Schmidt, 1993, ODNR Division of Water; illustration prepared by R. Roberts).

Melt waters from the final glacial period about 16,000 years ago carried sediment from the glaciers as they receded, through the local waterways including the Alum Creek and its tributaries. The surface deposits of till, or a mixture of glacial sediments that dropped out of the melting ice, have generally lower permeabilities in this area. Much of the glacially-derived material is probably from relatively local origins, but some of it was carried from as far as Canada. It is not uncommon to find rounded granite boulders carried here from that distance by the glacial activity.

Creek bottom substrates are silty in the slower-moving areas, while larger cobbles and gravel bars are present in areas with faster stream flow. The amount or “load” of sediment that is carried by creek waters has doubtlessly increased as a result of erosion related to land clearing activities and urbanization in the past 100-plus years. The diminishment of peak flows and flood events on the river below the reservoir dam has tempered the river's natural ability to move and sort its sediment, and remove its increased silt burden.

Soils in the Alum Creek watershed are generally compact and rich in clay and silt, having formed directly on top of glacial till. Due to the thick layer of till in most locations of the watershed, direct weathering of bedrock to form soils at the surface has not played a major role.

The Ecoregional Context

The United States Geological Survey defines ecoregions as "areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources; they are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components." The Alum Creek watershed and west-central Ohio are within the Eastern Corn Belt Plains ecoregion, as defined in a national (Level III) context. More specifically (Level IV), the watershed is in the Loamy, High Lime Till Plains ecoregion (USGS, 1998).

This region "contains soils that developed from loamy, limy, glacial deposits of Wisconsinian age; these soils typically have better natural drainage" than those in the Clayey, High Lime Till Plain region that lies to the north of the Alum Creek Reservoir. The soils also "have more natural fertility" than the Pre-Wisconsinian Drift Plains to the southwest in Ohio. The ecoregion where the Alum Creek watershed is located features a broad and nearly-level-terrain of "loamy, calcareous till [soils] which originally were forested with beech forests, oak-sugar maple forests, and elm-ash swamp forests on poorly-drained valley bottoms" until the past 200 years of intensive human activity. Outside of urbanized areas, the land in the ecoregion supports corn, soybean and livestock farming.

Watershed Soils

Soils play an important role in sustaining the vegetation and ecological life in any watershed. They develop over long periods of time and consist of water, air, minerals, and organic matter; approximately 50 % of soil volume is pore space. Soil quality is a measure of the ability of soils to cycle nutrients, hold water, filter excess nutrients and pollutants from surface water, and support a diversity of plants, animals, and microbes both above and below the surface.

The urbanization that dominates the lower Alum Creek watershed has no doubt impacted soil quality. Two key impacts that often occur during construction are erosion of top soil and compaction. Both can negatively impact water quality, as they reduce the water holding capacity and permeability of the soil: organic matter is lost during erosion and compacted soils are less porous. Therefore, eroded, compacted soils cannot absorb and filter runoff effectively. Root growth of plants may also be impeded in highly compacted soils (Randall, 2004). See Appendix 5 for a list of k-values (or sheet and rill erosion susceptibility) for soil types found in the lower Alum Creek watershed.

The general characteristics of soils within the Alum Creek watershed have been described by USDA soil surveys (McLoda & Parkinson, 1976; U.S. Department of Agriculture, 2004). In general, the upland soils in the watershed were formed in glacial till. The glacial till soils are slowly permeable and contain a perched water table that presents limitations when these soils are converted from agricultural to urban land use. Along the main stem of the river, soils are characteristic of alluvial (river-related) sediment deposits. These better drained, loamy alluvial soils are commonly flooded, making them poorly suited for development.

The alluvial soils found along the river are named *Medway, Genessee,* and *Sloan*. They have moderately good permeability to groundwater flow and seepage (measured as 0.2-2.0 inches per hour), and a high available water capacity. *Medway* is an occasionally-flooded silt loam, underlain at depth by gravelly silt loam. *Genessee* is an occasionally-flooded silt loam, nearly level, underlain by silty/clay/gravelly loams. It is well-suited to trees and other wildlife habitat vegetation. *Sloan* is a frequently flooded, nearly level, deep and very poorly drained silt loam found near the water's edge. Of all the land in the watershed, these areas are probably most critical to preserve in a natural state (along with wetland soils).

The predominant soils found in upland areas in most of the main watershed are *Bennington* and *Pewamo.* Both are usually considered to be naturally poorly-drained. *Pewamo* soils have somewhat slow permeability to shallow groundwater flow (0.2-0.6 inches of water per hour) and *Bennington* has slow permeability (0.06-0.2 inches of water per hour). Wetlands are often found among these two soil types, although they may not show standing water throughout the year. *Bennington* is a yellowish-brown, mottled, firm silty clay loam underlain by firm clay loam glacial till. Urban land areas with this soil have often been artificially filled in, and require artificial drainage by sewer systems, gutters and subsurface drains. *Bennington* is known for having a seasonal perched high water table in winter, spring and other extended wet periods. Increased runoff and erosion are known problems associated with construction on this soil type. The *Pewamo* soils are usually nearly level, deep, very poorly drained silty clay loam, found along the upland drainage areas. The subsurface soil is mottled, dark gray, firm silty clay and very firm clay, underlain by very firm clay loam and firm loam (glacial till). The soil holds a lot of water but drains slowly.

Along the western edge of Alum Creek, from approximately I-70 south to the Big Walnut Creek confluence, is an area featuring *Crosby, Kokomo* and *Celina* soils. These soils have moderately slow permeability to shallow groundwater flow (0.2-0.6 inches of water per hour). *Crosby* soils are considered deep but somewhat poorly-drained, found on nearly level broad upland areas between natural drainage ways. They feature silt loam underlain by silty clay loam and yellowish-brown and brown, mottled, firm clay loam and loam (glacial till). *Celina* soils are deep, moderately well-drained, gently sloping on broad uplands (usually now between artificial drainage-ways). The urban land development on this soil typically has involved more excavating than filling activities. Normally, this soil features a silt loam underlain by clay loam and firm glacial till loam. *Kokomo* soils are often wet, found in depressions and along headwater streams. It has a high available water capacity and high organic content. *Kokomo* is described as gray silty clay loam underlain by dark gray, mottled, firm silty clay, silty clay loam, and clay loam (glacial till).

Cardington, Alexandria, and *Bennington* soils are found in a small part of the very northern area of the lower watershed near the Alum Creek reservoir, an area that features more varied, rolling topography. These soils have moderately slow permeability to shallow groundwater flow (0.2-0.6 inches of water per hour). *Cardington* soils are found on slopes ranging from two to 12 percent grade. They feature a silty clay loam underlain by glacial till of brown, mottled, very firm clay loam. *Cardington* soils are deep, moderately well-drained, and found on "convex ridgetops and side slopes and on long, narrow areas along well-defined waterways and hillsides". The available water capacity in this soil is moderate; a seasonal perched high water table is found between depths of 24 and 36 inches in wintertime. *Alexandria* soils are deep, well-drained silt loams, underlain by calcareous brown, firm clay loam and loam (glacial till). *Bennington* soils (as already described above), are poorly-drained silty clay loams underlain by firm clay loam (glacial till).

C. BIOLOGY

Biologically, Alum Creek supports a very diverse community. Not only does it contain many native species of fish, insects, and mollusks (Hoggarth *et al*. 1997, 1999), but it also supports species of birds, mammals, and other wild animals within its streamside forests (Gottschang 1981, Peterjohn and Rice 1991). Still, Alum Creek, just like all ecosystems, continually reconstructs and changes its physical, chemical and biological makeup. More than any other reason, this is why it is important to understand what the conditions of the stream are today - to help predict what it will look like in the future and to provide baseline data to show how it has changed. Comparing historic data collected on Alum Creek with current conditions suggests that some areas that have been heavily impacted by surrounding urban landscapes have lost biodiversity and can support only a limited biological community.

To the extent of the knowledge of the writers of this report, only one state-endangered species has been identified in the watershed - the pale umbrella sedge (*Cyprus acuminatus*). The plant emerged in the College Knolls wetland in Westerville, south of County Line Road and east of Juniper Avenue, after the wetland was restored in 1995 (Dilley, 2004). The wetland lies at the headwaters of Spring Run, a tributary to Alum Creek.

The bald eagle (*Haliaeetus leucocephalus*) is a state-threatened species that was spotted flying over Alum Creek in Bexley in 2003. Bald eagles are known to have nesting sites in the Alum Creek Lake Park (around the Alum Creek Lake reservoir in Delaware County) and other large natural areas in Central Ohio.

Please see the section below for more information on notable mussel species occurring in the Alum Creek watershed.

Aquatic Biology

Animals and plants that live in streams can tell us a great deal about the quality and diversity of the habitats they have available to them, and the quality of the water that forms the medium in which they live, breed, feed, and breathe. Karr (1981) was one of the first to demonstrate that fish could be used to determine the relative integrity of flowing water habitats. Protecting biological integrity, or the relative health of an ecosystem and its ability to respond to perturbation, is one of the objectives of the Clean Water Act. It is important to realize that human health and standards of living are also ultimately dependent on natural ecosystems.

The majority of aquatic life data available for Alum Creek has been collected by the Ohio Environmental Protection Agency, and also by Dr. Michael Hoggarth, in the Department of Life and Earth Sciences at Otterbein College in Westerville, Ohio. The Ohio EPA has conducted limited studies of Alum Creek in 1974 –1976, 1986, 1996 (published in 1999), and 1999-2000 (published in 2003). Dr. Hoggarth has conducted studies in every year between 1997 and 2002 inclusive, generally in the northern reaches of the lower Alum Creek watershed. Both sources of data are drawn upon in this section to describe aquatic life in Alum Creek.

Macroinvertebrates

Nine phyla of invertebrates have been collected from Alum Creek (OEPA 1999, Hoggarth *et al*. 1997, 1999, Hoggarth 2000a, 2000b, 2001, 2002). The diversity of this fauna is shown in Appendix 6. The phyla included Porifera (sponges), Cnidaria (jellyfish and hydra), Platyhelminthes (flatworms), Nernetea (ribbon worms), Ectoprocta (also known as Bryozoa, moss animals), Endoprocta (entoprocts), Annelida (segmented worms and leeches), Arthropoda (isopods, amphipods, crayfish, and insects), and Mollusca (snails and clams – the family Unionidae - is treated below). The biology of four of these groups is fairly well understood and discussed below. Those four groups are leeches, crayfish, insects and mollusks.

Three species of crayfish have been collected from Alum Creek (Hoggarth *et al*. 1977, 1999, OEPA 1999). *Orconectes rusticus* (rusty crayfish) are widely distributed in the state and are aggressive. They are known to out compete and displace other crayfish when introduced into new streams. It is so widely distributed in the state and so aggressive, that it is difficult to delineate its original range in Ohio (Thoma and Jezerinac, 2000). *Orconectes rusticus* can survive in nutrient rich or poor environments as long as *Cladophora* species are present and there is other abundant food. In fact, the rusty crayfish is thought to prosper in regions where environmental disturbances have caused nutrient levels to rise.

Orconectes sanbornii (Sanborn's crayfish) is a less aggressive crayfish and on its western boundary in Alum Creek. It is usually less numerous than its conspecific. The other crayfish found in the creek, *Cambarus sciotensis* (Scioto crayfish) is more locally distributed and docile. It is usually found under the largest boulders in the fastest riffles during the daytime.

Four species of leeches have been collected from Alum Creek. Leeches demonstrate a fairly diverse life style (not all are parasitic), and are good indicators of water quality. Some species may be quite abundant in water polluted by organic wastes while others are eliminated by pollution either because their hosts are eliminated (the parasitic species) or other environmental conditions become adverse. The four species found in Alum Creek include both parasitic (*Helobdella* sp. and *Placobdella* sp.) and free living animals (*Erpobdella* sp. and *Mooreobdella* sp.).

Insects are by far the most diverse community found in Alum Creek. Eleven orders of insects have been collected from the creek (OEPA 1999, Hoggarth *et al*. 1997, 1999, Hoggarth 2000a, 2000b, 2001). This fauna includes 24 species of mayflies, 5 species of damselflies, 11 species of dragonflies, 3 species of stoneflies, 8 species of true bugs, 18 species of caddisflies, one species of moth, 3 species of hellgrammites, one species of spongillafly, 20 species of beetles, and 78 species of true flies (most of which are midge larvae – family Chironomidae). The large number of midge larvae collected from the creek is due to the sampling methods employed by OEPA (1987a).

Mollusks (other than unionids, which are described below) are another important part of the Alum Creek fauna. Seven families representing both gastropods (four families) and bivalves (three families plus the family Unionidae) have been found in the creek. The gastropods include both pulmonate (lung breathing) and prosobranch (gill breathing) species, all of which are native to the creek. The bivalves include both native (fingernail clams) and introduced species (Asiatic clam and zebra mussel). By far the most abundant mollusks in Alum Creek today are the introduced bivalves. Both are abundant in the creek below the reservoir dam to the mouth of the creek.

Mussels

Hoggarth (Hoggarth *et al*., 1997, Hoggarth, 2000a, 2000b, 2001) has collected 17 species of freshwater mussels from Alum Creek. All of these specimens were collected from Alum Creek Lake reservoir downstream. Included in this total are two Ohio Endangered Species, *Epioblasma triquetra* (snuffbox) and *Villosa fabalis* (rayed bean). Neither of these two species was collected alive, and both may be extirpated from the creek today. In addition to these two rare Ohio species, the U.S. Fish and Wildlife Service lists Alum Creek as former habitat for *Pleurobema clava* (clubshell) and *Epioblasma troulosa rangiana* (northern riffleshell). Neither of these species is thought to be extant in the creek now (USFWS, 1993).

Another unionid of interest collected from Alum Creek was *Obovaria subrotunda* (round hickorynut). This species is of interest not because it is rare, although it does appear to be in decline in the state, but because there is such a large population of this species in the creek. Thirty-one specimens of this species were taken, mostly from the creek near Polaris Parkway, which made it the most abundant mussel in the creek found during the 1997 study (Hoggarth *et al*. 1997). Other mussels of interest were *Lasmigona compressa* (creek heelsplitter) and *Pleurobema sintoxia* (round pigtoe) (Hoggarth *et al*., 1997). The Ohio Department of Natural Resources Division of Wildlife flagged these species as special interest species due to the recent decline in their population size and distribution. If these unionids should be extirpated, the habitat of neighboring species may also be impacted. The water quality of Alum Creek must have been suitable for mussel habitation based on previous studies.

Appendix 7 shows the unionid species collected by Hoggarth (Hoggarth *et al*., 1997, Hoggarth 2000a, 2000b, 2001). Overall, there were fewer species of unionids collected in 2000/2001 than in 1997. The differences probably represent the different areas where these collections were made. The 1997 collections were made from the reach from Alum Creek Lake reservoir dam in Delaware County to Alum Creek Park in Westerville. This reach of the creek has the highest habitat and biological life scores and supports the best population of mussels anywhere in the stream (OEPA, 1999). The 2000-2001 studies were of the stream downstream of Westerville. This reach has suffered numerous anthropogenic changes that are reflected in its fauna.

Fish

Fish are an important part of any aquatic ecosystem, and can be used to help determine overall ecosystem health. The Index of Biotic Integrity (IBI) takes several parameters into consideration, including pollution tolerant and pollution intolerant fish species, diversity of fish species, total number of fish found in a given area, what the fish eat, how they reproduce, and the condition that the specimens are in at the time of collection.

In their 1999 study, Ohio EPA took fish data at 15 sites on the Alum Creek, both below and above the Alum Creek Lake reservoir. Numerically, the most predominant species were: central stoneroller (17.2%), sand shiner (8.0%), green sunfish (6.8%), greenside darter (6.7%), and both longear and bluegill sunfish (5.8%). In terms of biomass, dominant species were: common carp (59.3%) golden redhorse (5.3%), river carpsucker (4.8%), white sucker (3.0%), and northern hog sucker (2.6%). This distribution represents the entire Alum Creek, as opposed to the lower Alum Creek watershed on which this document focuses. The upper reaches have been shown to be of better biological quality than the lower Alum Creek, and therefore may not accurately represent fish distribution in the lower Alum Creek as well.

Dr. Hoggarth conducted a fish study with his Otterbein College ecology class in the fall of 2002 (Hoggarth *et al.,* 2002). This study, which was conducted in the Westerville area, found 37 species of fish (Appendix 8). By far the most abundant species of fish is the bluntnose minnow (*Pimphales notatus*). The bluntnose minnow is a pollution tolerant species of fish and is probably the most common fish found in Ohio. The bluntnose minnow can be found in all of Ohio's waters except the deepest parts of Lake Erie and the Ohio River (Trautman, 1981). Several species of sunfish were also found, the most abundant being the bluegill (*Lepomis macrochirus*). Another species of fish found in large numbers was the spotfin shiner (*Cyprinella spilopterus*). The spotfin shiner is a widely distributed species, tolerant to a variety of habitats. It is generally the most numerous shiner where conditions are turbid, or there is considerable siltation or domestic and industrial pollutants present (Trautman, 1981).

There were also species of pollution intolerant fish found in Alum Creek. One such species is the rainbow darter (*Etheostoma caeruleum*). The rainbow darter can be found in riffle areas where there are gravel and sand bottoms. The rainbow darter is less tolerant to pollutants than other species of darter such as the johnny darter (*Etheostoma nigrum*), which were also found in Alum Creek, but more tolerant to pollution than the variegate darter (*Etheostoma variatum*), and the bluebreast darter (*Etheostoma camurum*), which were not found in Alum Creek. Another pollution intolerant species found was the black redhorse sucker (*Moxostoma duquesni*). Only one specimen was retrieved from Alum Creek. The black redhorse is less tolerant to pollution and siltation than other species of suckers found in Alum Creek including the golden redhorse sucker (*Moxostoma erythrurum*). However the northern hogsucker (*Hypentilium nigricans*) was found in greater numbers and is also intolerant to pollution and siltation.

Some species of fish that are new to Alum Creek or have been recently introduced include the saugeye (*Stizostedion canadense x vitreum*), and the Ohio muskellunge (*Esox masquinongy ohioensis*). These fish were most likely stocked into the area above the impoundment and were somehow washed downstream and are not naturally occurring species in Alum Creek. Other more common introduced species into Alum Creek include the common carp (*Cprinus carpio*), which is a species native to parts of Asia and was first introduced into Ohio in 1879 (Trautman, 1981).

In general, Hoggarth found that Alum Creek has a wide variety of fish present in its waters. This is most likely due to the abundance of different sub-habitats that are present in Alum Creek. Many of the fish collected are very specific to certain habitats, including the northern hogsucker, which is found in riffle habitat, and the rock bass (*Ambloplites rupestris*), which lives primarily in undercut bank and riprap structure habitats.

In past studies, 79 species of fish as well as 3 hybrid species have been found to occur in Alum Creek (Appendix 9), although most were not recorded in every study. Alum Creek species data were recorded by Williamson and Osburn in a study conducted in 1898. More recent studies were done by the Ohio EPA, and other data were collected by Troutman. Only a small number of fish species were recorded in all 4 collections, including common species such as the bluntnose minnow (*Pimphales notatus*), and the common carp (*Cyprinus carpio*).

Some additional species that have not been found historically in Alum Creek were collected in Hoggarth's study. One such species was the saugeye (*Stizostedion vitreum x canadense*). Several species of fish that should be present in Alum Creek that were not found by Hoggarth *et al*. (1997, 1999) were the least brook lamprey (*Lampetra aepyptera*), the paddlefish (*Polydon spathula*), and the variegate darter (*Etheostoma variatum*). Other species found in Alum Creek that were found by the Ohio EPA and not found in other studies were the longnose gar (*Lepisosteus osseus*), a hybrid carp/goldfish (*Cyprinus x Carassius*), and the freshwater drum (*Aplodinotus grunniens*). In the study done in 1896, many of the species that occur in Alum Creek were not recorded and some have since been extirpated or were simply misidentified. One such species that no longer occurs in Alum Creek is the river shiner (*Notropis blennius*).

Terrestrial Biology

Amphibians, Reptiles, and Mammals

Although studies specific to the Alum Creek watershed have not be conducted, there are many different species of reptiles, amphibians, and mammals that inhabit central Ohio (Appendix 10 and 11). Each species has a desired type of habitat in which it can be located. Reptiles occupy a variety of habitats, from small stony creeks with lots of crayfish, preferred by the Queen Snake (Regina septemvittata), to shallow, clear water of rivers or ponds, which is desired by Sternotherus odoratus, the Common Musk Turtle (Conant, 1938).

Amphibians are very common and are also excellent bio-indicators. They have permeable skin through which environmental contaminants can be absorbed, and since most live in both water and on land, they are more likely to be exposed to the degeneration of both aquatic and terrestrial habitats. There are 15 species of frogs and toads in Ohio and most are common statewide. Most of the species prefer moist areas near permanent or temporary bodies of water. For example, the Pickeral Frog (Rana palustris) can be found in cool, clean unpolluted sources of water (Davis & Menze, 2002). The Blanchard's Cricket Frog (Acris crepitans blanchardi) desires a habitat where algae and vegetation are emergent. Salamanders are also common, but more difficult to find. The Red-backed Salamander (Plethodon cinereus) has a wide range of ecological tolerance, but most salamanders occupy flat bottomland or slopes of ravines with glaciated till soil. The Giant Salamanders inhabit areas of 1 to 2 feet deep water with a swift running current and live under sunken boards or logs. Mudpuppies (Necturus maculosus) on the other hand, desire habitats with silt-free riffles or available shorelines.

There are a variety of mammals found in Ohio and around Alum Creek. Shrews, for example, can be found in moist areas that have enough forage. The Masked Shrew (Sorex cinereus) specifically desires hemlock-beech-maple woods with thick leaf mulch covering the ground (Gottschang, 1981). The Eastern Mole (Scalopus aquaticus) is found in the glaciated regions of Ohio in areas with uncompacted soil. Most of the bat species prefer hardwood forests. Squirrels, mice, fox, white-tailed deer, and rabbits have a wide range of habitats, but commonly are found in forested areas. The Southern Flying Squirrel (Glaucomys volans) can be found in mature beech-maple forests and the Eastern Chipmunk (Tamias striatus) inhabits deciduous woods.

Vegetation

Upland forests dominate the natural vegetation of the Alum Creek watershed. Within upland forests, mixed floodplain forests dominate. A mixed floodplain forest is described as having a variety of species that require a wet to moderately moist habitat (Anderson, 1982). Over eighteen different species of trees have been found in and around Alum Creek. Fourteen of these trees are characteristic to a mixed floodplain forest community. These species are *Celtis occidentalis, Ulma americana, Platanus occidentalis, Acer negundo, Acer rubrum, Acer saccharinum, Aesculus glabra, Aesculus octandra, Fraxinus americana, Juglans nigra, Quercus alba, Prunus serotina, Acer saccharum,* and *Tilia americana* (Anderson, 1982). Some other species found near Alum Creek are *Populus deltoids* and *Salix nigra* (Hoggarth *et al.,* 1997, 1999). These types are found in the more open forest area.

The vegetation of the Alum Creek watershed floodplains is drier than most floodplain forests because Alum Creek faces more drought conditions as opposed to high amounts of flooding. Alum Creek's floodplain forest is affected by development, which prevents the creek's access to floodplains, and the Alum Creek Lake reservoir dam, which lowers the frequency of large scale floods. Drying out this area will cause a loss of characteristic wetland vegetation that is found around Alum Creek. Some of these wetland plants are *Acorus calamus, Lonicera tatarica,* and *Equisetum* spp. (Hoggarth *et al.,* 1999).

Invasive species

Invasive species are plants or animals that have been introduced into a particular area from other states or countries. Many of them do not stray far from where they were introduced, but some are "invasive," meaning that they spread quickly and can displace native species in natural areas. Non-native plants have been introduced for a variety of reasons, such as for food, erosion control, landscaping, medicinal use, or simply by accident.

Comprehensive research regarding invasive species and their potential impacts in the Alum Creek watershed has not been conducted. However, the following invasive terrestrial species have been observed in or near the Alum Creek riparian corridor through Columbus (Grody, 2004):

Multiflora Rose (*Rosa multiflora*)	Wintercreeper Vine (*Euonymous fortunei*)
Burning Bush (*Euonymous alatus*)	Privets (*Ligustrum sp.*)
Japanese Barberry (*Berberis thunbergii*)	Japanese Knotweed (*Polygonum cuspidatum*)
Asiatic Bittersweet (*Celastrus orbiculatus*)	Glossy Buckthorn (*Rhamnus cathartica*)

Common Buckthorn (*Rhamnus fragula*) Autumn Olive (*Elaeagnus umbellata*)
Tree of Heaven (*Ailanthus altissima*)

Phragmites (*Phragmites australis*) and Purple Loosestrife (*Lythrum salicaria*) are two species that have not yet found in the watershed yet but are nearby. Four additional common invasive species found in the Alum Creek watershed are described in greater detail below:

Garlic mustard is a biennial herb that can grow up 4 feet tall (although often it's found much smaller) and produces small white clusters of flowers in early to mid spring. It prefers some shade and can be found in woodlands.

Honey suckle is an upright shrub that grows 6-15 feet in height and has dark, green, egg-shaped leaves. The plant produces berries that are eaten and dispersed by birds. Honey suckle is very common in the Alum Creek riparian corridor, especially in areas where the corridor is narrow and borders developed areas.

Common carp are physically destructive and disruptive when they tear up or dislodge aquatic vegetation or increase turbidity through keeping sediments stirred up. The latter can reduce the photic zone, potentially resulting in reduced photosynthesis and, hence, lower oxygen levels in the water column. The turbidity can also affect other fish species by reducing their ability to locate prey.

The *zebra mussel* was likely introduced to Alum Creek through boats at the Alum Creek Lake reservoir in Delaware County. Zebra mussels compete for many of the same resources (such as physical space and food items) as the native mussels and other invertebrates, and therefore may reduce these native species and even the fish that rely on these invertebrates for food.

D. HYDROLOGY

Climate

Central Ohio is located in the U.S. Department of Agriculture climate zone “5b,” which is considered temperate. Local weather has been described as “cold in the winter” and “uncomfortably warm” in the summer (McLoda & Parkinson, 1976). Although this statement may reflect personal preference, most residents can probably agree that regional weather, and precipitation, can often be quite erratic. The irregularity that largely governs regional weather patterns has also governed the evolution of local streams and rivers.

Hydrologic Cycle

Central Ohio receives 38 inches of annual precipitation. January, February, and October are the driest months, while July is the wettest (Figure 4). Monthly average precipitation is 3.2 inches. (House et al., 1994). Rainfall is of course only a part of a larger hydrologic cycle, or the complex network of continuously circulating water between the atmosphere and the earth, depicted in Figure 5.

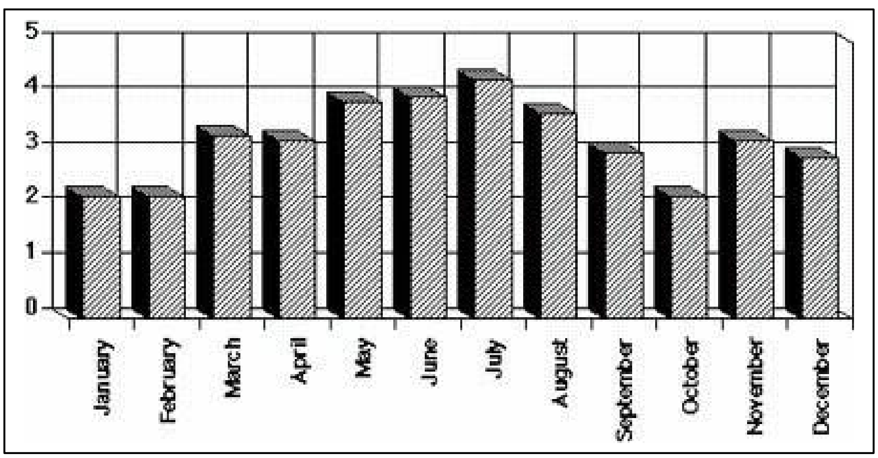


Figure 4: Average monthly precipitation (in inches) in Franklin County, Ohio (1961-1990). Source: OSU Extension FACT sheet AEX 480.25

The hydrology of this part of central Ohio has been altered due to the conversion of forest cover to urban and suburban land uses. But under natural forested conditions, the 38 inches of precipitation that falls in this region annually follows a variety of paths: about a quarter (10 inches) becomes run-off, which moves immediately to surface-water bodies like streams or lakes. Two inches evaporate relatively quickly from soils after a precipitation event. That leaves 26 inches to infiltrate into the soil’s surface. Plants help return the majority to the atmosphere by drawing water upwards through their roots to leaf surfaces (evaporation / transpiration). The remaining 6 inches enters groundwater (House et al., 1994).

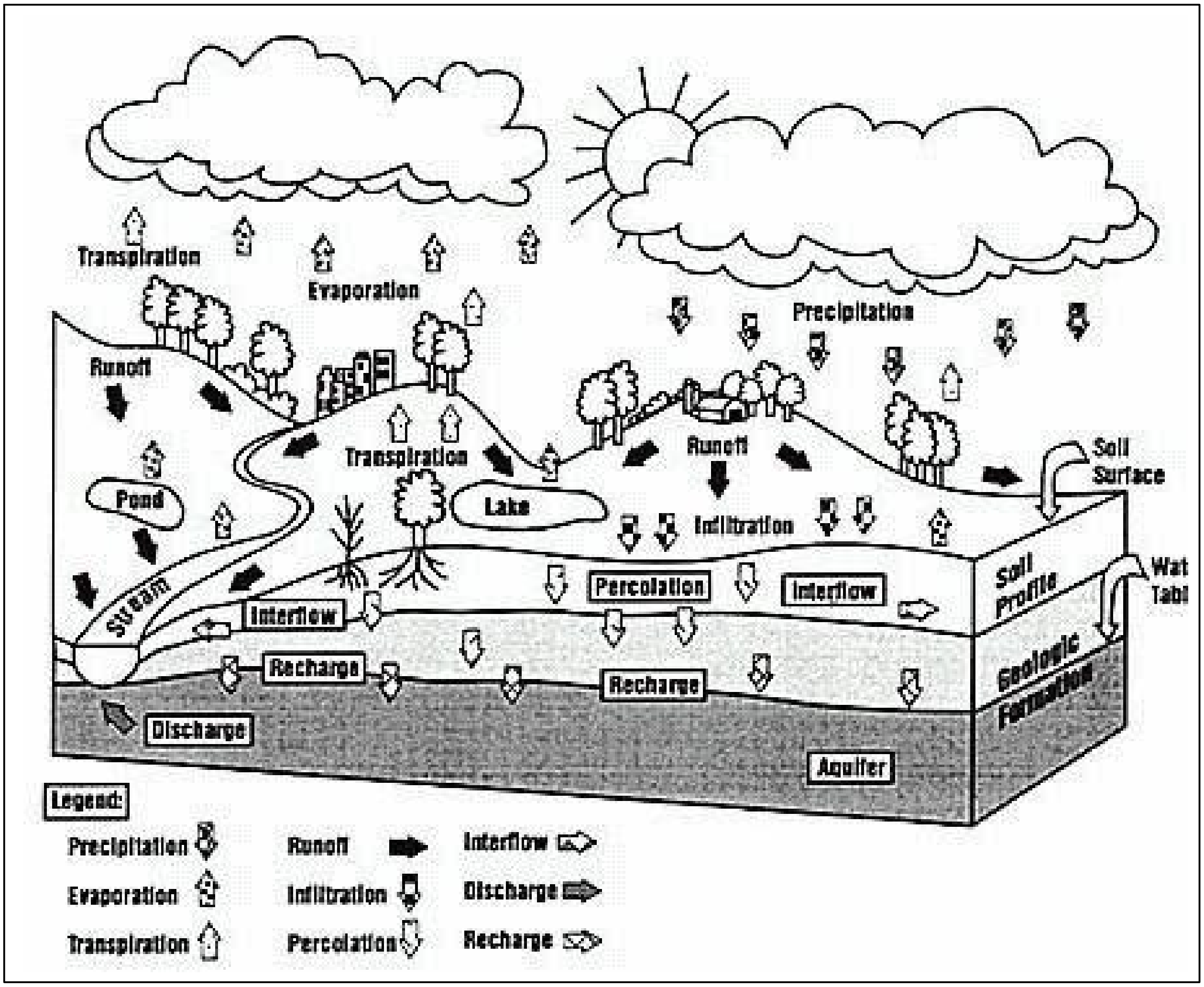


Figure 5: The Hydrologic Cycle (Brown, 1990).

This abundance of rain has brought the region a corresponding abundance of streams, and has no doubt helped fuel historical development trends in the area. The major drainage basin of the region is the Scioto River, which flows east out of Hardin County, then south through Delaware County and Columbus and continues south to the Ohio River. Major tributaries in central Ohio include the Olentangy River, Big Walnut Creek, and Big Darby Creek. Alum Creek is a sub-basin of the Big Walnut Creek, which Alum Creek flows into at Three Creeks Park in southeastern Franklin County (Figure 6). Within Franklin County, these river networks and their tributaries comprise 339 linear miles of waterways (House *et a*l., 1994).

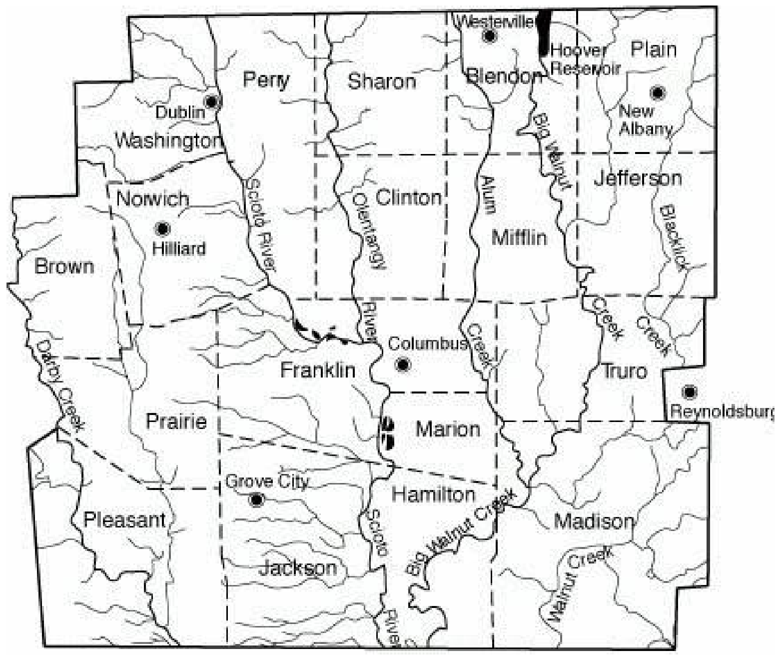


Figure 6: Franklin County surface water
(Source: OSU Extension FACT Sheet AEX-480.25)

Wetlands

Wetlands within the Alum Creek watershed have suffered the same fate as those across Ohio and our nation: many have been filled, drained, and converted to other uses, primarily agriculture. Ohio has lost over 90% of its wetlands since the time of European settlement (Dahl, 1990). This history has been written upon the Alum Creek landscape as much or perhaps more than other watersheds in the state, as this watershed encompasses some of the most developed land in Ohio. Wetlands surrounding Columbus that were originally destroyed or altered for agriculture were subsequently built over as urban and suburban development pressed outward. Many of the remaining wetlands have been (and continue to be) lost as the demand for land increases. Despite these intense pressures, many wetlands still exist within the Alum Creek watershed, and their importance to the creek and to society climbs rapidly as their cumulative acreage diminishes. For the myriad of functions and values associated with wetlands – flood control, water quality improvement, groundwater recharge, wildlife habitat, recreation, environmental education – these remaining Alum Creek wetlands should be protected and cherished.

A cursory review of the National Wetland Inventory (NWI) maps was made to generally characterize the wetland resource within the Alum Creek watershed (Dilley, 2004). The upper headwaters of Alum Creek (Mount Gilead USGS quadrangle, north of Alum Creek Lake Reservoir) are peppered with small forested and emergent (marsh) wetland systems, with one larger (2-3 acre) emergent system directly on a waterway near Mount Gilead. Proceeding south

(Marengo USGS quadrangle), the landscape continues to include a smattering of small (typically <1 to 3- acre) forested, scrub-shrub, and emergent wetlands, with a more densely spaced complex of wetlands west of Marengo in the vicinity of Bunker Run. This band of wetlands extends westward toward Ashley, near Turkey Run and the West Branch of Alum Creek. Several larger forested wetlands are identified within this complex which terminates northeast of Ashley on the western edge of Morrow County.

In Oxford Twp (Kilbourne USGS quadrangle), another large complex of forested and scrub-shrub wetlands is found west of the West Branch of Alum Creek, east-northeast of the town of Leonardsburg. A large riparian (floodplain) forested wetland system extends along Alum Creek, upstream and downstream of the West Branch confluence. Further south, adjacent to the Alum Creek Lake reservoir (Alum and Big Run), only scattered small wetlands are to be found; the better wetlands originally present were probably flooded out years ago with creation of the dam. Near the southern end of the reservoir (Galena USGS quadrangle), scattered forested, scrub-shrub, and emergent wetlands remain. Many historic wetland areas adjacent to the reservoir have been filled or dug out as ponds. Some of the remnant forested wetlands near the dam are known to provide breeding habitat for salamanders.

In the Westerville area, a large forested wetland system resides in the 100-year floodplain at the new Heritage Park. This particular wetland formed as the result of clay extraction from the clay-rich floodplain soils for brick-making in the late 1800's or early 1900's. The resulting depression has formed a high quality wetland with large sycamores and a stand of buttonbush (a wetland shrub). This area provides evidence of the potential for and value of restoration of certain wetland types within the Alum Creek watershed. Unfortunately, it takes decades for sites like these to mature and provide the functions and values exhibited by this system.

Two other unique (and symptomatic) wetlands in this community are the Mariner's Cove wetland (Figure 7) and Boyer Park wetland on the headwaters of Spring Run. The first is a valuable forested wetland and the latter, one of the few wetlands identified as an aquatic bed (having submersed or floating-leaved vegetation) on the NWI map (Northeast Columbus USGS quadrangle). Both areas are protected as preserves, but are now surrounded by development, limiting their functions. These are among the last of the wetlands on Spring Run.

Wetland area and diversity continues to decline downstream, with wetlands becoming even sparser inside the I-270 outerbelt. In this urbanized area, fewer forested wetlands remain and wetlands are generally confined to narrow fringes along creeks and tributaries. The exception is in Mifflin Township between McCutcheon Avenue and Agler Avenue, where a complex of forested, scrub-shrub and emergent wetlands still exists. Several emergent wetlands within this complex appear fairly large (up to 5 acres). Additional floodplain forested wetlands are shown on the NWI map adjacent to Alum Creek, west of the airport along Sunbury Road.

The south end of the watershed (Southeast Columbus USGS quadrangle) is almost devoid of wetlands north of Refugee Road. South of Refugee Road, however, there remains a complex of fairly large (3-5 acres) forested and emergent wetlands west of Alum Creek Drive. An additional complex that includes a narrow scrub-shrub wetland resides on either side of the creek. This area is approximately one mile north of the confluence at Three Creeks Park.

These wetlands constitute an important environmental amenity to the Alum Creek watershed, and every effort should be made to protect and expand this resource (through wetland restoration) to improve conditions for the creek and our local environment.

Figure 7: Mariner's Cove wetland in Westerville

Groundwater

Groundwater is "water that exists below the land surface and which fills the spaces between soils and sand grains or the cracks and crevices in rock. If the material is capable of yielding usable quantities of ground water to a well or spring, it is called an aquifer (OEPA, 2001: p1)." The upper most surface of an aquifer is known as a water table – lakes and streams occur where the water table is above the ground surface.

The amount of water that enters a stream as ground water discharge from underlying bedrock or glacial aquifers is known as the stream's baseflow. Streams may be either gaining streams that receive groundwater discharge, or losing streams that lose water through their bed to ground water infiltration. Whether a stream is gaining or losing is dependent on local climatic conditions and the porosity and permeability of the geologic material underlying the stream. Typically, gaining streams are characteristic of humid climates, whereas losing streams are predominately found in arid climates. In temperate Ohio, many streams alternate back and forth, depending upon seasonal variations in rainfall and other characteristics (FLOW, 2002).

The surface water in ponds and rivers is often connected through zones of saturated subsoils to local groundwater tables. The relative poor permeability (and poor drainage) of surface soils, especially in low lying areas in this watershed, may limit the contribution of groundwater to the dry season base flows in Alum Creek. Saturation in the upland areas may be present but it may not migrate rapidly enough to add much volume to the local tributary streams. The alluvial soils near the streams themselves remain permeable to water flow, and would continue to provide drainage even in times of severe drought (although the flow might go beneath the surface at times).

Simply observing a stream during summer drought conditions is one rough method of determining if ground water contributes to its overall flow. If a stream relies predominantly on surface run off from rain events to supply it with water, then extremely low flow rates should be observed during periods of absence of rain fall. These conditions were indeed observed in the Alum Creek prior to construction of the Alum Creek Lake Reservoir. Flow rates in the summer sometimes dropped below 1 cubic foot per second (cfs). This observation method would no longer work, however, in the Alum Creek, given that low flow rates are dominated by dam releases from the reservoir. Reservoir managers have set a minimum discharge rate of 5 cfs.

The Ohio Department of Natural Resources (DNR) has developed a Pollution Potential Index (ranging from 0 – 200) to rate the relative sensitivity of groundwater to local sources of contamination, based on factors such as the depth of water and geological features. The Franklin County portion of the lower Alum Creek watershed varies widely in its index rating. An area of highest pollution potential (180 – 199) exists in the southern end of the watershed in the vicinity of the Three Creeks Park. Further upstream, pollution potential ranges from 140 -179 along the creek and its floodplain. Pollution potential is lower in outlying areas of the watershed, with pockets in the 120 – 139 range or lower (Angle, 1995).

Surface Water

The amount of overland surface water flow in a watershed is typically measured as stream flow. Overland flow occurs when more precipitation falls than can be absorbed by the land. The excess precipitation drains off the surface into streams, and is measured as volume of water moving past a given point during a specific period of time. This is usually expressed in cubic feet per second (CFS) or millions of gallons per day (MGD). Stream flow in any given stream generally increases from its headwaters to its mouth, as the area of land that discharges to the stream also increases. Surface water runoff provides the bulk of flow for streams and rivers. As discussed above, ground water can also augment flow to a varying degree.

Stream flow in the lower Alum Creek watershed is highly affected by the presence of Alum Creek Lake, a 10 ½ mile long, 3,400 acre reservoir located in south-central Delaware County. It was completed in 1974, after a tremendous flood in 1959 spurred its creation. Dams in this region were often built to prevent major flood events by storing rainwater and slowly releasing it after periods of heavy rain have passed.

The reservoir is operated by the Army Corps of Engineers, who maintain specific pool levels for summer and winter to accommodate seasonal variations in precipitation. The winter pool level is kept lower in anticipation of spring rains and snow melt, while the optimal summer pool is kept higher to maintain drinking water supplies and opportunities for recreation. This typically results in a draw down, or release of water, in October and November, and a holding of water in late spring, although this is largely dependent on annual conditions. Often large rain events are passed through the dam, especially in late winter and early spring, in preparation for accommodating heavy spring rains.

The existence of this structure and its operation in accordance with flood control and water supply needs has dramatically altered Alum Creek stream flow compared with pre-dam flows, both within the current reservoir area and downstream of the reservoir. The ten mile reach of impounded stream behind the dam lacks basic river habitat features (such as runs, riffles, pools, and meanders) due to inundation and lack of flow, now more closely resembling lake habitat.

The quality of water as it exits the dam and again regains flow as Alum Creek is monitored to maintain temperature levels consistent with pre-dam temperature curves. A positive side effect of the reservoir in terms of water quality is its ability to trap sediment. As water enters the reservoir, upstream sediment contributions settle out due to the sharp decrease in flow. See the Physical Attributes Section of this document for more information on the effects of impoundment on aquatic life.

Alterations to flow rates downstream of the reservoir are shown in Figure 8 below. The USGS gathered flow data before and after dam construction at gages located at Africa Road just south of the dam, and in Columbus just south of Livingston Avenue. Although the pre and post-dam flows still follow the same general pattern, the post-dam hydrographs have been “smoothed out” to avoid both flood and drought events.

The most dramatic change is apparent in the Africa Road gage data, given that flow at this site is completely dominated by reservoir releases. The effect is less obvious at the Columbus gage site, due to the addition of at least 50 square miles of unregulated drainage. The regulation that the dam provides has kept flow rates from reaching the extremely high or low levels seen before the dam was constructed. Pre-dam flows of less than 1 CFS had been seen occasionally in the summer, but now summer flows now rarely drop below 10 CFS at the Africa Road gauge. The corps has also set a minimum dam discharge rate of 5 CFS.

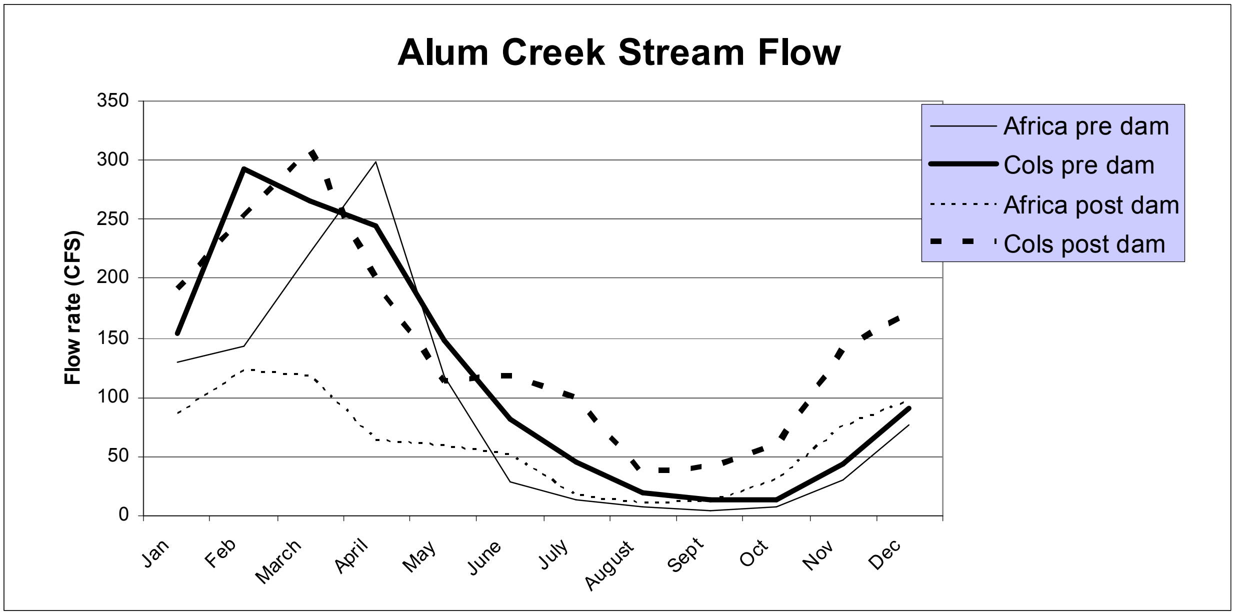


Figure 8: Alum Creek stream flow rates at two USGS gaging stations before and after the completion of the Alum Creek Lake Reservoir in 1974. The Africa gage flow data have been collected just south of the reservoir since 1963. The Columbus gage data were collected between 1924 and 1998 at Livingston Avenue. As of 1998, this location was altered to record only flood stage. Source: U.S. Geological Survey

Flood potential

A major impetus for the construction of the dam was the devastating flood of January 1959, when flow topped 26,400 cfs. Damages were estimated (in current dollar value) at $37 million, including about $17 million in the Alum Creek watershed (Sahr, 2002). Compared against average annual flow rates that have ranged from 39.1 cfs in 1934 (the “dust bowl” years) to 329 cfs in 1979, one can see that this flood was indeed monumental. Instantaneous peak flows associated with ten year storm events typically range near 6,000 – 8,000 cfs. Incredibly, the flow associated with this storm was only about half that which could be estimated for a realistic “worst case” event for a watershed of its size in Ohio (ODNR, 1963: p42).

The creation of the reservoir dam to prevent major flooding is possibly being counteracted by some of the effects of urbanization on streams, which actually increase flood potential. Natural vegetation and soils that act like sponges during storms have been replaced by impervious surfaces such as pavement and roof types. This transition reduces the absorptive capacity of the watershed and funnels larger volumes of water into stream after precipitation events. One reason for the severity of the January 1959 flood was that the ground was frozen and, like pavement, caused the rainfall to run off almost immediately. The floodplains that can typically store flood water have also been diminished by urban growth.

Based on a graphical interpretation of other severe flood events in Ohio, it is probable that a reasonable 50-year storm event could still cause peak flow rates in the lower watershed portion of the river on the order of 20,000+ cubic feet per second (ODNR, 1963: p42). Due to channel constraints and floodplain filling, the potential high water elevations during this type of flood event could conceivably equal or exceed those witnessed locally in 1959. Damage from such an event would be undoubtedly severe in cost.

Lowhead Dams

Beyond the reservoir, other impoundments within the watershed include five lowhead dams on the Alum Creek mainstem and numerous small dams on tributaries (Table 1, Figure 9). Lowhead dams are anywhere from 3 to 15 feet in height, and are usually low enough to allow flow over them or through a trough. The occurrence of lowhead dams is common in streams and rivers throughout the region. They were built for a variety of reasons, including flood control, sewer line crossings, or recreation and "aesthetics." The Nelson Park dam was one of many built in the area by the depression era Works Progress Administration (Jeffrey, 2003). Two dams were built for utilities, while others were built for recreation or unknown reasons.

Lowhead dams are unfortunately usually harmful to water quality and aquatic life, and sometimes to people. Like the larger reservoir dam upstream, lowhead dams eliminate riverine habit behind them by pooling water and creating lake-like conditions with minimal flow. See the Cultural Resources Section for more on how dams pose a danger to public safety, and the Physical Attributes Section for more on how dams affect stream ecology.

Figure 9: Lowhead dam across Alum Creek at Wolfe Park in Columbus, south of Broad Street

Location	Political Jurisdiction	Purpose	Date of Construction	Responsible Agency
Alum Creek Park South of Main St.	Westerville	Water Supply	1935	City of Westerville
Nelson Park South of Maryland Avenue	Columbus / Bexley (private lands)	Aesthetics and/or recreation. Constructed by the Works Progress Administration	Approximately 1940	Columbus Dept of Rec. & Parks, Malcolm D. Jeffrey, et al.
Wolfe Park North of Fair Ave.	Columbus	Aesthetics and/or recreation	Unknown	Columbus Dept. of Rec. & Parks
Wolfe Park Fair Avenue	Columbus	Sewer crossing 12" diameter	Unknown	Columbus Div. Of Sewerage & Drainage
Route 104 / Refugee Road	Unknown	Unknown	Unknown	Ohio Department of Transportation

Table 1: Lowhead dams occurring on Alum Creek (Source: City of Columbus and Franklin County Dam Inventory)

Tributaries

The flow rate in Alum Creek increases as it approaches its mouth due to the increasing area of land that it drains. A network of tributary systems conveys this flow to Alum Creek (Table 2). Many tributaries have been modified over time due to agricultural, suburban, or industrial land uses. For instance, streams flowing through farm fields were often straightened. Evidence of this kind of modification can be found along Bale Kenyon Road (in Delaware County) as streams cross the floodplain through agricultural fields before reaching Alum Creek.

Streams are often placed in pipes underground or lined with concrete when suburbs grew up around them, evident in the central, most heavily urbanized section of the watershed near Bexley. However, some tributaries in the watershed still exist in the natural form (Figure 10). Please see the Physical Attributes section to learn more about the status of Alum Creek watershed tributary streams.

Figure 10: A high quality tributary stream in Delaware County

Tributary Name	River Mile of Confluence with Alum Creek	Stream length (miles)	Water-shed size (square miles)	OEPA use designation	Municipality	Land mark or nearest downstream road crossing	Flows from East or West side of Alum Creek?
Unnamed	26.13	1.23	0.6	Undesignated	Orange Twp	I-71	West
Unnamed	25.95	3.92	1.6	Undesignated	Orange Twp	I-71	West
Unnamed	25.50	2.80	2.1	Undesignated	Orange / Genoa Twp	Worthington-Galena Road	East
Unnamed	25.08	3.01	0.7	Undesignated	Orange Twp	Worthington-Galena Road	West
Unnamed	24.35	1.25	0.4	Undesignated	Orange / Genoa Twp	Worthington-Galena Road	East
Unnamed	24.12	1.50	0.6	Undesignated	Orange Twp	Worthington-Galena Road	West
Unnamed / Indian Run*	23.47	3.80	3.2	Undesignated	Westerville / Genoa Twp	Polaris Parkway	East
Unnamed	23.34	1.29	0.4	Undesignated	Westerville	Cleveland Ave	East
Unnamed	22.97	2.42	1.0	Undesignated	Columbus / Westerville	Cleveland Ave	West
Unnamed	22.42	3.55	1.3	Undesignated	Westerville	Cleveland Ave	West
County Line Run	21.50	1.60	0.8	Undesignated	Westerville	Main Street	East
Alkire Run	Tributary to County Line Run	1.8	1.0	Undesignated	Westerville	Main Street	East
Noble Run*	20.34	6.11	3.9	Undesignated	Westerville / Columbus	Schrock Road	West
Meacham Run*	19.67	6.34	3.9	Undesignated	Columbus	I-270	West
Spring Run	17.22	7.20	7.8	WWH	Westerville / Blendon Twp / Genoa Twp	Route 161	East
Spring Run West	17.15	3.10	2.3	WWH	Columbus	Route 161	West
Kilbourne Run	16.34	2.64	1.7	WWH	Minerva Park/ Columbus	Morse Road	West
Unnamed	16.16	.057	0.2	Undesignated	Columbus	Morse Road	East
Unnamed	15.04	1.43	0.6	Undesignated	Columbus	Innis Road	West
Unnamed	14.52	1.84	1.3	Undesignated	Columbus	Innis Road	West
Unnamed	14.12	1.05	1.0	Undesignated	Columbus	Innis Road	West
Unnamed	13.58	0.79	0.6	Undesignated	Columbus	Innis Road	East
Unnamed	13.23	1.48	1.5	Undesignated	Columbus	Agler Road	West
Unnamed	12.12	0.78	1.1	Undesignated	Columbus	Mock Road	West
Unnamed	11.60	0.95	0.3	Undesignated	Columbus	Mock Road	West
Argyle Run*	9.74	2.4	2.5	Undesignated	Columbus	Airport Drive	West
American Ditch*	Unknown	2.6	0.7	Undesignated	Columbus	Maryland Avenue	West
Bliss Run	5.50	0.83	2.6	WWH	Columbus	I-70	East
Unnamed	3.66	1.16	0.7	Undesignated	Columbus	Watkins Road	East
Unnamed	1.48	1.23	0.6	Undesignated	Columbus	Williams Road	East

Table 2: Tributaries in the lower Alum Creek watershed. Asterisks (*) represent non-official names that are used by local community members or agency personnel.

Land Use

Data from 1994 ODNR satellite imaging show that urban land cover dominated the lower subwatershed at 44% (Table 3). Urban land cover is generally comprised of impervious surfaces such as roof tops and asphalt that can't absorb precipitation. Agriculture dominated the upper subwatershed land cover at 62%.

Land Cover Type	Upper subwatershed HUC # 05060001160010		Lower subwatershed HUC # 05060001160020	
	Square Miles	% of Area	Square Miles	% of Area
Urban / Impervious	2.8	11.5	23.3	44.4
Agriculture	15.1	61.7	16.5	31.5
Shrub / Scrub	0.2	0.6	0.6	1.1
Wooded	6.1	24.9	11.6	22.0
Open Water	0.1	0.5	0.1	0.2
Non forested wetlands	0.2	0.7	0.4	0.7
Barren	0.02	0.1	.03	0.1
Total	24.5		52.5	

Table 3: Land cover in the lower Alum Creek watershed. Source: 1994 ODNR satellite imaging

It's important to note that land use changes in the entire watershed have been dramatic since 1994, and impervious cover in both subwatersheds has increased. Landsat data from 2002 provided by the Delaware Soil & Water Conservation District show that the Delaware County portion of the upper subwatershed is now comprised of 29% urban/impervious land cover (Mather, 2004).

According to Ohio Department of Agriculture reports, the acreage of land in Delaware County in agricultural production dropped from 182,000 acres in 1990 to 175,000 acres in 2000, or 4%. Annual data show that 2003 acreage dropped to 167,000 acres, or an additional 5%, in just three years. The majority of this decline in acreage can likely be found in the southern portion of the county (Ohio Department of Agriculture, 2004).

Impervious Cover Impacts

As a watershed experiences growth in suburban and urban land uses, the existence of impervious, or hard, surfaces rises dramatically. The following excerpt from an OSU Extension Fact Sheet summarizes why increases in impervious cover can severely affect aquatic health (OSU Extension, 2001):

> Land development affects both the quantity and the quality of stormwater runoff, which in turn has impacts on watercourses. By enhancing and channeling surface drainage in favor of natural drainage systems, impervious surfaces like asphalt, concrete, and roofing increase the volume and velocity of the runoff, often resulting in flooding,

erosion, and permanent alterations in stream form and function. In addition, by blocking the infiltration of water and its associated pollutants into the soil, impervious surfaces interfere with the natural processing of nutrients, sediment, pathogens, and other contaminants, resulting in degradation of surface water quality.

Because of these impacts, a growing body of scientific research has found a direct relationship between the amount of impervious surface in a watershed and the water quality of the watershed's receiving stream (Figure 11). Many studies find that without nonpoint source management of some kind, stream water quality becomes increasingly degraded as impervious levels climb above 15%; in highly sensitive streams, degradation can begin when as little as 8% to 10% of the watershed area has impervious cover.

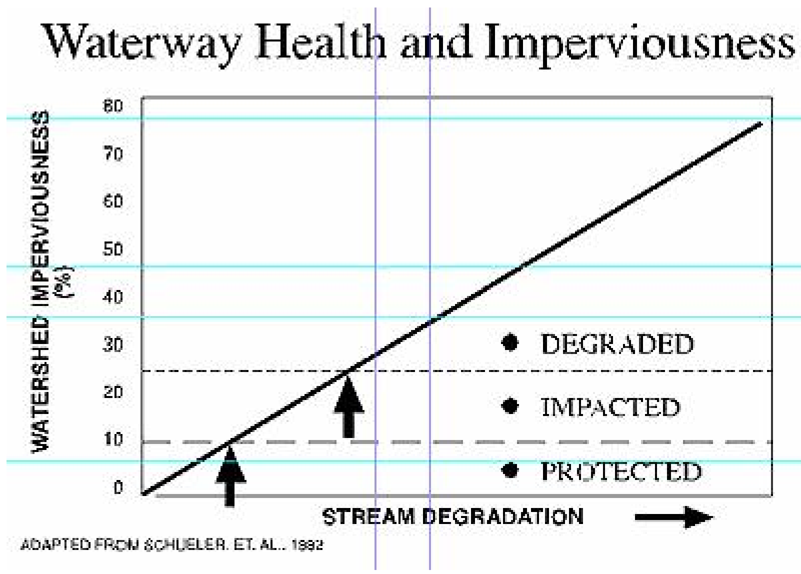


Figure 11: Waterway Health and Imperviousness. Source – Center for Watershed Protection

Protected Lands

A large portion of the Alum Creek corridor is in local municipal ownership and protected as parkland (see Watershed Map #6). Municipalities and the Metro Parks system have worked to preserve passive and active park space along Alum Creek, in part to establish a multi-use greenways trail. GIS analysis conducted by the Mid-Ohio Regional Planning Commission shows that over 50% of the riparian corridor (300 feet on both sides of creek) in Franklin County is currently protected as parkland or easement. Based on desk-top map analysis, this percentage is likely higher through Westerville, and lower through the Delaware County portion of the lower watershed. Less land along tributary streams is protected, although in Westerville two tributaries have at least partial protection – Alkire Run and the unnamed tributary south of Polaris Parkway.

Land Use History & Trends

Like much of central Ohio, Alum Creek watershed land cover was originally dominated by dense beech and oak sugar maple forests in upland areas, and by elm-ash forests in lowland areas. As the area became populated, first with native peoples and then Europeans, land adjacent to rivers was often the first to be used for human activities, since rivers themselves offered good routes for traveling into forested areas. Portions of the landscape were converted to villages and small agricultural plots, then large commercial farms and residential centers, and finally suburban, urban, and industrial complexes.

In the Alum Creek watershed, the City of Columbus was established in 1812, soon followed by Westerville in 1839 and Bexley in 1908. Many other small settlements sprang up among them, but their boundaries have long since merged as development moved outward from the larger population centers. Table 4 shows that Franklin County's population grew by 600% between 1820 and 1870, and continued at very high rate of growth for the next 100 years. While many cities in Ohio have experienced declines in population in the 1990's, Columbus and outlying areas continued to grow, adding about 100,000 people every ten years. Franklin County grew 11% between 1990 and 2000, and Delaware County to the north grew 64% during this time period, making it the fastest growing county in Ohio.

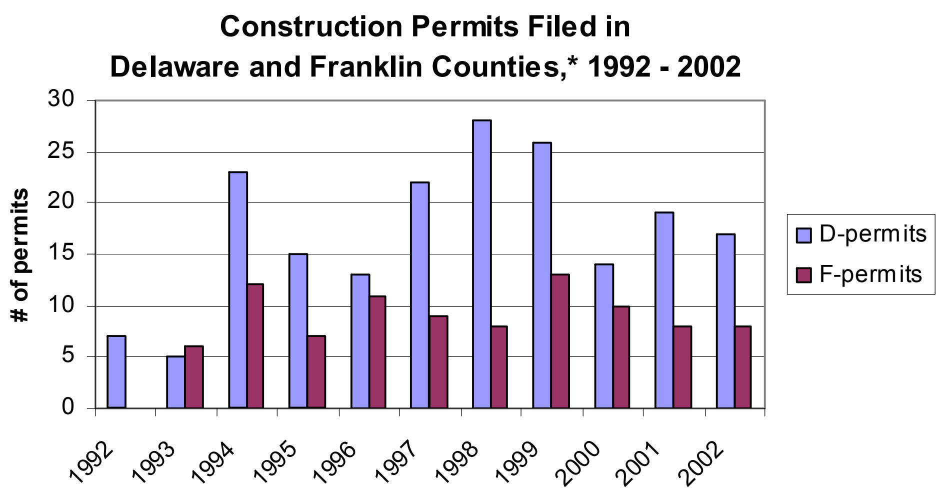
Year	1820	1870	1920	1970	1990	2000
Franklin	10,300	63,524	283,951	833,249	961,437	1,068,978
Delaware	7,639	25,175	26,013	42,908	66,929	109,989

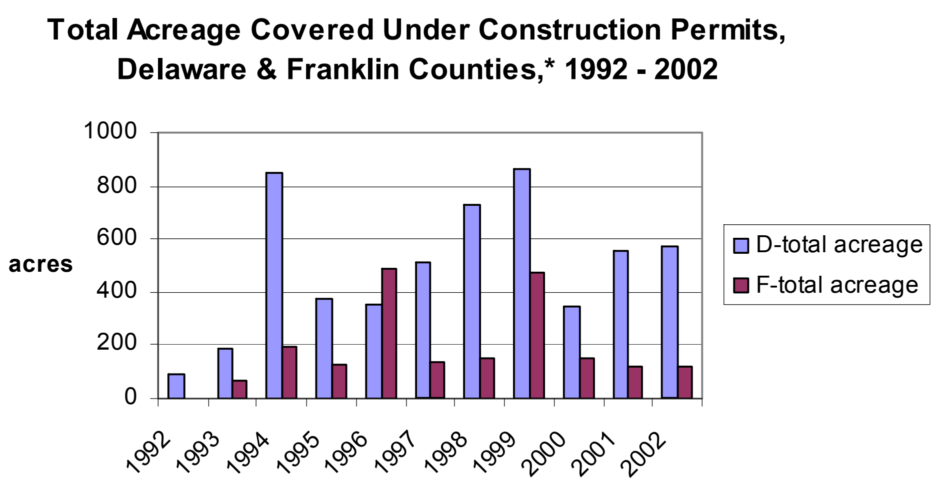
Table 4: Franklin County Population Growth. Source: Ohio Department of Development

The existence of over one million people in Franklin County by the year 2000 has brought with it significant changes for the watershed. Removal of forests and replacement with impervious (or impenetrable) surfaces has led to major changes in how rivers and tributary systems function hydrologically. Although Ohio's rivers have recovered somewhat from a low point in the 70's when passage of the Clean Water Act helped curb factory and municipal sewer discharges, issues of polluted storm water run-off, flash flooding, loss of habitat, and sedimentation continue to impact water quality.

The majority of the watershed is now dominated by urban and suburban land uses. The most heavily urbanized portion of the watershed is located roughly along the Interstate 70 corridor, which is closest to downtown Columbus and one of the oldest urban centers in the watershed. Much of the rest of the watershed is covered by suburban or industrial development. Some pockets of undeveloped land between the older urban areas of Columbus and Westerville remain, although they too are currently experiencing development pressure. The northern end of the lower watershed, between Westerville and the Alum Creek Lake reservoir, retains some rural character but is becoming rapidly urbanized.

The construction of two large regional shopping centers in the watershed in the past ten years helps illustrate this growth trend. They are the Polaris Fashion Place mall and shopping area north of I-270 on either side of I-71, and Easton Town Center, south of Morse Road between Sunbury Road and I-270. The issuance of construction site permits in the watershed, summarized in Figure 12 below, also demonstrates rapid land use change. Permits have been required for construction projects over five acres since 1994 under the Ohio EPA's Phase I stormwater regulations, and mandate sediment and erosion control plans for each site. (Note that the figures do not include permits issued by the city of Columbus for sites down to two acres.) These data show that construction activity in the Delaware County portion of the lower watershed has been outpacing that in the Franklin County portion of the watershed, even though the Delaware County portion contains half the land area. The number of permits issued in Delaware County seems to have peaked in 1998, but in 2000 and 2001 still covered over 500 acres annually.





Figures 12: Construction site permits filed with the Ohio EPA, Central District Office between 1992 and 2002 for the *Lower Alum Creek watershed portions of Delaware County and Franklin County. Source: Ohio EPA construction site permit database.

The Mid-Ohio Regional Planning Commission has forecasted future land use and population changes in the region to the year 2025 (MORPC, 2001). Figure 13 below shows study areas for the plan, and Table 5 lists predictions for the eight areas that overlap with potions of the lower Alum Creek watershed. These data demonstrate that growth will continue to occur in the northern region of the watershed (in areas 5 and 11) and also the very southern reach of the watershed (in area 38). Some areas in the central portion of the watershed that are already comprised of mature urban land uses will experience modest growth to modest decline in population. The growth anticipated in area 21 demonstrates the development of pockets of available land along the Alum Creek corridor, especially south of the Easton shopping area.

Plans for new roads correspond with this population growth. The Delaware County Thoroughfare Plan 2020, completed by the Delaware County Engineer's Office in 2001, also shows two large projects in the northern end of the watershed: a new intersection from I-71 to Big Walnut Road, and the northern extension of Cleveland Avenue across Alum Creek to Worthington Road.

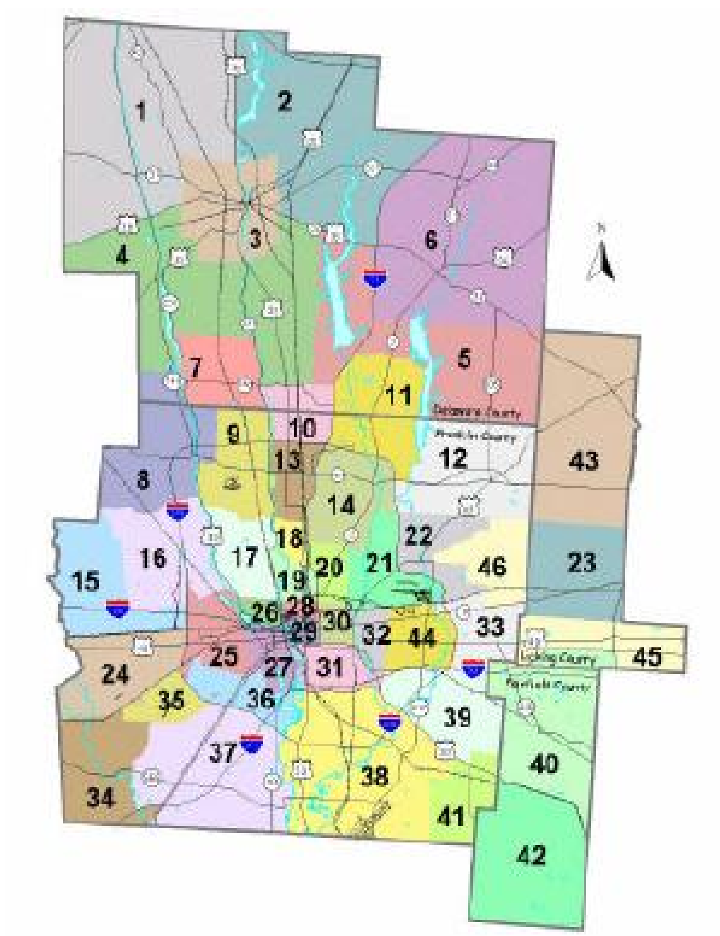


Figure 13: The above image shows local planning areas delineating within the MORPC 2025 Transportation plan. Population and land use predictions for the eight planning areas within the watershed are listed in the table below.

Area	Population % Change	Housing Units % Change	Retail Floor Space - % Change (sq. ft.)	Office Floor Space - % Change (sq. ft.)	Industrial Floor - % Change (sq. ft.)
SE Delaware (area 5)	119	185	287	30	669
Westerville (area 11)	39	54	78	177	21
Northland (area 14)	7	11	- 3	36	7
Northeast (area 21)	28	39	53	132	53
Near East (area 30)	-3	5	-6	11	-15
South (area 31)	-1	12	22	81	-7
Bexley (area 32)	7	9	0	7	35
Groveport/Obetz (area 38)	37	52	40	174	114

Table 5: Projected population and land use change (2000 – 2025) within Lower Alum Creek Watershed study areas. Source: MORPC, 2001: Year 2025 Transportation Plan

Land Use Trends by Area

The following section summarizes land use conditions and trends by area or political jurisdiction, including comprehensive and land use plans if available.

Southern Delaware County

The two townships in southern Delaware County that fall partially within the lower Alum Creek watershed are Orange Township and Genoa Township (Figure 14). These two townships are by far the fastest growing in the county, according to 2000 census data (Table 6). This is significant given that Delaware County was also one of the fastest growing in the state.

Both townships have recently completed comprehensive plans, Orange Township in 2001 and Genoa Township in 1999, to address rapid land use changes and the desire to maintain the area's rural character. Streams and other natural features are recognized as a critical resource to be protected in both plans. The Genoa Township plan states that "even though the major tributaries in the area may or may not be flood prone, buffer zones to encroaching development should be maintained" (Genoa Township, 1999:12). The plan also states that conservation easements should be used when possible to protect natural or cultural resources.

Genoa Township officials will revise their comprehensive plan in 2004, and are considering the inclusion of a subdivision regulation that would allow clustering of houses and green spaces within a given development. Such a "conservation subdivision" PRD (planned residential development) zoning designation may allow green space reserves to be applied along drainage ways.

Township	1980 Population	1990 Population	2000 Population	Growth Rate 1980 – 1990	Growth Rate 1990 - 2000
Genoa	3,678	4,053	11,293	10.20%	178.63%
Orange	1,941	3,789	12,464	95.21%	228.95%

Table 6: Population growth rate in Genoa and Orange Townships, Delaware County. Source: 2000 Census Data.

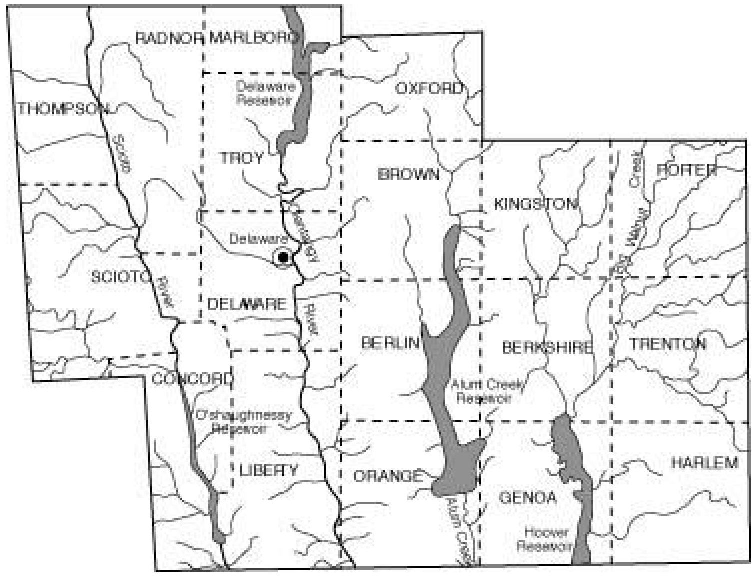


Figure 14: Water Resources of Delaware County. Source: OSU Extension Fact Sheet AEX -480.21

City of Westerville

Westerville was established in 1858 and still retains much of its historical character, especially in the central portion of the city. Suburban expansion followed after WWII, and the village grew rapidly into a city. Much of its land area is residential, with active retail and commercial corridors downtown and along State Street, Cleveland Avenue, Schrock Road, and Polaris Parkway. While much of Westerville has already experienced suburban land use changes, significant pockets of undeveloped land remain.

Land along Cooper Road and adjacent to Alum Creek has recently undergone a spate of new development, and another major office and commercial complex is underway in the northwest corner of the city. This activity is part of a development trend along Polaris Parkway, on the northern border of Westerville, and encompasses a large portion of the Alum Creek corridor. The Westerville Planning Department is committed to including provisions for a minimum fifty foot construction setback from Alum Creek to allow for a planned multi-use path and preservation of a narrow riparian tree line.

In Westerville's Parkland, Recreation, and Open Space (PROS) plan of 2000, minimum greenway buffers of 50 to 200 feet are recommended. Much of the creek corridor is in fact owned by the city of Westerville and maintained as a natural riparian zone.

City of Bexley

Bexley created a Master Plan for the southwest quadrant of the city in 2002. This area borders Alum Creek on its west side, Main Street to the north, Livingston Avenue to the south, and Montrose Avenue to the east. The Master Plan is a general vision of how this area will grow and change over the next twenty years. Redevelopment priorities and growth for educational institutions in the area were some issues on which the plan focused. Bexley City Council adopted the plan in early 2004.

The plan recognizes Alum Creek as Bexley's primary natural feature and as a regional asset. Accordingly, one of the plan's central goals is to preserve the existing natural corridor along the Alum Creek. Floodplain will be left undeveloped, and may be added to extend existing parkland from Schneider Park in the center of this area along the creek. Recreational trails will be enhanced with attempts to connect with the Alum Creek Multi-Use Trail, which is being built by the Columbus Recreation and Parks Department and will follow the west bank of Alum Creek between Main Street and Livingston Avenue.

There are several specific actions set forth in the SW Bexley Plan relating to Alum Creek. A riparian corridor zoning overlay is recommended to preserve the sensitive areas of the stream corridor and allow for a greenway with public access (consistent with the Franklin County Greenways Plan and the Watercourse Protection and Scenic Byway Model Ordinance, available on the web at www.morpc.org). For example, "a minimum 120-foot buffer zone from centerline of creek should be established, slopes should be protected, and the floodplain is not buildable." The plan also recommends that non-buildable land in the floodplain and greenway area be dedicated to the city to assist in enhancing the existing greenway.

City of Columbus

A large portion of the lower Alum Creek watershed falls within the boundaries of the city of Columbus. While much of this portion of the watershed is already dominated by urban and suburban land uses, pockets of undeveloped land still exist and new projects continue. The 1993 Columbus Comprehensive Plan calls for the protection of natural resources throughout the city, and supports the establishment of a greenway zoning overlay. The city attempted to pass a greenway zoning overlay in 2001 but was not successful. As of the end of 2004, the Public Utilities Department is attempting to revise its stormwater policies to institute buffers on large new developments during development plan review.

One method of examining growth patterns within Columbus is by reviewing area plans created by the city's Planning Division (available on the web at www.columbusinfobase.org). Table 7 and Figure 15 below show that a majority of the watershed area lying within Columbus boundaries is or will be covered by area plans. These plans are adopted by the city council as long range policy guidance for development, redevelopment and improvement of the physical environment. Area plans are often prepared for communities experiencing unusual growth, disinvestment, or decline. They are typically created in conjunction with local affected stakeholders and make recommendations on issues such as zoning to guide future growth, green space development, crime, and historic preservation. Area plans may also include provisions for preservation of natural amenities, including greenways and streams.

Five of these plans that are sizeable and/or border Alum Creek directly have been briefly summarized below, including Northland, Northeast, North Central, Near East, and Near South Side. The North East and North Central Area Plans were generally created to address new growth, while the three other plans were generally created to address decline or disinvestment. The content and year of publication of these summaries reflect that riparian buffer (natural land adjacent to rivers) preservation has become a more recent priority to residents and city planners, following a national trend of rising knowledge and awareness of the need for natural resource-sensitive planning.

Alum Creek Watershed Columbus Area Plans	
Plan Name	**Year Adopted**
Far North Plan	1994
Northland Plan – Volume 1	2001
North Linden Plan	Under development
South Linden Plan	Under development
Northeast Area Plan	1994
North Central Plan	2002
I-670 Corridor Development Plan	1989
Near East Area Plan	1995
Holtzman Main Neighborhood Plan	2001
Near Southside Plan	1997
Southside Plan	2002
Far Southside Plan	Under development
South Alum Creek Neighborhood Plan	Under development

Table 7: Columbus area plans that fall within a portion of the Alum Creek watershed. Note: area plans do not follow watershed boundaries, and thus also include areas outside the Alum Creek watershed. Source: Columbus Division of Planning.

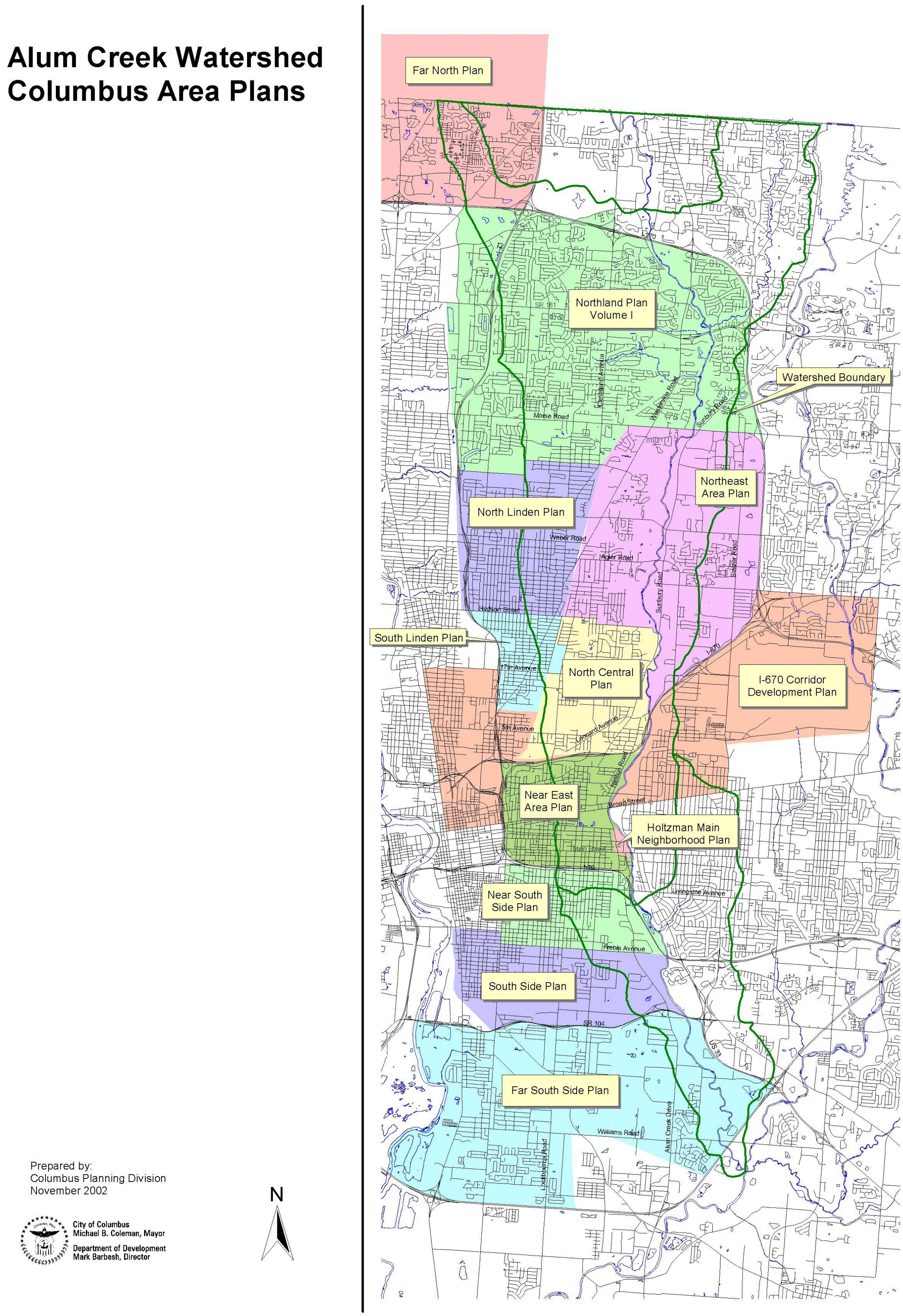


Figure 15: Area plans within the lower Alum Creek watershed. Source: Columbus Planning Division.

Northland Plan, 2001

Boundaries: I-270 on the north and east, Morse Road and Cooke Road on the south, and the Conrail line west of I –71 on the west. This area experienced much of its growth between 1960 and 1980, and since then has more gradually added residential developments. Current concerns center around maintaining and/or revitalizing commercial and residential vitality. Recommendations included:

- Protecting Alum Creek and its tributaries through adding riparian buffer area wherever possible
- Promoting access to the multi-use trail planned along Alum Creek
- Providing sewer service to some areas that have been identified as a health threat by the Columbus Health Department
- Tributary erosion mitigation

Northeast Plan, 1994

Boundaries: I-270 on the east, Morse Road on the north, Conrail tracks near Route 3 on the west, and Mock Road/Alum Creek/I-670 on the south. The Northeast Area commission requested planning assistance from Columbus in 1989 out of concern that they lacked a solid framework for making development recommendations. The community felt that the area was "underdeveloped," having grown in a non-cohesive and piece-meal manner. The southwestern portion had the most pre-existing residential developments, while the northern section was most sparsely covered. The community anticipated new development pressure after the completion of the I-670 interbelt. Recommendations included:

- Buffering of residential development from 1) the airport, 2) a new mixed use, 1,100 acre commercial and retail complex along Seltzer Road (which opened in 2001 as the Easton Town Center), and 3) I-670, with recreational and/or industrial land uses
- Finishing many platted subdivisions that were incomplete, and encouraging residential development infill
- Encouraging developers to donate land for neighborhood parks in new developments
- Protecting natural areas, specifically Alum Creek, through dedication of "land, scenic walkways, and easements"

The Northeast Area Commission worked with the Mid-Ohio Regional Planning Commission in 2000 to develop a scenic byway zoning overlay for Sunbury Road, but the effort was defeated by opposition of a few local residents.

Near East Plan, 1995

Boundaries: I-670 on the north, Alum Creek on the east, I-70 on the south, and I-71 on the west. Residents of this central city community requested planning assistance to address issues such as vacant houses and lots, lack of investment and redevelopment activity, and crime. The area is historically significant as the residential area of choice for Columbus's elite in the late 1800's and early 1900's, although it was also diverse in income, and ethnicity. It housed one of the area's earliest African-American communities and one of the nation's first public housing projects, Poindexter Village.

After WWII, the area began to show signs of deterioration as outlying suburbs became preferable to city neighborhoods. In the 1960's civil unrest was prominent in the area, and major clearing for interstate projects created an isolation effect which continues today. The area still experiences lower than average personal income and housing prices, and higher than average rates of unemployment and poverty. The area had also lost population between 1980 and 1990, and ethnic diversity decreased. Area plan recommendations included:

- Identifying strategies to encourage urban infill and historic preservation
- Ensuring maintenance and safety of current park land and recreational facilities, plus develop new green space
- While the plan mentioned the multi-purpose path along Alum Creek, it does not specifically mention the creek or greenway protection. Proposed zoning maps do not include existing park land.

Near Southside Plan, 1997

Boundaries: I-70 on the north, Alum Creek on east, Frebis Avenue on south, Parsons Avenue on the west. The 1997 area plan was created to address issues of perceived deteriorating housing conditions, abundance of vacant lots and houses, decline of commercial corridors, aging infrastructure, lack of historic preservation, increased traffic congestion, and insufficient parkland and recreational facilities. Of the 2,200 acres in the planning area, 75% was residential, with institutional, manufacturing, and commercial development composing the remaining quarter. Recommendations included:

- Revitalizing vacant lots and commercial areas
- Adding more green space, especially to buffer residential areas from industrial areas
- The plan did not specifically mention Alum Creek and its greenway as an amenity, nor did it recommend buffering industrial areas along Alum Creek Drive from the creek. It did show a picture of Alum Creek as receptor of area stormwater, but did not mention negative effects of stormwater on water quality.

North Central Plan, 2002

Boundaries: Hudson/Mock roads to the north, Alum Creek to the east, Conrail tracks/I-670 to the south, and Conrail tracks/17th Avenue/Joyce Avenue, and 25th Avenue to the west. Prior to the 1900s, the North Central area was mostly undeveloped. However, after the establishment of rail lines at the beginning of the 20th century, development increased substantially. Many of the area's first homes were built close to the rail lines so that people could be closer to employment opportunities. However, over time, residential development extended from the rail-influenced south and southwest sections to the southeast and northern portions of the North Central area.

The North Central Plan was originally initiated by residents within the community, but the North Central Area Commission's Planning Committee took the lead in formulating the plan. The Planning Committee's goals were to devise a land use pattern that would enhance residents' quality of life, create and maintain attractive and healthy neighborhoods, improve transportation options, increase affordable housing and employment opportunities, improve the relationship between city government and residents, and create a stronger bond between area businesses and community residents.

After several public meetings with concerned residents, a number of issues and recommendations for mitigation were identified. Specifically, the plan identified issues and recommendations for land use, development guidelines, housing, infrastructure, public transportation, recreation and parks, health and environment, economic development, safety, and education. Recommendations related to watershed issues included:

- Encouraging preservation of existing trees and the creation of parks, playgrounds, and community gardens in vacant lots.
- Promoting guidelines that require natural features (i.e. streams and trees) be incorporated into any development or redevelopment project.
- Providing accessible parks and open space for all residents in the area and providing linkages to and between parks and open space.
- Working to identify new park and open space opportunities on undeveloped land and approaching property and business owners to donate land for parks, community gardens, and open space.
- Establishing cleanup programs and education programs that "heighten the awareness of preserving the area's natural resources."
- Working with Friends of the Alum Creek and Tributaries throughout the Alum Creek watershed.
- The plan states that the Alum Creek is an important scenic feature of the area that has been under increasing development pressure. It mentions the fact that the City of Columbus is working to acquire easements and properties along the Alum Creek for a trail system. The plan recommends that any properties not needed for the trail system should be developed residentially and "in a manner consistent with the natural surroundings."

E. CULTURAL RESOURCES

Although some area residents consider central Ohio lacking in natural attractions, the region is rich in its abundance of waterways. The incredible benefits of these water resources are known to some, but few people are probably aware of how streams influence our daily lives. For instance, 77% of Franklin County households receive drinking water from local streams (House *et a*l., 1994). Residents can also fish, boat, and connect with the natural world in riparian parks and forests.

Riparian corridors are also deeply connected to our cultural and natural heritage. The location of streams has played a role in where towns and cities have been established, provided wooded routes for the Underground Railroad, and continue to harbor some of our last pockets of biodiversity in urban and rural areas alike. As awareness of the benefits of waterways as public resources increases, so too may residents become more involved in the protection of our watersheds.

Watershed History

Native Peoples & Early European Settlement

The earliest known people to settle in Central Ohio were the Archaic people (about 6000BC to 500BC). They were hunter-gatherers and left few physical records, although some pipes from this era have been found. They were followed by the Mound Builders, who occupied this land for more than two thousand years, between 800BC and 1400AD. They consisted of (Gelbach, 1997):

- The Adena, or Early Woodland people (about 800BC to 200AD), who were the first to cultivate crops here and settle year-round. They buried their dead in conical mounds.
- The Hopewell, or Middle Woodland people migrated into Central Ohio between about 400BC and 500AD. They traded widely but weren't very populous in Franklin County.
- The Fort Ancient, or Late Woodland, people (about 800AD to 1400AD) lived in larger communities along our waterways.

Remnants of only ten of the hundreds of mounds and earthworks documented in Franklin County when European settlers arrived remain today, the others having been destroyed by plows and new roads. The following are mounds known to have existed in the watershed, all of which have been destroyed (Gehlbach, 1997):

- Buttles Mound crossed East Fifth Avenue just east of Sunbury Road.
- Cornell Mound was located just northwest of the corner of Hiawatha Avenue and Knox Street in Westerville. It was 65 by 38 feet and about 4.5 feet high.
- Goldsmith Mound was located one mile north of Central College on the west side of Big Walnut Creek.
- Kish Mound was located just southwest of the intersection of Cleveland Avenue and Main Street in Westerville and was destroyed by residential development.

- Lutheran Senior City Mound was located just east of Cassady Avenue between 10th and 11th Avenues.
- Schrock Mound was located south of Sharon Woods Metro Park and was eliminated by road construction.

As the population of Fort Ancient people began to decline, other tribes migrated into the area. The principal of these were the Wyandot (woodland people of Iroquoian origin, called Huron by the French), Delaware, Shawnee (Algonquin group), Miami, Ottowa, and Chippewa. When European settlers started arriving in the area, the Wyandot were most prevalent in the Franklin County area. They had a large village in present-day Columbus and cultivated the plains across the river in present-day Franklinton (Franklin County, 1901).

The first "white" settlers of the area arrived at the end of the 18th century, some including Revolutionary War veterans who were granted land for service (McLoda & Parkinson, 1976). Some of the earliest arrivals settled along the Scioto River where the heart of downtown Columbus now lies. The first known settlers on the banks of Alum Creek arrived around 1798, including the families of Turner, Nelson, Hamilton, Agler, and Reed (Franklin County, 1901).

The following is a list of some of the first settlements and points of interest within the watershed:

- **Africa** (Orange Township, Delaware County) – Africa was named in the 1840's as a joke by a resident who did not like his abolitionist neighbors who helped escaped slaves. Thirty slaves that were freed in North Carolina did settle here around 1859. The village was inundated by the waters of the Alum Creek Reservoir after the dam was built in 1974.

- **Bexley** - The first one-room schoolhouse was built in 1864 at the corner of College and Livingston Avenues. In 1875, a second schoolhouse was built on Pleasant Ridge. In 1876, Capital University moved from the Goodale Park area to Pleasant Ridge. A building boom ensued, and the town of Bexley was established in 1908 when the Pleasant Ridge Civic Association combined with the tiny community of Jeffrey to its north. Bexley was named after the parish where the Kilbourne family had lived in England (Bexley Historical Society, 2002).

- **Blackberry Patch** (Montgomery Township) – This was the largest black community in Columbus in 1890 and was located on Long and Mount Vernon at Champion Avenue (at the far west edge of the watershed). It was a very poor shanty town where many blacks started out when they arrived here in the post-Civil War era.

- **Blendon Four Corners** (Blendon Township) – In 1821, the residents of the area raised $500 to have a depot and track built as well as the first tavern in the township.

- **Columbus** (Montgomery Township) - In 1812, Columbus was established on the east bank of the Scioto, across from Franklinton, to be the new state capital.

- **East Columbus** (Mifflin Township) – Other names for the village are Dakrumm or Rarigville. In 1905, a post office was built and in 1930, the Ralston Steel Company works were located there.

- **Franklin Township** - The west side of Alum Creek along Main Street featured the Norwood Amusement Park, which operated in the 1940's & 1950's. It had 17 rides, miniature golf, and paddle boats for rent. Concrete stairs and a platform on the river bank still exist at this site, and possibly originated from the park's use of the creek.

- **Hanford** (Montgomery Township) - Located on the west side of the creek across from Bexley, Hanford was the only African American town in Franklin County to be incorporated with its own government. The flood of 1959 wiped out most of the town and construction of I-70 highway obliterated the rest (Maag, 2002).

- **Madison Township** - The first mill in Madison Township was built by Matthew Taylor in about 1807 and was located on Alum Creek near the confluence with Big Walnut and Blacklick Creeks. The structure was no longer present as of 1858 (Martin, 1858).

- **Montgomery Township** - Before Truro Township built its first school, their children attended a school on Alum Creek in Montgomery Township run by Helen Tappan (Franklin County, 1901). The original county fairgrounds were located south of Broad Street, between Walnut Avenue and Alum Creek, approximately where Franklin Park is now located. The city of Bexley (see above) was also established in Montgomery Township.

- **Parks Mills** (Mifflin Township) – The first mill in Mifflin Township was built by A. McElvain around 1838 on Alum Creek. A settlement sprang up, and Park's Sawmill and a post office was established in 1851.

- **Poindexter Village** (Blendon Township) – An African-American settlement that sprung up on land owned by the McDannald family near Route 161 between Alum and Big Walnut Creeks. Mrs. McDannald had been captured by the Wyandots in her home of Virginia and brought to Franklin County. Her family followed and settled here. African-Americans felt comfortable forming a community there because the McDannalds were non-discriminating Mennonites.

- **Shepard Station** (Mifflin Township) – This was a railroad town just south of the current St. Mary's of the Springs, on Fifth Avenue between Nelson and Sunbury Roads. It was the site of Shepard's Sanitarium and a large ice company. People came from all around to soak in the healing waters at Dr. William Shepard's Water Cure and Medical Infirmary at 800 N. Nelson Rd. It was built around 1853 and was known nationally (Switzer, 2002). Shepard Station was annexed to Columbus in 1910. Margaret Avenue used to be Shepard Street, the library branch on Nelson Rd. is the Shepard Branch, and Shepard United Methodist Church is located on E. 5th Avenue.

- **St. Mary's of the Springs** (Mifflin Township) – Established 1868 because of several excellent springs in the area. There was also an iron spring and a white sulfur spring which were among the most valuable medicinal springs in Ohio. Later, it was the site of Ohio Dominican College.

- **Westerville** (Blendon Township) – The town was laid out in 1839 by Matthew Westervelt. In 1909, the national headquarters of the Ohio Anti-Saloon League moved to Westerville with their own American Issue Publishing Company (after having been established in Oberlin, Ohio in 1893). They had ambitious plans to build a Lincoln Memorial in Westerville, but they never materialized. The archives of the League are currently housed in the Westerville Public Library.

- **Zimmer** (Madison) – This town was located east of Alum Creek, just south of Winchester Pike, halfway between Alum and Big Walnut Creeks, and established in 1891. In 1901 the post office was closed and the mail routed to Groveport.

The Naming of Alum Creek

The following dialogue concerning the naming of Alum Creek was published in the Ohio State Journal in 1869 as a series of "letter(s) to the editor:"

- A "young pioneer" of the area stated that the name of the creek was supposed to be "Elm," after the elm trees that lined its banks. He claimed that people mistakenly called the trees "ellum" or "alum" trees and thus called the stream this also.
- A second letter in 1869 disputed the assertions of the prior letter, claiming that early surveys between 1799 and 1807 referred to it as Big Belly's or Allum creek.
- A third letter in 1869 stated that Big Belly was later renamed Big Walnut, and rightfully so (alluding to the fact that the name was silly and should have been changed). It seems that Big Walnut was originally called Big Belly, named after appearance of a local Indian, and was also called the Gahanna Creek. "I see by all the maps and surveys of the country within my observation, that Alum Creek is the title given to that stream of water." "…the cherished name of Alum Creek, deriving from the abundance of alum along its slate bound banks…"
- "The correct name of the creek is Alum and not Elm, as some have contended". It was named after "the substance which exudes in some places from its slate banks." (Franklin County, 1901)

The Underground Railroad

Ohio was a border state during the Civil War and over 40,000 slaves passed northward through it on their way to freedom. The system of north-south running rivers and streams were central to this corridor. The Sycamore Trail of Alum Creek was an important route on the railroad. The white bark of this floodplain tree guided slaves up Alum Creek at night as they waded through the creek northward from the safe Hanby House in Westerville (ODNR, 2002). Stops in the Alum Creek watershed included (Nelson, 1996):

- The Margaret **Agler** House at 2828 Sunbury Rd., built in the 1840s, has a secret room off an upstairs bathroom. It was known as the white house on the bend of the creek.
- The Zeta Phi fraternity house (called the Thomas Jefferson **Alexander** House) of Otterbein College, located at 48 W. College Avenue, had a barn used to hide slaves.
- Otterbein president (1848-54) Lewis **Davis's** House at 102 College Avenue was also a well-used stop. Slaves were hidden in an attic behind cornstalks.
- The William C. **Hanby** House in Westerville (on the corner of Main and Center Streets) was built in 1854. Hanby's son, Benjamin, was so moved by the story of a young slave that he wrote the song "Darling Nelly Gray" about her.
- The Christian **Heyl** House located at 1891 Sunbury Rd. has evidence of a trap door and tunnel that runs to the hay barn.
- The Zenus **Jackson** Homestead at 3845 Westerville Rd. was built in 1856 on property encircled with mounds built by the Adena. There were two secret rooms in the basement.
- The Timothy **Lee** Mansion was built in 1838 on the banks of Alum Creek at 1100 South Sunbury Rd.
- The **McDannald** House was located at 5947 Sunbury Rd.

- One of the most important stops was the Samuel **Patterson** House, built in 1841, which still stands at 6525 Africa Road. Three hay-filled barns provided hiding places.
- George **Stoner** Stagecoach Inn at 133 S. State St. in Westerville provided stagecoaches to transport runaway slaves.
- In Sharon Township, Ozem **Gardner** had an underground railroad house and sometimes conducted slaves from there "…up Alum Creek to another friendly station" (Franklin County, 1901).

Current Population Demographics

The 2000 census revealed that over a quarter of a million people call the lower Alum Creek watershed home. Table 8 compares demographic characteristics of this population to that of Franklin County as a whole. Although the watershed population appeared similar to that of Franklin County in many ways, including median per capita income and age profile, one characteristic that set it apart was a higher percentage of African Americans and people identifying themselves as an "Other" ethnicity. Alum Creek watershed residents also fared lower in the level of formal education completed when compared with Franklin County.

Characteristic	Lower Alum Creek Watershed Population	Franklin County Population
Population		
Total Population	257,300	1,068,978
White	61.9 %	75.5 %
African American	32.0 %	17.9 %
American Indian	0.2 %	0.3 %
Asian	2.0 %	3.1 %
Hispanic	2.1 %	2.3 %
Other	8.1 %	1.0 %
Population under 18 years	27.1 %	25.1 %
Population over 65 years	9.8 %	9.8 %
Families w/ single mothers	25.6 %	NA*
Families w/ single fathers	6.7 %	NA*
Housing		
Homeownership	57.5 %	56.9 %
Household Income		
Median Per Capita Income	$22,088	$23,059
Education		
High School Graduates	72 %	86 %
Bachelor's Degree	20 %	32 %

Table 8: Census data from 2000 comparing the Alum Creek watershed and Franklin County. Asterisks (*) = data not available. Sources: Franklin County – U.S. Census Bureau website quickfacts.census.gov; Alum Creek Watershed: MORPC analysis of 2000 census data

Recreation

Parks, Trails, and the Alum Creek Greenway

A greenway commonly refers to a linear open space or natural area along a watercourse. The benefits of greenways are numerous (MORPC, 2002):

- Greenways provide **high-quality residential environments and recreational amenities** which have been shown to increase property values and tax revenues and are becoming more important in attracting and retaining productive, high skilled residents and businesses.
- Greenways **connect neighborhoods** to downtowns, parks, schools, employment and shopping areas, cultural amenities and other activity centers.
- Greenways function as **stormwater and pollution reducing infrastructure** – free of cost. By preserving and promoting the expansion of vegetated areas along streams, water running off the surface after rainstorms is less likely to cause flooding and is also less polluted when reaching the river.
- Greenways form **migration routes for wildlife** and connect wildlife habitat in urban areas.
- Greenways have **proven successful** in cities as diverse as Raleigh, New York, Boston, Cleveland, Denver, Indianapolis, Portland, Toronto, San Francisco and Minneapolis, where they connect residents and visitors with thousands of acres of parkland and other attractions.

Greenways are even more important in growing urban environments. River corridors often provide the last remaining high quality pockets of natural areas in urban areas, partially due to their propensity to flood. Many entities in the Alum Creek watershed have worked to acquire and protect land along the Alum Creek with passive and active park lands (see Watershed Map #6).

This greenway has benefited tremendously from ambitious projects of the city of Westerville, city of Columbus, and Metro Parks to build a multi-purpose trail along the entire length of Alum Creek as it runs through Columbus and Westerville. The 22 mile section of the Columbus portion of the trail is scheduled to be completed by 2006. A schedule for the completion of segments of the trail is shown in Table 9.

Farther north, The Delaware Friends of the Trail have been working with local governments to promote trail development throughout the county. Plans exist to continue the Alum Creek trail north of Westerville through Genoa Township to Sunbury (in northeast Delaware County). While this route no longer follows Alum Creek, it may eventually connect the entire system to the Ohio to Erie Trail, which will traverse the state.

The expansion of this trail network will undoubtedly increase public access to Alum Creek. Despite its current prevalence of parks, the creek manages to stay relatively hidden to those that live near it or cross over it, existing somewhat in obscurity. Increased access, when combined with educational opportunities and signage, will likely build awareness of all the creek has to offer and support for management strategies.

In addition to large multi-use trail systems associated with greenway protection, many parks in the watershed afford (smaller and perhaps more quiet) nature trails and other recreational opportunities such as birding, cross-country skiing, biking, hunting, and fishing, to name a few.

Jurisdiction	Trail Segment	Status
Westerville	Northern corporate line TO Polaris Parkway	Construction not yet scheduled
	Polaris Parkway TO County Line Road	Construction not yet scheduled
	County Line Road TO Schrock Road	Completed
	I-270 TO Schrock Road	Completed
Columbus	Westerville/ I-270 TO Casto Park / SR 161	Completed
	Casto Park/ SR 161 TO Easton / Morse Road	Under construction - Opening June 2005
	Easton/ Morse Road TO Innis Park/ Innis Rd .	Construction scheduled for 2006
	Innis Park/ Innis Road TO Mock Park/ Mock Road	Construction scheduled for 2006
	Mock Park /Mock Road TO Ohio Dominican University	Construction scheduled for 2005
	Ohio Dominican University TO I-670/ Nelson Park	Under construction
	Nelson Park/ I-670 TO Academy Park/ Bryden Road	Completed
	Academy Park/ Bryden Road TO Pumphouse Park/ Main Street	Construction scheduled for 2005
	Pumphouse Park / Main Street TO Livingston Avenue	Completed
	Livingston Avenue TO Three Creeks Park	Construction scheduled for 2005
	Three Creeks Park TO Alum Creek Drive / SR 104	Construction scheduled for 2005
Columbus / Metro Parks	Three Creeks Park – from Route 104 to confluence	Completed

Table 9: Alum Creek Multi-Use Trail Schedule: Westerville to Three Creeks Park

Boating

The experience of boating on Alum Creek offers a dramatic contrast to merely catching glimpses of the creek from overpasses. Boaters are often surprised to experience a sense of wilderness while quietly drifting through a large city (Figure 16). Seasonal variations in the amount of water flowing in the creek, commonly measured in cfs (cubic feet per second), are quite high and should be considered when planning a trip. While high spring flows can pose a safety risk, low summer and autumn flows can slow a trip down considerably[1]. Boating in low flow conditions is still possible, depending on the weight of the boat and the occupants' willingness to occasionally step out to pass shallow areas.

Figure 16: Boaters on Alum Creek near Mock Park

While boaters should also be aware of obstructions such as downed trees, the most important safety hazard to be aware of are lowhead dams. According to a position paper published by the Columbus Recreation and Parks Department in 1989, use of the five rivers and over 90 miles of floatable channels in Columbus is severely restricted by lowhead dams (Columbus, 1989). Small dams were built on rivers for a variety of purposes: to protect sewer and other infrastructure crossings from erosion, create minimal pool levels for water intakes, create recreational opportunities and deep, still water for some species of game fish, and water livestock. Side effects of these dams include adverse impacts to aquatic life and creating a public safety hazard for boaters and waders.

The CRPD position paper explains why low head dams are dangerous:

> Lowhead dams typically have a flat top (weir), steep face, and energy dissipation basin (roller bucket) at the bottom. The weir spreads the flow of the stream at even depth over the entire width of the dam (except in very low flow conditions). The water gains speed as it drops down the steep face and plunges into a roller bucket at the bottom, where the plunging action is converted into a rolling action that creates a horizontal vortex (hydraulic roller action). Down stream flow is supplied by a narrow layer of water at the bottom of the bucket.

[1] The United States Geological Survey maintains a stream flow gauge on Alum Creek below the Alum Creek Lake Reservoir in Delaware County, at Africa Road. Real-time stream flow information can be accessed on their website at www-oh.er.usgs.gov.

> These vortexes can capture people and hold them underwater for long periods of time. These circumstances are usually not obvious to either persons on the bank or for boaters approaching from upstream. During low flow when less than an inch is passing over the dam, a healthy adult can usually escape the rolling vortex, although children may not be able to.

As of 1989, an average of two people were killed in lowhead dam accidents every year in Columbus. As a means to prevent further deaths, the sloping faces of dams like the one located in Wolfe Park (see Figure 9) were filled with large rock, which prevented a vortex from forming. Boaters can portage around lowhead dams to avoid them, although knowledge of their locations in advance is essential. As the CRPD report noted, they are often not visible to boaters approaching from upstream.

The five lowhead dams located on Alum Creek are listed in Table 1 in the Hydrology Section of this document. One is located in Westerville, while the remaining four are located between I-670 and SR 104. In this area, portaging many be difficult given steep incised banks; possible locations should be verified before embarking on a trip.

The limited presences of boat access points may also limit the ease of planning boating trips on Alum Creek. No formal access points currently exist, although a number of parks along the creek do offer informal access that may require over-land portages. Examples include Alum Creek Park in Westerville, Cooper, Innis, and Nelson Parks in Columbus, and Schneider Park in Bexley. Interest in boating has been enthusiastically expressed by local residents during community forums held for the creation of the Greenways Plan for Alum Creek (MORPC, 2002) and the Lower Alum Creek Action Plan.

Fishing

Fishing in Alum Creek is permitted (with a state fishing license) anywhere where public access along the creek is provided (such as in parks). Other opportunities for fishing in the watershed include ponds at Sharon Woods Metro Park and Three Creeks Park, and the Alum Creek Lake Reservoir in Delaware County. Otterbein Lake, located in Westerville just south of Main Street near the west bank of Alum Creek, is a borrow-pit that is being restored by a citizens group working collaboratively with city officials. When completed, this facility will provide fishing decks that are handicap accessible.

Although walking or boating along the creek often reveals solitary fishermen along its banks, some report that it isn't as popular as it once was due to urbanization, lack of access, and decline in water quality (Draper, 2002). Anglers must also contend with health risks if they are to keep the fish that they catch. A statewide fish consumption advisory has been issued by the Ohio Department of Health covering all Ohio streams due to mercury contamination. Mercury finds its ways into Ohio waters as an airborne by-product of fossil fuel combustion that is washed out of the sky during rain events. Coal burning power plants are the largest emitters of mercury in this region, although other industries and combustion of other fossil fuels also emits mercury.

The advisory warns that women of child bearing age, pregnant women, and children under 6 years of age should not consume more than one meal per week of any fish from any body of water in Ohio. In addition, the same group is advised to further limit consumption of species with a greater tendency to bio-accumulate toxins to no more than once a month. Common names for fish in this group include sheep's head, white perch, white bass, bull head, carp, and catfish. Size and age of any fish should also be taken into account. Theoretically, older fish have more time to accumulate toxins, and larger fish have the capacity to accumulate greater quantities.

Aside from the state-wide mercury advisory, the Ohio Department of Health also conducted a small study in 1996 of Alum Creek fish to determine if any additional consumption advisories (for other toxins) were necessary. Six fish that were caught between river mile 9.2 and 3.8 on Alum Creek - representing the urban core of the watershed from approximately Nelson Park to SR 104 - were analyzed. While low levels of PCB's and mercury were found in the tissues of the fish, the levels did not exceed the minimum threshold for issuing a fish consumption advisory, and represent a fairly common sample for an urban stream (Frey, 2002).

Swimming and Wading

The Clean Water Act of 1970 set forth the national goal of restoring and maintaining the nation's waters to "fishable and swimmable" status, meaning they should be able to support healthy aquatic systems and recreation. The Ohio Environmental Protection Agency (EPA) gauges the safety of human contact with rivers by measuring the prevalence of some forms of bacteria associated with human or animal excrement. A group of bacteria species called "fecal coliforms" are generally used as indicator species when water quality testing is conducted. These bacteria are prevalent in the human digestive tract, although they can cause slight intestinal illness if ingested. More importantly, they indicate that untreated sewage has reached the water and that other pathogens may be present.

The Ohio EPA has established standards for concentrations of fecal coliform that can still be presumed safe for "primary contact" (such as swimming and canoeing) and "secondary contact" (such as wading) recreation in Ohio streams and rivers. The criterion for primary contact is more stringent given the greater level of contact. In two recent Ohio EPA water quality studies of Alum Creek, exceedences of the primary and secondary contact standards were observed at almost every site. These exceedences comprised "the most frequent (water quality) violations observed in the Alum Creek mainstem (OEPA, 1999a)."

This does not mean that recreators *will* contract an illness if they come into contact with water, although higher concentrations of fecal coliform do present a higher level of risk. Precautions such as sanitizing hands and not touching them to mucous membranes after contact can help limit risks. Alum Creek is unfortunately not alone in its high level of fecal coliform. A recent Ohio EPA report shows that of the half of the state's watersheds that were tested, only 9 met these criteria (OEPA, 2002). Nonpoint source pollution, outdated sewer infrastructure, and unsewered areas are some of the sources of fecal coliform pollution. Other hazards to swimming and wading may be posed by litter and trash, including sharp objects and obstacles to canoe passage.

Other Cultural Amenities

Municipal recreation centers and educational institutions are community amenities that offer the potential for creating opportunities and programs to learn about and experience Alum Creek. Table 10 lists recreation centers located in the lower Alum Creek watershed.

Municipality	Name	Address
Westerville	Westerville	350 North Cleveland Avenue
Columbus	Brentnell	1280 Brentnell Avenue
Columbus	Brittany Hills	2618 Bethesda Avenue
Columbus	Driving Park	1100 Rhoades Ave
Columbus	Krumm Park	854 Alton Avenue
Columbus	Northeast	2502 Cassady Ave

Table 10: Recreation centers located within the Alum Creek watershed. Additional information can found online at www.columbusrecparks.com

Higher education institutions located within the Alum Creek watershed include:

Ohio Dominican University, Columbus
Trinity Lutheran Seminary, Bexley
DeVry University, Columbus
Capital University, Bexley
Otterbein College, Westerville
Technology Education College, Columbus

Public Water Supply

Alum Creek watershed surface and ground waters provide public water supplies for the City of Westerville and portions of the City of Columbus and Delaware County. The following section details water usage by these three entities, summarized below in Table 11.

	Westerville	DelCo			Columbus
Source	Alum Creek	Alum Creek	(Alum Creek + Alum Cr. Res.)	Alum Creek Lake Reservoir	Alum Creek Lake Reservoir
2001 Withdrawal (million gal.)	1,398	82.8	1,554	1,471	7,911
Ten year annual average (million gal.)	1,338	202*	1,688*	1,086	5,233
Distribution	Westerville	Eastern Delaware County			Northern Columbus

Table 11: Public water supply withdraws from Alum Creek and Alum Creek Lake Reservoir. * DelCo Water Company began withdrawing water directly from Alum Creek in 1999; these figures are four year averages between 1999 and 2002.

Alum Creek Lake Reservoir

When the Alum Creek Lake reservoir was constructed in 1974, three entities secured use of the stored water: DelCo Water Company, Westerville, and Columbus. All three entities are currently utilizing this water to meet part or all of their water supply needs.

DelCo Water Company's annual withdrawals from the reservoir have doubled over the last ten years from 700 million gallons (MG) in 1990 to 1,470 MG in 2001, although volumes vary from year to year. In addition to its reservoir intake, the company built a secondary intake downstream from the reservoir in Alum Creek itself (just south of Lewis Center Road) in 1999 to supply a newly constructed upground reservoir. Over the last 4 years, withdrawals have varied from 433 MG in 1999 to 83 MG in 2001. Withdrawals occur only during high flows and more frequently in the late summer and fall months.

DelCo's water supplies from the Alum Creek Lake reservoir and Alum Creek are distributed to homes and businesses in the eastern half of Delaware County (east of SR 23). However, the company's distribution system is designed to serve all portions of Delaware County if necessary. DelCo also draws water from the Olentangy River watershed for public water supply.

The City of Columbus also withdraws water for public water supply from Alum Creek Lake Reservoir. Withdrawals have averaged 5,233 MG annually over the past eleven years, although amounts have varied widely, from zero in 1994 to 11,399 MG in 2000. Withdrawal volumes have generally been increasing since 1994. Water is withdrawn most frequently in late fall and winter months, and piped east to the Hoover Reservoir (located on Big Walnut Creek in Delaware County). The Hap Cremean Water Plant treats water from Hoover Reservoir, and from there it's distributed to much of the northern half of Franklin County, including to Alum Creek watershed residents north of Interstate 70.

Alum Creek

The City of Westerville, located northeast of Columbus in northern Franklin and southern Delaware Counties, has derived all of its drinking water directly from Alum Creek since 1925. In 2001 the city withdrew almost 1,400 MG from Alum Creek, or about 4 million gallons per day (MGD), to serve 36,000 people. The city's water supply treatment plant is capable of treating up to 7.5 MGD.

Westerville constructed the Ross Windam lowhead dam across Alum Creek in 1935 to ensure a minimum pool level for its surface water intake line. The dam is located just south of Main Street, and depending on flow rates impounds water upstream to Cleveland Avenue. The intake is located just 5 miles south of Alum Creek Lake Reservoir. Water plant operators may request water releases from the reservoir managers if the water level falls too low, although this measure is rarely needed (perhaps once a year, or none in some instances). The city also created a 250 MG reservoir on an Alum Creek tributary known as Indian Run in 1959 to provide a back-up water supply. See Section I for information on Westerville's Source Water Assessment and Protection plan.

Groundwater

The City of Westerville is establishing a new well field in the Alum Creek floodplain to supplement its water supply. The first well came on line in 2003, and can withdraw 1.5 MGD. More wells and withdrawing capacity will be added as needs increase. The well fields are being constructed to meet growing water demands and to create a backup supply should use of Alum Creek surface water be restricted during an event such as a severe drought or chemical spill. One such event occurred in 1994 when a rain storm washed materials from a newly paved parking lot into Alum Creek near the Polaris area. Westerville's water plant was shut down for four days during the cleanup, and the city relied on an emergency connection to the Columbus water system.

An unincorporated area south of Westerville, known as Huber Ridge, also operates a private 1 MGD water supply treatment plant that draws from wells along Alum Creek. Both of these well fields are in sand and gravel aquifers that have some interconnectivity to the creek.

Other Intakes

The Ohio Department of Natural Resources (DNR) Division of Water manages a database of entities withdrawing surface waters across the state. A facility must have the capacity to withdraw 100,000 gallons per day to be registered in the database. While there are other small entities on Alum Creek that may withdraw water for various purposes (such as watering a pond), none beside the water supply entities discussed above met the 100,000 gallon threshold for the Ohio DNR database.

F. PHYSICAL ATTRIBUTES

Introduction

To understand how modifying a stream channel can affect stream health, it is important to first be familiar with stream morphology. Morphology is the shape of the stream itself, including its width, depth, cross-sectional pattern, sediment transport ability and sinuosity (or how much it meanders from side to side). In central Ohio, healthy river systems typically meander extensively, forming relatively wide floodplains with stream channels dominated by what's known as a "riffle-run-pool" habitat sequence (see below). Deeper pools form on the outside bends of meanders, with low-lying point bars at the inside of bends (Figure 17). Water can wash over point bars, depositing gravel and spreading out during periods of higher water. As a stream descends through its valley, shallow areas of rocks and gravel also form as the meanders move from one side of the stream's path to the other. These shallow areas are known as "riffles," which help regulate the stream's gradient (slope) and are important areas for aquatic life.

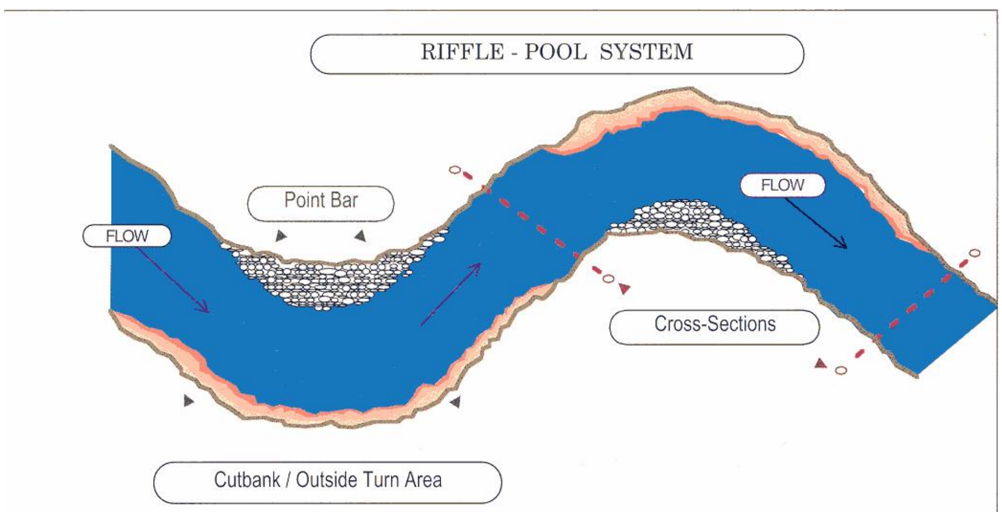


Figure 17: Basic elements of stream morphology. Source: Rosgen, D. 1996. Applied River Morphology. Illustrations by Hilton Lee Silvey.

Floodplain access is also critical to a healthy stream. The term refers to the ability of higher flows to spill out of the main channel, helping to alleviate the erosive stress that high flows and velocities place on the stream bank and bottom. Floodplains provide storage for excess water, areas for depositing heavy sediment loads associated with high runoff events, and rich areas of biological diversity. They also help store groundwater, which often comprises a significant portion of stream flow during summer and early fall. The following list defines these and other components found in healthy streams and rivers (Sanders, 2001):

- *Riffles* are shallow areas with fast flows where rocks break the surface, which increases dissolved oxygen and is critical habitat for many insect and crustaceans.
- *Runs* are areas of fast moving, shallow water where only larger rocks break the surface. They provide critical habitat for many fish and mussel species, and are used for spawning, feeding, and resting.
- *Pools* are wide, deep areas with slow current. They provide critical habitat for many species, refuge during droughts and winter, and cover for fish from most bird and mammal predators.
- *Floodplains* are low lying areas adjacent to the main channel which are inundated during periods of higher flow. They are critical for reducing sediment loads, storing flood water, and providing habitat.
- *Meanders* are bends in the stream channel formed as streams flow through floodplains.
- *Islands and bars* are dry areas of land within the channel of a stream below the ordinary high water level.
- *Undercut banks* are edges of the stream bank that overhang the water.
- *Root wads* are large underwater tree roots that provide cover (Figure 18).

Figure 18: The partially submerged roots of this Sycamore tree provide habitat for fish at Cherrington Park in Westerville.

Human changes to the landscape, whether from forest to agriculture, or from agriculture to urban, have profound impacts on stream morphology and ultimately stream quality. Three primary impacts have occurred in Alum Creek watershed:

- Increased impervious (or impenetrable) land cover, which increases the peaks, total amount and duration of runoff, resulting in stream bed and stream bank erosion. (Stream bed erosion is often referred to as “incision.”)
- Loss of floodplain through filling, construction of levees, and stream bed erosion
- The modification of channels themselves to create more buildable or farmable land and increase drainage during higher runoff periods

Loss of floodplains reduces habitat and a stream's ability to store excess water, and increased imperviousness exacerbates this problem. Both lead to down cutting of the stream bed. Channel habitat declines because of increased scouring, and eventually the stream deepens to the point where higher, steeper banks collapse, increasing sediment load and impairing the typical pool-riffle habitat. Because eroding banks threaten adjacent land uses, they are often stabilized (with significant expenditures of public and/or private funds) with rock, concrete or other materials, locking in the destructive patterns and eliminating riparian habitat.

The creation of levees, or burms of land built on river banks to prevent flood waters from spilling over, can also limit a river's access to floodplains. Detailed data on the extent of levees in the Alum Creek watershed have not been collected, although they have been observed in areas such as Cooper Road (Westerville), Cooper Park (northern Columbus).

Based on preliminary map analysis, several sections of Alum Creek appear to have been straightened. These include reaches where Alum Creek passes under I-270, under SR 161, in the 5th Avenue / I-670 reach, and under SR 104. In all, these reaches constitute approximately 15% of the length of the lower Alum Creek mainstem.

Other impacts associated with population growth in the Alum Creek watershed include the creation of lowhead dams and significant modification to tributary streams. This probably occurred first through agricultural drainage projects, but urbanization has further degraded tributaries. Appendix 12 summarizes map analysis and some field analysis of tributary streams.

The remainder of this chapter further describes stream habitats found in sections of the lower Alum Creek watershed. The first section, from the Alum Creek Lake reservoir to Schrock Road, corresponds with the upper subwatershed 14 digit HUC. The next three sections fall within the lower subwatershed 14 digit HUC. See Table 15 in the next segment of Section III for all Qualitative Habitat Evaluation Index (QHEI) scores.

Alum Creek Lake Reservoir Dam to Schrock Rd (upper subwatershed HUC)

Mainstem

Alum Creek quickly regains its shape as a meandering stream as water is released from the reservoir. Qualitative Habitat Evaluation Index (QHEI) scores range from the 70's to the upper 50's. Pools, riffles, and runs are evident, however the channel is somewhat incised resulting in eroding banks in isolated areas. One lowhead dam has been installed in this reach, just south of Main Street in Westerville, to provide water supply for the City of Westerville. Partially due to entrenchment and encroaching land uses, floodplain access is somewhat reduced, as it is for the majority of the lower watershed. The riparian corridor consists of mature trees such Sycamore and Cottonwood and low shrubs such as Honeysuckle.

The wooded corridor is still relatively narrow due to remaining agricultural land use and increasing suburban residential growth, although through the city of Westerville much of it is preserved as parkland. A 1994 ODNR land cover survey indicated that 69% of the corridor in the upper subwatershed was wooded (within 200 feet of both sides of the creek).

Tributaries

Most tributary streams in this area are unnamed and generally range in watershed size from 1 to 3 square miles and are 1 to 4 miles in length. They have likely been modified as a result of agricultural drainage projects, although channel morphology is recovering. According to the 2003 OEPA water quality report, two tributaries were found to be meeting water quality standards, and one (Unnamed Tributary at RM 25.5) was described as excellent due to ground water recharge and channel morphology (OEPA, 2003a). This tributary does contain unrestricted livestock access, although it should be noted that this is a very unlikely threat elsewhere in the watershed. Like all other tributaries in the area, the stream is threatened by burgeoning residential growth and stormwater runoff. Some new development has already occurred, although the stream has been assessed since 1999.

Land development in the southern portion of this area, including the Polaris shopping area and the city of Westerville, has further impacted tributary streams. Figure 19 shows a tributary south of Polaris Parkway that has been lined with concrete. Streams have a natural tendency to move over time across a floodplain, continually eroding and building new banks. Locking a stream in place with concrete, rip-rap, or other material is often done to protect structures built in the path of its movement. Streams are also lined with concrete to speed conveyance of rain water, and to prevent severe erosion, which is often the result of increased flow rates due to urbanization. Modification of tributaries is widespread throughout developed portions of the watershed.

Figure 19: Unnamed tributary exiting a pipe on the south side of Polaris Parkway into a stream bed lined with concrete.

The benefits of maintaining natural channels, however, are becoming more well-known:

- Soil and vegetation that line stream beds retain water during storm events, slowing its progression towards rivers and lowering peak flood flows downstream.
- Biological and microbial activity in open channels breaks down and absorbs pollutants.
- Natural stream channels (even small ones) provide habitat for a wide variety of wildlife.
- Natural streams are amenities that improve the visual aesthetics and economic value of neighborhoods.

Schrock Road to I-670

Mainstem

This river reach has been modified and straightened in some sections, although QHEI scores are relatively fair to good (in the 60's and 70's). Stream channel entrenchment is well established, although bank erosion is not a large concern because stream flow is largely controlled by the reservoir dam. Based on general observation, floodplain access has been limited through a combination of incision, floodplain filling, and levee construction.

However, a large number of parks (such as Mock and Innis) have helped maintain a riparian corridor with large mature trees, as has large lot zoning along Sunbury Road, and existence of golf courses, schools, churches and nurseries along the creek's banks (Figure 20). A 1994 ODNR land cover survey indicated that 59% of the corridor in the lower subwatershed (HUC) was wooded (within 200 feet of both sides of the creek). But increasingly, commercial and residential developments are encroaching on wooded riparian corridor. For example, Figure 21 below shows an industrial area on the banks of the creek just south of I-270.

Figure 20: Boaters near Mock Park, an area with a wooded riparian corridor.

Figure 21: An industrial park south of I-270 where most riparian vegetation has been removed.

Tributaries

There are several large named tributaries in this portion of the watershed, such as West Spring Run and Kilbourne Run, with subwatershed sizes ranging from 2 to 8 square miles. Many tributaries also remain unnamed, such as those that flow through Champions and Bridgeview golf courses. For the most part, these tributaries are severely impacted from stormwater runoff from suburban Columbus, resulting in severe entrenchment, eroding banks, and loss of floodplain access. A QHEI score as low as 26 was reported for Spring Run (OEPA, 2003a). However, the corridors of some tributaries retain large undeveloped wooded tracks, especially within the few ravine systems, and are likely capable of recovery or restoration.

I-670 to SR-104

Mainstem

This river reach is the most impacted in the lower Alum Creek watershed, with habitat modifications playing a large role in its nonattainment status. This portion of the watershed is the oldest in terms of established communities and contains the most impervious surface, likely in excess of 50%. QHEI scores have been reported in the 50's. The stream corridor is very confined by roads and highways and is severely entrenched. Bank erosion is still not a large problem because upstream flow is regulated by the reservoir dam and there are several lowhead dams in the area. Although extensive parkland exists, the riparian corridor is thin, especially from Broad Street to Livingston Avenue. The Ohio EPA described this reach as "largely channelized" in their 1999 Alum Creek study (OEPA 1999a: p10).

There are five lowhead, or small, dams on the lower Alum Creek, four of which are located between I-670 and SR 104 (Table 1, Figure 22). Dams fundamentally alter streams by converting free-flowing, meandering waterways with diverse habitats into lake-like impounded areas with still water. The lack of pool-riffle habitat results in low dissolved oxygen levels, sediment accumulation and poor in-stream habitat structure. As a result, many river species cannot survive in these areas.

Location	Political Jurisdiction	Purpose	Date of Construction	Responsible Agency
Alum Creek Park South of Main Street	Westerville	Water Supply	1935	City of Westerville
Nelson Park South of Maryland Avenue	Columbus / Bexley (private lands)	Aesthetics and/or recreational. Constructed by the Public Works Administration	Approximately 1940	Columbus Department of Recreation & Parks, Malcolm D. Jeffrey, et al.
Wolfe Park North of Fair Ave.	Columbus	Aesthetics and/ or recreational	Unknown	Columbus Department of Recreation & Parks
Wolfe Park Fair Avenue	Columbus	Sewer crossing 12" diameter	Unknown	Columbus Division of Sewerage & Drainage
Route 104 / Refugee Road	Columbus	Unknown	Unknown	Ohio Department of Transportation

Table 1: Lowhead dams on the Alum Creek mainstem. Source: Columbus Public Utilities Dept Dam Inventory

Figure 22: The Nelson Park Dam

The Ohio EPA has published two recent water quality reports on Alum Creek, in 1999 and 2003. The only areas found to be in nonattainment of warmwater habitat aquatic life use standards were within a two mile reach containing the Nelson Park dam and the two Wolfe Park dams. The nonattainment site at river mile (RM) 8.6 is between the Nelson Park and Wolfe Park dams and is slightly impounded. The nonattainment site at RM 7.5 site is just downstream of the Wolfe Park dam. The Route 104 dam is also within a partial attainment reach.

The 1999 report states that the nonattainment reach is “largely channelized and frequently impounded by numerous, small lowhead dams (exhibiting) obvious habitat limitations” (OEPA, 1999a: p10). Concerning low dissolved oxygen measurements, OEPA also cites the “pooled, slow-flowing nature” of the impounded areas (OEPA, 1999a: p110). Impairment of these river reaches is also influenced by other sources of pollution such as sewer overflows.

Tributaries

This portion of the watershed is the most heavily urbanized, with very few tributaries remaining above ground. Pre-existing tributaries were likely covered by urban development many decades ago and placed in pipes or stormwater sewers (which continue to discharge into Alum Creek). One known tributary in the area named American Ditch is partially underground and has been associated with toxic industrial drainage to Alum Creek. Further south (near Livingston Avenue), Bliss Run has been partially placed underground, almost entirely channelized throughout its aboveground reach, and dammed before reaching its confluence with Alum Creek.

SR 104 to Confluence with Big Walnut Creek

The last four miles of Alum Creek before its confluence with Big Walnut Creek demonstrate continued stream morphology problems, although recovery of channel integrity and aquatic life is evident. Due to upstream impervious cover and increased stormwater flows, some spots of dramatic bank erosion have developed (Figure 23). However, this portion of the stream is largely surrounded by parkland, which allows the stream to reestablish a meander pattern. This has resulted in restoration of pools and riffles and the creation of new floodplain adjacent to the main channel.

Figure 23: Erosion on the far bank and a re-establishing floodplain on the near bank of Alum Creek in Three Creeks Park

Direct evidence of channel modifications is demonstrated in Appendix 13, which shows a map comparing a 1996 aerial photograph to a 1964 topographic map. The blue line representing surface water paths in 1964 clearly shows a tributary east of the Alum Creek main stem which is not present in the 1996 aerial photograph. Appendix 13 also shows that a meander bend in the stream was straightened between 1964 and 1996, and that a lowhead dam below SR 104 was installed. Reasons for the straightening are unknown, though it was possibly done in conjunction with SR 104 bridge work or an activity at an adjacent land fill.

Regulations were set forth in the 1972 Clean Water Act that required permits for alterations to stream channels and wetlands (401 certifications), although enforcement in Ohio did not begin until 1982. The premise of the regulation is “no net loss” - if any entity wishes to fill or move a stream channel, they are required to mitigate for the negative environmental impacts by protecting an equivalent (or greater) amount of stream channel elsewhere. Between 2000 and 2003, the Friends of Alum Creek & Tributaries have submitted comments and mitigation suggestions for at least eight 401 certification permits for wetland filling or stream degradation in the lower Alum Creek watershed.

Status and trends

Continuing land use change in the watershed, forecasted by the Mid-Ohio Regional Planning Commission (MORPC, 2001), will remain a challenge in protecting aquatic and riparian habitat. However, some natural channel recovery is apparent in tributaries and the mainstem of Alum Creek and opportunities for preservation do exist. Please see the Hydrology segment of this section for more information on trends in land use and population growth.

G. WATER RESOURCE QUALITY

Water Quality Evaluations

The primary sources of biological and water quality data available for Alum Creek are a series of comprehensive studies conducted by the Ohio Environmental Protection Agency's Division of Surface Water (DSW). The following section, which has been adapted from the Lower Olentangy River Watershed Inventory (FLOW, 2002), describes DSW methods for stream assessment.

The Clean Water Act requires that all states develop water quality standards to monitor streams and the many sources and types of pollution threatening surface water quality. Ohio must adopt water quality standards to protect, maintain, and improve the quality of the state's surface waters such that they will achieve the goal of being "swimmable and fishable." Ohio's water quality standards include three major components: 1) beneficial use designations, 2) numeric criteria for chemicals and aquatic life (fish and macroinvertebrates), and 3) narrative "free from" standards.

Use Designations

Beneficial use designations describe existing or potential uses of water resources. They take into account the use and value of the waterway for water supply, protection and propagation of aquatic life, and recreation. Ohio EPA has assigned use designations to most major streams and rivers in Ohio; the lower Alum Creek has been classified as suitable for aquatic life (warmwater habitat), water supply for industrial and agricultural uses, and primary contact recreation.

Aquatic Life Use Designations and the standards ascribed to them are used most frequently to describe the health of a stream. Biological and chemical water quality standards have been created for each of the three categories of aquatic life use designations listed below:

- Exceptional Warmwater Habitat (EWH) is the most biologically productive environment. These waters support "unusual and exceptional" assemblages of aquatic organisms, which are characterized by a high diversity of species, particularly those that are highly pollution intolerant and/or rare, endangered, threatened, or of special status. These constitute Ohio's best water resources and have the most stringent standards.
- Warmwater Habitat (WWH) defines the "typical" assemblage of aquatic organisms for Ohio rivers and streams. It is the principal restoration target for the majority of water resource management efforts.
- Modified Warmwater Habitat (MWH) applies to streams with extensive and irretrievable physical habitat modifications, such as impacts from mining, channelization, and dams. Biological criteria for warmwater habitat are not attainable in these streams; aquatic biotas are generally composed of species tolerant of low dissolved oxygen, silt, nutrient enrichment, and poor habitat quality.

Attainment of these uses can be expressed in degrees. While some streams may be meeting all of the water quality standards associated with their designation (full attainment), others may be only meeting some (partial attainment), and still others may not be meeting any (nonattainment).

Numeric Criteria

The OEPA uses chemical, physical, and biological measures to determine the general health of Ohio's surface waters. Attainment of aquatic life uses are based on *biological criteria* that measure the populations and diversity of fish and invertebrates living in the stream. Ohio is unique in its use of biological criteria, which are excellent indicators of water quality. Since species differ in habitat preferences, sensitivity to pollution, and life span, their relative abundance or absence can create a broader and more accurate picture of the integrity of a water resource than using water chemistry data alone.

Biological criteria vary according to aquatic life use designation and ecoregion (Table 12). For each of the five ecoregions in Ohio, biological performance at natural or least-impacted habitats (reference sites) are used as a basis for establishing criteria. These biological measurements consist of three indices that are used to characterize aquatic life impairments and their causes:

The *Index of Biological Integrity (IBI)* measures fish species diversity and populations. The index is a number that reflects total native fish, indicator species, pollution intolerant and tolerant species, and physical condition. Combined, the higher the calculated index, the healthier the aquatic ecosystem. The highest possible score is 60.

The *Modified Index of Well-Being (Miwb)* is based on a calculation of fish biomass and density. To prevent high readings in streams with pollution tolerant species, 13 such species are excluded from the calculation. A score of 10 or above is considered to be excellent.

The *Invertebrate Community Index (ICI)* is based on measurements of the macroinvertebrate communities. Macroinvertebrates are aquatic animals that lack a backbone and are easily visible with the unaided eye. They include mollusks like snails and mussels, worms, crustacean arthropods like water fleas and sowbugs, and a variety of insect larvae. The ICI is particularly useful in evaluating stream health because the pollution tolerance (or intolerance) of many species has been well characterized. Like the IBI, the ICI scale is from 0 to 60 with the higher score representing the healthier macroinvertebrate communities and therefore a higher water quality stream.

Ohio EPA Aquatic Life Use Designations	Index of Biological Integrity (IBI)	Modified Index of Well Being (Miwb)	Invertebrate Community Index (ICI)
Exceptional Warmwater Habitat	50	9.4/9.6	46
Warmwater Habitat	40/42	8.3/8.5	36
Modified Warmwater Habitat	24	5.8/6.2	22

Table 12: Minimum biological index scores per aquatic life use designation for the Eastern Cornbelt Plains Ecoregion.

Numeric standards for a variety of chemicals (usually measured in micrograms / liter or parts per billion) have also been developed to measure water quality. These *chemical criteria* are derived from laboratory studies, which measure the sensitivity of aquatic organisms to varying concentrations of chemicals. While chemical criteria are not used to determine use attainment, they are used to describe the level of water quality necessary to support aquatic life and to regulate entities that discharge waste waters through National Pollutant Discharge Elimination System (NPDES) permitting. Chemical criteria exist for parameters such as dissolved oxygen (DO) and ammonia, as well as potentially toxic substances, including organic compounds, pesticides, and heavy metals. While Ohio EPA has not developed criteria for nutrients (nitrate, phosphorus), they have developed guidelines for these parameters based on aquatic life performance at reference sites.

In addition to chemical and biological criteria, Ohio EPA has also devised *physical habitat criteria* that are measured with the *Qualitative Habitat Evaluation Index, or QHEI*. DSW staff have demonstrated that habitat plays a major role in the occurrence and maintenance of viable populations of both fish and macroinvertebrates. Habitat conditions are largely dependent on local geography and the nature and extent of man-made modifications of the aquatic environment such as dams, straightening, and substrate embeddedness (from sedimentation).

The QHEI is a numerical index based on visual estimates of stream habitat features. These include substrate quality, in-stream cover, channel morphology, riparian zone and bank quality, pool and riffle quality, and stream gradient. As with the IBI and ICI, the higher the total index score, the better the quality of the habitat. High quality sections of rivers and streams in Ohio typically have QHEI scores in excess of 75. Streams with QHEI of 60 can generally support warmwater biota, while streams with scores less than 45 generally cannot.

Narrative "Free From" Criteria

Narrative "Free From" criteria are general water quality criteria that apply to all Ohio surface waters. These state that all waters shall be free from sludge, floating debris, oil and scum, color and odor-producing materials, toxic substances that are harmful to human and aquatic life, and nutrients in concentrations that may cause algal blooms.

Summary Results of Ohio EPA Alum Creek studies

The remainder of this section summarizes findings of recent studies related to Alum Creek's water chemistry, sediment chemistry, physical habitat, biology, and overall attainment status. Water quality assessments were conducted in 1996 and 2000 by the Ohio EPA Division of Surface Water (DSW), and the resulting reports were published in 1999 and 2003, respectively. These reports are referred to as "Technical Support Documents," or TSD's. The 1999 report contains data from 13 lower Alum Creek mainstem sampling points, ranging from River Mile (RM) 26.7 just down stream from the Alum Creek Lake Reservoir in Delaware County, to RM 0.8 near the mouth of the creek. The 2003 TSD contains data from only 6 lower mainstem sampling points, but also includes assessments of six tributary streams (OEPA, 1999, 2003).

The Ohio EPA Division of Emergency and Remedial Response (DERR) also published a report on the lower Alum Creek watershed in 2001 called the Phase I Geographic Initiative. The purpose of the Phase 1 Geographic Initiative was to "identify unregulated sources of pollution that could adversely impact Alum Creek..." and to "recommend additional investigations and remedial actions (Myers, 2001: p1)."

The 1999 TSD reported that about 8 miles, or about one third, of the lower Alum Creek mainstem was in partial or non-attainment of its aquatic life use designation, largely within the most heavily urbanized section of the watershed between I-670 and SR 104. A small section of partial attainment also existed further north along the mainstem between I-270 and SR-161.

In comparison, the 2003 TSD showed a smaller percentage of the lower Alum Creek fully meeting warmwater habitat use attainment criteria. While fewer sampling points made describing attainment for the entire stream more difficult, partial attainment had spread much farther north along the mainstem into Westerville (replacing full attainment reaches). This was likely to due to impacts associated with recent land use changes in the area. Tributary data were also collected for the first time in 2003. The four tributaries located in urbanized areas were not meeting attainment standards, while the two tributaries located in less developed portions of the watershed were still meeting attainment standards. Please see the table and figures below for summaries of these findings.

Stream Segment	Attainment Status - Number of River Miles			Cause of Impairment	Sources of Impairment
	Full	Partial	Non		
1999 Alum Creek study -					
Alum Creek – entire mainstem	~19	~7	~1	*Not provided*	*Not provided*
2003 Alum Creek study -					
Alum Creek – Upper Subwatershed *Alum Creek Dam to Columbus Boundary (RM 26.7 – 19.9)*	6.8 (all)	---	---	NA (full attainment)	NA (full attainment)
Alum Creek – Lower Subwatershed *Columbus Boundary to Big Walnut Creek (RM 19.9 – 0)*	2.25	17.65	---	Siltation – H Organic enrichment – H Flow alterations – H Direct habitat alteration - H Ammonia – M Cadmium – M Priority Organics – M Pathogens – S	Land development – H Urban runoff – H Impoundment – H Channelization - H Storm sewers – M
Spring Run	---	1.95	4	Habitat alterations – H Pathogens – M Siltation – S Organic enrichment – S Ammonia – S	Channelization – H Urban runoff – H
W. Spring Run	---	---	3.1	Habitat alterations – H Flow alterations – H	Urban runoff – H Channelization – H Natural – M
Kilbourne Run	---	---	1	Organic enrichment – H Pathogens – M Siltation – S	Urban runoff - H
Trib to Alum Creek (RM 25.50)	0.7	---	---	NA (full attainment)	NA (full attainment)
Trib to Alum Creek (RM 23.47)	1.3	---	---	NA (full attainment)	NA (full attainment)

Table 13: Attainment status and causes / sources of impairment in the lower Alum Creek watershed. Note that attainment status was not provided by stream segment in the 1999 report. Sources: OEPA 1999, 2003.
H = High magnitude, M = Moderate magnitude, S = Slight magnitude (cause or source of impairment)

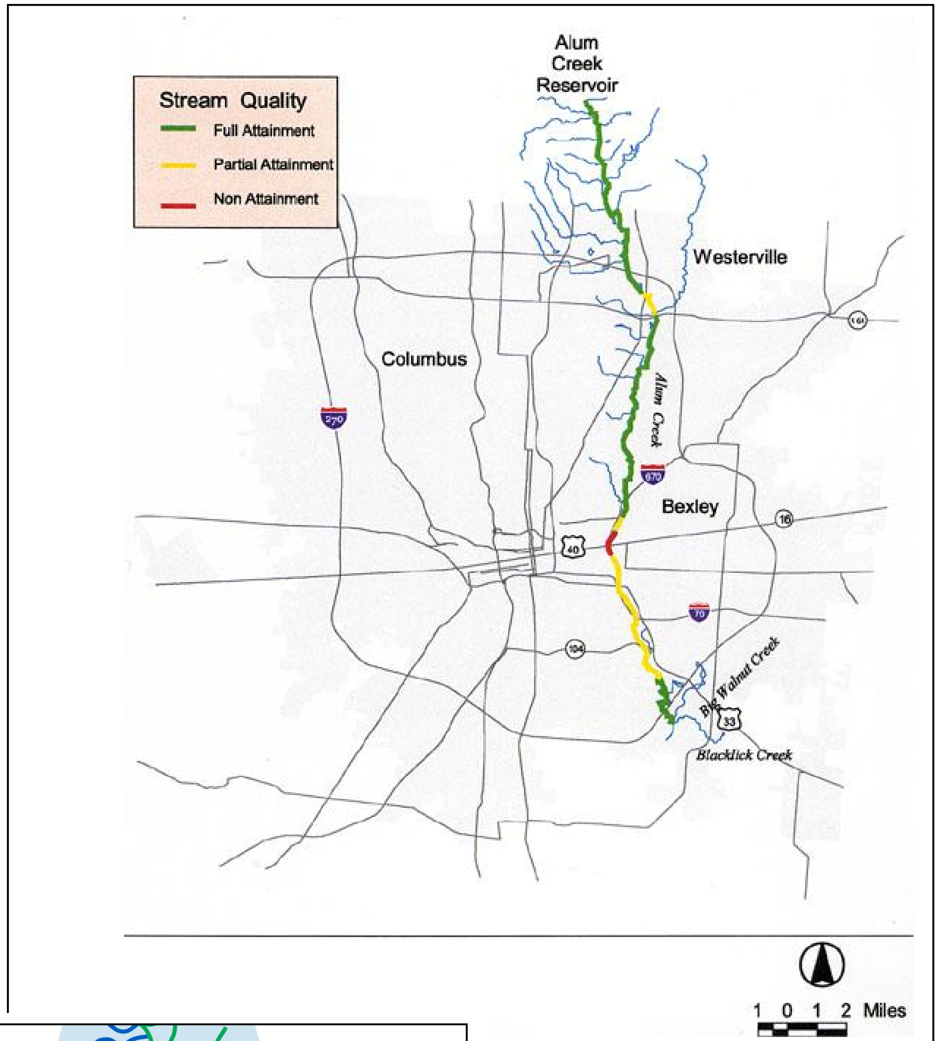


Figure 24: 1999 aquatic life use attainment status for the lower Alum Creek mainstem. Source: OEPA, 1999. Map created by Fred Myers (Myers, 2001). Attainment boundaries are approximate.

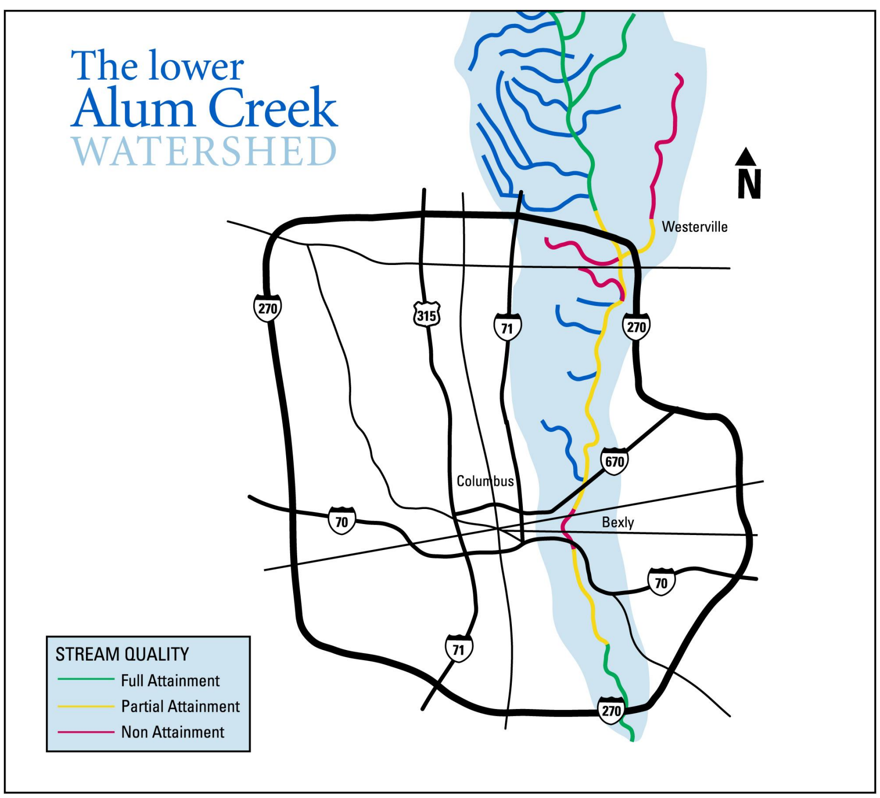


Figure 25: 2003 aquatic life use attainment status for the lower Alum Creek mainstem. Source: OEPA, 2003. Map created by OSU Extension, Columbus Ohio. Attainment boundaries are approximate.

Water Chemistry
(For graphical representation of the following data, please see Figure 26 below)

Pathogens

Violations of primary and secondary contact recreation standards for bacteria have been documented at almost every sampling point in the lower watershed (Table 14). Probable causes of these exceedences are urban/suburban runoff, unsewered areas, and numerous sewer overflows. Values for the mainstem sample sites did decline somewhat between 1996 and 2000.

Dissolved Oxygen

Violations of the WWH criterion for dissolved oxygen (DO) were reported in the 1999 TSD at River Miles (RM's) 23.8, 9.1, 6.6, and 3.9. At RM's 23.8 and 9.10, DO violations took the form of exceedences of the 24-hour average WWH criterion (called Diel DO), as measured by a Datasonde continuous monitoring unit. Diel DO criterion for a WWH is 5.0 mg/L. At RM 23.8, averages of 4.8 and 4.7 mg/L (respectively) were found in two consecutive 24 hour periods, and at RM 9.1, an average of 4.0 mg/L was detected for one 24 hour period. The lowest seven miles of Alum Creek, however, showed the most serious DO violations, with measurements of 2.5 mg/L and 3.5 mg/L at RM's 6.6 and 3.9, respectively. Though these single measurements are dramatically low, on average these sites performed above the minimum WWH criterion of 4.0 mg/L. DO problems in the lower segment of the Creek are probably due to several low head dams that restrict water flow, as well as the input of oxygen demanding pollutants through urban runoff. No DO violations were reported in the mainstem of Alum Creek in the 2003 TSD.

Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand, which is a surrogate measure of organic enrichment, was elevated above the 95th percentile background level in four of six assessed tributary streams (as reported in the 2003 TSD): Unnamed Tributary at RM 25.5, Spring Run, West Spring Run, and Kilbourne Run. By far the highest readings were found in Unnamed Tributary 25.5, where unrestricted livestock access has been observed.

Nutrients

Nutrient concentrations (nitrates, ammonia, and phosphates) reported in the 1999 TSD were within normal ranges, although algal growth was noted within RM 8.6 to 3.8, indicating limited areas of elevated nutrient concentrations. Dips in dissolved oxygen may also be a reflection of high nutrient levels, especially at RM 23.8, where the day-time super saturation that is typical to nutrient (versus organic) enrichment was present.

Nutrient concentrations reported in the 2003 TSD were much more prevalent, although methods for analysis were somewhat different in the two reports. While Ohio EPA standards for nutrients don't exist, reference background levels that are associated with warmwater aquatic life use attainment have been established (OEPA, 1999b) and were used in the 2003 TSD. These do not necessarily indicate toxicity, but are useful in considering effects on dissolved oxygen levels and other parameters.

In the mainstem, nitrite values exceed 75th and/or 90th percentile background readings as four of five sampling sites (RM 22.10, 13.40, 3.8, and 0.7). Ammonia concentrations exceeded the 75th percentile range in all five sampling sites, the 90th percentile at RM 0.7, and the 95th percentile range at RM 3.9. Sources at RM 3.9 may include leachate from old landfills. Other potential sources throughout the watershed include discharging home sewage treatment systems and sewer overflows.

Nutrient enrichment in tributary streams was even more prevalent, perhaps due to proximity to sources and a reduced potential for dilution. Ammonia and nitrite concentrations were above the 75th or 90th percentile background level at almost every tributary sampling site. Ammonia was reported above the 95th percentile in Unnamed Tributary at RM 25.5, Spring Run, and West Spring Run.

Suspended Solids/ Turbidity

Total suspended solids (TSS) analysis reported in the 1999 TSD revealed two large mainstem peaks at RM 21.60 and 9.1, both correlating with storm events. The 2003 TSD reported higher values in the northern end of the watershed with a peak at RM 19.9 (103 mg/L). Elevated concentrations are likely caused by construction site erosion.

TSS values reported for tributary streams in the 2003 TSD were considerably more elevated than those found in the mainstem. Spring Run showed moderate elevation (105 mg/L), while Unnamed Tributary at RM 25.5, West Spring Run, and Kilbourne showed even greater values (563, 203, 224 mg/L, respectively). These are likely due to construction site runoff and stream bank erosion.

Metals

Heavy metals were reported at very low concentrations in the mainstem water column in the 1999 TSD and 2003 TSD. Elevated levels of zinc were present in tributary stream Bliss Run.

Other contaminants

Water column samples taken in 1996 at 6 locations within the study area were analyzed for volatile and semi-volatile organic compounds, pesticides, and PCBs. Compounds detected included: benzene hexachloride, dieldrin, endosulfan I, naphthalene, and 1,2,4-trimethlybenzene. All concentrations were below the criteria for toxicity, except for 1,2,4-trimethylbenzene which has no established criterion.

Sample Site (River Mile)	1999	2003	
	Fecal Coliform (colonies/ml)	Fecal Coliform (colonies/ml)	E.coli (colonies/ml)
26.3 - Lewis Center Rd	---	NS	NS
23.8- Worthington Galena Rd	---	NS	NS
22.6 (22.1, 21.6)- Cleveland Ave	2200, 4600	---	300, 340, 430, **1000**
19.8 - Schrock Road	**8454**	---	340, **1200**
17.4 - Upstream Huber Ridge	1350, **2000, 7820**	NS	NS
15.4 - Morse Road	**5300, *49000***	NS	NS
13.5 - Innis Road	4500, ***>60000***	**5259**	310, **730, *4400***
9.2 – Impounded Downstream American Ditch	**6900, *52000***	NS	NS
8.6 - Downstream American Ditch	NS	NS	NS
7.5 - Wolfe Park	2100, 2500, 4000, 4400 ***>60000***	NS	NS
6.6 - Livingston Ave	**5000, *49000***	NS	NS
3.9 - Refugee Road	3800, ***60000***	3300	**530, 1110**
.8 – Mouth	***>60000***	---	360, 460, 490
Unnamed Trib at RM 25.5; .2	NS	3300, 5250, ***21000, 31000***	455, 590, ***3000, 18000, 29000***
Unnamed Trib at RM 23.47; .8	NS	----	320, 410, 440, **620, 650**
Spring Run – 3.7 Walnut St	NS	**8273, *27000***	**730, 1040, *2500, 8910, 25000***
Spring Run – 0.2, Buenos Aires Rd	NS	2300, **8818, 11000**	360, **818**, ***7200, 9640***
West Spring Run - .1	NS	9000, ***55000***	1600, **10100, *35000***
Kilbourne Run - .4	NS	4000, **10000**	710, ***7400, 10300***
Bliss Run	NS	2600, 4100, **17000, *55000***	450, ***2400, 2500, 11200, 54500***

Table 14: Fecal coliform & E.coli bacteria violations. Source: OEPA 1999, 2003

Maximum Primary Contact Recreation Criterion: E. coli: 298/100ml, Fecal coliform 2000/100ml
Maximum Secondary Contact Recreation Criterion: E. coli: 576/100ml, Fecal coliform 5000/100ml
NS = Not sampled
---- = No violation
Regular Text = primary contact violation
Bold Text = secondary contact violation
Italic Text = extremely elevated levels, 5≤ times above secondary contact criterion

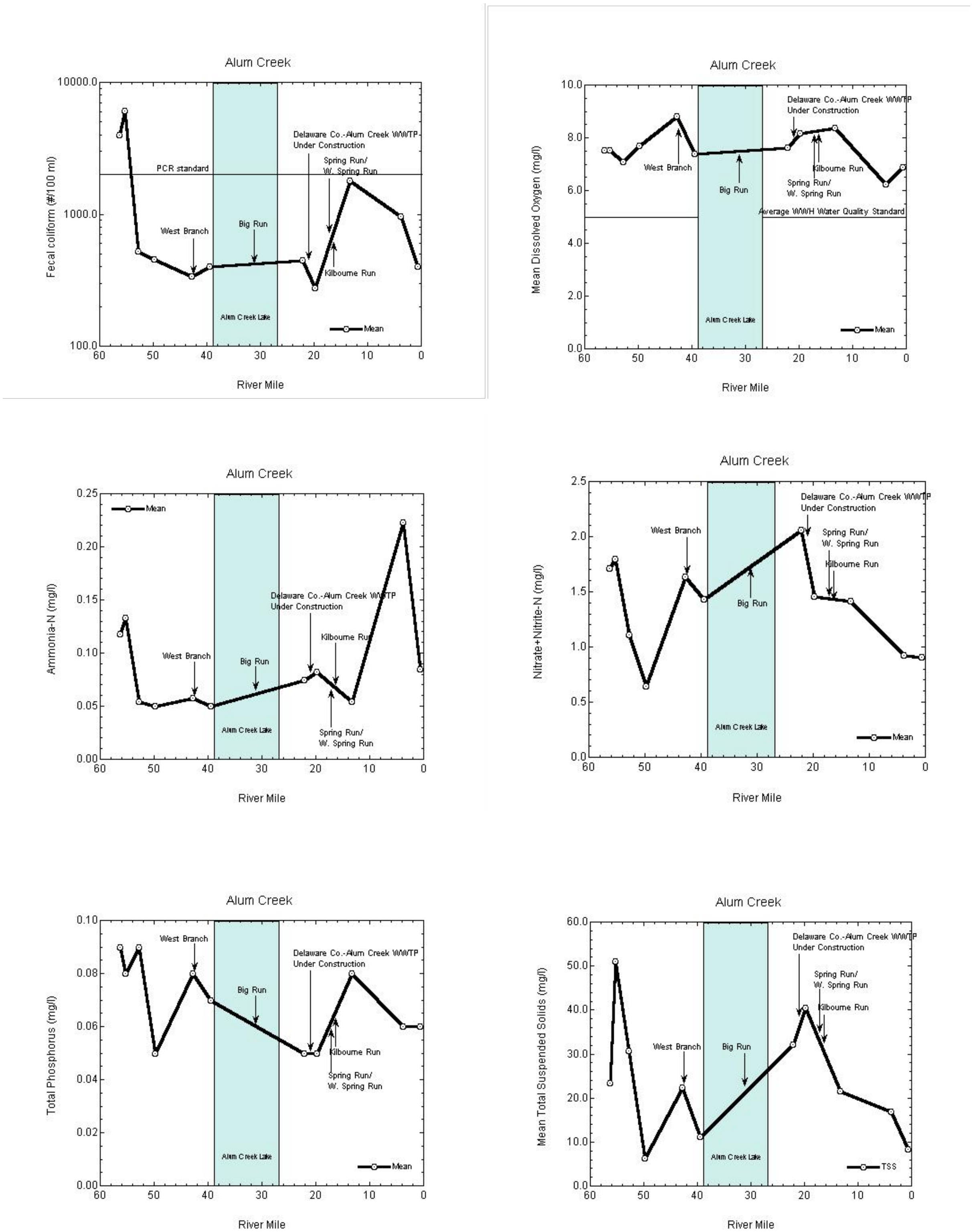


Figure 26: Chemical water quality values for the lower Alum Creek mainstem, 2000. Source: Ohio, 2003a.

Sediment Chemistry

Sediment contamination was addressed by both the Ohio EPA Division of Surface Water (DSW) in 1996 and 2000 and by the Division of Emergency and Remedial Response (DERR) in 1994-5. In the 1996 study, DSW collected sediment samples from 6 locations along the Alum Creek (RM's 42.8, 26.3, 17.4, 17.2, 9.1, and 6.6). In 2000, they added RM 3.9 to their sample set. Ohio EPA-DERR conducted a sediment study in 1994-5, collecting samples near four unregulated and potentially hazardous waste sites at Cassidy Park (close to Maryland Avenue), Maryland Avenue (RM 9.1), Jeffrey Park (south of Maryland Avenue), and Anchor Landfill (north of I-70 bridge).

Sediment samples were analyzed for heavy metals, volatile organic compounds, pesticides and PCBs. Sediments were classified by their level of contamination. Two different classification systems were used by the two Ohio EPA agencies. Based on the work of Kelly and Hite (1984), DSW classified heavy metal contamination on a scale from "non-elevated" to "extremely elevated". Both DERR and DSW (for organics) classified samples by their potential toxicity to aquatic benthic organisms, at a "No Effect level", "Lowest Effect Level (LEL)", or "Severe Effect Level (SEL)". The "effect level" system was developed by Persuad et al. (1994) and Ohio EPA (1996), and states that "exceedences of the SEL level indicate that adverse effects are likely, while exceedences of the LEL indicate a potential for adverse effects (Myers 2001: 8)." Results are described below according to site, ordered from upstream to downstream, and also listed in table form in Appendix 14.

RM 26.3 (directly downstream from the Alum Creek Reservoir) DSW
Sediment contained highly elevated concentrations of chromium and iron, elevated levels of nickel, and slightly elevated levels of copper and zinc. Organic contaminants were not detected. Elevated iron is probably from natural sources. The water treatment plant may be the source of other metals. Elevated metal concentrations at this site are surprising since it is directly downstream from the Alum Creek reservoir.

RM 17.40 (upstream from Huber Ridge WWTP) DSW
A variety of polynuclear aromatic hydrocarbons (PAHs), which are constituents of tar, were found at concentrations greater than the lowest effect level (LEL). These could be caused by recent road construction. Low levels of the plasticizer [2-ethylhexly] phthalate were also detected.

RM 17.20 (downstream from Huber Ridge WWTP) DSW
Highly elevated arsenic levels and slightly elevated levels of most other metals were found at this site. PAH concentrations were approximately double those found at RM 17.40.

Cassady Park (sample ID: SE 75) DERR hazardous waste site
Concentrations of arsenic, copper, lead, mercury, nickel, and zinc exceeded the LEL. Concentrations of various semi-volatile organic compounds (SVOCs) also exceeded the LEL level. (In this case, SVOC is synonymous with PAH).

RM 9.10 (American Ditch or Maryland Avenue) DSW and DERR

Zinc concentrations were highly elevated, cadmium concentrations were extremely elevated, and other metals varied from slightly elevated to elevated. Every metal concentration exceeded the LEL in one or both of the DSW and DERR analyses (including arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc). Drainage from the contaminated soil at the ASARCO site through American Ditch is probably the cause of high metal concentrations. Also found at levels above the LEL were the pesticides methoxyclor, endosulfan I and II, and 4,4 DDT; a type of PCB called PCB-1260; and various SVOCs. The DERR sample showed seven different SVOCs at concentrations above the SEL (Severe Effect Level), though the DSW sample determined the concentrations to be much lower (Myers, 2001: Table 3-4). Contamination by pesticides, PCBs, and SVOCs is most likely due to urban runoff or industrial inputs.

Jeffrey Park (sample ID: SE 73) DERR hazardous waste site
Concentrations of arsenic, cadmium, copper, lead, mercury, and zinc exceeded the LEL. Concentrations of three types of SVOCs exceeded the SEL, and concentrations of the pesticides endosulfan I and II exceeded the LEL.

RM 6.6 (Livingston Ave) DSW
Concentrations of cadmium were highly elevated, concentrations of zinc were elevated, and concentrations of lead were slightly elevated. Concentrations of several PAHs, the pesticide dieldrin, and PCB-1260 were found above the LEL.

Anchor Landfill (sample ID: AN-SE30) DERR hazardous waste site
An incredibly high arsenic concentration of 55.3mg/kg was found, compared to the SEL of 33 mg/kg. Concentrations of cadmium, copper, lead, mercury, nickel, and zinc were all above the LEL. Six pesticides and PCB-1260 were found at concentrations above the LEL.

RM 3.9 (State Route 104) DSW, 2000
Concentrations of arsenic, cadmium, chromium, copper, lead, nickel, and zinc were above the LEL. Two different pesticides and PCB-1260 were found at concentrations above the LEL.

Regarding the results of their 1996 study, the Ohio EPA-DSW reports that “a potential for adverse effects on the biological community in Alum Creek is possible” (OEPA, 1999: p112). The contaminants found in stream sediment remain for long periods of time, and have a tendency to bioaccumulate in the tissues of aquatic organisms.

Physical Habitat

The 1996 survey of near and instream macrohabitats at 14 locations along the lower Alum Creek and one site on the West Branch (a tributary north of the reservoir in Delaware County) yielded a range of QHEI values between 52.0 and 81.0, and mean QHEI of 64.8 (+/- 9.99 SD). Streams with a mean QHEI of 60 or more are considered to have macrohabitat of sufficient quality to support aquatic life consistent with WWH criteria.

Though the average QHEI was within WWH criterion, macrohabitat quality was deficient in the stream segment between RM 9.2 (Nelson Park dam pool) and RM 3.9 (Refugee Rd), showing QHEI scores between 52 and 56.5. In this segment, aquatic habitat is adversely affected by historic channelization, urban runoff, and impoundments (dams). Every station within this segment showed six to seven modified habitat attributes such as extensive channelization, high substrate embeddedness, fair to poor channel development, and low sinuosity (curviness).

The QHEI scores in the 2003 report averaged a much stronger score of 78, although evaluations were not completed between RM 9.2 and 3.9 (Table 15). The 1999 TSD also reported that the remaining sections of Alum Creek were found to be of sufficient quality to support an aquatic community consistent with WWH criteria. At most stations, channel configuration was in a natural or recovering state with adequate sinuosity and riffle-run-pool complexes and substrates were typically coarse gravel and cobble. However, many modified habitat attributes were present despite high QHEI values. See the "Physical Attributes" Section of this document for more information on stream habitat.

Biotic Indicators of Water Quality

Macroinvertebrate Community

Sixteen sites on Alum Creek were evaluated in 1996 for their macroinvertebrate assemblages. Evaluations ranged from poor to exceptional quality, with a range of Invertebrate Community Index (IC) scores from 10 to 50 (ICI criteria are 36 for WWH and 46 for EWH) (see table below).

Marginally Good to Very Good ICI Scores were found in the segment from RM 28.2 to RM 13.5 at non-mixing zone sites (ICI=36) and near the mouth at RM 0.7 (ICI=42). Artificial substrates from these sites contained high densities of tanytarsini midges (61.4%-81.0%) and low densities of pollution tolerant taxa (0.1%-5.8%). Moderate numbers of mayfly and caddisfly larvae were collected.

Fair to Poor ICI Scores were found from RM 8.6 to RM 3.8. The lowest ICI score on the Alum creek (10) was found just downstream from the Nelson Park dam. At this site, only one mayfly taxon, no caddisfly taxa, and a low percentage of tanytarsini midges were collected. Additionally, there was an area of bacterial growth upstream from the dam wall and stream edges were covered with algae. At the next few sites (RMs 7.6, 6.2, and 3.8) ICI scores increased into the fair range but low EPT (pollution sensitive taxa) richness and high percentage of pollution tolerant insects showed a continuing negative influence on community structure.

The 2003 DSW report showed ICI scores declining in upstream sites where they had previously been in the marginally good to very good range. The largest decline was visible at RM 19.8, which was sampled in both studies. The 1999 report showed a score of 42 for the ICI, while the 2003 report showed a score of 28, which is well below the minimum WWH score of 36. Further downstream at RM 13.4, the score fell only two points from 34 in 1999 to 32 in 2003. Both of these scores are considered below the minimum criteria but in the "non-significant departure" range.

Fish Community

Fish sampling included 15 stations on Alum Creek in 1996 from RM 44.1 to RM 0.8 and one station on the West Branch at RM 0.6. Numerically, the predominant species were: central stoneroller (17.2%), sand shiner (8.0%), green sunfish (6.8%), greenside darter (6.7%), and longear and bluegill sunfish (5.8%). According to biomass, dominant species were: common carp (59.3%), golden redhorse (5.3%), river carpsucker (4.8%), white sucker (3.0%), and northern hog sucker (2.6%). Overall, the fish assemblage of Alum Creek was characterized as marginally good to good. Index of Biological Integrity (IBI) and the Modified Index of Wellbeing (MIwb) scores ranged between fair and very good (28-49 and 7.7-9.2, respectively) (see Table 15 below).

Nine sites were sampled in the 13-mile segment stretching from RM 26.3 to RM 13.5. All sites performed above the WWH criterion for IBI and MIwb except for the RM 17.4 site just upstream from Huber Creek. At this site, a deviation of just 0.1 units in MIwb indicated a structural evenness of the fish community just below the minimum criteria; however, this subpar score did not seem to indicate any significant impact and was attributed to background stressors.

In the remaining highly urbanized segment, mixed results were obtained. The MIwb scores either met or exceeded WWH criterion, indicating a structural evenness, adjusted abundance, and adjusted biomass comparable with WWH biological criterion. However, IBI scores showed a severe decline in community performance from RM 9.2 to 3.9. Diminished community attributes included a high proportion of environmentally tolerant species, a low proportion of lithophils and round-bodied suckers, and a high incidence of DELT anomalies. Likely causes of this poor performance include the Alum Creek storm tank discharge, highly modified habitat (channelization and impoundment), and urban runoff.

Habitat improved closer to the confluence with Big Walnut Creek, and full recovery of the IBI was noted at RM 0.8. Measurement of IBI and MIwb at the West Branch site (RM 0.6) indicated good to very good fish community performance.

Once again the 2003 DSW report saw a decline in fish metrics further upstream from the previously impaired reach between RM 9.2 and 3.9. The MIwb score at river mile 13.4 was barely in attainment in 1999, and fell 0.3 points into non-attainment in 2003.

2003 Results - River Mile	1999 Results - River Mile	IBI	Miwb	ICI	QHEI	Use Attainment Status	Location
Alum Creek (mainstem)							
	26.3 / 26.2	40	8.6	44	75.0	Full	Lewis Center Rd – Dst Reservoir
	23.8 / 24.0	42	8.3	40	58.0	Full	Worthington Galena Road
	22.6 / 22.5	43	*7.9*	40	57.5	Full	Cleveland Ave – Dst Polaris
22.4 / 22.1		43	*8.0*	46	70.5	Full	Cleveland Avenue
	19.8 / 19.8	45	8.9	42	77.5	Full	Shrock Road
19.8 / 19.8		42	*8.2*	**28**	79.5	Partial	Shrock Road
	17.4 / 17.3	*38*	**7.7**	*34*	74.0	Partial	Ust Huber Ridge WWTP
	17.2 / 17.2	40	9.0	P/P	N/A	N/A	Huber Ridge Mixing Zone
	15.4 / 15.3	43	8.4	38	62.5	Full	Morse Road – Dst Huber Ridge
	13.5 / 13 .5	*36*	*7.9*	*34*	75.5	Full	Innis Road, Suburban
13.4 / 13.5		*38*	**7.6**	*32*	79.0	Partial	Innis Park
	9.2 / --	**28**	*8.0*	---	52.0	Partial	Dst. American Ditch – Impounded
	-- / 8.6	--	--	**10**	--	Non	Dst American Ditch
-- / 7.6		--	--	**24**	--	Non	Wolf Park
	6.6 / 6.2	**35**	8.7	**30**	52.5	Partial	Livingston Avenue – Dst. CSO
	3.9 / 3.8	**32**	9.0	**28**	55.5	Partial	Refugee Road
3.8 / 2.7		*39*	9.2	**28**	86.5	Partial	Refugee Road
	0.8 / .07	*38*	9.2	42	67.0	Full	Mouth
0.8 / 0.7		42	8.9	46	73.0	Full	Mouth
Unnamed Tributary at RM 25.50							
0.2 / -		52	NA	**-**	63.0	Full	Africa Road
Unnamed Tributary at RM 23.47							
0.8 / -		40	NA	-	64.0	Full	Africa Road
Spring Run							
6.0 / 5.4		**24**	NA	**VP**	26.0	Non	Maxtown Road / Blue Heron Road
3.7		**28**	NA	**P**	59.0	Non	Walnut Street
0.2		44	NA	F	58.0	Partial	Buenos Aires Road
West Spring Run							
0.4 / -		**20**	NA	-	60.0	Non	State Route 3
Kilbourne Run							
0.4 / -		**28**	NA	-	66.0	Non	State Route 3

Table 15: Biological and habitat index scores and use attainment for lower Alum Creek watershed sampling sites.
Source: OEPA, 1999, 2003.

Italics = Non significant departure from criteria
Bold = Scores below criteria, signifying partial or non attainment

Point Sources

Pollution sources are classified into two general categories. Those originating from a location that can be specifically identified, such as the end of a pipe, are referred to as "point sources." Alternately, "nonpoint sources" of pollution are diffuse, originating (for example) as runoff from roadways or lawns. The Clean Water Act (CWA) of 1972 set forth many policies to clean up the nation's waterways, including both point and nonpoint source pollution. At the time, point sources were both more visible and easier to contain, and were therefore the focus of the first CWA programs to be implemented.

The legislation established the National Pollution Discharge Elimination System (NPDES) to document and permit all point sources. Permits generally set limits on the amount of various chemicals that facilities could discharge, which were based on the more stringent of the following two criteria:

- federal effluent guidelines developed for specific industries, or
- the assimilative capacity of the watercourse in question. (i.e., a facility's effluent should not prevent the water course from meeting EPA standards for humans or aquatic life.)

Implementation of the NPDES system has dramatically reduced the amount of point source pollution nationwide. Six NPDES permitted facilities[2] exist in the lower Alum Creek watershed (Table 16), and all facilities are currently meeting their permit limits.

Facility	Discharge Location Description	Discharge Location - River Mile	Discharge Design Limit	Discharge Current Actual
Westerville Water Treatment Plant	Unnamed tributary to Alum Creek north of Main Street, Westerville	21.2	NA	.033 MGD
Alum Creek Wastewater Treatment Plant	South of Alum Creek Park in Westerville	20.95	10 MGD	2.3 MGD
Huber Ridge Water Treatment Plant	South of Route 3 bridge	17.9	NA	.09 MGD
Huber Ridge Wastewater Treatment Plant	North of Route161 bridge	17.2	1.03 MGD	.65 MGD
ASARCO, Inc.	American Ditch, to Alum Creek at Maryland Ave.	9.10	NA	Rainfall dependent
Alum Creek Stormwater Tanks (CSO)	Main Street, Columbus	7.0	NA	Rainfall dependent

Table 16: NPDES permitted facilities in lower Alum Creek watershed. NA = non-applicable: permits for these facilities do not dictate limits for discharge volume.

[2] One additional facility, Certified Oil, holds an NPDES permit to discharge to the lower Alum Creek, but that will not be renewed when it expires due to a change in facility operations. There are two additional facilities with NPDES permits located north of the Alum Creek Lake Reservoir: Delaware County Home WWTP and Ashley WWTP.

Alum Creek Wastewater Treatment Plant (Delaware County)

This facility is located near the intersection of I-71 and Powell Road and is operated by Delaware County. Effluent is piped approximately four miles to its discharge point on Alum Creek south of Main Street in Westerville. This distance was required partially because of the plant's distance from the creek, but also to avoid Westerville's public water supply intake (north of Main Street) and a notable fresh-water mussel colony.

The facility began operation in June 2001, and its 10 million gallon per day (MGD) design capacity makes it the largest NPDES permitted discharger to Alum Creek. It is currently operating at less than a quarter of its capacity, averaging 2.3 MGD, but increases are expected as population growth continues in Delaware County.

The Ohio EPA has not conducted a comprehensive water quality study of Alum Creek since the wastewater facility began operations. However, a small study conducted by Dr. Michael Hoggarth and his Otterbein College students showed a decline in ICI scores below the discharge when compared to scores directly above the discharge (Hoggarth *et al.*, 2002). It should be noted that ICI declines in this area were also shown in the 2003 TSD, based on data collected in 2000 before the facility opened. Other factors, such as land use change and sedimentation, may have contributed to these results, but these impacts should be evenly distributed throughout this river reach.

Huber Ridge Wastewater Treatment Plant

This private facility services the Huber Ridge Subdivision, located in an unincorporated section of Blendon Township (Franklin County) just north of SR 161 and west of I-270, and is operated by the Ohio American Water Company. The plant was constructed in 1962, and was identified in a study conducted by Ohio EPA in 1972 as a significant source of water quality degradation. In 1994, in accordance with a federal consent order, the facility upgraded its equipment and treatment capacity. The Ohio EPA's 1999 water quality report concluded that the facility is no longer a significant pollution source (OEPA, 1999). The facility has a design capacity of 1.03 MGD, and currently operates at 1/10 of that capacity.

Huber Ridge Water Treatment Plant

This facility withdraws ground water near Alum Creek to provide public water supply for the Huber Ridge Subdivision (see above). The presence of dissolved solids and suspended solids (such as calcium and magnesium) that are a by-product of the treatment process is the primary reason for permitting water treatment facilities. This facility's discharge point was located within a small river reach that was in partial attainment of standards in the Ohio EPA 1999 water quality report, but was not mentioned as a potential source of impairment. Its average discharge is 90,000 gallons per day (GPD), or .09 MGD.

Westerville Water Treatment Plant

This facility is located just north of Main Street in Westerville, and is operated by the City of Westerville. It discharges approximately .033 MGD to an unnamed tributary above the intake.

As mentioned above, the presence of dissolved solids in discharge waters are the primary cause for permitting of water treatment facilities.

ASARCO Incorporated

ASARCO was a zinc smelting facility that began operations in the 1920's and closed in 1986. Surface water runoff from ASARCO was discharged to American Ditch, which in turn discharges to Alum Creek near Maryland Avenue just north of the Nelson Park Dam. The Ohio EPA Integrated Water Quality Report of 2002 (OEPA, 2002) suggests that zinc and cadmium found in Alum Creek sediments were a result of insufficient treatment of surface waters running off this site. The site has been capped, and the current NPDES permit requires monitoring for heavy metals in storm water runoff and treating water emerging from under the cap.

Although industrial facilities that do not discharge process water are generally not required to apply for NPDES permits, ASARCO has been required to do so since 1997 given its history. The facility's current permit (effective March 1, 2002) required the owners to conduct monitoring to delineate the zinc and cadmium sediment contamination within American Ditch and Alum Creek (from immediately upstream of the American Ditch confluence to river mile 6.0). It also required a review of current federal and state guidance for sediment remediation and how it will apply to American Ditch and Alum Creek. Actual field sampling was conducted in November 2003. If results show significant contamination that is determined to be the result of runoff from the ASARCO facility, various options for a cleanup plan will be considered. Possible mechanisms include further permit requirements or an enforcement consent decree.

Alum Creek Storm Tanks (CSO)

The Alum Creek Storm Tanks, located next to Alum Creek south of Main Street, and owned by the City of Columbus. The tanks contain an engineered discharge point for a combined sewer collection system. Under normal conditions, the system conveys both wastewater and rain water to a wastewater treatment facility. But during heavy rain events, combined systems were designed to overflow into waterways to relieve pressure and prevent basement backups. Combined systems are found in older city neighborhoods and were considered a conventional engineering practice at the time they were built - newer systems collect sewage and storm water separately. The Alum Creek Storm Tanks are intended to provide primary treatment (solids settling and skimming of floatables) of the discharge before it is released during periods of high rainfall.

Table 17 shows estimated discharge volumes between 2001 and 1997, although volumes were often not available due to equipment failure. Of the data that were collected in the five-year period between 1997 and 2001, volumes varied widely due to differences in annual precipitation. Eight million gallons were discharged in 1999, while 100 million gallons were discharged in 1997.

Year	**Monthly discharges (million gallons)**												**Total Annual Discharge (million gallons)**
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
1997				1.4		83.5*	9.5*	6.3					100.7*
1998	1			27.1		7.9						15.5	51.5
1999				6		1		1				*	8.0*
2000	*			*	2.9	0.4	1.7	3.8*	2.8			40.2	51.8*
2001					14.4		2.4	7.2			6.3	2.6	32.9
Total	1*	0	0	34.5*	17.3	92.8	13.6*	18.3*	2.8	0	6.3	58.3*	244.9

Table 17: Monthly and annual discharges from the Alum Creek Storm Tanks (CSO), 1997-2001. Source: Columbus Department of Public Utilities. * = Incomplete data; discharge occurred but total flow was not measured.

The Alum Creek Storm Tanks are a part of the sewer system that terminates at the Columbus Southerly Wastewater Treatment Plant (which discharges into the Scioto River), and therefore are included within the facility's permit. The permit requires the city of Columbus to report and record when overflows occur and conduct sampling of storm tank effluent (although data are not currently available). The language in the permit requires that the discharges "minimize impacts on water quality." The Ohio EPA, along with the USEPA, is currently reviewing the city's Long Term Control Plan (LTCP) for CSOs. See Appendix 15 for a more detailed review of projects that will affect CSO discharges.

SSOs (Sanitary Sewer Overflows)

Like combined sewer systems, some sanitary sewer systems were also designed to discharge into surface waters during heavy rain events, or in the event of a dry weather sewer blockage, to alleviate excess pressure. The water collected in these systems is not as diluted with rain water as combined sewer systems, and may pose a greater potential threat to public and aquatic health. Eight such Sanitary Sewer Overflows (SSO's) exist in the lower Alum Creek watershed (Table 18).

The SSO's may discharge with less frequency and are less influenced by heavy precipitation events than CSO's, but other factors such as blockages due to tree roots or grease, as well as inflow and infiltration, play a role in SSO overflow frequency. Reports provided by the City of Columbus Public Utilities Department revealed that over a 13 month period between August 2002 and October 2003, 113 SSO discharges occurred in the Alum Creek watershed. Although eight SSO points exist in the watershed, only three discharged in that time frame. Discharge volumes were obtained for only 2 of 113 events but totaled over nine million gallons.

While the federal Clean Water Act called for sanitary sewer overflows to be eliminated, some SSO points were still permitted in Columbus by the Ohio EPA. The City of Columbus did, however, enter into a consent decree with the Ohio EPA in 2002 concerning SSO's citywide. The consent decree was spurred by a "notice of intent to sue" filed by the Ohio Chapter of the Sierra Club, claiming that the discharges were a violation of the Clean Water Act. The decree included a fine the city agreed to pay to the Ohio EPA and allocation of funds to a local environmentally beneficial project. It also included language to ensure the completion of planned capital improvement projects (CIP's) that will reduce or eliminate SSO discharge points through rehabilitation and increasing capacity.

<table>
<tr><th>Receiving Waters</th><th>Discharge Location / Landmark</th><th>Number of "Inland" Relief Points</th><th># of Discharges, Aug. 2002 – Oct. 2003</th></tr>
<tr><td>Unnamed tributary (ditch)</td><td>East of Cleveland Avenue, south of Ferris Road</td><td>1</td><td>3</td></tr>
<tr><td>Unnamed tributary (ditch)</td><td>East of Purdue Avenue, north of Aberdeen Avenue (near Agler Road)</td><td>7</td><td>52</td></tr>
<tr><td>Unnamed tributary (ditch)</td><td>At Parkwood Avenue, West of Woodland Avenue, south of Mock Road</td><td>1</td><td>--</td></tr>
<tr><td>Alum Creek</td><td>Fair Avenue / Wolfe Park pedestrian suspension bridge, east bank</td><td>1</td><td rowspan="4">58</td></tr>
<tr><td>Alum Creek</td><td>Kenton Ave., south of Main Street, just north of Schneider Park (Bexley), west bank</td><td>4</td></tr>
<tr><td>Alum Creek</td><td>North of Livingston Avenue</td><td>11</td></tr>
<tr><td>Alum Creek</td><td>Roads End / Bliss Run, Berwick</td><td>1</td></tr>
<tr><td>Unnamed tributary</td><td>East of Alum Creek Drive, north of Refugee Road</td><td>1</td><td>--</td></tr>
</table>

Table 18: Overflow events for Sanitary Sewer Overflows in the lower Alum Creek watershed, August 2002 through October 2003. In-land relief points are SSO's that discharge to waterways indirectly by first discharging into a storm sewer system. Source: City of Columbus Public Utilities Department.

A major CIP that will improve the sewer collection capacity and reduce sewer overflows is the Big Walnut Augmentation / Rickenbacher Interceptor (BWARI). This two-part project will tunnel a new sewer system from the Southerly WWTP to I-270 and Alum Creek Drive by 2008. The increased capacity will provide in-pipe storage to reduce sewer overflows at the Southerly WWTP (Scioto River). While the BWARI project will have no direct and immediate benefit to Alum Creek, the infrastructure will lay the foundation for future improvement projects in eastern Franklin County that will benefit the Alum Creek watershed in the reduction of sewer overflows.

Columbus, in the meantime, is taking other prevention and maintenance measures that should limit the volume and frequency of discharges. These include conducting inflow and infiltration studies, (commonly referred to as "I/I studies") to locate the sources of excess water entering the system, disconnection of outdated private property stormwater connections to the sanitary system, and rehabilitation of older sewer lines through the trenchless cured-in-place piping method to seal out infiltration during precipitation events. See Appendix 15 for a more detailed review of projects that will affect SSO discharges.

Nonpoint Sources

Unlike point sources of pollution that have discrete discharge locations, nonpoint sources (NPS) of pollution have diffuse origins and can be generated over a broad area. When precipitation falls on lawns and streets it often encounters and absorbs pollutants as it drains into tributaries or stormwater collection systems. These pollutants can include sediment, gasoline, lawn care chemicals, industrial chemicals, fecal bacteria, and even excessive heat absorbed from asphalt. Although wastewater is conveyed in sanitary sewers to treatment facilities, stormwater collected along street curbs does not receive treatment, and drains directly in waterways (Figure 27).

Much NPS pollution in urban areas occurs as polluted runoff, although habitat disturbances such as dams, levies, and channelization are also included in this category. While point sources are regulated by the Ohio EPA and their impacts have been largely diminished over the last thirty years, nonpoint sources of pollution are very difficult to control. Perhaps because of this, NPS pollution is now considered the largest source of degradation to the nation's waterways.

The following section discusses various nonpoint sources of pollution in the Alum Creek watershed. Please note that water quality data regarding these pollutants can be found in the prior segment ("Summary Results of Ohio EPA Alum Creek Studies"). Most of the data that support these discussions were published in two Ohio EPA water quality studies of Alum Creek, referred to as Technical Support Documents (TSDs), in 1999 and 2003 (OEPA 1999a, 2003a).

Figure 27: Polluted stormwater discharge into Alum Creek

NPDES Phase I & II Stormwater Regulations

Stormwater refers to precipitation that is collected from urban streets by sewer systems and discharged to local waterways. The Clean Water Act established a program to reduce the extent of pollution conveyed in stormwater by requiring municipalities to create stormwater control plans. The program was implemented in two phases: Phase I went into effect in 1992, and required large municipalities to develop control plans to address six major components:

- education and outreach for NPS prevention,
- public involvement and participation in plan development,
- detecting illicit discharges to stormwater systems,
- controlling pre-construction runoff (soil erosion),
- controlling post construction runoff (stormwater volume and quality), and
- good housekeeping to prevent NPS from in-house activities.

Phase II of the stormwater regulations, which were broader in scope and also applied to smaller municipalities, took effect in Spring of 2003. Since then, the entire watershed has been encompassed by Phase I (City of Columbus), and Phase II (townships in Delaware and Franklin Counties, Cities of Westerville and Bexley, and Village of Minerva Park) communities. The consequences of these regulations are discussed throughout the remainder of this section.

Sedimentation

Census data for Franklin and Delaware Counties reflect that the Alum Creek watershed, like the rest of central Ohio, is growing rapidly (see the Cultural Resources segment for census data and the Hydrology segment for land use change information). The construction sites that dot the landscape are generally prepared by removing vegetation with heavy machinery, which can result in multiple acres of disturbed land with bare soils at any given time. These areas are extremely vulnerable to erosion during rain events because the vegetation that would normally hold soil in place has been removed. Sediment can by washed by the ton into streams during precipitation events, where it causes severe problems, such as:

- smothering organisms living on the river bottom (insects and fresh water mussels);
- burying river bottom substrates, such as fine gravels or cobbles, that serve as fish habitat and spawning and breeding grounds;
- clogging fish gills and causing difficulty in their breathing; and
- spurring bank erosion by filling in the stream channel and causing a shift in flow patterns.

Some aquatic species are more sensitive to sedimentation than others. As sedimentation worsens, biodiversity can be lost from a given aquatic system. The 1999 TSD states that most sampling stations were "not excessively burdened with embedding fines" (OEPA 1999a: p117), although in the most impacted area between river miles (RM) 9.2 and 3.9, high overall substrate embeddedness was noted.

The more recent 2003 TSD shows that at the four locations where habitat evaluations were performed (RM 19.8 - Schrock Road; RM 13.4 - Innis Park; RM 2.7 – Refugee Road; RM 0.8 – Mouth), four out of five showed high to moderate riffle embeddedness and three showed high to moderate overall embeddedness (OEPA, 2003a). Siltation is listed as a high magnitude cause of impairment for the lower subwatershed mainstem and many tributaries. Two sites on the mainstem, Shrock Road and Innis Park, were for the first time since the 1980's found to be in nonattainment of water quality standards, and macroinvertebrates were in decline. It is very likely that construction site erosion in the Westerville and Sunbury Road areas is contributing to this decline (Bolton, 2002). In addition, bank erosion may be contributing sediment loads in tributaries.

Phase I & II stormwater regulations require municipalities to create programs to limit erosion from construction sites. Developers must submit soil and erosion control plans for every site over one acre in size (as of 2003) and utilize “Best Management Practices,” (BMPs), to prevent erosion. Municipalities are responsible for inspecting the sites to ensure compliance. There are many BMPs in use, although improper installation and maintenance is common and limits effectiveness (Patterson, 2000). For example, Figure 28 shows a failed sediment fence at a construction site near Alum Creek tributary Alkire Run north of County Line Road. The Friends of Alum Creek & Tributaries submitted over 15 complaints regarding failed erosion control measures between 2000 and 2003. Six of these were generated during a single visit to a five square mile area of Delaware County in 2003.

Figure 28: A failed sediment fence near an Alum Creek tributary allows sediment to wash into the stream.

The most efficient BMP currently available is a centralized sediment pond, which has been estimated to result in a 50 – 85% sediment reduction, depending on proper implementation and maintenance. Timely seeding of exposed areas that will remain dormant or have received final grading is also thought to be an efficient erosion prevention practice. Other practices, such as inlet covers and sediment fencing, provide lower ranges of effectiveness (Kallipolitis, 2005).

The City of Columbus has had an erosion and sediment control program in place since 1994. Up until 2003, when Phase II regulations were promulgated, areas outside of the City of Columbus were inspected on a complaint basis by the OEPA Division of Surface Water. New erosion and sediment control programs in Phase II communities will likely result in a dramatic improvement in compliance, although Phase II communities have five years (to 2008) to fully implement all programs. Given the rate of land use change in southern Delaware County, townships there elected to implement soil and erosion control programs on a fast-track schedule to have programs in place by 2004.

Bacteria and Unsewered Areas

The Ohio EPA has established standards for concentrations of fecal coliform bacteria that can be presumed safe for primary contact (swimming and canoeing) and secondary contact (wading) recreation in Ohio streams and rivers. In the 1999 & 2003 TSD's, exceedences of the primary and secondary contact standards were observed at almost every sampling location. These exceedences composed "the most frequent (water quality) violations observed in the Alum Creek mainstem" (OEPA, 1999a). The prevalence of bacteria in Alum Creek waters is due to a combination of point and nonpoint sources of pollution, including sewer overflows, municipal wastewater treatment facilities, home sewage treatment systems, and urban runoff. This section focuses on the latter two nonpoint sources of pollution.

While much of the Alum Creek watershed lies within municipal jurisdictions, significant pockets of developed land do not have sanitary sewer service. Within Franklin County, sections of both recently annexed City of Columbus lands and remaining pockets of township lands are unsewered. Portions of Orange and Genoa Townships in Delaware County are also unsewered. These areas rely on individual home sewage treatment systems (HSTS), mainly on-lot septic/leach systems or off-lot aeration systems. As shown in Table 19 below, there are over 300 HSTS in the lower Alum Creek watershed. However, this estimate excludes the most prevalent kind of system – residential septic/leach - because data are generally not available.

The Franklin County Board of Health estimates that there are 14,000 on-lot residential systems in the county, and is currently seeking funds to conduct comprehensive research. The Delaware Health District (DHD) does maintain a database of HSTS systems, although it currently does not include systems that were installed before the database was established in 1988. In the Delaware County portion of the lower Alum Creek watershed, 190 residential on-lot systems have been installed since 1988, and an additional 1300 to 1500 HSTS systems are estimated to have been installed prior to 1988 (Sutherland, 2005).

Jurisdiction	System Type				Total Number of Systems*
	Semi-public off-lot	Semi-public on-lot	Semi-public Total	Private off-lot	
Columbus TOTAL	15	12	*27*	24	51
Mifflin Twp	--	--	--	*47*	--
Blendon Twp	--	--	--	*24*	--
Clinton Twp	--	--	--	*14*	--
Westerville	--	--	--	*7*	--
Sharon Twp	--	--	--	*3*	--
Franklin Co. TOTAL	15	8	*23*	95	118
Orange Twp	*3*	--	--	*65*	*68*
Genoa Twp	*6*	--	--	*55*	*61*
Delaware Co. TOTAL	9	8	*17*	120	137
All Jurisdictions	**39**	**28**	***67***	**239**	**306**

Table 19: HSTS in the lower Alum Creek watershed. *Does not include residential on-lot (septic/leach) systems.

A number of factors can cause failure of HSTS and lead to untreated sewage reaching surface waters. Septic systems can fail if the system is improperly sited in non-absorbent soil, too small for the household waste load, or loses treatment capacity due to wet weather, aging, or lack of maintenance. Effluent can break through to the surface of a leach bed and become runoff into a local stream. Aeration systems rely on motors to aerobically break down wastes before they are discharged directly into a stream or ditch. These motors require maintenance and can stop working without the system owner's knowledge. What's more, older aeration systems were not designed to eliminate fecal bacteria, and thus contribute bacteria loadings even if they are in perfect functioning order. Failing HSTS can also contribute solid wastes (organic enrichment) that disturb the equilibrium of aquatic systems by spurring the growth of oxygen-depleting algae.

The Local Health Departments (LHD's) in the Alum Creek watershed, including those of Columbus, Delaware County, and Franklin County, perform inspections of HSTS's. Generally, the LHD's conduct annual inspections on all semi-public systems, both on and off-lot. In addition, all residential off-lot systems are inspected once a year. Residential on-lot systems are inspected on a complaint basis only. Inspections are usually visual, although a dissolved oxygen meter may be used to collect data if discharge is surfacing or looks suspicious. One LHD has estimated a 25% annual failure rate of discharging HSTS's.

A number of sewer extension projects are progressing throughout the watershed. Table 20 and Watershed Map #19 show ten sewering projects that are either completed, in progress, or have been identified as a future need. These projects are targeting problematic areas and should dramatically reduce the number of systems and bacteria loadings to Alum Creek and tributary streams. A few of the planned projects, including Cleveland Heights and Ferris Park, are the result of an old contract between the City of Columbus and Franklin County that allows sewer line extensions to township areas without annexation by Columbus. However, broad scale sewer extension to all areas within the Franklin County portion of the watershed that contain HSTS has not been planned.

Delaware County has completed a draft sewer master plan that includes problem areas identified for sewer tie-in and portions of the county where sewer service will be extended (DCRPC, 2003). Problem areas identified in the lower Alum Creek watershed include the Hanawalt Road area listed in the table below, and an additional area surrounding Perkins Lane. The latter is located southwest of the intersection of Big Walnut Road and State Route 3. Despite progress throughout the watershed, many clusters of systems exist outside of current project boundaries.

Other than HSTS, another nonpoint source of bacteria is general urban runoff, which may carry waste from pets and waterfowl. Like septic seepage, pet waste can wash off of lawns and into storm sewer systems and streams. Unfortunately, no data on the contribution of this potential source of bacteria are available. Most municipalities in the watershed do have ordinances mandating that pet owners pick-up after their pets.

Number	Name	Jurisdiction	Status	Comments
1	Hanawalt Road area	Westerville / Delaware County	Planned	Residents negotiating w/ Westerville and Delaware County for sewer line connections, as of Nov. 2003
2	Home Acre Drive area	Franklin County	Identified	No plans existing for this area
3	Dempsey Road area	Franklin County	Identified	No plans existing for this area
4	Strimple Avenue area	Columbus	In progress or completed	To be completed under Columbus Div. of Sewerage and Drainage Capital Improvement Project # 619
5	Cleveland Heights	Franklin County	In progress or completed	On Franklin County's list of 13 areas to be sewered under contract with city of Columbus. Two of three phases are completed as of November 2003.
6	Morse Road - Sunbury Rd. to Cleveland Ave.	Franklin County	In progress or completed	As of November 2003, 80% of businesses had tied into sewer, remaining 20% in progress. Morse Rd. at Cleveland Heights was completed as part of the Cleveland Heights project.
7	Ferris Road area	Franklin County	Planned	On Franklin Co.'s list of 13 areas to be sewered under contract w/ Columbus. To begin in 2004.
8	Florian Drive area	Columbus	In progress	
9	McCutcheon Road area	Columbus	In progress or completed	Sewer has been extended to part of the area; remaining residents will tie in as sewer lines are extended within 200 ft of property.
10	Mecca Road area	Franklin County	Identified	No plans existing for this area
11	Purdue Ave./Agler Rd.	Franklin County	Completed	

Table 20: Sanitary sewer extension projects in the lower Alum Creek watershed as of December 2003. Sources: Franklin County Board of Health, Delaware General Health District.

Nutrients

Nutrients are compounds that fuel living creatures. But while they are required by all life forms, excessive amounts of nutrients can harm the chemical balance of aquatic systems. Elevated levels of nutrients can trigger a population boom of waterborne algae and depletion of dissolved oxygen. A severe dip in dissolved oxygen can kill aquatic life, while sustained low levels can reduce diversity and abundance of aquatic species over time. Point and nonpoint sources of nutrients exist in the lower Alum Creek watershed, including sewage (septic systems, CSO's, SSO's, and pet waste), home lawn care products, and industrial chemicals.

While nitrogen, phosphorus, and potassium levels were found to be within normal ranges in the 1999 TSD, algal growth along the stream margin, especially in urban and impounded areas, indicated that elevated levels of nutrients existed. One diel dissolved oxygen reading in the Westerville area also showed the signature variability and super saturation of nutrient enrichment. The 2003 TSD reported that nutrients were elevated against background, especially in tributaries. Higher values seemed to correlate with wet weather, indicating runoff from suburban areas as the likely source. Nutrient enrichment was evident in Spring Run due to a super saturated day-time dissolved oxygen reading. Moderate but consistent levels of nutrients in Unnamed Tributary at RM 25.5 and 23.47 may indicate HSTS's as a source.

Research completed by the Ohio EPA suggests that physical habitat quality is a critical factor in determining if the effects of nutrients will be mitigated or exacerbated (OEPA, 1999b). While nutrient levels in tributaries such as Spring Run are not exceptionally high, their effects are likely exacerbated by very poor stream morphology. A wooded riparian corridor and active floodplain in a healthy stream habitat would help assimilate these pollutants.

Toxics

The following excerpt from OSU Extension Fact Sheet AEX-441-00 (OSU Extension, 1990) introduces nonpoint sources of toxic pollutants:

> Toxic contaminants are substances that can harm the health of aquatic life and/or human beings. Toxins are created by a wide variety of human practices and products, and include heavy metals, pesticides, and organic compounds like PCBs. Many toxins are very resistant to breakdown and tend to be passed through the food chain to be concentrated in top predators. Fish consumption health advisories are the result of concern over toxins. Oil, grease, and gasoline from roadways and chemicals used in homes, gardens, yards, and on farm crops, are major sources of toxic contaminants.

Toxic chemicals are found to a limited degree in the Alum Creek water column. Of greater concern is their prevalence in Alum Creek sediments, especially in slow moving sections of the river.[3] Heavy metals, volatile organic compounds, pesticides, and PCB's have all been detected in Alum Creek sediment, predominantly in the most heavily urbanized section of the watershed between I-670 and SR 104. The Sediment Chemistry segment (in Section III) details these findings, but the most extreme were arsenic and organic compounds found at two locations that were deemed at the "severe effect level" to aquatic organisms (Myers, 2001).

Industrial facilities can also contribute toxic materials to surface waters through nonpoint source pollution. The ASARCO company, which once smelted zinc, was discussed earlier in the Point Sources segment. Although it has recently been required to file for a point source discharge permit (under NPDES), it is probable that the facility contributed heavy metals (zinc and

[3] Some metals, such as iron, have natural sources; their presence in waterways is not always indicative of pollution.

cadmium) to Alum Creek via urban runoff in the 1970's and 80's. River sediments downstream from this facility, in a tributary stream referred to as "American Ditch" and in Alum Creek, are heavily contaminated with heavy metals. Alum Creek is in nonattainment of aquatic life standards in this reach, although a mixture of causes is probable.

Aside from ASARCO, Alum Creek contends with a long legacy of industrial facilities located in close proximity to the creek, notably along Joyce Avenue and south of Livingston Avenue. The Ohio EPA Division of Emergency and Remedial Response (DERR) published a report in 2001 that examined some of these facilities, namely old landfills and industrial sites between I-670 and SR-104. Their goal was to learn to what extent the facilities had in the past or continue to contribute pollutants to Alum Creek and if they would qualify for federal cleanup funds (under the Superfund program, or CERCLA). The report details available records for defunct and operating landfills and industrial facilities, and also provides results of sediment sampling.

The report described a cluster of older industrial facilities (including ASARCO) that drained to American Ditch, once known as "Acid Ditch," and storm sewers (Appendix 16). The cluster is located along Joyce Avenue north of I-670. The report states that "Many of the pollutants found in Alum Creek sediment occur in American Ditch; therefore, American Ditch is identified as a significant migration pathway of chemical pollutants (Myers 2001: p14)."

The DERR report also revealed that eight old landfills are located along the creek in southern Columbus from I-70 south to State Route 104. Many of them had accepted toxic materials that are still detectable in leachate outbreaks, on-site sediments, and ground water. The report concluded that further assessment of some industrial and landfill sites would be necessary.

Pollutant spills are another possible nonpoint source of a wide array of pollutants, including toxic materials. The 2003 TSD summarized a database maintained by DERR for self-reported spills in the year 2000. Over 20 spills were reported in the Alum Creek watershed that year, the majority of which consisted of sewage and petroleum products. The TSD states that "this list should be considered only a small fraction of the pollutants that are spilled into the basin on a regular basis" (OEPA, 2003a:60).

Industrial Stormwater Permits

One component of Phase I stormwater regulations addresses industrial facilities that have the potential to contribute nonpoint source pollution through surface runoff. Permits are required based on facility size and activity. There are 33 facilities within the lower Alum Creek watershed that hold such permits (Appendix 17) and are inspected jointly by the Ohio EPA and the City of Columbus Division of Sewerage and Drainage. Industrial stormwater permits focus on preventing pollution by utilizing Best Management Practices (BMP's) that minimize facility exposure to the environment. For instance, an awning erected over a potential spill area can prevent polluted runoff during storm events. Facilities must also monitor the water quality of stormwater generated from their grounds.

Debris

Although debris, or garbage, is not included in the standard suite of NPS pollutants, it does limit community enjoyment of natural resources and can in fact harm aquatic life. Tremendous amounts of debris can be found in urban waterways, often blowing off of road ways near creeks or delivered through storm sewer systems. Waterways can act as garbage "sinks," trapping garbage with mud and water.

The amount of garbage removed from Alum Creek during recent cleanups helps illustrate the magnitude of garbage as a cause of toxic and aesthetic degradation. During a six month period in 2001, the Friends of Alum Creek & Tributaries and other volunteers removed approximately 80 tires, 10 shopping carts, and 150 bags of trash (averaging 20 lbs. each). Trash included plastic bags, glass bottles and shards, steel and aluminum cans, a steel barrel half full of "oily goo," several other barrels with unknown former contents, an electric stove, a large doghouse with asphalt shingle roofing and fiberglass batting, 28 auto glass sections, a car hood, a cast iron sink, small electronic appliances (including a laptop computer and a telephone), metal furniture, and other debris. Other cleanups have yielded used diapers and syringes. On a ten mile canoe trip from Westerville to Nelson Park in Columbus, approximately 200 tires, a car, and two lead-acid vehicle batteries (which were removed and recycled) were sighted among the other typical garbage items.

Habitat disturbances

Habitat disturbances such as dams, levees, and channelization are also considered to be nonpoint sources of pollution, and can be found throughout the Alum Creek watershed. Impoundments and channelizations were indicated in the 2003 TSD as major sources of impairment for the Alum Creek mainstem and some tributaries. According to 1994 ODNR satellite data, the lower subwatershed (14 digit HUC) of Alum Creek contained 44% impervious land cover. This has resulted in habitat degradation in the lower subwatershed, while northern ends of the watershed are threatened. See the Physical Attributes segment (Section III) for more information.

Status and Trends

According to the 2003 TSD, approximately 18 miles of Alum Creek were in partial attainment and 9 miles were in full attainment of WWH aquatic life use standards. This signified a decline, down from 19 miles of full attainment reported in the 1999 TSD. During the period of time between the two reports, partial attainment status had spread much further north along the mainstem.

Although data presented for tributaries in the 2003 TSD were the first ever reported, they show similar trends. The three tributaries evaluated in more urbanized areas were not meeting attainment standards, while the two tributaries evaluated in Delaware County that were not yet affected by land use change were fairing well. The land use change that has so dramatically affected attainment status is anticipated to continue.

IV. WATERSHED IMPAIRMENTS, GOALS, AND IMPLEMENTATION

Section IV Table of Contents

A. Introduction

The action items contained in this section are based on a planning process that focused on collaboration among over 100 stakeholders in the Alum Creek watershed. At the outset of the planning process, participants devised six over-arching goals (or ends-objectives) for the action plan to guide their decision making. These were:

- Improve water quality and biological diversity
- Promote a healthy, functioning stream ecosystem
- Protect and increase natural landscapes, including green space
- Promote community awareness, use, stewardship, and involvement
- Protect human health
- Promote sustainable, long-term management efforts, including informed decision making

These overall goals were used to help frame the issues, and as a measure for considering and selecting from a range of action alternatives. Specific goals and performance indicators are included below for each stream segment, and are organized according to four focus areas. Brief descriptions of stakeholder involvement and commitments are included at the head of each action table.

Actions were formulated for the two subwatersheds within the lower Alum Creek watershed. The subwatersheds were delineated by the United States Geological Survey and identified by their 14-digit Hydrologic Unit Code (HUC) numbers. Actions were also formulated for six tributary streams, and are included below within their corresponding 14 digit HUC subwatershed.

Priorities

Given the scope of the issues addressed in this document and the variability in impairment issues and attainment status found throughout the watershed, it was necessary to set priorities for actions and stream segments. The following list of prioritized restoration and protection efforts will provide guidance as the plan is implemented.

Priority actions (in order):

1) Actions where local partners and opportunities for collaboration have been identified.
2) Actions that will help achieve targets for sediment and habitat TMDL's.
3) Actions to preserve riparian corridor, which will help prevent and mitigate impacts from continuing land use change (including sedimentation and habitat modification).
4) Actions to selectively remove lowhead dams, which have a large potential to dramatically improve water quality in the watershed's only nonattainment reach (and help achieve the habitat TMDL target).
5) Actions for nonpoint source pollution education in selected areas where urban runoff pollution has been identified as a source of impairment.

Priority stream segments (in order):

1) The upper subwatershed is the top priority stream segment because it is in attainment (according to most recent data) but threatened by land use change. Within this subwatershed, priority actions include 1) riparian corridor preservation and 2) sediment and erosion control.
2) The Spring Run watershed, which is a tributary to Alum Creek (in the lower subwatershed), is the second priority stream segment because it is currently in partial and nonattainment, but potential exists for making water quality improvements. This is due to the watershed's small size (8 square miles) and existence of strong local partnerships. Actions addressing 1) nonpoint source education and 2) stream morphology assessments will be enacted first.
3) The lower subwatershed, which is in partial and nonattainment, is the third priority stream reach. Priority actions include 1) riparian corridor preservation, 2) sediment and erosion control and 3) selective low head dam removal.

Total Maximum Daily Loads (TMDL's)

At the time of publication of this document, the Ohio EPA had produced a draft Total Maximum Daily Load (TMDL) restoration plan for the Big Walnut Creek basin, which includes Alum Creek, Big Walnut Creek, and Blacklick Creek (Ohio EPA, 2004). TMDL's are developed by Ohio EPA for impaired waters to determine the extent of pollution reduction necessary for a given stream to regain ecological health, or achieve full use attainment. This is accomplished by identifying pollutant sources, estimating their load contributions, and determining the extent of load reduction needed from each source.

In the Alum Creek watershed, TMDL's have been developed for sediment, pathogens, and habitat. The pathogen TMDL follows the methodology described above; load allocations and reductions have been prescribed for various NPS sources. For sediment and habitat, however, traditional load-based TMDL's were not developed because these two parameters were considered environmental conditions rather than pollutants. The TMDL target for both sediment and habitat is based on composite scores for specific parameters within the Qualitative Habitat Evaluation Index (QHEI).

The QHEI is comprised of measures of six components: substrate, instream cover, riparian characteristics, channel condition, pool/riffle quality, and gradient/drainage. However, the Ohio EPA has found that some of these components are more strongly correlated with attainment than others. As stated in the TMDL report, "Further analysis of the QHEI components as they relate to IBI scores led to the development of a list of attributes that are associated with degraded communities. These attributes are modifications of natural habitat and were classified as high-influence or moderate-influence attributes based on the statistical strength of the relationship" (Ohio EPA, 2004: 37).

Based on this information, a TMDL Habitat Target was developed based on three components, each worth one point: QHEI score/ Target Ratio (1 point) + moderate influence attribute score (1 point) + high influence attribute score (1point) = 3.

Similarly, a Sediment TMDL Target was developed that assigns a point to each of three QHEI attributes that reflect sediment loading. A target score equal to or greater than 33 is based on scores for substrate (14), channel morphology (14), and riparian zone/bank erosion (5).

While **performance indicators** are included with each action below to gauge implementation progress, the above TMDL targets are the long term indicators of the success for the plan, and will be assessed through water quality monitoring. Please see the Evaluation Section for more information.

Rationale for land use and habitat recommendations

While habitat recommendations such as lowhead dam removal are expected to have a direct positive impact on water quality, protecting riparian corridors will work indirectly to mitigate current and prevent future nonpoint sources of impairment. Ohio EPA Alum Creek water quality reports (see below) have shown a decline in water quality correlated with the spread of land use change. Actions to preserve riparian corridors can help prevent this decline in currently attaining areas, and help prevent further decline and allow for recovery in partially attaining river reaches. Protective land use regulations, when paired with site specific preservation, will:

- provide floodplain for the storage of increased stormwater volumes, which will reduce further impacts to the stream channel (and potentially local residents);
- assimilate sediment and nutrient loads; and
- allow lateral movement of the stream channel, which will aid its recovery from stormwater impacts (such as entrenchment) and direct hydromodifications (such as channelization).

The Ohio EPA has conducted extensive research which suggests that physical habitat quality plays a major role in determining if the effects of nutrients will be mitigated or exacerbated (OEPA, 1999b). Protection of the many benefits that riparian corridors provide is also a general common sense approach to long term watershed management. These include flood storage, in-stream habitat development, recreation, terrestrial biodiversity, control of water temperature and oxygen levels, organic debris for primary food chains, and buffering of runoff pollutants.

Data sources

Two water quality reports that were completed by the Ohio EPA are frequently referred to within this section and have provided a majority of the information on which recommendations are based. Studies were conducted in 1996 and 2000, and the resulting reports were published in 1999 and 2003, respectively (OEPA 1999a, 2003a). These reports are referred to as “Technical Support Documents,” or TSD’s. The 2003 report includes tributary data but it is also limited in number of mainstem sampling sites (6 over 27 miles). The 1999 report contains data from 13 mainstem sampling points.

Attainment status and causes and sources of impairment

The following table summarizes attainment status and causes and sources of impairment identified by the Ohio EPA in the 2003 TSD. Additional causes and sources of impairment identified through action planning research are also presented in the following pages.

Please note that while stream sediment pollutants (cadmium and priority organics) have been identified as causes of impairment in the lower watershed, actions to address them have not been included in the plan. The Ohio EPA is pursuing enforcement action against a private company (ASARCO) that was a likely source of sediment pollutants near River Mile 9.1 and in a tributary stream. The company may be required to perform sediment remediation. Action planners wished to wait for outcomes of the enforcement action and consider any pertinent data gathered during remediation before setting further action. Given the plethora of actions identified in the plan, action planners also wished to focus on the most feasible actions first; sediment remediation will be very complex and costly. This issue will be revisited during future plan revisions.

Stream Segment	Attainment Status			Cause of Impairment	Sources of Impairment
	Full	Partial	Non		
Alum Creek – Upper Subwatershed *Alum Creek Dam to Columbus Boundary (RM 26.7 – 19.9)*	6.8	---	---	NA	NA
Alum Creek – Lower Subwatershed *Columbus Boundary to Big Walnut Creek (RM 19.9 – 0)*	2.25	17.65	---	Siltation – H Organic enrichment – H Flow alterations – H Direct habitat alteration - H Ammonia – M Cadmium – M Priority Organics – M Pathogens – S	Land development – H Urban runoff – H Impoundment – H Channelization - H Storm sewers – M
Spring Run *(RM 7.2 – 0)*	---	1.95	4.0	Habitat alterations – H Pathogens – M Siltation – S Organic enrichment – S Ammonia – S	Channelization – H Urban runoff – H
West Spring Run *(RM 3.1 – 0)*	**---**	**---**	3.1	Habitat alterations – H Flow alterations – H	Urban runoff – H Channelization – H Natural – M
Kilbourne Run *(RM 2.6 – 0)*	---	---	1.0	Organic enrichment – H Pathogens – M Siltation – S	Urban runoff - H
Trib to Alum Creek at RM 25.50 *(RM 2.8 – 0)*	0.7	---	---	NA	NA
Trib to Alum Creek at RM 23.47	1.3	---	---	NA	NA

Attainment status and causes and sources of impairment
H = High magnitude; M = Moderate magnitude; S = Slight magnitude; T= Threatened

B. LOWER ALUM CREEK WATERSHED ACTIONS

The following actions are not related to a specific impairment issue and will apply to the entire lower Alum Creek watershed, including both 14-digit HUC subwatersheds (upper subwatershed / 05060001160010 and lower subwatershed / 05060001160020).

Task Description (Objective)	Resources	How	Time Frame	Performance Indicators
Seek endorsement of the action plan from planning stakeholders	- FACT staff time	- Contact stakeholders and request endorsement of the plan (i.e. through resolutions of support)	2005	- # of written resolutions from major stakeholders
Create monitoring program to assess water quality and habitat, including primary headwater habitat designations (HHEI)	- Staff / volunteer time OSU Extension, FACT - 319 grant funds ($90,000) to hire part-time staff, purchase equipment, analyze samples, etc.	- Apply for grant funds, hire staff to conduct monitoring and involve volunteers - Establish program with assistance from OSUE - Create database, monitor multiple parameters quarterly	2004 - 2005 2006 2006	- # of samples taken - # volunteer monitors involved - annual summary report of findings

C. UPPER SUBWATERSHED ACTIONS (HUC # 05060001160010)

Background

The upper subwatershed extends along the mainstem from the Alum Creek Lake Reservoir dam at RM 26.7 to Schrock Road at RM 19.9, encompassing 6.8 Alum Creek river miles. As determined by the Ohio EPA, this reach is fully meeting its Warmwater Habitat (WWH) aquatic life use designation. However, the one location within this subwatershed that was sampled in 2000 (RM 22.1 / Cleveland Avenue) was marginally meeting full attainment standards (OEPA, 2003a). The next sampling point, located just one tenth of a mile downstream from the subwatershed boundary (RM 19.8 / Schrock Road), was in partial attainment due to depressed Invertebrate Community Index (ICI) scores.

This subwatershed is threatened by land development, which could potentially deliver sediment and pathogens (via stormwater runoff) to the stream. Land development and associated increased stormwater flows also have the potential to deliver other runoff pollutants, modify the integrity of the stream channel, and reduce riparian vegetation cover (as has occurred in the lower subwatershed).

Problem statement

Violations of primary contact recreation standards for **bacteria** were observed *at every sampling site in the watershed* in the 1999 and 2003 Technical Support Documents (TSD's), and secondary contact recreation violations were observed in all but two sites. In the upper subwatershed, new and existing home sewage treatment systems (HSTS), are potential sources. Approximately 140 semi-public and private discharging treatment systems have been identified in the Delaware County portion of the watershed. General urban runoff, including pet waste, is another potential source, but loading data are not available. In addition, one cattle lot operation is known to exist in the upper watershed along Unnamed Tributary 25.5.

The Big Walnut Creek Watershed Total Maximum Daily Load (TMDL) Draft Report states that a 54% reduction in pathogen loading will be required to meet the TMDL pathogen target, which is a 30 day geometric mean of 1,000 fecal coliform colonies / 100 ml. Load reductions are prescribed for runoff (69%), cattle (100%), and aerator (56%) sources (Ohio EPA, 2004).

The 1999 TSD also reported extremely variable and supersaturated diel dissolved oxygen readings at RM 23.8 (Worthington-Galena Rd.), which is a signature of **nutrient enrichment**. Likely sources of nutrients in the area are nonpoint source pollutants such as lawn care products.

At the single mainstem sampling point in this subwatershed (RM 22.1 /Cleveland Avenue), **sedimentation** was evident in the Qualitative Habitat Evaluation Index (QHEI) assessment, which showed high overall substrate embeddedness. The attribute score was 12.5, while a minimum score of 14 is considered the minimum for supporting WWH aquatic life. At RM 19.8, just one tenth of a mile downstream from the upper HUC boundary, low ICI scores resulted in partial attainment status, and excessive sedimentation was observed.

A review of Ohio EPA construction permit records revealed that over 180 construction permits covering approximately 5340 acres, or 1/3 of the upper subwatershed area, have been filed in the last ten years in the Delaware County (for sites over five acres). According to 2000 census data, the two Delaware County Townships (Genoa and Orange) that lie partially within the watershed are among the fastest growing in the state, and FACT volunteers have observed general noncompliance with erosion and sediment control regulations in the area. The Big Walnut Creek Watershed TMDL Draft Report has sets forth a Sediment TMDL target score of 33 based on the sum of three QHEI components that reflect sediment loadings: substrate (14), channel morphology (14), and riparian zone/bank erosion (5) (Ohio EPA, 2004).

This rate of land use change will also likely result in increased delivery of **urban runoff pollutants** (such as pathogens, nutrients, and organic compounds) via stormwater. Increased impervious cover and related increased peak storm flows may affect **stream channel integrity**, causing bank erosion and channel entrenchment *(*see "Physical Attributes" in Section IV). The Draft Big Walnut Creek TMDL Report has set forth a Habitat TMDL target score that ascribes one point to each of three components: QHEI score/Target Ratio, moderate influence attributes score, and high influence attribute score. Habitat assessments at River Mile 23.8 and 22.6 are not currently meeting the Habitat Target Score of 3.

<u>Long Term Goals</u>
(*please see the introduction of this section for more information on all TMDL targets)*

- Sediment TMDL scores of 33 or better
- Habitat TMDL score of 3
- Fecal coliform: TMDL target - 30 day geometric mean of 1,000 fecal coliform colonies/100 ml

<u>Mid-Term Goals</u>

- Maintain full use attainment *(Additional mid-term goals are stated below for specific actions, and summarized in the Evaluation Section).*

<u>Priorities</u>
Among the many actions listed below for the upper subwatershed, those affecting 1) riparian corridor preservation and 2) stormwater and sediment control are priority actions that will be enacted first.

Organic / Nutrient Enrichment & Human Health — Upper Subwatershed

A work group consisting of watershed residents, Ohio EPA staff, health department representatives, and City of Columbus Division of Sewerage and Drainage, and Delaware Health District representatives met throughout 2003 to identify sources and develop alternatives for actions. The Big Walnut Creek Total Maximum Daily Load (TMDL) Draft Report has prescribed pathogen load reductions for runoff (69%), cattle (100%), and home aerator (56%) sources. These load reductions are long term goals of the action plan and will result in meeting the TMDL pathogen target of 30 geometric mean fecal coliform level of 1000 colony forming units /100ml.

Approximately 130 discharging systems exist in the upper watershed. The Delaware Health District expects to upgrade 20 of these by 2010. In addition, sewer line extension to two problem areas will eliminate approximately 35 discharging systems by 2015. Upgrade and sewer extension projects should reduce aerator pathogen loading by 40% by 2015. Actions to address the one known cattle feed-lot operation in the upper watershed are included with Unnamed Tributary 25.5. Urban runoff load reductions will be addressed through educational actions in the table below. Please see the watershed inventory for more information on pathogen, nutrient, and organic enrichment sources, and the introduction of this section for more information on the TMDL.

Task Description (Objective)	Resources	How	Time Frame	Performance Indicators
Home Sewer Treatment System (HSTS) Actions				
Review regulations for sighting, permitting, and use of technology for new systems	- Delaware Health District (DHD) staff time and 319 grant ($225,000 for county program, including actions below)	- Review Delaware County regulations, enact needed revisions - DHD Apply for 319 grant	2004	- New regulations adopted
Create septic/leach system databases	- DHD staff time and 319 grant	- Per new state regulations, DHD use existing GIS database to add all systems and inspection dates	Completed by 2007	- Database completed
Using GIS, map existing discharging and semipublic systems for which data exists	- FACT staff time - OSU Extension mapping services - DHD staff time	- Access data from health departments and create GIS map to show where systems exist	DONE	- Maps completed
Strengthen inspection policies and enforcement on failing systems	- DHD staff time, 319 grant and/or health levy	- Inspect all new systems and all existing systems as they are added to the database. - DHD apply for 319 funds in 2004, allocate funds from sewage budget per levy	2006 2004	- Growth of database - Grant application submitted - Inspections performed - Levy placed on ballot
Upgrade 20 failing Home Sewage Treatment Systems (HSTS)	- DHD staff time - Replacement cost incumbent upon home owner, DHD will seek low interest loans via DEFA ($100,000): $15 - $10k to replace $5 - $2k to upgrade	- Map analysis of existing systems - Apply for grant funding - Determine appropriate system to install - Issue sewage permit - Perform inspection - Record system in database	Completed by 2008	- Documentation of Board of Health priority - Sewage permits recorded, inspections made - GIS database - # upgrades completed
Sewer Line Extension Actions				
- Identify areas of need through Delaware County Sewer Master Plan - Extend sewer lines to	- DHD staff time - County Commissioner approval of sanitary sewer master plan and implementation funding	- Complete map analysis of areas of need for sanitary sewer - Advise public officials - Assist in drafting sewer master plan, work with	Plan fully implemented (sewers installed) by 2015	- Documentation of approved sewer master plan from Delaware County - sewer line extension to

problem areas, eliminate 35 discharging systems		Commissions to approve plan - Implement plan – sewer extension		areas of need - number of HSTS eliminated
Education / Urban Runoff Actions				
Institute education programs for - HSTS maintenance - Nutrients / lawn care - Pet waste	- DHD staff time and 319 grant ($5,000 for county-wide program via DHD grant) - FACT staff time and 319 funds ($2,000) - Phase II officials	- Apply for grant funds - Create educational materials and update web site - Distribute materials at community events - DHD sponsor HSTS maintenance workshops	2004 2005 - February 2004	- Number workshops held and documentation of evaluations - Documentation and inventory of materials created and used - Web site available

Stormwater & Construction — Upper Subwatershed

A work group consisting of watershed residents, municipal utility and service department representatives, and SWCD staff met throughout 2003 to identify sources and discuss alternatives for actions. The watershed coordinator also met individually with Phase II program administrators to discuss opportunities to achieve common action plan and Phase II stormwater goals. The resulting actions are listed below. FACT (and other partnering organizations) will work jointly with Westerville and Delaware County as phase II advisory group members to help further develop Phase II programs.

The Big Walnut Total Maximum Daily Load (TMDL) report has established a Sediment TMDL target score of 33, based on the scores of three Qualitative Habitat Evaluation Index (QHEI) components. Meeting the target score through actions to reduce sediment loading form construction sites and improve/protect riparian and floodplain land is a long term action plan goal. These actions, plus the implementation of Phase II stormwater regulations, should result in a 20% reduction in sediment loading compared to land use change without implementation of local programs. Please see the introduction of this section for more information on the TMDL, and Section III for more information about sediment erosion from construction sites.

Task Description (Objective)	Resources	How	Time Frame	Performance Indicators
Construction site sediment delivery				
Adoption of effective sediment and erosion control BMP's	Staff time – partnering organizations: Delaware County Engineer, FACT, Westerville, Soil & Water Conservation Districts (SWCD)	- Assess BMP's currently recommended in Phase I / II permits - Westerville pass revised ordinance for construction site runoff control	2006 2005	- Meetings conducted - Ordinance passed
Explore alternatives for increased inspection and enforcement of BMP's	-Staff time- partnering organizations -Municipal budgets for personnel to conduct inspections	- Westerville explore alternatives, revise current policy, and conduct trainings for inspection personnel - Del Co Engineer's Office: implement program (bimonthly inspections) by Jan 2004; assess performance end of 2004	2004 2004	- Meetings conducted - Inspection goals - Inspection rates / # conducted
Create citizen network to monitor compliance, beginning with education campaign	- Staff time, partnering organizations - 319 grant funding to conduct meetings, workshops, produce materials ($2,500)	- Education campaign: presentations, media, FACT workshop/ materials for citizens, w/ local hotlines - Enlistment of citizens to report non-compliant sites - Westerville & FACT meet w/ civic assoc. to build network - Create informal maps to help track sites / monitoring activity - Target areas with steep slopes, highly erodible soils	- Initial workshop 2004 - Print materials, repeat work-shop: 2006	- # citizens enlisted in task force - # workshops conducted - # of complaints for erosion control violations
General NPS pollution awareness				
Develop water quality monitoring program in Westerville	- Westerville city staff time; budget allocations (approximately $5,000 annually) for workshop & sample analysis - FACT and partnering organization staff time	- FACT coordinate water quality monitoring training for Westerville staff - Westerville: establish quarterly monitoring program - Westerville: draft ordinance to allow corrective action when NPS problems are found	2005 2005 2004	- Training conducted - Program established - Ordinance passed
Educate various	- Staff time, partnering	- Conduct drain labeling	Ongoing	- Number of drain

audiences on NPS prevention	organizations - 319 grant funding – ($1,000) to produce materials	- Produce and distribute educational materials - Seek speaking opportunities - Coordinate w/ Phase II programs; Target Spring Run Watershed in cooperation w/ Westerville Service Dept.	Produce materials: 2006	labeling events, residents receiving materials - Number of speaking engagements
Promote adoption of creek reaches / area cleanups	Staff time, partnering organizations	- FACT work w/ partners to promote adoption programs; (i.e., Keep ___ Beautiful) - Create FACT web page	Beginning 2005	- # of creek reaches or areas adopted - # of cleanups - Web page developed
Post-construction stormwater BMP's				
Conduct tour / workshop on effects of stormwater on stream morphology	Staff time: - FACT, Westerville, Orange Twp, Genoa Twp, FSWCD	- Tour an impacted/ unimpacted tributary w/ officials and give presentation on effects of stormwater	2005	- Workshop conducted - Survey of workshop attendees
Review quantity controls for new / redevelopment	- Staff time, partnering organizations	- Review Phase I/II permit for post-construction BMP's and assess local programs - FACT provide feedback to design manual development in Westerville and Delaware Co. - Explore use of structural litter control BMP's	2006	- Meetings conducted - Policies revised
Promote pilot project for low impact development and/or innovative stormwater controls	Staff time: FACT, DCRPC, Orange Twp, Genoa Twp, Westerville	- Assess feasibility with local governments - Promote revision to development codes, if necessary	2006	- Meetings conducted - Low impact develop-ments or stormwater controls constructed
Promote retention of natural channels in tributaries	Staff time: Westerville, Delaware County, FACT	Assess policy in Westerville, Delaware Co., adopt revisions if necessary	2005	- Policies adopted or revised

Land Use				**Upper Subwatershed**
A work group consisting of representatives from municipal development departments, natural resource agencies, local communities, and regional planning agencies met throughout 2003 to identify sources and discuss alternatives for actions. Through individual and work group meetings, Delaware County township and Westerville representatives agreed to jointly research developing land use regulations specific to their jurisdictions. Implementation of land use regulations will help achieve Habitat and Sediment TMDL targets.				
Task Description (Objective)	**Resources**	**How**	**Time Frame**	**Performance Indicators**
Education of different audiences on the benefits of floodplains, greenways / riparian corridors related to the environment, economy, and public health	- Staff time, partnering organizations: Westerville Rec & Parks; Delaware County Friends of the Trail, MORPC, etc.	Audiences: - public, zoning / development commissions, land owners Components developed by FACT: - Web page- links to local gov't - Presentations to commissions - News articles	2004 – 2005	- Meetings attended - Presentations given - News articles published
Land use regulations, recommendations per municipality				
Westerville	Staff time: - Westerville, Columbus Dev. Dept., FACT	- Explore use of riparian corridor overlay zoning - Implement source water protection zoning regulations	2005	- Meetings conducted - Policies enacted - Resolutions passed
Genoa Twp Orange Twp	Staff time: - DCRPC, FACT, Orange & Genoa Townships - Grant funds ($10,000) for consultant services	- Submit grant for consultant - Explore use of riparian overlay zoning - Revise subdivision regulations: conservation planned residential district and subdivision floodplain	2005 2005 - 2006	- Meetings conducted - Policies enacted - Resolutions passed
Delaware County	Staff time: - DCRPC - FACT	- Revisions to floodplain regulations - develop setback requirements and public comment provisions on floodplain permits	2005	- Meetings conducted - Policies enacted - Resolutions passed

Habitat & Hydromodification

Upper Subwatershed

There are a number of organizations with potential to encourage long-term corridor protection within the Alum Creek Watershed with a variety of goals. In the summer of 2003, representatives met with action plan work groups and outlined their goals for land acquisition, recreation, and restoration in the Alum Creek watershed. The participants acknowledged that working in partnership to address these issues is an effective means to offset costs, better serve property owners and residents, and achieve the goals of multiple organizations. Increasing canoe access has been identified as a project that holds great interest and significant opportunity to build public support, but currently lacks a concerted effort.

While this river reach is in full attainment of its designated aquatic life use, two sampling sites (River Mile 23.8 /Worthington Rd., and River Mile 22.1 /Cleveland Ave.) are not meeting the TMDL Habitat Target Score of 3. Achieving this target and the Sediment TMDL target is the long term goal of this section. The short-term goal is to preserve 50 acres (or 10,000 linear feet) of riparian land. Habitat continues to be threatened by intense land use change, and recent data have shown a decline in water quality as land use changes has spread to new sections of the watershed. Preserving riparian land will help achieve targets through providing benefits such as in stream habitat and cover, adequate space for lateral channel movement, and filtration of sediment and nutrients. Please see the introduction of this section for more information on the TMDL.

Task Description (Objective)	**Resources**	**How**	**Time Frame**	**Performance Indicators**
Preserve and restore riparian corridor on the mainstem and tributaries ***Protect fifty acres*** *by 2010, for upper and lower subwatershed. (equal to 10,000 lf by 200 lf)*	Maps provided by Columbus (CRPD) and Westerville Rec. & Parks Departments (WRPD)	Partnering organizations & FACT conduct desk-top analysis of maps and aerial photos to determine areas for further investigation	Ongoing; initial analysis in 2004	- Potential areas identified
	Staff time, partnering organizations: CRPD, FACT, WPRD, SWCD, Orange and Genoa Townships	Conduct site visits, assessment, and priority ranking based on criteria developed by work group	Ongoing; initial analysis in 2005	- Specific sites identified and prioritized
	Staff time – partnering organizations	- Develop database of parcels for protection, submit to OEPA 401 mitigation clearinghouse	Ongoing; initial database in 2005	- Database completed, submitted to OEPA
	Staff time – partnering organizations	Research resources of partnering organizations – goals, interests, and funding	2004	- Meetings among partnering organizations, resource assessment
	Staff time – partnering organizations	Coordinate landowner contact among partner organizations	Ongoing; initial contacts in 2005	# partner organizations meeting and /or collaborative efforts
	- Staff time, partnering organizations - 319 funds ($1,200) for outreach materials	- Apply for grant funds - FACT & partners develop promotional/ educational material	2004 2006	- Materials developed - # distributed
	-319 grant funds -$700 - Staff time, partnering organizations	Conduct workshop / meeting for land owners: purpose & benefits	2005 -2006	- # people attending workshop
	Staff time, partnering organizations	Contact owners w/ range of options: stewardship to long-term protection strategies	2005 - 2006	- # of contacts made - # of agreements - # acres w/ bmp's
	Staff time, partnering organizations	Design annual monitoring, inspections, and contact plan	2005	Plan completed
	Staff time, partnering organizations	Funding: Research various options, apply as appropriate - Clean Ohio Funds	Ongoing - Apply in 2005	- # applications submitted - # grants or other

		- Municipal funding – ie Westerville CIP budget - 401 mitigation - Donation campaign - Columbus Foundation	- Annually - As permits are submitted - Begin 2005 - Apply Nov 05	allocations obtained
	Staff time – partnering organizations	Support Westerville, and Greenheads* in the creation of the Otterbein Lake restoration Project along greenway through in-kind donations, publicity, etc.	Ongoing	- Otterbein Lake event listings in FACT literature - Grant letters of support
Increase canoe access to Alum Creek *Install first site by 2008, second site by 2010 (upper and lower subwatershed)*	Staff time – partnering organizations: CRPD, WRPD, Orange Township, Otterbein College, Greenheads	Analyze list of potential sites; select and prioritize (*in order for upper watershed*): 1. Alum Creek State Park 2. Westerville dam, above (Astronaut Grove) & below (Alum Creek Park)	Completed	Sites selected
	Staff time – partnering organizations	Research funding – - ODNR Div. of Watercraft grants - Municipalities – Westerville CIP budget	2006	Funding sources researched
	Staff time – partnering organizations, FACT	Contact partnering organizations to assess interest and resources	2006	Organizations contacted
	Staff time – partnering organizations, FACT	Apply for grant funding to install ramp and other site modifications	2006 - 2007	Grant application submitted
	- 319 grant funds ($2,000) - FACT staff time	- Apply for grant funds - Produce "Alum Creek Water Trail" materials showing access points, landmarks, hazards, etc.	- 2004 - After first access point is constructed	Materials produced
Coordinate natural and cultural heritage signage on Alum Creek multiuse trail	Staff / Volunteer time: Westerville RPD FACT Greenheads	Partnering organizations explore additional trail signage; coordinate with Columbus Parks & Recreation Department	2005 - 2006	- Agreements between Westerville & Columbus on blended formatting
Promote conservation of wetlands and natural stream channels	Staff time, FACT, WRPD	- FACT continue monitoring and submitting comments 401 permits - Submit wetlands list to OEPA 401 mitigation clearing house	Ongoing 2005	- # of comment letters filed, hearings attended - List submitted to OEPA
Conduct stream morphology research on mainstem and tributary streams	- 319 grant funds ($90,000) for monitoring staff - Staff time, FACT, OSUE, ODNR	- FACT apply for grant funds, hire part-time staff - Collect channel morphology data	2004 - 2005 2006 - 2007	- morphology data collected in database

* The "Greenheads" (a term referring to mallard ducks) is a local citizen's group dedicated to protected natural resources in Westerville.

D. UPPER SUBWATERSHED TRIBUTARY ACTIONS

Actions listed above for the entire upper subwatershed mainstem will also apply to all tributary streams in the subwatershed. The following actions have also been developed for these specific tributary streams.

Unnamed Tributary at River Mile 25.5

Background

This stream flows for 2.8 miles along the very northeastern edge of the watershed through Genoa and Orange Townships. The stream's first water quality assessment was conducted by Ohio EPA in 2000. All 0.7 miles that were evaluated were fully attaining WWH aquatic life use standards (although the stream's aquatic life use is undesignated). However, a small cattle operation with access to the tributary was noted upstream of the sampling point, presenting a source for the **ammonia, nutrients, and pathogens** which threaten the stream's full attainment status.

Problem statement

Organic and nutrient enrichment, pathogens, and TSS were all observed at elevated levels (above 95th percentile background), and can be linked directly to the presence of cattle in the stream during three of the five field visits by the Ohio EPA. High ammonia levels were prevalent regardless of the presence of cattle, and could indicate other sources such as discharging home wastewater treatment systems. This is the only tributary within the lower subwatershed known to have perennial, cool groundwater flow. These conditions may be supporting the excellent assemblage of aquatic life found in the tributary despite the observation of unrestricted cattle.

Goals:

- Maintain full attainment status
- Fecal coliform: TMDL target score - 30 day geometric mean of 1,000 fecal coliform colonies / 100 ml, through reducing cattle pathogen loading by 100%

Task Description (Objective)	Resources	How	Time Frame	Performance Indicators
Eliminate livestock access to stream	- Cost share program (such as EQIP) - DSWCD and FACT staff time	- Research cost share and incentive programs for the installation of BMP's - Coordinate contacting land owner with DSWCD; present BMP options - Create Livestock Waste Management Plan (LWMP) if necessary	2007	- landowner contacted, site investigated - conservation plan developed - BMP's installed

Unnamed Tributary at River Mile 23.47

This stream flows for 3.8 miles through Genoa and Orange Townships, starting near Big Walnut Road and passing through a corner of Westerville before reaching Alum Creek north of Polaris Parkway. It is called Indian Run by some local residents, and a portion of it has been impounded to provide a back-up water supply for the city of Westerville. This stream was studied for the first time by the Ohio EPA in 2000, and 1.3 mile that was evaluated is fully attaining WWH standards (although the stream's aquatic life use is undesignated). However, slightly elevated levels of pathogens, nutrients, and organic enrichment were noted. These elevated levels were present in dry and wet weather. Proximity to unsewered subdivisions was noted in the TSD. Aside from actions developed for the entire upper subwatershed, no actions specific to this tributary have been developed.

E. LOWER SUBWATERSHED ACTIONS (HUC # 05060001160020)

Background

The lower subwatershed extends along 19.9 miles of the Alum Creek mainstem from Schrock Rd. (north of I-270) at River Mile (RM) 19.9 to the creek's mouth at Three Creeks Park. As determined by the Ohio EPA, 17.7 miles of the mainstem are partially attaining WWH aquatic life use standards, while 2.2 miles near the creek's mouth are fully attaining standards. A sampling site at RM 7.5 was found to be in nonattainment in the 2003 TSD, as was RM 8.6 in the 1999 TSD. (Although the 1999 TSD reported one river mile in nonattainment, the 2003 TSD omitted nonattainment mileage due to insufficient data).

Many causes of impairment are present in the lower subwatershed, and in some areas appear to be acting synergistically to produce poor water quality. Siltation, organic enrichment, flow alterations, direct habitat alterations, ammonia, cadmium, priority organics, and pathogens have been identified as causes of impairment by the Ohio EPA, resulting from land development, urban runoff, impoundments, channelizations, and storm sewers (sewer overflows). In addition, Alum Creek stream morphology has been impacted by urbanization and increased stormwater flows.

Problem statement

Violations of primary and secondary contact recreation criteria for **pathogens** were found at every sampling location in the lower subwatershed. The 2003 TSD mentions urban runoff and storm sewers as sources of pathogens. Eight sanitary sewer overflows (SSO's) and one combined sewer overflow (CSO) are located on the mainstem and tributary streams between RM 15.4 and 3.9. The highest concentration of sewer overflows (five) occurs within a two mile reach between Broad Street and Livingston Avenue, which also contains three lowhead dams. In addition, approximately 150 off-lot aeration systems (private and semi-public combined) and 20 semi-public, on-lot septic systems have been identified in the lower subwatershed.

The Big Walnut Creek Total Maximum Daily Load (TMDL) Draft Report states that a 94% reduction in pathogen loading will be required to meet the pathogen target (1,000 fecal coliform colonies/100ml, 30 day geometric mean). Load reductions are prescribed for runoff (44%), CSO (91%), and aerators (91%).

Although no dissolved oxygen violations were reported in the 2003 TSD, violations were reported in the 1999 TSD at RM 9.9, 6.6, and 3.9. These were attributed to **organic enrichment** from urban runoff and sewer overflows, compounded by lack of riffle development in low gradient reaches and/or impoundments.

Ammonia values in excess of the 75th percentile background level were found at every mainstem sampling location, and could be attributed to a mixture of sources – HSTS's, sewer overflows, and general urban runoff. A peak above the 95th percentile level was observed at RM 3.8, and remained elevated above the 90th percentile level at RM 0.7. The TSD indicates leachate from many older landfills in the vicinity as a possible source. Though the values observed are elevated when compared to background (up to .31mg/L), they are below standard TMDL targets for ammonia (1mg/L).

Siltation is listed as a high magnitude cause of impairment in the 2003 TSD due to land development. While suburban and urban land uses are well established in the lower subwatershed, remaining areas of undeveloped land are under heavy development pressure. For example, construction of the 1,000 acre Easton Towne Center regional shopping complex was underway when these data were collected in 2000. In 1996 and 2000, QHEI substrate scores ranged from 8.5 to 14.5; a score of 14 is considered the minimum for supporting a WWH aquatic life assemblage. The Big Walnut Creek Watershed TMDL Draft Report sets forth a Sediment TMDL target score of 33 based on scores of three QHEI components that reflect sediment loadings: substrate (14), channel morphology (14), and riparian zone/bank erosion (5) (Ohio EPA, 2004).

Substrate sediments sampled at RM 3.9 were reported in the 2003 TSD. **Priority Organics and Cadmium** were among the most prevalent pollutants, possibly due to the presence of landfills and industrial sites south of Livingston Avenue. Contaminated sediments have also been documented at various locations along the mainstem according to the 1999 TSD and a report published by the Ohio EPA Division of Emergency & Remedial Response in 2001 (Myers, 2001). The most notable problems were high levels of semi-volatile organic compounds (SVOC's) in the vicinity of RM 9.1 (Nelson Park) and high levels of arsenic just upstream of Route 104.

Significant **habitat alterations** are evident in the lower subwatershed, including channelization, numerous impoundments, and morphological impacts from increased impervious cover and stormwater delivery. Much growth has occurred since 1994 when satellite data showed 45% impervious cover in the lower subwatershed, a level thought to cause serious stream morphology impacts. Incised channels and lack of floodplain access is prevalent. The two sampling points found to be in nonattainment in 1999 (RM 8.6) and 2003 (RM 7.5) were both within a two mile reach containing three lowhead dams. QHEI scores in this reach were in the mid-50's and included many highly modified attributes, such as lack of pool-riffle habitats.

The Big Walnut Creek Watershed TMDL Report sets forth a Habitat TMDL target score that is the sum of three components, each worth one point: QHEI score/Target Ratio, moderate influence attributes score, and high influence attribute score. Habitat assessments at River Mile 23.8 and 22.6 are not currently meeting the target Habitat TMDL Score of 3.

<u>Long Term Goals</u>

- Sediment TMDL scores of 33 or better
- Habitat TMDL score of 3
- Fecal coliform: TMDL target - 1,000 fecal coliform colonies /100ml (30 day geometric mean)

<u>Mid-Term Goals</u>

- Maintain full use attainment in river reaches that are currently in attainment, and restore sampling locations that are in nonattainment (River Miles 8.6 and 7.5) to at least partial attainment. (Additional mid-term goals are stated below for specific actions, and summarized in the Evaluation Section).

<u>Priorities</u>

Among the many actions listed below for the lower subwatershed, those affecting 1) riparian corridor preservation, 2) stormwater and sediment control and 3) lowhead dam removal are priorities.

Organic / Nutrient Enrichment & Human Health **Lower Subwatershed**

A work group consisting of watershed residents and representatives from Ohio EPA, health departments, and Columbus Division of Sewerage and Drainage met throughout 2003 to identify sources and develop alternatives for actions. The Big Walnut Creek Total Maximum Daily Load (TMDL) Draft Report has prescribed pathogen load reductions for runoff (44%), home aerators (91%), and CSO's (91%), which are long term goals of this plan that will enable achieving the TMDL pathogen target of 1000 fecal coliform /100ml (30 day geometric mean)

The Franklin County portion of the watershed contains 110 discharging aeration systems, while the Columbus portion of the watershed contains 40. Actions specific to Columbus systems were not developed. The Franklin County Board of Health (FCBH) expects to eliminate at least 20 systems through sewer line extension to problem areas by 2015. Of the remaining aeration systems, it expects to update 45 systems (50%) by 2015 and another 45 (100%) by 2025. This would constitute a 95% loading reduction from aeration systems in Franklin County, and a 73% reduction of aerator loading total for the lower watershed. Actions to eliminate the single CSO discharge point in the watershed and reduce runoff loading of pathogens are also described below. Please see the watershed inventory for more information on pathogen, organic enrichment, and nutrient sources, and see the introduction of this section for more information on the TMDL.

Task Description (Objective)	Resources	How	Time Frame	Performance Indicators
HSTS / Sewer Extension Actions				
Create septic/leach, sanitary sewer system and vacant property databases	- Health Dept staff time - GIS database, staff proficiency - No external funding sources needed	- Franklin Co. Board of Health (FCBH), in coordination w/ Auditor's Office 2005 reappraisal update; Franklin Co. Planning Dept's GIS staff; private firms involved in Phase II Storm Water planning; and FCBH's GIS staff - Columbus Health Dept: completed in 2003	2007	- Databases completed
Strengthen inspection policies/ regulations to inspect all systems (discharging and non-discharging) and strengthen enforcement on failing systems	- OEEF grant for ed./ outreach ($15,000) - FCBH staff time - Require permit fees on all systems to fund expanded inspection program	- FCBH pass revision to existing policies/ regulations, WQ standards to inspect all systems and to strengthen enforcement policies - Outreach / education program, apply for funds	2007	- Inspection and enforcement policies adopted - Systems inspected at prescribed frequencies (i.e., once every five years for on-lot systems)
Using GIS, map existing discharging and semi-public systems for which data exists	- FACT staff time, - OSU Extension mapping services - Health dept database	- FACT access data from health departments and create GIS map (with OSUE assistance) to show system locations	Completed	- Maps completed
Upgrade failed discharging HSTS's to minimize pollution loading (FCBH) *Goal: upgrade 45 systems by 2015, and a total of 90 systems by 2025*	- FCBH staff time - Grant funds for outreach program - Research access to revolving loan funds - Cost may be incumbent on system owners: $500 - $1000 per system	- FCBH and staff pursue necessary in-house policy changes - Apply for education grants - Secure funds for loans, CDBG grants to homeowners, or 319 funds for conversions.	2007	Number of HSTS's upgraded
- Use map to identify areas of failed HSTS's - Extend sewer lines to problem areas, or upgrade HSTS's that	- Funding approval from Franklin County Commissioners and Columbus City Council: average cost	- Health Departments, elected officials, Department Heads - Complete map analysis of critical areas HSTS clusters - Joint meeting with Columbus	2004 2004 Ongoing	- Documentation of map analysis - Agreements / plans for sewer extension

will not have access to sewers within 20 years (FCBH) *Goal: extend to three areas by 2015 to eliminate 20 systems*	estimated at $10,000 per HSTS removed - FCBH staff time	and Franklin County Officials - Complete extension projects	Ongoing, through 2015	
Education / Urban Runoff Actions				
Institute education programs on HSTS, lawn care, and pet waste	- 319 grant funds, ($5,000) - FACT staff time	- Apply for grant funds - Create materials, web page - Coordinate w/ Phase I/II communities	2004 2005-2006 Ongoing	- Number of workshops - Web page created - Materials distributed
Sewer Overflow Actions				
Sewer Overflows	- City of Columbus DOSD staff time - FACT staff time - Franklin County Sanitary Engineer staff time	Columbus DOSD, FACT, Sanitary Engineer: - Develop operations and maintenance plan and schedule - Complete capital improvement projects, provide schedule - FACT attend DOSD advisory committee meetings	Ongoing; schedule completed by end of 2005	- Reduction in TSS, bacteria - Sewer overflows repaired, treated, or on maintenance plan *(See appendix 15 for Columbus project schedule)*

Stormwater & Construction **Lower Subwatershed**

A work group consisting of watershed residents, municipal utility and service department representatives, and SWCD stormwater specialists met throughout 2003 to identify sources and discuss alternatives for actions. In 2003, FACT representatives also participated in a Columbus DOSD stormwater manual advisory group to revise stormwater policies.

The Big Walnut Creek Total Maximum Daily Load (TMDL) report has established a Sediment TMDL target score of 33, based on three components of the Qualitative Habitat Evaluation Index (QHEI). Meeting this score is an overall goal of the plan through reducing sediment loading form constructions sites, and also improving and protecting riparian and floodplain habitat. These actions, plus the implementation of Phase II stormwater regulations, should result in a 20% reduction in sediment loading compared to land use change without implementation of local erosion control programs. Please see the introduction of this section for more on the TMDL.

Task Description (Objective)	Resources	How	Time Frame	Performance Indicators
Construction Site Sediment Delivery				
Adoption of effective sediment and erosion control BMP's	Staff time, partnering organizations: FACT, Columbus DOSD, Bexley, FSWCD	- Assess BMP's currently recommended in Phase I / II permits	2006 - 2007	- Meetings conducted
Explore alternatives for increased inspection and enforcement of BMP's	Staff time, partnering organizations	- Research existing inspection and record keeping policies per Phase I / II permits	2007	- Meetings conducted - Inspection goals set - Inspection rates/ #'s
Create citizen network to monitor compliance, beginning with education campaign	- Staff time, partnering organizations - 319 funds ($2,500) for workshop and materials	- Education campaign: presentations, media - Workshop / materials on erosion control for citizens, recruit volunteers	2006 2006 2004 - 2006	- # citizens enlisted in task force - # workshops conducted - # of erosion control violation complaints
Litter				
Greater enforcement of existing laws	-Staff time, Franklin County / Nail-a-Dumper organizations, FACT, Columbus	- Meet to explore means to increase program, enforcement. - FACT web page and materials with hotline information	2007 2005	- # Meetings - # of enforcement actions - web page completed
Assess use of structural and nonstructural BMP's to reduce litter delivery via storm system	Staff time – partnering organizations	- Assess current use of litter control BMP's - Install BMP's (such as inlet controls, street sweeping) - Target area within Columbus for pilot project - develop maintenance plan	2006 2007 2007 2007	- # meetings - # BMP installations - Maintenance plan developed and implemented
General NPS Education				
Educate various audiences on NPS prevention	- Staff time, partnering organizations - referrals, labeling material - MORPC & Columbus DOSD - 319 funds ($2,000) to produce materials	- Conduct drain labeling - Produce and distribute educational materials - Seek speaking opportunities - Target Bexley, work cooperatively on Phase II education programs	Ongoing 2006 Ongoing 2006	- # drain labeling events - # of speaking engagements - # events where materials are distributed
Promote adoption of creek reaches / area cleanups	Staff time, partnering organizations	- FACT work w/ partners to facilitate adoption programs; (i.e. Keep ___ Beautiful) - FACT develop web page	Ongoing 2005	- # of creek reaches adopted - # of cleanups - Web page developed
Post-construction stormwater BMP's				
Review quantity controls	Staff time, partnering	- Research /assess Phase I/II	2006	- Meetings conducted

for new / redevelopment	organizations: FACT, Columbus DOSD, Bexley, FSWCD	post-construction BMP regs - Support revisions to Columbus stormwater manual	2005	- Policy revisions
Promote retention of natural channels in tributaries	Staff time: Columbus DOSD, FACT, MORPC	- Support Columbus's revision to stormwater manual, which promotes natural channel retention	2005	- policy adopted
Identify critical areas, develop pilot projects for stormwater retrofits	Staff time: FACT, Columbus DOSD, MORPC	- Work w/ Columbus to identify sites w/ potential to improve stream quality and serve as pilot	2007	- # meetings conducted - sites identified

Land Use — Lower Subwatershed

A work group consisting of watershed residents and representatives from municipal development departments, natural resource agencies, and regional planning agencies met throughout 2003 to identify sources and discuss alternatives for actions. Through individual and work group meetings, Columbus and Bexley representatives agreed to jointly research developing land use regulations specific to their jurisdictions. Implementation of land use regulations will help achieve Habitat and Sediment TMDL targets through protecting the riparian corridor.

Task Description (Objective)	Resources	How	Time Frame	Performance Indicators
Education on the natural, economic, and health benefits of floodplains, greenways, and riparian corridors.	- Staff time, partnering organizations: FACT, Columbus, Bexley, MORPC, FSWCD, etc.	Audiences: public, commissions, land owners - Web page- links to local gov't, presentations with commissions, news articles	2004-2005	- Meetings attended - Presentations given - News articles published
Land use regulations, options per municipality:				
Franklin County	Franklin County flood -plain administrators	- Add public comment for floodplain fill permits	2006	-Meetings held -Policy revisions
Columbus	Staff time: CRPD, DOSD, Development Department - City Council	- Revision of parkland dedication ordinance (CRPD) - Support riparian setbacks via stormwater master plan and drainage manual (DOSD) - Support watercourse protection zoning (Devel. Dept) - Develop tree preservation ordinance	- 2005 - 2005 - 2005 - 2006	- Policy revisions finalized
Bexley	Development Office	Pursue riparian corridor overlay zoning set forth in SW Bexley plan	Estimated 2005 - 2006	- Zoning ordinances adopted

Habitat & Hydromodification **Lower Subwatershed**

There are a number of organizations with the potential to encourage long-term corridor protection within the Alum Creek Watershed for a variety of goals. In the summer of 2003, representatives met with the Alum Creek habitat work group and outlined their goals for land acquisition, recreation, and restoration in the Alum Creek watershed. The participants acknowledged that working in partnership to address these issues is an effective means to offset costs, better serve property owners and residents, and achieve the goals of multiple organizations. Increasing canoe access has been identified as a project that holds great interest and significant opportunity to build public support, but currently lacks a concerted effort.

The majority of this portion of the watershed is partially attaining its designated aquatic life use. Four sampling locations (river miles 9.2, 7.5, 6.6, and 3.9) are not meeting the TMDL Habitat Target Score of 3. Achieving this target and the Sediment TMDL target are long term goals. A mid-term goal of preserving 50 acres (or 10,000 linear feet) of riparian land has also bee established. Habitat continues to be threatened by intense land use change, which likely caused the loss of several full attainment river miles in this subwatershed between 1996 and 1999. Preserving riparian land will help prevent further water quality degradation and may, when combined with other actions such as dam removal, allow the river to recover full use attainment and meet the Habitat TMDL target. Removal of two lowhead dams is another mid-term action plan goal listed below.

Task Description (Objective)	Resources	How	Time Frame	Performance Indicators
Preserve and restore riparian corridor on the mainstem and tributaries *Protect fifty acres by 2010, for upper and lower subwatershed. (equal to 10,000 lf by 200 lf)*	Maps provided by Columbus Rec & Parks Dept (CRPD)	Conduct desk-top analysis of maps, aerial photos, determine areas for further investigation	Ongoing, initial analysis in 2005	Potential areas identified
	Staff time, partnering organizations: Bexley, FSWCD, Columbus	Conduct site visits, assessment, and ranking based on developed criteria	Ongoing, initial analysis in 2005	Specific sites identified and prioritized
	Staff time, partnering organizations	- Develop database of parcels for protection - Submit to OEPA 401 mitigation clearing house	Ongoing; initial database in 2005	Database completed, submitted to OEPA
	Staff time, partnering organizations	Research resources of partnering organizations – goals, interests, and funding	2004	Meetings among partnering organizations
	Staff time, partnering organizations	Coordinate landowner contact among partner organizations	Ongoing; initial contact in 2005	Number of partner organizations meeting
	- Staff time, partnering organizations - 319 funds ($1,200) for production of outreach materials	- Apply for grant funds - Develop promotional and/or educational materials as needed and once more is learned about target audience	2004 2006	- Materials developed - # distributed
	- 319 funds ($700) - Staff time, partnering organizations	Conduct workshop / meeting for land owners. Campaign purpose, benefits, etc.	2005 - 2006	# people attending workshop
	Staff time, partnering organizations	Contact owners w/ range of options: stewardship to long-term protection strategies	2005 - 2006	- # of contacts made - # of agreements
	Staff time, partnering organizations	Design annual monitoring, inspections, and contact plan	2005	Plan completed
	Staff time, partnering organizations	Research funding options: - Clean Ohio Funds - Municipal funding - 401 mitigation - Donation Campaign	Ongoing - Apply in 2005 - Annually - As permits are submitted - Begin 2005	- # applications submitted - # grants or other allocations obtained

		- Columbus Foundation	- Apply Nov 05	
Increase canoe access to Alum Creek *Install first site by 2008, second site by 2013 (upper and lower subwatershed)*	Staff time, partnering organizations: CRPD, Bexley, Westerville, Columbus Outdoor Pursuits, Metro Parks	Analyze list of potential sites; select and prioritize (*in order for lower watershed*): 3. Morse Road 4. Innis Park 5. Nelson Park (Maryland Ave.) 6. Three Creeks Park:	DONE	Sites selected
	Staff time, partnering organizations	Research funding – ie., ODNR Division of Watercraft grants	2004	Funding sources researched
	Staff time, partnering organizations	Contact partners to assess interest, resources	Ongoing; initial contact in 2006	Organizations contacted
	Staff time, partnering organizations, FACT	Apply for grant to install ramp and other site modifications	2006 -2007	Grant application submitted
	- 319 funds ($2,000) - FACT staff time	- Apply for grant funds - Produce "Alum Creek Water Trail" materials showing access points, landmarks, hazards, etc.	2004 After first access point is constructed	Materials produced
	- Staff time, FACT, CRPD - Signage funding from CRPD ($1,500)	Until actual ramp can be constructed, install visible signage at Nelson Park take-out	2005	Signage installed
Selective removal of low head dams *Goal: remove two dams by 2008, and restore nonattainment sampling locations (River Mile 8.6 and 7.6) to at least partial attainment status.*	Staff time, partnering organization	Prioritize dams for removal: Nelson Park, Wolfe Park, Route 104	Completed	- Prioritized list of dams
	Staff time, partnering organizations; ODOT	Explore removal of Rte 104 dam as ODOT 401 stream mitigation project	2006	- Number of inquiry, contacts made
	Staff time, partnering organization	Contact local stakeholders and dam owners to assess partnership interests	2004 - 2005	- # of contacts made, meetings held
	Staff time, partnering organizations	Conduct public meeting - answer questions, concerns	2005	- Meetings held, presentations given
	319 grant funds - $20,000	Engineering / feasibility study regarding contaminated sediments, downstream implications, cost, post-removal design, etc.	2004 - 2006	- Feasibility study conducted
	FACT staff time	Submit plan to ODNR Div of Water, Dam Safety Section for approval	2005 - 2006	- Plan submitted
	FACT staff time	Submit plan to US Army Corps & OEPA, determine if 404 / 401 permits are necessary	2005 - 2006	- Plan submitted
	FACT staff time, OEPA	Determine if ASARCO will be conducting sediment remediation per NPDES permit	2005	- Contacts made, outcomes of ASARCO permit determined
	Staff time, partnering organizations	Pursue funding: - 319 grant funds, municipal CIP budgets & in-kind services, Columbus Foundation	2004 - 2005	- # / types of funding obtained
	319 grant funds ($290,000 for removal, research, and restoration)	Conduct pre-removal research, breach Nelson Park and Wolfe Park dams	2006	- Dam removed

	319 grant funds (see above)	Conduct post-removal research, channel reconstruction	2006	- Research conducted - Channel reconstructions completed
Create comprehensive natural and cultural heritage signage on Alum Creek multi-use trail	- Staff / Volunteer time: CRPD, Metro Parks, FACT, Ohio Arts /Humanities Councils, MORPC, Freedom Society - Funding: $60,000 from CRPD budget and grant funds (such as Columbus Fndtn, Arts/Humanities Cnls)	- CRPD contract for regional design concept ($18,000 in 2004 dept budget), with input from partnering organizations - Coordinate with neighboring municipalities (ie Westerville) - CRPD install signage as portions of trail are completed ($100 - $600 per sign)	2004 2004 - 2005 2005 - 2006	- # of organizations & individuals contribute to design - Agreements between Westerville & Columbus on blended formatting - Research conducted, plans for signage produced - # of signs installed
Promote conservation of wetlands	FACT CRPD	- Continue monitoring and commenting on 401 permits - Submit list of wetlands to Ohio EPA 401 mitigation clearing house	Ongoing 2005	- Number of comment letters filed, hearings attended - List submitted to OEPA
Pursue tributary project at Bridgeview Golf Course	FACT, ODNR, Columbus State Com. College Foundation	- Resume discussion of tributary daylighting project, to coincide w/ course expansion	2007	- Number of meetings held
Conduct stream morphology research on mainstem and tributary streams	- 319 grant funds ($90,000) for part-time monitoring staff - Staff time, FACT , OSUE, ODNR	- FACT apply for grant funds, hire part-time staff - Collect stream data on channel modification, bank height ratios, levees, floodplain access, and evaluate tributaries against Headwater Habitat criteria	2004 - 2005 2006 - 2007	- morphology data collected in database

F. LOWER SUBWATERSHED TRIBUTARY ACTIONS

Actions listed above for the entire lower subwatershed will also apply to all tributary streams in the subwatershed. The following specific actions have also been developed for the tributary streams below. Nutrient enrichment is described in most of the tributaries, although the values are not extreme. The effect of these nutrient loadings on aquatic life is probably exacerbated by lack of good stream morphology (OEPA, 1999 b). Stream morphology assessments will be an important first step in addressing nonattainment reaches.

Spring Run

Note: Since the city of Westerville spans the upper and lower (Spring Run) subwatersheds, some actions concerning the city of Westerville in the upper subwatershed have been repeated below.

<u>Background</u>
Spring Run is a tributary to Alum Creek that flows approximately 7.2 miles from central Genoa Township south and then west to its confluence with Alum Creek just north of SR 161. This stream's aquatic life use is undesignated, and its water quality was assessed by the Ohio EPA for the first time in 2000. Based on data collected from three sampling points, the upper 4 miles of the stream are not attaining WWH aquatic life use standards, while the lower 2 miles were partially attaining standards. Causes of impairment identified by the Ohio EPA include pathogens, ammonia, and organic enrichment, as well as habitat alterations and siltation. Sources of impairment include urban runoff and channelization. TMDL's were developed for pathogens and habitat.

<u>Problem Statement</u>
Water quality samples from RM 3.7 (Walnut Street) and 0.2 (Buenos Aires Road) were analyzed for **pathogens**. Exceedences were observed in almost every sample, with fecal coliform counts up to five times the limit for secondary contact recreation. Most subdivisions in the watershed have central sanitary sewer service, although portions of some subdivisions and single homes remain on discharging and on-lot systems. General urban run-off, including pet waste, is another potential source. The pathogen TMDL target, prescribed load reductions, and actions for the lower watershed will also apply to Spring Run (specific loadings and actions were not developed).

At RM 3.7, **nutrient and organic enrichment** was mostly limited to a single storm event, where biological oxygen demand (BOD), TSS, and ammonia were recorded above 95th percentile background levels. Some enrichment was also detected during dry weather, which may indicate that discharging and on-lot HSTS's are likely sources. Nutrient enrichment near the mouth was evident in diel (24-hour) dissolved oxygen (DO) readings that showed high levels of variation and "excessive" supersaturation during the day.

Habitat impacts include channelization (notably in Westerville) of the stream channel and the suite of typical responses to increased impervious cover and stormwater delivery, including incised channels with eroding banks. A levee was also built recently near the stream's mouth at a park in Blendon Township. Local residents have reported that the levee has prevented the stream's access to the floodplain and caused erosion of the opposite stream bank. QHEI scores range from 24 at Maxtown Road to 59 near the mouth**. Siltation** is likely the result of bank erosion, although some new development in the watershed continues, especially in the stream's headwaters.

TMDL analysis showed that Spring Run is not meeting the Habitat TMDL target score (3) for at all three sampling locations (river miles 0.2, 3.7, and 6.0), and is not meeting the Sediment TMDL target score (33) at two sampling locations (river miles 3.7 and 6.0). Achieving this target and the Sediment TMDL target are long term goals fop this section. Further assessment of current habitat conditions is needed to address habitat limitations

Long Term Goals

- TMDL Habitat Score of 3
- Fecal coliform: TMDL target - 1,000 fecal coliform colonies /100ml (30 day geometric mean)
- TMDL Sediment Score of 33

Mid-Term Goals

- QHEI score of 45 at Walnut Street and 60 at Buenos Aires Blvd
- Restore the stream from partial / non attainment to full / partial attainment.

Priorities

Among the lower watershed tributaries, Spring Run will be a priority, and actions to 1) reduce nonpoint source pollution (pathogens, nutrients, etc) and 2) assess stream morphology will be enacted first.

Task Description (Objective)	Resources	How	Time Frame	Performance Indicators
Organic Enrichment & Human Health				
Work with Delaware & Franklin Co Health Dept's to target failing HSTS systems	- Staff time: FACT, health depts. - DEFA/ 319 cost share programs	- Create septic / leach system database and inspection policies - Strengthen inspection policies and enforcement - Upgrade HSTS's - Institute education programs	2007 - 2008	- database completed - # of HSTS upgrades - # of educational programs conducted
Stormwater				
Conduct public outreach campaign on NPS prevention	- Staff time, partnering organizations - 319 grant funding to produce materials ($1,500)	Target civic associations and residents of Spring Run watershed: - Host lawn care program - Seek speaking opportunities - Hold Spring Run creek walk - Conduct drain labeling - Produce educational materials - Coordinate with Phase I/II community programs	Ongoing through 2008 2004 Materials- 2005	- # drain labeling events, participants - # of speaking engagements - # events where materials are distributed
Develop water quality monitoring program in Westerville	- Westerville staff time; budget for workshop, sample analysis (about $5000 annually for city-wide program) - FACT staff time	- FACT plan staff training - Westerville: establish quarterly program, draft ordinance to allow corrective action when problems are found	2004	- Training conducted - Program established - Ordinance passed
Habitat & Hydromodification				
Determine existence of remaining natural riparian buffer lands in headwaters, target for preservation	- Staff time, partnering organizations: FACT, Westerville RPD - Maps provided by Westerville RPD	Conduct desk-top analysis of maps and aerial photos to determine areas for further investigation	2005	- Analysis completed, parcel list developed
Conduct stream morphology assessments	FACT, ODNR, Westerville Service and RPD	Assess stream morphology of tributary to learn more about habitat disturbances as basis for potential for recovery / restoration goals	2006	- Assessment completed
Explore feasibility of stream channel restoration project	FACT, ODNR, Westerville Service and RPD	- After stream morphology assessment, research cost for channel restoration	2008	- estimate received

West Spring Run

Background

West Spring Run is a tributary to Alum Creek that flows east for 3.1 miles through Columbus along the north side of SR 161 to Alum Creek. It was evaluated for the first time by the Ohio EPA in 2000, and reported to have 3.1 miles in nonattainment of WWH aquatic life use standards (although the stream's use is undesignated). Nonattainment status was due to habitat alterations and flow alterations. Ohio EPA identified sources include urban runoff, channelization, and natural sources.

Problem Statement

While **pathogens** and nutrient enrichment are not included in the Ohio EPA's cause / source assessment, the 2003 TSD notes that bacteria exceedences were evident in the majority of samples, one over ten times the maximum standard for secondary contact recreation. **Nutrient and organic enrichment** was reported during wet weather sampling, which is indicative of urban runoff pollution. (Ammonia, Nitrite, and BOD were reported above the 90/ 95^{th} percentile). **Siltation** was evident with elevated TSS (203 mg/L), likely due to bank erosion. High levels of impervious cover in this established suburban area has likely led to stream morphology impacts and bank erosion. **Channelization** was noted by the Ohio EPA field staff.

The pathogen TMDL target (1000 colony forming unites/ 100ml 30 day geometric mean) and prescribed load reductions for the lower watershed apply to West Spring Run, as does the TMDL Habitat Score of 3. Actions targeted pathogens for the lower watershed will apply to this watershed as well; no tributary-specific actions were developed. Further assessment is needed to develop actions to address habitat deficiencies. Please see the introduction of Section IV for more information on TMDL's.

Long Term Goals

- Fecal coliform: TMDL target - 1,000 fecal coliform colonies /100ml (30 day geometric mean)
- Habitat TMDL Target Score of 3

Task Description (Objective)	**Resources**	**How**	**Time Frame**	**Performance Indicators**
Conduct stream morphology assessments	FACT, ODNR, Westerville Service and RPD	Assess stream morphology as basis for potential for recovery / restoration goals	2007 - 2008	- Assessment completed

Kilbourne Run

Background
Kilbourne Run is a tributary to Alum Creek located south of West Spring Run and flowing east for 2.6 miles through Minerva Park and Columbus to Alum Creek. The one river mile of Kilbourne Run evaluated by the Ohio EPA in 2000 was not attaining its WWH use designation due to excessive organic enrichment, pathogens, and siltation. Urban runoff was identified as the source of these impairments.

Problem Statement
Water quality samples in Kilbourne Run were limited to three occasions due to low flows. All three samples showed **bacteria** violations, sometimes twice the maximum level for secondary contact recreation. **Nutrients** were slightly elevated above background levels, while **organic enrichment** was evident with a BOD reading above the 95th percentile background. Total Suspended Solids (TSS) were detected above the 95th percentile background level. **Siltation** is likely due to bank erosion, which was also addressed in the Northland Plan Volume 1 conducted by the Columbus Division of Planning in 2001.

The pathogen TMDL target (1000 colony forming unites/ 100ml 30 day geometric mean) and prescribed load reductions for the lower watershed apply to Kilbourne Run, as does the TMDL Habitat Score of 3. Actions targeted pathogens for the lower watershed will apply to this watershed as well; no tributary-specific actions were developed. Further assessment is needed to develop actions to address habitat deficiencies. Please see the introduction of Section IV for more information on TMDL's.

Long Term Goals
- Fecal coliform: TMDL target - 1,000 fecal coliform colonies /100ml (30 day geometric mean)

Task Description (Objective)	**Resources**	**How**	**Time Frame**	**Performance Indicators**
Conduct stream morphology assessments	FACT, ODNR, Westerville Service and RPD	Assess stream morphology as basis for potential for recovery / restoration goals	2008	- Assessment completed

G. Bliss Run

Background
Bliss Run flows southwest for 1.5 miles into Alum Creek south of Livingston Avenue (further upstream portions of the stream have been piped underground). Although this stream is designated WWH, biological communities and use attainment were not evaluated in 2000. Impaired chemical water quality was evident with elevated levels of pathogens, nutrient enrichment, ammonia, and zinc, likely due to urban runoff.

Problem statement
Extremely elevated levels of bacteria were observed (55,000 colonies /100 ml) in Bliss Run. According to available data, this area is serviced by central sanitary sewers and contains no home sewage treatment systems. Possible sources of **pathogens** could include urban runoff (pet waste) and faulty sanitary sewer infrastructure. Actions targeted pathogens for the lower watershed will apply to this watershed as well; no tributary- specific actions were developed (see the introduction of Section IV for more information on TMDL's). Levels exceeding the 90^{th} percentile background level were detected for ammonia, nutrients (nitrates and phosphorus), and BOD (organic enrichment). These moderately elevated levels were present consistently, regardless of rain events.

Long Term Goals:
- Fecal coliform: TMDL target - 1,000 fecal coliform colonies /100ml (30 day geometric mean)

Task Description (Objective)	**Resources**	**How**	**Time Frame**	**Performance Indicators**
Work w/ Columbus DOSD to analyze results of sanitary sewer inflow/ infiltration studies	- Staff time, FACT, Columbus DOSD - Columbus CIP budget	DOSD conduct inflow and infiltration studies, upgrade system to eliminate cross flow of sanitary to storm systems	2004-2006	- Study completed - Repairs completed

COMMUNITY ACTION PLANNING

The goal of this portion of the planning process was to facilitate the participation of a wider range of community members by not limiting the topic to water quality, but instead asking community members what they valued about Alum Creek and wanted to create more of to improve their neighborhoods.

Interviews with over one hundred watershed residents and a planning meeting with forty residents led to the creation of five "themes," or areas of interest, which were: water quality, litter control, recreation, greenspace, and education and awareness.

Not surprisingly, some of the projects developed to address these themes were also identified in the technical section of the plan, and therefore are not included in this section. They include enhancing litter prevention and cleanup programs, creating an Alum Creek Water Trail (for boating), creating a riparian zoning overlay, and creating a Franklin County Land Trust.

The remaining community projects are listed below. At the time of the community meeting, participants did not feel that they had the resources to implement these projects themselves; however, participants will be encouraged to assist in development and implementation of projects as work begins. Standing FACT committees will also provide a platform to coordinate implementation of some community projects.

Implementation priorities will be based on where the most resources and interest exists among FACT and planning participants. Two projects in particular have emerged as having high levels of interest and potential for success: 1) tributary naming and 2) education and awareness of the use of Alum Creek as an Underground Railroad route. Please see Section I ("Introduction") for more information on the community planning process.

Task Description	Resources	How	Time Frame	Performance Indicators
Wet Shoe Project	- FACT staff and volunteer time -Grant funds (estimated $10,000 -$50,000)	- Meet with community members to develop site along creek to encourage public education and interaction - Identify local partners, apply for grants funds to create conceptual plan and develop site	2008	- site identified - grant application - site completed
Name Tributaries	- Staff and volunteer time: FACT, MORPC, local municipalities	- Research local names with community members - Host community meetings - Submit application to USGS - Publicize name, research funds for signage	2005 – 2010	- # community meetings - # of streams officially named
Market value of Alum Creek to watershed neighborhoods	- Staff and volunteer time: FACT - Funds for literature ($5 per house)	- Prepare literature, create "welcome wagon" literature drop for new residential developments with watershed address, NPS education - Track web site hits after literature drops	2008	- # houses were literature is dropped - web site hits
Celebrate Underground Railroad along Alum Creek	- Staff /volunteer time: FACT, CRPD, OSU African Studies Dept., Friends of Freedom - Grant funds to host events ($5,000), - CRPD budget for signage ($50,000)	- Create virtual tour on FACT website - Assist Columbus Recreation and Parks Dept. in including information on UGRR in interpretive greenways signage - Celebrate cultural heritage of UGRR along creek through awareness campaign: press, events, tour, signage, etc.	2006 2004 – 2008 2007	- # events held - # attendees - # of sings erected - web page created
Create Alum Crk Neighborhood Directory	- FACT volunteer time	- Create directory of civic associations, homeowners associations, and housing developments in the watershed for education and outreach purposes	2006	- Directory created

V. EVALUATION

Evaluation is an essential component of any planning document, given that circumstances and attitudes of planning participants and watershed residents will change over time. The goal of evaluating the action plan will be to determine which actions are working and which need to revised, and will aid in achieving efficient use of resources. Plan evaluation will be conducted at multiple levels (please see the table below for a summary):

- **Tier I:** Implementation of specific actions will be gauged with the performance indicators listed with actions in Section IV. These can be thought of as "short term goals," and are generally more administrative.

- **Tier II:** Where appropriate, specific goals for the implementation of Best Management Practices (BMP's) have also been included, and progress towards those goals can be assessed. For example, the plan states a goal of preserving 50 acres of riparian land by 2010, which can be compared to actual acres preserved. These can be thought of as "mid-term goals," and also include interim attainment goals.

- **Tier III:** The plan also states "long term goals," which for the most part correspond with TMDL targets (see Section IV for more information on TMDL's). For instance, maintaining full attainment and achieving TMDL target scores for habitat, sediment, and fecal coliform are listed as goals for the upper (14 dig HUC) subwatershed. Progress towards these goals will be assessed through water quality monitoring, which is included as an action in Section IV to be implemented by FACT.

Tier I and Tier II evaluation will be conducted annually to determine if actions have been successfully completed. Tier III evaluation will allow stakeholders to determine if completing those actions have resulted in attaining water quality goals. While water quality data will be analyzed annually, a more thorough evaluation of data and goals will be conducted on a five-year basis, along with plan revision.

One potential challenge will be the long-term availability of water quality data. As of early 2005, FACT anticipates receiving an Ohio EPA 319 Implementation Grant to fund water quality monitoring for three years (2006 – 2009). FACT anticipates continuing monitoring efforts past that point, although funding is not guaranteed.

Another source of data will include Ohio EPA assessments, which occur on a rotating basin basis throughout the state every 5-10 years. The existence of a Total Maximum Daily Load (TMDL) report by the Ohio EPA for the Big Walnut Creek basin should ensure that assessments will be completed. Other data sources that could be utilized if necessary include the three universities located along the creek (Otterbein University, Ohio Dominican University, and Capital University), and the City of Columbus. The later is currently collecting ambient data as well as data at stormwater and CSO discharge points.

Primary responsibility for evaluating the action plan will lie with the Friends of Alum Creek & Tributaries (FACT) and the Alum Creek Action Plan Steering Committee. FACT will initiate an annual review process through convening the steering committee. Through ongoing quarterly action plan meetings, stakeholders will also receive opportunities to evaluate actions and revise the plan. A more thorough effort to include stakeholders, FACT members, and other watershed residents will be made during five year evaluations.

The following table summarizes some of the information provided in the plan that will be necessary to complete an evaluation. Note that only actions to which quantified BMP implementation or load reductions could be ascribed are included below as mid-term targets.

<table>
<tr><th colspan="2">Upper subwatershed</th></tr>
<tr><th colspan="2">Long term goals (Tier I)</th></tr>
<tr><td colspan="2">• Maintain full attainment status
• Achieve sediment TMDL scores of 33 or better
• Achieve habitat TMDL score of 3
• Achieve Fecal coliform: TMDL target - 1,000 fecal coliform colonies /100ml (30 day geometric mean), through:
- Reduce aerator loading by 56%
- Reduce NPS (runoff) loading by 69%
- Reduce cattle loading by 100%</td></tr>
<tr><th colspan="2">Mid-term goals (Tier II)</th></tr>
<tr><td>General</td><td>• Maintain full use attainment</td></tr>
<tr><td>Organic Enrichment</td><td>• Reduce pathogen loading from aerators 40% by 2015 through
- Upgrading 25 systems
- Eliminating 40 systems through extension of sanitary sewer to two problem areas
• Reduce cattle pathogen loading by 100% by 2008 through applying BMP's at the one known cattle lot in the upper watershed, along unnamed tributary 25.5.</td></tr>
<tr><td>Stormwater & Construction</td><td>• Reduce sediment loading by 20% through implementing Phase II stormwater programs and through pubic education</td></tr>
<tr><td>Habitat & Hydromodification</td><td>• Preserve 50 acres, (or 10,000 by 200 linear feet) of riparian land by 2010 (in upper and lower watersheds combined)</td></tr>
<tr><th colspan="2">Lower subwatershed</th></tr>
<tr><th colspan="2">Long term goals (Tier I)</th></tr>
<tr><td colspan="2">• Maintain full attainment status in reaches that are currently in attainment
• Achieve sediment TMDL scores of 33 or better
• Achieve habitat TMDL score of 3
• Achieve Fecal coliform: TMDL target - 1,000 fecal coliform colonies /100ml (30 day geometric mean), through:
- Reduce aerator loading by 91%
- Reduce NPS (runoff) loading by 44%
- Reduce CSO loading by 91%</td></tr>
<tr><th colspan="2">Mid-term goals (Tier II)</th></tr>
<tr><td>General</td><td>• Maintain full use attainment in river reaches that are currently in attainment, and nonattainment reach (River Miles 8.6 and 7.5) to at least partial attainment.</td></tr>
<tr><td>Organic Enrichment</td><td>• Reduce pathogen loading from aerators 75% by 2025 through
- Upgrading 90 systems
- Eliminating 20 systems through extension of sanitary sewer to problem areas by 2015</td></tr>
<tr><td>Stormwater & Construction</td><td>• Reduce sediment loading by 20% through implementing Phase II stormwater programs and through pubic education</td></tr>
<tr><td>Habitat & Hydromodification</td><td>• Preserve 50 acres, (or 10,000 by 200 linear feet) of riparian land by 2010 (in upper and lower watersheds combined)
• Remove two lowhead dams by 2008</td></tr>
</table>

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APPENDIX

1) FACT Organizational Structure

2) Action Plan Participants

3) Education & Outreach Actions

4) FACT 2005 Fundraising Plan

5) K-Values of Watershed Soils

6) Macroinvertebrates of Alum Creek

7) Fresh Water Mussels of Alum Creek

8) Fish Distribution of Alum Creek near Westerville, Ohio

9) Historic Fish Distribution of Alum Creek

10) Reptiles & Amphibians of the Alum Creek Watershed

11) Mammals of the Alum Creek Watershed

12) Tributary Stream Morphology Data

13) Stream Channelization at State Route 104

14) Sediment Chemistry

15) Columbus DOSD Projects that Will Affect Sewer Overflows

16) Industrial Facilities Draining to Maryland Avenue Sewer and American Ditch

17) Industrial Stormwater Permits

APPENDIX 1

Friends of Alum Creek & Tributaries
Organizational Structure

Board of Directors, 2005:
Barbara Logan, Chair
David Hohmann, Vice-Chair
Jim Lunde, Co-Treasurer
Jan Tague, Co-Treasurer
Carol Elder, Secretary
Margaret Ann Samuels, Watershed Watch Committee
Joe Bonnell, Education & Outreach Committee
Harold Highland, River Corridor Committee

Staff
Heather Doherty, Watershed Coordinator

Bylaws

1.0 NAME: This organization shall be known as the "Friends of Alum Creek and Tributaries" or "FACT". The term "organization", as used in these bylaws, refers to the Friends of Alum Creek and Tributaries (FACT).

2.0 PURPSOE: FACT is committed to finding ways to preserve and protect Alum Creek as a natural area while providing citizen access for environmentally responsible recreation, educational opportunities, and citizen enjoyment at many levels.

3.0 MEMBERSHIP

- 3.1 Membership is open to any individual, family, business, government agency, educational institution, or other organization that subscribes to the purpose of FACT.
- 3.2 Voting members shall be members in good standing who are residents of Alum Creek watershed or interested in the protection and preservation of Alum Creek watershed. To retain membership in good standing, persons shall have paid the annual dues as set by the membership. Membership is based on a calendar year.
- 3.3 Membership in good standing will be terminated by (a) receipt by the Steering Committee of the written resignation of a member, (b) by the death of a member, (c) the failure of a member to pay annual dues, or (d) by unanimous action of the Steering Committee based upon conduct by the member that is inconsistent with membership. In reference to item (d) above, a member may be reinstated if the member corrects the cause of termination. Charter members shall be those members present at the meeting during which these bylaws were first adopted.

4.0 ORGANIZATION AND OFFICERS

- 4.1 The Board of Directors of FACT shall be the Chair, Vice-Chair, Secretary, and Treasurer. All officers shall be voting members of the organization and serve as volunteers
- 4.2 Elections for the office of Chair, Vice-Chair, Secretary, and Treasurer shall be conducted per Robert's Rules of Order. Nominations will be made by the Nominating Committee. Any member in good standing may make additional nominations from the floor or in writing to any member of the Steering Committee. It is incumbent upon the nominator to determine the willingness of the nominee to serve.
- 4.3 The duties of the Chair shall include, but are not limited to:
  - scheduling meetings and developing meeting agendas
  - presiding over all meetings of the organization
  - serving as chair of the Steering Committee and as an ad hoc member of other committees.

- 4.4 The duties of the Vice-Chair shall include, but are not limited to assuming the duties of the Chair should that office become vacant and presiding at meetings of the organization and its Steering Committee when the Chair is unable to attend.
- 4.5 The duties of the Secretary shall include, but are not limited to:
  - maintaining the official records of the organization.
  - recording and distributing the minutes of the meetings.
  - maintaining a current record of the names and addresses of members in good standing.
  - maintaining an attendance record of those attending meetings and special events.
  - sending out notices of meetings along with supporting materials.
- 4.6 The duties of the Treasurer shall include, but are not limited to:
  - receiving and depositing revenue from dues or other sources in a depository to be approved by the steering committee.
  - keeping and maintaining accurate records of all receipts and disbursements and accounts.
  - reporting on the financial status of the organization to the Steering Committee and at regular meetings of the organization.
  - providing a list to the Secretary of all members who have met their dues requirements.
  - providing such other financial information or keeping such other financial records as may be required.
- 4.7 All officers are elected for a one year term. Re-election to these offices is permitted.
- 4.8 The immediate past Chair will continue to serve as a member of the Board of Directors in an advisory capacity for one year.

5.0 COMMITTEES

- 5.1 Standing Committees: The following standing committees will be established to address concerns of FACT:
  - Personnel: Carried out by the Board of Directors; approves personnel policy, evaluates coordinator annually, manages other personnel.
  - Fundraising: Writes and manages grants, fundraising activities, tracks membership.
  - Education/Outreach: Builds awareness and support, public relations, educational opportunities.
  - Watershed Watch: Monitors construction activity, stormwater, sewer lines, and other potentially harmful activity.
  - River Corridor: Acts to preserve, protect, and improve the areas around the creek and watershed.
  - Watershed Action Planning Advisory Committee: Coordinated by the Watershed Coordinator.
- 5.2 Other (Ad Hoc) Committees: The Steering Committee may appoint such other standing or ad hoc committees as deemed necessary to support the efforts of the organization.
- 5.3 Steering Committee: The Steering Committee will be composed of the Chair, Vice-Chair, Secretary, and Treasurer of the organization and the chairs of each established standing and ad hoc committee.
- 5.4 The duties of the Steering Committee shall include, but not be limited to:
- acting as an Executive Committee to direct the business activities of the organization.
- acting as the Nominating Committee.
- creating or eliminating standing or ad hoc committees as deemed necessary.
- calling special meetings.
- recommending projects to the existing committees.
- authorizing expenditures of the organization and approving payment of indebtedness incurred by the organization.
- 5.5 Scope of Work of Committees: Each committee will initially establish a scope of work and initiate projects and activities that will enable it to carry out the established scope of work. The duties and activities developed by the committees shall be approved by the Steering Committee.
- Committee Chair Selection: Each standing and ad hoc committee is to elect a chair by the end of its second meeting. The committee chairs will also serve as members of the Steering Committee.

6.0 MEETINGS

- 6.1 The organization shall meet as determined by the Steering Committee.

- The Board of Directors must meet annually.
- Members shall be provided with an agenda for each meeting and business materials that may be considered or acted upon, whether or not they are set forth in the agenda.
- Special meetings may be held as needed.

7.0 DECISION MAKING

- The organization will make every effort to operate by consensus. Consensus means that everyone can live with the decision. Group decisions will be made by all members in good standing which are present at the meeting.
- Quorum – A simple majority of members present at a meeting will constitute a quorum and, if consensus can not be reached, decisions requiring a vote will require a two thirds majority vote of the quorum present.
- Any voting member amy call for a vote on any issue during the course of a meeting.
- Procedures not covered in these bylaws will be covered by Roberts's Rules of Order.

8.0 MISCELLANIOUS PROVISIONS

- 8.1 Copies of all records, except financial records, shall be kept at _________.
- In the event that FACT dissolves, all funds shall be distributed as follows:
  - Grant money will be disbursed as per grant agreement.
  - Balance to another 5013C organization, with values agreeing with the mission of FACT, as determined by the Board of Directors at the time of dissolution.

9.0 AMENDMENTS: Any amendments to the bylaws may be adopted by a two thirds majority vote of the members present at a regularly called meeting. The notice for the meeting at which the vote to adopt the amendments is to take place shall include the proposed amendments.

APPENDIX 2

Alum Creek Watershed Action Plan:
Committee Members and the Decision Making Process

Action Plan Steering Committee

Frances Beasley (Committee Chair), Columbus Department of Public Utilities
Joe Bonnell, Ohio State University Extension
Jeff Cox, Columbus Division of Sewers & Drains
Keith Dimoff, Ohio Environmental Council
Carol Elder, Friends of Alum Creek & Tributaries
Michael Hoggarth, Otterbein College
Dan Lorek, Bexley Development Department
Dick Lorenz, Westerville Division of Water
Vince Mazeika, OEPA Division of Surface Water
Stephen McClary, Columbus Planning Division
Jerry Wager, Columbus resident

Habitat & Hydromodification Work Group

Chair: Terry Lahm, Capital University
Jill Snyder, Metro Parks
Elayna Grody, Columbus Recreation & Parks Department
J.T. Lowder, Watershed Resident
Arthur Morris, OSU Graduate Associate
Bob Wattenshchaidt, U.S. Army Corp of Engineers
Dick Seebode, Columbus Outdoor Pursuits
Hector Santiago, Franklin Soil & Water Conservation District
Jim Ward, Delaware County Commission
Maureen Lorenz, Columbus Recreation & Parks Department
Doug Jackson, Bexley Recreation & Parks Department
Cindy Lynch, Metro Parks
Mike Hoggarth, Otterbein College
Jerry Wager, Ohio Department of Natural Resources

Land Use Work Group

Chair: Dan Lorek, Bexley Development Department
Stephen McClary, Columbus Planning Division
Frank Eubanks, Watershed Resident
Candy Canzoneri, Greenheads
Frances Beasley, MORPC - Franklin County Greenways
Mac Albin, Metro Parks
Charity Raimonae, Acorn Farms
Mike Hooper, Westerville Parks & Recreation Department
Dave Horn, Columbus Audubon
Paul Riedinger, Delaware County Friends of the Trail
Pat McCabe, St. Mary of the Springs
Andrea Gorzitze, MORPC - Franklin County Greenways
Tom Farahay, Orange Township Zoning Office
Leslie Warthman, Genoa Township Zoning Office
Shawn Mason, Centex Homes
Elizabeth Clark, Columbus Planning Division

Stormwater & Construction Work Group

Chair: David Hohmann, Ohio EPA & FACT Vice-Chair
Brad Westall, Columbus Recreation & Parks Department
Luanne Hendricks, Watershed Resident
Mike Bolton, Ohio EPA, DSW
Gregg Sablak, Delaware Soil & Water Conservation District
Jeff Cox, Columbus Stormwater Management Section
John Dean, Westerville Public Service Department
Dorothy Prichard, Bexley Public Service Department
Anne Lowder, Watershed Resident
Susan Banbury, Westerville City Engineering Office
Bret Bugerford, Delaware County Engineer's Office
Emily Dick, Franklin Soil & Water Conservation District

Organic Enrichment & Human Health Work Group

Helga Kaplan, Chair, Watershed Resident
Larry Korecko, OEPA – DSW
Mike Gallaway, OEPA – DSW
Yvonne Thornton, Columbus Division of Sewerage & Drainage
Dan Binder, Columbus Water Quality Research Laboratory
Dick Lorenz, Westerville Water Department
Dale Harmon, Columbus Health Department
Dick Morris, Columbus Division of Sewerage & Drainage
Tom Shockley, Franklin County Engineer's Office
Paul Rosile, Franklin County Board of Health
Susan Sutherland, Delaware County Health District

Others Participants

Erin Miller, Friends of Lower Olentangy Watershed
Tim Granata, Ohio State University
Alicia Silverio, ODNR Division of Water
Paul Gledhill, Delaware Soil & Water Conservation District
Fred Myers, OEPA – Division of Emergency and Remedial Response
Tatyana Arsh, Columbus Division of Sewerage & Drainage

Community Action Planning Forum Participants

Frances Beasley, MORPC / Franklin County Greenways Initiative
Joe Bonnell, OSU Extension
Linda Brownstein, Westerville resident
Carol Elder, FACT member and Westerville resident
Don Emmert, Franklin Soil & Water Conservation District
Frank Eubanks, Franklin Park Area Association, Columbus
Brian Fadley, FACT member and Columbus resident
Leslie Fowler, FACT member and Bexley resident
Carl Gray, Woodland-Hold Civic Association, Columbus
Luanne Hendricks, FACT member and Westerville resident
Harold Highland, FACT member and Westerville resident
Becky Hohmann, FACT member and Bexley resident
David Hohmann, FACT member and Bexley resident
Mark Hopkins, Westerville Parks & Recreation Department
Alfonso Hooper, Brittney Hills Civic Association, Columbus
David Horn, Columbus Audubon Society
Karr'yen Jones, Northeast Area Commission, Columbus
Barbara Logan, FACT member and Columbus resident
Pat Marida, Central Ohio Sierra Club

Nancy Hill McClary, North Central Area Commission, Columbus
Holleh Moheimani, Capital University
Kathy Nelson, Columbus City Schools and Friends of Freedom Society
Alice Porter, Northeast Area Commission
Chris Walker, Franklin Park Conservatory
Margaret Ann Samuels, FACT member and Bexley resident
Jean Schmitt, FACT member and Bexley resident
Kathrine Schleich, FACT member and Westerville resident
Nancy Schleich, FACT member and Westerville resident
Jan Tague, FACT member and Westerville resident

Decision Making

Decision making among the work groups, action plan steering committee, and the Friends of Alum Creek Board of Directors remained very informal throughout the planning process. Written policies were not developed due to a lack of need, especially given that collaboration was the defining approach. A verbal agreement was established in early 2002 between the action plan steering committee members and the FACT board of directors that although FACT wished to provide autonomy to planning participants, the board would reserve the final right to make decisions on content of the plan, given that FACT was to maintain final responsibility for its implementation.

Work group chairs carried out logistical responsibilities, including correspondence with group members, maintaining meeting notes, and at times helping set agendas and lead meetings. The action plan steering committee's primary role was providing guidance on developing the planning process and major topics, and will continue to guide implementation and evaluation of the action plan.

APPENDIX 3

Education & Outreach Actions

The actions below represent all education and outreach actions included in Section IV of the Lower Alum Creek Watershed Action plan, listed here together to help coordinate education projects.

Issue	Description	Audience
Home Sewage Treatment Systems (HSTS)	Outreach on changing inspection & enforcement policies	Owners of systems
Nutrient & organic enrichment	HSTS, lawn care, pet waste. Print materials.	General public, target Spring Run, HSTS system owners
Sediment & erosion control citizen action network	Enlist citizens to monitor compliance on construction sites. Begin with workshops/ materials on erosion control techniques	Target upper watershed
NPS pollution	Drain labeling, print materials, presentations, etc.	General public. Target Spring Run, Bexley
Stormwater (volume)	Conduct tour/ workshop on effects of stormwater on tributaries	Decision makers in upper watershed
Greenways	Benefits of greenways and floodplains: natural, economic, health, etc. Components: web page, presentations, news articles	Public, zoning officials, land owners
Stewardship	Target land owners, as part of preservation campaign. Present stewardship as one option of spectrum including easements.	Land owners
Recreation	Alum Creek Water Trail materials	General
Trail Signage	Continue to work with recreation departments to produce / coordinate signage	General
Litter	Increase enforcement of laws, general programs (hotlines and signage), materials	General
Lowhead dams	Outreach regarding negative effects and benefits of removal	Communities living near dams
Spring Run	Target of many NPS education components (labeling, presentations, literature, etc). Host creek walk.	Spring Run watershed communities
Tributary naming	Research local names with residents, hold public meetings, submit USGS petition	Tributary watershed communities, civic associations
Underground Railroad	Develop strategy, trail research and signage, event, materials	Central watershed, minority communities
Other community projects	Wet Shoe Project; Welcome Wagon; Neighborhood Directory	General

APPENDIX 4

FACT Fundraising Plan 2005

Strategy	Expected Revenue	Action Steps	Who	When / Cost
MEMBERSHIP: **goal 150 ($9,000)**		4-5 memberships per board member		
Individual / family / org Renew (80%) 85 * $30 New 40 * $30	$ 3,750	1. Mail 2 membership appeals (*One sent)* 2. After 2nd appeal, board make personal contacts to non-renewals 3. Go to events, collect names 4. Add contacts to prospect list	Staff Staff / Board Staff / volunteers Board	Feb. 1, Nov. 1 June Ongoing Ongoing, Sept- Oct
Supporting Renew (100%)13 * $100 New 10 * $100	$ 2,300	1. Send two membership appeals (*One sent)* 2. After 2nd appeal, board make personal contacts to non-renewals 2. Board members solicit businesses - draft letter /follow up call/ meetings 3. Continue to build database	Staff Board/ Staff Board Board/Staff	Feb.1, Nov.1 June Ongoing, January Ongoing, Sept - Oct
Government 2 municipalities * 1,000	$ 2,000	1. Write personal letters, set up meetings (DONE) 2. Followup calls 3. Devise strategy for other jurisdictions (for 2006)	--- Staff Board / staff	--- end of January August
Major Donor 1*1,000	**$ 1,000**	Send letter, set up mtg (DONE)	Staff – initiate Board – go to mtg	November 05
		SPECIAL EVENTS		
Raffles	$ 400	1. Board members take turns securing raffle item for three ed/out meetings and major cleanups 2. Staff / volunteers / steering committee sell tickets before meeting	Board Board / Staff	Bimonthly / No cost
Old Bag of Nails "Cocktails for Conservation"	$ 1000	1. Meet with OBN staff/owner 2. Develop invite list, Bexley resident coordinator	Jim, Heather Jim, Heather, Board	Event in May?
Canoe Float	$ 300	1. Determine river reach, equipment, date 2. Extend invites to members first, partners for free?	Jim, Mike	Event in June / July?
FR Dinner	$ 2,500	1. Meet with Winebrenners to start planning event 2. Publicity / invites / planning, etc.	Staff Staff / Board	April April - September
		FOUNDATION GRANTS		
Five-Star Restoration Grant	*Up to $20,000*	1. Assess feasibility, partners, etc. 2. Write grant (Due March 1st)	Staff / Watch com. Staff / Watch com.	ASAP February
Altria Grant	*Up to $20,000*	1. Reassess need, feasibility for use of grant for consultant to work on zoning 2. Write grant (Due November 1st)	Staff/ Board Staff / FR committee	August
Research other grants	- 0 -	1. Make grants calendar	Staff	January
		CORPORATE GIVING		
UBS Employee Volunteer Grant	$ 500	1. Consider grant projects 2. Apply for grant	Staff; Jim Lunde	(no deadline)
		OTHER		
Phase II Education Contract	?	1. Talk to Bexley in February, reassess interest	Staff	February
Work Place Giving		1. File 501(c)3 2. Enlist with Earth Shares, ODNR/OEPA	Board Staff	January 05 End of September
TOTAL	13,700			

Appendix 5

K-values for Soils Found in the Lower Alum Creek Watershed

Soil Type	Soil Symbol	County	K – Value	Soil Type	Soil Symbol	County	K – Value
Alexandria	AdB	Fr*	.37	Kendallville	KeB	Del	.37
Alexandria	AdC2	Fr	.37	Kendallville	KeC2	Fr	.37
Alexandria	AdD2	Fr	.37	Kokomo	Ko	Fr	.32
Alexandria	AdE2	Fr	.37	Latham	LbF	Fr	.49
Algiers	Ag	Fr	.37	Lobdell	LoA	Del	.37
Amanda	AmD2	Fr	.43	Loudonville	LsA	Del	.28 - .37
Amanda	AmE	Del*	.43	Lybrand	LyD2	Del	.43
Amanda	AmF	Del	.43	Lybrand	LyE2	Del	.43
Bennington	BeA	Del	.43	Millgrove	MfA	Del	.32
Bennington	BeB	Fr, Del	.43	Millgrove	MhA	Del	.28
Bennington	BfA	Fr, Del	.43	Medway	Mh	Del	.32
Bennington	BfB	Fr	.43	Miamian	MkB	Fr	.37
Blount	BoA	Fr	.43	Miamian	MlC2	Fr	.37
Blount	BoB	Del	.43	Miamian	MiD2	Fr	.37
Cardington	CaB	Del	.37	Ockley	OcA	Fr	.37
Cardington	CaB2	Fr, Del	.37	Ockley	OcB	Fr	.37
Cardington	CaC2	Fr	.37	Ockley	OcC2	Fr	.37
Cardington	CbB	Fr, Del	.37	Pewamo	Pm	Fr	.24
Cardington	CbC	Fr	.37	Pewamo	Pn	Fr	.24
Celina	CeB	Fr	.37	Pewamo	PwA	Fr	.28
Celina	CfB	Fr	.37	Rossburg	RoA	Del	.37
Condit	Cn	Fr	.37	Ross	Rs	Fr	.32
Condit	CnA	Fr	.37	Shoals	Sh	Fr	.37
Crane	CpA	Del	.28	Sleeth	SlA	Fr	.32
Crosby	CrA	Fr	.43	Sloan	SkA	Del	.28
Crosby	CrB	Fr	.43	Sleeth	SmA	Fr	.32
Crosby	CsA	Fr	.43	Sloan	SnA	Del	.28
Crosby	CsB	Fr	.43	Sloan	So	Fr	.37
Eel	Ee	Fr	.37	Sloan	SoA	Del	.28
Eldean	ElA	Fr	.37	Thackery	ThB	Fr	.37
Eldean	ElB	Fr	.37	Udorthents	Uc	Del	---
Eldean	ElC2	Fr	.37	Udorthents	UdB	Del	---
Eldean	ElD2	Fr	.37	Udorthents	Up	Fr	---
Eldean	EmA	Fr	.37	Udorthents	Ur	Fr	---
Eldean	EmB	Fr	.37	Udorthents	Us	Fr	---
Gallman	GaC2	Fr	.37	Udorthents	Ut	Fr	---
Gallman	GbA	Del	.37	Udorthents	Ur	Fr	---
Gallman	GbB	Del	.37	Water	W	Fr, Del	---
Genesee	Gn	Del	.37	Warsaw	WdB	Fr	.28
Glynwood	GwB	Fr	.43	Wea	WeB	Fr	.32
Glynwood	GwC2	Del	.43	Westland	Wt	Fr	.28
Jimtown	JmA	Del	.37				

K-values indicate the susceptibility of a soil to sheet and rill erosion by water. Fr = Franklin County; Del = Delaware County. Data Source: Soil Survey of Franklin County, OH (McLoda and Parkinson, 1976), and Delaware Soil & Water Conservation District.

APPENDIX 6: Macroinvertebrates collected from Alum Creek.

Taxa	Common Name	OEPA	Hoggarth *et al.*
Porifera	Sponge		
Spongillidae			
Spongilla sp.			X
Ephydatia sp.		X	
Eunapius sp.		X	
Trochospongilla sp.		X	
Cnidaria	Hydra & Jellyfish		
Hydrozoa			
Hydra sp.		X	
Craspedacusta sp.		X	
Plathyhelminthes	Flatworm		
Planaria			
Dugusia sp.			X
Nermetea	Ribbon Worm	X	
Ectoprocta	Moss Animal		
Fredericella sp.		X	
Paludicella sp.		X	
Plumatella sp.		X	
Endoprocta	Endoprocts		
Urnatella sp.		X	
Annelida			
Oligochaeta	Aquatic Worm	X	X
Hirudinea	Leech		X
Helobdella sp.		X	
Placobdella sp.		X	
Erpobdella sp.		X	
Mooreobdella sp.		X	
Isopoda	Isopod		
Caecidotea sp.		X	
Amphipoda	Amphipod		
Hyalella sp.		X	
Crangonyx sp.		X	X
Decapoda	Crayfish		
Cambaridae			
Orconectes rusticus	Rusty Crayfish	X	X
Orconectes sanbornii	Sanborn's Crayfish	X	
Cambarus sciotensis	Scioto Crayfish	X	X

APPENDIX 6: Macroinvertebrates collected from Alum Creek. - Continued

Taxa	Common Name	OEPA	Hoggarth *et al.*
Ephemeroptera	Mayfly		
Baetidae			
Baetis intercalaris		X	X
Callibaetis sp.		X	
Centroptilum sp.		X	
Procloeon sp.		X	
Diphetor hageni		X	
Baetiscidae			
Baetisca sp.			X
Isonychiidae			
Isonychia sp.		X	
Ephemerellidae			
Eurylophella sp.		X	
Ephemeridae			
Ephemera sp.		X	
Caenidae			
Caenis sp.		X	X
Leptophlebiidae			
Choroterpes sp.		X	
Leptophlebia sp.		X	
Paraleptophlebia sp.		X	
Heptageniidae			
Leucrocuta sp.		X	
Nixe sp.		X	
Stenacron sp.		X	X
Stenonema exiguum		X	X
Stenonema femoratum		X	
Stenonema m. integrum		X	
Stenonema pulchellum		X	
Stenonema terminatum		X	
Stenonema tripunctatum		X	
Stenonema vicarium		X	
Tricorythidae			
Tricorythodes sp.		X	X
Odonata-Zygoptera	Damselfly		
Coenagrionidae			
Argia sp.		X	X
Enallagma sp.			X

APPENDIX 6: Macroinvertebrates collected from Alum Creek. - Continued

Taxa	Common Name	OEPA	Hoggarth *et al.*
Calopterygidae			
Hexagenia limbata		X	X
Calopteryx sp.		X	X
Hetaerina sp.		X	
Odonata-Anisoptera	Dragonfly		
Macromiidae			
Macromia sp.		X	X
Gomphidae			
Gomphus sp.		X	
Stylogomphus albistylus		X	
Dromogomphus sp.			X
Aeshnidae			
Aeshna sp.		X	
Basiaeschna janata		X	
Boyeria vinosa		X	X
Nasiaeschna pentacantha		X	X
Corduliidae			
Somatochlora sp.		X	
Epitheca cynosura		X	
Libellulidae			
Libellula Lydia		X	
Plecoptera	Stonefly		
Perlidae			
Acroneuria frisoni		X	
Neoperla clymene		X	
Isoperlidae			
Isoperla sp.			X
Hemiptera			
Gerridae	Water strider		
Gerris gerris			X
Corrixidae	Water boatman		
Sigara sp.		X	X
Trichocorixa sp.		X	
Nepidae	Water scorpion		
Ranatra sp.		X	X
Belostomatidae	Giant Water Bug		
Belostoma sp.		X	

APPENDIX 6: Macroinvertebrates collected from Alum Creek. - Continued

Taxa	Common Name	OEPA	Hoggarth *et al.*
Pleidae	Pigmy Back Swimmer		
Neoplea sp.		X	
Naucoridae	Creeping Water Bug		
Pelocoris sp.		X	
Notonectidae	Back Swimmer		
Notonecta sp.		X	
Trichoptera	Caddisfly		
Hydropsychidae			
Hydropsyche depravata		X	X
Hydropsyche dicantha		X	
Hydropsyche simulans		X	
Cheumatopsyche sp.		X	X
Ceratopsyche morose		X	
Macrostemum zebratum		X	
Helicopsychidae			
Helicophsyche borealis			X
Limnephilidae			
Pycnopsyche sp.		X	X
Philopotamidae			
Chimarra obscura		X	
Psychomyiidae			
Lype diversa		X	
Polycentropidae			
Polycentropis sp.		X	X
Cernotina sp.		X	
Neureclipsis sp.		X	
Hydroptilidae			
Hydroptila sp.		X	
Leptoceridae			
Mystacides sepulchralis		X	
Nectopsyche diarina		X	
Oecetis nocturna		X	
Triaenodes sp.		X	
Lepidoptera	Butterfly & Moth		
Pyralidae			
Petrophia sp.		X	

APPENDIX 6: Macroinvertebrates collected from Alum Creek. - Continued

Taxa	Common Name	OEPA	Hoggarth *et al.*
Megaloptera	Dobsonfly & Fishfly		
Sialidae			
Sialis sp.		X	
Corydalidae			
Corydalus cornutus		X	X
Nigronia serricornis		X	
Neuroptera	Spongillafly		
Sisyridae			
Climacia sp.		X	
Coleptera			
Gyrinidae	Whirlygig Bettle		
Dineutus sp.			X
Gyrinus sp.		X	X
Haliplidae	Crawling Water Beetle		
Haliplus sp.		X	
Peltodytes sp.		X	X
Dytiscidae	Predaceous Diving Beetle		
Hydoporus sp.		X	
Laccophilus sp.			X
Hydrophilidae	Water Scavenger Beetle		
Berosus sp.		X	
Enochurus sp.		X	
Helophorus sp.		X	
Paracymus sp.		X	
Tropisternus sp.		X	
Psephenidae	Water Penny Beetle		
Ectpria sp.		X	
Psephenus herricki		X	X
Elmidae	Riffle Beetle		
Ancyronyx variegata		X	
Dubiraphia bivittata		X	
Dubiraphia quadrinotata		X	
Dubiraphia vittata		X	
Macronychus glabratus		X	X
Stenelmis sp.		X	
Dryopidae	Long-toed Water Beetle		
Helichus sp.		X	

APPENDIX 6: Macroinvertebrates collected from Alum Creek. - Continued

Taxa	Common Name	OEPA	Hoggarth *et al.*
Diptera			
Chironomidae	Midge fly		X
Ablabesmyia mallochi		X	
Ablabesmyia rhamphe		X	
Clinotanypus pinguis		X	
Conchapelopia sp.		X	
Hayesomyia senata or *Thienemannimyia norena*		X	
Helopelopia sp.		X	
Labrundinia pilosella		X	
Meropelopia sp.		X	
Nilotanypus fimbriatus		X	
Pentaneura inconspicua		X	
Procladius sp.		X	
Brillia flavifrons		X	
Corynoneura lobata		X	
Cricotopus bicinctus		X	
Cricotopus termulus		X	
Cricotopus sylvestris		X	
Nanocladius crassicornus		X	
Nanocladius distinctus		X	
Nanocladius spiniplenus		X	
Nanocladius downesi		X	
Orthocladius sp.		X	
Parakiefferiella sp.		X	
Parametriocnemus sp.		X	
Rheocricotopus robacki		X	
Synorthocladius semivirens		X	
Thienemanniella taurocapita		X	
Thienemanniella lobapoderma		X	
Thienemanniella similis		X	
Thienemanniella xena		X	
Axarus sp.		X	
Chironomus decorus		X	
Cryptochironomus pseudotener		X	
Cryptotendipes sp.		X	
Dicrotendipes neomodestus		X	
Dicrotendipes modestus		X	
Dicrotendipes fumidus		X	

APPENDIX 6: Macroinvertebrates collected from Alum Creek. - Continued

Taxa	Common Name	OEPA	Hoggarth *et al.*
Dicrotendipes lucifer		X	
Dicrotendipes simpsoni		X	
Endochironomus nigricans		X	
Glyptotendipes amplus		X	
Harnischia curtilamellata		X	
Microtendipes caelum		X	
Microtendipes pedellus		X	
Nilothauma sp.		X	
Parachironomus frequens		X	
Parachironomus pectinatellae		X	
Parachironomus albimanus or *duplicatus*		X	
Phaenopsectra obediens		X	
Phaenopsectra punctipes		X	
Phaenopsectra flavipes		X	
Polypedilum flavum		X	
Polypedilum fallax		X	
Polypedilum illinoense		X	
Polypedilum ophioides		X	
Polypedilum halterale		X	
Polypedilum scalaenum		X	
Stenochironomus sp.		X	
Tribelos jucundum		X	
Xenochironomus xenolabis		X	
Cladotanytarsus mancus		X	
Paratanytarsus sp.		X	
Rheotanytarsus exiguus		X	
Rheotanytarsus distinctissimus		X	
Tanytarsus glabrescens		X	
Hemerodromia sp.		X	
Tipullidae	Crane fly		
Antocha sp.		X	
Hexatoma sp.		X	
Limonia sp.		X	
Tipula abdominalis		X	X
Dolichopodidae			
Hydrophorus sp.		X	
Simulidae	Black fly		
Simulium sp.		X	X

APPENDIX 6: Macroinvertebrates collected from Alum Creek. - Continued

Taxa	Common Name	OEPA	Hoggarth *et al.*
Certopogonidae		X	
Dixidae			
Dixella sp.		X	
Culicidae			
Chaoborus sp.		X	
Anopheles sp.		X	
Cules sp.		X	
Tabanidae	Deer fly		X
Empididae	Dance fly		X
Mollusca			
Hydrobiidae		X	
Physidae			
Physella integra		X	X
Ferrisidae			
Ferrissia rivularis		X	X
Pleuroceridae			
Elimia livescens		X	X
Corbiculidae			
Corbicula fluminea		X	X
Sphaeriidae			
Sphaerium striatinum			X
Musculum transversum			X
Pisidium compressum			X
Dreissenidae			
Dreissena polymorpha		X	X

Identification of invertebrates followed Burch, 1972, 1989, Merritt and Cummins, 1996, and Thoma and Jezerinac, 2000.

OEPA = Ohio EPA, 1996 & 2000

Hoggarth *et al.* = Hoggarth, 2000a, 2000b, & 2001 and Hoggarth *et al.*, 1997 & 1999

APPENDIX 7: Freshwater mussels previously collected from Alum Creek in Westerville, OH

Taxon	Common Name	1997	2000/2001
Amblema plicata plicata	three ridge	1	5
Elliptio dilatata	spike	6	X
Epioblasma triquerta	snuffbox	X	
Fusconaia flava	wabash pigtoe	9	2
Lampsilis radiata luteola	fat mucket	16	22
Lampsilis ventricosa	plain pocketbook	X	3
Lasmigona complanata	white heelsplitter	X	2
Lasmigona compressa	creek heelsplitter	1	
Lasmigona costata	fluted-shell	3	
Obovaria subrotunda	round hickorynut	31	5
Pleurobema sintoxia	round pigtoe	X	
Ptychobranchus fasciolaris	kidney shell	4	1
Pyganodon grandis	giant floater	X	1
Strophitus undulatus	creeper		4
Utterbackia imbecillis	paper pondshell	X	
Villosa fabalis	rayed been	X	
Villosa iris iris	rainbow	6	

Common names of mussels followed Turgeon *et al*., 1998.

APPENDIX 8: Fish collected from Alum Creek during Hoggarth 2002 study in Westerville, Ohio, upstream and downstream of the Alum Creek Wastewater Treatment Plant.

Species	Common Name	Upstream	Downstream
Dromosoma cepedianum	gizzard shad	1	0
Cprinus carpio	common carp	3	5
Semotilus atromaculatus	northern creek chub	2	0
Luxilus chryocephalus	striped shiner	0	10
Cyprinella spilopterus	spotfin shiner	47	33
Notropis stramineus	sand shiner	40	0
Pimephales promelas	fathead minnow	1	1
Pimephales notatus	bluntnose minnow	244	269
Campostoma anomalum	stoneroller minnow	5	19
Moxostoma duquesni	black redhorse	1	0
Moxostoma erythrurum	golden redhorse	18	8
Hypentilium nigricans	northern hogsucker	32	11
Catostomus commersoni	white sucker	4	12
Minytrema melanops	spotted sucker	6	9
Ameriurus natalis	yellow bullhead	3	2
Percopsis omiscomaycus	trout-perch	1	0
Perca flavescens	yellow perch	3	3
Fundulus notatus	blackstriped topminnow	4	39
Pomoxis annularis	white crappie	0	1
Pomoxis nigromaculatus	black crappie	2	2
Ambloplites rupestris	rock bass	4	7
Micropterus dolomieui	smallmouth bass	5	3
Micropterus salmoides	largemouth bass	5	5
Lepomis cyanellus	green sunfish	31	35
Lepomis macrochirus	bluegill sunfish	107	137
Lepomis megalotis	longear sunfish	6	26
Lepomis gibbosus	pumpkinseed sunfish	1	0
Stizostedion canadense x vitreum	saugeye	1	0
Percina caprodes	logperch darter	4	6
Etheostoma nigrum	Johnny darter	1	11
Etheostoma blenniodes	greenside darter	25	14
Etheostoma zonale	banded darter	5	1
Etheostoma caeruleum	rainbow darter	5	2
Etheostoma flabellare	fantail darter	9	4
Cottus bairdi	mottled sculpin	5	5

APPENDIX 8: Fish collected from Alum Creek during 2002 Hoggarth study – Continued

Species	Common Name	Upstream	Downstream
E*sox masquinongy ohioensis*	Ohio muskellunge	1	0
Noturus miurus	brindled madtom	2	0
Total Number of Species		32	32
Total Number of Individuals		613	723

Scientific names followed Trautman, 1981 and Robins *et al*., 1991. Common names followed Robins *et al*., 1991.

APPENDIX 9: Historic fish distribution in Alum Creek.

Species	Common Name	W. & O.	Troutman	OEPA	Hoggarth *et al*.
Lampetra aepyptera	Least Brook Lamprey		X		
Polydon spathula	Paddlefish		X		
Lepisosteus osseus	Longnose Gar			X	
Dorosoma cepedianum	Gizzard Shad		X	X	X
Esox a. vermiculatus	Grass Pickerel	X	X	X	
Esox m. ohioensis	Ohio Muskellunge		X	X	X
Cyprinus carpio	Common Carp	X	X	X	X
Carassius auratus	Goldfish		X	X	
Cyprinus x *Carassius*	Hybrid Carp/Goldfish			X	
Notemigonus crysoleucas	Golden Shiner			X	
Erimystax dissimilis	Streamline Chub			X	
Nocomis bigutatus	Hornyhead Chub		X		
Nocomis micropogon	River Chub	X	X		
Rhinichthys a. meleagris	Western Blacknose Dace		X	X	X
Semotilus atromaculatus	Northern Creek Chub X	X	X	X	
Phenacobius mirabilis	Suckermouth Minnow			X	X
Phoxinus erythrogaster	Southern Redbelly Dace		X		
Cyprinella whipplei	Steelcolor Shiner		X	X	
Cyprinella spilopterus	Spotfin Shiner		X	X	X
Luxilus cornutus	Common Shiner	X	X		
Luxilus chrysocephalus	Striped Shiner		X	X	X
Lythrurus ardens	Rosefin Shiner	X	X	X	X
Notropis blennius	River Shiner	X			
Notropis atherinoides	Emerald Shiner	X		X	
Notropis amblops	Northern Bigeye Chub	X	X	X	
Notropis photogenis	Silver Shiner		X	X	X
Notropis rubellus	Rosyface Shiner	X	X		
Notropis stramineus	Sand Shiner		X	X	X
Notropis volucellus	Mimic Shiner		X	X	
Ericymba buccata	Silverjaw Minnow	X	X	X	
Pimephales notatus	Bluntnose Minnow	X	X	X	X
Pimephales promelas	Fathead Minnow		X	X	X
Compostoma anomalum	Stoneroller Minnow	X	X	X	X
Ictiobus bubalus	Smallmouth Buffalofish		X		
Carpiodes cyprinus	Quillback Carpsucker		X	X	
Carpoides carpio	River Carpsucker			X	
Carpoides velifer	Highfin Carpsucker			X	
Moxostoma anisurum	Silver Redhorse	X	X	X	X
Moxostoma duquesnei	Black Redhorse		X	X	X
Moxostoma erythrurum	Golden Redhorse		X	X	X
Hypentilium nigricans	Hog Sucker	X	X	X	X
Catostomus commersonii	White Sucker	X	X	X	X
Minytrema melanops	Spotted Sucker		X	X	X
Ictalurus punctatus	Channel Catfish		X	X	X
Ameiurus natalis	Yellow Bullhead	X	X	X	X
Ameiurus nebulosus	Brown Bullhead	X		X	
Ameiurus melas	Black Bullhead	X	X	X	
Pylodictis olivaris	Flathead Catfish			X	
Noturus flavus	Stonecat Madtom	X	X	X	X
Noturus miurus	Brindled Madtom	X	X	X	X
Percopsis omiscomaycus	Trout-Perch		X	X	X
Fundulus notatus	Blackstripe Topminnow		X	X	X
Labidesthes sicculus	Brook Silverside	X	X	X	
Culaea inconstans	Brook Stickleback			X	
Morone chrysops	White Bass		X	X	
Pomoxis annularis	White Crappie		X	X	X
Pomoxis nigromaculatus	Black Crappie		X	X	X
Ambloplites rupestris	Northern Rock Bass	X	X	X	X
Micropterus dolemieui	Smallmouth Blackbass	X	X	X	X
Micropterus salmoides	Largemouth Blackbass		X	X	X
Micropterus puntulatus	Spotted Blackbass			X	

APPENDIX 9: Historic fish distribution in Alum Creek - Continued

Species	Common Name	W. & O.	Troutman	OEPA	Hoggarth *et al*.
Lepomis cyanellus	Green Sunfish	X	X	X	X
Lepomis macrochirus	Bluegill Sunfish		X	X	X
Lepomis humilis	Orangespotted sunfish		X	X	
Lepomis megalotis	Longear Sunfish	X	X	X	X
Lepomis gibbosus	Pumpkinseed sunfish		X	X	X
Lepomis spp.	Hybrid Sunfish			X	X
Stizostedion canadense	Sauger			X	
Stizostedion vitreum	Walleye		X	X	
Stizostedion vitreum x canadense	Hybrid Walleye/Sauger			X	X
Perca flavescens	Yellow Perch		X	X	X
Percina caprodes	Ohio Logperch Darter	X	X	X	X
Percina maculata	Blackside Darter	X	X		X
Etheostoma blennioides	Greenside Darter	X	X	X	X
Etheostoma nigrum	Central Johnny Darter	X	X	X	X
Etheostoma zonale	Eastern Banded Darter	X	X	X	X
Etheostoma variatum	Variegate Darter		X		
Etheostoma caeruleum	Rainbow Darter	X	X	X	X
Etheostoma spectabile	Orangethroat Darter		X		
Etheostoma flabellare	Barred Fantail Darter	X	X	X	X
Aplodinotus grunniens	Freshwater Drum			X	
Cottus bairdi	Mottled Sculpin		X	X	X
Total (79 species + 3 hybrids)		34	62 + 3 hybrids	68 + 2 hybrid	45

W & O = Williamson and Osbourn, 1898. Trautman = Trautman, 1981. Hoggarth = Hoggarth et al., 1997, 1999 & Hoggarth, 2000a, 2000b, 2001, and 2002.

APPENDIX 10: Amphibians and reptiles reported from the Alum Creek watershed.

Common Name	Scientific Name
Amphibians	
American Toad	*Bufo americana*
Fowler's Toad	*Bufo fowleri*
Blanchard's Cricket Frog	*Acris crepitans blanchardi*
Grey Tree Frog	*Hyla versicolor*
Spring Peeper	*Pseudacris crucifer*
Chorus Frog	*Pseudacris crucifer*
Wood Frog	*Rana sylcatica*
Bull Frog	*Rana catesbeiana*
Leopard Frog	*Rana pipiens*
Pickeral Frog	*Rana palustris*
Green Frog	*Rana clamitans*
Mudpuppy	*Necturus maculosus*
Smallmouthed Salamander	*Ambystoma texanum*
Green Salamander	*Aneides aeneus*
Spotted Salamander	*Ambystoma maculatum*
Red-spotted Newt	*Notophthalmus v. viridescens*
Dusky Salamander	*Desmognathus fuscus*
Slimy Salamander	*Plethodon glutinosus*
Red-backed Salamander	*Plethodon cinereus*
Two-lined Salamander	*Eurycea bislineata*
Reptiles	
Queen Snake	*Regina septemvittata*
Brown Snake	*Storeria dekayi*
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*
Eastern Racer	*Coluber constrictor*
Black Rat Snake	*Elaphe o. obsolete*
Massasaga rattlesnake	*Sistrurus c. catenatus*
Eastern Box Turtle	*Terrapene carolina*
Map Turtle	*Graptemys geographica*
Painted Turtle	*Chrysemys picta*
Musk Turtle	*Sternotherus odoratus*

APPENDIX 11: Mammals reported from the Alum Creek watershed.

Common Name	Scientific Name
Mammals	
Virginia Opossum	*Didelphis virginiana*
Short-tailed Shrew	*Blarina brevicauda*
Masked Shrew	*Sorex cinereus*
Silver-haired Bat	*Lasionycteris noctivagans*
Red Bat	*Lasiurus borealis*
Hoary Bat	*Lasiurus cinereus*
Eastern Pipistrelle	*Pipistrellus subflavus*
Gray Squirrel	*Sciurus carolinensis*
Red Squirrel	*Tamiasciurus hudsonicus*
Long-tailed Weasel	*Mustela frenata*
White-tailed Deer	*Odocoileus virginianus*
Striped Skunk	*Mephitis mephitis*
Evening Bat	*Nycticeius humeralis*
Eastern Cottontail	*Sylvilagus floridanus*
Beaver	*Castor canadensis*
Meadow Vole	*Microtus pennsylvanicus*
Eastern Chipmunk	*Tamias striatus*
House Mouse	*Mus musculus*
Deer Mouse	*Peromyscus maniculatus*
White-footed Mouse	*Peromyscus leucopus*
Eastern Harvest Mouse	*Reithrodontomys humulis*
Norway Rat	*Rattus norvegicus*
Big Brown Bat	*Eptesicus fuscus*
Muskrat	*Ondatra zibethicus*
Mink	*Mustela vison*
Coyote	*Canis latrans*
Eastern Mole	*Scalopus aquaticus*
Raccoon	*Procyon lotor*
Red Fox	*Vulpes vulpes*
Gray Fox	*Urocyon cinereoargenteus*
Woodchuck	*Marmota monax*

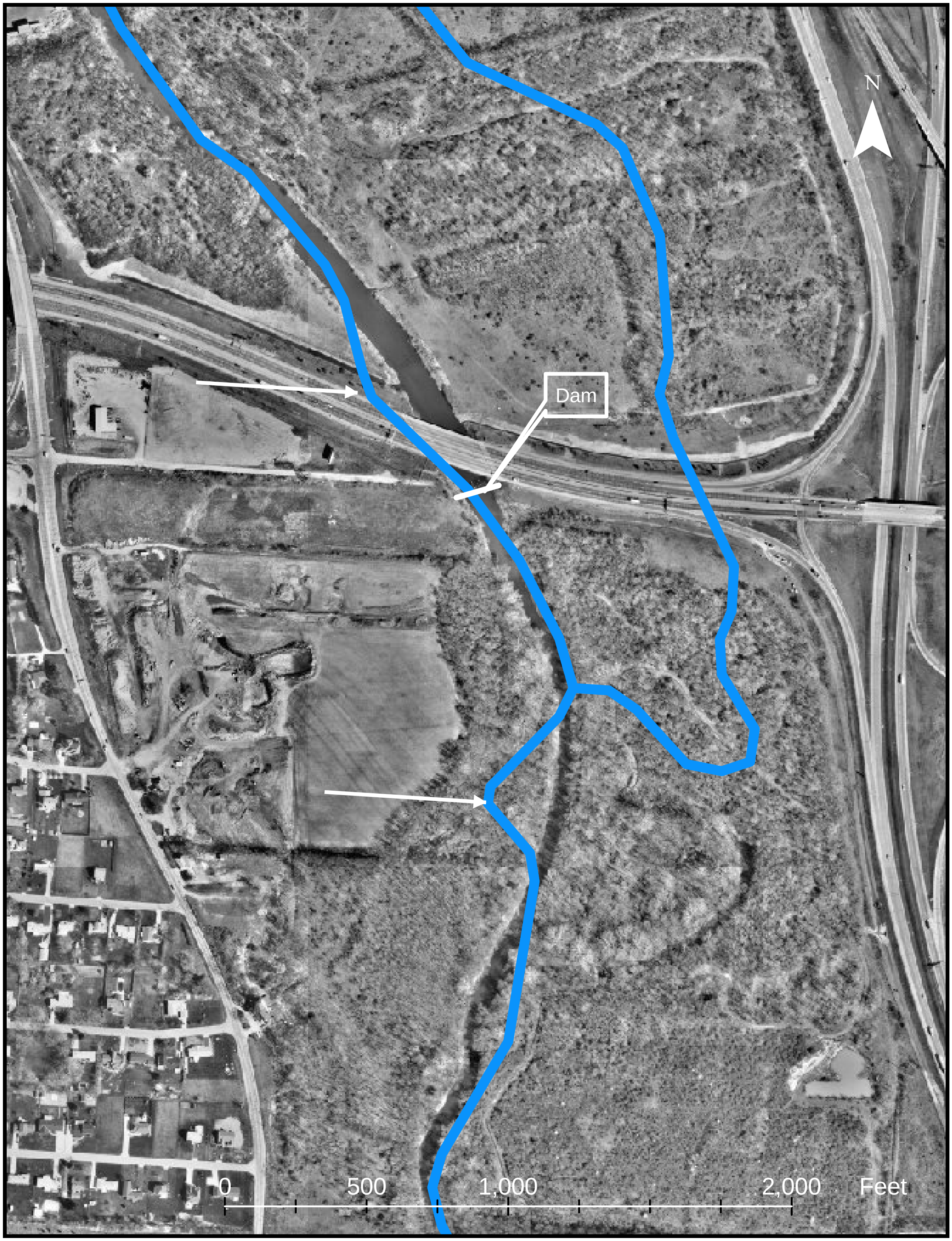
APPENDIX 12

Lower Alum Creek Watershed Tributary Morphology Data

These data were collected through field visits to selected tributaries in August 2004, and map analysis.

Tributary Name	Confluence River Mile	Stream length (mi.)	Watershed size (sq. mi.)	Bank Height Ratio	Map analysis observations
Unnamed	26.13	1.23	0.6	--	Tributary streams between 26.13 and 24.12 (north of Polaris Parkway) share common characteristics: they are dominated by ravine systems that then cut into a wide floodplain before entering Alum Creek. While the ravines would limit encroachment or modification, most of the tributaries have likely been ditched through agricultural fields in the floodplain. This land use is now being converted to suburb, with further modifications, including on-line stormwater detention, increased stormwater flows, and riparian encroachment.
Unnamed	25.95	3.92	1.6	3.5 (with intermediate terraces)	*Per field observations:* Reach observed had likely been straightened, but bank erosion and recovery of floodplain and sinuosity evident. Prone to further vertical incision, due to the size of the stream system and existing incision. See also description for 26.13
Unnamed	25.50	2.80	2.1	--	Was in attainment of WWH aquatic life use in 1999, but new development activity has affected the stream via delivery of sediment and stormwater and direct modifications due to road crossings. Possible that the stream had previously been straightened for agricultural purposes. See also 26.13.
Unnamed	25.08	3.01	0.7	1; 1.5; 1.3	*Per field observations:* Erosion and lateral movement (instability) in some areas, but others maintain good floodplain access. Has been modified as it enters the floodplain, but recovery is evident. See also 26.13.
Unnamed	24.35	1.25	0.4	--	Many ponds in this subwatershed – heavily altered with development of homes and golf course. Some portions have been straightened. See also 26.13.
Unnamed	24.12	1.50	0.6	--	Old map shows that headwaters may retain woodlots. See also 26.13
Unnamed / Indian Run	23.47	3.80	3.2	--	Dammed to create reservoir for Westerville backup water supply. Headwaters are in flat areas – possibly have been straightened and contain old field tiles for agricultural drainage. Encroachment from new development may be limited – map analysis appears to show development was built around (not over) stream.
Unnamed	23.34	1.29	0.4	--	Appears straightened across Alum Creek floodplain, although city of Westerville has preserved some riparian buffer
Unnamed	22.97	2.42	1.0	2	*Per field observations:* Flows near Germain amphitheater and under Worthington Galena Road. Has been straightened as agricultural ditch, and is still incising. Near Polaris Parkway, runs through parcel that may be development soon.
Unnamed	22.42	3.55	1.3	--	Ravine system. County Line Road being extended near it.
County Line Run	21.50	1.60	0.8	--	County Line Run and Alkire Run look geologically similar: low gradient flow through Alum Creek floodplain, probably artificially straightened in the past.
Alkire Run	Tributary to County Line Run	1.8	1.0	1.7	Not severely prone to further incision because the stream is very small (limited flow power). Has not created a "valley" for itself, so easy to build near. Clay / silt bottom, perhaps naturally.
Noble Run	20.34	6.11	3.9	--	Flows through Sharon Woods – good sinuosity in that reach, but has received stormwater impacts from upstream development in the Polaris area.
Meacham Run	19.67	6.34	3.9	--	Has a confined valley, which may have prevented severe encroachment as developments were built around it. Stormwater impacts, but good recovery as it passes under I-270.

Spring Run	17.22	7.20	7.8	3.5; 2	*Per field observations:* Highly developed, some straightening in the past, bank erosion and placement of rip rap to prevent further erosion. Quality of riparian corridor improves inside I-270 with a few neighborhood parks. Some have high shale cliffs.
Spring Run West	17.15	3.10	2.3	--	Has a defined valley, which might have helped limit encroachment as suburbs were built around it. Perhaps modified as it flows through area of light industry north of SR 161.
Kil-bourne Run	16.34	2.64	1.7	3	*Per field analysis:* Some riparian buffer present (near SR 3), but surrounded by suburban development. Channel has widened and banks are eroding due to stormwater impacts. Riprap has been placed at outside bends, and some grade control structures were created in the stream channel. Channel does not appear to be incising still, but rather in state of recovery (redeveloping meander and floodplain).
Unnamed	16.16	.057	0.2	--	Possibly straightened for past agricultural purposes
Unnamed	15.04	1.43	0.6	--	
Unnamed	14.52	1.84	1.3	--	Tribs 14.52 – 9.74 (Morse Road to Mock Road): have similar features. Headwaters are in old developments, possibly placed in storm sewers (some have "open ditches", especially farther south). As they flow west towards Alum Creek, run through significant ravines that may be as of yet undisturbed.
Unnamed	14.12	1.05	1.0	--	See description for 14.52
Unnamed	13.58	0.79	0.6	--	See description for 14.52
Unnamed	13.23	1.48	1.5	--	See description for 14.52
Unnamed	12.12	0.78	1.1	--	See description for 14.52
Unnamed	11.60	0.95	0.3	--	See description for 14.52
Argyle Run	9.74	2.4	2.5	--	See description for 14.52
American Ditch	Unknown	2.6	0.7	--	Heavily modified: Most of this stream is underground in a pipe, though few areas are above ground.
Bliss Run	5.50	0.83	2.6	--	Heavily modified: upper half of the stream is underground in stormwater pipes. Becomes above-ground at Livingston Avenue, but heavily straigtened, and then dammed at College Avenue to form the "twin lakes."
Unnamed	3.66	1.16	0.7	--	Flows through abandoned land fill area, fairly low gradient. Crosses Rte 104 into Three Creeks Park
Unnamed	1.48	1.23	0.6	--	Low gradient, appears straightened for agricultural purposes. Flows through Smith Farms.



Hydromodification of the Alum Creek at State Route 104 and U.S. Route 33.
Aerial photography from 1996 is compared with stream location in blue in 1964
(USGS SE Quadrangle Topograpic map).

APPENDIX 14: Alum Creek Sediment Data

Contaminant	Effect Level		Sample Location										
			RM 42.8 Myers Rd. DSW	RM 26.3 Africa Rd. or Lewis Center Rd. DSW	RM 17.4 Upst Huber Ridge WWTP DSW	RM 17.2 Huber Ridge Mixing Zone DSW	Just above RM 9.1 Cassady Park DERR	RM 9.1 Dnst Am. Ditch or Maryland Ave. DSW	RM 9.1 Dnst Am. Ditch or Maryland Ave. DERR	~ RM 8.8 Jeffrey Park DERR	RM 6.6 Livingston Ave. DSW	RM ? Anchor Landfill DERR	RM 3.9 State Rt 104 DSW (2000)
Heavy Metals	**LEL**	**SEL**	**Concentration in Sediment (mg/kg)**										
Arsenic	6	33	**34.7**	1.25	8.58	21.4	12.6	15.3	11	8.6	7.69	**55.3**	11.2
Cadmium	0.6	10	1.21	0.13	0.42	0.59	ND	4.41	4.1	2.4	1.17	2.2	1.33
Chromium	26	110	30	44	18	24	12.9	31	14	9.5	18	15.8	28.2
Copper	16	110	21	23	10	23	30.5	34	31.2	22.8	19	35.2	32.1
Iron*			37500	**43600**	15000	24900		24000			13700		
Lead	31	250	27	32	27	26	38.8	50	48.9	33.6	65	131	76
Mercury	0.17	2	0.026	0.031	0.041	0.037	0.28	0.12	0.34	0.33	0.095	0.19	0.096
Nickel	16	75	48	43	24	33	28.1	31	31	19.6	23	21.6	26.2
Zinc	120	820	131	127	72	125	160	351	358	205	175	284	197
Semi-Volatile Organic Compounds	**LEL**	**SEL**	**Concentration in Sediment (mg/kg)**										
Anthracene	0.220	11.1	ND	ND	ND	ND	0.28J	0.9	**13**	4.1J	0.7	0.66	ND
Benzo(a)antracene	0.320	44.4	ND	ND	0.8	1.6	1.2	3.9	37	12	2.8	2.1	3.3
Benzo(a)pyrene	0.370	34.2	ND	ND	0.8	1.8	1.4	4.2	33	10	2.9	2.1	3.2
Benzo(b)fluoranthene	N/A	N/A	ND	ND	1.0	2.2	1.4	5.2	34	12	3.4	2.4	4.4
Benzo(g,h,i)perylene	0.170	9.6	ND	ND	0.6	1.6	1.4	3.1	**13**	2.2J	2.2	0.7	2.7
Benzo(k)fluoranthene	0.240	40.2	ND	ND	0.7	1.9	1.2	4.5	33	10	2.5	2.0	2.8
Bis[2-ethylhexyl] phthalate*			ND	ND	1.3	0.7		2.1			1.2	2.5	
Chrysene	0.340	13.8	ND	ND	1.1	2.4	1.9	5.8	**49**	**15**	3.7	2.5	4.8
Dibenz(a,h)anthracene	0.060	3.9	ND	ND	ND	ND	ND	1.0	**15**	ND	0.8	0.36J	1.1
Fluoranthene	0.750	30.6	ND	ND	2.6	4.5	3.4	11.8	**120**	**36**	7.6	3.8	8.9
Indeno(1,2,3-cd)pyrene	0.200	9.6	ND	ND	0.7	1.6	1.3	3.2	**20**	6.2	2.4	0.88	3
Phenanthrene	0.560	28.5	ND	ND	1.5	ND	1.3	6.6	20	28	4.2	3.2	4.2

Pyrene	0.490	25.5	ND	ND	1.9	3.6	2.8	9.1	**82**	**28**	5.9	3.4	7.2
Pesticides and PCBs	**LEL**	**SEL**	**Concentration in Sediment (ug/kg)**										
Dieldrin	2	2730.0	ND	ND	ND	ND	ND	ND	ND	ND	13	9.9D	ND
Endosulfan I^~	0.175						30P		540DP	190		ND	ND
Endosulfan II^~	0.104						ND		72	42DP		7.3	ND
Methoxychlor^	3.59		ND	ND	ND	ND	ND	23	ND	ND	ND	46	ND
Endrin~	2.67	39000					ND		ND	ND		13	ND
4,4 DDD~	5.53	180					ND		ND	ND		ND	8.28
4,4 DDT~	1.19	360					ND		34P	ND		7.2P	ND
Chlordane~	4.5	180					ND		ND	ND		23	20.8
PCB-1260	5	720	ND	ND	ND	ND	ND	57	ND	ND	57	180	37.9

Upst: Upstream; Dnst: Downstream
SEL: Severe effect level (Persuad et al, 1993)
LEL: Lowest effect level (Persuad et al, 1993)
Bold underlined concentration value: Exceeds SEL
* Not evaluated by DERR
^ These pesticides were not evaluated by Persuad, et al. The LEL given is the ecological data quality level (EDQL) from US EPA-Region 5
~ Results for these pesticides were not given by DSW
Data Qualifiers
J: Estimated value, usually detected below sample quantitation limit
D: Compound identified in an analysis at a secondary dilution
P: Greater than 25% difference between the two GC columns for the detected concentrations. The lower of the two results is reported.

(Source: Myers, 2002 and OEPA 1999)

APPENDIX 15

Description of Studies and Projects to Reduce Infiltration and Inflow, Sewer Surcharging and Water-In-Basement Complaints from Sanitary Sewers Located in the Alum Creek Tributary Area

1. CIP 405.1, Driving Park Area Infiltration and Inflow Study:
   This study was completed in 1999. The following ten projects were identified to mitigate street, yard and water-in-basement flooding including separate sewer overflows due to inadequate Stormwater systems, inflow and infiltration and inadequate hydraulic capacity of the sanitary sewers:

   A. CIP 626, Rhoads Avenue Sanitary Sewer Replacement:
   This project included the replacement of existing dual sanitary sewers under Rhodes Avenue from the Deshler Tunnel to Sycamore Street with approximately 2,000 feet of 36-inch diameter pipe. The work also included the replacement of existing 8-inch and 10-inch sanitary sewers in Rhoads Avenue from Sycamore Street to Rainbow Park with about 360 feet of 12-inch diameter pipe. Approximately 50 manholes were rehabilitated during construction, in addition to several improvements to the storm water sewer system.

   The I&I study completed under CIP 405.1 demonstrated that replacement of smaller sanitary sewer pipes with larger pipes and rehabilitation of manholes will reduce I&I, water-in-basement complaints and surcharging. Water-in-basement reductions will occur upstream of this project. No designed SSOs were located within the project limits. **This project was completed in 2003 at a cost of $ 989,000.**

   B. CIP 627, Deshler Avenue Sanitary Sewer Replacement:
   This project included the replacement of the existing 8-inch sanitary sewer in Deshler Avenue with approximately 2,600 feet of various diameter pipe (8-inch to 30-inch). The work also included installation of approximately 1,900 feet of various diameter (12-inch to 24-inch) storm sewer, 26 manholes and 8 catch basins.

   The I&I study completed under CIP 405.1 demonstrated that replacement of the existing 8-inch diameter sanitary sewer in Deshler Avenue with larger pipes will reduce I&I, surcharging, replace badly damaged service lateral connections, and provide additional capacity for future sewer extensions that will allow eventual separation of combined sewers for a portion of the area west of the project. No designed SSOs were located within the project limits. **This project was completed in 2002 at a cost of $ 1,201,000.**

   C. CIP 628, Driving Park Sanitary Sewer Improvements:
   This project included the rehabilitation and repair of approximately 130 feet of 8-inch diameter, and approximately 450 feet of 190-inch diameter sanitary sewer

pipes by the cured-in place pipe method (CIPP). The work also included rehabilitation and repair of manholes and reinstatement of service laterals after the CIPP work is completed.

The I&I study completed under CIP 405.1 discovered deteriorated manholes and pipes, misaligned, broken and cracked pipe sections. The rehabilitated sanitary sewers were located at Ellsworth Avenue north of Kossuth Street, the alley east of Struder Avenue and west of Lockbourne Avenue, the sewer east of the intersection of Seymour and Geers Avenues, and Frebis Avenue near Frebis Lane. No designed SSOs were located within the project limits. **This project was completed in 2002 at a cost of $ 400,000.**

D. CIP 629, Miller Avenue Sanitary Sewer Replacement:

This project included the replacement of the existing 8-inch sanitary sewer in Miller Avenue from Columbus Street to south of Whittier Street with approximately 1,600 feet of 10-inch diameter pipe. The work also included installation of 7 new manholes.

The I&I study completed under CIP 405.1 discovered deteriorated pipes, misaligned, broken and cracked pipe sections, debris deposits, partial blockages, root intrusion and sags in the pipe. Replacement of the existing 8-inch diameter sanitary sewer in Miller Avenue with a larger pipe will reduce I&I, surcharging, and eliminate the above defects. No designed SSOs were located within the project limits. **This project was completed in 2000 at a cost of $ 413,000.**

E. CIP 631, Columbus/Kossuth Sanitary Sewer Replacement:

A design contract in the amount of $ 411,000 was awarded to R.D. Zande & Associates in August 2001 for preparation of plans and specifications. The project will include replacement of existing sanitary sewers with approximately 4,200 feet of 24-inch diameter pipe in Columbus Street, the alley west of Lilley, the alley north of Whittier Street, and the alley west of Seymour. The work includes the replacement of an existing sanitary sewer in Kossuth Avenue with 850 feet of 27-inch diameter pipe. Four SSOs will be eliminated. Approximately 60 Americans With Disabilities Act (ADA) wheelchair ramps will be installed under this project.

The I&I study completed under CIP 405.1 discovered numerous damaged pipe sections and manholes which allow I&I to enter the sanitary system thus exceeding the existing sewer hydraulic capacity. Four designed SSOs currently provide relief. Replacement of smaller diameter pipe with larger ones will increase the capacity, reduce I&I and surcharging and allow for the elimination of four SSOs along Columbus Street. These include SSOs Columbus Reference Nos. 132, Columbus & Studer; 133, Columbus & Linwood; 192, Columbus & alley west of Kelton; and 194, Columbus & Miller.

The Notice To Proceed was just issued and construction should commence shortly. Kokosing Construction Company was awarded the project; their bid was $3,311,000. The SSO Consent Order requires construction to start by December 2005 and be completed by December 2007.

F. CIP 632, Bulen Avenue/Sycamore Street Sanitary Sewer Replacement:
A design contract in the amount of $ 206,000 was awarded to R.D. Zande & Associates in August 2001 for preparation of plans and specifications. The project will include replacement of existing sanitary sewers with approximately 1,200 feet of various diameter (15-inch 30-inch) pipe in Sycamore Street from Rhodes Avenue and down Bulen Avenue to Gault Street. Work also includes rerouting a section of sanitary sewer that currently runs through a storm sewer manhole and installation of 4 catchbasins. One SSO will be eliminated. Approximately 48 Americans With Disabilities Act (ADA) wheelchair ramps will be installed under this project.

The I&I study completed under CIP 405.1 discovered extensive leaks at pipe joints and manholes which allow I&I to enter the sanitary system thus exceeding the existing sewer hydraulic capacity and causing water-in-basement complaints. One designed SSO currently provides relief. Some pipe sections have flat slopes which contribute to grease and debris accumulation in the pipes. Replacement of smaller diameter pipe with larger ones will increase the capacity, reduce I&I and surcharging and allow for the elimination of the SSO at the intersection of Bulen and Gault, SSO Columbus Reference No. 198. **This project was completed in 2004 at a cost of $ 1,189,000.**

G. CIP 633, Fairwood Avenue Replacement Sanitary Sewer:
This project included the replacement of an existing 18-inch diameter sanitary sewer in Fairwood Avenue with approximately 2,900 feet of 30-inch diameter pipe, and rehabilitation of approximately 300 feet of 8-inch diameter sanitary sewer. The work also included the replacement of an existing stormwater catchbasin and rehabilitation of manholes.

The I&I study completed under CIP 405.1 demonstrated that the sewer line had numerous broken service lateral connections that contribute significant amounts of I&I thus exceeding the hydraulic capacity of the pipe. Replacement of smaller sanitary sewer pipes with larger ones and rehabilitation of other pipes will reduce I&I, water-in-basement complaints and surcharging. **This project was completed in 2003 at a cost of $ 1,192,000.**

H. CIP 634, Frebis/Ellsworth Sanitary Sewer Replacement:
A design contract in the amount of $ 87,000 was awarded to Pomeroy & Associates in February 2003 for preparation of plans and specifications. The project will include rerouting of an existing 8-inch sanitary sewer in the intersection of Frebis and Ellsworth Avenues. Several defective portions of an 8-inch sanitary sewer and 36-inch storm sewer will be replaced near the intersection

of Moler and Berkeley Roads. Work also includes installation of approximately 1500 feet of 15-inch storm sewer and eleven catch basins along Moler Road. A catch basin will also be removed from the sanitary sewer in Alum Creek Drive in the vicinity of the 1-70 exit ramp.

The I&I study completed under CIP 405.1 revealed excessive I&I entering manholes, pipe segments, and numerous structural pipe damage throughout the study area. Rerouting and replacing the sanitary sewers and installation of the storm sewer will reduce I&I, surcharging and water-in-basement complaints.

Final plans and specifications were submitted January 2005. Bidding is now scheduled for mid 2005 with construction scheduled to begin in early 2006. Construction costs are estimated to be $ 381,000. The SSO Consent Order requires construction to start by December 2006 and be completed by December 2008.

I. <u>CIP 635, Livingston Avenue Sanitary Sewer Improvements:</u>
A design contract in the amount of $ 165,000 was awarded to Pomeroy & Associates in February 2003 for preparation of plans and specifications. The project will include rerouting of an existing 8-inch sanitary sewer in the intersection of Frebis and Ellsworth Avenues. Several damaged portions of an 8-inch sanitary sewer and 36-inch storm sewer will be replaced near the intersection of Moler and Berkeley Roads. Work also includes installation of approximately 1500 feet of 15-inch storm sewer and eleven catch basins along Moler Road. A catch basin will also be removed from the sanitary sewer in Alum Creek Drive in the vicinity of the 1-70 exit ramp. One SSO will be eliminated.

The I&I study completed under CIP 405.1 revealed excessive I&I entering manholes, pipe segments, and numerous structural pipe ddamage throughout the study area. One designed SSO currently provides relief. Rerouting and replacing the sanitary sewers and installation of the storm sewer will reduce I&I, surcharging, water-in-basement complaints and allow for the elimination of the SSO at the intersection of Seymour and Livingston, SSO Columbus Reference No. 655. No designed SSOs are located within the project limits.

Final plans and specifications were submitted January 2005. Bidding is now scheduled for mid 2005 with construction scheduled to begin in early 2006. Construction costs are estimated to be $ 381,000. The SSO Consent Order requires construction to start by December 2006 and be completed by December 2008.

J. <u>CIP 636, Forest Street Sanitary Sewer Replacement:</u>
A design contract in the amount of $ 63,000 was awarded to Pomeroy & Associates in February 2003 for preparation of plans and specifications. The project will replace an existing 8-inch diameter sanitary sewer in Forest Street from the alley west of Seymour to the alley east of Fairwood with a 15-inch

diameter pipe, and continue north in the alley east of Fairwood and increase to an 18-inch diameter pipe up to Rainbow Park. The sanitary sewers will be separated in the intersection Forest and Seymour.

The I&I study completed under CIP 405.1 revealed excessive I&I entering manholes, pipe segments, and numerous structural pipe damage throughout the study area. Replacing the sanitary sewers with larger pipes and rerouting the sanitary sewer in the intersection of Forest and Seymour will reduce I&I, surcharging and water-in-basement complaints.

No designed SSOs are located within the project limits.

Final plans and specifications were submitted March 2004. Bidding is now scheduled for early 2005 with construction scheduled to begin in the fall of 2005. Construction costs are estimated to be $ 330,000. The SSO Consent Order requires construction to start by December 2006 and be completed by December 2008.

2. <u>CIP 405.7, Northwest Alum Creek Area Infiltration and Inflow Study:</u>
   This project is generally bounded by Ferris Road, Alum Creek, Fifth Avenue, Karl Road and Joyce Avenue. The goal of this project is to mitigate street, yard, and water-in-basement flooding including separate sewer overflows due to inadequate stormwater systems, inflow and infiltration and inadequate hydraulic design of the sanitary sewer systems.

   This is a multi-staged project that will begin with a comprehensive inventory and study of the sanitary, storm and combined infrastructure. It includes extensive flow monitoring, field investigations and input from area residents. The first stage concludes with the development of a prioritized and sequenced listing of capital improvement projects that are required to enhance the overall performance of service within the Northwest Alum Creek Area. **Selection of an engineering firm will begin in late spring 2005 and be under contract by the end of the year. Estimated costs for this study phase is $6 million.**

   The second stage involves the procurement of design services contracts for design and preparation of plans and specifications for each of the projects identified from the I&I study. The third stage concludes with the procurement of construction services contracts for the construction of each project.

   The SSO Consent Order requires the City to continue with the study of this area as appropriate pursuant to the System Evaluation and Capacity Assurance Plan (SECAP) which is part of this order.

3. <u>CIP 405.11, Livingston/James Area Infiltration and Inflow Study:</u>
   This project is generally bounded by the eastern Bexley corporation limits and the western and southern corporate limits of Whitehall. The goal of this project is to mitigate

street, yard, and water-in-basement flooding including separate sewer overflows due to inadequate stormwater systems, inflow and infiltration and inadequate hydraulic design of the sanitary sewer systems.

This is a multi-staged project that will begin with a comprehensive inventory and study of the sanitary, storm and combined infrastructure. It includes extensive flow monitoring, field investigations and input from area residents. The first stage concludes with the development of a prioritized and sequenced listing of capital improvement projects that are required to enhance the overall performance of service within the Livingston/James Area. **CDM has been selected as the engineering firm to perform the study phase of this project. They will be awarded a contract in the amount of $7 million.**

The second stage involves the procurement of design services contracts for design and preparation of plans and specifications for each of the projects identified from the I&I study. The third stage concludes with the procurement of construction services contracts for the construction of each project.

The SSO Consent Order requires the City to continue with the study of this area as appropriate pursuant to the System Evaluation and Capacity Assurance Plan (SECAP) which is part of this order.

4. Stormwater Projects, Bliss Run;

   A. Phase 1, From Alum Creek to Roosevelt Avenue:
   Construction Complete.

   B. Phase 2, Roosevelt Avenue to Brownlee Avenue:
   Construction is underway and about 80% complete.

   C. Phase 3, Brownlee Avenue to Fair Avenue and James Road:
   Design is under final review. Bids are scheduled for early 2005 and construction is scheduled to begin in mid 2005.

LOWER ALUM CREEK WATERSHED MAPS

The following maps were created in cooperation with the Ohio State University Extension and the Ohio State University Center for Urban and Regional Analysis. Detailed soils maps (3a – 3f) were created by the Mid-Ohio Regional Planning Commission and the Delaware Soil and Water Conservation District for Franklin and Delaware County portions of the lower Alum Creek watershed, respectively.

1) Base Map, entire watershed
2) Base Map, lower Alum Creek
3) Soils
   - 3a) Delaware County Soils
   - 3b) Delaware County Drainage Classes
   - 3c) Delaware County Slope Classes
   - 3d) Franklin County Soils
   - 3e) Franklin County Drainage Classes
   - 3f) Franklin County Slope Classes
4) Wetlands
5) 100 Year Floodplain and Elevation Contours
6) Recreation and Protected Lands
7) Land Use (1994 ODNR)
8) Parcel-based Land Use (2003 Franklin County Auditor)
9) Historical Sites
10) Population Density
11) Use Attainment 1999
12) Use Attainment 2003
13) River Miles
14) QHEI and Lowhead Dams
15) Index of Biotic Integrity – 1996/ 2000
16) Invertebrate Community Index – 1996/ 2000
17) Modified Index of Wellbeing – 1996 /2000
18) Wastewater Treatment Plants and Sewer Overflows
19) Home Sewage Treatment Systems (& Sewer Extension Projects)

Base Map

Alum Creek Watershed

Franklin, Delaware and Morrow

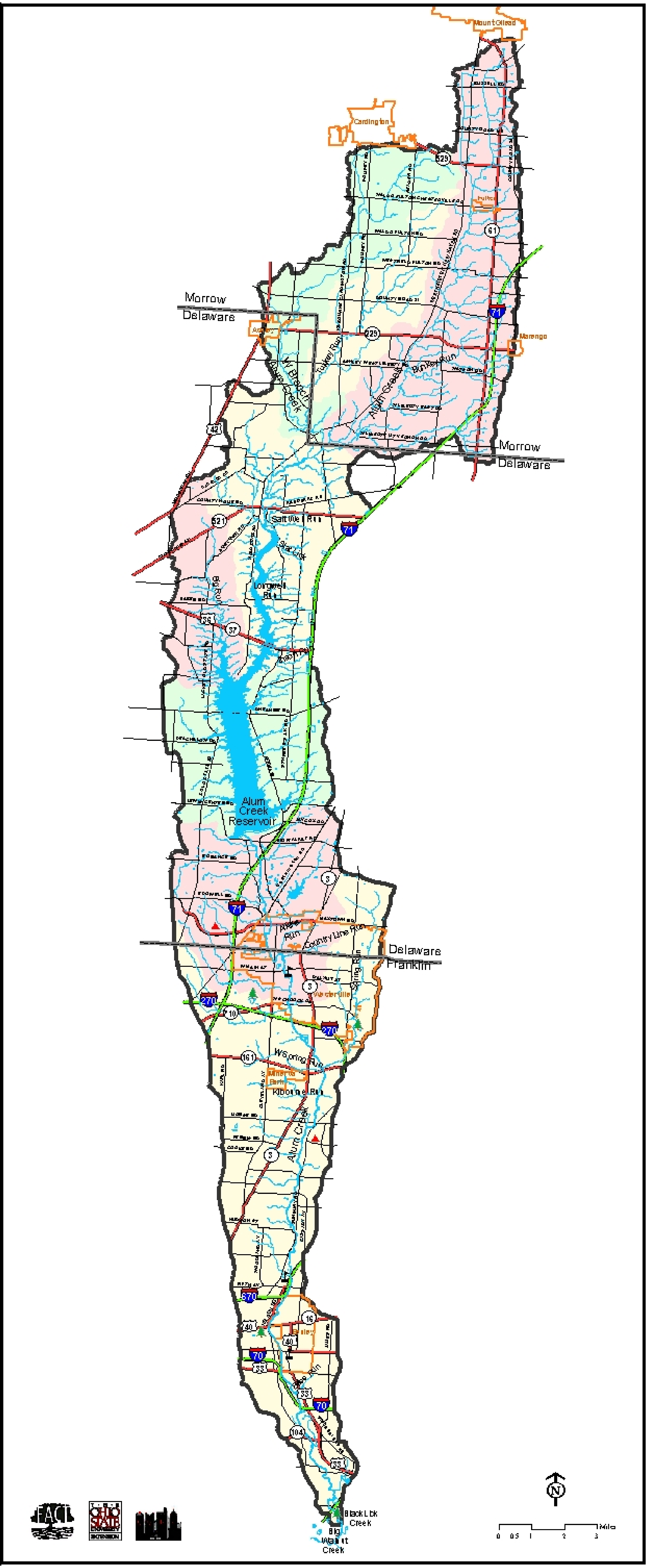
- Watersheds
- Alum Creek/Streams
- Interstate
- US & State Routes
- Major Roads
- Municipal Boundary
- Park
- School
- Shopping

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: Franklin and Delaware County Auditor's Offices, Ohio EPA, US Census Bureau, US Natural Resources Conservation Service

Liability Disclaimer: The information shown on the map is for planning purposes only. The Center for Urban and Regional Analysis (CURA) makes no guarantee or warranty concerning the accuracy of information contained in the data.

Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003



Base Map
Alum Creek Watershed
Franklin and Delaware

Watersheds
Alum Creek/Streams
Interstate
US & State Routes
Major Roads
Municipal Boundary
Park
School
Shopping

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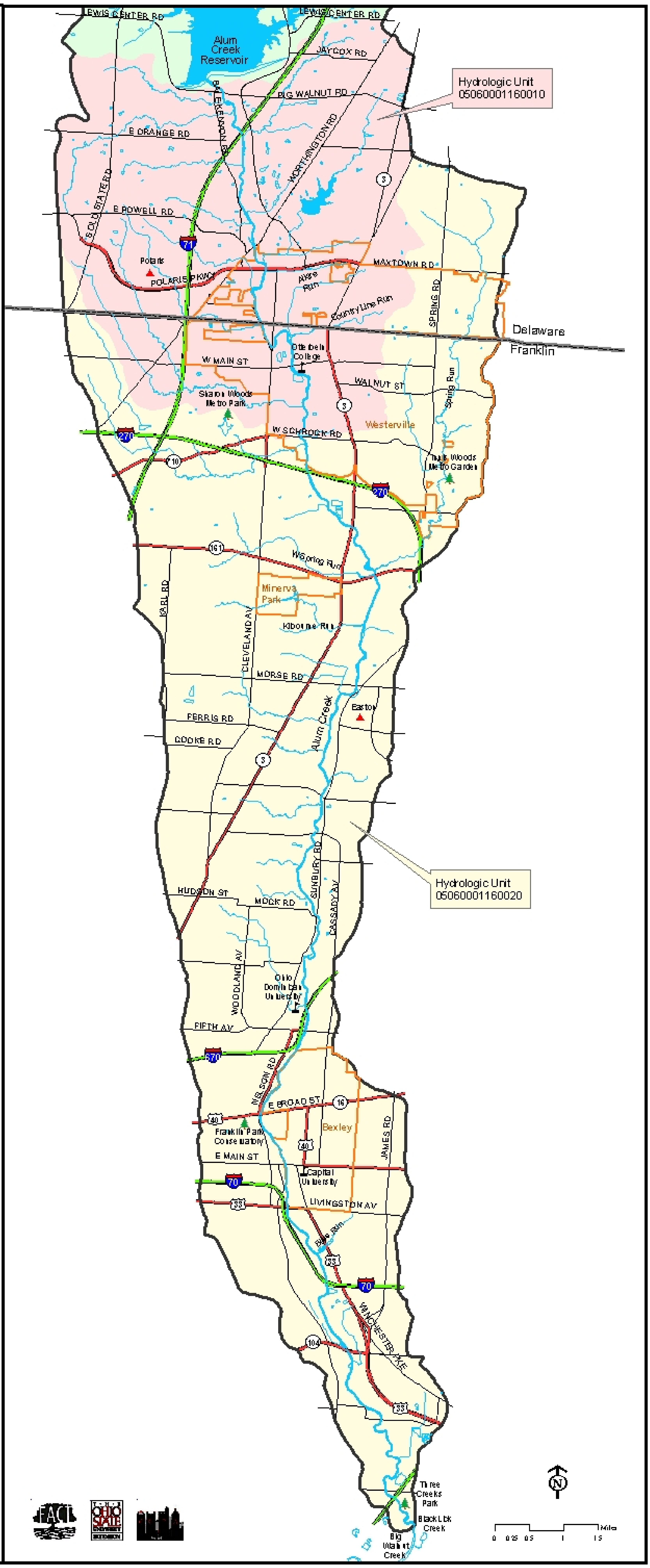
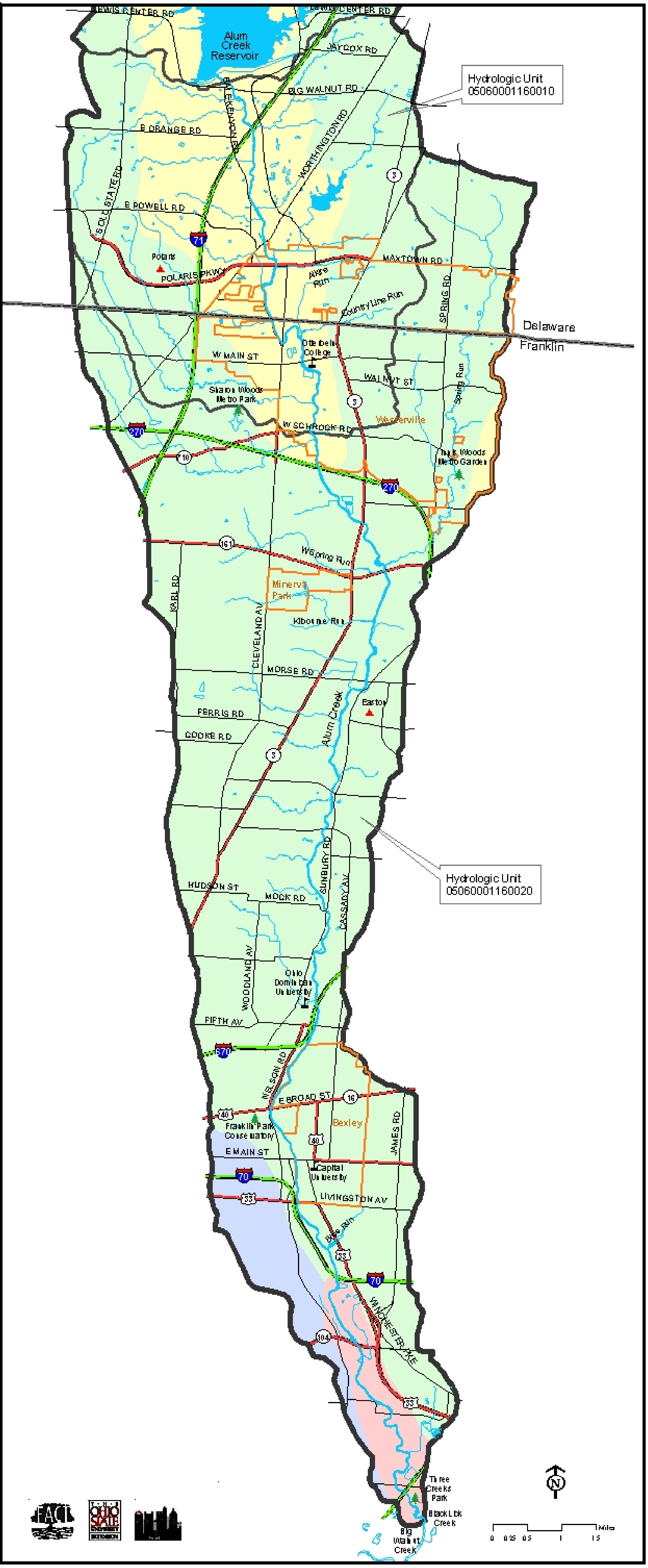


Soils
Alum Creek Watershed
Franklin and Delaware



- Watersheds
- Alum Creek/Streams
- Interstate
- US & State Routes
- Major Roads
- Municipal Boundary
- Park
- School
- Shopping
- Bennington-Pewamo-Cardington
- Cardington-Bennington-Sloan
- Crosby-Miamian-Brookston
- Eldean-Ockley-Sleeth

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: US Geological Survey, Franklin and Delaware County Auditor's Offices, Ohio EPA, US Natural Resources Conservation Service

Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003

Wetlands Inventory 1987

Alum Creek Watershed

Franklin and Delaware

- Watersheds
- Alum Creek / Streams
- Farmed Wetland (wet meadow in agricultural areas)
- Open Water
- Shallow Marsh (emergent vegetation in water < 3 ft.)
- Shrub/Scrub Wetland (emergent woody veg. in water < 3 ft.)
- Upland Woods
- Wet Meadow (grassy vegetation in water < 6 inches)
- Woods on Hydric Soil

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: Ohio Department of Natural Resource, Franklin and Delaware County Auditor's Offices, Ohio EPA, US Natural Resources Conservation Service

Data Description: The Wetlands Inventory is based on analysis of satellite data and is intended solely as an indicator of wetland sites for which field review should be conducted. The satellite data reflect conditions during the specific year and season the data was acquired and all wetlands may not be indicated. Data was produced from April 1987 Landsat Thematic mapper data (cell size 30*30 meters) using ERDAS Image processing software. The class of woods on hydric soils, wet meadow and farmed wetland fall on hydric soils when digital soils data is available for the county.

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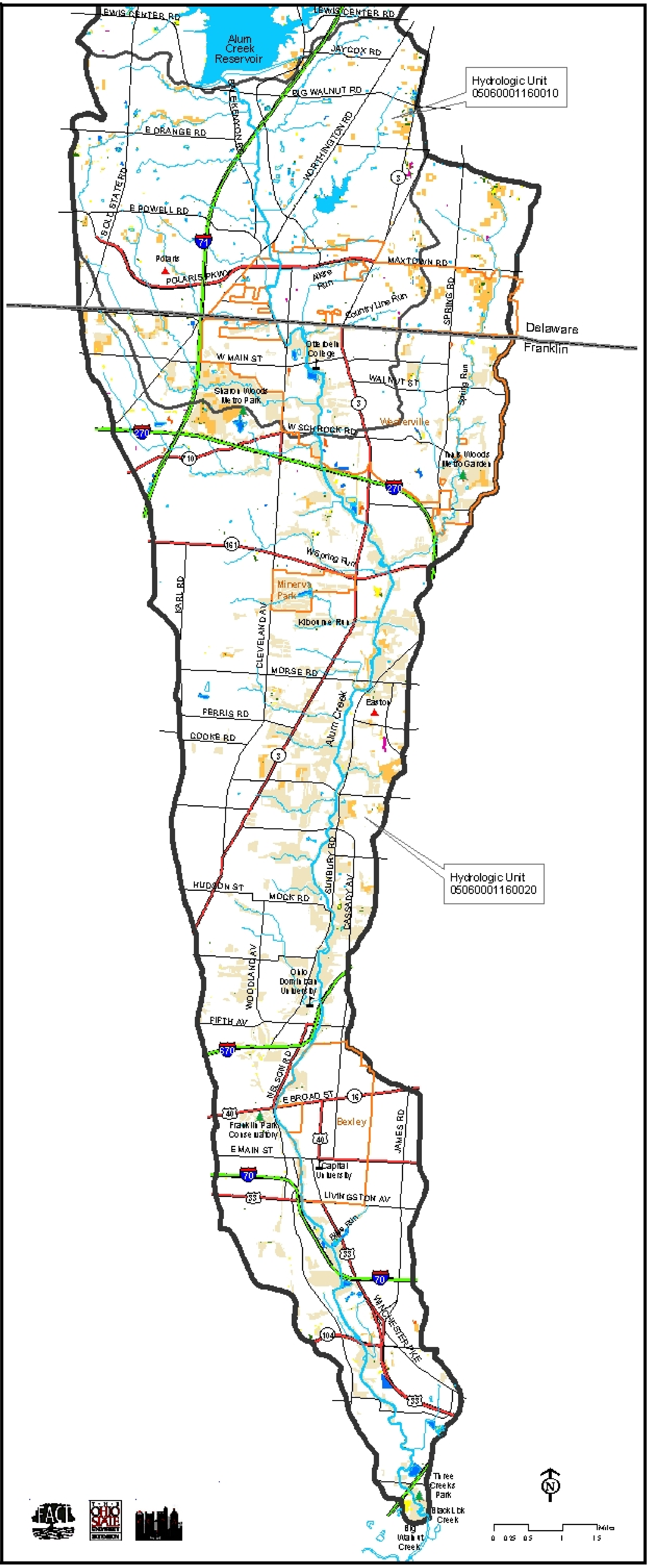
Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003



100 Year Floodplain & Contours

Alum Creek Watershed

Franklin and Delaware

- Watersheds
- Alum Creek/Streams
- Interstate
- US & State Routes
- Major Roads
- Municipal Boundary
- Park
- School
- Shopping
- 100 Year Floodplain
- Contours

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: Franklin and Delaware County Auditor's Offices, US Geological Survey, Ohio EPA, US Natural Resources Conservation Service

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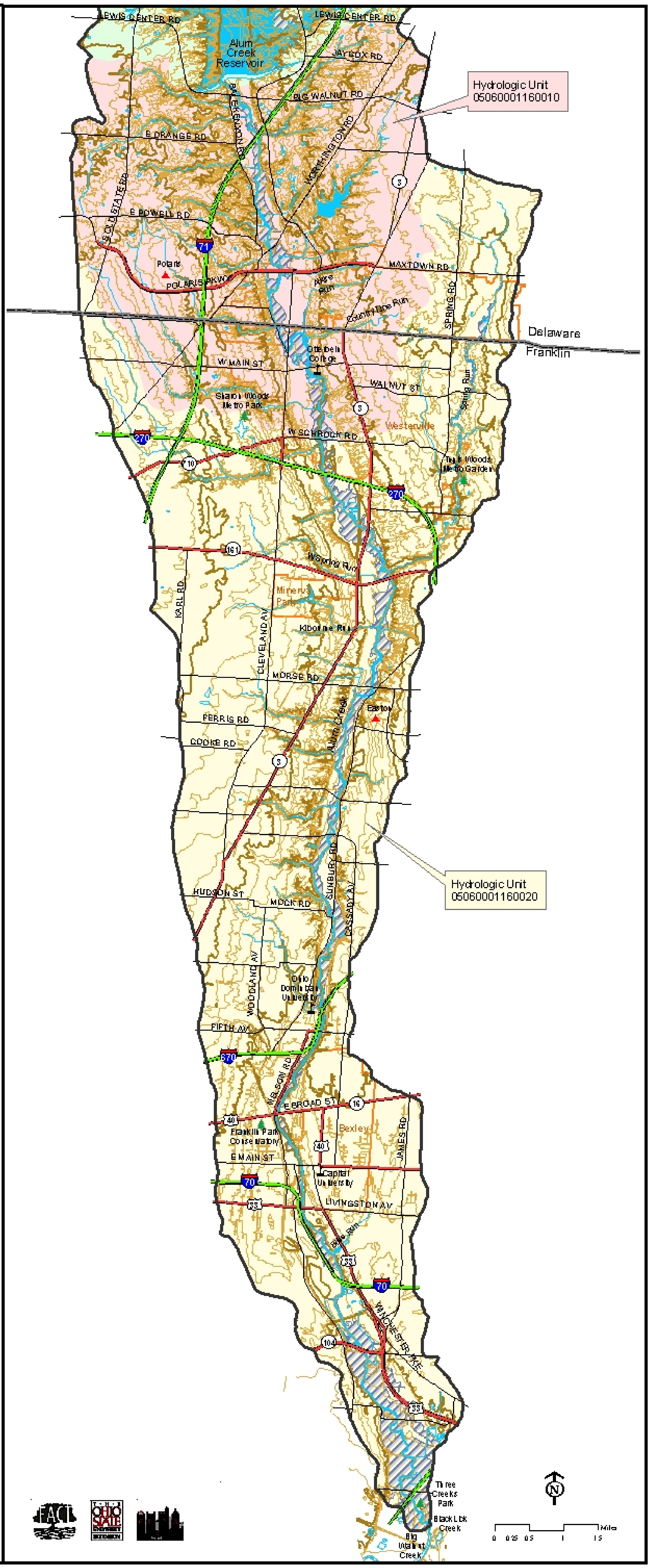

Recreation & Protected Lands*

Alum Creek Watershed

Franklin and Delaware

- Watersheds
- Alum Creek/Streams
- Interstate
- US & State Routes
- Major Roads
- Municipal Boundary
- School
- Shopping
- Recreation Centers
- Multi-Use Trails
- New Easement
- Parks

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: City of Columbus, City of Westerville, Delaware County Regional Planning, Franklin and Delaware County Auditor's Offices, Ohio EPA, US Natural Resources Conservation Service

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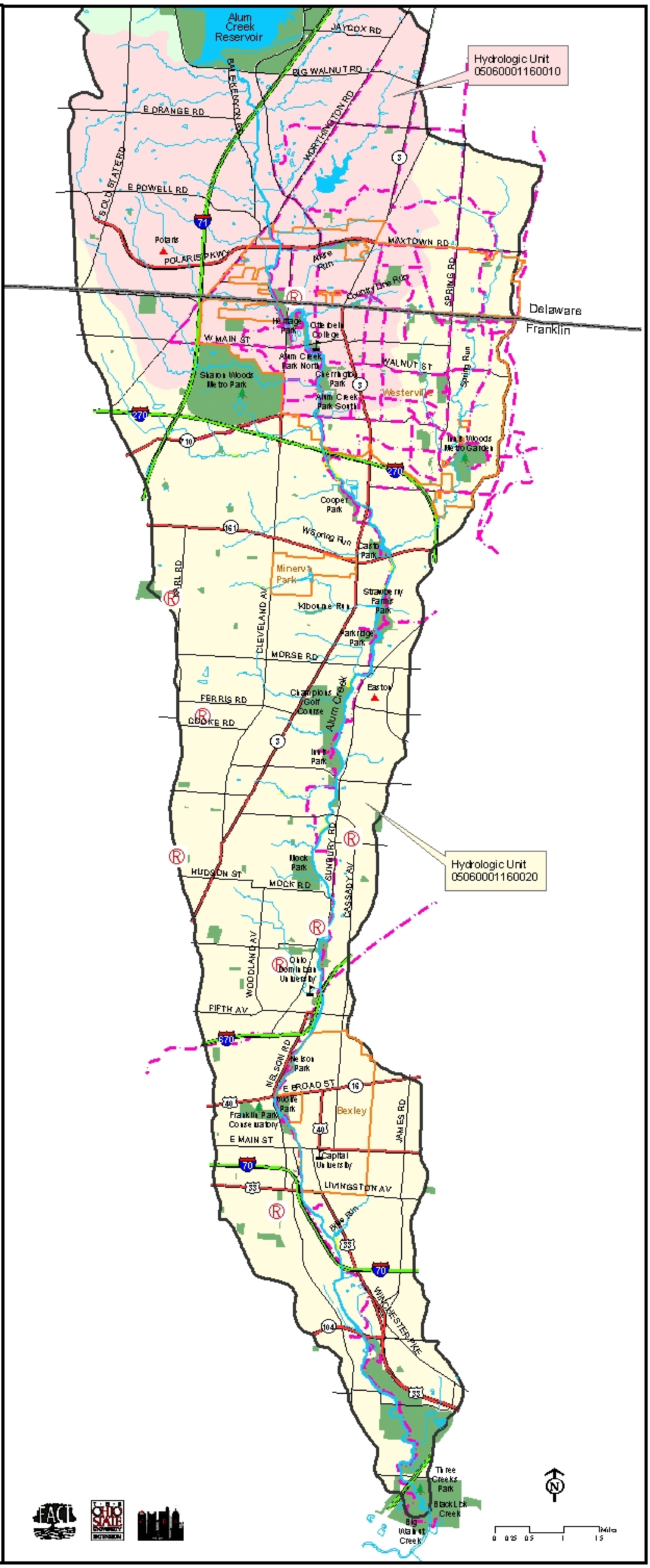
Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003

*** Map includes current and proposed trail routes.**



- Watersheds
- Alum Creek/Streams
- Interstate
- US & State Routes
- Agriculture
- Barren
- Non Forested Wetlands
- Open Water
- Shrub/Scrub
- Urban/Impervious Surfaces
- Wooded

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: Ohio Department of Natural Resources, Franklin and Delaware County Auditor's Offices, Ohio EPA, US Natural Resources Conservation Service

Data Description: The land cover inventory was produced by the digital image processing of Landsat Thematic Mapper Data acquired in Fall of 1994. The Thematic Mapper is a multi-spectral scanner that collects electromagnetic radiation reflected from the earth's surface in the visible, near infrared and mid-infrared wavelength bands. The resolution of the data is a 30*30 meter cell. The information reflects the conditions of the satellite data during the specific year and season the data was acquired.

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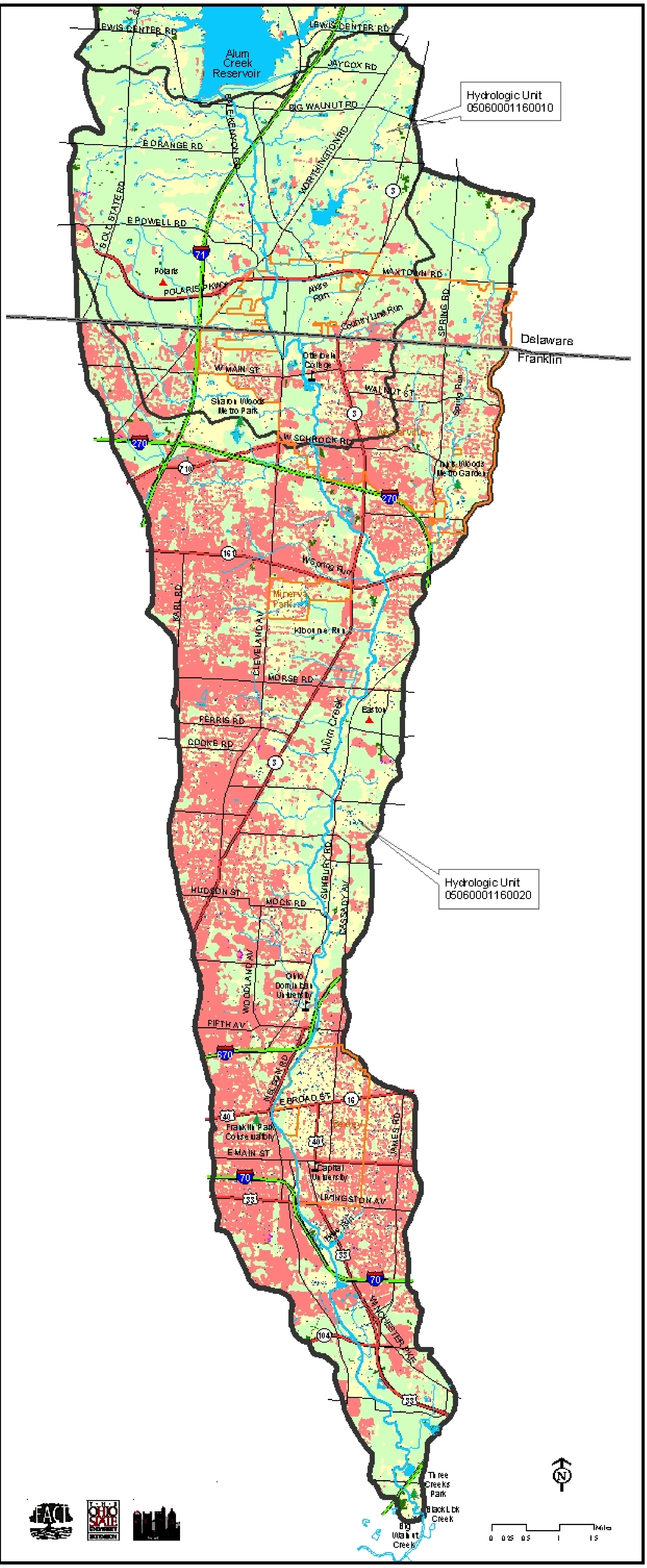
Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003

Land Use / Land Cover 1994
Alum Creek Watershed
Franklin and Delaware



Historical Sites

Alum Creek Watershed

Franklin and Delaware

- Watersheds
- Alum Creek/Streams
- Interstate
- US & State Routes
- Major Roads
- Municipal Boundary
- Park
- School
- Shopping
- Burial Mounds
- Underground Railroad Stops

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: Franklin and Delaware County Auditor's Offices, Ohio EPA, US Natural Resources Conservation Service

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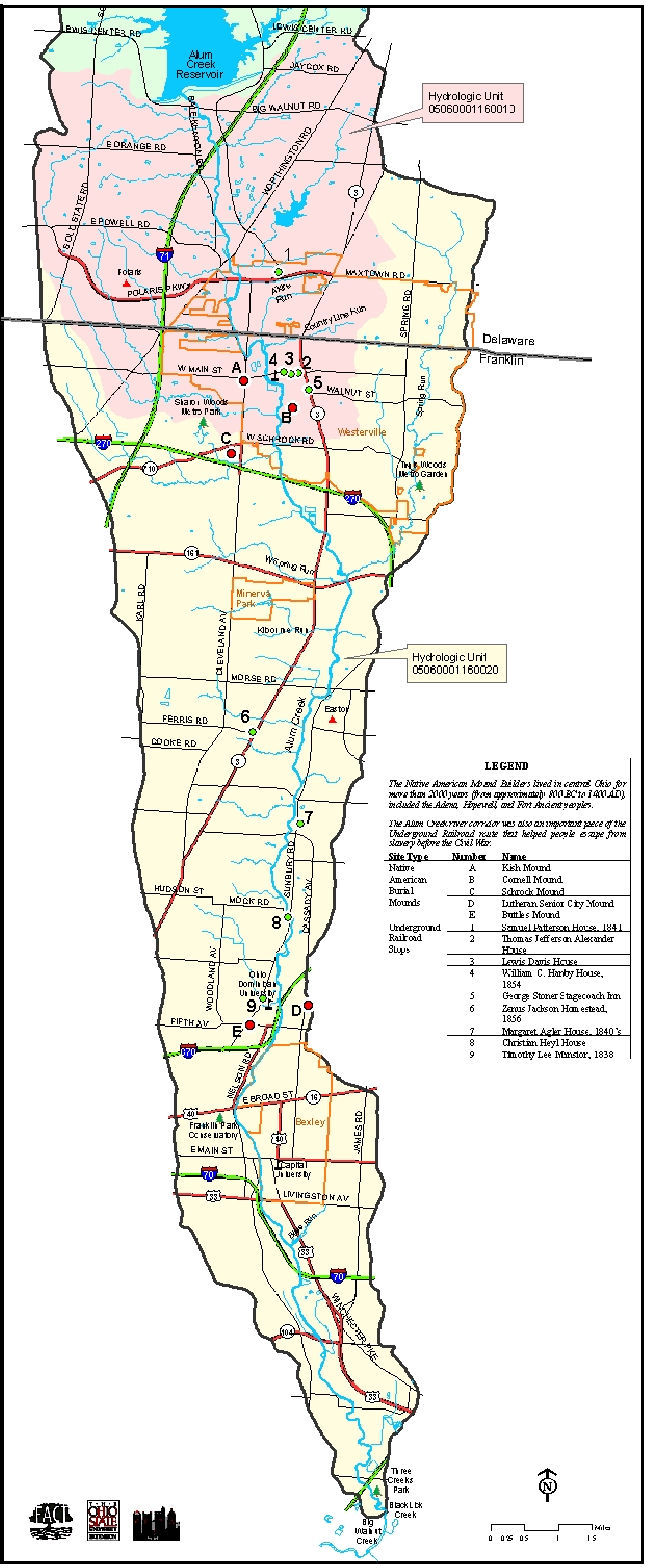
Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003

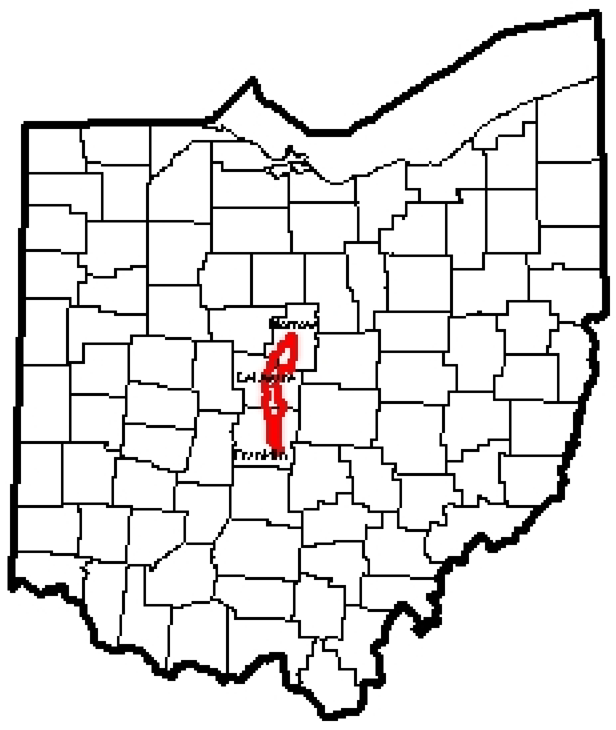


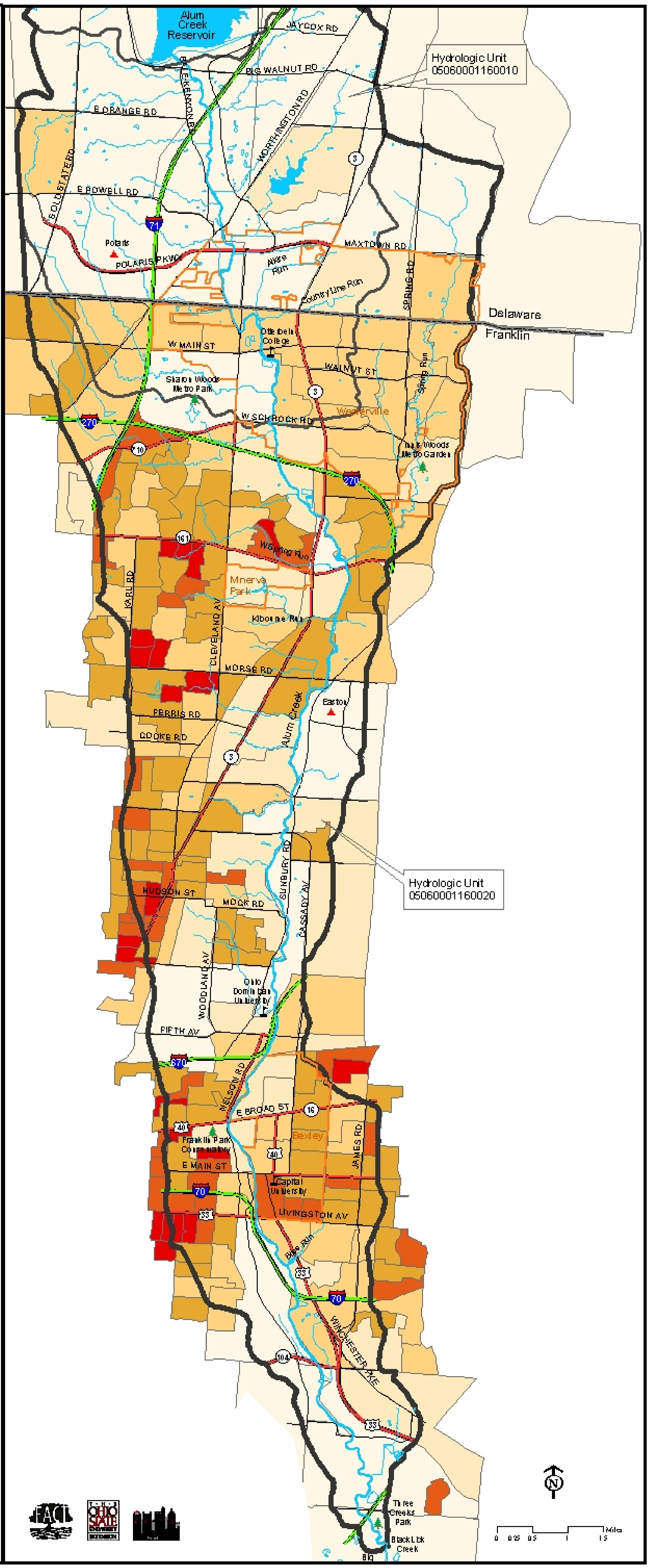
LEGEND

The Native American Mound Builders lived in central Ohio for more than 2000 years (from approximately 800 BC to 1400 AD), included the Adena, Hopewell, and Fort Ancient peoples.

The Alum Creek river corridor was also an important piece of the Underground Railroad route that helped people escape from slavery before the Civil War.

Site Type	Number	Name
Native American Burial Mounds	A	Kish Mound
	B	Cornell Mound
	C	Schrock Mound
	D	Lutheran Senior City Mound
	E	Buttles Mound
Underground Railroad Stops	1	Samuel Patterson House, 1841
	2	Thomas Jefferson Alexander House
	3	Lewis Davis House
	4	William C. Hanby House, 1854
	5	George Stoner Stagecoach Inn
	6	Zenus Jackson Homestead, 1856
	7	Margaret Agler House, 1840's
	8	Christian Heyl House
	9	Timothy Lee Mansion, 1838





- Watersheds
- Alum Creek/Streams
- Interstate
- US & State Routes
- Major Roads
- Municipal Boundary

Population Density (Person/Square Mile)

- < 1000
- 1000 - 2500
- 2500 - 5000
- 5000 - 7500
- 7500 - 10000
- >10000

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: Census Bureau, Franklin and Delaware County Auditor's Offices, Ohio EPA, US Natural Resources Conservation Service

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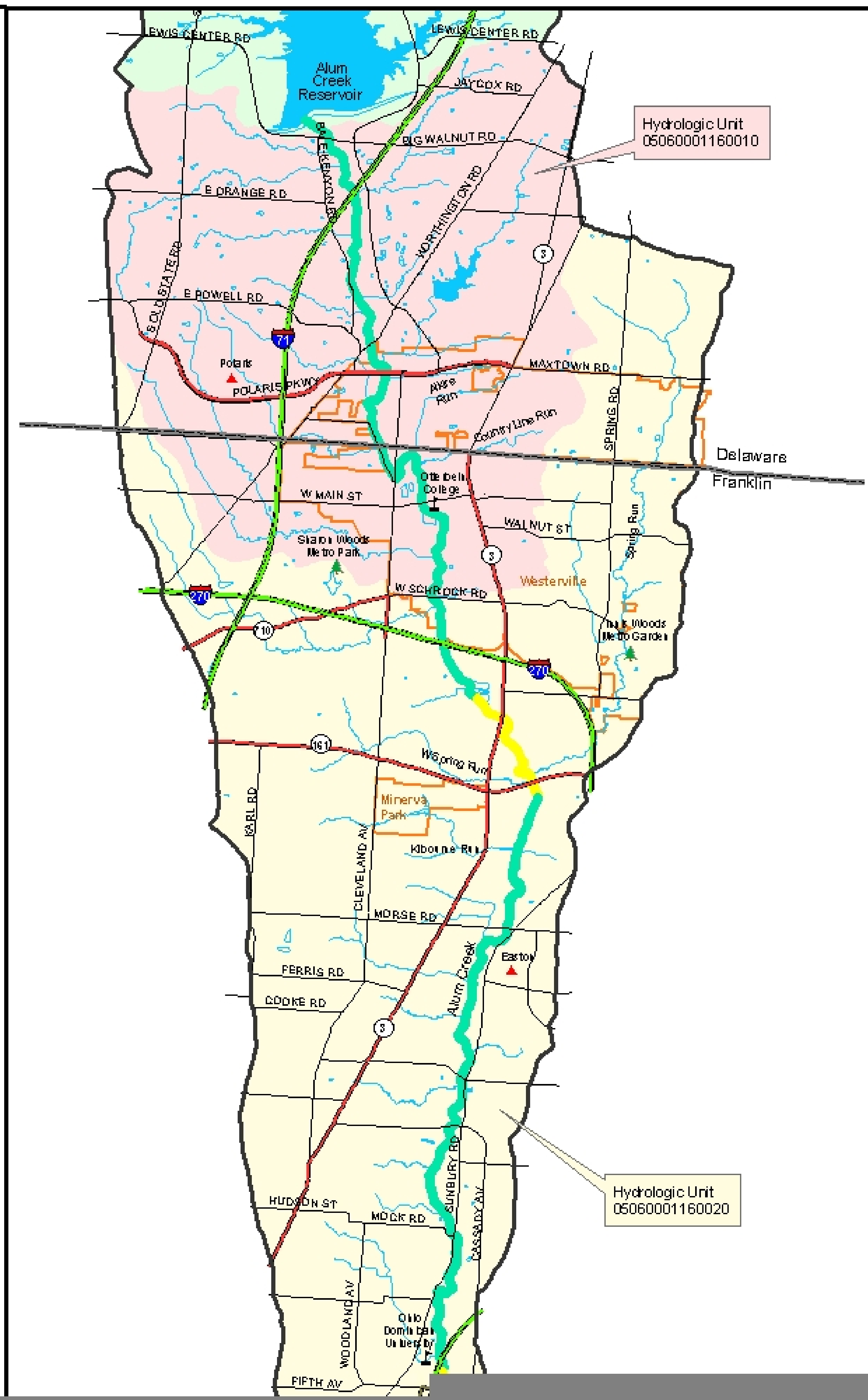
Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003

Census 2000 Population Density

Alum Creek Watershed

Franklin and Delaware



Watersheds
Alum Creek/Streams
Interstate
US & State Routes
Major Roads
Municipal Boundary
Park
School
Shopping
Full
Non
Partial

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: Ohio EPA, Franklin and Delaware County Auditor's Offices, US Natural Resources Conservation Service

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Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003

*** Map indicates approximate areas of use attainment.**

...ned

Attainment Status 2003*

Alum Creek Watershed

Franklin and Delaware

Watersheds
Alum Creek/Streams
Interstate
US & State Routes
Major Roads
Municipal Boundary
Park
School
Shopping
Full
Non
Partial

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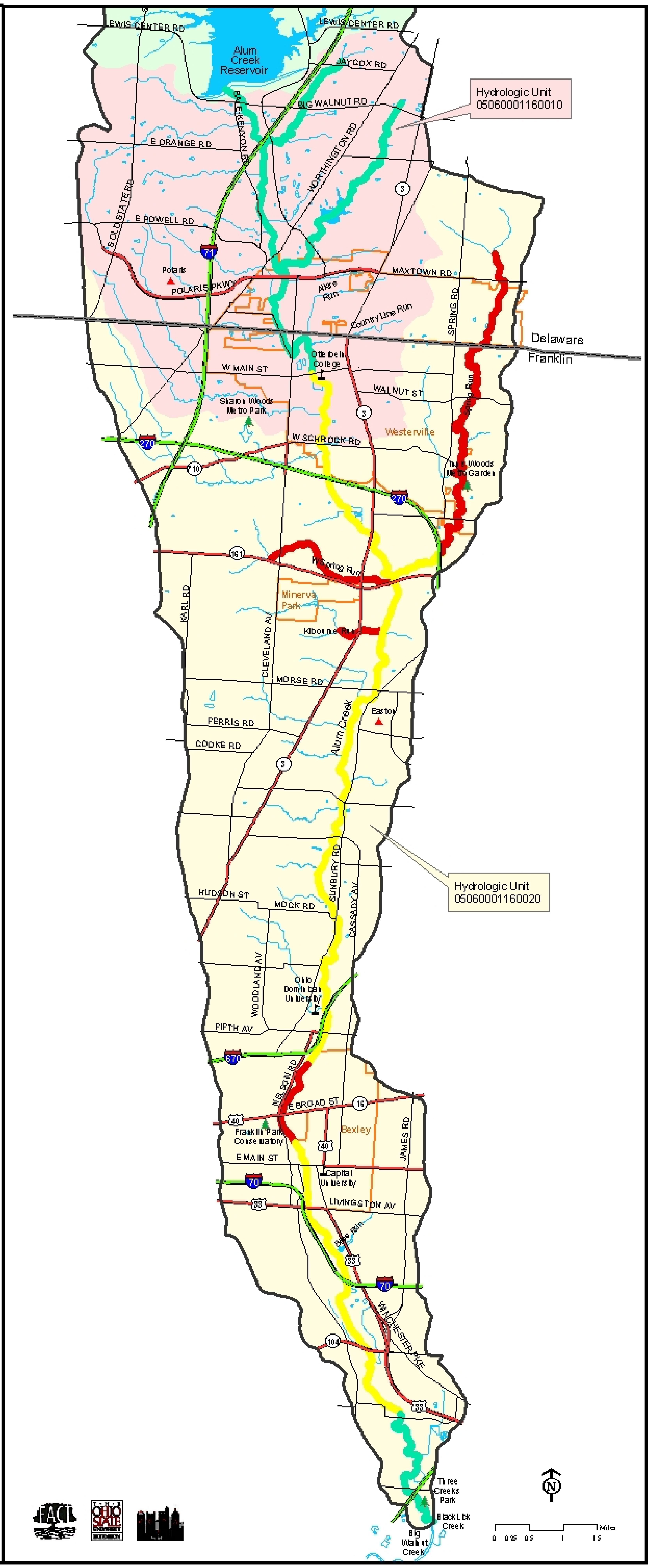
*** Map indicates approximate areas of use attainment.**



River Miles
Alum Creek Watershed
Franklin and Delaware

- Watersheds
- Alum Creek/Streams
- Interstate
- US & State Routes
- Major Roads
- Municipal Boundary
- Park
- School
- Shopping
- River Miles

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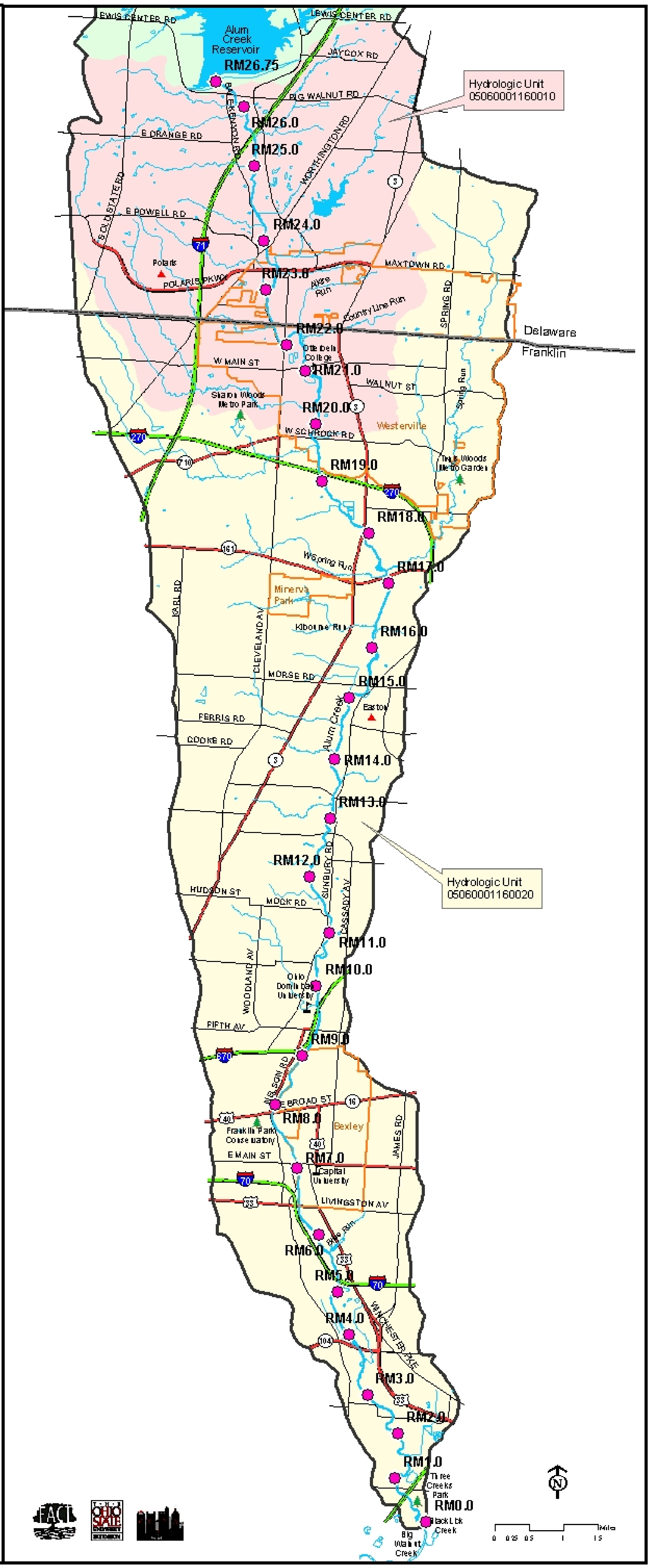
Data Source: Ohio EPA, Franklin and Delaware County Auditor's Offices, US Natural Resources Conservation Service

Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003



Watersheds
Alum Creek/Streams
Interstate
US & State Routes
Major Roads
Municipal Boundary
Park
School
Shopping
Qualitative Habitat Evaluation Index
2000 Score / 1996 Score
Lowhead Dam

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

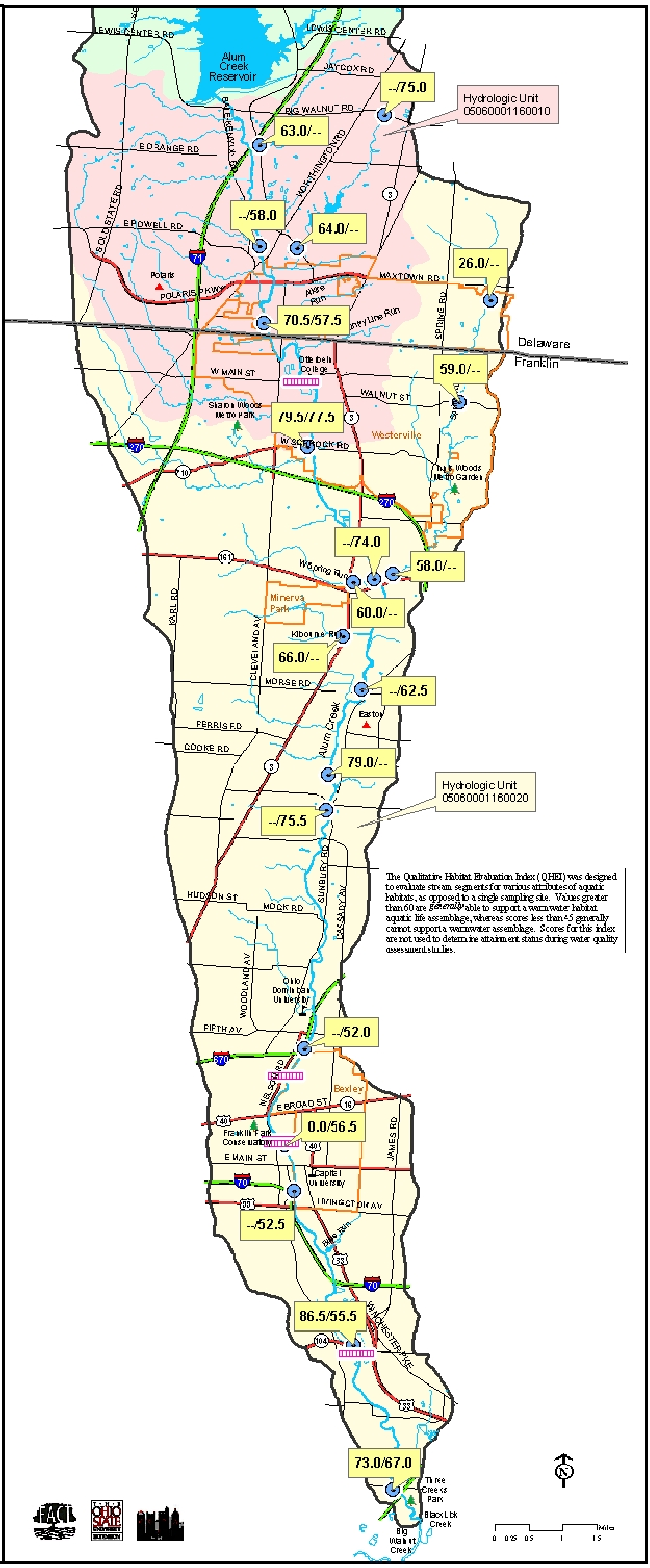
Data Source: Ohio EPA, Franklin and Delaware County Auditor's Offices, Ohio EPA, US Natural Resources Conservation Service

Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003

Qualitative Habitat Evaluation Index & Lowhead Dams

Alum Creek Watershed

Franklin and Delaware



The Qualitative Habitat Evaluation Index (QHEI) was designed to evaluate stream segments for various attributes of aquatic habitats, as opposed to a single sampling site. Values greater than 60 are generally able to support a warmwater habitat aquatic life assemblage, whereas scores less than 45 generally cannot support a warmwater assemblage. Scores for this index are not used to determine attainment status during water quality assessment studies.

Index of Biotic Integrity

Alum Creek Watershed

Franklin and Delaware

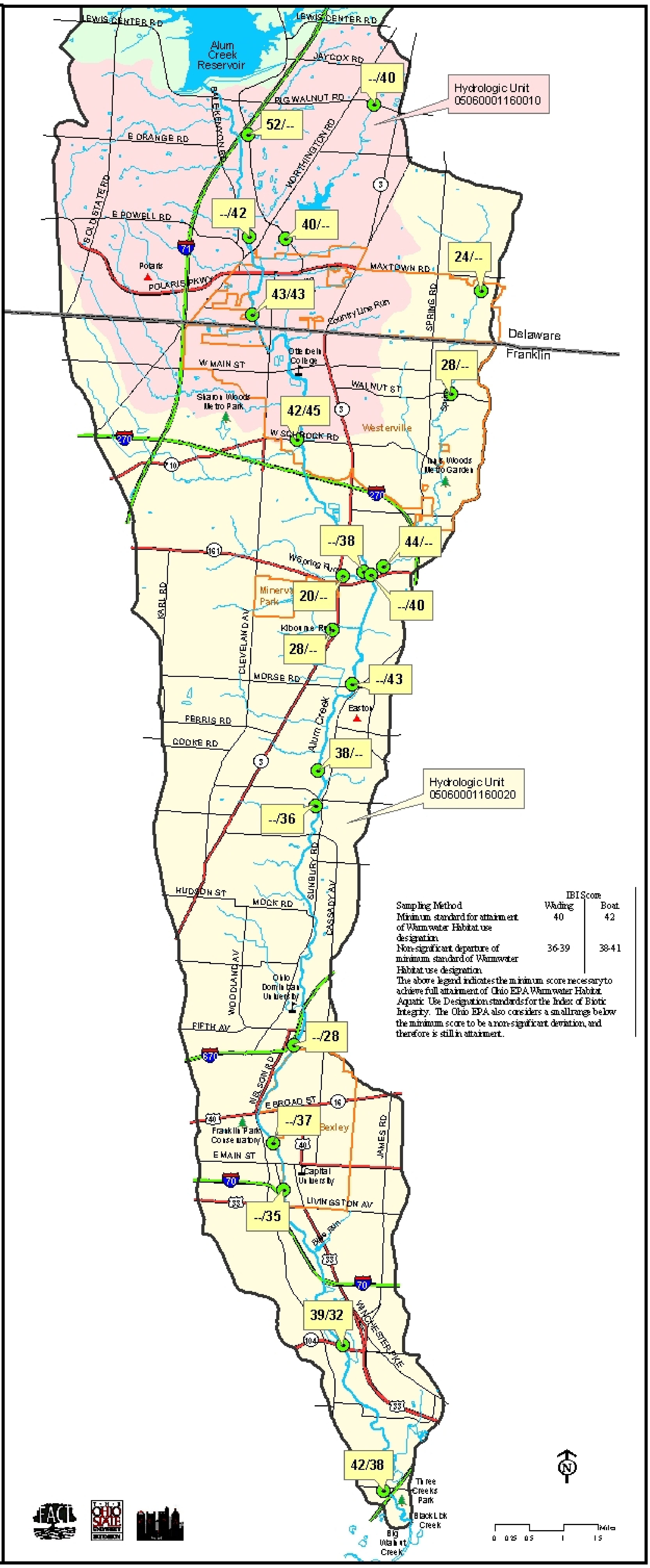
Watersheds
Alum Creek/Streams
Interstate
US & State Routes
Major Roads
Municipal Boundary
Park
School
Shopping
Index of Biotic Integrity 2000 Score / 1996 Score

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: Ohio EPA, Franklin and Delaware County Auditor's Offices, US Natural Resources Conservation Service

Liability Disclaimer: The information shown on the map is for planning purposes only. The Center for Urban and Regional Analysis (CURA) makes no guarantee or warranty concerning the accuracy of information contained in the data.

Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003



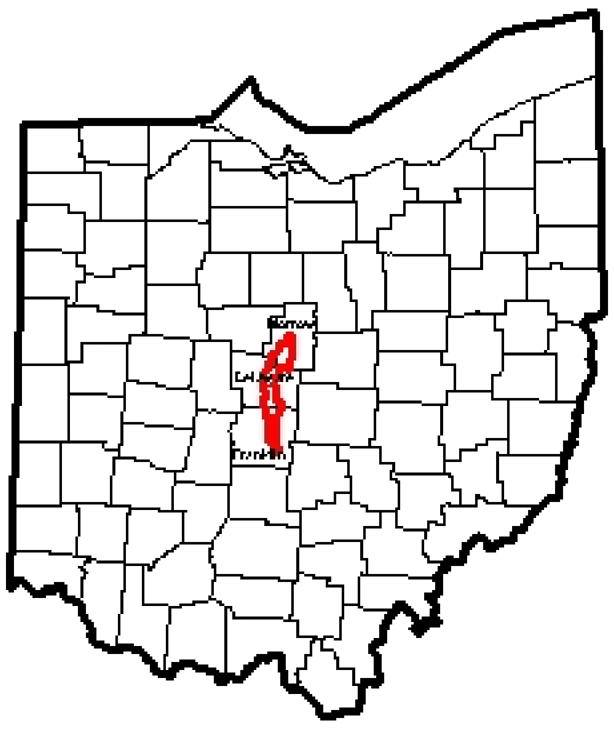
Sampling Method	IBI Score Wading	IBI Score Boat
Minimum standard for attainment of Warmwater Habitat use designation	40	42
Non-significant departure of minimum standard of Warmwater Habitat use designation	36-39	38-41

The above legend indicates the minimum score necessary to achieve full attainment of Ohio EPA Warmwater Habitat Aquatic Use Designation standards for the Index of Biotic Integrity. The Ohio EPA also considers a small range below the minimum score to be a non-significant deviation, and therefore is still in attainment.

Invertebrate Community Index

Alum Creek Watershed

Franklin and Delaware



- Watersheds
- Alum Creek/Streams
- Interstate
- US & State Routes
- Major Roads
- Municipal Boundary
- Park
- School
- Shopping
- Invertebrate Community Index 2000 Score / 1996 Score

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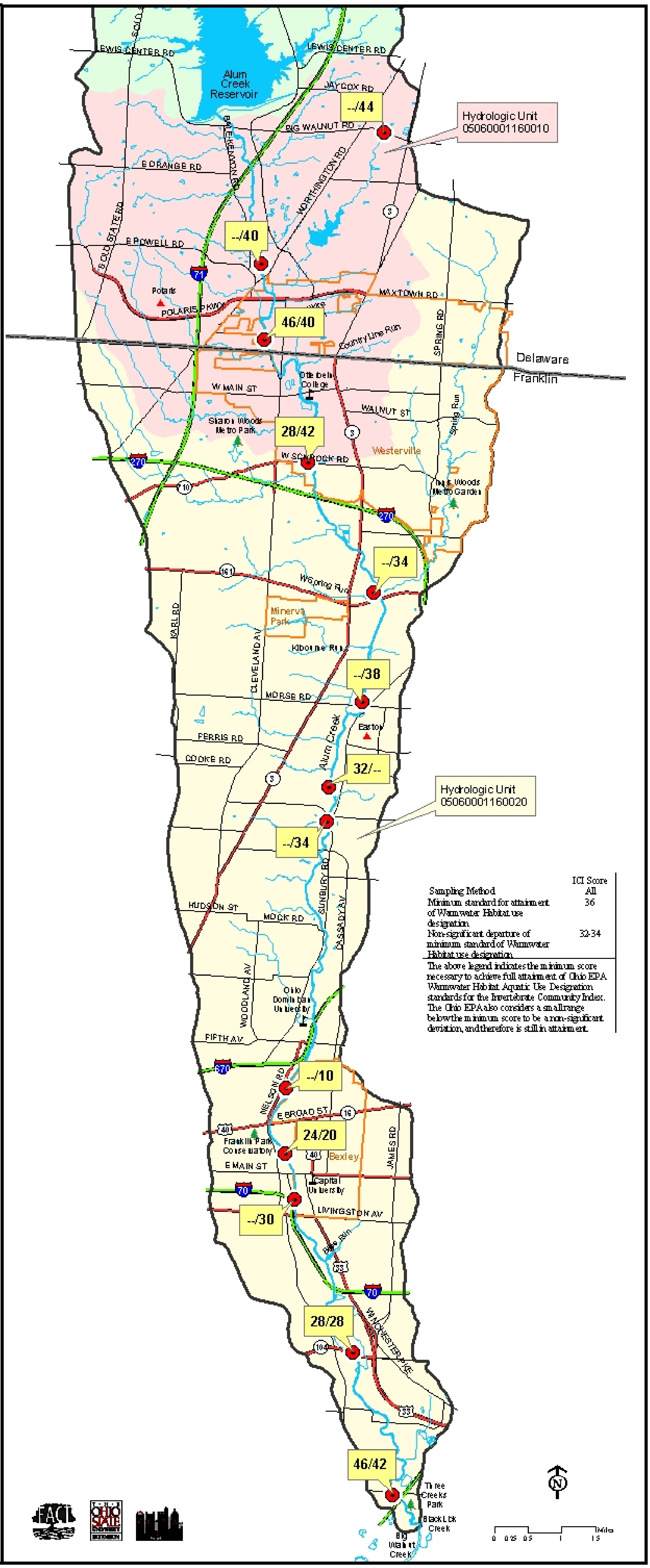
Data Source: Franklin and Delaware County Auditor's Offices, Ohio EPA, US Natural Resources Conservation Service

Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003



Modified Index of Well Being

Alum Creek Watershed

Franklin and Delaware

- Watersheds
- Alum Creek/Streams
- Interstate
- US & State Routes
- Major Roads
- Municipal Boundary
- Park
- School
- Shopping
- Modified Index of Well Being 2000 Score / 1996 Score

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: Franklin and Delaware County Auditor's Offices, Ohio EPA, US Natural Resources Conservation Service

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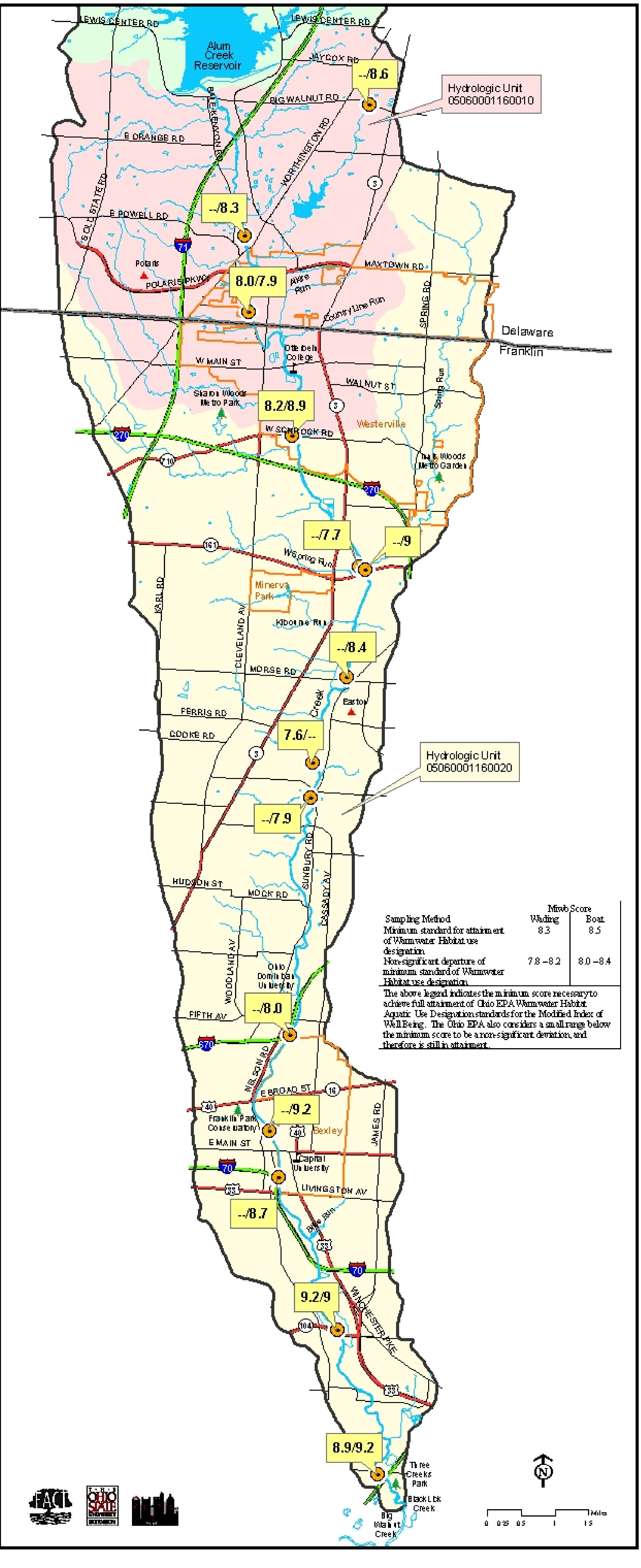
Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003



Sampling Method	Miwb Score Wading	Boat
Minimum standard for attainment of Warmwater Habitat use designation	8.3	8.5
Non-significant departure of minimum standard of Warmwater Habitat use designation	7.8 – 8.2	8.0 – 8.4

The above legend indicates the minimum score necessary to achieve full attainment of Ohio EPA Warmwater Habitat Aquatic Use Designation standards for the Modified Index of Well Being. The Ohio EPA also considers a small range below the minimum score to be a non-significant deviation, and therefore is still in attainment.

Waste Water Treatment Plants & Sewer Overflows

Alum Creek Watershed

Franklin and Delaware

- Watersheds
- Alum Creek/Streams
- Interstate
- US & State Routes
- Major Roads
- Municipal Boundary
- Park
- School
- Shopping
- Combined Sewer Overflows
- Sanitary Sewage Overflows
- Waste Water Treatment Plants

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: City of Columbus Public Utilities Department, Franklin and Delaware County Auditor's Offices, US Natural Resources Conservation Service

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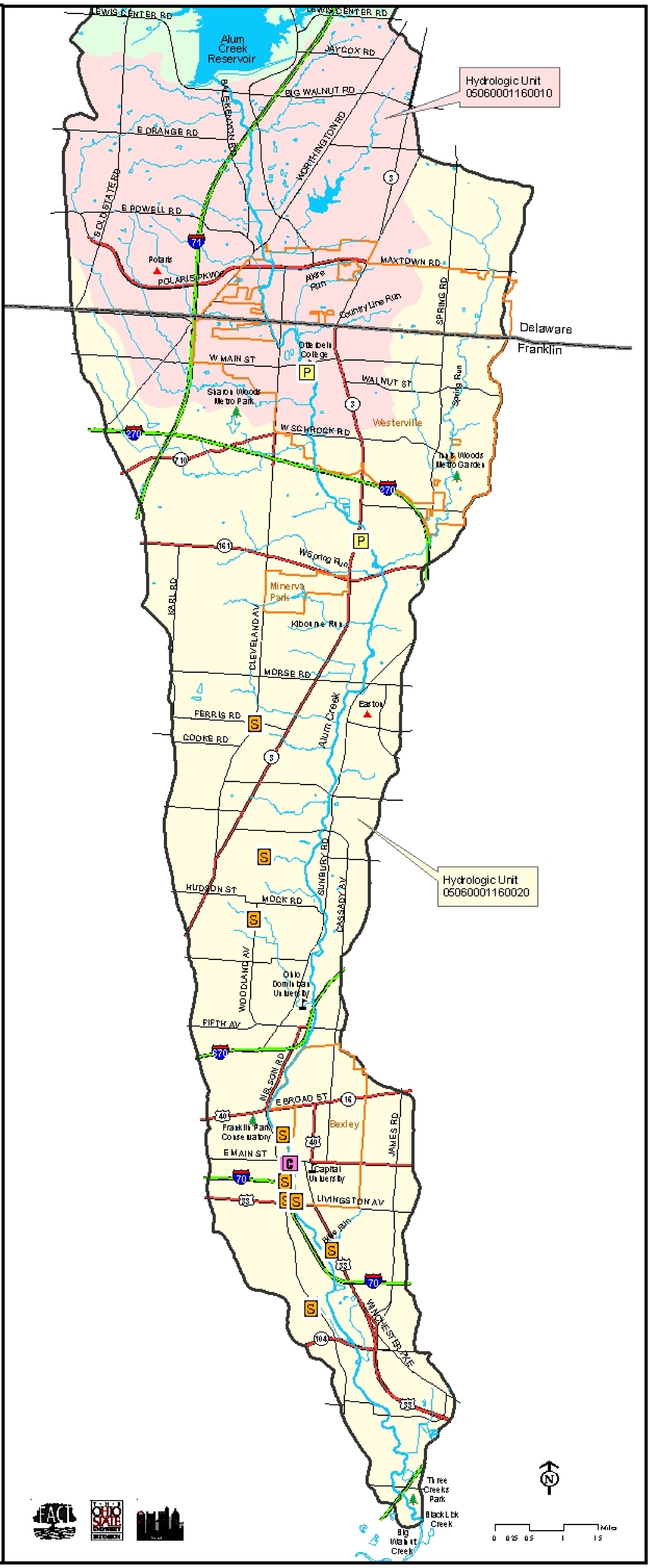
Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003



Semi-public & Residential Sewage Treatment Systems*

Alum Creek Watershed

Franklin and Delaware

- Delaware Co. Residential Aerators
- Delaware Co. Semi-public Systems
- Franklin Co. Residential Aerators
- Franklin Co. Semi-public Systems: Septic/Leach
- Franklin Co. Semi-public Systems: Aerators
- Columbus Residential Aerators
- Columbus Semi-public Systems: Septic/Leach
- Columbus Semi-public Systems: Aerators

Sanitary Sewer Extension Projects

- Identified
- In Progress/Completed
- Planned

This publication was financed through a grant from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319 (h) of the Clean Water Act.

Data Source: Local Health Departments, Franklin and Delaware County Auditor's Offices, US Natural Resources Conservation Service

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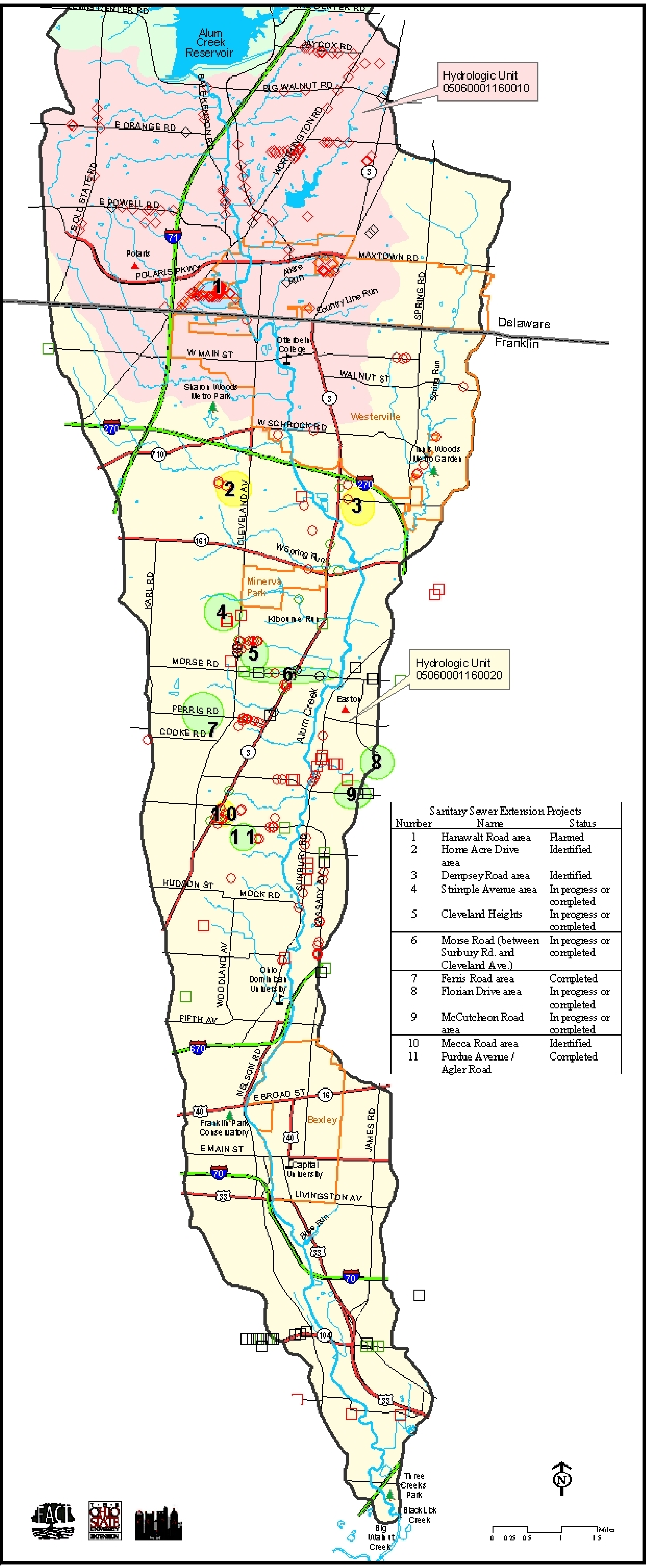
Map prepared by the Center for Urban and Regional Analysis, OSU. Oct. 2003

*** Map does not incude residential septic/leach systems. Delaware County data represents systems installed after 1988.**



Number	Name	Status
1	Hanawalt Road area	Planned
2	Home Acre Drive area	Identified
3	Dempsey Road area	Identified
4	Strimple Avenue area	In progress or completed
5	Cleveland Heights	In progress or completed
6	Morse Road (between Sunbury Rd. and Cleveland Ave.)	In progress or completed
7	Ferris Road area	Completed
8	Florian Drive area	In progress or completed
9	McCutcheon Road area	In progress or completed
10	Mecca Road area	Identified
11	Purdue Avenue / Agler Road	Completed

Sanitary Sewer Extension Projects