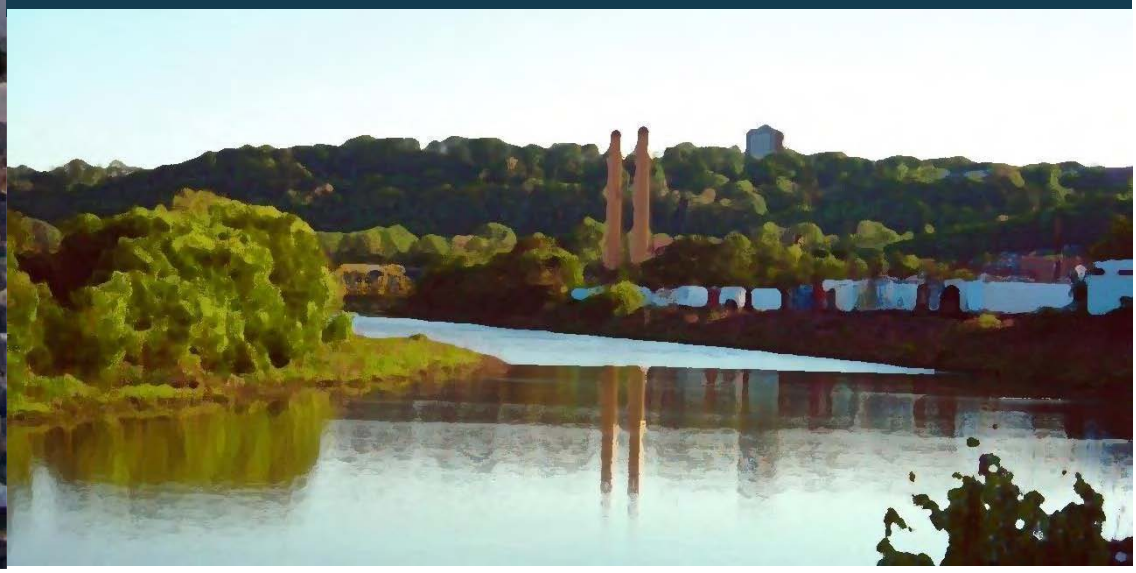
Lower Mill Creek Watershed Action Plan

July 2014



Watershed Coordinator

To be determined…the Lower Mill Creek does not have an officially designated "Watershed Coordinator". In the meantime, implementation will be coordinated by the members of this Watershed Action Plan working group and associated stakeholders.

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Purpose Statement

The overriding goal of this Plan is to initiate a process that restores an urban stream system to its former standing as a vibrant regional asset. That goal supports the Plan's purpose statement:

"The purpose of the Lower Mill Creek Watershed Action Plan is to document current conditions; to identify effective strategies, programs and projects that are needed and can be employed; and to craft a roadmap for improving water quality and ecological health in the Lower Mill Creek Watershed that will, in turn, create more livable neighborhoods and provide public health, environmental, social, and economic benefits for many years to come."

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Distribution List

The draft of the Lower Mill Creek Watershed Action Plan has been provided to the following agencies:

- The Mill Creek Watershed Council of Communities
- The Mill Creek Restoration Project
- Hamilton County Planning and Development Department
- Ohio Kentucky Indiana Regional Planning Agency
- ….etc.

The Lower Mill Creek Watershed Action Plan is also available to download in PDF format at the following website: Not yet available

A copy has also been sent the Public Library of Cincinnati located at the Downtown branch. Not yet

If you wish to get a digital copy of the Lower Mill Creek Watershed Action Plan please contact:

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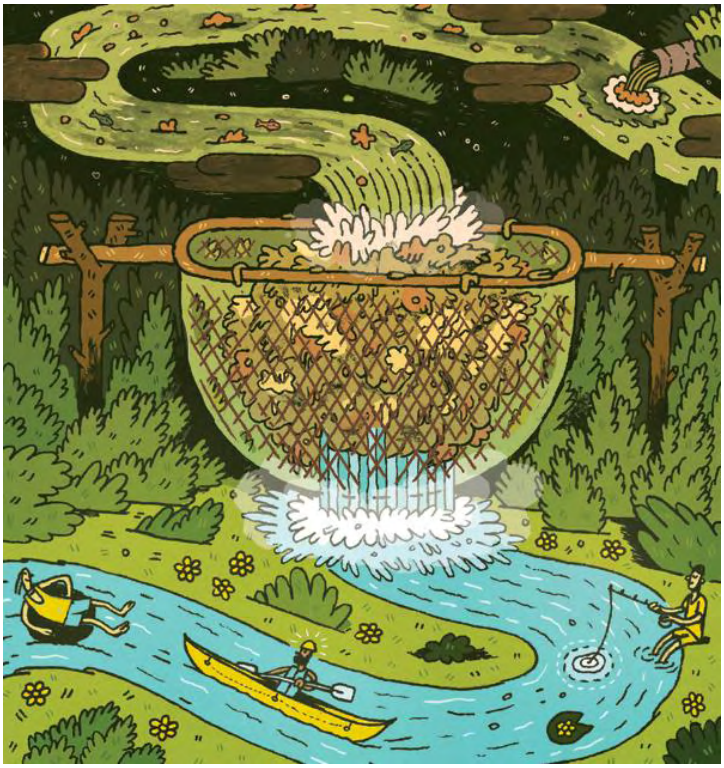
Endorsement of Plan

The following agencies and jurisdictions have formally adopted the Lower Mill Creek Watershed Action Plan:
Jurisdiction Endorsement starts after endorsement of LMCWAP by EPA (according to Ohio WAP Guide)

List of Jurisdictions in LMC Watershed:

- Amberley Village
- Arlington Heights
- Cheviot
- City of Cincinnati
- Columbia Township
- Deer Park
- Elmwood Place
- Golf Manor
- Green Township
- Lockland
- Norwood
- Reading
- Saint Bernard
- Silverton
- Springfield Township
- Sycamore Township
- Wyoming

1 INTRODUCTION



[About the Mill Creek] It's a post-industrial vista, to be sure. But Cincinnati's irrepressible greenness explodes along the shallow riverbed and up along the West Fork Mill Creek, which converges with the Mill Creek below this bridge, descending from Mt. Airy forest and the valley's rim. Trees grow from the roof of the old incinerator. A northern water snake writhes from the water to sun itself on an algae-encrusted tire. A blue heron balances on a submerged shopping cart, contemplating the cost-to-benefit ratio of taking a stab at the ponderous, circling carp. …To many, the Mill Creek continues to be just another spoiled waterway. Still, despite everything we've done, it never holds a grudge."

Cedric Rose, "The Ripple Effect"
Cincinnati Magazine (9/1/2012)

1.1 THE LOWER MILL CREEK WATERSHED ACTION PLAN FRAMEWORK

This watershed action plan (WAP) focuses on the Lower Mill Creek (LMC) watershed located in southwest Ohio. The goal of the LMC-WAP is to restore and maintain the chemical, physical and biological integrity of water bodies within the watershed, an objective of the Clean Water Act of 1972. This plan will address chemical and biological integrity by identifying water quality standards (WQS) and proposing recommendations to achieve them; and physical integrity by evaluating and monitoring the physical attributes of existing stream channels. As a complex urban watershed, the chemical, physical and biological evaluation of the LMC will focus on nutrient levels, habitat, flooding, channelization, erosion, storm water runoff impacts, riparian corridor loss, public health issues and more.

This plan will further address water resource impairment (chemical, biological, and physical) within the watershed and propose solutions for restoration and protection, utilizing the Mill Creek Total Maximum Daily Load (TMDL) report (Ohio Environmental Protection Agency, 2004). The TMDL process was established by the Clean Water Act as a method for identifying and restoring impaired water bodies. The Mill Creek watershed was identified as a priority impaired water on Ohio's 2004 303(d) list of impaired waterways based on data collected in 1997 and 2002. Biological and chemical surveys indicate nutrients, bacteria, organic enrichments, organic chemical pollutants, metals and habitat alterations are some of the primary causes of the impaired watershed (Ohio EPA, 2004). The TMDL for the Mill Creek focuses on nutrients – phosphorus and nitrogen. In

the case where areas currently meet water quality standards, methods for further protection of those areas will be proposed. This plan will ultimately identify watershed restoration priority action items supported by key stakeholders.

Such items will aim to restore the hydrologic network to levels that will:

- Restore natural stream functions
- Improve native habitat
- Reduce storm water runoff
- Provide water quality benefits
- Improve local stewardship of streams and watersheds

The LMC-WAP has been prepared in accordance with the Ohio Environmental Protection Agency's 1997 document titled "A Guide to Developing Watershed Action Plans in Ohio" including the 2003 Appendix 8 updated by the United States Environmental Protection Agency (USEPA).

1.2 THE MILL CREEK

The Mill Creek flows 28 miles from its headwaters in southeastern Butler County, Ohio through Hamilton County, Ohio and the heart of the City of Cincinnati, to its confluence with the Ohio River. The Mill Creek is very much tied to the industrial past of the city, as along the creek you can find railroads, highways, industrial and commercial properties, small to large corporations, residential areas, and some public areas including parks.

The Mill Creek watershed (see Figure 1) spans a drainage area of 166.2 square miles, of which, 130 square miles are within Hamilton County. Along its course, the Mill Creek has an average gradient of 11.9 feet per mile (Ohio Department of Natural Resources, 1960). The majority of the Mill Creek flows on top of a buried aquifer composed of permeable sands and gravel from historic glacial deposits and outwash. Major tributaries to the Mill Creek include East Fork, Sharon Creek, Cooper Creek, Amberley Creek, West Fork Mill Creek, Bloody Run, Ross Run and West Fork. These tributaries and their sub-basins reflect the general characteristics and associated impacts of urban development. The average gradient for the major tributaries of the Mill Creek is 51.8 feet per mile (Ohio EPA, 2004).

The Mill Creek watershed encompasses 37 political jurisdictions, including the City of Cincinnati, Forest Park, North College Hill, Norwood, Reading, Sharonville, Springdale, and others. About a half of the area of the City of Cincinnati, a third of Hamilton County and a tenth of Butler County lie within the LMC watershed.

More than 450,000 people are estimated to live within the watershed's natural boundaries (Mill Creek Watershed Council of Communities, 2005). This number, however, continues to decline as residents move from older inner city neighborhoods to newer outer-ring suburbs. Many international companies operate plants along the banks of the creek, including Procter & Gamble, General Electric, Ford, Ralston-Purina, Formica and Henkel. The Mill Creek Valley continues to be the transportation and industrial center of the

Cincinnati region.

The United States Geological Survey (USGS) maintains a watershed-based hierarchical code system, called Hydrological Unit Code (HUC). As land areas delineated in this system go from the large to small, they are denoted with additional digits. A 12-digit code is applied to the smallest area in the hierarchy, also known as a "HUC-12". This HUC-12 hierarchical boundary is the framework of modern WAPs.

The Mill Creek watershed is composed of five HUC-12 boundaries (see Figure 1 and Table 1). The East Fork Mill Creek was covered by the Upper Mill Creek Watershed Management Plan that was completed in 2005 (highlighted in purple on Figure 1 and Table 1).

This watershed action plan will address the lower two HUC-12 boundaries known as Congress Run and West Fork (highlighted in orange on Figure 1 and Table 1), which are collectively known as the Lower Mill Creek (LMC) watershed.

Table 1 - Mill Creek's HUC-12 Boundaries and Watershed Action Plan Status

Name	HUC-12 #	Area (Acres)	Watershed Action Plan
East Fork Mill Creek	0509020301-01	30,261	UMC-WAP (2005)
West Fork Mill Creek	0509020301-02	23,179	N/A
Sharon Creek	0509020301-03	20,356	N/A
Congress Run	0509020301-04	19,176	LMC-WAP
West Fork	0509020301-05	15,118	LMC-WAP

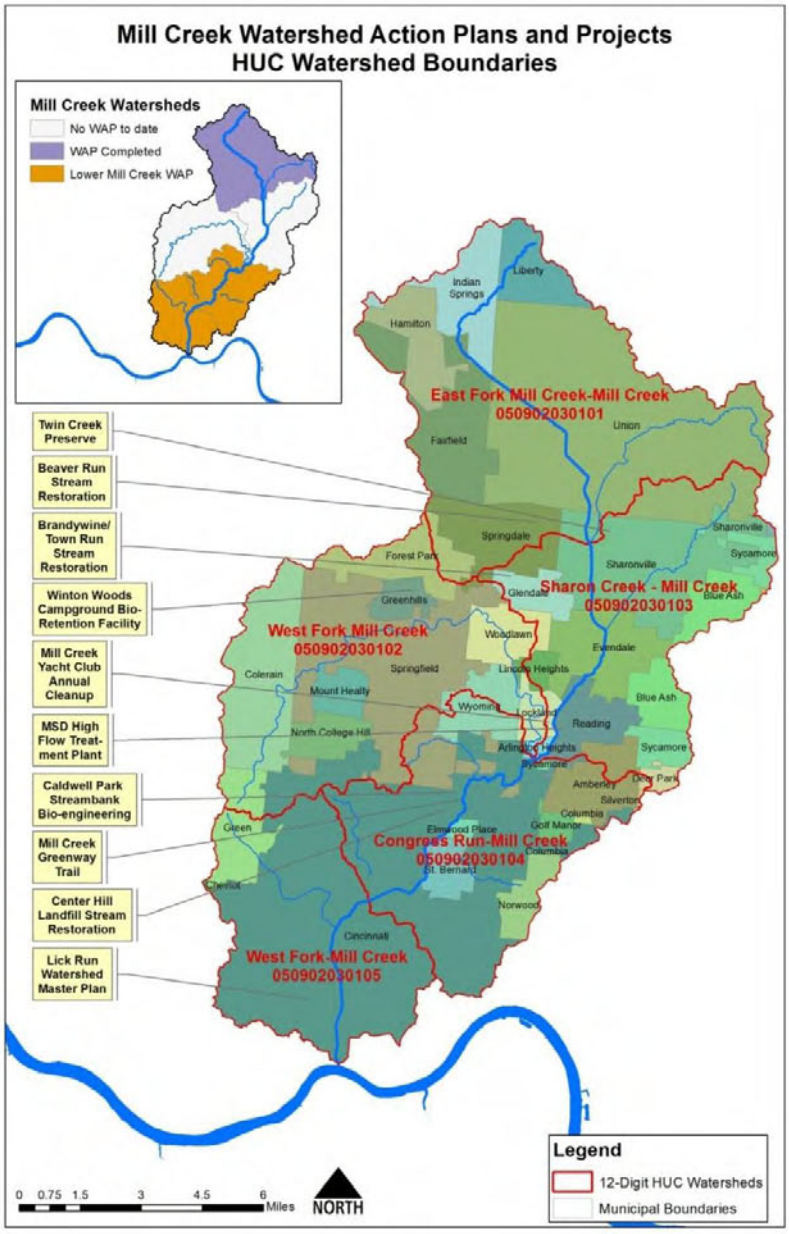


Figure 1 – The Mill Creek Watershed and HUC-12 Boundaries

1.3 THE LOWER MILL CREEK WATERSHED

The Lower Mill Creek (LMC) watershed, sometimes called the South Branch Mill Creek, covers approximately 15,355 acres within the greater Mill Creek watershed. The LMC watershed is a combination of two HUC-12 boundaries, Congress Run (0509020301-04) and West Fork (0509020301-05) (shown on Figure 1 and Table 1). The length of the Mill Creek within the LMC watershed is 11.5 miles, extending from the Cincinnati neighborhood of Roselawn to the confluence of the Ohio River.

Sub-sewersheds of the Lower Mill Creek watershed

A sewershed is a catchment area defined by storm drain infrastructure emptying into a common outlet. The LMC watershed boundary contains roughly 12 different sub-sewershed areas as delineated by the Metropolitan Sewer District of Greater Cincinnati (MSDGC) (see Figure 2). These sub-sewersheds are known as: Amberley, Bloody Run, Bold Face, Clifton, Denham, Downtown, Gest, Hartwell-Carthage, Kings Run, Lick Run, Mitchell, River East, Ross Run, Upper Mill and West Fork. Parts of this document refer to these sewersheds to encapsulate MSDGC's current and planned programs and initiatives for improving infrastructure and restoring water quality.

Three additional sub-sewersheds, Downtown, Bold Face, and River East, also contain small areas within the LMC watershed but they are not included in the analysis of this report for two reasons. The first reason is that these three sub-sewershed's rainwater surface-flows drain primarily to the Ohio River instead of the Mill Creek. The second reason for not including them at this time, MSDGC is still analyzing these three sub-sewersheds and developing solutions for addressing combined sewer overflows in these areas. For this reason, they could still be added in future versions and updates to the LMC-WAP as more is known.

These sub-sewersheds are of great focus to the LMC-WAP because the bulk of the major tributaries that once comprised the LMC watershed have been replaced by underground sewer systems as development increased in the region. Based on a typical year of rainfall, 19.3 billion gallons of runoff drain from these 15 sub-sewersheds to the Lower Mill Creek each year (MSDGC). In the past, the primary objective of storm water management was to remove rainfall as quickly as possible without jeopardizing safety, often through surface storage and underground pipe networks. This method of storm water management can, however, have significant impacts on the environment. For example, storm water flow from urbanized areas can contribute to combined sewer overflows; degrade natural habitats; increase sedimentation, turbidity, toxicity, temperature and bacterial contamination in streams; deplete oxygen resources; and lead to excessive aquatic plant growth that harms aquatic life and limits recreational uses.

In more than 700 cities across the country containing more than 40 million people, wastewater and storm water management is further complicated by combined sewer systems (U.S. EPA, 2008). Combined sewer systems are sewers that are designed to collect storm water runoff, domestic sewage, and industrial wastewater in the same pipes. Most of the time, combined sewer systems transport all of their wastewater to a centralized plant, where it is treated and discharged to a water body (e.g., the Mill Creek or Ohio River). During certain rain storms, pipes are overloaded and storm water and sanitary sewage combine and overflow into the region's streams and rivers. This is called a combined sewer overflow, or CSO. Combined sewer

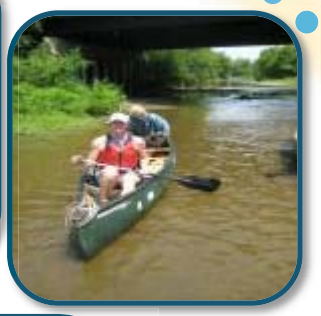
overflows are point-source discharges to the waters of the United States, and are therefore subject to Section 301(a) of the Clean Water Act and the implementing regulations for the National Pollutant Discharge Elimination System (NPDES).

Table 2 - Lower Mill Creek Sub-sewershed Areas

Sub-sewershed	Acres	Sq. Miles
Amberley	1,654	2.58
Bloody Run	2,211	3.45
Clifton	3,488	5.45
Denham	1,316	2.05
Gest	471	0.74
Hartwell-Carthage	4,161	6.50
King's Run	3,846	6.00
Lick Run	2,718	4.24
Mitchell	1,574	2.45
Ross Run	3,912	6.11
Upper Mill	1,924	3.00
West Fork	5,524	8.63
Total	**32,799**	**51.24**

Figure 2 - Lower Mill Creek Sub-sewersheds

The "Irrepressible" Mill Creek Watershed



2 DEFINING THE LOWER MILL CREEK WATERSHED

2.1 BOUNDARIES

2.1.1 COUNTIES

The Mill Creek watershed expands over Butler County, Ohio and Hamilton County Ohio, with a small section in Warren County, Ohio. The LMC watershed is completely within Hamilton County, Ohio.

2.1.2 INCORPORATED AND UNINCORPORATED AREAS

There are 17 jurisdictions in the LMC-WAP study area (see Figure 3):

- Amberley Village
- Arlington Heights
- Cheviot
- City of Cincinnati
- Columbia Township
- Deer Park
- Elmwood Place
- Golf Manor
- Green Township
- Lockland
- Norwood
- Reading
- Saint Bernard
- Silverton
- Springfield Township
- Sycamore Township
- Wyoming

There are 38 neighborhoods from the City of Cincinnati located within the LMC-WAP study area (see Figure 4):

- Avondale
- Bond Hill
- Camp Washington
- Carthage
- Clifton
- College Hill
- Corryville
- CUF
- East Price Hill
- East Walnut Hills
- East Westwood
- English Woods
- Evanston
- Fay Apartments
- Hartwell
- Heights
- Kennedy Heights
- Lower Price Hill
- Millvale
- Mount Airy
- Mount Auburn
- North Avondale
- North Fairmount
- Northside
- Over-The-Rhine
- Paddock Hills
- Pleasant Ridge
- Queensgate
- Roselawn
- Sedamsville
- South Cumminsville
- South Fairmount
- Spring Grove Village
- Walnut Hills
- West End
- West Price Hill
- Westwood
- Winton Hills

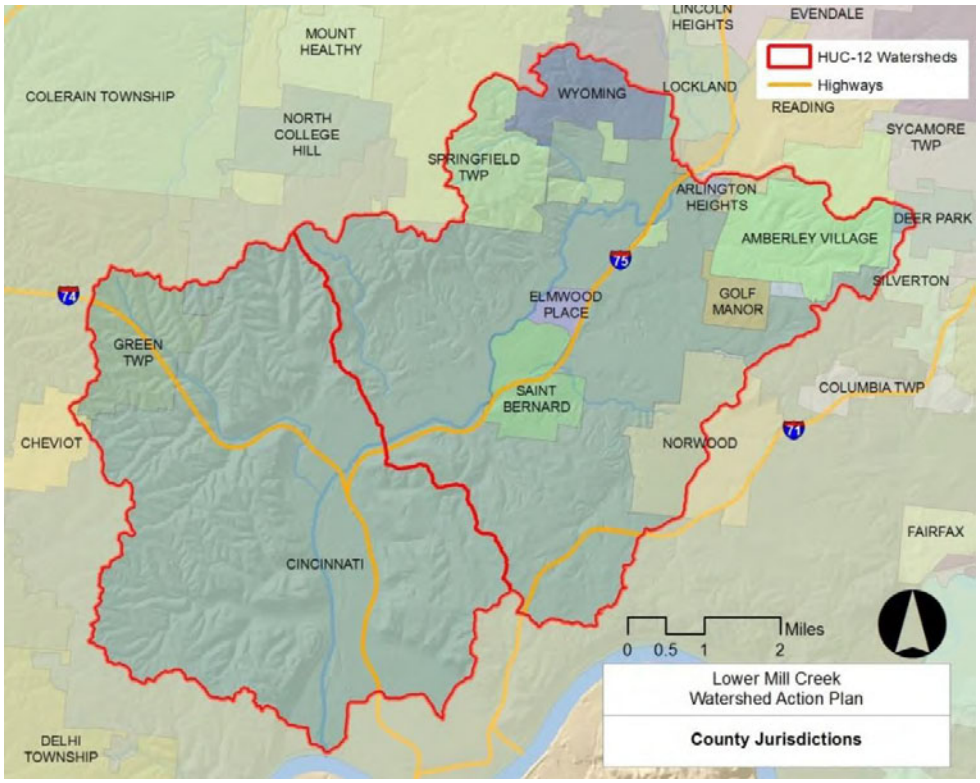


Figure 3 - County Jurisdictions

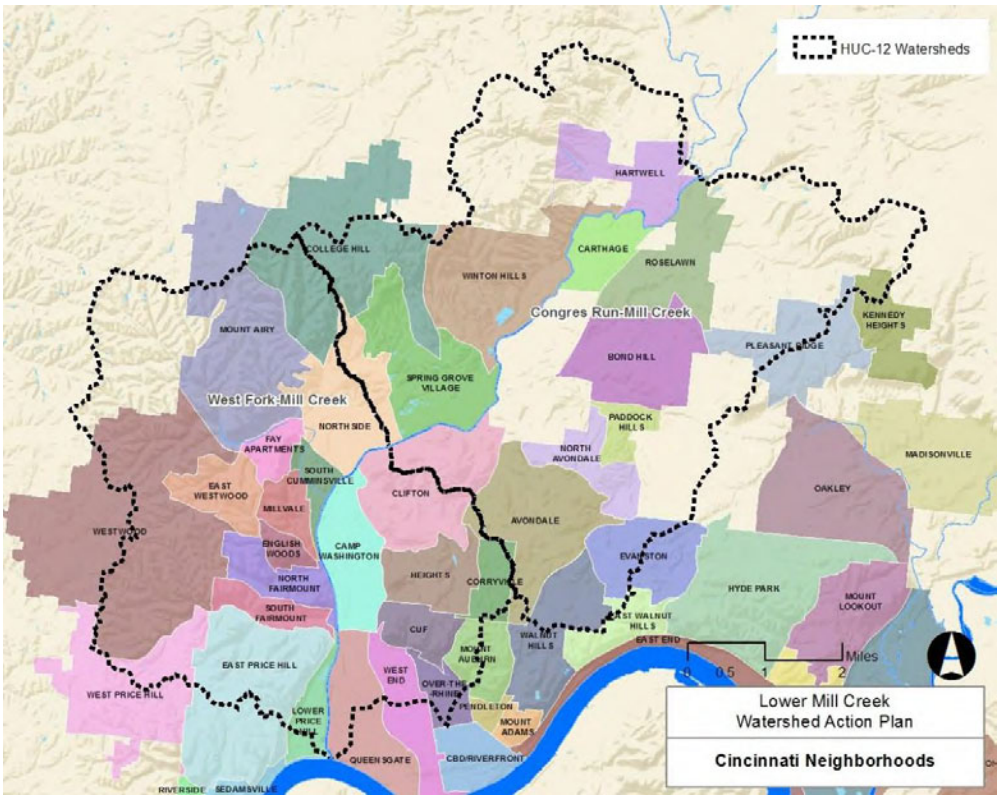


Figure 4 – City of Cincinnati Neighborhoods

2.1.3 PARKS

The LMC watershed contains 3,751 acres of both passive recreation such as hiking trails and picnic shelters and active recreation areas that contain ball-fields, playgrounds, and golf courses.

Nearly all the parks within the LMC watershed are owned and maintained by the Cincinnati Parks Board , the City of Cincinnati Recreation Commission, or the Hamilton County Parks District. The Cincinnati Park Board controls 5 regional parks, 70 neighborhood parks and 34 nature preserves as well as parkways and neighborhood gateways within the City of Cincinnati. The Park Board's newest community program, "Living Our Green Life," provides useful tips, conservation education and practical resources to enable residents to live a healthier, "greener" and more economical lifestyle every day.

The largest of the parks is Mt Airy Forest. Accessible from Mt. Airy and Westwood, Mt. Airy Forest's 1,459 acres includes miles of hiking trails and bridle trails (located off Diehl Road) for horseback riders. Mt. Airy has Ohio's only wheelchair accessible public tree-house, an enclosed dog park, and disc golf. Mt. Airy Arboretum's specialty gardens, gazebos and picturesque lake are a favorite wedding site. Mt. Airy has two forest lodges and three picnic areas that can be reserved, as well as two council areas for organized youth group overnight camping. Or just come for a picnic at one of 23 picnic areas within the park, complete with tables, charcoal grills, and swing sets.

The most visited park is the Cincinnati Zoo and Botanical Garden. The Cincinnati Zoo is located in the Cincinnati neighborhood of Avondale. It was founded on 65.4 acres (26.5 ha) in the middle of the city, and since then it has acquired some of the surrounding blocks and several reserves in Cincinnati's outer suburbs.

A. Recreational

There are many recreational opportunities found in the LMC watershed. All together, the LMC watershed has nearly 7,000 acres of parks and open space, approximately 17% of the total area. Hamilton County, which contains the LMC watershed, boasts Ohio's third largest park system with more than 12,500 acres of land. The City of

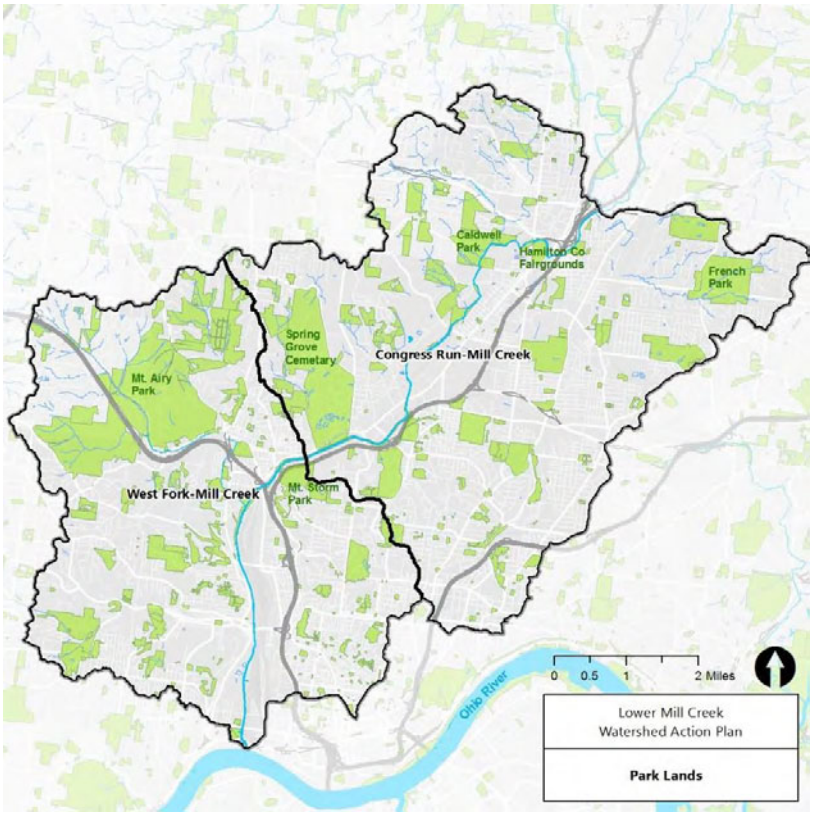


Figure 5: Park Lands

Cincinnati manages more than 5,000 acres of parkland. These parks serve as a valuable resource helping to absorb rainfall, trapping pollutants from overland runoff and providing green space within urban and suburban areas.

B. Golf Courses

Golf courses are an important consideration for watershed planning because they can sometimes be a major source of nonpoint runoff and pollution due to the nutrients that it takes to keep the grass looking green and healthy. On the other hand, golf courses can be an important factor for reducing storm water overflow volumes because of the many water features on the courses that can absorb and detain excess rainwater. Many courses are now taking this a step further and looking for ways to improve storm water quality using storm water best management practices. Several golf courses exist within the LMC watershed, including:

- Golf Manor
- Maketewah Country Club
- Avon Fields Golf Course
- Clovernook Country Club
- Wyoming Golf Course
- Dunham Recreation Complex

C. Bicycle Facilities

Bike trails are a special kind of bicycle path that are valued for their recreational quality and provide a scenic experience for the users. Several bike trails can be found in the LMC as shown in Table 3:

Table 3: Public Bike Trails in the Lower Mill Creek

Trail Name	Description of Trail	Owner
Nature Trail	0.3 mile loop trail in Rapid Run Park along a tributary of Lick Run	Cincinnati Parks
Valley Trail	0.3 mile trail along a tributary of Mill Creek runs from Trailside Museum to the northwest corner of Burnet Woods	Cincinnati Parks
Red Oak Trail	0.9 mile trail along a tributary of West Fork runs from the oval in Mt. Airy Forest to West Fork Road	Cincinnati Parks
Ravine Creek Trail	0.6 mile trail along both a tributary and Mill Creek in Caldwell Nature Preserve	Cincinnati Parks
Creek Trail	0.6 mile trail adjacent to Amberley Creek in French Park	Cincinnati Parks
Gardner Park Trail	0.4 mile trail adjacent to West Fork Mill Creek	Village of Lockland
Vorheestown Bicentennial Trail	0.5 mile trail paralleling Mill Creek	City of Reading
GE ELFUN Society Upper Meadow Trail	1.2 mile hillside trail encircling a tributary of Mill Creek on Gorman Heritage Farm	Cincinnati Nature Center
Pin Oak Trail	0.7 mile loop trail along a tributary of West Fork Mill Creek and past adjacent ponds and meadows in Fahrbach-Werner Nature Preserve	Hamilton County Park District
Creekside Trail	0.7 mile trail along both a tributary and West Fork Mill Creek in Trillium Trails	Hamilton County Park District

2.1.4 SCHOOL DISTRICTS

The LMC watershed contains many public, private, parochial, vocational and higher level learning institutions. The public school districts listed by the Ohio Department of Natural Resources' (ODNR) Earth Resources Information Network (ERIN) watershed planning reports are shown in Table 4 and Table 5 below.

Furthermore, three major colleges are found within the LMC watershed, the University of Cincinnati, Xavier University, and Cincinnati State Technical and Community College. These colleges are actively developing their campus infrastructure to treat stormwater on site as much as possible. In fact, Cincinnati State has worked with MSDGC to implement several on-campus storm water best management practices (BMPs) as part of MSDGC's demonstration program called "Early Success Projects". They are also tremendous resources for gathering watershed planning information, training future stormwater management professionals and getting individuals involved in watershed planning efforts.

Table 4 - Congress Run (04) School Districts

School Districts	Area of Watershed (acres)
City of Cincinnati	14,269.1
Deer Park Community City	67.8
Finneytown Local	1,241.8
Lockland Local	66.9
Norwood City	1,079.2
Reading Community City	207.7
St. Bernard-Elmwood Place City	1,199.2
Winton Woods City	0.0
Wyoming City	1,072.6

Source: (ODNR, 2011)

Table 5 - West Fork (05) School Districts

School Districts	Area of Watershed (acres)
City of Cincinnati	14,015.0
Deer Park Community City	1,126.7

Source: (ODNR, 2011)

2.1.5 CONSERVANCY DISTRICTS

Mill Valley Conservancy District

Mill Valley Conservancy District is a quasi-governmental agency created to be a sponsor to the Army Corps of Engineers for a flood control project in Hamilton County. The board is comprised of three board members appointed by the Hamilton County Conservancy Court. Board members currently represent their respective agencies which include MSD, Hamilton County Engineer's Office, the Mill Creek Watershed Council of Communities and local communities, specifically Sharonville. There is also a Treasurer, Secretary, Legal Staff and Controller who attend each of the quarterly board meetings. The MVCD currently owns and maintains completed sections of the flood control project and remains the local sponsor for any potential modifications or completion of the flood control project in the Mill Creek Valley.

The Hillside Trust

The hillsides form an integral part of the natural fabric of Greater Cincinnati and Northern Kentucky. First-time visitors are often struck by the dramatic relief in topography, and the stunning overlooks of picture postcard proportions.

Of the 80 square miles that comprise the incorporated area of Cincinnati, 15 square miles, or 18%, represent hillsides. Of the 264,849 acres that comprise Hamilton County, within which Cincinnati is located, 60,043 acres, or 23%, consist of hillsides. This percentage of hillside acreage is similar in the three Northern Kentucky Counties of Campbell, Kenton and Boone.

As the supply of buildable land diminishes, combined with growing market demand for "view" properties, the region's hillsides have come under increasing development pressure over the last 40 years. The advent of heavy earth moving machinery and technological advances has made it possible to build on a hillside, build into it, or simply haul it away all together.

In over its 30 years of public service, The Hillside Trust has matured from serving just Cincinnati and Hamilton County, to an organization that also serves the surrounding counties of Clermont, Campbell, Kenton, and Boone. It has become a well- respected organization that has built a solid reputation through a three-part mission of research and education, advocacy, and land conservation. A fourth component involving land banking was originally planned, but a lack of funding made it impossible to implement.

2.1.6 SEWER DISTRICTS

The Metropolitan Sewer District of Greater Cincinnati (MSDGC)

MSDGC is a publicly operated wastewater utility serving the City of Cincinnati, Hamilton County, other Hamilton County (Ohio) political subdivisions, as well as parts of three adjacent counties (Butler, Clermont, and Warren). MSDGC's ratepayer base includes approximately 230,000 residential and commercial users, and 250 industrial users, who represent a population of about 855,000. To date, the northwestern part of Hamilton County and portions of adjacent counties are not served by public sewers.

The sewage collection and treatment network spans an area that covers approximately 290 square miles,

contains over 200,000 separate sewer connections, and includes approximately 2,994 miles of sanitary and combined sewers. MSDGC partners with other utilities and cities that are similarly dependent upon the Ohio River and its tributaries for wastewater discharge and drinking water, including Pittsburgh (Pennsylvania), Louisville (Kentucky), and Paducah (Kentucky). In 2009, MSD operated seven major wastewater treatment plants, more than 120 pump stations, and three package treatment plants, which collectively treated approximately 167 million gallons per day of collected wastewater. Treated water (called effluent) is released into the region's creeks and rivers. MSDGC is responsible for protecting the natural environment by ensuring that wastewater is treated to required standards. Concurrently, MSDGC is working to reduce the occurrences of wastewater entering waterways during heavy rain events, when the sewer system becomes overloaded. MSDGC uses a 5-year capital planning cycle for the repair, replacement, or improvement of its physical infrastructure assets. The capital budget in 2010 was $165 million, and is estimated at $908 million for the 5-year planning cycle of 2010 to 2014.

Combination Sewers Data

- Total length: 869 miles
- Sizes: 4" to 246"
- Age*: 1 to 145 years
- Average age**: approx. 90 years

Sanitary Sewers Data

- Total length: 2,107 miles
- Sizes: 1" to 156"
- Age*: 1 to 145 years
- Average age**: approx. 40 years

Storm Sewers Data

- Pump Stations
- 117 Public, 61 Private
- SSO (Sanitary Sewer Overflows) 63
- Total CSO (Combined Sewer Overflows) 214
- Total 82 Diversion dams
- 81 Gratings
- 26 Regulators
- 12 Dual chambers
- 5 Overflows
- Drop gates
- 1 High rate separator
- 1 Vortex valve

*The oldest known sewer segments were built in 1865.
**The average age was calculated using sewer segments with known installation dates (approx. 76 percent of

the sewer segments in the database).

MSDGC's Operational System

The MSDGC collection system is made up of an extensive system of pipes that receive flow from homes, businesses, and runoff from older storm water pipes that are combined with sewer collection pipes, also known as combined sewers. This collection and conveyance system brings wastewater to MSDGC's wastewater treatment centers. These facilities treat wastewater and release effluent back into the region's creeks and rivers. The waste removed in treatment is referred to as sludge, which is incinerated at two MSDGC facilities. This system delivers important community and public benefits by collecting and treating raw sewage.

Sanitary Sewer Overflow (SSO) and Combined Sewer Overflow (CSO) Elimination

In more than 700 cities across the country, wastewater and storm water management is complicated by combined sewer systems (U.S. EPA, 2008). These combined sewer systems are sewers are designed to collect storm water runoff, domestic sewage, and industrial wastewater in the same pipes which most of the time, is transported to a centralized plant, where it is treated and discharged to a water body (e.g., the Mill Creek or Ohio River). During certain rain storms, pipes are overloaded and storm water and sanitary sewage combine and overflow into the region's streams and rivers. This is called a combined sewer overflow, or CSO. Combined sewer overflows are point-source discharges to the waters of the United States, and are therefore subject to Section 301(a) of the Clean Water Act and the implementing regulations for the National Pollutant Discharge Elimination System (NPDES). Under the Clean Water Act, cities are now required to reduce and eliminate the release of untreated wastewater into the environment through combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs).

Sanitary Sewer Overflow (SSO) Elimination

MSDGC is under a Federal Consent Decree to resolve the SSO and CSO problem. The U.S. EPA has mandated that MSDGC eliminate the 17 most active SSOs in the service area by the end of 2007. MSDGC must also develop a detailed plan to resolve the remaining SSOs by 2022. As of 2005, MSDGC has eliminated half of the SSOs with approximately 76 SSOs (including the 17 most active) remaining.

Combined Sewer Overflow (CSO) Elimination

MSDGC is making necessary improvements to its sewage systems, particularly those with combined sewers that carry both sewage and storm water in the same pipes. MSDGC's current sewer system is old, parts of it are deteriorating, and portions are not large enough to handle the mixture of sewage and storm water that enters it during heavy rains. During wet weather, billions of gallons of raw sewage mixed with storm water overflow into local rivers and streams and back up into basements.

As one of the top five CSO dischargers in the country, MSDGC is under a Federal Consent Decree to resolve this problem. The U.S. EPA has mandated that MSDGC capture and treat, or remove 85 percent of the 14 billion gallons of combined sewer overflows. The solution to this problem is coined by MSDGC as "Project Groundwork", one of the largest public works projects in the history of our community. Project Groundwork is a two-phased, multi-year initiative comprised of hundreds of sewer improvement projects across the LMC

watershed. The local community thru MSDGC ratepayers will be investing over a billion dollars over the next ten years on sewer infrastructure to address the combined sewer overflows issues.

MSDGC is faced with finding solutions that are affordable to ratepayers and also meet the environmental, social and economic needs and desires of affected communities. The multi-billion-dollar construction initiatives of MSDGC will result in significant sewer improvements and will provide economic, environmental, and social benefits for our communities, now and in the future. Under the Project Groundwork initiative, MSDGC plans to use a blend of both "gray" infrastructure and "green" infrastructure that will create the most sustainable solutions for our region's infrastructure needs.

Conventional, gray engineering solutions such as sewer pipe upgrades and overflow storage facilities are often used to comply with federal Consent Decrees; however, planners and engineers have alternatives for managing storm water runoff. Green storm water management, commonly referred to as green infrastructure, focuses on retaining and treating storm water as close to the source as possible; allowing it to infiltrate into the ground or evaporate into the atmosphere; and rediscovering and restoring natural systems to receive storm water.

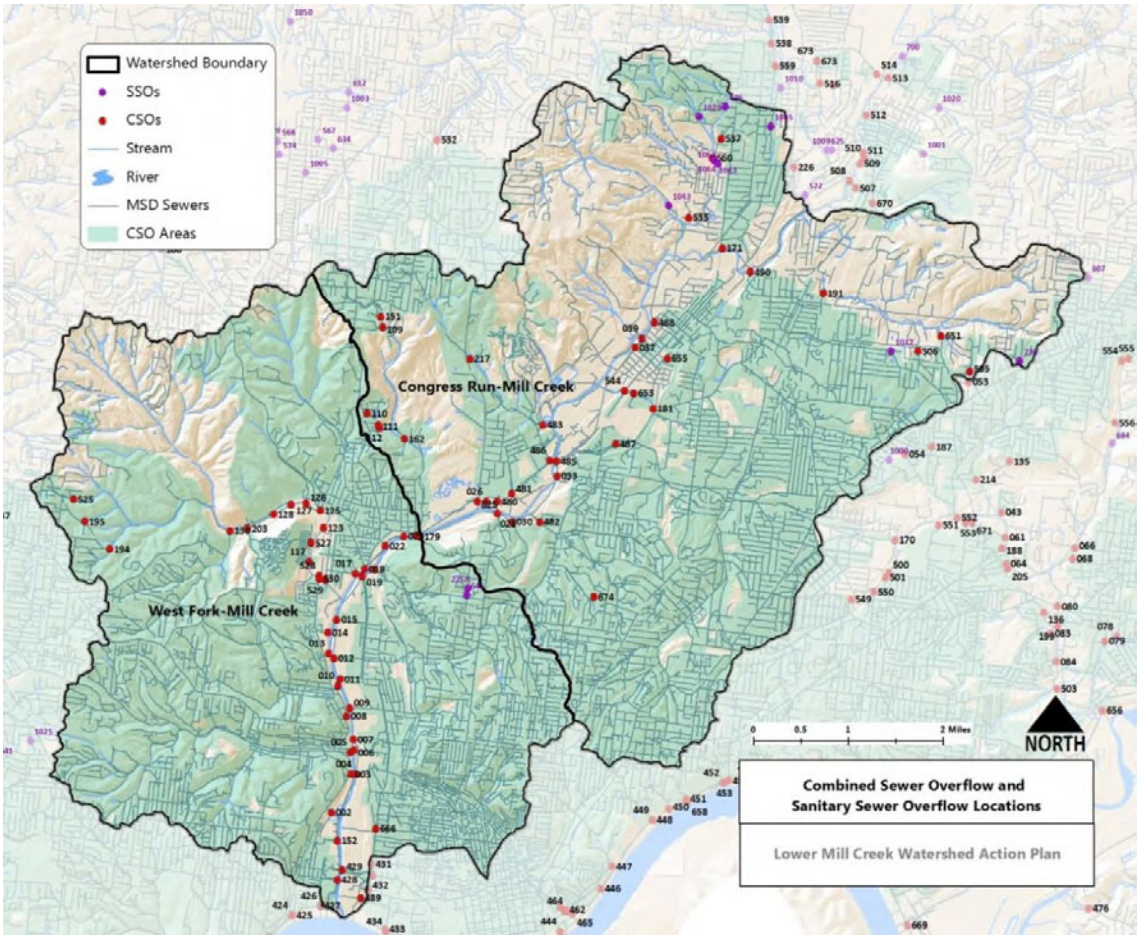


Figure 6: Combined Sewers Overflow and Sanitary Sewer Overflow Locations

2.1.7 SOIL AND WATER DISTRICTS

Hamilton County Soil and Water Conservation District (HCSWCD)

Hamilton County Soil and Water Conservation District is a legal subdivision of the State of Ohio responsible for the conservation of natural resources within Hamilton County. This public organization is committed to assisting Hamilton County citizens through education, technical assistance and leadership to be stewards of soil and water resources.

2.1.8 STORM WATER DISTRICTS

Hamilton County Storm Water District (HCSWD)

The Hamilton County Storm Water District was established in response to the federally mandated NPDES Phase II storm water program. The Storm Water District represents Hamilton County's commitment to storm water issues. The District membership consists of 42 of the 49 jurisdictions in Hamilton County including all 12 of the townships.

2.1.9 AGRICULTURE DISTRICTS

In Hamilton County, agricultural land has been steadily converted to urban land uses to meet population growth demands, but there are still some agriculture support services provided to local farmers.

Ohio State University—Hamilton County Cooperative Extension

Ohio State University Extension is the outreach arm of The Ohio State University with local offices in each of Ohio's 88 counties. The Hamilton County Office offers diverse programming for citizens in the areas of 4-H Youth Development, Family and Consumer Sciences, Community Development, and Horticulture/Floriculture.

2.1.10 REGIONAL PLANNING AGENCIES

Regional planning in the LMC watershed is accomplished through the efforts of the City of Cincinnati City Planning and Buildings Department, Hamilton County Planning and Development and OKI Regional Council of Governments.

City of Cincinnati—Department of City Planning and Buildings

The City Planning Division was reestablished in 2007 and is responsible for the following:

- Administration of the zoning code, subdivision rules and regulations, and other land use regulatory processes
- Staff to the City Planning Commissions and Historic Conservation Board
- Provide demographic, mapping and analysis services
- Develop special plans, including the Consolidated Plan, Urban Renewal Plans, Community Plans, and Tax Increment Financing plans
- Manage federally funded program reviews, including environmental reviews of projects
- Conduct heritage and historic research
- Provide professional guidance to property owners concerning certificates of appropriateness and

other action affecting the City's historic resources.

Hamilton County—Planning and Development Department

This department serves the Hamilton Board of County Commissioners by providing advisory planning services to the unincorporated areas of the County. The department's various planning activities include programs for subdivision compliance, community planning, development review and census/data and information systems. They monitor development trends, evaluate current policies, and update the Hamilton County Master Plan and related regulations for zoning, subdivision of land and traffic circulation. Land use control responsibilities include development review for consistency with zoning regulations, subdivision rules, and thoroughfare plans.

OKI Regional Council of Governments

The Ohio-Kentucky-Indiana Regional Council of Governments (OKI) is a council of local governments, business organizations and community groups committed to developing collaborative strategies, plans and programs which will improve the quality of life and the economic development potential of the Tri-state. Board Members consist of top elected officials from each of the political jurisdictions within the regional tri-state boundaries. Their Land Use Planning Committee seeks to provide communities with the tools to integrate planning efforts with greenspace and other resources that affect a regions quality of life. OKI has traditionally provided staff support to the Mill Creek Watershed Council of Communities and has helped raise awareness for the improvement of the Mill Creek watershed.

2.2 SPECIAL DESIGNATIONS

2.2.1 NATIONAL AND STATE WILD AND SCENIC RIVERS, AND LOCAL DESIGNATIONS

The South Branch Lower Mill Creek Watershed does not contain any sections of a national or state designated scenic river. The closest state designated scenic river is the Little Miami River, which does go through Hamilton County but is not part of the lower Mill Creek or any of its headwaters.

2.2.2 PHASE II STORM WATER COMMUNITIES

In September 1992, USEPA designated 850 Phase I communities across the U.S. with populations of 100,000 or more. Cincinnati and Hamilton County were exempted because of combined sewers. In 1999, NPDES Phase II rules were published which included Cincinnati and all of Hamilton County except Crosby Township.

On February 12, 2003, the Hamilton County Storm Water District was established to meet Phase II requirements on a countywide basis and on March 5, 2003, the membership to the district was determined. The majority of the LMC watershed is covered by the Hamilton County Storm Water District's (HCSWD) Phase II storm water permit, including the areas Springfield Township, Green Township, and Delhi Township. Several municipalities within the LMC boundary have also joined the HCSWD including Amberley Village, Norwood, St. Bernard, Elmwood Place and Golf Manor.

Other municipalities within the LMC boundary have are utilizing their own Storm water Management Utility

(SMU) to comply with Phase II including the City of Cincinnati and the City of Wyoming. Copies of the Phase II permits are available from the jurisdictions and storm water district.

2.3 DEMOGRAPHICS

2.3.1 SOCIOLOGIC STATISTICS

Methodology

Data for following demographic indicators was gathered from the U.S. Census Bureau and ESRI Business Analyst Online. The data was gathered by the lowest available measurement (e.g. block, block groups, tracts) and then filtered by the Lower Mill Creek boundary using a geographic computer program called ArcView GIS. This allowed us to find demographics that most closely align to the watershed boundaries that can cross many jurisdictional boundaries. When 2010 Census data was not available down to the Census Tract or lower, ESRI Business Analyst Online was able to provide 2010 estimates.

Population

Based on Census 2010 data, the total population of the LMC watershed is 208,150 people. ESRI Business Analyst Online estimates for the total population of each sub-sewershed are listed in Table 6.

Table 6 - Population by Sub-sewershed

Sub-sewershed	Population
Amberley	3,942
Bloody Run	18,778
Clifton	16,432
Dunham	9,873
Gest	190
Hartwell-Carthage	14,021
Kings Run	20,211
Lick Run	23,095
Mitchell	16,257
Ross Run	35,264
Upper Mill	11,134
West Fork	23,254

Source: (ESRI, 2010)

D. Census Data by HUC-12 Boundaries

Using the ODNR ERIN watershed planning reports…

Table 7 - Population by HUC-12 Boundaries

	Population		
HUC-12	**1980**	**1990**	**2000**
Congress Run (04)	145,863	129,158	119,567
West Fork (05)	124,945	119,506	109,115

Source: (ODNR, 2011)

Table 8 - Education by HUC-12 Boundaries

Education (reported by tract)	Congress Run (04)	West Fork (05)
Enrolled K-12	23,309	20,367
Enrolled College	7,835	14,692
Completed <9	47,654	36,114
Completed HS diploma or GED	21,497	16,430
Some College	14,472	11,219
Associates Degree	4,210	3,498
Bachelors Degree	10,013	7,859
Graduate Degree	7,029	5,179

Source: (ODNR, 2011)

Table 9 - Households by HUC-12 Boundaries

Households	Congress Run (04)	West Fork (05)
Average Size	2.3	2.3
Average Income	$52,989	$36,310

Source: (ODNR, 2011)

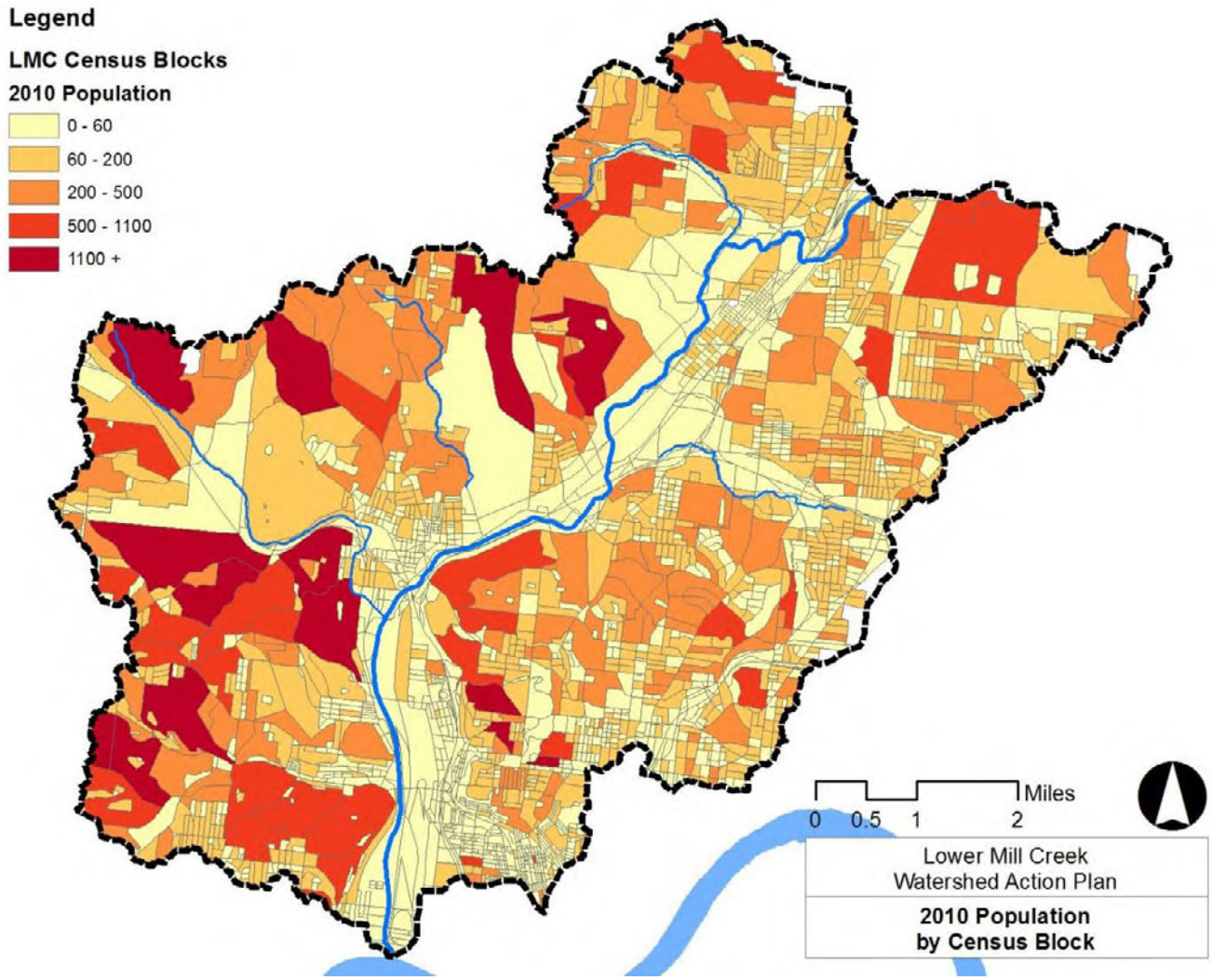


Figure 7 - 2010 LMC Watershed Population by Census Block

Source: (U.S. Census, 2010)

Population

Based on the 2010 Census data, the LMC watershed contains approximately 208,150 people.

Median Age

- 33.6 years old

Sex

- Total Male Population: 100,016
- Total Female Population: 108,134

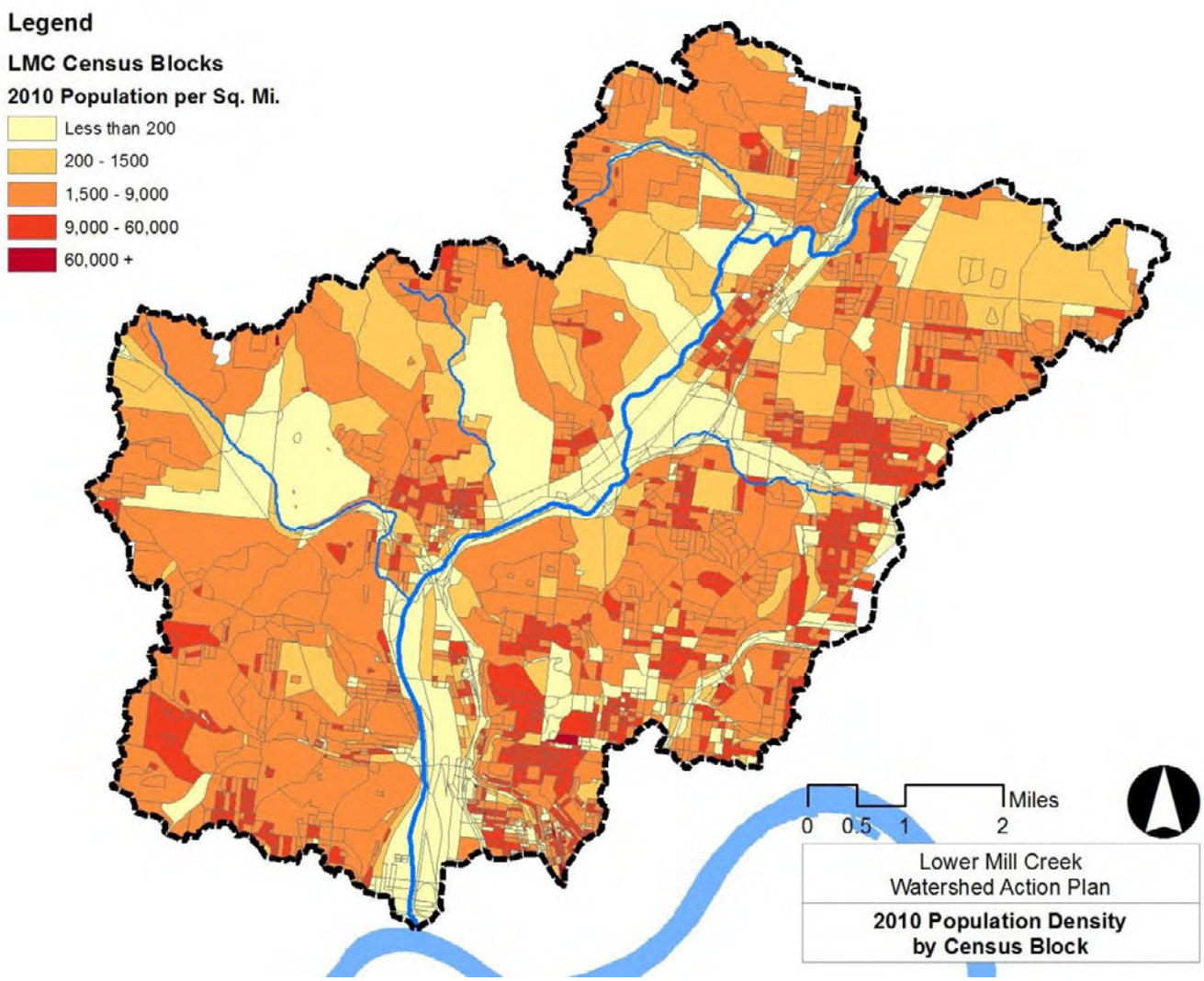


Figure 8 - 2010 LMC Watershed Population Density

Source: (U.S. Census, 2010)

Population Density

The Lower Mill Creek Watershed Population Density map (see Figure 8) shows population densities based on the persons per square mile within Census blocks. Some of the areas with the highest population densities include neighborhoods in the Clifton, Mitchell and Ross Run sub-sewersheds.

The density map also shows that the Census blocks located adjacent to the Mill Creek have some of the lowest population densities, most likely due to flooding and property protection issues, as well as, the predominate land uses that have historically been more industrial.

Population Growth/Decline

Based on 2010 Census Data, the City of Cincinnati saw a population loss of 10.37% from 2000 to 2010. Hamilton County saw a similar loss in population during this time of 5.10%. Compare this to the State of Ohio, which has had a growth in population of 1.60%. The Lower Mill Creek watershed, which is primarily composed of land within the City of Cincinnati and enclosed within Hamilton County, could be expected to have seen a population decline in the 5 to 10% range. Looking at the region, the population seems to be shifting northeast towards Butler County, which experienced a population growth of 10.6%, for a total of 368,130.

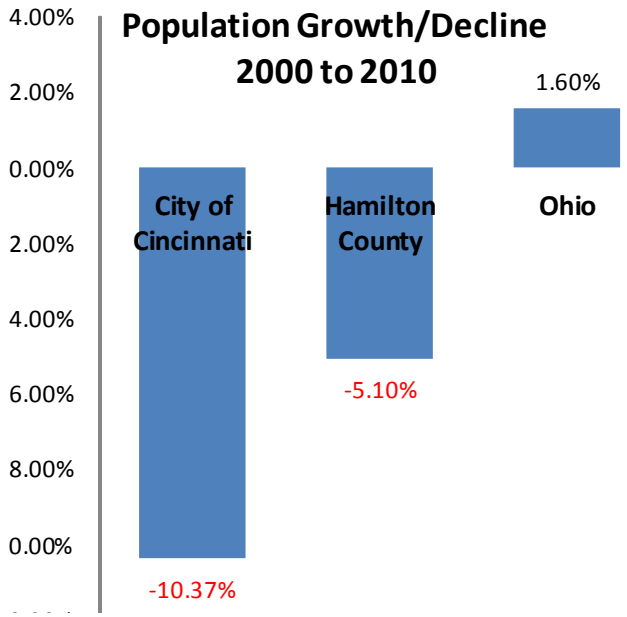


Figure 9 - Population Growth/Decline

Source: (U.S. Census, 2010)

Education Levels

In 2010, the educational attainment of the population aged 25 years or older in the Lower Mill Creek was distributed as follows:

- 20.5 percent had not earned a high school diploma (compared to 14.8 percent in the U.S.)
- 29.8 percent were high school graduates only (compared to 29.6 percent in the U.S.)
- 6.7 percent had completed an Associate degree (compared to 7.7 percent in the U.S.)
- 14.4 percent had a Bachelor's degree (compared to 17.7 percent in the U.S.)
- 10.6 percent had earned a Master's/Professional/Doctorate Degree (compared to 10.4 percent in the U.S.)

Source: ESRI Business Analyst, U.S. Census

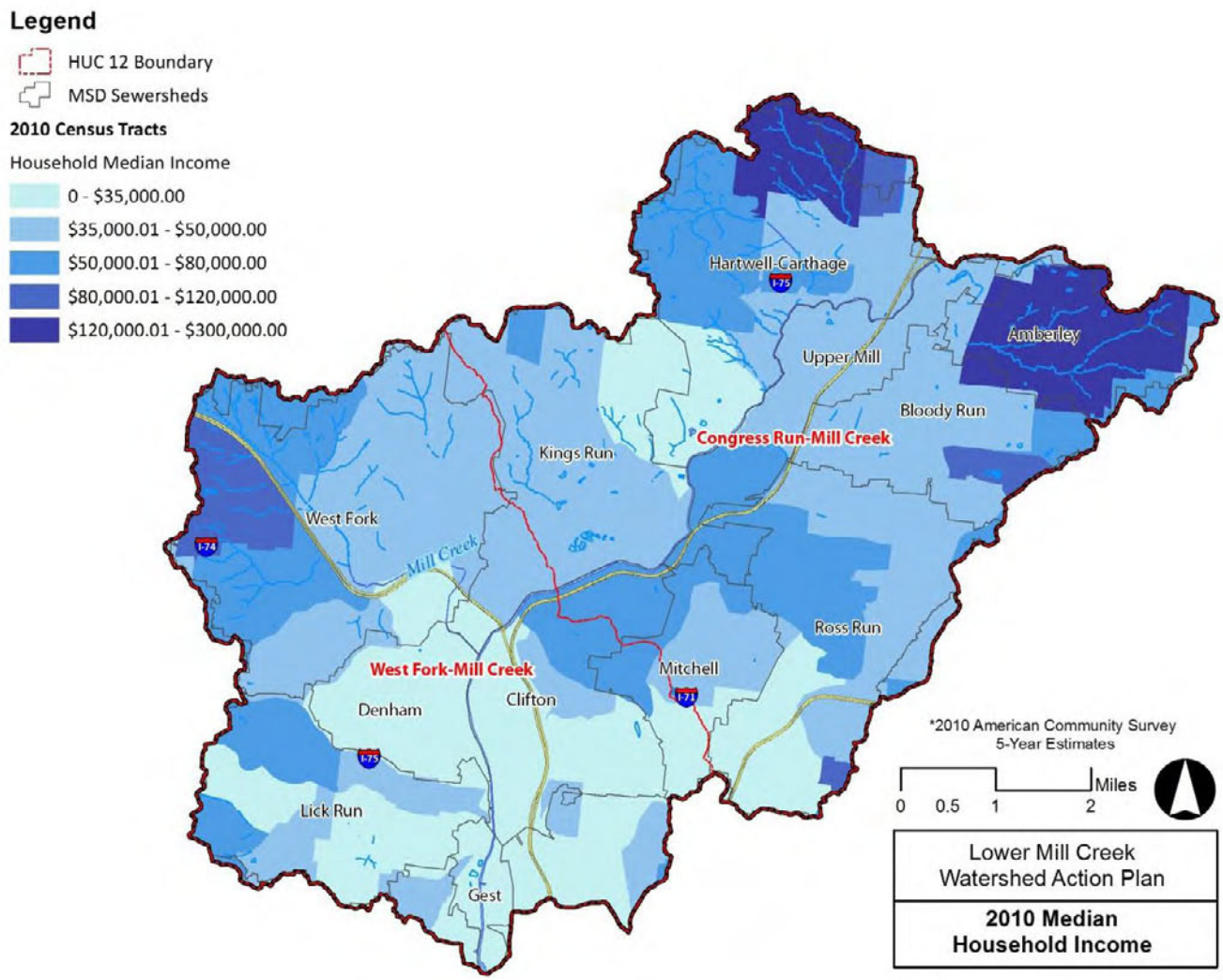


Figure 10 - LMC Watershed Median Household Income

Source: (U.S. Census, 2010)

Median Household Income

The median household income for the LMC watershed is $43,643. The median household income for Hamilton County is $50,046. The median household income for the State of Ohio is $45,050.

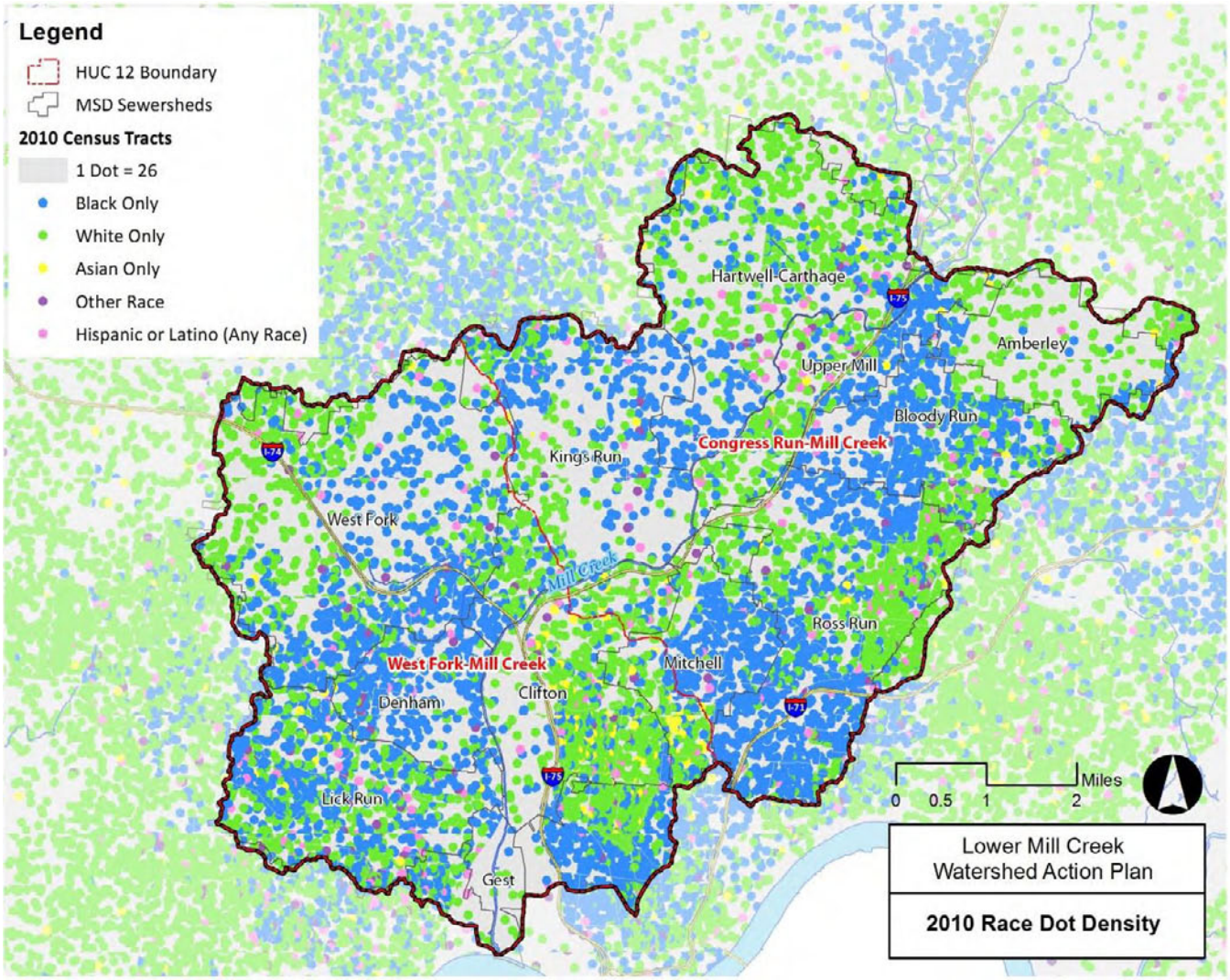


Figure 11 - LMC Watershed Race Dot Density

Source: (U.S. Census, 2010)

Race

The LMC watershed represents a very diverse population as shown by the 2010 Race Dot Density Map in Figure 11. Each randomly placed dot within a given Census tract represents 26 people, so this map spatially shows race integration/separation and population densities.

Based on the 2010 Census data, the LMC watershed contains a Total White Population of 96,315; Total Black Population of 99,499; Total Asian Population of 4,048; and All Other Races including Two or More Races of 8,288. The LMC watershed also includes Total Hispanic and Latino Population (Any Race) of 5,762.

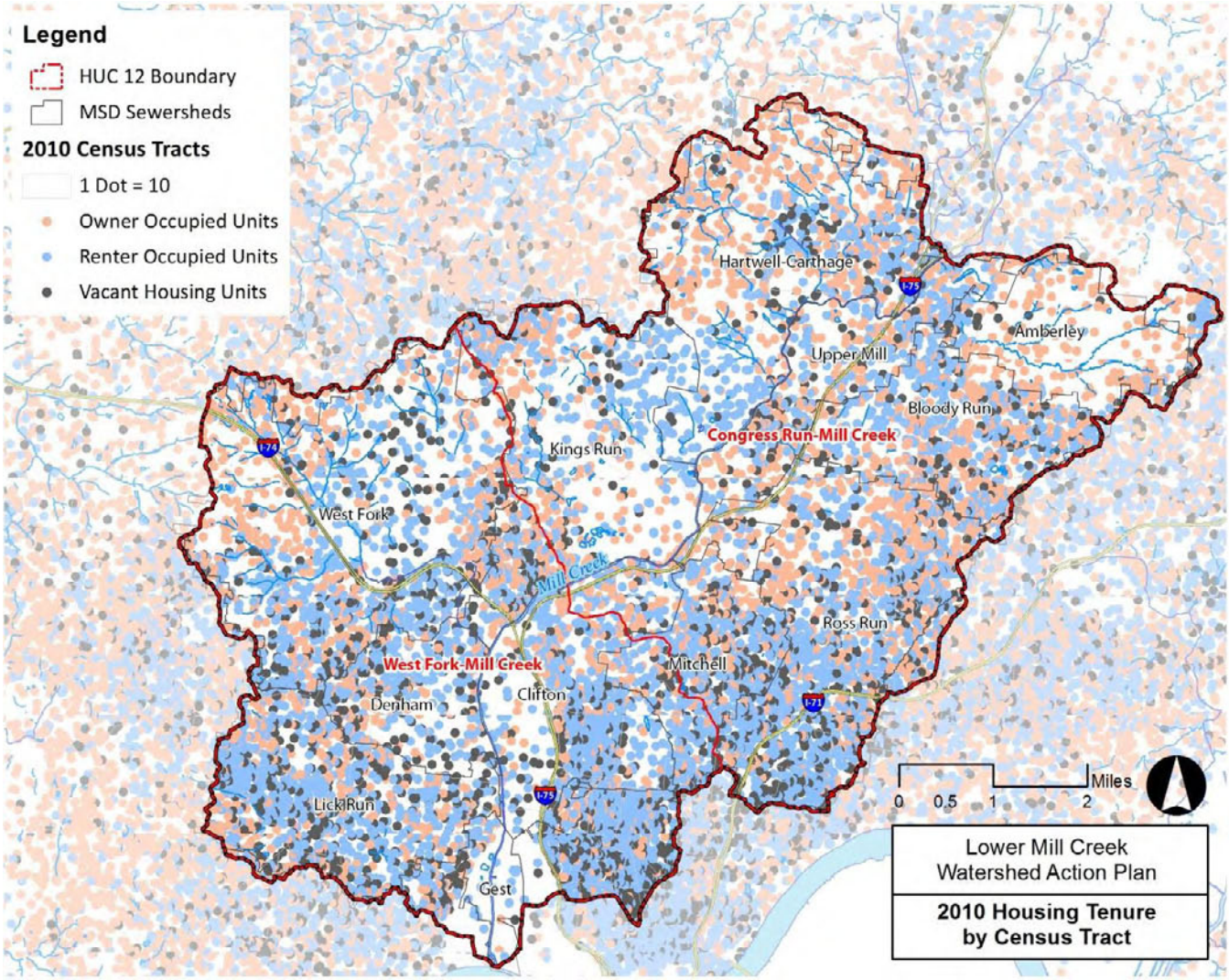


Figure 12 - LMC Watershed Housing Tenure

Source: (U.S. Census, 2010)

Housing Tenure

There are 107,119 Total Housing Units in the LMC watershed. Of that total, 34,784 are Owner Occupied, 53,172 are Renter Occupied, and 19,163 are vacant units.

A large of amount of renter occupied housing units is located near downtown Cincinnati and the Clifton/Uptown areas. These two areas are also the two largest employment centers in the region, so rental housing units have clustered near to them. Recent strategies by local government and the private sector have been trying to attract more owner occupied housing to these urban areas.

Vacant housing units seem to be relatively scattered across the LMC watershed. These vacant housing units could indicate a decline in housing stock quality and/or decline in market demand in these areas.

2.3.2 ECONOMIC STATISTICS

Employment

Based on the Ohio Department of Jobs and Family Services Data (see Table 10), the City of Cincinnati and Hamilton County have nearly the same unemployment rate as the rest of the Ohio. However, with an approximately 10% unemployment rate, Hamilton County and the City of Cincinnati are more likely to see a near-term loss in population until the unemployment rate declines.

Table 10 - Civilian Labor Force Estimates (Avg. 2010)

	Civilian Labor Force	Employment	Unemployment	Unemployment Rate (%)
Cincinnati City	160,300	144,300	16,000	10.0
Hamilton County	431,400	390,900	40,500	9.4
OHIO (Seasonally Adjusted)	5,898,000	5,303,000	595,000	10.1

Source: (ESRI, 2010)

Population by Employment

Currently, 82.9 percent of the civilian labor force in the LMC watershed is employed and 17.1 percent are unemployed. In comparison, 89.2 percent of the U.S. civilian labor force is employed, and 10.8 percent are unemployed. In five years the rate of employment in the market area will be 85.9 percent of the civilian labor force, and unemployment will be 14.1 percent. The percentage of the U.S. civilian labor force that will be employed in five years is 91.2 percent and 8.8 percent will be unemployed. In 2000, 61.5 percent of the population aged 16 years or older in the market area participated in the labor force, and 0.0 percent were in the Armed Forces (ESRI, 2010).

In the current year, the occupational distribution of the employed population is:

- 58.9 percent in white collar jobs (compared to 61.6 percent of U.S. employment)
- 22.9 percent in service jobs (compared to 17.3 percent of U.S. employment)
- 18.2 percent in blue collar jobs (compared to 21.1 percent of U.S. employment)

Commuting Patterns

In 2000, 66.6 percent of the LMC watershed population drove alone to work, and 2.5 percent worked at home. The average travel time to work in 2000 was 22.9 minutes in the market area, compared to the U.S. average of 25.5 minutes (ESRI, 2010).

2.3.3 ECONOMIC PATTERNS

GO Cincinnati

The GO Cincinnati: Growth and Opportunities for Greater Cincinnati (2008) report focused on the goal of increasing the City of Cincinnati's tax revenue and bringing jobs back to the city core. The report identified the current trend in Cincinnati's office space market is demand for drivable, sub-urban office space. The supply of this type of office space is mostly located north of the I-275 loop between I-75 and I-71, which is driving demand further away from Cincinnati. The LMC watershed, which is located within the I-275 loop, does not currently have the supply of this type of office space to meet demand growth.

The GO Cincinnati report recommendations included looking for areas to focus economic development initiatives and investments. The existing economic opportunity areas identified were Downtown, Uptown, and Over-the-Rhine and they added three new areas of Seymour/Reading Road Corridor, Queensgate/South Mill Creek Corridor and Madison Road Corridor.

Here are the recommendations for each of these three new areas directly from the GO Cincinnati report:

> ***Madison Road Corridor*** – This area could be a complex employment/retail/high density housing concentration that will allow the City to offer products not currently available; specifically, it will provide "drivable sub-urban" office product, generally not available in the City, mixed with walkable urban places.
>
> ***Seymour/Reading Roads Corridor*** – This area should be redeveloped to combine low-density drivable sub-urban business sites near the Seymour/I-75 Interchange with redevelopment of select obsolete commercial space on Reading Road into a high-density retail/attached housing walkable urban place.
>
> ***Queensgate/South Mill Creek*** – This corridor should be redeveloped as a "green industrial" park in drivable sub-urban configuration and should encourage the redevelopment of Lower Price Hill. Cincinnati is home to a number of the nation's leading companies on the forefront of the coming green economy (GE, Duke Energy, among others)

In summary, the *GO Cincinnati* report creates a strategy primarily focused on the redevelopment of the large supply of vacant brownfields to increase the office and industrial space supply within the City. The targeted economic growth areas are all located along the I-75 corridor within the LMC watershed. Redevelopment of these past industrial areas could bring prosperity and growth back to some of these increasingly disinvested areas.

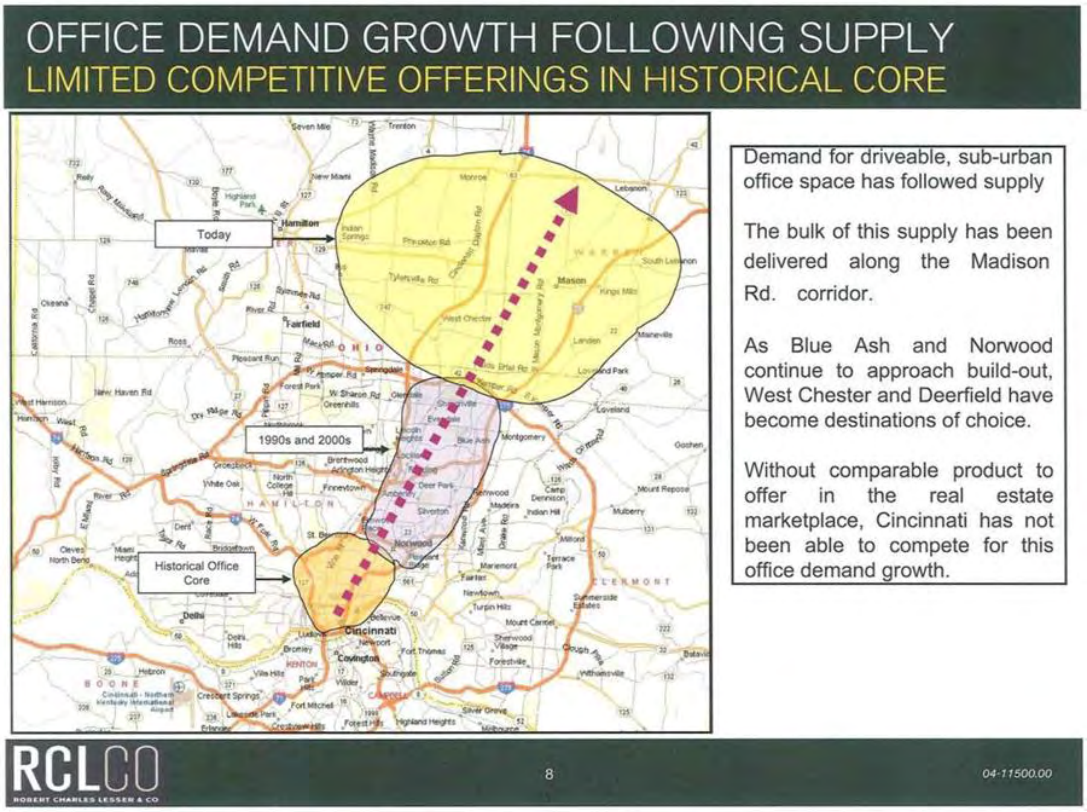


Figure 13 - GO Cincinnati excerpt

Source: GO Cincinnati: Growth and Opportunities for the City of Cincinnati (2008), City of Cincinnati

Figure 14 - Revive I-75: Overview of Four Study Areas

Source: Revive Cincinnati: Neighborhoods of the Lower Mill Creek Valley (2011), City of Cincinnati and Urban Design Associates

REVIVE I-75

The City of Cincinnati hired Urban Design Associates (UDA) to study the I-75 Focus Area and create a plan that will energize and improve the quality of life for its neighborhoods. The outcome was a report called Revive Cincinnati: Neighborhoods of the Lower Mill Creek Valley, completed in 2011. Four study areas were identified by the City based on the location of highway interchanges: Mitchell; Northside/South Cumminsville; Camp Washington; and Queensgate. The strategies presented in the Revive I-75 Plan could radically transform the shape of these communities, elevating the Mill Creek to the status of "major regional asset".

Figure 15: Revive I75 - Northside and South Cumminsville "Illustrative Plan"

Source: (Revive I-75, 2011)

Revive I75 report recommendations:

- (1) Make Elmore Street a tree-lined boulevard from Beekman to the Dooley Bypass, linking the ball fields at the West Fork to the Mill Creek Greenway.
- (7) Create a linear park as part of the Mill Creek Greenway Project, extending from the Mill Creek Road bridge south to the Hopple Street viaduct.
- (10) Restore the West Fork stream network, incorporating natural stormwater detention and infiltration strategies.

EXISTING CONDITIONS BIRD'S-EYE VIEW

ALTERNATE REDEVELOPMENT BIRD'S-EYE VIEW

PROPOSED REDEVELOPMENT BIRD'S-EYE VIEW

Revive I75 report recommendations:

•(1) Naturalize the Mill Creek where possible to naturally treat water runoff and enrich the greenway

•Make trail connections between Mill Creek, parks, recreation facilities, cemeteries, and downtown St. Bernard (via Miami/Erie Canal ROW).

•Remove 50% of Mill Creek's concrete channel after the Mitchell Avenue Bridge to provide a soft transition to Salway Park and to create a more desirable environment for future development to physically embrace.

•Work with ODOT to implement sustainable landscape strategies, including porous paving, swales, rain gardens, enhanced tree canopy, etc. at the Mitchell Avenue interchange. Where possible, treat stormwater adjacent to the Mill Creek by creating wetlands and water quality improvements.

Figure 16: Revive I75 -Mitchell Avenue

Source: (Revive I-75, 2011)

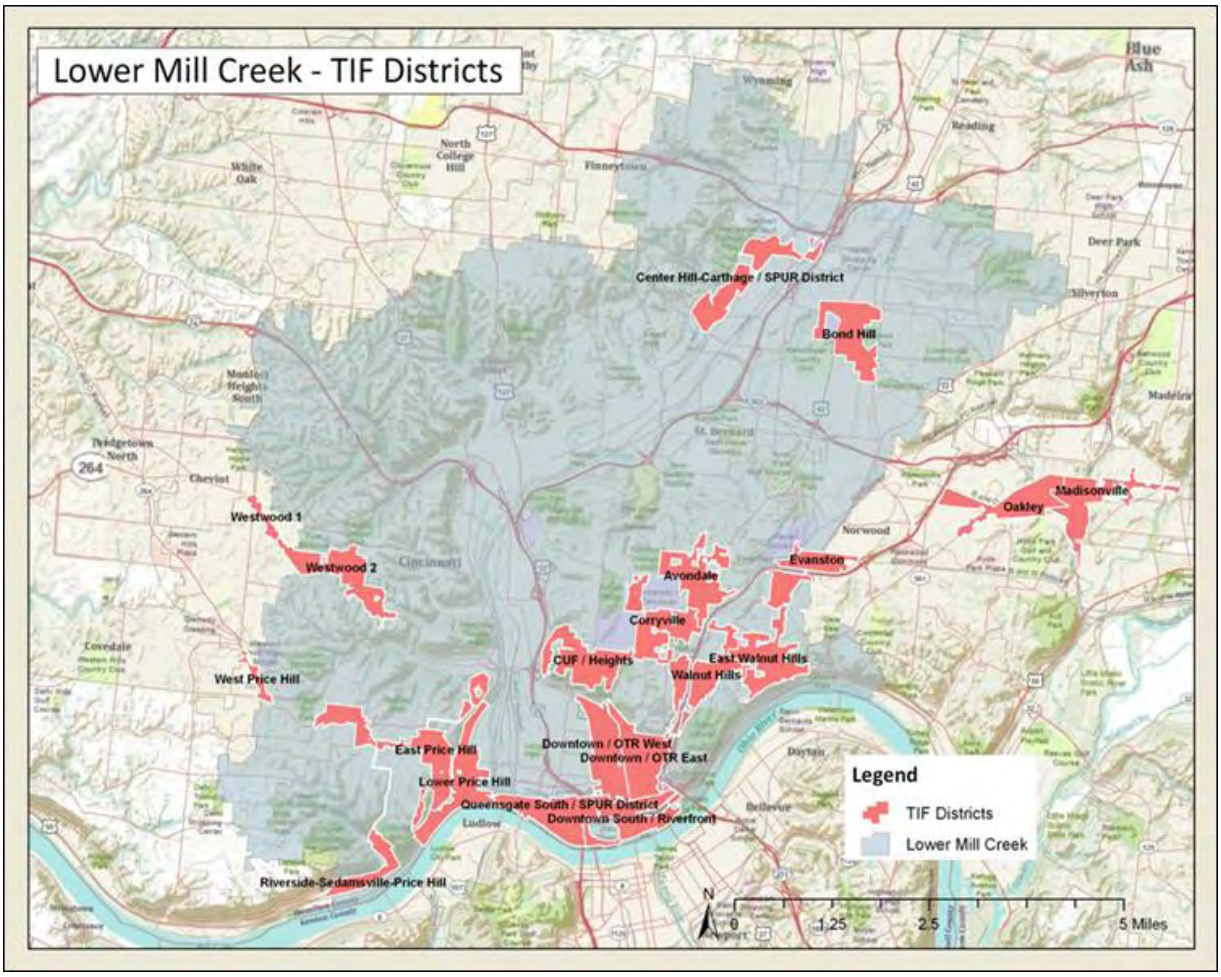


Figure 17 - City of Cincinnati TIF Districts (2010)

Source: CAGIS data, Prepared by Hamilton County Planning & Development

Tax Increment Financing Districts

A Tax Increment Financing (TIF) District is an economic development tool used by municipalities for building infrastructure and other municipal assets. These areas represent places that the City has strategically targeted for reinvestment and growth. The map below shows the currently established TIF districts in the City of Cincinnati located near the LMC watershed.

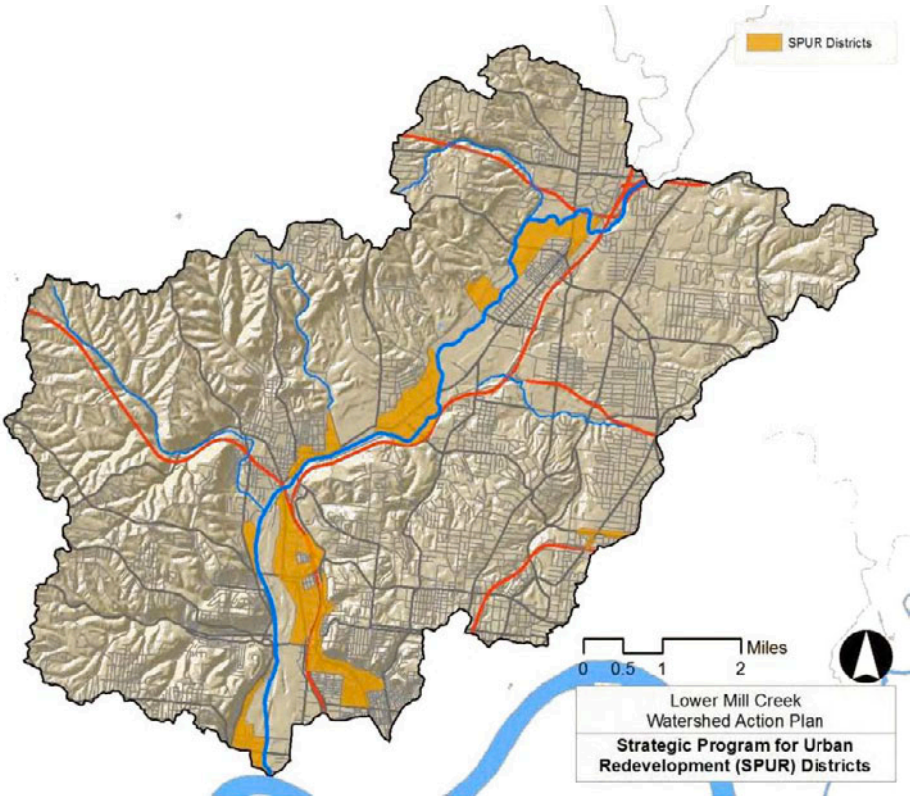


Figure 18 -SPUR Districts

Strategic Program for Urban Redevelopment

The City of Cincinnati's Strategic Program for Urban Redevelopment (SPUR) is an initiative to return vacant, contaminated, or underutilized land to productive uses. The SPUR team is designed to overcome the complex issues posed by brownfield properties and other urban redevelopment projects. Currently the SPUR team is focused on 16 target areas within City limits.

2.4 GEOGRAPHIC LOCATORS

2.4.1 USGS HUC-12 DELINEATIONS

The United States Geological Survey (USGS) maintains a watershed-based hierarchical code system, called *Hydrological Unit Code* (HUC). As land areas delineated in this system go from the large to small, they are denoted with additional digits. A 12-digit code is applied to the smallest area in the hierarchy, also known as a "HUC-12". This HUC-12 hierarchical boundary is the framework of modern WAPs.

The Mill Creek watershed is composed of five HUC-12 boundaries. The LMC-WAP addresses the lower two HUC-12 boundaries known as Congress Run (0509020301-04) and West Fork (0509020301-05) (highlighted in orange on Figure 1 and Table 1).

Table 11 - Stream Segment Name, State ID# and River Mile

	Stream Segment Names						
	East Fork Mill Creek	West Fork Mill Creek (headwaters to mouth)	Mill Creek (Sharon Creek to West Fork Mill Creek)	Mill Creek (West Fork Mill Creek to Ohio River)	Sharon Creek	Bloody Run	Mill Creek (Headwaters to Sharon Creek)
Stream Segment - ID#	OH62-31	OH62-26	OH62-27	OH62-23	OH62- 28	OH62- 23.2	OH62-30
Upper River Mile to Lower River Mile	RM 7.10 to mouth		RM 15.63 to 11.57	RM 11.57 to 0.00	RM 5.50 to mouth	RM 3.90 to mouth	RM 28.35 to 15.64

2.4.2 STATE 305(B) IDENTIFICATION NUMBERS

The LMC-WAP focuses on the West Fork-Mill Creek unit (HUC 0509020301-05) and the Congress Run-Mill Creek (HUC 0509020301-04). Additionally, stream segment designations within the Mill Creek watershed, with their corresponding river miles, are shown in Table 11.

2.4.3 GEOGRAPHIC INFORMATION SYSTEMS RESOURCES

ODNR and the Earth Resources Information Network

The boundaries of the LMC watershed can be seen online at the Ohio Department of Natural Resources (ODNR) webpage called Earth Resources Information Network (ERIN). On this page is there is an online Watershed mapping viewer where you can find many useful types of resources for watershed planning including: HUC-12 boundaries, past TMDL report information, demographic estimates, and more.

Cincinnati Area Geographical Information System (CAGIS)

Several layers of information such as land use, parcel lines, zoning and more are available at the CAGIS website.

CAGIS also maintains a more detailed database for subscribers that include many important shapefiles for GIS users.

2.5 LMC WATERSHED BACKGROUND AND HISTORIC INFORMATION

2.5.1 WATERSHED PROTECTION AND MANAGEMENT

There are two primary watershed protection and management agencies in the LMC watershed; the *Mill Creek Watershed Council of Communities* (MCWCC) and *Groundwork: Cincinnati-Mill Creek*, formerly known as the Mill Creek Restoration Project (MCRP). Generally, the MCWCC focuses on the northern half of the Watershed and Groundwork: Cincinnati-Mill Creek on the southern half, although both provide services and activities that cover the entire Mill Creek watershed.

2.5.2 WATERSHED PLANNING

Watershed planning in the LMC watershed is very active due to the many jurisdictions, projects and watershed advocacy groups found in the watershed. Appendix A shows many of the past, current and future planning activities and documents that have shaped the Lower Mill Creek's past and will guide its future. The matrix identifies each planning activity's significance to the LMC-WAP, main purposes, geographically area addressed, who developed the document, who is working to implement the plan, and if the plan is active or inactive. This matrix includes watershed specific plans for improving water quality and recreational use, as well as, major planning activities such as the ongoing *Plan Cincinnati* effort which will greatly determine future land use decisions in the LMC watershed.

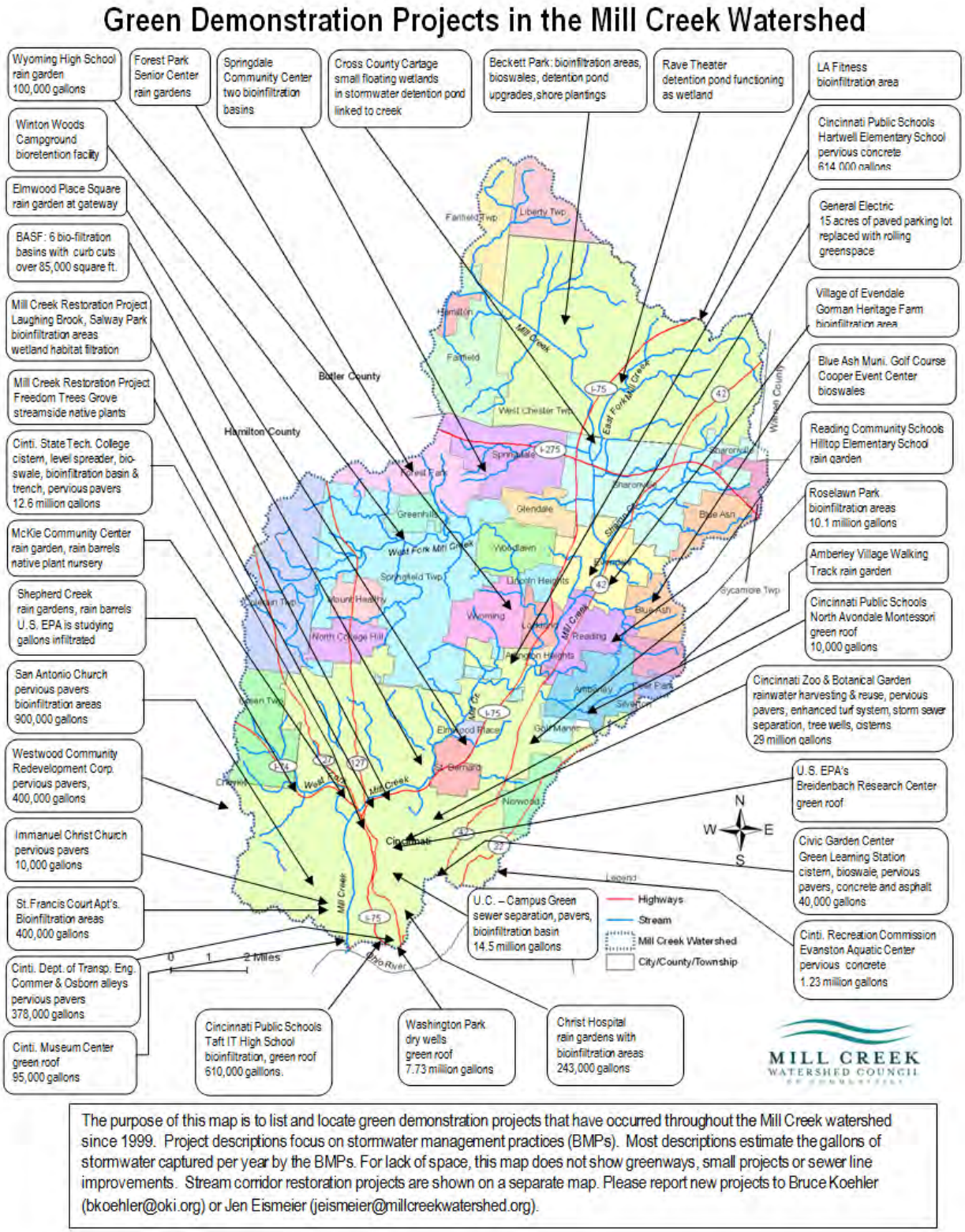


Figure 19 - Green Demonstration Projects in the Mill Creek Watershed

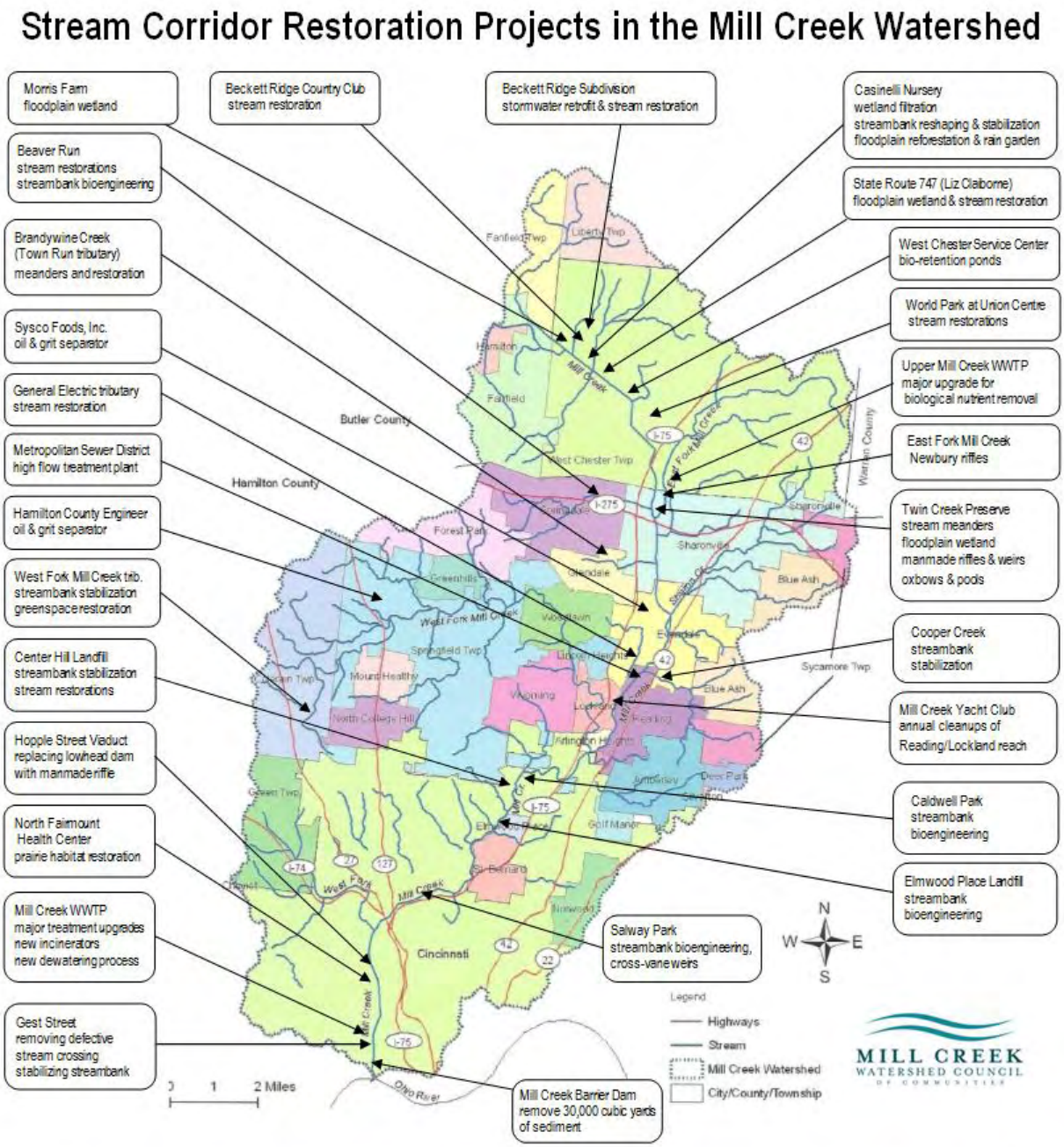


Figure 20 - Stream Corridor Restoration Projects in the Mill Creek Watershed

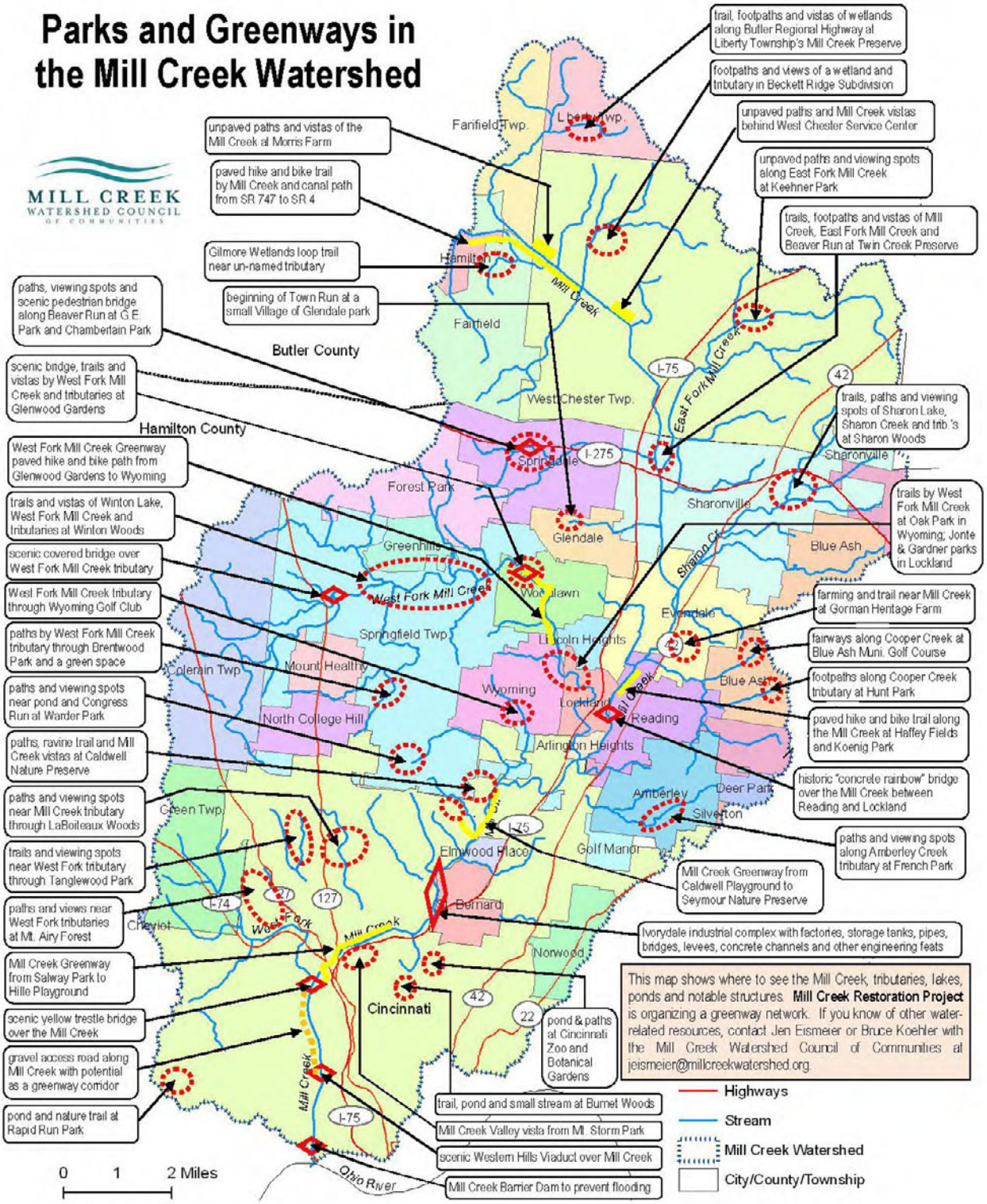


Figure 21 - Parks and Greenways in the Mill Creek Watershed

3 WATERSHED PLAN DEVELOPMENT

3.1 LOWER MILL CREEK WATERSHED PARTNERS

3.1.1 LOCAL AND STATE GOVERNMENT AGENCIES

Cincinnati Parks

The Cincinnati Park Board maintains and operates the City of Cincinnati's system of parklands. Their mission is "to conserve, manage, sustain, and enhance parks' natural and cultural resources and public greenspace for the enjoyment, enlightenment and enrichment of the Cincinnati community."

Park holdings constitute more than 5,000 acres, which amounts to approximately 10 percent of Cincinnati's total land area. These holdings consist of five regional parks, 70 neighborhood parks, 34 natural areas, 30 sites managed by the Cincinnati Recreation Commission, five parkways, nine scenic overlooks, 50 miles of hiking and bridle trails and such specialized sites as the Cincinnati Zoo and Pioneer Cemetery. Park Board responsibilities also extend to the management of the City's natural resources, urban forestry and highway greenspaces and gateways. In 2010 the Park Board entered into an official partnership with MSDGC to install and maintain green infrastructure projects for storm water control.

Cincinnati Parks are rated a Top Urban Park System in the Excellent Parks study by the Trust for Public Land. Cincinnati Parks have over 6 million visits per year - an economic impact of over $25 million to the Greater Cincinnati Region.

75 City Parks are open to the public daily 6 a.m. to 10 p.m. year-around. These include:
5 regional parks, 7 river parks, 68 neighborhood parks, 33 natural areas, 5 neighborhood nature centers, 52 playgrounds, 5 parkways, 18 scenic overlooks, 65 miles of hiking trails and over 80,000 street trees.
Two Disc Golf Courses at Burnet Woods (Clifton) and Mt. Airy Forest
Two off-leash Dog Parks: Doris Day Dog Park (Mt. Airy) and Armleder Dog Park (Linwood)
A nationally recognized conservatory with more than 3,500 plant species from around the world

The Ohio Kentucky Indiana Regional Council of Communities

The Ohio-Kentucky-Indiana Regional Council of Governments (OKI) is a council of local governments, business organizations and community groups committed to developing collaborative strategies to improve the quality of life and the economic vitality of the region.

Formed in 1964, OKI has spent 46 years cultivating partnerships and alliances that range from the federal

government to local councils. Its 117 members represent governmental, social and civic groups from nearly 200 communities in the eight-county, three-state region.

Together, OKI works to solve interstate dilemmas, create far-reaching development plans, break through political bureaucracy, provide services to the public and advocate for federal funding.

OKI has final authority over all federal dollars spent on transportation in the region. Each year, OKI approves roughly $40 million in funding for projects in the region.

While OKI's primary mission has been transportation, OKI is not confined to just highways and pavement.

Since federal transportation investments stimulate land use change, OKI developed a Fiscal Impact Analysis Model to give local governments a way to determine costs and benefits by analyzing the budgetary impacts of alternative land use scenarios.

OKI's Water Quality planning program involves work that enables wastewater treatment projects to obtain permits and promotes practices to reduce storm water runoff and restore streams.

OKI's Clean Air Program is leading the fight for cleaner air in the region by bringing ozone and particulate matter pollution issues to the forefront of people's minds.

3.1.2 WATERSHED ORGANIZATIONS

Groundwork Cincinnati—Mill Creek

Groundwork Cincinnati—Mill Creek (formerly the Mill Creek Restoration Project) is a private nonprofit organization created in 1994.

Its mission is to serve as catalyst for developing sustainability in the Mill Creek Watershed through community-based planning and empowerment, environmental education, and economically sound ecological restoration.

Groundwork Cincinnati accomplishes its mission by:

Creating Greenways along Mill Creek and its Tributaries
Greenways are linear corridors of open space with trees and other vegetation that connect people and places together and wildlife with their habitat. When greenways are created along rivers, they provide many benefits for people and places. For example, greenways can include hike and bike trails that provide recreation, improve the environmental condition, as well as create alternative transportation opportunities.

From 1997 to 1999, MCRP led the creation of the landmark Mill Creek Watershed Greenway Master Plan, working in partnership with more than 150 community groups and organizations to complete it. Now MCRP is working with local governments, businesses and citizens to implement pilot greenway projects that will help to improve water quality and ecosystem health, stimulate economic revitalization, and contribute to the quality of life for Mill Creek Watershed neighborhoods and suburban communities. All of the pilot greenway projects will become part of future vital, living corridors within the Mill Creek Watershed. Each greenway site will connect to other greenspace and trails in southwest Ohio and support development of an envisioned 28-mile greenway trail beginning in Butler County and ending at the confluence of Mill Creek and the Ohio River.

In 2004 MCRP planted the first Mill Creek Freedom Trees Grove in partnership with the National Underground Railroad Freedom Center and Paul Hemmer Companies. MCRP has made the commitment to plant ten thousand native hardwood trees along Mill Creek and its major tributary streams over the next ten years.

Providing Environmental Education and Training

MCRP sponsors ongoing opportunities for interdisciplinary environmental education and technical capacity building for people who live and work in the Watershed. Every year, MCRP works with more than 1,000 middle and high school students and their teachers, providing a variety of classroom and fieldwork experiences. Since 1994, MCRP has organized dozens of fieldwork events along the river that provide "hands on" training for students, civic volunteers, and nearby residents, property owners and businesses. In addition, MCRP provides paid on-the-job training for inner city residents and has provided pollution prevention technical assistance and funding for small businesses in the Mill Creek Valley. MCRP is also the publisher of a book on the environmental history of Mill Creek titled "The Mill Creek: An Unnatural History of an Urban Stream."

Restoring Water Quality and Other Natural Resources

Everyone deserves rivers and streams where there is safe fishing and swimming. MCRP serves as a steady advocate for environmentally sound and cost effective ways to achieve flood damage reduction, recommends state-of-the-art, environmentally-sustainable maintenance and management of the Mill Creek riverine system, and encourages the ongoing regeneration of these natural resources.

Mill Creek Watershed Council of Communities

The Mill Creek Watershed Council of Communities enables Mill Creek communities to protect and enhance the value of the Mill Creek, its tributaries, and Watershed. Through collaborative action, the Council strives to make the Mill Creek area a more desirable place to live, work and play.

The Council acts to achieve the vision of a restored Mill Creek that is an asset to the region. Incorporated as a non-profit organization in 1995, the Council provides a forum for making watershed-based decisions among the 37 political jurisdictions in the 166-square mile drainage by undertaking initiatives and projects that create direct environmental and economic improvement in the Mill Creek Watershed. Council efforts focus on watershed action planning, project implementation, creating opportunity to explore the watershed through

recreation and volunteer events, and watershed-scale research and monitoring.

The Council functions as a regional forum for consensus building and takes an integrated approach to watershed problem solving by balancing environmental and economic perspectives with the needs of its local constituents.

3.1.3 ADDITIONAL LOCAL AND REGIONAL WATERSHED GROUPS

Table 12 - Local and Regional Watershed Groups shows other watershed groups who care for the parallel streams of the Little Miami and the Great Miami and other local and regional waters.

Table 12 - Local and Regional Watershed Groups

Watershed Group	Watersheds of Focus
Friends of the Great Miami	Lower Mainstem Great Miami River
Greenacres Water Quality Project	Little Miami, Mill Creek, Great Miami, and Ohio
Little Miami Incorporated	Little Miami
Little Miami River Partnership	Little Miami River
Miami Conservancy District	Great Miami River
Mill Creek Restoration Project	Mill Creek
Mill Creek Watershed Council of Communities	Mill Creek
Save Local Waters (Regional Storm Water Collaborative)	OKI Tri-State Region

3.2 MISSION STATEMENT

"The purpose of the Lower Mill Creek Watershed Action Plan is to document current conditions; to identify effective strategies, programs and projects that are needed and can be employed; and to craft a roadmap for improving water quality and ecological health in the Lower Mill Creek Watershed that will, in turn, create more livable neighborhoods and provide public health, environmental, social, and economic benefits for many years to come."

The goal for the Lower Mill Creek Watershed is to reach and maintain full attainment for water quality standards of Warm water Habitat and Primary Contact recreation use designation, and also to restore Lower Mill Creek and its tributaries as dynamic waterways within an urban environment setting that will be protective of human health, preserve and restore part of our natural heritage, offer outdoor educational opportunities in an urban environment, and build economically stronger communities for the future. In order to have a long lasting beneficial impact upon the waterway, it will be necessary to impact the way members of the community think about the waterway; how Lower Mill Creek affects them, and how their actions affect Lower Mill Creek. The future management of the LMC watershed can greatly influence the quality of the waterway and its Watershed as well as its impact on the Ohio River.

The Lower Mill Creek Watershed Action Plan will serve as a map for protecting and improving local water resources in the Lower Mill Creek watershed. The plan will ultimately identify the actions we take for watershed restoration. Such actions will aim to restore the hydrologic network to levels that will:

- Restore natural stream functions
- Improve native habitat
- Reduce storm water runoff
- Provide water quality benefits
- Improve local stewardship of streams and Watersheds

3.3 LMC-WAP STRUCTURE, ORGANIZATION, ADMINISTRATION

The development of the LMC-WAP has been a collaborative effort between the Mill Creek Watershed Council of Communities, Groundwork Cincinnati—Mill Creek, the Metropolitan Sewer District of Greater Cincinnati, the City of Cincinnati (Parks, Office of Environmental Quality, Department of Planning and Buildings), Hamilton County (Planning and Development, Soil and Water Conservation District), the Ohio*Kentucky*Indiana Regional Council of Governments, Watershed Residents, Landowners, and local communities.

3.3.1 LEGAL STATUS

The Mill Creek Watershed Council of Communities is a 501(c)(3) nonprofit organization.

3.3.2 PARTNER ROLES & RESPONSIBILITIES DEFINED

The LMC-WAP workgroup was initiated in January 2012 by MSDGC as an ad hoc committee, and future meetings were coordinated by the Mill Creek Watershed Council of Communities.

One or more members of MSDGC were present at all workgroup meetings and assisted with plan development. MSDGC provided an FTP site for storing electronic resources including the draft document, maps, pictures, and other various items. MSDGC also provided meeting space for the LMC-WAP workgroup.

Hamilton County Planning and Development was responsible for holding the latest version of the LMC-WAP and checking it out to those who wished to make edits. This ensured that there were no duplicate efforts. Hamilton County Planning and Development also assisted with workgroup meeting facilitation.

3.3.3 GROUP DECISION MAKING PROCESS

Decision making was reached by consensus of the workgroup members thru meetings and group email communications as well as by larger public meetings, such as the *Lower Mill Creek Technical Charrette*. Workgroup members were also responsible for reviewing, commenting and editing various editions of the LMC-WAP.

3.3.4 WAP ENDORSEMENT BY KEY WATERSHED PARTNERS

See **Endorsement of Plan** (page xv) at the beginning of this document.

3.3.5 WAP ADOPTION BY LOCAL UNITS OF GOVERNMENT

See **Endorsement of Plan** (page xv) at the beginning of this document.

3.3.6 INFORMATION & EDUCATION COMPONENT

The following Educational Outreach meetings:

- LMC-WAP Water Quality Technical Charrette (November 5, 2012)
- 2012 Neighborhood Summit

The following Educational Materials:

- 2012 Neighborhood Summit Handout – “Lower Mill Creek and Watershed Action Planning”

4 WATERSHED INVENTORY

4.1 DESCRIPTION OF WATERSHED

The following section includes an inventory of data used to characterize the natural systems present within the LMC watershed. These systems include the watershed's geology (topography, geology and soils), biological features (threatened, rare and endangered species; and invasive species), water resources (climate and precipitation, surface water and ground water), land use, cultural resources, previous and complimentary efforts, physical attributes of streams and floodplains and water resource quality.

4.1.1 GEOLOGY

In Ohio, ecoregions play a part in both water resource assessments and regulations. The Ohio EPA partly bases its water quality standards, especially biocriteria, on the five types of ecoregions that had been designated for the state when the standards were set. More specifically, ecoregions influence the criteria to be applied for warmwater habitat, which is the predominant aquatic life use designation for streams.

The Mill Creek lies within the Till Plains section of the Central Lowland physiographic province and the Interior Plateau ecoregion. The Interior Plateau is a diverse ecoregion both in geologic (e.g. elevation, soils, water bodies, etc.) and ecologic (e.g. biota, etc.) characteristics. Elevations within this area vary from about 500 feet near the Ohio River, to more than 1000 feet on some of the higher hills.

The majority of the streams in this ecoregion are perennial. Stream density over much of the region is approximately two miles per square mile, except in areas containing numerous limestone sinks, where surface streams are much less common. Large Watersheds cover 200 to 500 square miles. Natural lakes are few, and occur mainly in areas underlain by limestone, which may include many limestone sinks containing standing water (OKI, 2011).

In general the Mill Creek Valley consists of shale and limestone bedrock of Ordovician age overlain by unconsolidated glacial outwash in the lowlands and/or till in the uplands of variable composition and thickness. The St. Peter Sandstone occurs at a depth of approximately 900 feet below land surface and is about 400 feet thick. Beneath the St. Petersburg Sandstone are undifferentiated dolomites and marbles (USGS, 2002). New geotechnical studies to a depth of approximately 350 feet are currently being conducted, in conjunction with an ongoing Army Corps of Engineers flood damage reduction project, that are providing a more detailed picture of the structure and composition of unconsolidated materials and bedrock beneath the Mill Creek Valley. Descriptions of the topography, geology, soils and glacial history of the LMC watershed are provided below.

A. Topography

The Mill Creek flows about 28 miles through a 2-mile-wide valley from southern Butler County to its confluence with the Ohio River. The valley is generally broad and flat, bounded by glacial and alluvial terraces and

relatively steep bedrock walls. The creek and its tributaries flow from the upland areas along the valley walls at altitudes of about 780 feet to the confluence with the Ohio River, which is an altitude of 444 feet. The average gradient of the valley along the course of the Mill Creek is 12 feet per mile (USGS, 2002). Major tributaries include East Fork Mill Creek, Sharon Creek, Beaver Run, Town Run, West Fork Mill Creek, Cooper Creek, Congress Run and West Fork Creek.

The Upper Mill Creek watershed is characterized by moderate to steeply sloping terrain in the upper reaches that drains to a wide, flat valley. The flat valley of the Upper Mill Creek is a crucial feature of the overall Mill Creek watershed because it provides a large amount of flood storage for storm water runoff. However, it should be noted that access by floodwater to this floodplain is often restricted by farm levees or other embankments.

Elevations at the watershed rim are near 980 feet mean sea level (m.s.l.) while the lowest elevations are approximately 580 feet. Typical stream slopes are 1% in the upper reaches and 0.1% in the lower valley.

The topography of the landscape influences hydrologic patterns, vegetation and habitat, and can even constrain land uses. As shown in the figure below, the project area was characterized in regard to slopes, allowing for a quick assessment of areas where storm water can collect (i.e., flat areas), versus areas where storm water will rapidly runoff (i.e., steep areas). Slopes were classified into five ranges: 0-3%, 3-8%, 8-15%, 15-25%, and over 25%. Wet weather strategies will vary depending on the type and extent of slopes throughout the project area.

B. Slope

Steep hillsides, defined as areas with slopes of 15 percent or greater, can exacerbate the volume of storm water runoff entering sewer infrastructure.

C. Surficial Geology

The nature of sub-surface rock (i.e. geology) helps to determine not just the nature and chemistry of the soil above, but also the rate at which it forms. This in turn strongly affects the vegetation that will grow naturally and the type of agriculture or horticulture that can be sustained. Geologic formations of alluvium, sand, and gravel provide the greatest opportunities for natural infiltration, as they can allow for greatest sub-surface transmission and conveyance of water.

Along the Great Miami River to the west, sand and gravel deposits from past glaciers are harvested in great quantities. However, on the Mill Creek there are very few mining locations (Debrewer, et al., 2000).

Most of the surficial materials within the watershed have been disturbed by human activity over the last two hundred years.

D. Soils

Soils found within the LMC watershed are developed from four geologic soil materials: alluvium, residuum, glacial till and glacial outwash. The alluvial soils are those formed in materials transported and deposited by streams. Residual soils are common on hillsides and result from the weathering of limestone and shale bedrock. The predominant soils in upland areas formed in glacial till, which consist primarily of loam material deposited in the uplands by ice sheets. Loess, or silty material transported by wind, is common in the upper part of soils in areas of glacial till. Glacial outwash consists of gravel and sands deposited in valleys by retreating glaciers. Thick deposits of sands and gravels, with interbedded clayey till are found in Reading and Lockland. Some glacial terrace gravels are also found in the valley (USGS, 2002).

Soils are classified into one of four groups: group A, group B, group C, or group D. Group A soils consist of deep, well-drained sands or gravelly sands that have a high rate of infiltration and therefore low runoff potential when thoroughly wet. These soils typically have less than 10 percent clay and more than 90 percent sand or gravel (i.e., loam, sandy loam, silt loam). Soils in group B have moderately low runoff potential when thoroughly wet and consist of moderately-drained, coarse textured soils. They typically have between 10 and 20 percent clay and 50 to 90 percent sand (i.e., loam, silt loam, silt and sandy clay loam). Soils in group C have moderately high runoff potential when thoroughly wet. They typically have between 20 and 40 percent clay and less than 50 percent sand (i.e., loam, silt loam, sand clay loam, clay loam and silty clay loam). Group D soils consist of fine particles that have a slow rate of infiltration and high runoff potential when thoroughly wet. They typically have greater than 40 percent clay and less than 50 percent sand (i.e., Clay).

Of the soils present among the LMC watershed, the majority are hydrologic group C or D, having limited potential for infiltration. There are several pockets where shallow infiltration is possible due to the presence of soils in hydrologic soil group B. The pockets occur along the Ohio River, in the Amberley sub-sewershed (in a wide strip in the south end of Amberley Village), in the western portion of the Bloody Run sub-sewershed and eastern portion of the Upper Mill sub-sewershed (parts of Bond Hill and Roselawn), in the Denham sub-sewershed (in an area of North Fairmont), in the Mitchell sub-sewershed (within the I-75 corridor), and in the West Fork sub-sewershed (along the hilltops in Mt. Airy Forest). West Fork sub-sewershed also has soils of hydrologic soil group A along the West Fork Creek.

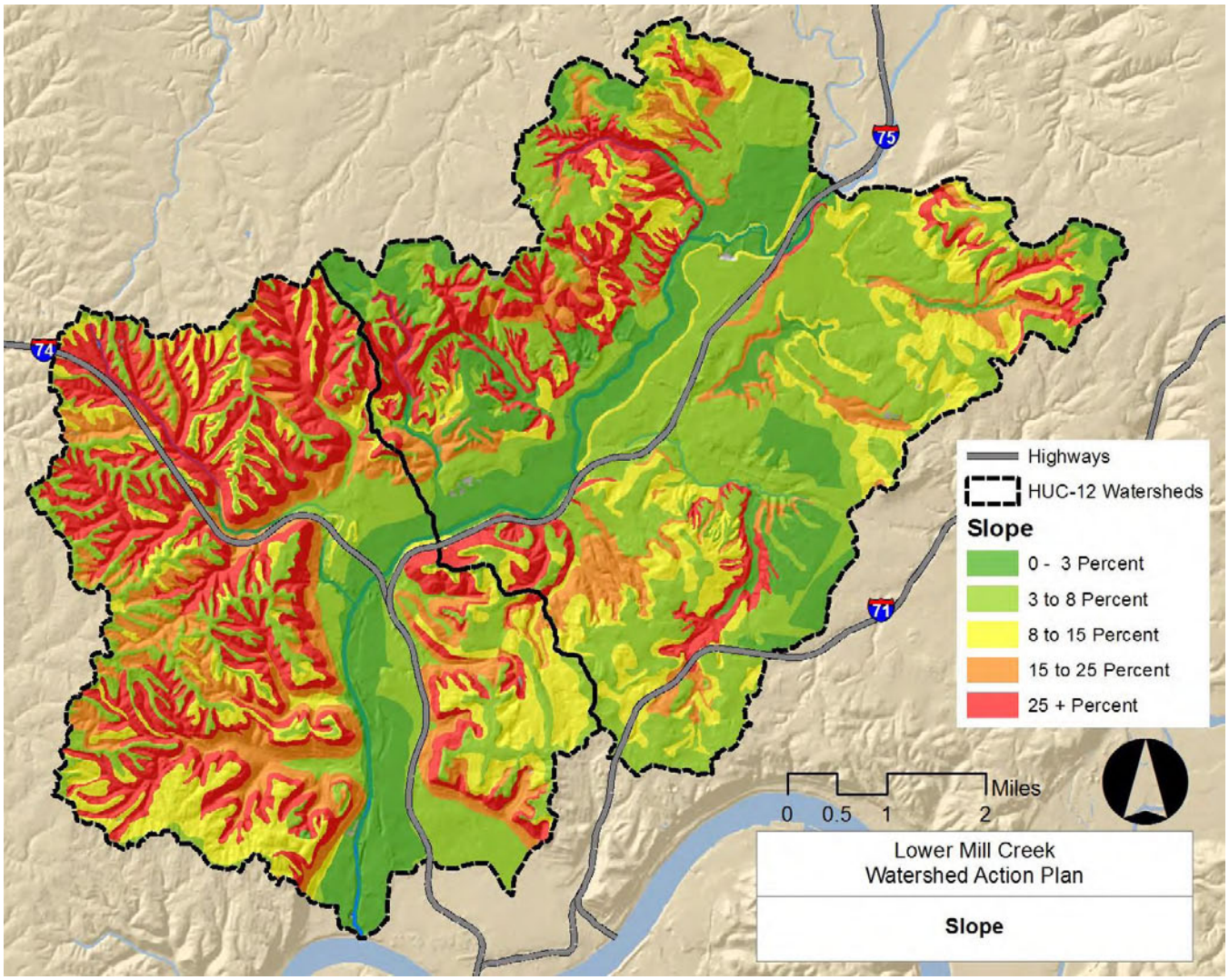


Figure 22 – Slope

Table 13 – Soil Resources

	Congress Run (01-04)	West Fork (01-05)
Prime Farmland:	224.2 acres	20.2 acres
Highly Erodible Land:	12,797.7 acres	12,073.1 acres
Frequently Flooded:	0.0 acres	0.0 acres
Hydric:	0.0 acres	0.0 acres
Partially Hydric:	11,948.5 acres	6,163.3 acres
Soil Drainage		
Well:	6,524.8 acres	9,291.0 acres
Moderately well:	8,433.9 acres	2,834.7 acres
Somewhat poorly:	126.4 acres	0.0 acres
Poorly drained:	0.0 acres	0.0 acres

Source: ODNR, ERIN Watershed Reports, 2012

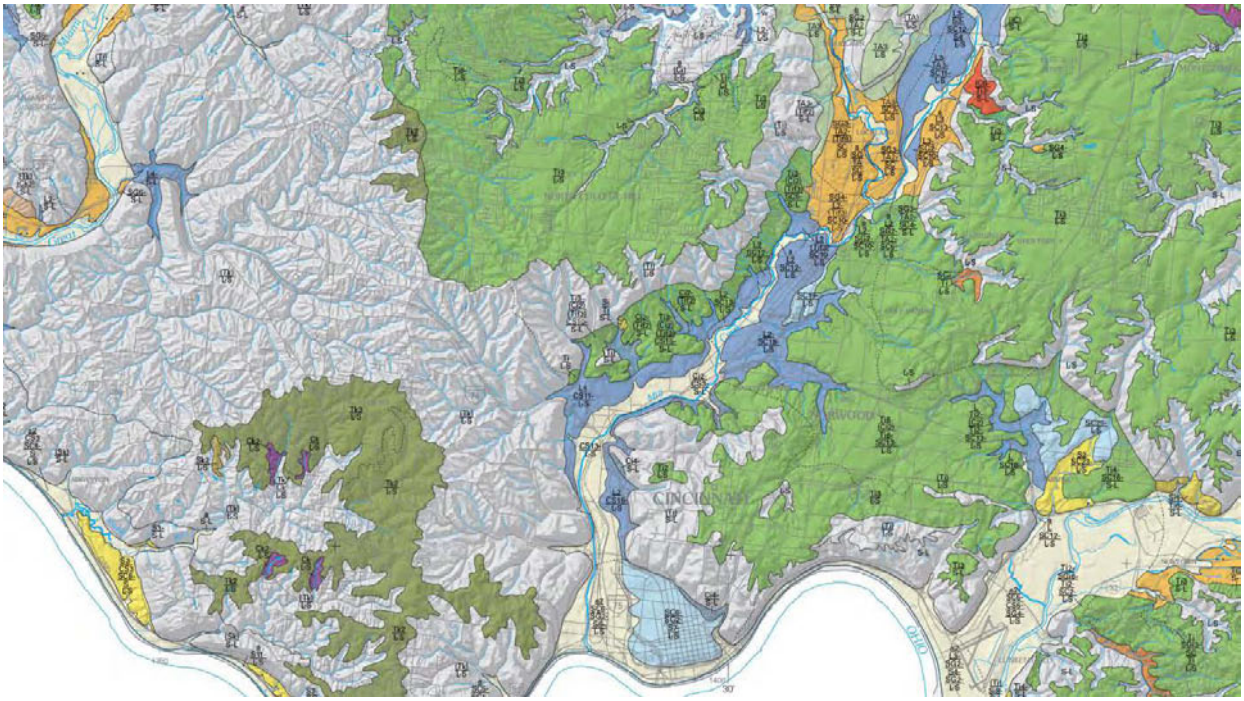


Figure 23 – Surficial Geology

KEY TO LITHOLOGIC COLORS*

Surficial Units

- W — Water
- Fill — Made land and pits
- A — Alluvium
- C — Clay, Wisconsinan-age
- CI — Clay, Illinoian-age
- CC — Clay, Pre-Illinoian-age (Kansan-age in old terminology)
- G — Gravel, Wisconsinan-age
- IC — Ice contact deposits, Wisconsinan-age
- IM — Till and water laid deposits, Wisconsinan-age
- F — Silt, Wisconsinan-age
- LI — Silt, Illinoian-age
- LA — Silt, clay, sand and gravel, Wisconsinan-age
- S — Sand, Wisconsinan-age
- SI — Sand, Illinoian-age
- SP — Clayey to pebbly sand, Pre-Illinoian-age
- SC — Fine sand, clay, and silt, unspecified age
- SG — Sand and gravel, Wisconsinan age
- SGI — Sand and gravel, Illinoian-age
- SGA — Sand and gravel with paleosol, Pre-Wisconsinan-age
- SGC — Sand and gravel, Wisconsinan-age with clay and silt interbeds
- TA — Loam till, Wisconsinan-age
- TI — Loam till, Illinoian-age
- TC — Clay loam till, Pre-Illinoian age

- LS — Limestone
- L-S — Limestone and Shale
- S-L — Shale and Limestone

* The colors on this map depict the uppermost continuous unit and are intended to assist in visualizing the geology of the area. Discontinuous units (in parentheses) and subsurface-only units are excluded in color assignments.

Figure 23 is a snapshot of the Hamilton County section of the Mill Creek Valley from the map Surficial Geology of the Ohio Portions of the Cincinnati and Falmouth 30 X 60 Minute Quadrangles, which the Ohio Division of Geological Survey published in 2004. The map designates 26 surficial units shown in the snapshot of the legend to the right. Descriptions of these surficial units are described in greater detail and shown with much more clarity by downloading the map from the link below.

The full map (77 MB) can be accessed online at: ftp://ftp.dnr.state.oh.us/Geological_Survey/SurficialPDF_Drafts/CincinattiFallmouth_Surficial_v4.pdf

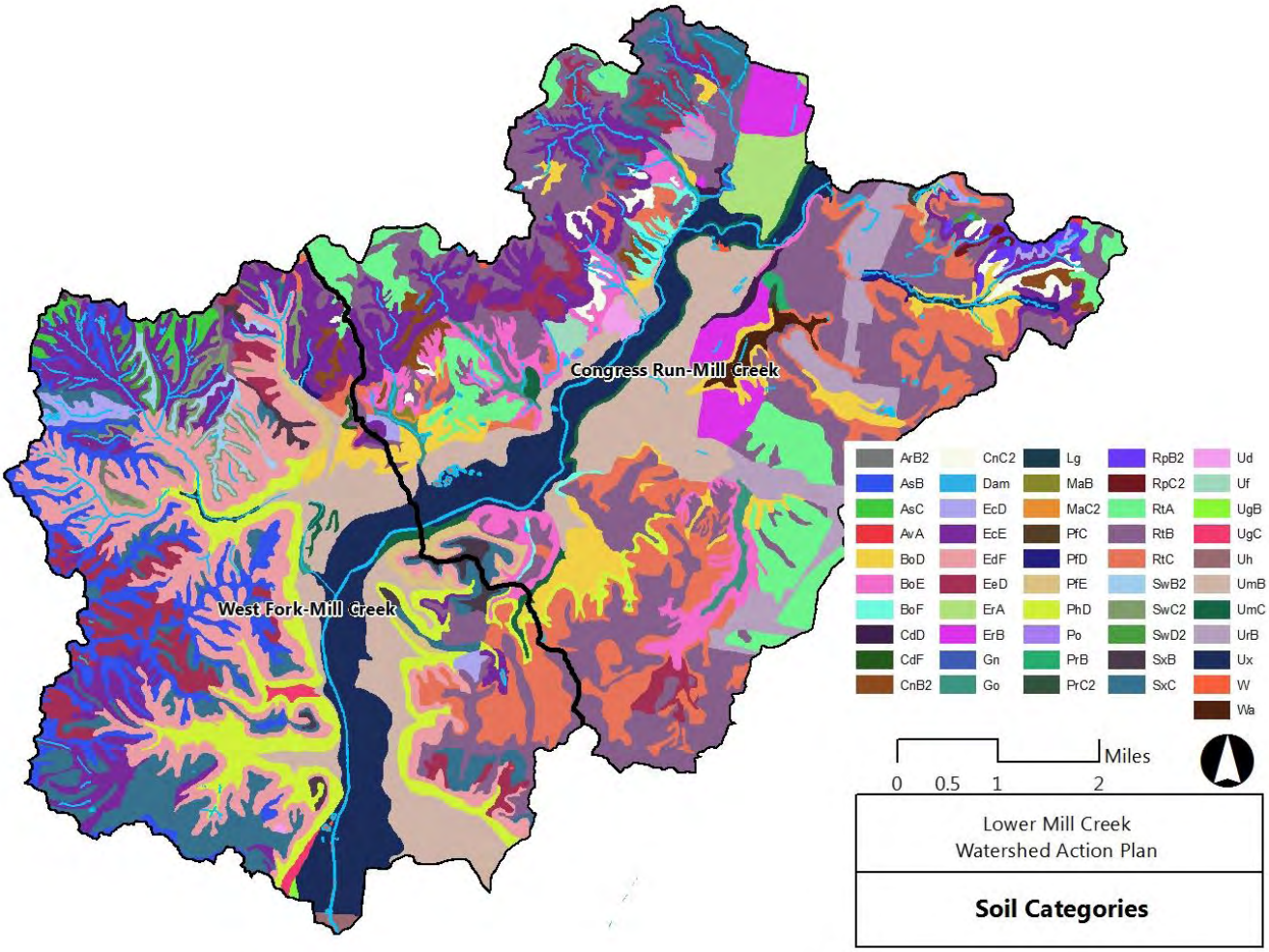


Figure 24 - Soil Categories

For detailed information on individual soil categories and their properties please see "Soil Survey of Hamilton County Ohio" (1982), prepared by the United States Department of Agriculture Soil Conservation Service in cooperation with Ohio Department of Natural Resources Division of Lands and Soil, and Ohio Agriculture Research and Development Center.

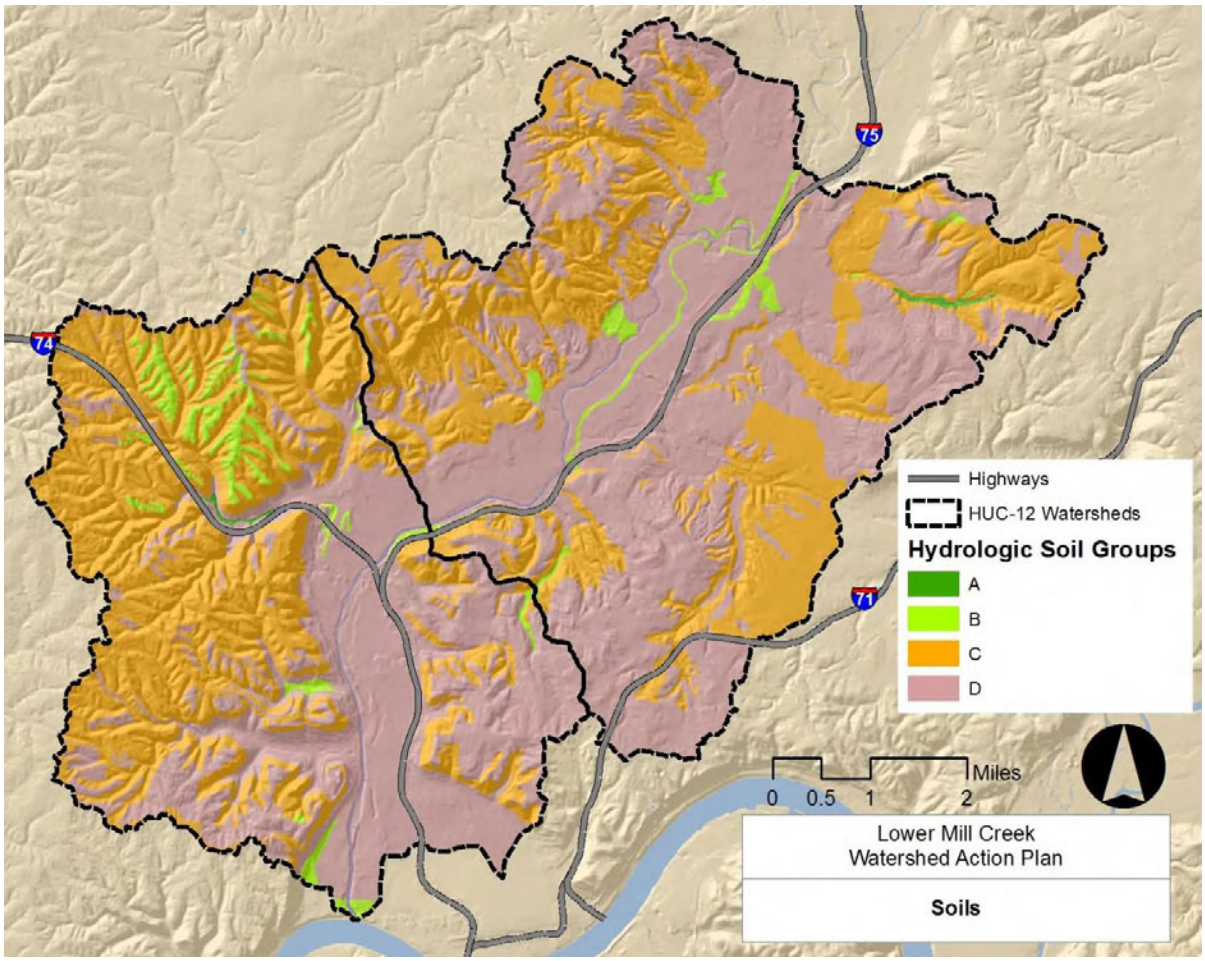


Figure 25 – Soil Hydrologic Groups

Table 14 – Hydrologic Soil Groups by Area

Hydrologic Soil Group	Congress Run (01-04)	West Fork (01-05)
A:	37.6 acres	20.2 acres
B:	1990.8 acres	2012.4 acres
C:	10788.2 acres	3024.1 acres
D:	2327.8 acres	7075.0 acres
A/D:	0.0 acres	0.0 acres
B/D:	0.0 acres	0.0 acres
C/D:	0.0 acres	0.0 acres

Source: ODNR, ERIN Watershed Reports, 2012

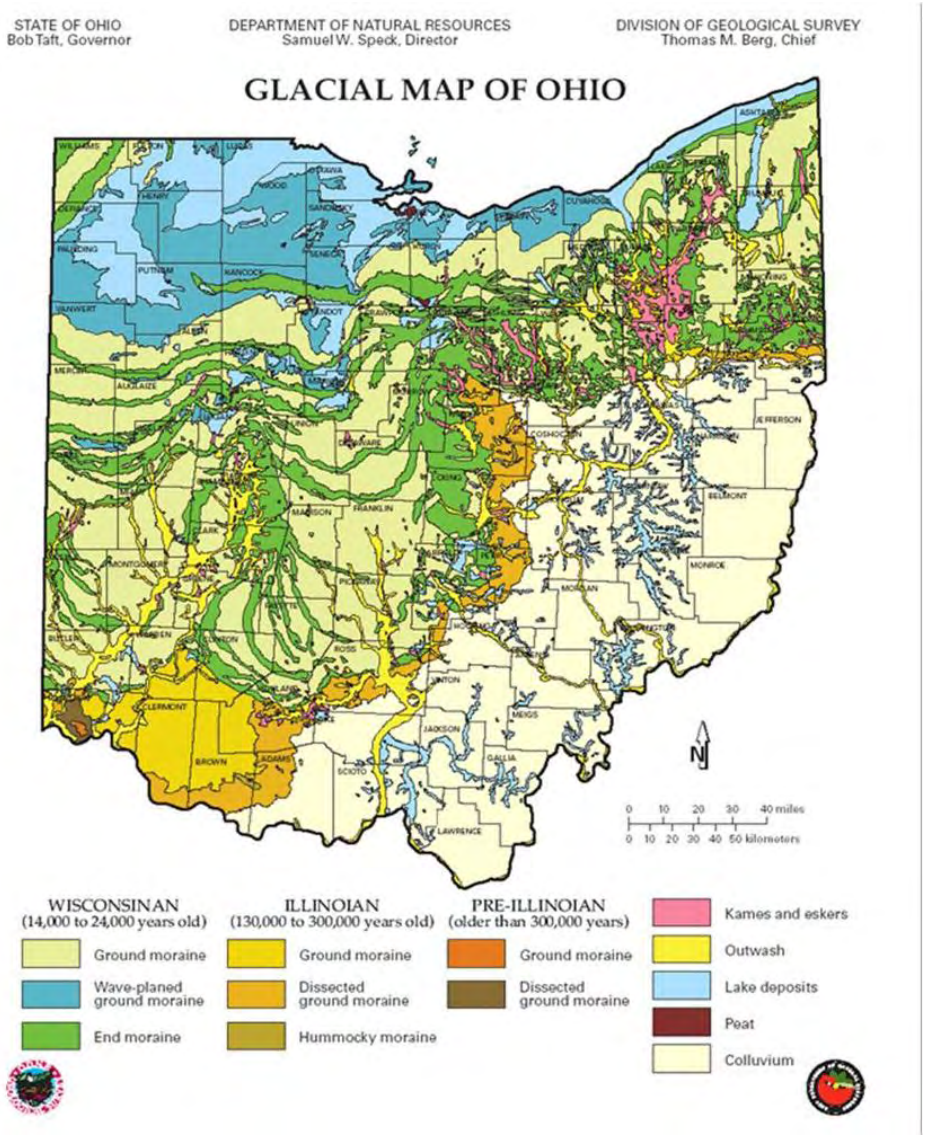


Figure 26 - Glacial Map of Ohio

Source: ODNR

E. *<u>Glacial History</u>*

It is suggested that the pre-glacial Licking River flowed northward through what is now the Mill Creek Valley. Three Pleistocene ice sheets once covered portions of Southwest Ohio with the first, the Kansan, occurring about 1.2 million years ago. The Kansan ice sheet blocked the northward flow of the pre-glacial Licking River and redirected it westward toward the Mississippi River. The erosive action of the new river, called the Deep Stage Ohio, broadened the present day Mill Creek Valley. The Illinoisan ice sheet, which covered the area approximately 400,000 years ago, established the present course of the Ohio River, transforming the northward flow to a westerly flow. The Mill Creek was formed at that time in the valley of the former Deep Stage Ohio and acted as a conduit for glacial meltwater to flow southward to the new Ohio River (Hedeen, 1994).

The final ice sheet that impacted the region was the Wisconsin, which occurred approximately 70,000 years ago. The southernmost lobe extended down the Mill Creek Valley to the north of St. Bernard. Downcutting at the time through the existing Illinoisan till produced large terraces in the Mill Creek Valley where the City of Norwood and Spring Grove Cemetery lie today. The retreating Wisconsin glacier deposited alluvial sand, gravel and soil that originated in northern Ohio and Ontario, Canada. Terraces created from these deposits underlie downtown Cincinnati. Post glacial erosion by the Mill Creek has resulted in a shallow channel inscribed into the valley floor (Hedeen, 1994).

4.2 BIOLOGICAL FEATURES

4.2.1 RARE, THREATENED, ENDANGERED SPECIES

Black Crowned Night Herons, an endangered Ohio species, have established a rookery in the lower three-mile section of Mill Creek, near the Ohio River. Adult birds have been sighted as far upstream as East Fork Mill Creek and west on the Great Miami River. This is the only documented Black Crown Night Heron rookery in the state of Ohio in the Ohio River basin.

A. Federally Endangered Species present within Hamilton County

Mammals

- Indiana bat (Myotis sodalist)

Plants

- Running buffalo clover (Trifolium stoloniferum)

Mussels

- Fanshell (Cyprogenia stegaria)
- Pink Mucket pearlymussel (Lampsillis abrupta)
- Rayed Bean (Villosa fabalis)
- Sheepnose (Plethobasus cyphus)

Indiana bat
Credit: Animal.discovery.com

Running buffalo clover
Credit: FS.FED.us

Fanshell
Credit: FWS.gov

Indiana bat and Running Buffalo clover are the only two species likely to be present in the LMC watershed. However, watershed improvements may contribute to water quality in the Ohio River downstream from Mill Creek where some of the federally endangered mussel species may be present.

Bald Eagle – no longer protected under the federal Endangered Species act but protected under the Bald and Golden Eagle Protection Act.

B. State of Ohio Endangered Species

The Ohio Department of Natural Resources, Division of Natural Areas and Preserves, maintains a list of currently-listed and located endangered, threatened, and rare species for Ohio. From this list the endangered species located in LMC watershed were mapped. This information is vitally important for watershed

management since endangered species habitat should be protected or improved to preserve the endangered species.

The State of Ohio includes all the federally endangered species listed above as well as 4 mammals, 16 birds, 5 reptiles, 4 amphibians, and 17 insect species (U.S. Fish and Wildlife Service, 2012). Of these, the only one documented within the LMC watershed is the cave salamander which has been found in Mt Airy Forest (ESI Inc., 2011).

Amphibians

- Cave salamander (Eurycea lucifuga)

C. *State of Ohio Threatened Species*

The State of Ohio lists 11 bird, 3 reptile, 1 amphibian, 13 fish, 4 mollusk, 2 crayfish, and 22 insect species. Of these, Black crested night herons, Peregrine falcons, and Kirtland's water snake has been documented in the LMC watershed. Other species which may be present are Midland mud salamanders. This information is vitally important for watershed management since endangered species habitat should be protected or improved to preserve the endangered species.

Birds

- Black crested night heron (*Nycticorax nycticorax)*
- Peregrine falcon (Falco peregrines)

Reptiles

- Kirtland's water snake (*Clonophis kirtlandii)*

Amphibians

- Midland mud salamander (Pseudotriton montanus diastictus)

The Ohio Department of Natural Resources, Division of Natural Areas and Preserves, maintains a list of currently-listed and located endangered, threatened, and rare species for Ohio. From this list the endangered species located in Lower Little Miami River watershed were mapped, shown in Figure 27 - Rare, Threatened, and Endangered Species.

Yellow Crowned Night Heron
Credit: Animalspot.net

Kirtland's Snake
Credit: Herpedia.com

Cave Salamander
Credit: DNR.state.oh.us

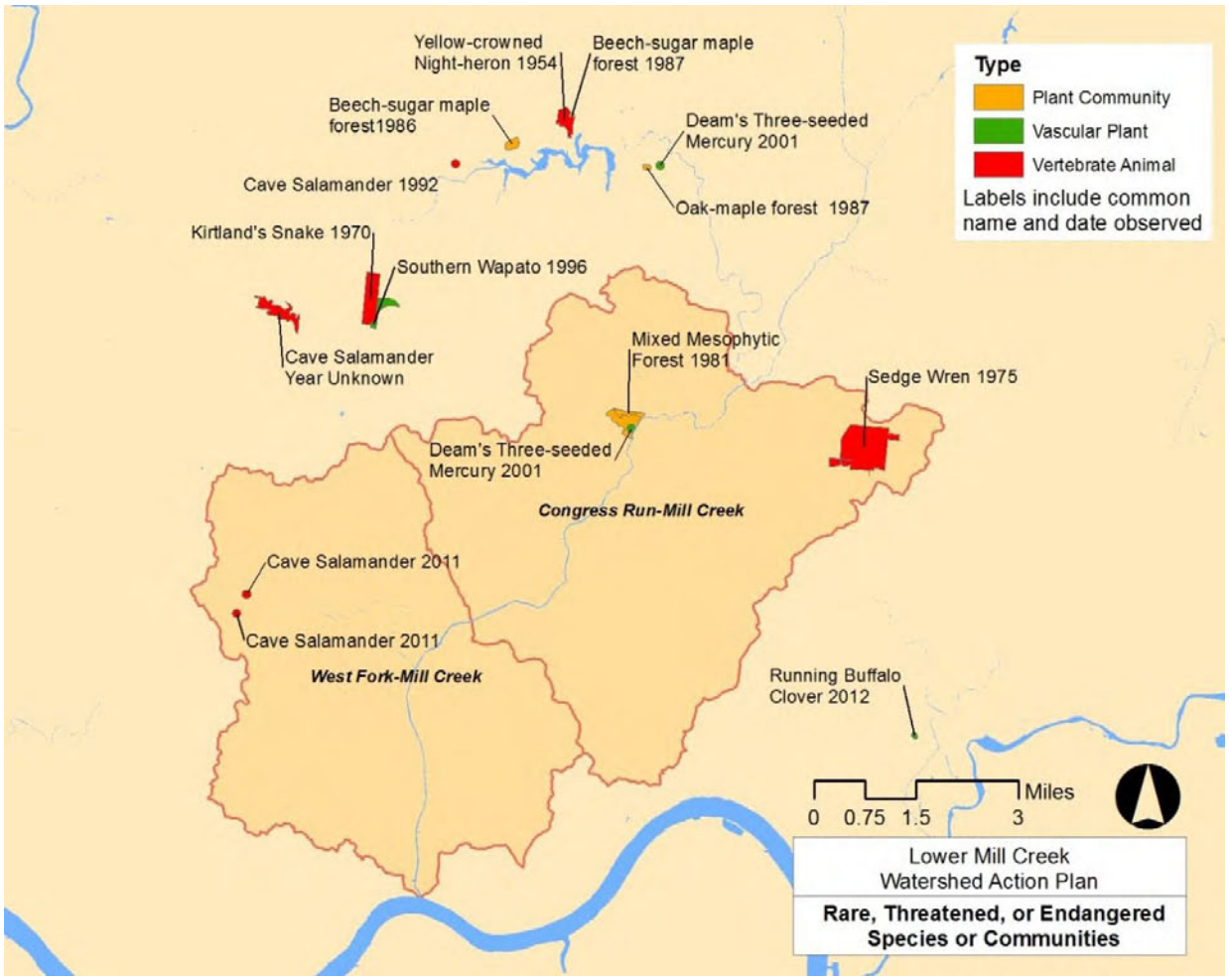


Figure 27 - Rare, Threatened, and Endangered Species

Table 15 - Rare, Threatened, and Endangered Species in the LMC Watershed

Scientific Name	Common Name	Category	Last Observed	State Status	Federal Status
Oak-maple forest		Plant Community	1981-09		
Acalypha virginica var. deamii	Deam's Three-seeded Mercury	Vascular Plant	2001-09-20	P	
Mixed mesophytic forest		Plant Community	1981-09		
Eurycea lucifuga	Cave Salamander	Vertebrate Animal	1992-06-16	E	
Beech-sugar maple forest		Plant Community	1987-08		
Acalypha virginica var. deamii	Deam's Three-seeded Mercury	Vascular Plant	2001-08-21	P	
Clonophis kirtlandii	Kirtland's Snake	Vertebrate Animal	1970	T	FSC
Nyctanassa violacea	Yellow-crowned Night-heron	Vertebrate Animal	1954-06	T	
Sinkhole		Other (Ecological)	1977-07		
Oak-maple forest		Plant Community	1987-08		
Beech-sugar maple forest		Plant Community	1986-04		
Eurycea lucifuga	Cave Salamander	Vertebrate Animal	1960	E	
Cistothorus platensis	Sedge Wren	Vertebrate Animal	1975	SC	
Sagittaria montevidensis	Southern Wapato	Vascular Plant	1996-10-19	P	

Source: (ODNR, 2012)

4.2.2 INVASIVE NONNATIVE SPECIES & POTENTIAL IMPACTS

A. Invasive and Nonnative Species

According to ODNR's Division of Natural Areas and Preserves (DNAP), there are more than 700 species of non-native species in Ohio. However, some alien species are classified as invasive due to their ability to rapidly grow, reproduce and overtake the surrounding area by oppressing the growth of the more common floral species. Another major problem with invasive plants is attributed to the lack of natural predators or natural control measures in the invaded areas. The division (ODNR-DNAP) has compiled a list of more than 60 plants that are currently impacting nature preserves, wildlife areas, parks and forests throughout the state (see Appendix C). The potential impacts of non-natives and invasive species are unlimited in nature. Managers of natural areas across the country may spend an exorbitant amount of man hours and dollars to control the invasive species. The non-native invasive species may also eliminate other important native species by out-competing them for water, nutrients and space.

The LMC watershed includes 3,273 acres of protected forests. Of these, 2,014 (greater than 60%) are highly degraded by invasive plant species (Table 16). Some of the top invasive non-native plants in the LMC watershed include; bush honeysuckles (Lonicera sp.), buckthorn (Rhamnus sp.), garlic mustard (Alliaria petiolata), fig buttercup/lesser celandine (Ranunculus ficaria L), multiflora rose (Rosa multiflora), Japanese knotweed (Polygonum cuspidatum), winter creeper (Euonymus fortune), Callery pear (Pyrus calleryana) and tree-of-heaven (Ailanthus altissima).

B. LMC Watershed Known Invertebrate Invasive Species

There are four known invertebrate invasive species. These are:

- Emerald Ash Borer (Agrilus planipennis),
- European Gypsy Moth (Lymantria dispar),
- Freshwater Jellyfish (Craspedacusta sowerbyi),
- Zebra Mussel (Dreissena polymorpha)

Emerald Ash Borer
Credit: Mymontys.com

European Gypsy Moth
Credit: Purdue Coop Extension

Zebra Mussel
Credit: DNR.state.oh.us

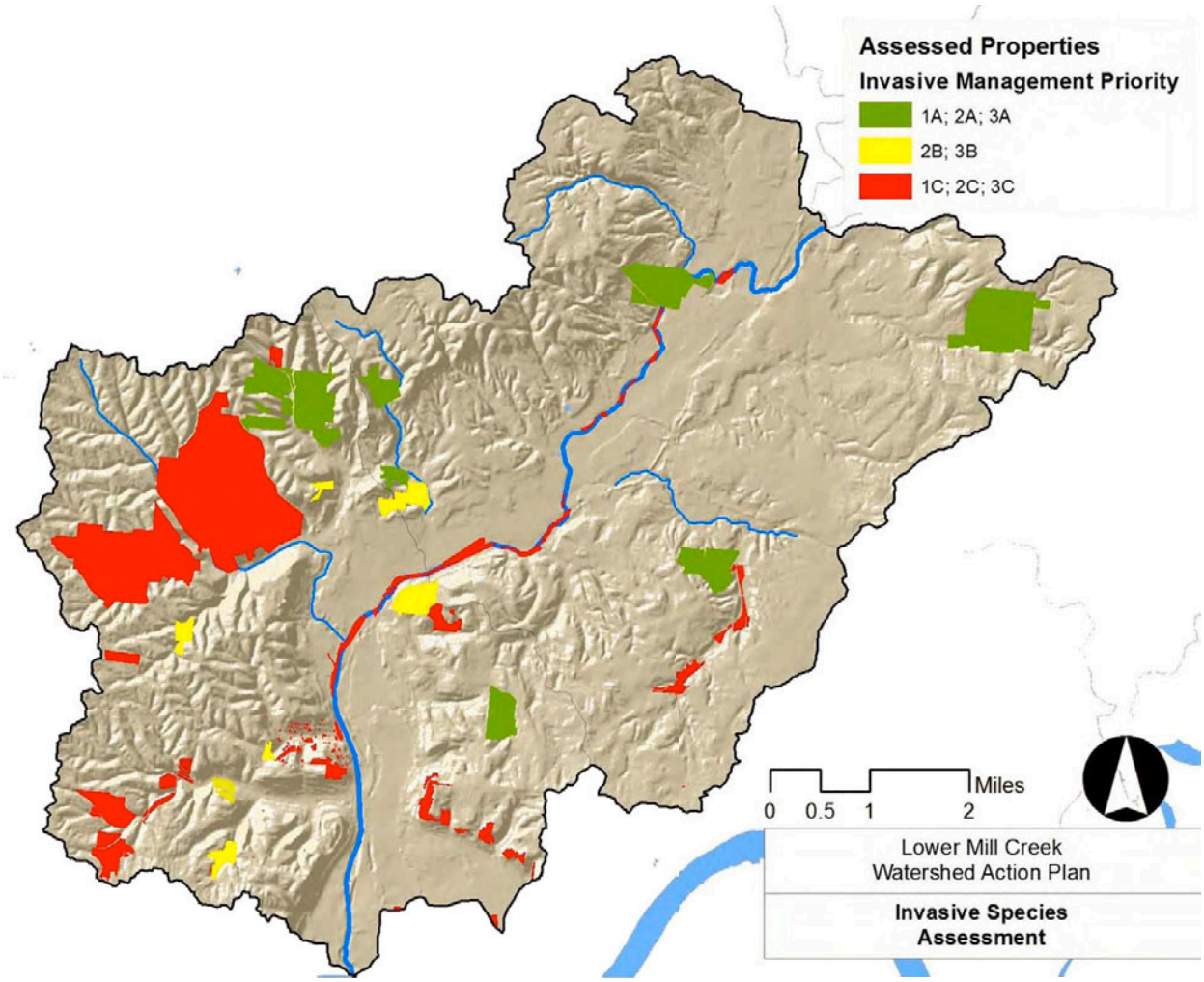


Figure 28 - Invasive Species Assessment for Protected Lands

Table 16 - Invasive Species Inventory and Management Priority for Protected Lands

Invasive Management Priority	Acreage in LMC Watershed	Percentage %
1A	216	6.6
2A	395	12.0
3A	427	13.0
2B	23	0.7
3B	198	6.0
1C	34	1.0
2C	188	5.7
3C	1,792	54.8
Totals	3,273	100.0

Figure 28 - Invasive Species Assessment for Protected Lands Map Description

The Cincinnati Park Board has developed an inventory system that prioritizes invasive species management based on their potential impact on native forest and understory species. Parks with an "A" rating contain relatively high percentage of native plants and a low percentage of invasive species. Parks with a "B" rating have pockets of desirable plants. Parks with a "C" rating are either covered with turf, impervious surfaces, or contain a high percentage of invasive species. Priority is determined by the percentage of area covered by invasive honeysuckle. Parks with a "1"contain less than 25% of their area covered by honeysuckle, a "2" rating indicates between 25 and 50% coverage, and a '3" rating indicates greater than 50% honeysuckle coverage by area. This rating system was applied to all protected property within the LMC watershed.

4.3 WATER RESOURCES

4.3.1 CLIMATE AND PRECIPITATION

Cincinnati's climate is humid and temperate with hot and humid summers and moderately cold winters. Highest temperatures occur in July with an average of 76^0 F and lowest temperatures occur in January with an average temperature of 30^0 F. The highest recorded temperature was 105^0 F and the lowest recorded temperature was -22^0 F. The average annual precipitation is 42.15 inches with the wettest month in May and the driest in February. Rain occurs, on average, 126 days each year (Midwestern Regional Climate Center).

The climate is humid and temperate with a mean annual temperature of about 54.6 F, ranging from 31 F in January to 76 F in July. During a typical year, the area receives approximately 42.2 in of precipitation, with Feb (2.62 in) usually being the driest month and May (4.71 in) the wettest month. MSDGC currently uses 41.17 inches as a typical year rainfall.

Table 17 - Climate and Precipitation Monthly Averages and Records for Cincinnati, Ohio

Month	Avg. High	Avg. Low	Mean	Avg. Precipitation	Record High	Record Low
Jan	40°F	22°F	31°F	2.82 in.	74°F (1950)	-22°F (1994)
Feb	45°F	25°F	35°F	2.63 in.	76°F (1972)	-9°F (1951)
Mar	55°F	33°F	44°F	3.88 in.	85°F (1986)	-6°F (1980)
Apr	66°F	42°F	54°F	3.86 in.	90°F (1986)	19°F (1964)
May	75°F	52°F	64°F	5.03 in.	94°F (1962)	27°F (1966)
Jun	83°F	61°F	72°F	4.05 in.	101°F (1988)	39°F (1966)
Jul	87°F	65°F	76°F	3.86 in.	101°F (1988)	47°F (1972)
Aug	86°F	63°F	75°F	3.61 in.	103°F (1988)	43°F (1965)
Sep	79°F	55°F	67°F	2.83 in.	100°F (1964)	32°F (1963)
Oct	68°F	43°F	56°F	3.11 in.	91°F (1959)	18°F (1962)
Nov	56°F	34°F	45°F	3.20 in.	82°F (1987)	-3°F (1958)
Dec	43°F	26°F	35°F	3.15 in.	75°F (1982)	-14°F (1989

4.3.2 SURFACE WATERS INCLUDING WETLANDS

Surface waters in the LMC watershed are mapped by sub-sewersheds. Table 18 - Surface Waters by Sub-sewersheds shows the size of lakes, ponds and potential wetlands by sub-sewersheds.

Wetlands are places that are inundated with water frequently enough to support plants and wildlife adapted to saturated soil conditions. Swamps, marshes, and bogs are examples of wetlands. Although a site-specific survey is required to confirm the presence of wetlands, the presence of hydric soils is the best way to indicate their possible presence at a large scale. Hydric soils are specific soil types formed under conditions of frequent saturation, flooding, or ponding.

Table 18 - Surface Waters by Sub-sewersheds

LMC Sub-sewersheds	Total Watershed Area (Acres)	Size of Lakes and Reservoirs (Acres)	Potential Wetland Area (Acres of Hydric Soils)	Wetland Type(s)
Lick Run	2718.9	0.73	0.63	Freshwater Pond
West Fork	5524.1	4.56	9.59	Freshwater Pond
Ross Run	3912.9	0	0	(None)
Bloody Run	2211.4	7.47	3.87	Freshwater Pond, Freshwater Forested/Shrub Wetland
Amberley	1654.5	1.39	3.56	Freshwater Pond
Upper Mill	1924.6	0.24	7.47	Freshwater Pond, Riverine
Kings Run	3846.0	18.04	36.62	Freshwater Pond, Riverine
Hartwell-Carthage	4161.7	22.13	71.95	Freshwater Pond, Freshwater Forested/Shrub Wetland, Riverine
Gest	471.1	6.44	23.54	Freshwater Pond, Riverine
Denham	1316.9	0	6.15	Riverine
Mitchell	1574.6	0.73	0.95	Freshwater Pond
Clifton	2622.2	2.20	68.71	Freshwater Pond, Riverine
Total		**63.93**	**233.04**	

Table 19 – Water Resources Summary

	Congress Run (01-04)	West Fork (01-05)
100 year floodplain:	401.5 acres	254.7 acres
Wetlands (2007):	143.2 acres	100.3 acres
Ponds & Lakes:	47.3 acres	34.0 acres
Streams & Rivers	62.7 acres	46.6 acres
Approximate # of water wells:	145	115
Area highly sensitive to groundwater contamination:	19,174.5 acres	15,116.9 acres
Area above Sole Source Aquifer:	277.6 acres	0.0 acres
Area in the Emergency Management Zone:	0.0 acres	0.0 acres

Source: (ODNR, 2011)

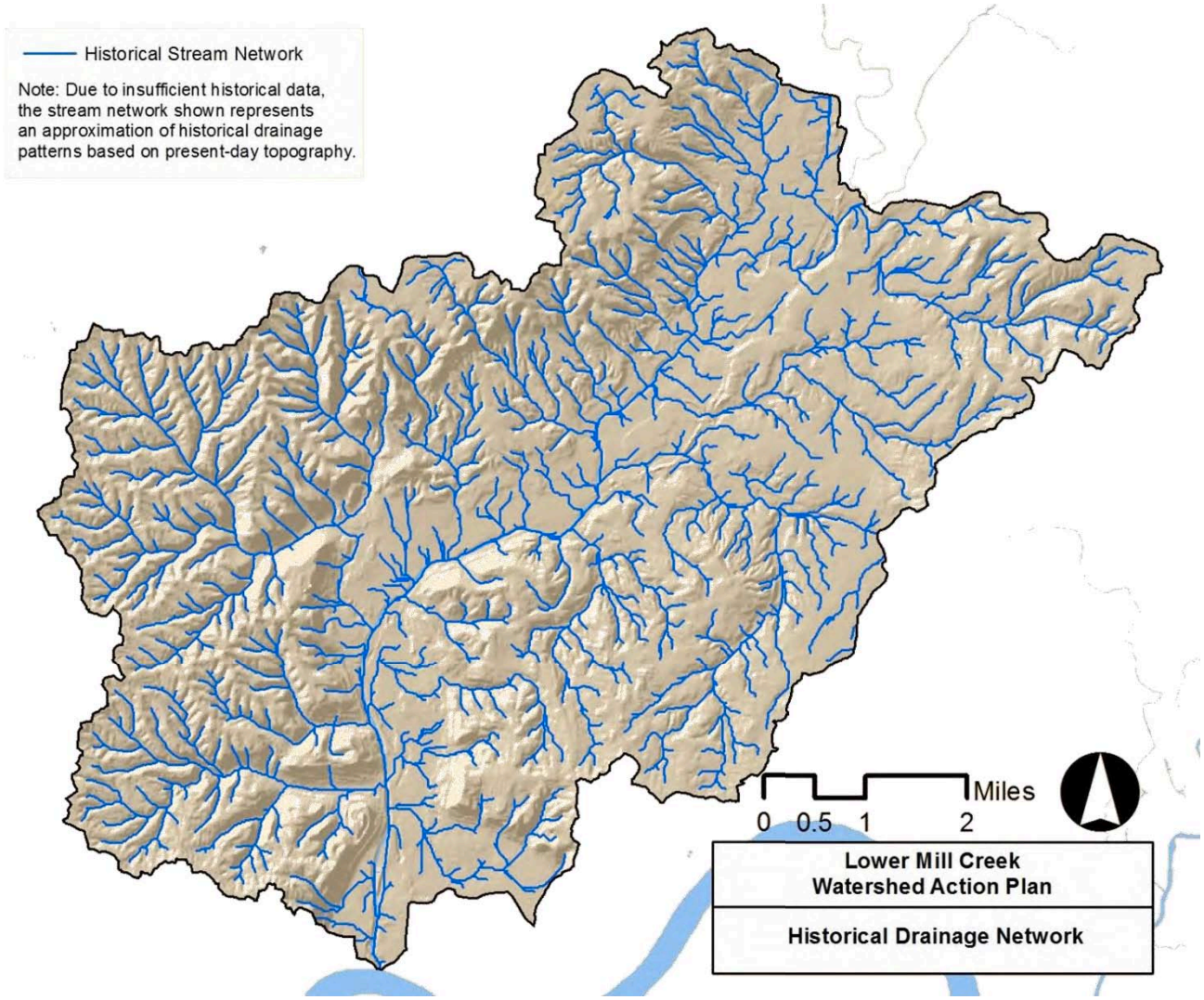


Figure 29 - Historic Stream Network

4.3.3 STREAMS

Figure 29 depicts a pre-development hydrologic network of an extensive system of creeks and streams. This network naturally conveyed storm water runoff to the Mill Creek. Today urban development and underground sewer systems have replaced most of this stream network.

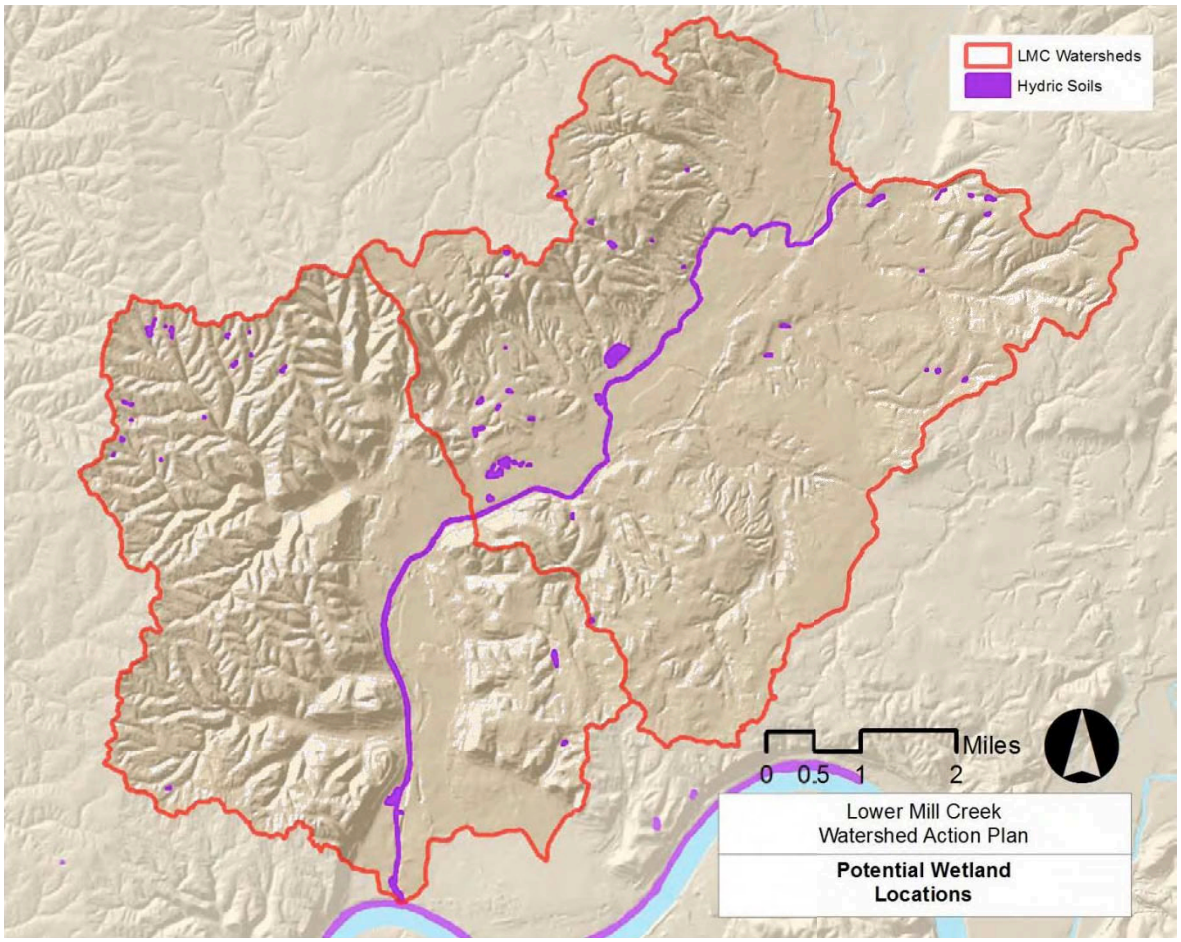


Figure 30 - Potential Wetlands

4.3.4 WETLANDS

Figure 30 - Potential Wetlands highlights the hydric soils in the LMC watershed. Although a site-specific survey is required to confirm the presence of wetlands, the presence of hydric soils, one of the criteria for determining wetlands, is the best way to indicate their possible presence at a large scale. On the whole, wetland habitat is restricted to the Mill Creek streambed and small pockets of isolated wetlands. This is a result of the overwhelming urbanization of the watershed.

Table 20 - Wetland Type

Wetland Type	Potential Wetland Area (Acres of Hydric Soils)	% of Total
Freshwater Pond	81.89	34.10%
Freshwater Forested/Shrub Wetland	2.94	1.20%
Riverine	155.13	64.60%

4.3.5 SURFACE WATER FLOW

A. ODNR – Gazetteer of Ohio Streams

The Ohio Department of Natural Resources maintains a "Gazetteer of Ohio Streams" which lists some general attributes for the Mill Creek and several named tributaries to the Mill Creek.

Table 21 - Mill Creek and Selected Tributaries Attributes

Stream Code	Stream Name	Flows Into	Length (miles)	Elevation (source)	Elevation (mouth)	Average Fall (ft/mile)	Drains (sq. mile)
304	Mill Creek	Ohio River	28.1	780	444	11.9	164.00
304.01	West Fork Mill Creek	Mill Creek	5.0	873	467	81.1	9.74
304.02	Ross Run	Mill Creek	4.9	740	490	51.1	5.92
304.03	West Fork Mill Creek	Mill Creek	15.2	890	528	23.8	36.42
304.04	Sharon Creek	Mill Creek	5.5	872	557	57.3	10.50
304.05	East Fork Mill Creek	Mill Creek	7.1	895	570	45.8	9.47

Source: (Ohio Department of Natural Resources, 1960)

B. USGS – Surface Flow Statistics – Mill Creek at Carthage, OH (032590000)

More detailed surface water records for the Mill Creek are tracked by the USGS's continuous monitoring station (03259000) located at Mill Creek, 100 ft. downstream from Anthony Wayne Avenue bridge at Carthage, OH. The drainage area for this site is 115 square miles. There are several periods of record at this station: a continuous discharge gage from November 1946 to September 2002 and then from October 2010 to current year, and a crest stage gage from October 2002 to September 2010.

The U.S. Geological Survey provides waters-resource data available in several forms including Water Year Data Summary Reports which were used to extract the following tables.
Table 22 shows surface water discharge monthly mean statistics for Water Year Oct 2010 to Sept. 2011. *Table 23* shows surface water discharge monthly mean statistics from Water Year 1997 – 2011. Table 24 shows summary statistics that compare Water Year 2011 with Water Years 1997-2011.

According to these summary statistics, the maximum peak flow was 9,030 cfs recorded on Sept. 14, 1979. The maximum peak stage was 21.82 feet recorded on Sep 14, 1979.

The Water Year 2011 was one of the wettest years ever recorded. The annual mean in Water Year 2011 was 252 cfs, which was also the highest annual mean on record. April 2011 recorded the highest monthly mean of any month on record at 901 cfs. The lowest daily mean for Water Year 2011 was estimated at 20 cfs at the beginning of September. The highest daily mean in Water Year 2011 was 2,670 cfs, recorded on Sep 26. On this day, Cincinnati received 3.76 inches of rain, which was the wettest September day in history (records date back to 1871).

Upstream of this site, flow has been regulated by West Fork Mill Creek Reservoir (6.9 mi upstream) since 1953. Also, there are some interbasin transfers of water between Mill Creek and Great Miami River basins by industrial and municipal operations.

Table 22 - Mill Creek at Carthage, OH (032590000) – Water Data Report 2011: Discharge (cfs), Water Year October 2010 to September 2011 Daily Mean Values

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Total	932	5,198	3,329	2,168	11,070	11,487	27,038	13,977	4,406	2,445	2,093	7,965
Mean	30.1	173	107	69.9	395	371	901	451	147	78.9	67.5	266
Max	150	1,290	1,000	35	2,060	1,700	2,640	2,360	718	450	369	2,670
Min	21	23	28	30	48	53	55	75	24	22	21	20

Source: (U.S. Geological Survey, 2011)

Table 23 - Mill Creek at Carthage, OH (032590000) - Statistics of Monthly Mean Data Discharge (cfs) for Water Years 1997-2011, By Water Year (WY)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean	86.1	111	166	207	202	231	299	215	191	121	81.1	110
Max	192	173	294	548	395	371	901	451	461	299	165	333
(WY)	(2002)	(2011)	(1997)	(2005)	(2011)	(2011)	(2011)	(2011)	(1997)	(2003)	(2003)	(2003)
Min	28.9	32.5	75.0	43.0	94.5	51.2	75.4	59.8	68.0	33.7	43.2	26.6
(WY)	(1998)	(2000)	(2006)	(2001)	(2006)	(2001)	(1997)	(1999)	(2006)	(2002)	(1998)	(1999)

Source: (U.S. Geological Survey, 2011)

Table 24 - Mill Creek at Carthage, OH (032590000) - Summary Statistics (cfs)

	Water Year 2011	Water Years 1997 - 2011
Annual total	92,108	-
Annual mean	252	172
Highest annual mean	-	252 2011
Lowest annual mean	-	108 1999
Highest daily mean	2,670, Sep 26	4,100, Jul 18, 2001
Lowest daily mean	[a]20, Sep 3	9.4, Aug 21, 2006
Annual seven-day minimum	21, Oct 1	9.8, Aug 17, 2006
Maximum peak flow	7,240, Sep 26	9,030, Sep 14, 1979
Maximum peak stage	17.33, Sep 26	21.82, Sep 14, 1979
Instantaneous low flow	[a]20, Sep 3	0.00, Aug 18, 1948
10 percent exceeds	773	410
50 percent exceeds	70	70
90 percent exceeds	23	21

[a] Estimated

Source: (U.S. Geological Survey, 2011)

HUC-12 Watershed	Acres of 100 Year Flood Plane
West Fork-Mill Creek	221
Congress Run-Mill Creek	332

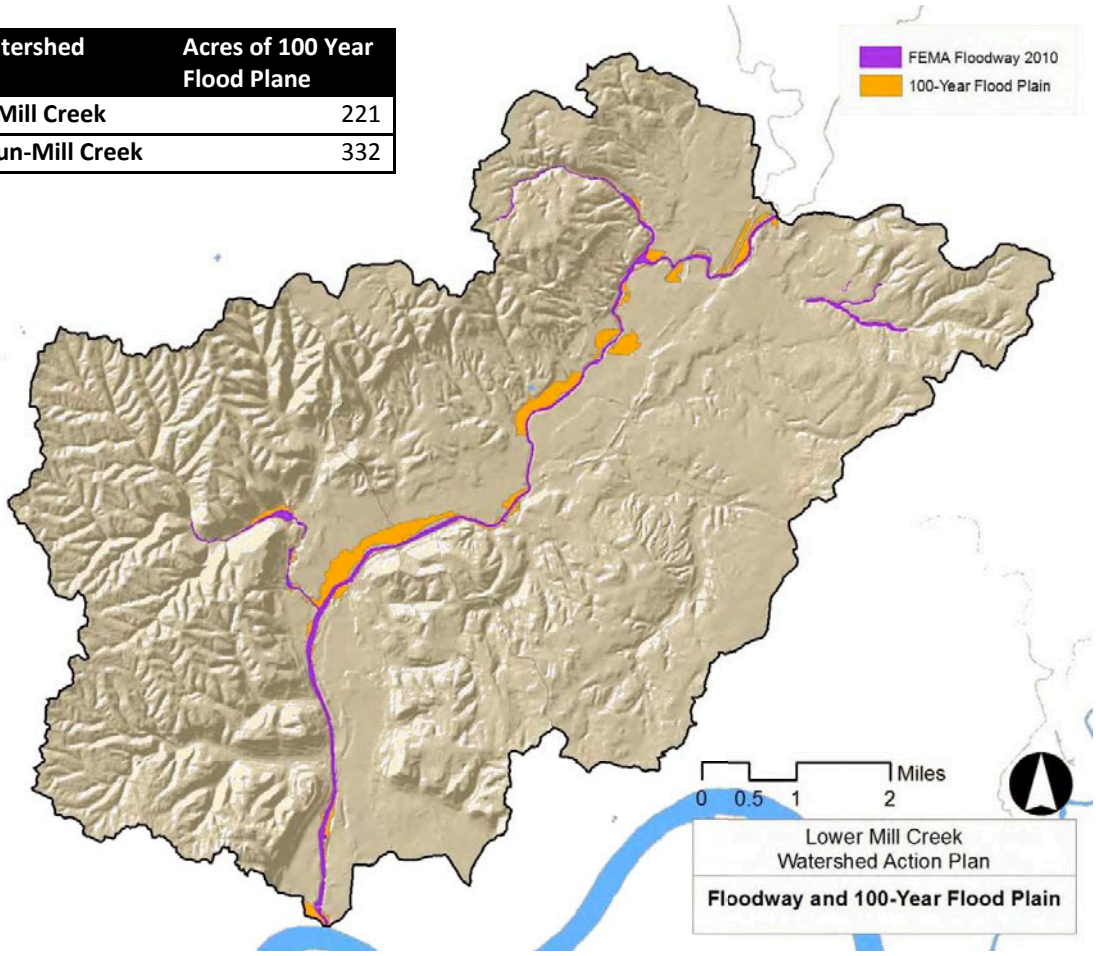


Figure 31 - LMC Watershed Floodway and 100-Year Flood Plain

4.3.6 FLOODING AND FLOODPLAIN AREAS

Flooding and the damages caused by floods have been a chronic issue throughout the history of Mill Creek, since its colonization in the 1800s. There are two main causes of flooding in the Mill Creek. First, winter and spring floods cause typical backwater flooding conditions from the Ohio River basin. The development of the Mill Creek Barrier Dam and Pump Station, finished in 1948, provided much needed protection from Ohio River flooding. Second, severe thunderstorms cause flash flooding as a result of the ever increasing impervious surfaces from development and industrialization in the area. Increased development has led and will continue to lead to a decrease in floodwater storage and increased levels of runoff. Added debris from bank erosion and degradation has caused stream blockages, which further compounds flooding conditions during storm events (US Army Corps of Engineers, Louisville District, 2010).

Flooding issues in the Mill Creek have been further compounded by heavy industrialization of the creek and its surrounding lands, as well as the erosion and deterioration of its banks, which have resulted in the deposition of debris and sediments within the creek.

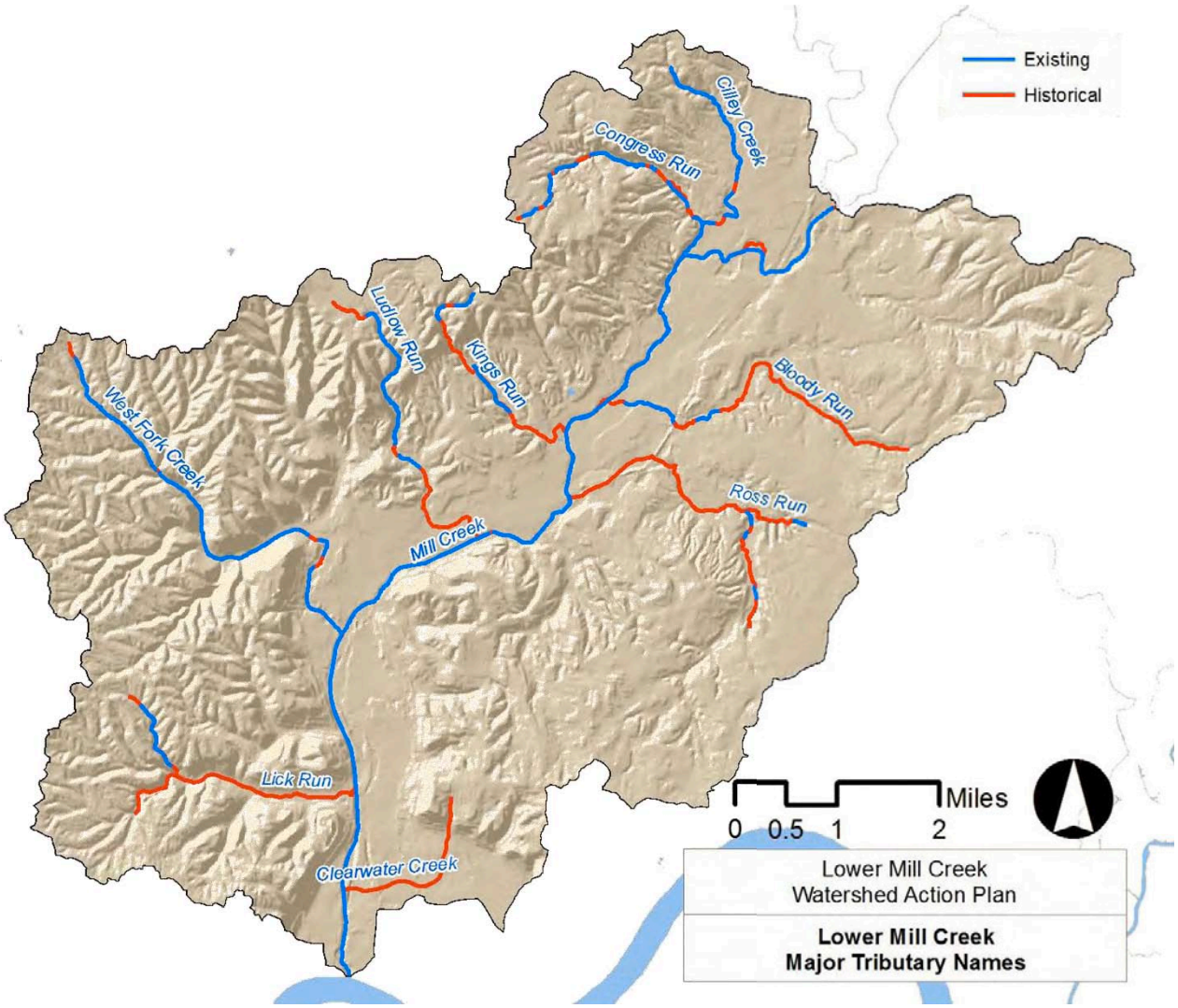


Figure 32 - Major Tributary Names

4.3.7 TRIBUTARY NAMES

Major tributaries included in the LMC watershed are: East Fork Mill Creek (7.1 miles), Sharon Creek (5.5 miles), West Fork Mill Creek (15.2 miles), Ross Run (4.9 miles), and West Fork Creek (5.0 miles). Other tributaries include Beaver Run, Town Run, Amberley Creek, Cooper Creek, Congress Run, Bloody Run, Lick Run, and Seymour Nature Reserve Tributary (Bloody Run and Lick Run now flow beneath the surface in culverts and storm sewers.) These tributaries, as well as several additional smaller ones, enter Mill Creek from the hillsides that characterize the watershed. They are generally underlain by thinly inter-bedded shales and limestone bedrock except for the lower reaches at the confluences with Mill Creek. The average gradient for the major tributaries is 51.8 feet per mile

4.3.8 TRIBUTARY USE DESIGNATIONS

A. Beneficial Use

Beneficial use designations describe existing or potential uses of water bodies. They take into consideration the use and value of water for public water supplies, protection and propagation of aquatic life, recreation in and on the water, agricultural, industrial and other purposes. Ohio EPA assigns beneficial use designations to water bodies in the state. There may be more than one use designation assigned to a water body. Examples of beneficial use designations include: public water supply, primary contact recreation, and aquatic life uses (warm water habitat, etc.).

B. Aquatic Life Habitat

Only two designated areas – West Fork Creek, which has its mouth at the Mill Creek (RM 3.45) from its headwaters to Montana Avenue (RM 2.1), and the Winton Ridge Tributary, which has its mouth at Mill Creek (RM 6.85) - are designated as warmwater habitat under the aquatic life habitat designation. These segments meet the baseline regulatory requirements in line with Clean Water Act "fishable goal" expectation. Both the Mill Creek from Center Hill Road (RM 7.9) to the mouth at the Ohio River and Bloody Run are designated as modified warmwater habitat. This designation allows less restrictive requirements for dissolved oxygen and ammonia and may result in less restrictive wastewater treatment requirements. The West Fork Creek from Montana Avenue to the mouth at Mill Creek (RM 3.45) and Ross Run are designated as limited resource waters. This designation has less restrictive aquatic life criteria for the majority of pollutants and may result in less restrictive wastewater treatment requirements.

C. Public Water Supply

In the West Fork-Mill Creek none of the identified segments are used as public water supplies – rather they are all designated for agricultural and industrial uses.

D. Recreation

The Mill Creek from RM 7.9 to the mouth of the Ohio is designated for primary contact recreation as it can allow full body immersion, has high proximity to residential areas, and/or an intermediate potential for exposure to bacteria. This designation indicates an intermediate risk of swimmer's illness after exposure and calls for a baseline level of disinfection. The remaining segments are under the most restrictive category – secondary contact recreation – where water depth precludes full body immersion, has low proximity to residential areas, and/or the lowest potential exposure to bacteria. It presents the greatest risk of swimmer's illness after exposure and requires slightly less disinfection of wastewater.

Table 25 - Ohio EPA Aquatic Life Use Designation Miles

	West Fork-Mill Creek	Congress Run-Mill Creek
Coldwater Habitat (CWH)	0.0	0.0
Exceptional Warmwater Habitat (EWH)	0.0	0.0
Warmwater Habitat (WWH)	2.9	6.0
Limited Resource Water (LRW)	2.2	2.4
Limited Warmwater Habitat (LWH)	0.0	0.0
Modified Warmwater Habitat (MWH)	4.6	5.3
Seasonal Salmonid Habitat	0.0	0.0

ODNR, ERIN Watershed Reports, 2012

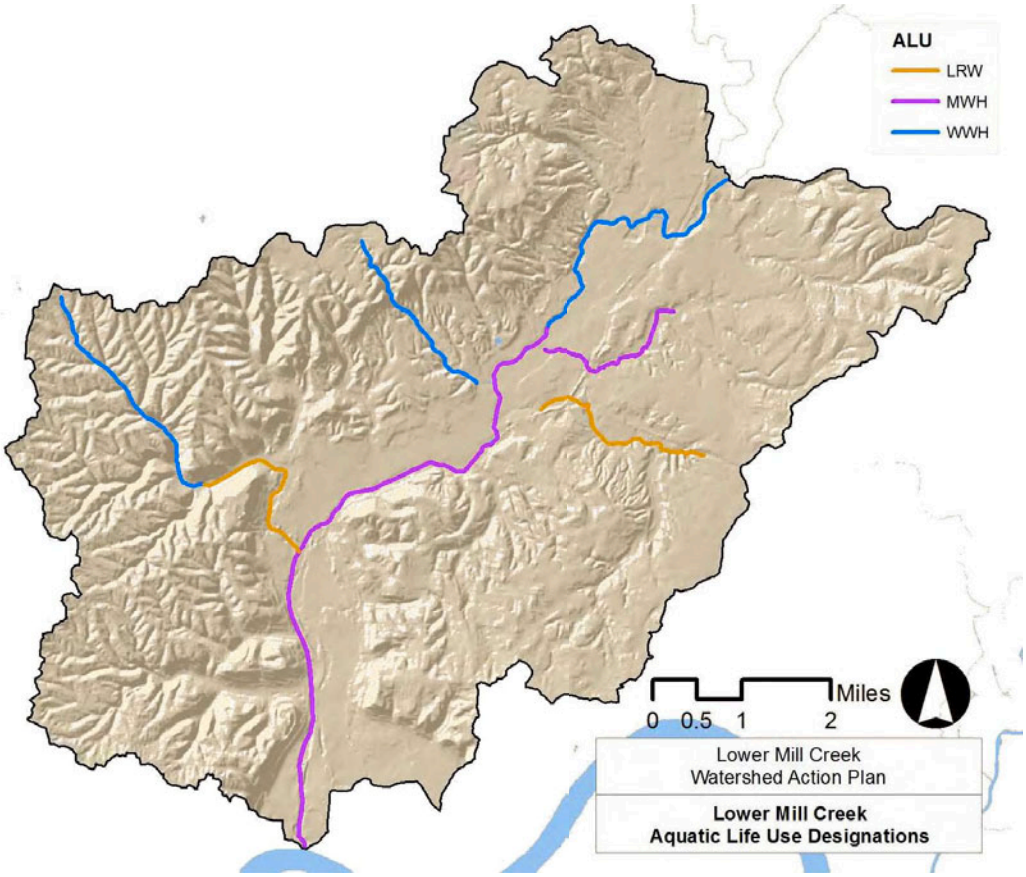


Figure 33 - Lower Mill Creek Aquatic Life Use Designations

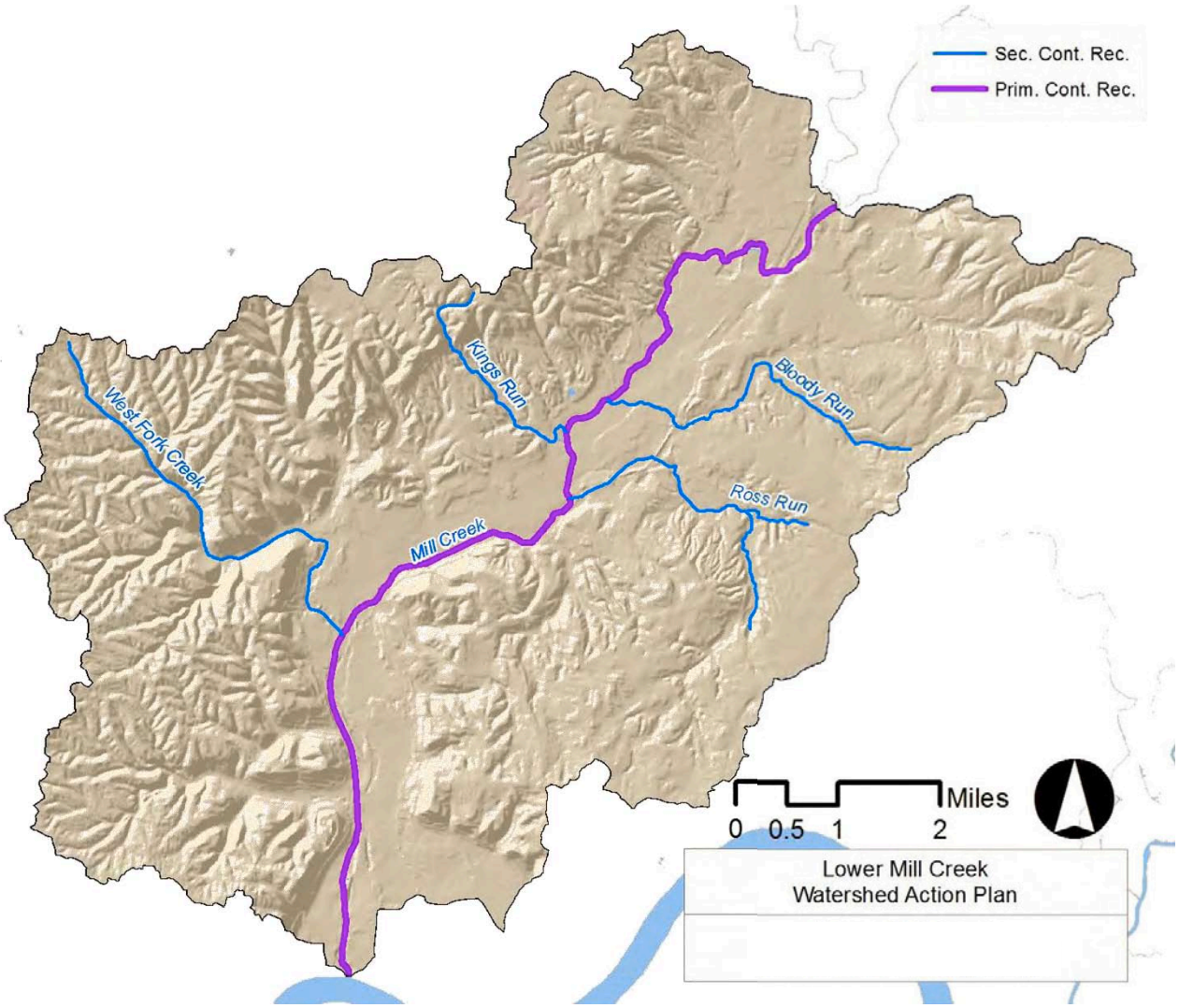


Figure 34 - Recreational Use Designations

Primary Contact Recreation—Key Attributes: water depth allows full body immersion; high proximity to residential areas; intermediate potential exposure to bacteria. Practical Impacts: intermediate risk of swimmer's illness after exposure; baseline level of disinfection

Secondary Contact Recreation—Key Attributes: water depth precludes full body immersion; low proximity to residential areas; lowest potential exposure to bacteria. Practical Impacts: greatest risk of swimmer's illness after exposure; slightly less disinfection of wastewater

4.3.9 LAKES AND RESERVOIRS

There are approximately 88 lakes, ponds and reservoirs in the LMC watershed with a total surface area of about 64 acres. Many of the larger water bodies are storm water retention basins or lakes and ponds in cemeteries and golf courses. The vast majority of water bodies (80%) are less than one acre in size. The largest reservoir, at almost 20 acres, is located at a landfill on Este Avenue near the Mill Creek. Spring Grove Cemetery, located in the Kings Run watershed, contains a total of 16 acres of water bodies. The pie-chart below depicts the area of surface water bodies in the LMC watershed by land use category. (Note: cemeteries are included in the residential category.)

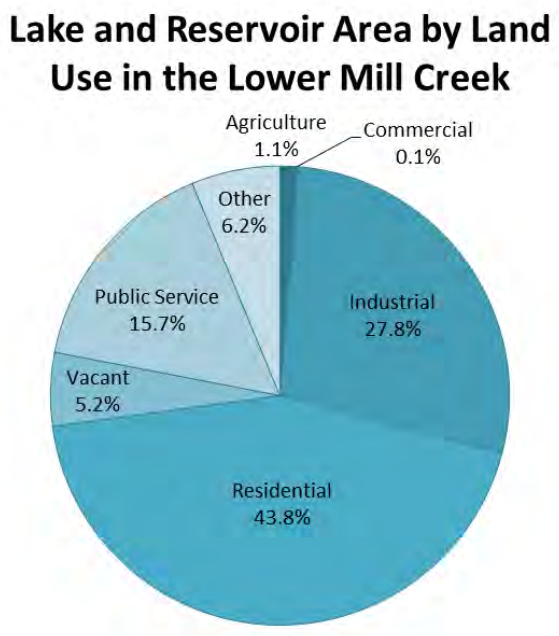


Figure 35 - Lake and Reservoir Area by Land Use

West Fork Lake and Dam

Just upstream of the LMC watershed, the West Fork Lake and Dam are located in the West Fork Mill Creek watershed (05090203-01-02). The West Fork Lake is known to many as Winton Woods Park, which the Hamilton County Park District manages and develops the recreation areas around West Fork Lake.

The West Fork Lake is a 183 acre man-made lake, constructed from 1949 to 1952 as a flood control project of the U.S. Army Corps of Engineers (USACE). The USACE Louisville District designed, built, and currently operates the dam to reduce flood damages downstream. According to the USACE Louisville District, the West Fork Lake has prevented more than $51.9 million in flood damages since impoundment.

The West Fork Lake and Dam are of interest to the LMC-WAP as this lake helps to control a significant amount of storm water during heavy rains by storing it and then releasing it at a controlled rate determined by the USACE.

Table 26 - West Fork Lake Report, August 13, 2012

Project	Winter Pool Feet	Summer Pool Feet	Flood Pool Feet	6 A.M. Outflow CFS	Inches Avail.	Percent Utilized
West Fork Lake	675	675	702	2	6.19	0.42

Source: USACE Louisville District

Image Credit: CityBeat.com

4.4 GROUNDWATER

Groundwater is water that occurs below the surface of the Earth, where all the pore spaces in the sub-surface material are completely filled with water. Groundwater moves slowly, commonly less than one foot per day, and moves from higher to lower water table elevations. It ultimately discharges to streams, lakes, wetlands, and the ocean. This discharge is called base flow and is important to many ecosystems.

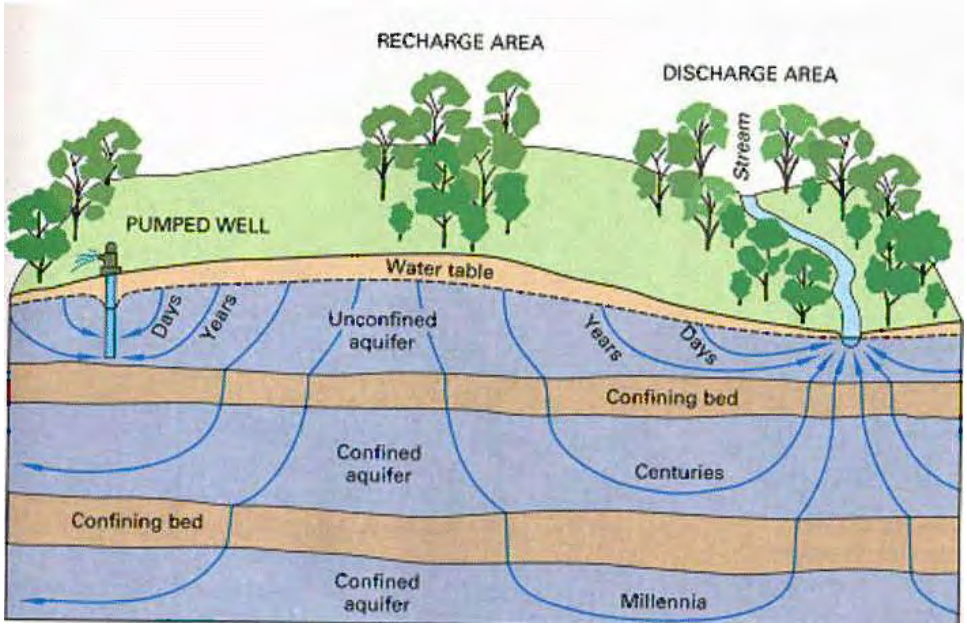


Figure 36 - Groundwater Flow Diagram

Source: USGS circular 1139

4.4.1 AQUIFERS

Aquifers are subsurface areas that hold groundwater and from which significant quantities of groundwater can be extracted. There are three main types of aquifers: sand and gravel, fractured rock, and limestone or karst formations.

Much of the Mill Creek Valley overlies a buried valley aquifer composed of highly permeable sands and gravel deposited during past glacial events. These aquifers tend to thin out laterally towards the Mill Creek Valley slopes. Two primary glacial outwash aquifers have been identified in the Mill Creek Valley – a deeper, confined aquifer (used historically for water supply) and an upper aquifer (40-60 feet below ground surface) rarely used to supply water. The shallow aquifer is not present in some areas of the valley. These two aquifers are typically separated by a leaky confining unit throughout the valley. Historical vertical gr adients suggest that water flows from the upper into the lower aquifer through the leaky confining unit. Groundwater in the lower aquifer generally flows from north to south along the primary orientation of the Mill Creek. Insufficient recent data on the upper and water table aquifers exist to provide an accurate description of flow direction. (USGS, 2002) A water table aquifer layer containing discontinuous layers of outwash up to 30 feet deep is present in some

parts of the watershed. The water table aquifer, when present, is often covered by till and soil. Evidence from 2001 flooding events in Hamilton County suggests that the water table aquifer is recharged by surface water infiltration.

Access to groundwater played a key role in industrial development and growth of municipalities in the Cincinnati area. Very little groundwater was ever used for residential consumption. Large distilleries first located in the region due to ready access of groundwater. Groundwater was also used historically for the pork-packing industry, paper mills and industrial process. Over-pumping of the aquifers by industry and local municipalities led to steep declines in the water levels of more than 100 feet by the 1950s. As demand for groundwater declined over time due to availability of water from the City of Cincinnati and private water suppliers the water levels in the lower aquifer has risen from 65 to 105 feet higher than they were in the mid-1950s. In a recent USGS report, most industries in 2000 reported that they use water derived from the Great Miami River valley. Three cities – Glendale, Lockland and Wyoming (all in Hamilton County and outside the Upper Mill Creek Watershed) – produce municipal water from wells (U.S. Geological Survey, 2002).

In the Ross Run sub-sewershed, the presences of thick layers of gravel and sand outwash deposits that fill the bottom of the ancient paths of the Ohio River valley suggest the area's long glacial history. In the city of Norwood, for example, the former path of the Ohio River formed the Norwood Trough, an area spanning the northern portion of the Watershed from Fairfax to St. Bernard. Norwood's industrial character can be attributed to this trough as the availability of artesian groundwater, which at the time was cheaper and cleaner than city water, made Norwood an attractive location. These artesian wells supplied Norwood's water needs until the late 1950s when industrial development in the Mill Creek Valley had significantly lowered the water table and Norwood found it more economical to buy its water from Cincinnati. After a spill of carbon tetrachloride into the Ohio River in 1977, Norwood uncapped one of the artesian wells at Park and Linden avenues to use as an alternative source of drinking water. Today the well is tested for purity three times daily.

Beneath the Mill Creek Valley is a large lobe of the Great Miami Buried Valley Aquifer System, a major groundwater resource underlying parts of 14 counties in Southwest Ohio. In the LMC watershed, the aquifer has glacial deposits of sand and gravel at thicknesses of 200 feet or more. A fairly continuous layer of relatively impermeable clay divides the sand and gravel deposits into a shallow aquifer and a lower aquifer (Ohio Kentucky Indiana Regional Council of Governments, 2011). North of the LMC watershed and the Village of Lockland, the lower aquifer is continuous in the buried valley, while the shallow aquifer and water-table aquifers are not (U.S. Geological Survey, 2002).

A. Sole Source Aquifer Status

While the buried valley aquifers in the Mill Creek watershed remain capable of producing water for human consumption, the USEPA excluded it from sole source aquifer designation in 1988. The July 8, 1988 Federal Register (page 25671) includes the following statement about this exclusion:

> *"The designated area (Buried Valley Aquifer System of the Great Miami/Little Miami River Basins) does not include the Mill Creek Basin in Butler and Hamilton Counties. This basin contains a Class 1 aquifer, but the*

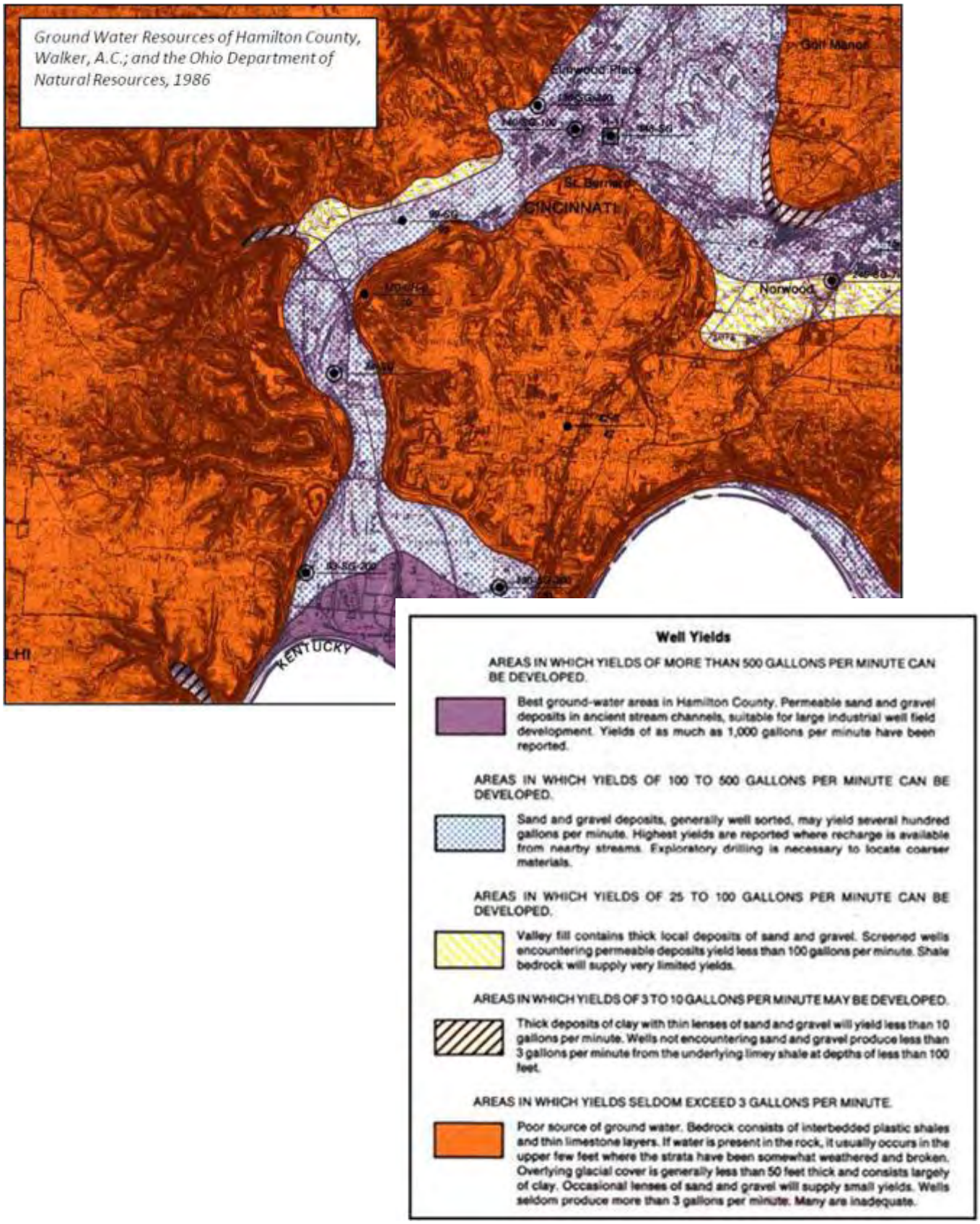
population in the drainage basin depends primarily on surface water for their drinking water supply. Although the communities of Wyoming, Lockland, Glendale and Reading do use ground water as their water source, they can connect to the Cincinnati water system if the aquifer becomes contaminated beyond levels commensurate with public health. When considered as a separate hydrologic system, the Mill Creek Basin does not meet the criteria established by EPA for sole source eligibility."

The July 8, 1988 Federal Register Notice includes the following from a May 18, 1988 public meeting in the Summary of Public Comments on page 25672: When considered as a separate hydrologic system, the Mill Creek Basin (MCB) Aquifer supplies only about 20% of the drinking water, with the majority of the population on surface water from the Cincinnati System. The area is highly industrialized, and a substantial portion of the recharge area is already occluded by development. The Mill Creek itself is highly channelized and, in many stretches, enclosed in a cement channel which prevents it from gaining flow in those stretches from ground water."

B. *Well Yields and Recharge*

Ground water within the LMC watershed varies widely in its accessibility and yield volumes. Permeable sand and gravel layers are located in ancient river beds beneath the City of Cincinnati and Lower Price Hill. In the rest of the Mill Creek Valley sand and gravel aquifers may be found near streams where recharge is available. *Figure* 37 - Ground Water Resources of Hamilton County identifies areas by relative well yield with the highest yields expected in the Mill Creek Valley and lower yields in the surrounding hills.

Figure 37 - Ground Water Resources of Hamilton County



4.4.2 FLOW REGIME

The Mill Creek lobe of the Great Miami Buried Valley Aquifer System flows slowly, generally from northeast to southwest along the Mill Creek Valley's primary orientation. Ultimately, Mill Creek Valley groundwater flows into the Ohio River Valley Aquifer in a fan shaped area underlying downtown Cincinnati and the riverfront.

According to the map in Figure 37 - Ground Water Resources of Hamilton County (Ohio Department of Natural Resources, Division of Water, 1986), nearly all of the aquifer underlying the lower Mill Creek Valley is an area where water well yields of 100 to 500 gallons per minute can be developed. The map legend explains the aquifer has generally well sorted sand and gravel deposits that provide the highest yields where recharge is available from nearby streams. The 1986 map also shows that part of the aquifer beneath downtown Cincinnati, as far north as Liberty Street at I-75, is one of Hamilton County's best groundwater areas where water well yields can range from 500 to 1,000 gallons per minute.

A more recent map titled *Yields of the Unconsolidated Aquifers of Ohio* (Ohio Department of Natural Resources, Division of Water, 2000) shows that the entire length of the Mill Creek Valley aquifer can yield more than 500 gallons per minute. The newer map also shows that fringes of the Mill Creek Valley aquifer can yield 100 to 500 gallons per minute from glacial deposits underlying parts of Norwood, St. Bernard and Cincinnati's Center Hill area. Valley fringe aquifer beneath much of Cincinnati's Northside neighborhood can yield 25 to 100 gallons per minute.

Natural recharge to the Mill Creek's aquifers is principally from precipitation (Eagon and Associates, 1999). The 1999 study said more information was needed to determine whether "the recharge occurs as leakage from the Mill Creek, diversion of storm water runoff to channels where infiltration is possible, or increased percolation from precipitation and runoff through windows in the confining bed, or some combination of all of these factors."

The volume of recharge was estimated in 1970 at 8.5 million gallons per day (MGD) by the U.S. Geological Survey (Water Supply Paper # 1893). Previous studies, however, estimated recharge at 10.7 MGD in 1943 (Klaer and Thompson) or 13.0 MGD in 1940 (Bernhagen and Schaefer). The later studies benefitted from more groundwater and pumpage data over longer time periods. Most of the recharge occurs north of Lockland (USGS, 1970). Direct recharge is small in areas where the lower aquifer is overlain by a confining bed of clay (Eagon and Associates, 1999). Such is the case in LMC watershed.

Recharge in the LMC watershed is further reduced by:

- Impervious surface cover associated with roads, parking lots, roofs, sidewalks, courts, plazas, patios and more
- Storm sewers that convey precipitation as runoff to the Mill Creek
- Combined sewers that convey precipitation as runoff to the Mill Creek Wastewater Treatment Plant or directly to the Mill Creek when they overflow
- Concrete streambanks and stream channels built in the 1980s and early 1990s by the U.S. Army Corps of Engineers for the Mill Creek Flood Damage Reduction Project

The demand for groundwater throughout the Mill Creek watershed increased steadily since industrial development began in the late 1800s. Industrial and municipal pumpage increased to 4.6 MGD by 1918. By about 1940, groundwater used more than doubled to nearly 10.0 MGD. World War II production generated a record pumpage of 17.5 MGD in 1942. From then until 1952, the rate leveled out at 14.4 MGD, but that was enough to cause declining well yields and a dropping water table. It was generally recognized that a groundwater problem existed throughout the Mill Creek watershed and that natural recharge was clearly being exceeded (Eagon and Associates, 1999).

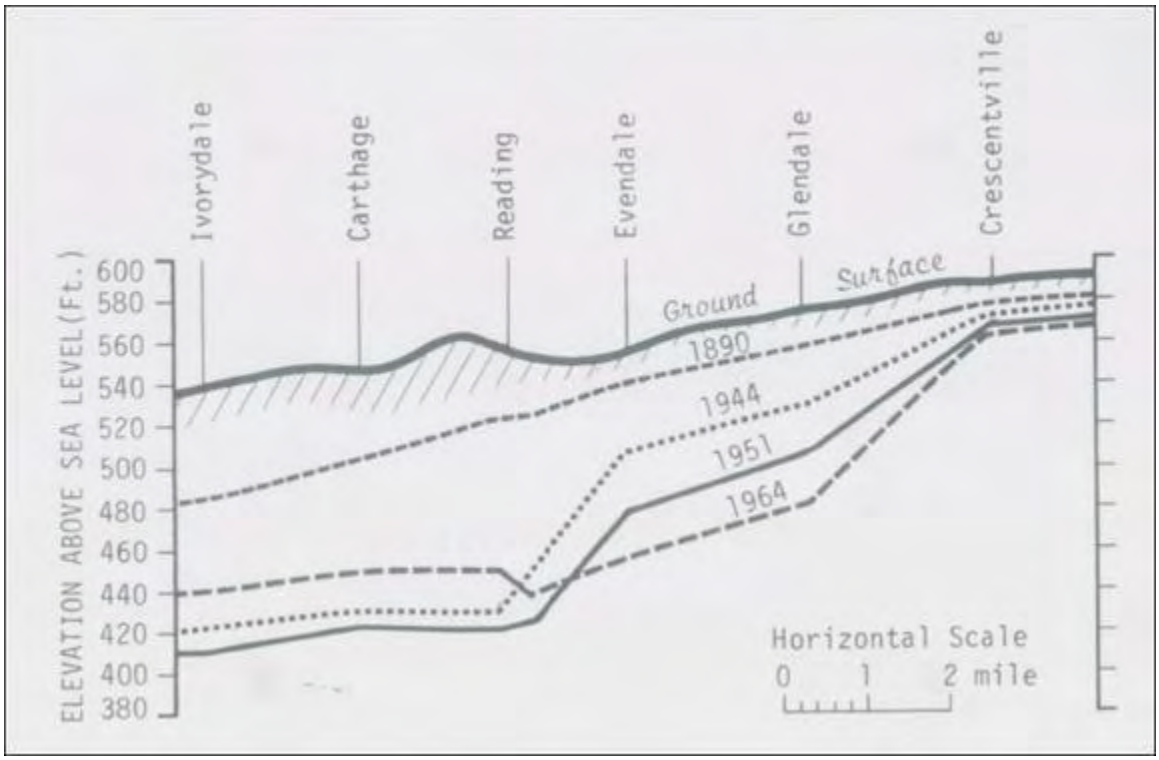


Figure 38 - Decline of Ground Water Levels in the Mill Creek Watershed

Source: OKI, 1977

The declining groundwater levels are diagrammed in Figure 38, which was copied from the Regional Water Quality Management Plan (OKI, 2011).

In 1952, local industries jointly created the Southwestern Ohio Water Company to supply the Mill Creek industrial complex with groundwater from a highly productive segment of the Great Miami Buried Valley Aquifer System. The industries now rely on water piped from a large well with horizontal collector lines in Colerain Township, inside the Big Bend of the Great Miami, next to Heritage Park. On a daily basis, the radial well pumps millions of gallons of clean groundwater from the Great Miami River watershed to the Mill Creek

watershed. This inter-basin transfer provides Mill Creek industries with plentiful process water, typically for cooling. The transfer also ensures a healthier base flow for Mill Creek surface water and resolves concerns about well yields or lowering water tables.

Rising water tables are the current trend for the Mill Creek watershed. Since the 1950s, groundwater levels of the lower Mill Creek aquifer have risen 65 to 105 feet in a study area stretching from Lockland to West Chester (U.S. Geological Survey, 2002). Though the USGS report does not address the LMC watershed, it bodes well for groundwater flow in the lower watershed's aquifers.

4.4.3 SOURCE WATER ASSESSMENT PLAN (SWAP) INFORMATION

No public water systems withdraw groundwater in the LMC watershed, so the area is not subject to any Source Water Assessment Plans. Three municipalities, however, rely on Mill Creek aquifer resources in the central Mill Creek Valley, two to six miles north of the lower Watershed. The three municipalities are:

1. Glendale, which operates 2 wells in the Village of Evendale, immediately south of the Ford plant and Sharon Road, between the Mill Creek and Sharon Creek.
2. Lockland, which operates 3 wells in the City of Sharonville, north of Sharon Road and the Ford Motor Co. assembly plant, between the Mill Creek and Sharon Creek to the east.
3. Wyoming, which operates 6 wells in Wyoming, near the Wyoming City Building on Oak Avenue, southwest of West Fork Mill Creek.

Glendale, Lockland and Wyoming recognized the benefits of collaboration and worked together on a joint wellhead protection area delineation study by Eagon & Associates in 1999. The study computed their combined groundwater pump rate in 1998 at 2.2 MGD. Individually, the municipalities used:

- Glendale, 0.41 MGD
- Lockland, 0.65 MGD
- Wyoming, 1.08 MGD

Though Glendale, Lockland and Wyoming are north of the LMC watershed, their source water assessment plans are instructive for groundwater protection efforts in the LMC watershed. The plans can be downloaded from a secure website operated by the Ohio EPA at: http://epa.ohio.gov/ddagw/swap_assessments.aspx.

The need for source water protection in the Mill Creek watershed has been most obvious in Reading. The city operated a hometown well-field along the east bank of the Mill Creek for decades but closed the operation in 1993 due to groundwater contamination from several industries and hazardous waste handlers. Reading now purchases treated surface drinking water from Greater Cincinnati Water Works. The Cincinnati-owned utility is another major source of inter-basin transfer to the Mill Creek watershed. The water works withdraws surface water from the Ohio River and groundwater from a well-field along the Great Miami River in southwest Fairfield for distribution to all but eight of the Mill Creek watershed's 36 political jurisdictions. The exceptions are Liberty Township, Fairfield Township, West Chester Township, City of Hamilton, City of Fairfield, Village of

Lockland, Village of Glendale and City of Wyoming.

In addition to the Ohio EPA's source water assessments, the U.S. EPA is authorized to designate a groundwater supply as a Sole Source Aquifer. Such a designation means that the aquifer is the sole or principal source of drinking water in a petitioned area. If contaminated, the aquifer would pose a significant hazard to public health. All federal financially assisted projects built in a Sole Source Aquifer area are subject to the U.S. EPA's review to ensure that these projects are designed and built to avoid a public health threat.

Table 27 –Ohio EPA Ground Water Wells and Protection Areas by Time of Travel

Watershed	System	# of Wells	1 year (acres)	5 year (acres)
Congress Run-Mill Creek	Wyoming City PWS	5	12.1	1.0
West Fork-Mill Creek	N/A	N/A	N/A	N/A

Source: (ODNR, 2011)

On a petition from the OKI Regional Council of Governments, the U.S. EPA issued a Federal Register Notice on July 8, 1988, designating the Great Miami Buried Valley Aquifer System as a Sole Source Aquifer. The designation, however, does not include the "Mill Creek Basin in Butler and Hamilton Counties." The federal notice stated: "This basin "contains a Class I (highly productive) aquifer, but the population in the drainage basin depends primarily on surface water for their drinking water supply. Although the communities of Wyoming, Lockland, Glendale, and Reading do use ground water as their water source, they can connect to the Cincinnati water system if the aquifer becomes contaminated beyond levels commensurate with public health. When considered as a separate hydrologic system, the Mill Creek Basin does not meet the criteria established by EPA for sole source eligibility."

In its summary of public comments, the Federal Register Notice added: "During a public meeting May 18, 1988, the question arose as to whether the Mill Creek Basin (MCB) Aquifer should be included in the designated area. When considered as a separate hydrologic system, the MCB Aquifer supplies only about 20 percent of the drinking water, with the majority of the population on surface water from the Cincinnati System. The area is highly industrialized, and a substantial portion of the recharge area is already occluded by development. The Mill Creek itself is heavily channelized and, in many stretches, enclosed in a cement channel which prevents it from gaining flow in those stretches from ground water. Proponents for inclusion of the MCB Aquifer maintained that to exclude it from the designated area would disrupt the integrity of the (Great Miami) Buried Valley Aquifer System Sole Source Aquifer and have adverse impacts on the water supply of those communities that do use the MCB Aquifer for their supply."

Sensitivity of Ground Water to Local Sources of Contamination

Reading's loss of a well field to hazardous waste plumes illustrates that ground waters of the Mill Creek

watershed are vulnerable, if not highly sensitive, to local sources of contamination.

From a hydrogeological perspective, aquifers of the LMC watershed have a moderately high pollution potential. Researchers assigned LMC watershed aquifers potential scores of 143 to 167 on a scale that ranges from 77 to 201. A higher the score signifies a higher the potential for groundwater pollution. *Figure 39 - Ground Water Pollution Potential of Hamilton County* uses warmer colors to illustrate more sensitive areas. The map originates from Ground Water Pollution Potential of Hamilton County, Ohio, which was published in 1989 by the University of Cincinnati Groundwater Research Center in Cooperation with the Ohio Department of Natural Resources, Division of Water, Ground Water Resources Section. They used the DRASTIC mapping process, a nationally recognized methodology that assigns weighted scores to seven major hydrogeological factors that form the acronym DRASTIC:

D – Depth to water
R – Recharge (net recharge)
A – Aquifer media
S – Soil media
T – Topography
I – Impact of the vadose zone media
C – Conductivity (hydraulic) of the aquifer

From a policy perspective, drinking water protection areas in the Mill Creek watershed have a moderate to high susceptibility to contamination. The Ohio EPA conducts susceptibility analyses to evaluate the likelihood that public water system's source water could become contaminated. Each analysis is based on:

- hydrogeological sensitivity of the aquifer to contamination
- available water quality data for the water system
- number and types of potential contaminant sources located in the water system's protection area

Though the LMC watershed has no public water systems reliant on groundwater, it is instructive to know that the Ohio EPA considers the City of Wyoming's drinking water protection area in Wyoming, Lockland and Lincoln Heights to be moderately susceptible to contamination. This determination is based on two reasons:

A relatively thick layer of glacial till is present between the ground surface and the aquifer, providing limited protection to the aquifer. Significant potential contaminant sources exist in Wyoming's protection area. These general conditions prevail for ground waters of the LMC watershed.

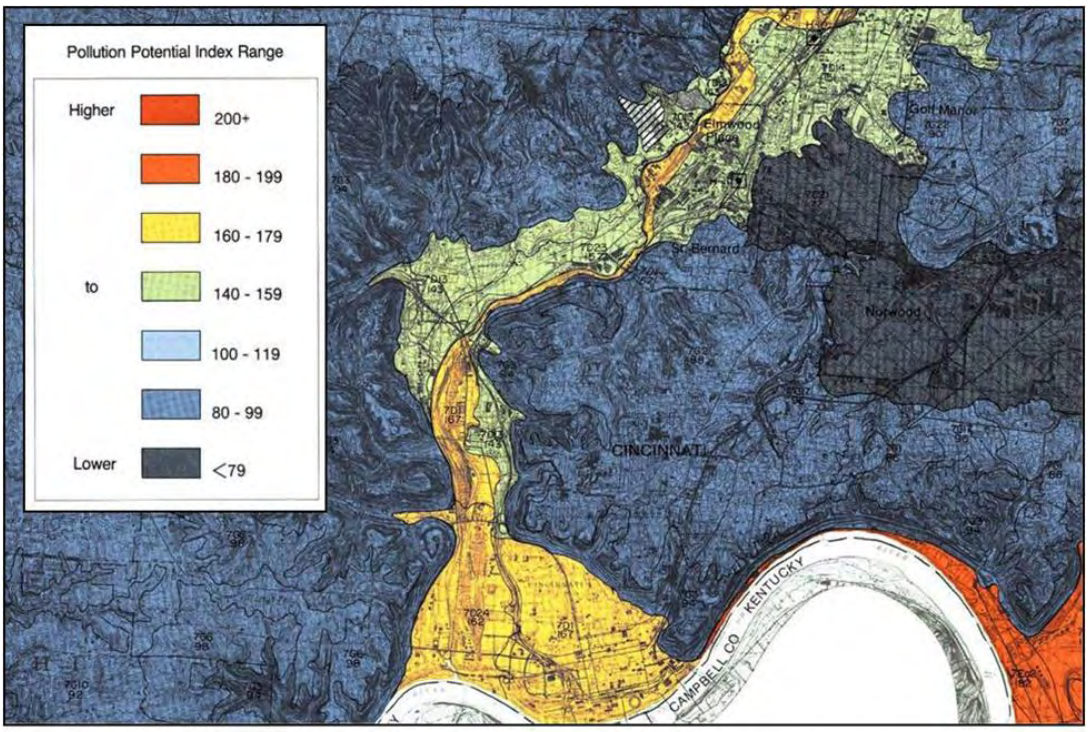
On the other hand, the Ohio EPA says the Village of Glendale's drinking water protection area in Evendale and Sharonville is highly susceptible to contamination due to:

- A relatively thin, discontinuous layer of low-permeability material overlies the aquifer.
- The geologic sensitivity of the sand and gravel deposits in the Mill Creek aquifer is significant.
- Significant potential contaminant sources are present within and just outside of Glendale's protection

area.

Lockland's drinking water protection area in Sharonville was also was rated by Ohio EPA as highly susceptible to contamination.

Figure 39 - Ground Water Pollution Potential of Hamilton County provides a map of ground water pollution potential for the LMC watershed. The pollution potential ranges from moderate to moderately high in the Mill Creek valley to low in the upland portions.



Ground Water Pollution Potential of Hamilton County by the University of Cincinnati Ground Water Research Center in cooperation with the Ohio Department of Natural Resources Division of Water, published in 1999.

Figure 39 - Ground Water Pollution Potential of Hamilton County

Source: (ODNR, 2011)

4.5 LAND USE

4.5.1 URBAN AND RURAL

Land use within the LMC watershed has changed significantly over the years as urban development has gradually replaced the natural landscape. Approximately 59 percent (23,601 acres) of the LMC watershed is covered by urban development, leaving approximately 41 percent (16,338 acres) as vacant or open space.

NLCD Land Cover Description for Figure 63

11. Open Water—All areas of open water, generally with less than 25 percent cover of vegetation or soil.
21. Developed, Open Space—Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes
22. Developed, Low Intensity—Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20–49 percent of total cover. These areas most commonly include single-family housing units.
23. Developed, Medium Intensity—Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50–79 percent of the total cover. These areas most commonly include single-family housing units.
24. Developed, High Intensity—Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses, and commercial/industrial. Impervious surfaces account for 80 to 100 percent of the total cover.
31. Barren Land (Rock/Sand/Clay)—Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earthen material. Generally, vegetation accounts for less than 15 percent of total cover.
41. Deciduous Forest—Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.
42. Evergreen Forest—Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.
43. Mixed Forest—Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.
52. Shrub/Scrub—Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20 percent of total vegetation. This class includes true shrubs, young trees in an early successional stage, or trees stunted from environmental conditions.
71. Grassland/Herbaceous—Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
81. Pasture/Hay—Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the

production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.

82. Cultivated Crops—Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.

90. Woody Wetlands—Areas where forest or shrubland vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

95. Emergent Herbaceous Wetlands—Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

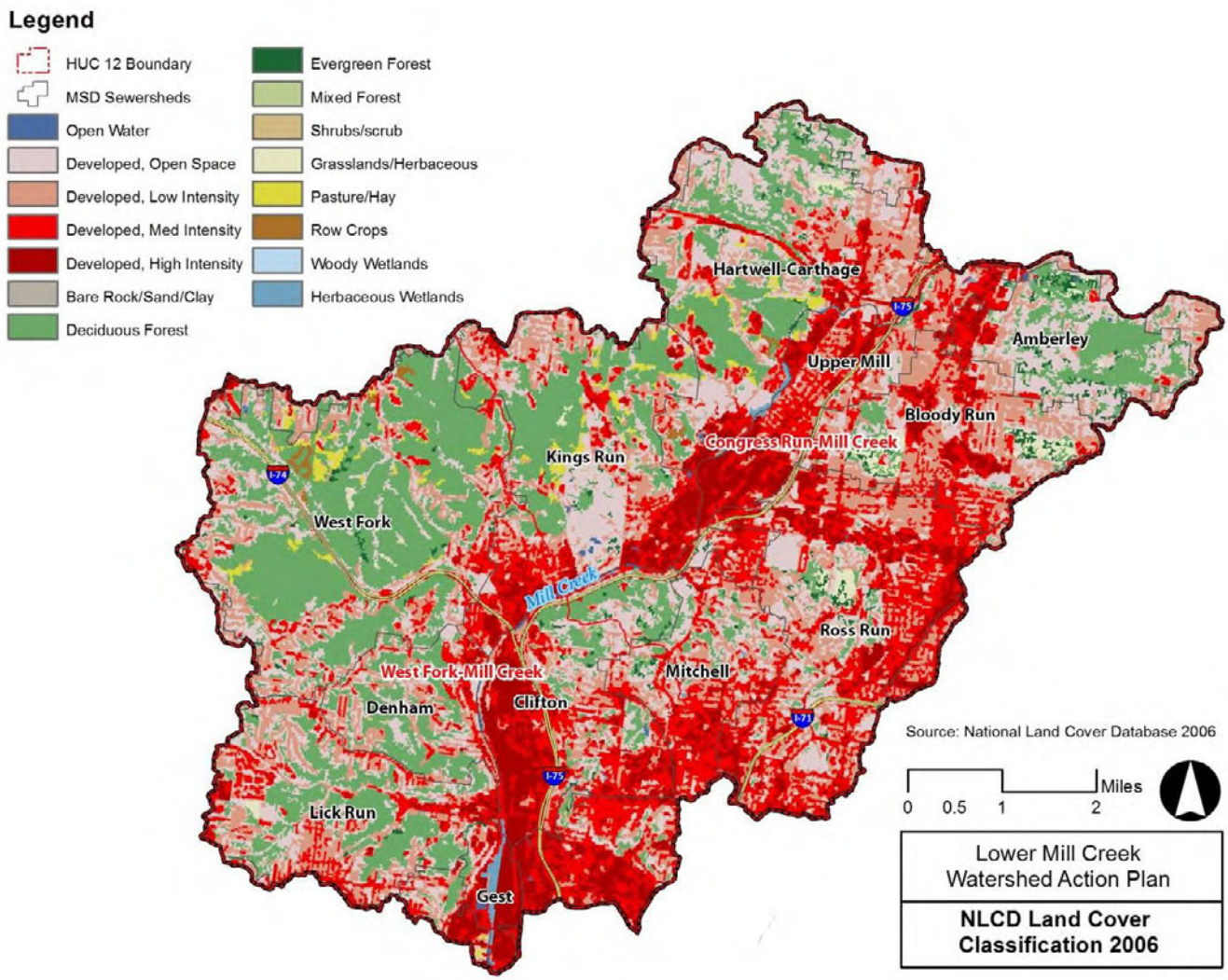


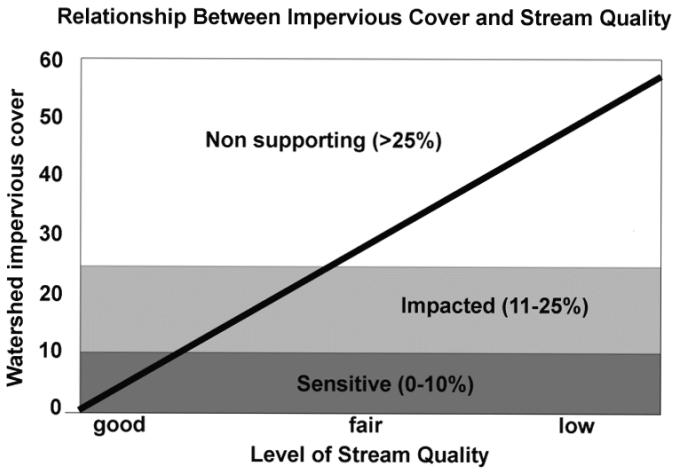
Figure 40 - NLCD Land Cover Classification

Source: National Land Cover Database 2006

A. *Impervious Surfaces*

Impervious surfaces can include buildings, pavement, roadways and highways, and bridges. These areas can greatly increase the rate of storm water runoff by reducing or even preventing the natural infiltration of storm water into soils. Quantification of imperviousness can offer a relatively objective measure of Watershed impairment.

The Center for Watershed Protection, in the report "Impacts of Impervious Cover on Aquatic Systems" (2003), states that as little as 10% watershed impervious cover is linked to a decreasing ability to achieve a high water quality indicator score, between 10-25% watershed impervious cover is linked to a pronounced decline in ability to achieve a high water quality indicator score, and above 25% is defined as the upper threshold where attainments of even a warm water habitat biocriterion is effectively lost. Several other reports have linked a decline in amphibian, plant and insect community species richness and density to increases in watershed impervious cover (Findlay & Houlahan, 1997) (Horner, Booth, Azous, & May, 1997) (Taylor, 1993) (Boward, Kazyak, Stranko, Hurd, & Prochaska, 1999) (Hicks & Larson, 1997).



Source: Center for Watershed Protection 1998

Figure 41 - Impervious Cover and Table 28 – Impervious Surfaces by Type and Area, shows a breakdown of CAGIS planimetric data layers which indicate several highly impervious surfaces. By knowing the total area of these types of impervious surfaces, we can begin to estimate the potential impact of certain types of BMP solutions, such as rain barrels and green roofs for buildings, and green streets and bio-swales for roadways. The CAGIS data is more accurate than the National Land Cover Database, but unfortunately not all the layers within CAGIS are easily prepared to quantify impervious cover area (e.g. parking lots, driveways); but they are shown on the map in Figure 41 in their "polyline" format.

NLCD Impervious Surface Data – Raster Based

The NLCD data provides useful and appropriately scaled land use descriptions and classifications for Watershed

based planning and management. The NLCD models use raster pixels in a mapping Zone to produce a per-pixel estimate of imperviousness in urban areas. The impervious surface data classifies each pixel into 101 possible values (0% – 100%). This procedure offers a consistent and repeatable method to characterize urban areas across the Nation.

According to NLCD Impervious Cover data, impervious surfaces (classified as 20-100% impervious to correspond with the watershed decline statistics) cover approximately 17,752 acres, or 52 percent of the total watershed. This is not an actual measure of total impervious cover or *effective impervious cover* (only measures IC that is hydraulically connected to the drainage system), but a generalized measure which has the benefit of capturing the variability in imperviousness (i.e. forest vs. grass vs. concrete) thru a percent classification.

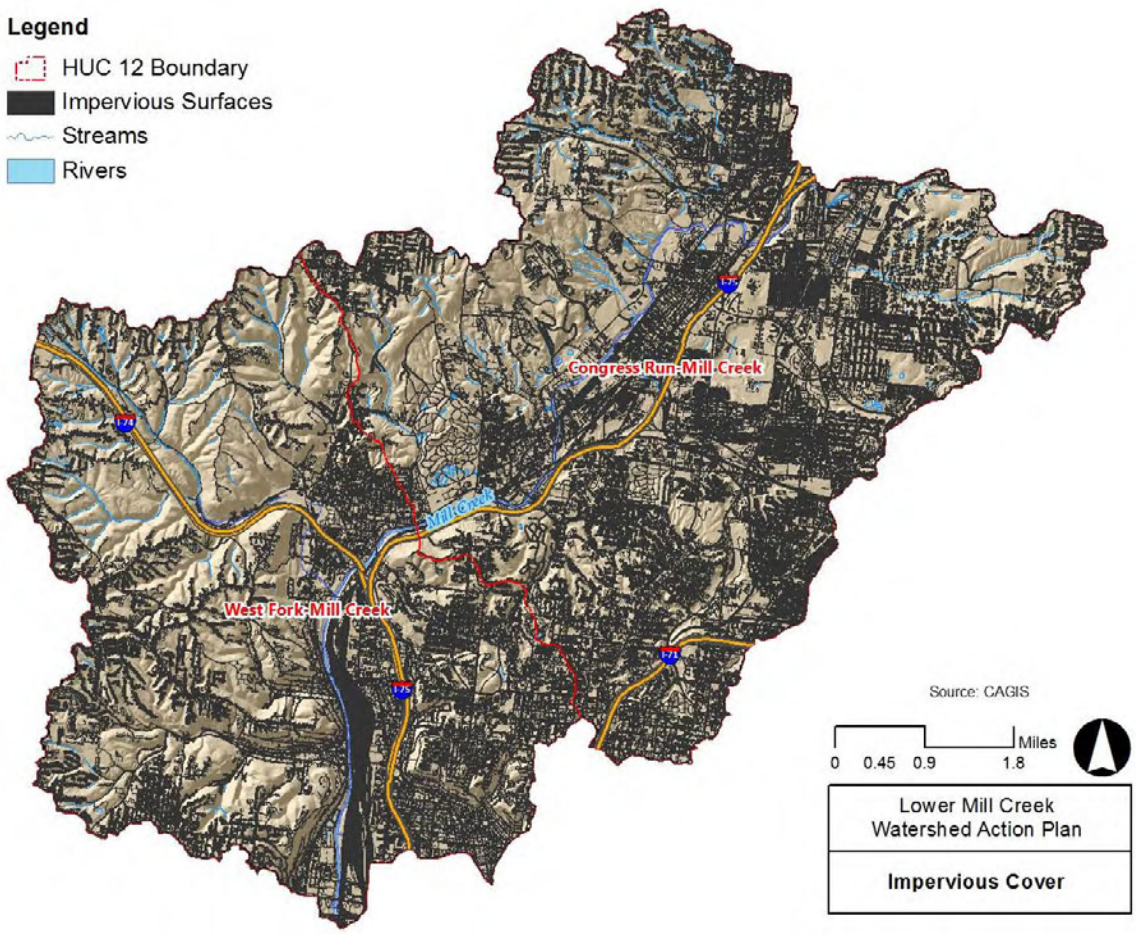


Figure 41 - Impervious Cover

Source: (CAGIS, 2012)

Table 28 – Impervious Surfaces by Type and Area

Impervious Surface Types	LMC Watershed Total Area (acres)	Percentage of Total Area
Buildings	3,512	10.2%
Roadways	2,539	7.4%
Parking Lots	unknown	unknown
Driveways	unknown	unknown
Sidewalks	586 (approx.)	1.7%
Other	unknown	unknown
LMC Watershed Total	**34,346**	**100%**

Source: (CAGIS, 2012)

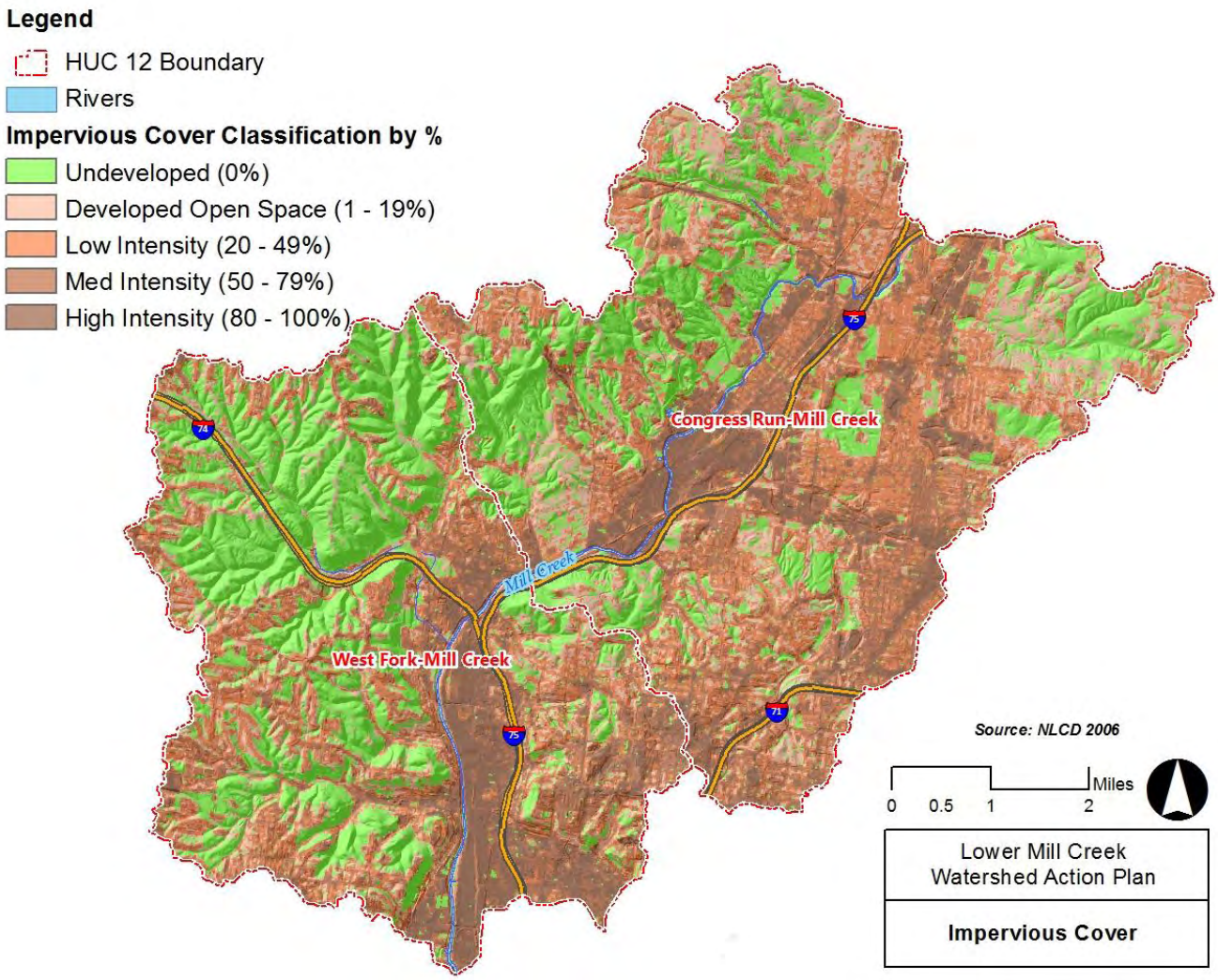


Figure 42 - Impervious Cover Classification by Percent

Source: NLCD 2006

Table 29- Impervious Surfaces Land Classification by Percent

Imperviousness Cell Classification	Acres	Percentage of Total Area
Undeveloped (0%)	10,562.9	31%
Developed Open Space (1 - 19%)	6,000.4	17%
Low Intensity (20 -49%)	7,584.6	22%
Med Intensity (50 - 79%)	6,690.7	19%
High Intensity (80 - 100%)	3,476.3	10%
Totals	**34,314.9**	**100%**

Source: NLCD 2006

B. *Existing Land Use*

The Lower Mill Creek is mostly built out, with a majority of remaining undeveloped open spaces being more difficult to build upon due to slope or soil conditions. Of the approx. 31,000 acres that compose the Lower Mill Creek Watershed, nearly a third of this area is used for single-family property.

Several land use trends are visible on Figure 43. The industrial development corridors that follow the Mill Creek, I-75 Highway, Norwood Lateral and Reading Road to the North. In the southern half of the Lower Mill Creek, the average parcel sizes are smaller and the diversity of uses is more mixed; more indicative of urban centers. Large public parcels standout such as: Mt. Airy Park in the West Fork sub-sewershed, French Park in the Amberley sub-sewershed, and the major institutions in the Clifton sub-sewershed (e.g. University of Cincinnati, various hospitals).

Public services are the second most common property type although they encompass a broad range of functional uses which includes schools, universities, parks, city property, county property, state property, federal property, and more. Institutional properties are also a common land use in the Lower Mill Creek and can include hospitals, libraries and certain types of schools. Public utilities can include land used for rail-roads which is prominently shown on the map along the lower Mill Creek corridor from the Gest sub-sewershed on the south to the Clifton sub-sewershed on north.

Table 30 - Existing Land Use by Type and Area

Land Use	Area (Acres)	Percent of Total
Single-Family	9,166.96	29%
Public Services	6,371.03	20%
Vacant	3,292.56	11%
Multi-Family	2,010.43	6%
Institutional	1,612.35	5%
Heavy Industrial	1,234.19	4%
Light Industrial	1,223.52	4%
Commercial	1,134.39	4%
Public Utility	926.06	3%
Two-Family	912.61	3%
Educational	852.47	3%
Parks and Recreation	744.42	2%
Unclassified	536.69	2%
ROW, Streets, other	377.95	1%
Office	265.61	1%
Congregate Housing	218.31	1%
Agricultural	178.79	1%
Multi-Use	76.89	0%
Mobile Homes	0.17	0%
Totals	**31,135.38**	**100%**

Source: (CAGIS, 2012)

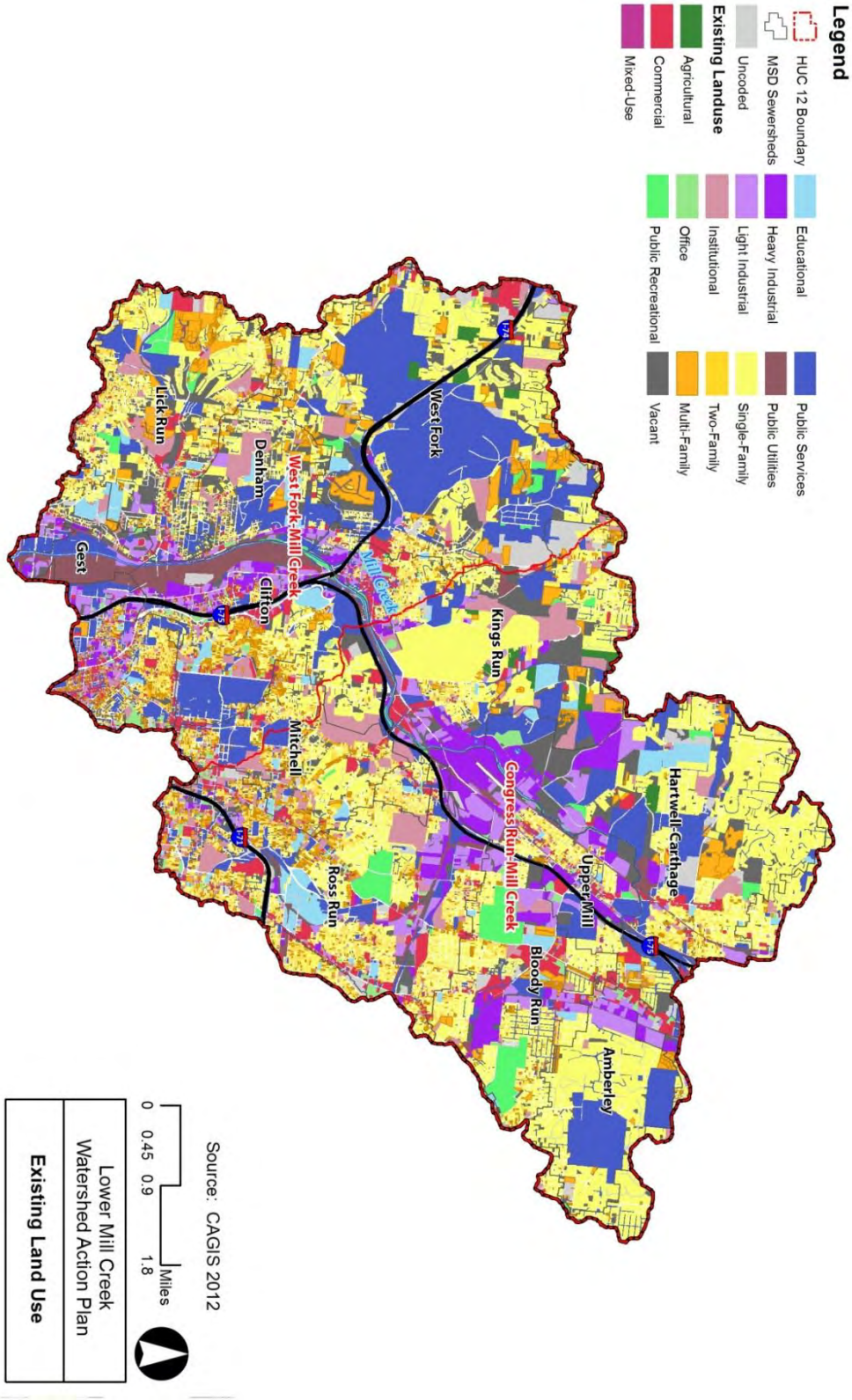


Figure 43 - Existing Land Use

Source: (CAGIS, 2012)

4.5.2 LOCATION OF HOME SEWAGE TREATMENT SYSTEMS

Failing home sewage treatment systems (HSTS) are a serious public health concern because of the potential that people will come into direct contact with untreated sewage in yards, ditches or streams. Storm water runoff will carry the untreated sewage with its high concentration of nutrients into streams causing organic enrichment, excessive algal growth, and loss of dissolved oxygen. The flushing of untreated sewage into lakes and streams can potentially introduce pathogens (bacteria and viruses) into the water supply, and create a contact hazard for recreational users.

The LMC watershed contains 898 HSTS with the highest concentration of these in the West Fork and Hartwell-Carthage sub-sewershed. The HSTS are sorted by sub-sewershed in *Table 31 - Home Sewage Treatment Systems by Sub-sewershed* and mapped in *Figure 44 - Septic System Locations*.

4.5.3 FORESTS

The Mill Creek valley when first surveyed in 1788 was completely covered by dense deciduous forests (Hedeen, 1994). The valley was primarily covered by beech-maple forests with stands of oak, hickory, and other mixed mesophytic species. Land was rapidly cleared for agriculture and timber that was necessary to support a growing human population and corresponding industries. By 1881, the forest canopy had been reduced to 15% of its original coverage (Ford & Ford, 1881) (Hutslar, 1971) (Plowman, 1908).

An aerial survey conducted in 2010 indicates that the forest canopy within LMC watershed has rebounded to its current level of 13,860 acres (40.4% canopy coverage). The forest is comprised of a range of early succession species such as black locust and hackberry, to later succession species such as oak and maple that have regenerated on properties that were previously used for agriculture. The LMC watershed contains 2,869 acres of protected forest and 97 acres of forests that are held by land trusts.

A. Forest Quality

The Cincinnati Park Board (CPB) conducted a forest quality inventory of protected lands and lands held by trusts. The CPB has developed an inventory system that prioritizes invasive species management based on their potential impact on native forest and understory species, shown in *Figure 28 - Invasive Species Assessment for Protected Lands* on page 58. Forests with an "A" rating contain relatively high percentage of native trees and understory and a low percentage of invasive species. Parks with a "B" rating have pockets of desirable trees and understory plants. Parks with a "C' rating contains early to mid successionary forests with a high percentage of invasive species. Within the LMC watershed, 611 acres of forested protected lands are high quality (22.4%), 409 acres are of moderate quality (20.4%), and 1,707 acres (71.2%) are poor quality.

Federal, state, county, and city agencies own and manage properties that include 3,945 acres of forested canopy. The remaining canopy is comprised of private properties and public right of ways.

Tree canopy in the LMC watershed is shown in ***Figure 45 - Tree Canopy***.

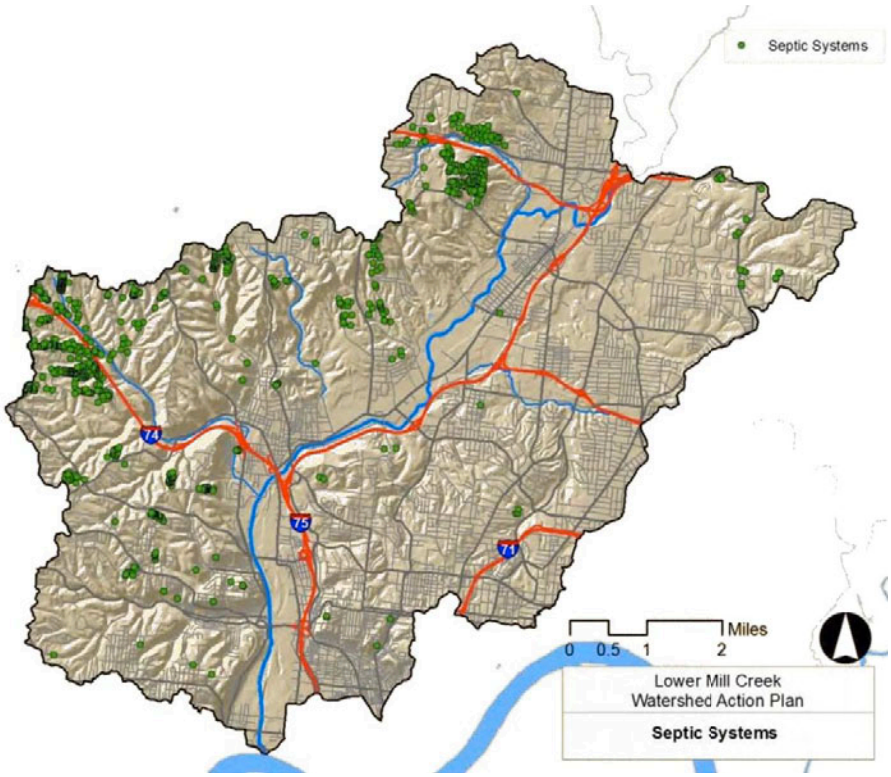


Figure 44 - Septic System Locations

Source: (CAGIS, 2012)

Table 31 - Home Sewage Treatment Systems by Sub-sewershed

Sub-sewershed	Septic Systems
Lick Run	17
West Fork	459
Ross Run	3
Bloody Run	0
Amberley	17
Upper Mill	2
Kings Run	68
Hartwell-Carthage	278
Gest	0
Denham	47
Mitchell	0
Clifton	7
Total	**898**

Source: (CAGIS, 2012)

B. *Tree Canopy*

In the lower Mill Creek, most of the original forested area has been replaced by urban development. The remaining forested areas exist within designated parks and preserves. Tree canopy is an important component of natural systems. **Table 32: Total Tree Canopy** quantifies the total tree canopy by subwatershed boundary. A watershed's tree canopy provides valuable benefits in regard to natural storm water management, air quality improvement, habitat, and quality of life. Native tree cover can intercept, absorb, and filter storm water.

Human Nature, using CITYgreen™, a GIS-based tool that analyzes the ecological and economic benefits of tree canopy cover, investigated tree canopy benefits in terms of annual rainfall using the 1970 typical year precipitation dataset. In addition to computing air pollution removal and carbon storage, this tool calculates storm water runoff using the Natural Resource Conservation Service (NRCS) model (TR-55 method).

Using the Lick Run sub-sewershed (1,261 acres of canopy) as an example of storm water runoff savings, a *CITYgreen* analysis showed storage volume capacity at approximately 56.8 million gallons during a 2-year, 24-hour storm event of 2.86 inches. (This storm event was obtained from Table 8, Page 184 of the Rainfall Frequency Atlas of the Midwest.) This 56.8-million gallons value represents the volume of additional storm water that would have to be managed if the trees were removed from the landscape of the Lick Run sub-sewershed.

Figure 45 - Tree Canopy

Table 32: Total Tree Canopy

Watershed	Area (acres)
West Fork	7,976
Congress Run	8,117
Total	**16,093**

Source: (CAGIS, 2012)

4.5.4 AGRICULTURE

Much of the LMC watershed has been urbanized, but a few small pockets of agriculture still exist, as shown in ***Figure 46 - Agriculture Land in the LMC Watershed***.

A 2011 land classification study indicates that only the West Fork (42.6 acres) and Kings Run (59.6 acres) sub-sewershed contain agricultural land use; approximately 0.32% of the LMC watershed. There is no current, overall data available for the agricultural land used in the watershed, nor tillage, grazing, crop rotation or chemical use patterns.

Site visits to the properties indicate the following mix of agricultural use:
Kings Run: see map *Figure 47 - Kings Run Sub-sewershed Agriculture Uses*
West Fork: see map *Figure 48 - West Fork Sub-sewershed Agriculture Uses*

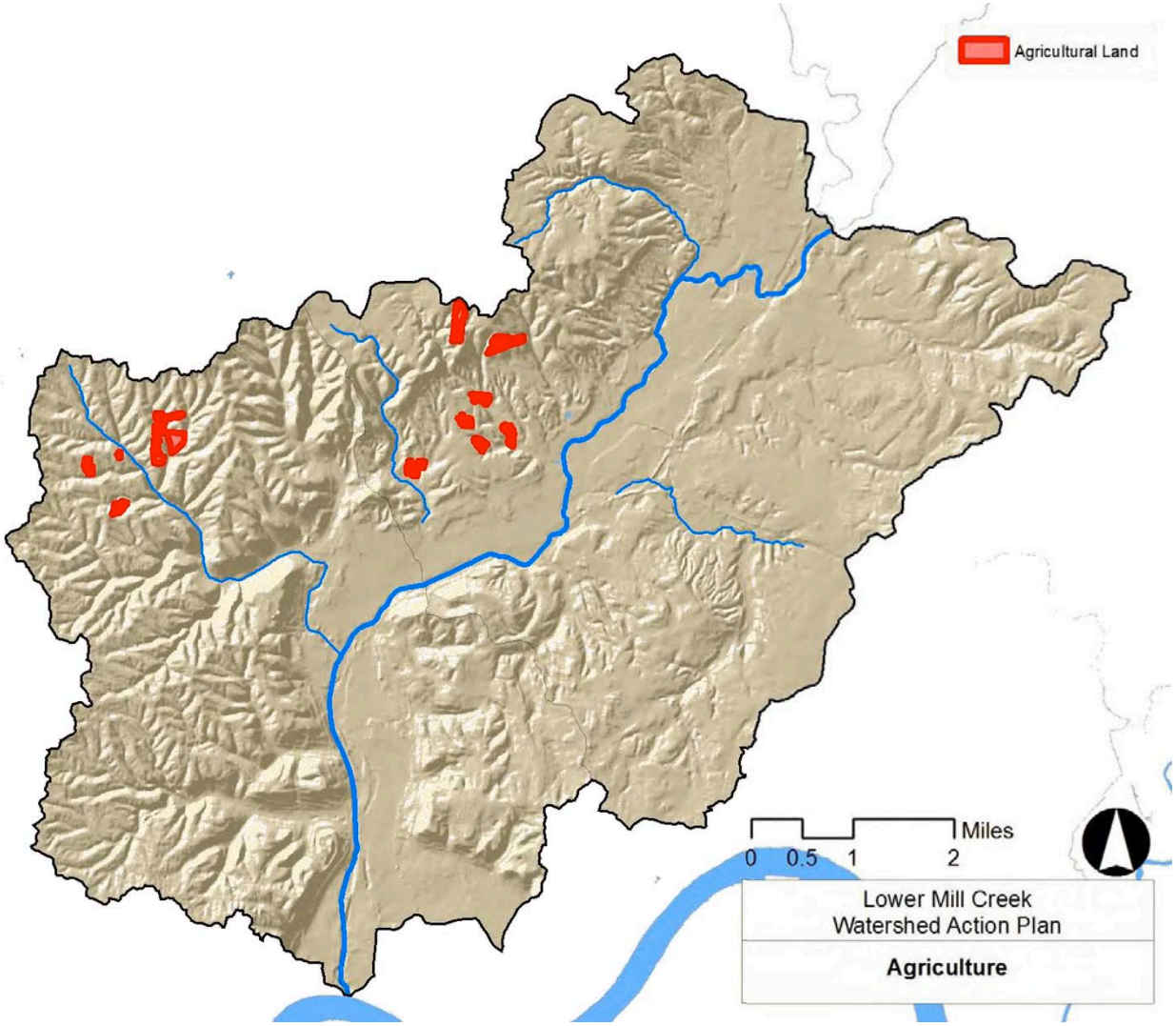


Figure 46 - Agriculture Land in the LMC Watershed

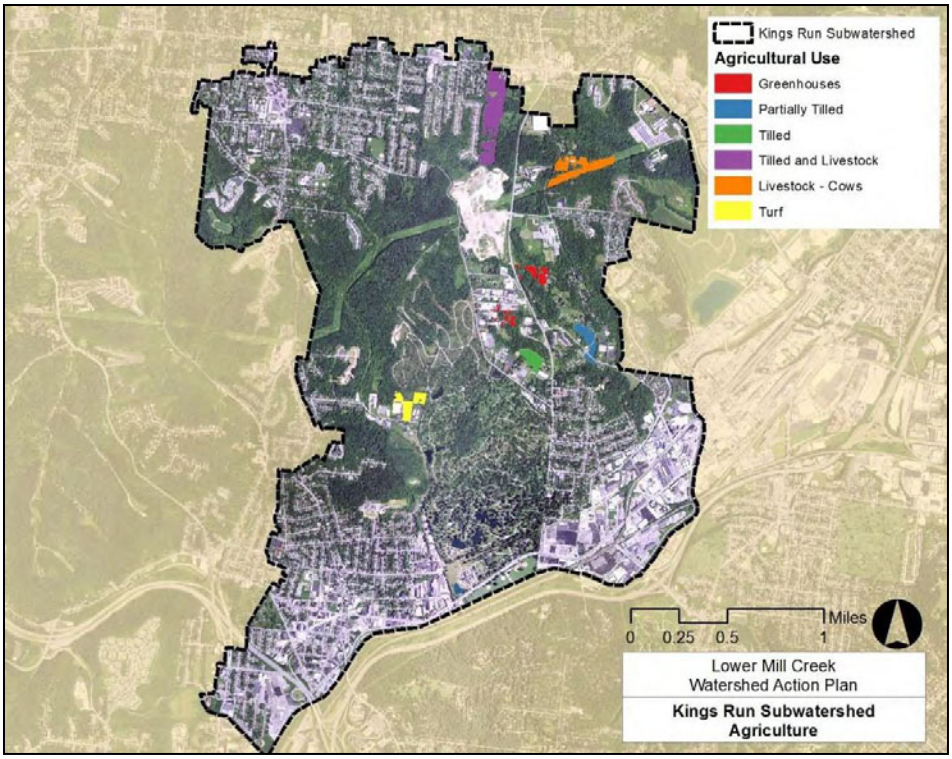


Figure 47 - Kings Run Sub-sewershed Agriculture Uses

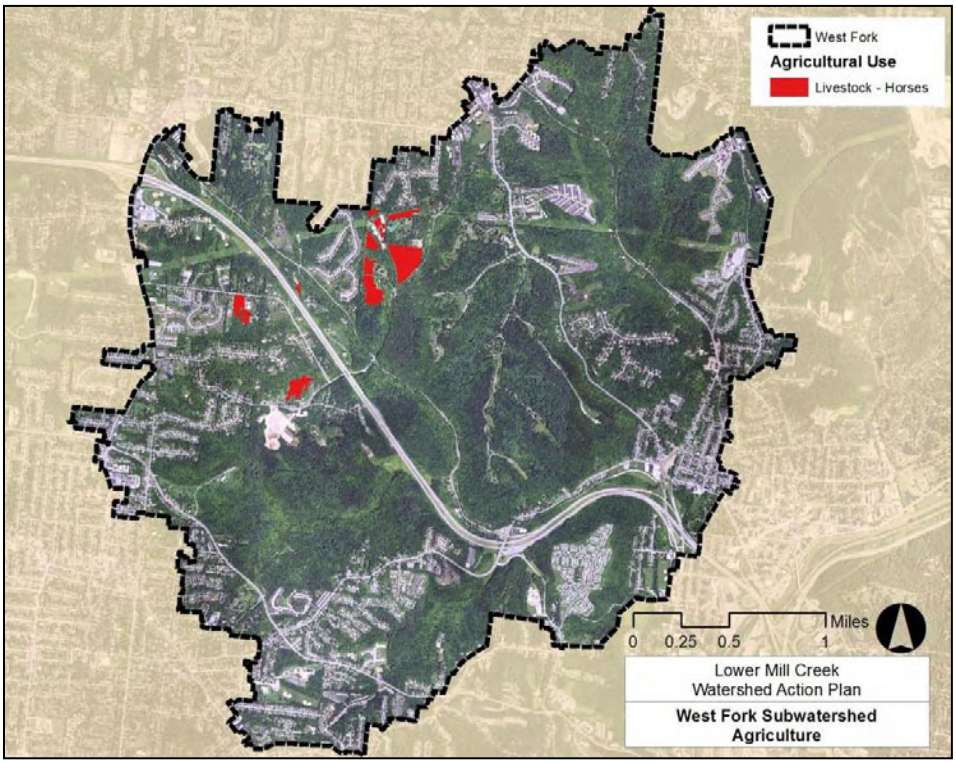


Figure 48 - West Fork Sub-sewershed Agriculture Uses

4.5.5 BARREN LAND

The LMC watershed contains 1,172 acres of barren land that comprises 3.7% of the total watershed area; shown on ***Figure 49 - Bare Soil Land Cover in the LMC Watershed***. Construction sites, material storage yards, landfills, and railroads are the most common cause of barren lands in the LMC watershed.

Table 33 - Barren Lands by LMC Watershed shows that the largest amount of barren land by acres and percentage is the Gest sub-sewershed with 39% of the land categorized as barren. These barren lands in this subwatershed are mostly railroad yards.

Table 33 - Barren Lands by LMC Watershed Sub-sewersheds

Sub-sewershed	Total Watershed Area (Acres)	Barren Land Area (Acres)	% Barren Land
Lick Run	2,718.9	25.3	0.9%
West Fork	5,524.1	67.5	1.2%
Ross Run	3,912.9	113.0	2.9%
Bloody Run	2,211.4	40.6	1.8%
Amberley	1,654.5	10.5	0.6%
Upper Mill	1,924.6	148.7	7.7%
Kings Run	3,846.0	114.1	3.0%
Hartwell-Carthage	4,161.7	136.9	3.3%
Gest	471.1	184.1	39.1%
Denham	1,316.9	11.7	0.9%
Mitchell	1,574.6	32.6	2.1%
Clifton	2,622.2	287.0	10.9%
Total		**1,172.0**	**3.7%**

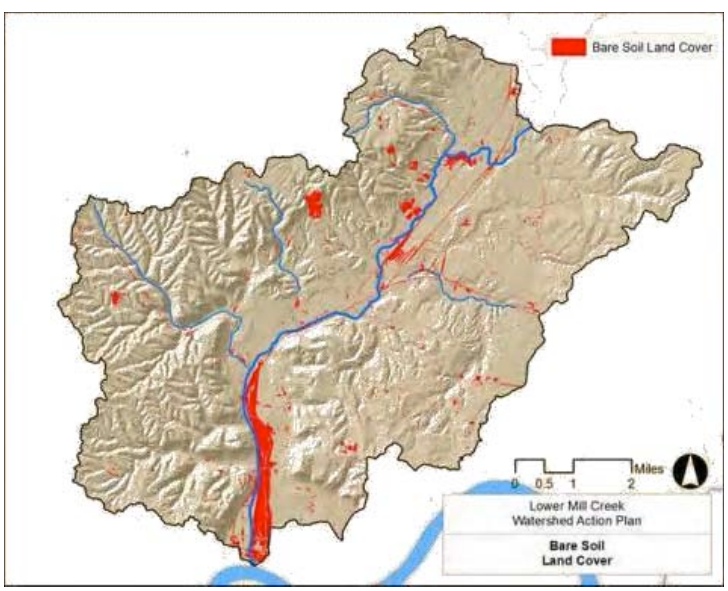


Figure 49 - Bare Soil Land Cover in the LMC Watershed

4.5.6 PROTECTED LANDS

The LMC watershed contains over 3,824 acres of protected lands, of which, 2,864 acres are forested. Ownership is comprised primarily of holdings controlled by the Cincinnati Park Board (91.4%). The Cincinnati Recreation Department (CRC) manages 205 acres (5.3%), and the Mill Creek Valley Conservancy District (MCVCD) manages 122 acres (3.2 %). The CPB manages its lands to maintain a balance of 60% in a natural state and 40% "developed" with park facilities and other supporting infrastructure.

Cincinnati Parks

The largest public park is Mt Airy Forest, a 1459 acre forest of rolling hills, streams, and trails. All Cincinnati Parks larger than 10 acres are listed in Table 34.

Cincinnati Recreation Commission

The Cincinnati Recreation Commission provides recreational, cultural, educational, and leisure activities, as well as programs and events, to the community through each recreation center in the City. CRC properties are primarily managed for athletic activities but serve as protected open space. The largest CRC property in the LMC watershed is Dunham Recreation Center. CRC properties larger than 10 acres are listed in Table 35.

Table 34: Cincinnati Parks Over 10 Acres

Name	Acres	Name	Acres
Mt. Airy Forest	1430.00	Fox Preserve	21.50
French Park	282.37	Cinergy Hillside	20.02
Bradford-Felters Tanglewood Park	182.00	Inwood Park	19.78
Caldwell Park	153.55	Church Of The Way Hillside	18.66
Burnet Woods	87.15	Rapid Run Park	18.09
Greeno Woods	86.24	College Hill Greenspace	17.88
Seymour Preserve	75.99	Salway Park	17.23
Avon Fields Golf Course & Ed Center	74.83	Caldwell Park	14.97
Fairview Park	35.24	Bellevue Hill Park	14.68
Victory Park	34.59	Victory Parkway	14.59
Glenway Woods	34.47	Coy Field	14.37
Roselawn Park	32.86	Hensley Tract	14.18
Bradford-Felters Tanglewood Park	32.48	Hammond North Hillside	14.18
Edgewood Grove	32.20	Winton Commons	13.79
Bracken Woods Park	30.22	Jackson Hill Park	11.40
Buttercup Valley	26.87	Agape	10.46
Ryan Memorial Commons	23.43	Ellis Hillside	10.34
St Clair Heights	23.31	Wayne Playground	10.01
Thomas Eynon Hillsides	21.77		

Table 35 – CRC Properties Over 10 Acres

NAME	AREA
Dunham Sports Complex	71.74
Colerain & Shepherd Ballfields	13.47
Hartwell Rec Center	10.82

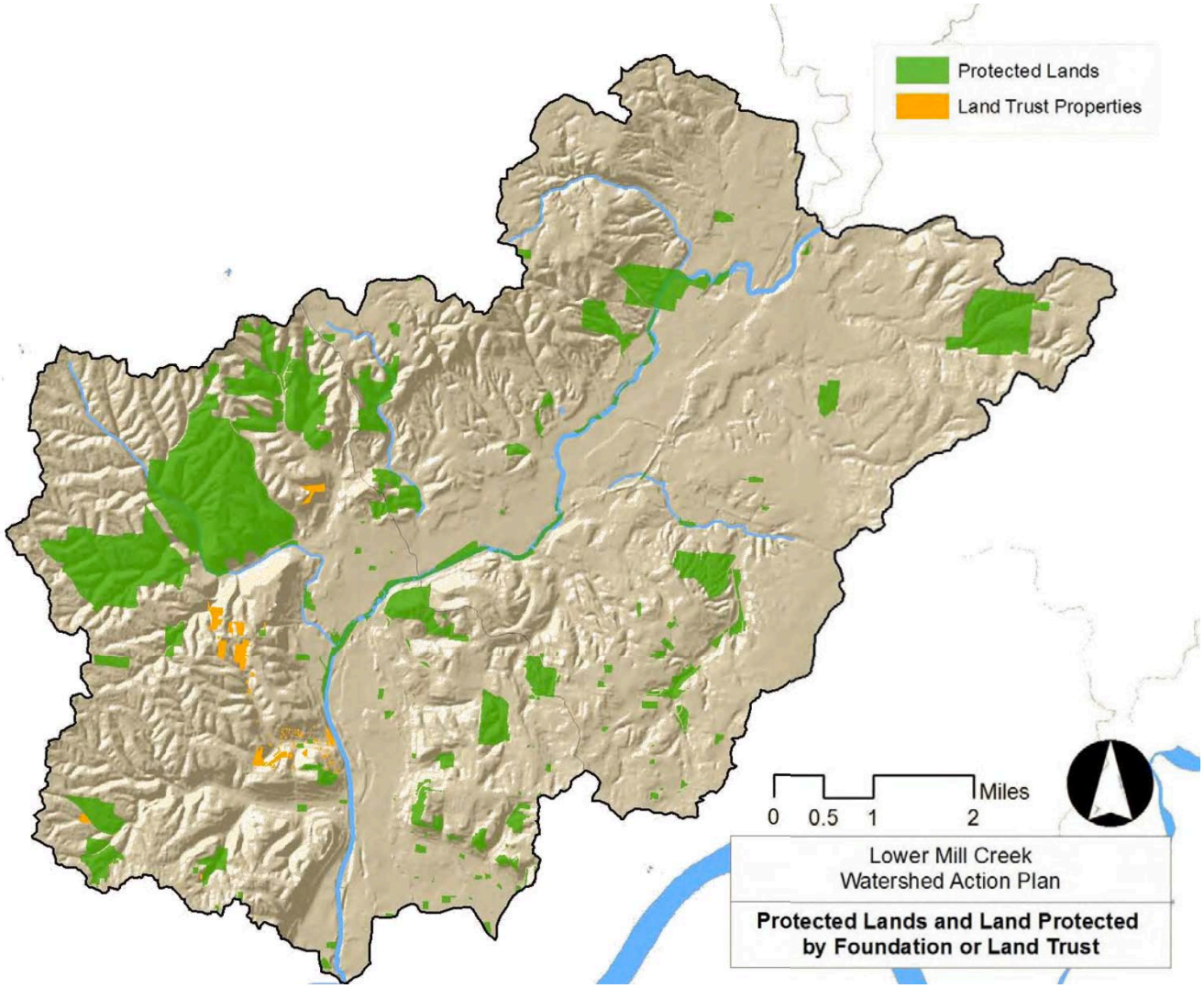


Figure 50 - Protected Lands and Lands Protected by Foundations or Land Trust

4.5.7 LAND PROTECTED BY FOUNDATIONS OR TRUSTS

The LMC watershed contains 116 acres of land that is protected by several foundations and trusts. These lands are included on the map *Figure 50 - Protected Lands and Lands Protected by Foundations or Land Trust*. Below you will find a description of the major individual trust or foundations that currently exist.

North Fairmount Community Center

The largest property holder is the ***North Fairmount Community Center*** (NFCC). The NFCC holds vacant parcels for preservation of open space as well as development and lists their mission as:" The NFCC is committed to meeting basic needs of our neighbors, and creating a quality of life that will keep North Fairmount a great place to live".

The Hillside Trust

The Hillside Trust protects 27 acres of hillsides that are highly erodible and prone to landslides. Their mission "is one of hillside and greenbelt conservation through a three-part mission of research and education, advocacy, and land conservation".

The Western Wildlife Corridor

The Western Wildlife Corridor manages 6 acres of greenspace. Its mission is "to protect the scenic beauty and natural resources of the Ohio River Valley through direct land protection and through the promotion of responsible land use".

Mill Creek Valley Conservancy District

The Mill Creek Valley Conservancy District (MVCD) is the official sponsor of the Army Corps of Engineers Flood Control Project. MVCD is a quasi-governmental agency created to be a sponsor to the Army Corps of Engineers for a flood control project in Hamilton County. The MVCD currently owns and maintains completed sections of the flood control project and remains the local sponsor for any potential modifications or completion of the flood control project in the Mill Creek Valley. All protected lands are shown on *Figure 50 - Protected Lands and Lands Protected by Foundations or Land Trust*.

As the local sponsor of the Corps project, MVCD had to remain a viable entity for the Mill Creek to remain an active Corps project. The board of the MVCD is comprised of three board members appointed by the Hamilton County Conservancy Court. Board members currently represent their respective agencies which include MSD, Hamilton County Engineer's Office, the Mill Creek Watershed Council of Communities and local communities, specifically Sharonville. There is also a Treasurer, Secretary, Legal Staff and Controller who attend each of the quarterly board meetings.

Mill Creek Valley Conservancy District has 132.55 acres of land from the northern border of the Hamilton County to the Ohio River along or at the vicinity of Mill Creek.

To date, the MVCD has not been successful in acquiring all of the land, easements and agreements by which their funding was to be sustained and consequently the organization has become less financially stable as time went on.

4.5.8 LAND USE STATUS AND TRENDS

Project Groundwork and the Sustainable Infrastructure Program
The Metropolitan Sewer District of Greater Cincinnati (MSDGC) and the United States Environmental Protection Agency (US EPA) are working to address Combined Sewer Overflow (CSO) issues affecting the City and the Ohio River.

A large effort is analyzing and evaluating viable sustainable infrastructure alternatives to this problem.

Use of sustainable infrastructure includes "source control or storm water offloading through:

- Combined sewer separation (both natural conveyance and storm sewers)
- Bioretention and storm water detention
- Stream restoration
- Stream daylighting
- Other Low Impact Development (LID) best management practices (BMPs)."

These source control measures reduce the volume of storm water flows draining into the CSO system during wet weather events. Between 1996 and 2004, the US EPA and MSDGC agreed to a Long-Term Control Plan, Interim Partial Consent Decree (2002), and finally a Global Consent Decree (Consent Decree on Combined Sewer Overflows, Wastewater Treatment Plants, and Implementation of Capacity Assurance Program Plan for Sanitary Sewer Overflows) that was entered by the US District Court for Southern District of Ohio Western Division on June 9, 2004.

Under the Global Consent Decree, MSDGC must capture, treat or remove 85% of the 14 billion gallons of annual overflows from the City's combined storm and sanitary sewers, and eliminate all overflows from the City's sanitary-only sewers.

The City's response, called Project Groundwork, will lead to an investment of over $2 billion in infrastructure improvements. As described on the MSDGC's program website, Project Groundwork is intended to:

- Reduce or eliminate sewage overflows into local rivers and streams and sewage backups into basements;
- Benefit Hamilton County communities through environmentally, socially and economically sustainable solutions to these current problems; and
- Revitalize the economy through creation of jobs and growth opportunities for local businesses.

As the central component of Project Groundwork, the MSD has committed to using LID and source reduction storm water techniques blended with the use of conventional sewer separation, conveyance and storage, sometimes called "gray infrastructure," to achieve maximum environmental, social and economic benefit while managing storm runoff volumes and preventing sewer overflows. The sustainable infrastructure approach

combines the natural systems and processes of soils and plants used in LID and source reduction techniques with engineered systems, in order to store storm runoff and treat storm water through infiltration, evaporation and evapotranspiration.

Sustainable Infrastructure techniques have the advantage of including landscape features that improve the aesthetic and environmental quality of neighborhoods where they are installed, and providing ancillary economic benefits. Within Cincinnati, the sustainable infrastructure program is intended to enhance the quality of the neighborhoods, parks and districts where CSO improvements are made, and to yield an overall greater return on the public investment in CSO controls than would be realized through conventional, underground storage tunnels and systems.

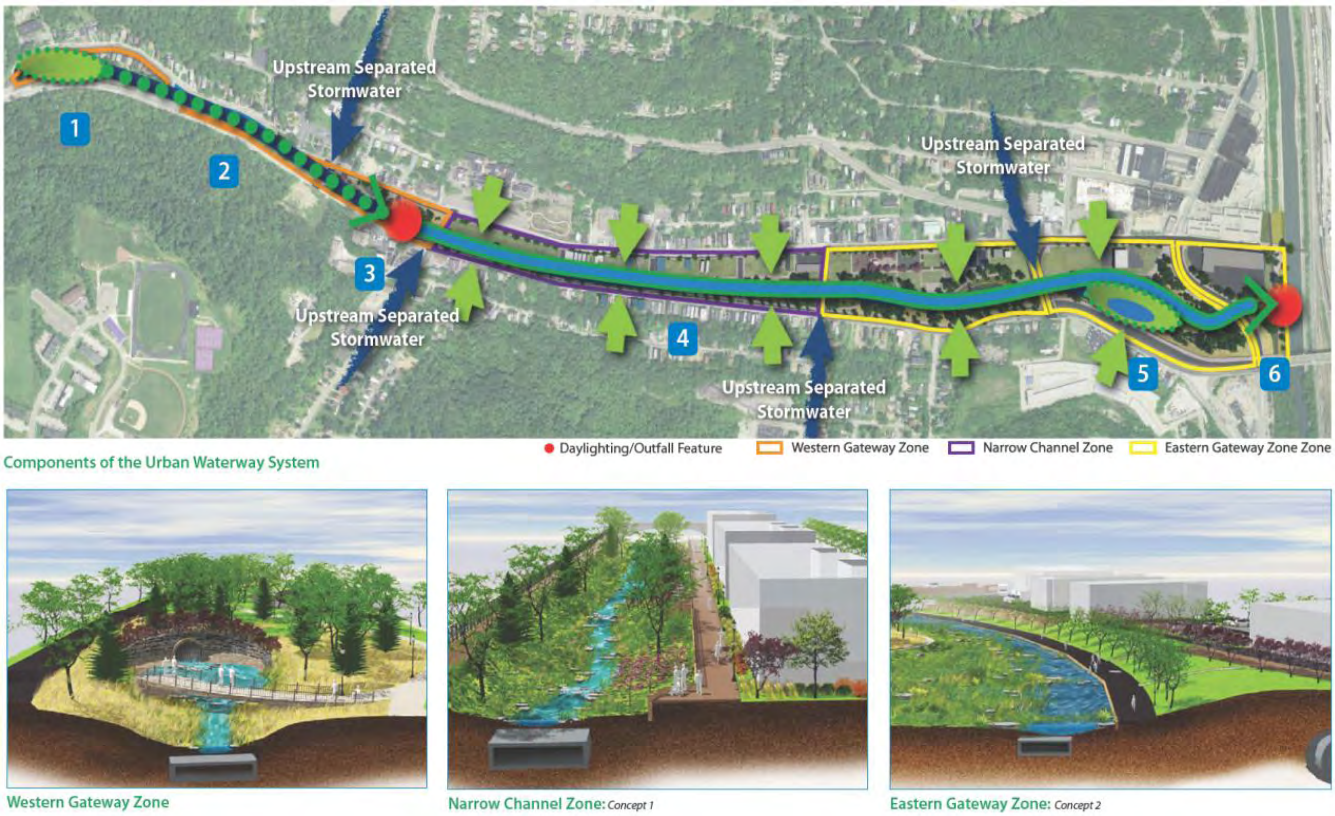


Figure 51: Lick Run Master Plan Conceptual Drawings

Source: (MSDGC, 2012)

An example of MSDGC's new source control strategy combining an innovative mixture of "green" and "grey" infrastructure is the Lick Run Master Plan project, which when constructed, features a series of underground storm sewers, water quality features, and natural, aboveground waterways constructed throughout the watershed to transport stormwater and natural drainage to the Mill Creek. The central element is a "daylighted" urban waterway that will run through the middle of South Fairmount between Queen City and Westwood avenues east of White Street.

Interstate 75 Reconstruction Project

Within the Lower Mill Creek Watershed, Interstates 74 and 75 cover 120 acres and generate 128 MG of storm water runoff annually. It is imperative that future construction within these interstate corridors integrates both water quantity and water quality opportunities. As impervious pavement increases, so will the amount of storm water runoff unless efforts are made to capture the excess waters.

The Ohio Department of Transportation (ODOT) is beginning a multi-billion dollar rebuild of the I-75 expressway through the LMC basin. The effort is divided into three separate projects, "The Brent Spence Bridge," "I-75 Mill Creek Expressway," and "Thru the Valley." The southernmost project, The Brent Spence Bridge, is just to the east of the Gest and Lick Run sub-sewershed, while the I-75 Mill Creek Expressway is almost entirely within the Clifton sub-sewershed, with a short segment along the border between the Mitchell and King's Run sub-sewershed, and just skirting the western edges of the Ross Run and Bloody Run sub-sewershed. This massive rebuild required ODOT to study and include in the project area a whole corridor around the Interstate. At the same time, the Cincinnati Department of City Planning and Buildings is studying land use and possible urban design improvements, as well as economic and traffic impacts at critical points immediately adjacent to the project corridor, mostly around highway interchanges.

MSDGC is closely involved in improving storm water handling within and near the corridor, as well as coordinating with its own major projects nearby. The City of Cincinnati and the Metropolitan Sewer District of Greater Cincinnati have partnered with Urban Design Associates to study opportunities for economic development, neighborhood revitalization, green infrastructure and transportation improvements in vital I-75 corridor neighborhoods, projects for which can be viewed in the Revive I-75 Cincinnati Focus Area Plan.

4.6 CULTURAL RESOURCES

Sites of Historical, Cultural, or Recreational Significance

The Lower Mill Creek watershed includes a treasure trove of historic and cultural sites that make up the rich history of the City of Cincinnati. An estimated 174 National Register Historic Properties (NHRP) can be found throughout the LMC watershed. Furthermore, there are hundreds of Ohio Historic Inventory (OHI) sites that date from the nineteenth and early twentieth century.

The Mill Creek Watershed Greenway Master Plan identified some of the more significant historic and cultural assets, including:

- 733-acre Spring Grove Cemetery, established in 1845, where prominent Cincinnati families are buried, is the largest private, rural-style cemetery in the country.
- Residence of Samuel Hannaford, a former Cincinnati mayor and famous architect, with fifty-eight of his buildings listed on the National Register.

- Procter & Gamble's 243 acre Ivorydale manufacturing site, where Mill Creek flows through the corporate campus and the original 1884 buildings are still in use.
- Union Terminal, built in 1931-33, famous for its Art-Deco rotunda and Weinhold Reiss murals depicting Cincinnati history.

The United States Army Corps of Engineers, Louisville District, conducted an *Environmental Impact Statement for the Mill Creek, Ohio*, released in December 2004, as a Component of the General Reevaluation Report (GRR) Flood Damage Reduction Project. As part of this study, a literature review and pedestrian walkover survey was carried out to examine identified and potential cultural resources and the impacts of each flood reduction project upon them. This included shovel testing and hand excavations of areas parallel to the Mill Creek, roughly in 15 m intervals.

The USACE literature review identified no archaeological sites within the study area listed on the NRHP. Fourteen historic structures or resources were identified by the literature review within the study area and are included in the Appendix (of USACE report). A review of the OHI revealed 226 previously recorded architectural resources in the project area, 98 of which were eligible for the NHRP.

The field surveys were organized by channel section (see *Figure 58 - Channelization in the Lower Mill Creek*) and included shovel testing and soil boring samples, which revealed a couple of historic and pre-historic sites.

Section 7C

This section did not reveal any prehistoric or historic resources. However, an old bridge abutment foundation was identified. It was "V"-shaped and built of cut limestone blocks. The intact bridge is a wood and steel frame bridge that extends across the East Branch of the Mill Creek. It was identified to be severely deteriorated and no longer in use. The mortar and cement for the stonework and round nails suggest a construction in the twentieth century. Because of its low likelihood for any significant archaeological remnants, NHRP was not recommended.

Section 7B

In section 7B of the proposed channel, three prehistoric sites and one historic site were identified. The historic site was an industrial/commercial structure, which contained 63 recovered artifacts, which was potentially eligible for inclusion to the NRHP. The three prehistoric sites included small prehistoric lithic scatter, which indicate short-term, limited activity and, therefore, non-significant use.

Section 6

In Section 6 one historic resource was identified. This site was a historic structural foundation with an associated scatter located in a small group of trees and bushes north of the Mill Creek. The main foundation is continuously laid, cut limestone and mortar. Two small cement "boxes" were located near the foundation, but there function was unknown. This site was not recommended for NHRP eligibility. Section 6 also included an architecture resource, Ham-2620-60 (a bridge).

4.7 PREVIOUS AND COMPLIMENTARY EFFORTS

4.7.1 HISTORY AND PREVIOUS WATER QUALITY (WQ) EFFORTS IN THE LMC WATERSHED

A. Total Maximum Daily Load (TMDL) Program

The TMDL program identifies and restores polluted waters. It can be viewed as problem solving: investigate the problem, decide on a solution, implement the solution, and check back to make sure the solution worked. By integrating programs and aligning resources, Ohio is pursuing TMDLs as a powerful tool to develop watershed-specific prescriptions to improve impaired waters.

B. Global Consent Decree

The remediation of Combined Sewer Overflows (CSOs) and Sanitary Sewer Overflows (SSOs), and a comprehensive Water-In-Basement (WIB) response program are key components of the Global Consent Decree that was submitted by MSDGC and approved by the Cincinnati City Council and the Board of County Commissioners. On December 4, 2003, the Consent Decree was filed with the United States District Court for the Southern District of Ohio, Western Division, for review and approval.

Project Groundwork

Developed in 2006, this plan addresses the Global Decree's requirements and implements capacity-based sanitary sewer and CSO issues of the Interim and Global decrees was known as MSD's Wet Weather Improvement Plan. In 2008, MSD branded this improvement effort as "Project Groundwork."

C. National Pollutant Discharge Elimination System (NPDES) Phase II

Implementation of Storm water Phase II programs in the watershed. All watershed communities are subject to Phase II storm water quality regulations.

D. Mill Creek Watershed Greenway

The Mill Creek Greenway Trail, a multi-objective program, will physically transform the Mill Creek corridor and watershed by helping to eliminate blight; economically revitalizing Mill Creek neighborhoods and communities; creating jobs; stimulating the local economy; increasing Mill Creek's visibility; regenerating the health of the river and its natural resources; and providing opportunities for bike commuting, people-powered short trips, multi-modal transportation, recreation, outdoor exercise, and environmental education.

E. Cincinnati Centennial Parks Master Plan

The mission of the Cincinnati Board of Park Commissioners is "to conserve, manage, sustain, and enhance parks' natural and cultural resources and public greenspace for the enjoyment, enlightenment and enrichment of the Cincinnati community." The Cincinnati Park Board manages more than 5,000 acres, which amounts to approximately 10 percent of the City's total land area. This area is comprised of five regional and 70 neighborhood parks, 34 nature preserves, five neighborhood nature centers, 30 sites managed by the Cincinnati Recreation Commission, five parkways, 16 scenic overlooks, 65 miles of hiking and bridle trails,

roughly 1,000 miles of street trees, gateways, an arboretum and one of the larger public plant conservatories in the country.

The Centennial Parks Master Plan, adopted in 2007, focuses heavily on Cincinnati's hillsides and streams, greenways and trails, and expands upon George Kessler's 1907 park plan's vision of parkways and scenic boulevards to include the interstate system that creates green filters that cleanse air and water. The plan promotes 'parks as agents of transformation' for Cincinnati.

F. Cincinnati Comprehensive Plan

A Comprehensive Plan provides a "blueprint" for how a community or region should grow in the future. It is a long-range plan—looking 20-30 years into the future. It will inform current and future decision makers about where we are, where we want to go, how we will get there and who will help us along the way. It addresses a wide range of recommendations relating to land use, transportation, parks, health, environment and open space, community facilities, utilities and infrastructure, institutions, urban design, historic preservation, community character and identity, housing and neighborhoods, and economic development, among others.

The City of Cincinnati's Comprehensive Plan will also incorporate the recommendations and the vast work already completed in other plans and studies such as GO Cincinnati, Agenda 360, and COMPASS, as well as recommendations from other City documents such as the View Corridor Study and Park Board Centennial Master Plan. PLAN CINCINNATI will develop prioritized recommendations necessary for future growth.

4.7.2 LISTING OF CURRENT ONGOING EFFORTS TO MEET WQ STANDARDS IN THE WATERSHED

A. Existing Management Plans and Strategies

- Agenda 360: A Regional Action Plan. February 2009.
- Biennial Assessment of Ohio River Water Quality Conditions for 2005, 2006, 2007, 2008, and 2009. Ohio River Valley Water Sanitation Commission. 2010.
- Centennial Parks Master Plan. Cincinnati Park Board and Human Nature. 2007.
- City of Cincinnati Comprehensive Plan. In progress.
- City of Cincinnati 2010 – 2014 Consolidated Plan: Strategic Plan. Revised September 23, 2009.
- GO Cincinnati: Growth and Opportunities Study For the City of Cincinnati. FINAL REPORT. January 2008.
- GO Cincinnati: Growth and Opportunities Study For the City of Cincinnati. Action Steps for the Targeted Implementation of GO Cincinnati Recommendations. November 2009.
- Hamilton County Regional Planning 2030 Plan and Implementation Framework.
- Lower Mill Creek Coarse Evaluation Planning Background Report. Hamilton County Regional Planning Commission. 2009.
- Mill Creek, Ohio, Flood Damage Reduction Project: Final General Reevaluation Report. Vol. 5. US Army Corps of Engineers, Louisville. March 2005.
- Mill Creek Watershed Action Plan Final Draft: Upper Mill Creek Watershed Management Plan. Mill Creek Watershed Council of Communities. December 2005.
- OKI 2030 Regional Transportation Plan- June 12, 2008.
- OKI Land Use Commission Regional Policy Plan. April 14, 2005.

- The Mill Creek Watershed Greenway Master Plan. By Fuller, Mossbarger, Scott and May; Greenways Incorporated, Biohabitats, Inc., Rhinoworks. June 1999.
- The Mill Creek: An Unnatural History of an Urban Stream. By Stanley Hedeen. 1994.
- Total Maximum Daily Loads for the Mill Creek Basin: Final Report. Prepared by Ohio Environmental Protection Agency Division of Surface Water. September 2004.
- Upper Mill Creek Watershed Management Plan. Mill Creek Watershed Council of Communities. September 2005.
- Year 2000: Ohio Water Resource Inventory. Ohio Environmental Protection Agency. September 11, 2000.
- 2008 305(b) Report: Ohio's Ground Water Quality. Ohio Environmental Protection Agency Division of Drinking and Ground Waters. December 2008.

*See **Appendix** for a complete list of Community and Watershed Plans*

B. Metropolitan Sewer District of Greater Cincinnati Water Quality Improvement Projects and Strategies

Better local control of storm water entering combined sewers will reduce sewer overflows.

Low Impact Development (LID) methods used by MSD include pervious paving, green roofs, and rain barrels, among others. MSD is partnering with numerous local organizations to design and construct dozens of "demonstration" projects to identify which of these green practices are most effective. Some current projects include:

- Cincinnati Zoo – pervious paving, rainwater harvesting, bioswales, and green roofs.
- Cincinnati Public Schools – shallow and deep green roofs, rain gardens, urban planters, bioswales, and pervious paving.
- American Red Cross – shallow, sloped green roof and bioswales

Proposed strategies include reforesting steep hillsides and right-of-ways, storm water offloading and water quality opportunities along interstate right-of-ways, and recreational opportunities along the Mill Creek Greenway. A CITYgreen analysis of reforestable areas in the LMC sub-sewersheds showed a potential annual benefit of 130 MG if 1,187 acres (60 percent of existing canopy-deficient areas) were reforested.

C. Park Reforestation

The canopy network provides valuable benefits in regards to natural storm water runoff management and air quality improvement. Based on a CITYgreen analysis, recommendations include not only protecting the existing canopy within the sub-sewersheds, but reforesting 60 percent of the canopy-deficient areas along major interstate corridors, road right-of-ways, and steep slopes.

4.8 EARLY SETTLEMENT CONDITIONS IN THE LOWER MILL CREEK WATERSHED

A. Native Americans and the Miami Purchase

The Shawnee were the main Native American Tribe in the LMC watershed at the time of early American and European settlement. They called the area Maketewa. Since the Shawnee had no commercialized industrial element to their culture, the streams and creeks of the LMC watershed remained unspoiled. At the time of the U.S. Revolutionary War, Ohio was still considered the western frontier. After the United States victory over the British, more American and European settlers began immigrating into the LMC watershed. These early and isolated settlements were met with resentment and violent resistance from the Shawnee. This resistance made settlement of the LMC watershed dangerous and limited (Ohio History Central).

Simultaneously, a New Jersey Congressman named John Cleves Symmes wanted to increase settlement in the LMC watershed and contracted with the U.S. Treasury Board to purchase land in the area. The acquisition was known as the Miami Purchase and encompassed the area from the Great Miami River to the west, to 20 miles east, to the Ohio River to the south, and where the eastern boundary met the Great Miami River to the north. The purchase was advertised and was meant to attract those on the east coast to settle west. There were four early settlements built between 1788 and 1789; Losantiville which is now downtown Cincinnati, Columbia which is now Columbia Tusculum, South Bend, and North Bend. Even though these settlements had occurred in less than a year, it was still a dangerous frontier. In 1789, Fort Washington was built to provide security in the LMC watershed and general area to repel attacks from Shawnee and other Native tribes (Hedeen, 1994).

For the next few years, settlements were occasional, yet development rarely occurred away from the safe vicinity of Fort Washington. In 1794, the Battle of Fallen Timbers gave the United States military victory over the Shawnee. The subsequent treaty and administrative control over the Shawnee gave settlers an assurance of relative safety as they immigrated west into the area in and around the LMC watershed. A tremendous increase in immigration and development in the area would occur.

B. Deforestation from Advanced Settlements

Over the next few decades, the LMC watershed saw an explosion of growth and immigration from American and European settlers. As advertised, the LMC watershed became heavily developed with settlements, houses, mills, and other early industry. By the 1820's, the growth over the area and along the Mill Creek had occurred so rapidly that deforestation was beginning to take its toll.

Deforestation drastically changed the natural habitat of the LMC watershed. The loss of trees severely impacted the wildlife, streams, and creeks. With their habitat drastically reduced, many species of wildlife, now thought to be incredible in the area, disappeared (Hedeen, 1994). The LMC watershed was home to Black Bear, Mountain Lions, Gray Wolves, Turkey, and many other wild creatures. They eventually vanished from the area and several species of birds became extinct. The deforestation adversely impacted many fish species as well. Deforestation caused heavy sediments to form on the bottom of creeks and streams and caused dramatic decreases in water elevation in dry seasons. These conditions caused the generational decline of

many fish species in the streams and creeks of the LMC watershed (Hedeen, 1994).

Deforestation was also thought to have led to the flood control problems we even face today. The numerous roots of trees acted as forms of natural storm water management. The loss of these trees, and their roots, may have led to an increase in flood issues. In 1808, the first flood to impact settlements was recorded and flooding periodically continued. With the combination of increased settlements into the watershed and flooding issues, the early settlers and developers continued to build more appropriate infrastructure in the area. The infrastructure improvements made way for even more immigration into the LMC watershed.

C. The Miami and Erie Canal and Railroads

In the mid-to-late 19th Century, the boom in population and industrial development in the LMC watershed was greatly supported by the construction of the Miami and Erie Canal and numerous railroad lines and yards. These transportation and logistical services supported many industries. Some of these include various mill industries, general manufacturing, breweries, slaughterhouses, and meat packing plants. This population and industrial growth in the LMC watershed led to extreme levels of pollution in the creeks and streams, especially in the Mainstem of the Mill Creek. The boom also led to the eventual sewer capacity issues that are faced in the watershed today.

4.9 CHANNEL AND FLOODPLAIN CONDITIONS

A. Background

Occurrences of extreme flooding in the LMC watershed in Hamilton County, Ohio in the late-nineteenth century to the mid-twentieth century affected the growing population and developing industries of the area. While extreme flooding was rare, these occurrences were so impactful that they caused major disruptions in citizens' quality of life and businesses' ability to produce goods and services. They required costly and lengthy clean up and displaced hundreds of families across the watershed. The devastating flood of 1959 prompted eight local political jurisdictions and Hamilton County to form the Mill Creek Conservancy District to develop plans of action to reduce flooding in the Mainstem of the Mill Creek. The conservancy lobbied for Federal assistance and in 1967 the U.S. Army Corps of Engineers was assigned to the project.

Historically, there are two conditions within the Mill Creek watershed that perpetuated flooding problems along the creek. First, winter and spring floods caused typical backwater flooding conditions from the Ohio River basin. This is no longer a problem because downtown Cincinnati and Mill Creek are now protected from Ohio River flooding by the Cincinnati Local Protection Project and the Mill Creek Barrier Dam and Pump Station (Rowlette, 2005). Second, severe thunderstorms caused flash flooding as a result of the ever increasing amount of impervious surfaces from development and industrialization in the area. Increased development has led and will continue to lead to a decrease in floodwater storage and increased levels of runoff. Added debris from bank erosion and degradation has caused stream blockages, which further compounds flooding conditions during storm events. Over the years, millions of dollars have been lost as a result of damages to industrial facilities, small businesses, and local residents.

B. Flood Control Options

When the Army Corps of Engineers were assigned to solve the flooding problems in the Mill Creek they analyzed numerous plans that called for dams, diversion, channelization, and levees. Ultimately, they developed three plans to solve the flooding issues and weighed their options using cost benefit analysis. The first option was to build dams and reservoirs, but rising property values in the area made acquisition prices too high and cost prohibitive. The second option considered diverting the Mill Creek to the Great Miami River. However, this option was rejected due to rising property values, recent development in Southern Butler County, and a projected loss of $24,000,000 annually in property taxes for Butler County. The third option proposed eighteen miles of channelization and eleven miles of levees in Hamilton County. The cost benefit analysis projected the third option to be the most favorable. The U.S. Congress authorized the funds to establish the Mill Creek Local Protection Project under the River and Harbor Act of 1970, Title II-Flood Control. The project would be funded jointly by the River and Harbor Act and by a local share managed by the Mill Creek Conservancy District.

4.10 FORESTED RIPARIAN CORRIDOR ASSESSMENT

Riparian Corridor Assessment:

Overall, 75.4% of the area of the riparian corridors is forested with the largest deficits by percentage occurring in the Clifton and Upper Mill Creek sub-sewersheds. The biggest need for reforestation by acreage is the Hartwell-Carthage (64.48 acres) and the West Fork (60.71 acres) sub-sewersheds.

Table 36 - Forested Riparian Corridor by Sub-sewershed

Sub-sewersheds	Buffer Zone Acres	Forested Buffer Acres	Percentage Forested	Acres Needed
Amberley	107.07	88.44	83%	18.63
Bloody Run	7.34	5.49	75%	1.84
Clifton	76.10	34.67	46%	41.43
Denham	43.79	31.39	72%	12.39
Gest	25.24	18.54	73%	6.70
Hartwell-Carthage	253.12	188.64	75%	64.48
Kings Run	127.77	93.57	73%	34.20
Lick Run	47.72	43.74	92%	3.97
Mitchell	12.86	9.75	76%	3.12
Ross Run	15.40	13.00	84%	2.40
Upper Mill	66.25	30.70	46%	35.55
West Fork	377.70	316.98	84%	60.71
Totals	**1,160.33**	**874.90**	**75.4%**	**285.43**

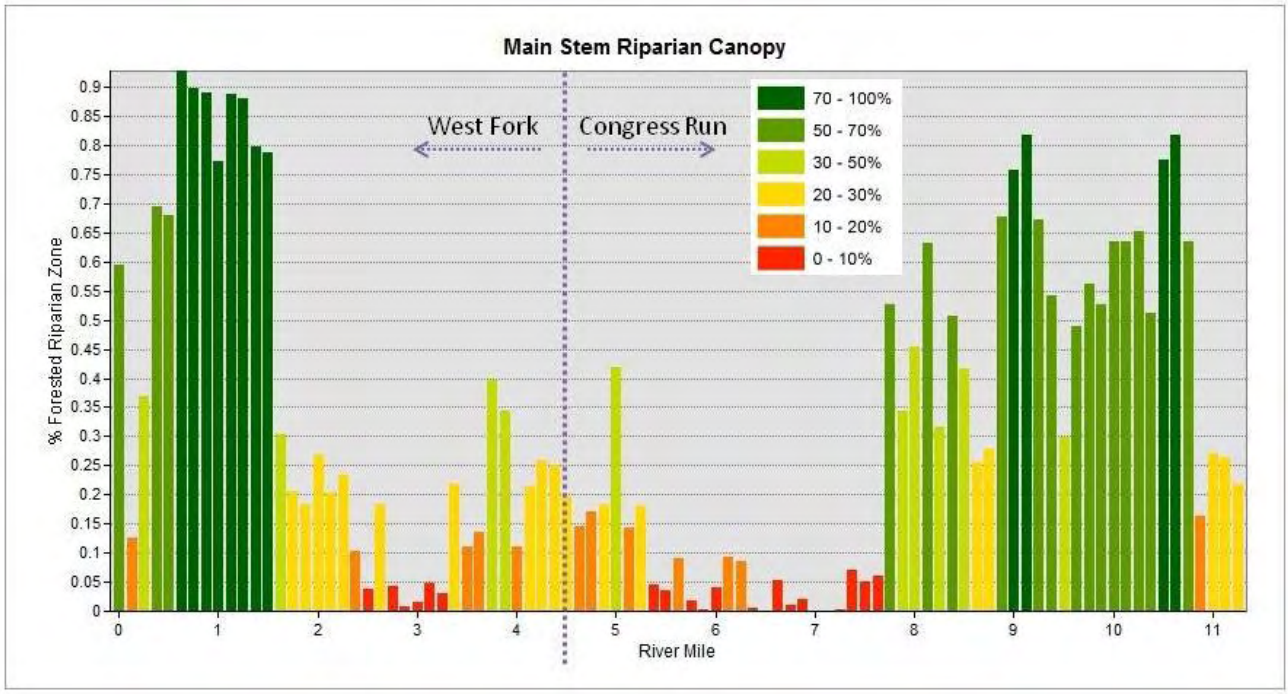


Figure 52: Main Stem Riparian Canopy

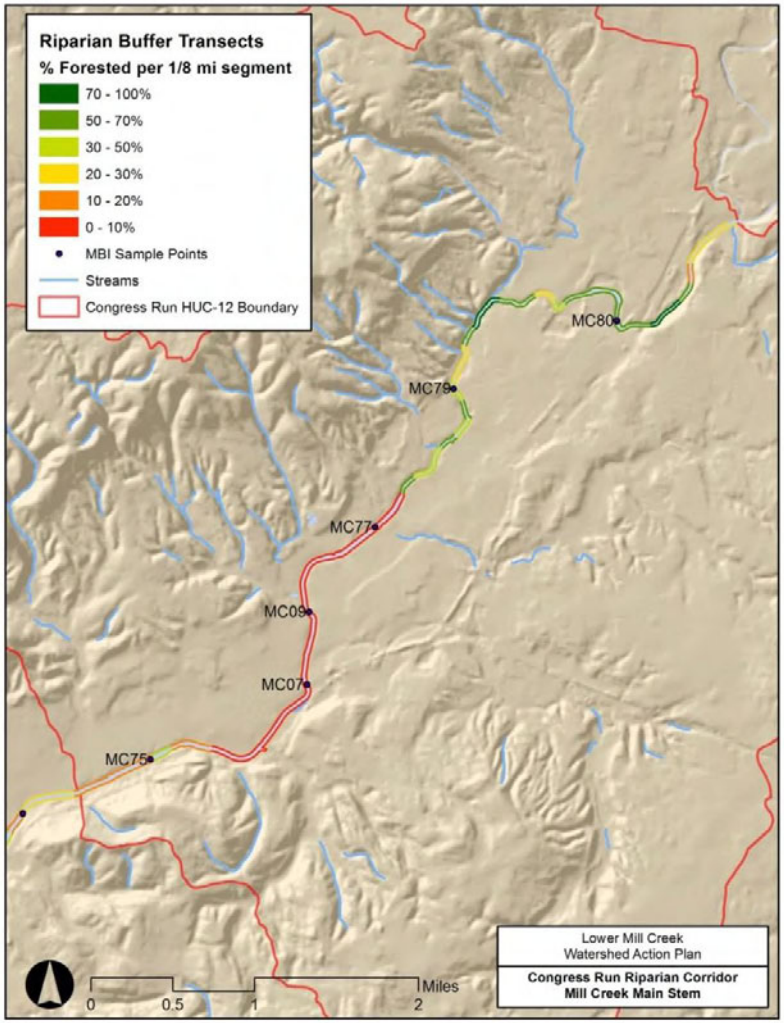


Figure 53: Congress Run Riparian Corridor Assessment

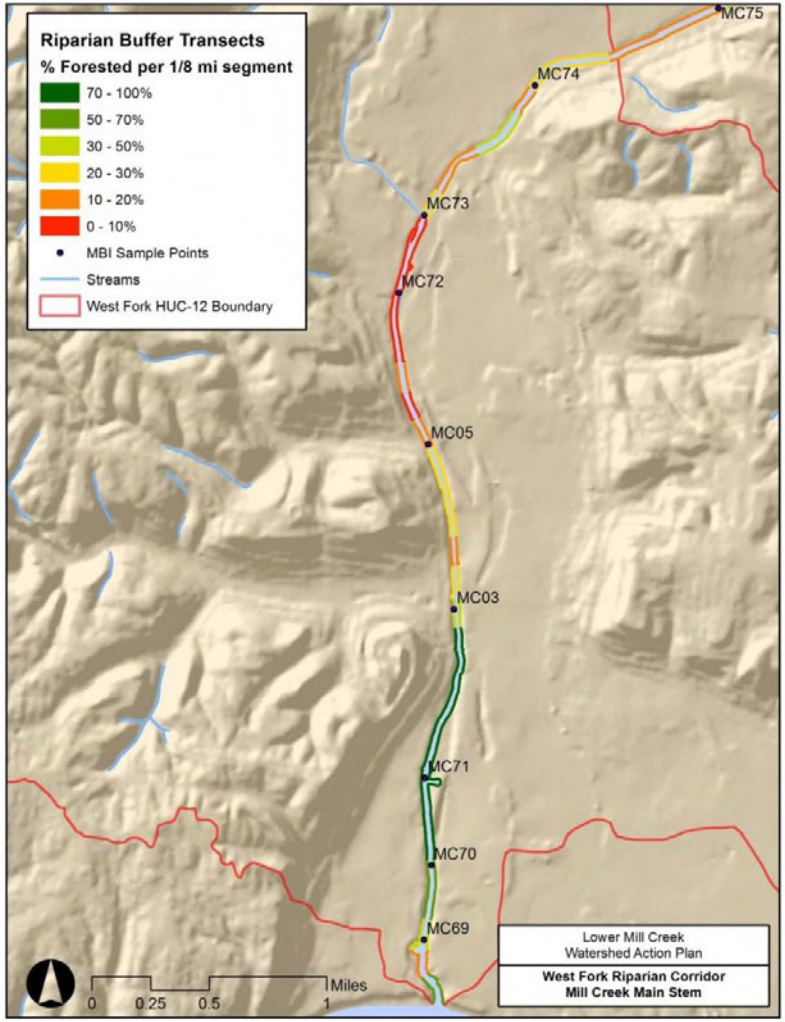


Figure 54: West Fork Riparian Corridor Assessment

4.11 QUANTIFY FORESTED NATURAL RIPARIAN BUFFER AND PERMANENT PROTECTION

A. *Riparian Corridor Policy and Regulation:*

On June 14, 2009, the Hamilton County Commissioners adopted new Hamilton County Stormwater District Rules and Regulations as required by the NPDES Phase II Stormwater Permit issued by the Ohio EPA for water quality. These new Rules and Regulations cover all participating members of the Stormwater District. These new Rules and Regulations include a chapter, *Article IV-Stream Corridor Protection Rules and Regulations*, which establishes a minimum encroachment area on streams from certain buildings, activities and earthworks for all new developments. This new Stream Corridor Protection Zone is for all streams with a drainage area greater than 100 acres. The width of the protection zone expands from 25 feet to 50 feet from the stream bank, based on the size of the contributing drainage area, and increases more in areas of steep slopes or for protection of wetlands. In some places, the 100-year FEMA Floodway extends the coverage of the protection zone. The enforcement actions for civil or criminal violations of the Stream Corridor Protection Zone include fees and/or stream restoration and possibly building removal.

B. *Riparian Corridor Public Ownership:*

The LMC watershed contains 3,824 acres of protected lands, of which, 2,864 acres are forested. Ownership is comprised primarily of holdings controlled by the Cincinnati Park Board (91.4%). The Cincinnati Recreation Department (CRC) manages 205 acres (5.3%), and the Mill Creek Valley Conservancy District (MCVCD) manages 122 acres (3.2 %).

Table 37 – Protected Riparian Corridors by Ownership Agency

Ownership Agency	Total Buffer Zone Acres	Forested Buffer Zone Acres	Non-Forested Buffer Zone Acres
Cincinnati Parks	316	284	32
Mill Creek Valley Conservancy District	53	10	43
Cincinnati Public Schools	12	12	0
State of Ohio	25	10	15
Hamilton County	13	8	5
United States	0	0	0
Other City Property	40	24	16
CMHA	13	10	3
Totals	**472**	**358**	**114**

The forested riparian corridor assessment for protected lands used the legal standard established for Cincinnati and Hamilton County to establish the baseline of 60 feet for riparian corridor width.

Overall, 75.8% of the area of the riparian corridors is forested with the largest reforestation need by acreage are Mill Creek Valley Conservatory properties (43 acres) and Cincinnati Park Board properties (32 acres).

4.12 QUANTIFY NATURAL CHANNEL AND MODIFIED CHANNELS

The LMC watershed contains approximately 80 miles of above ground streams that pass through urban areas, parks, and private property.

4.13 DAMS

A. Mill Creek Barrier Dam

The Barrier Dam, which began construction in 1941 by the U.S. Army Corps of Engineers and finished in 1948, was built to prevent rising water from the Ohio River and tributary flow from the Mill Creek from causing local flooding in the Mill Creek Valley. When the Ohio River approaches flood stage (52 feet), floodgates are installed to prevent the Ohio River from backing up into the Mill Creek. Pumps are then activated to pump water from the Mill Creek, over the Barrier Dam, and into the Ohio River. Normal Ohio River pool elevation is 26 feet.

Coordinates: 39°6'13"N 84°32' 46"W. Mill Creek Barrier Dam (Cincinnati)

Figure 55: Mill Creek Barrier Dam Location

Figure 56: Mill Creek Barrier Dam

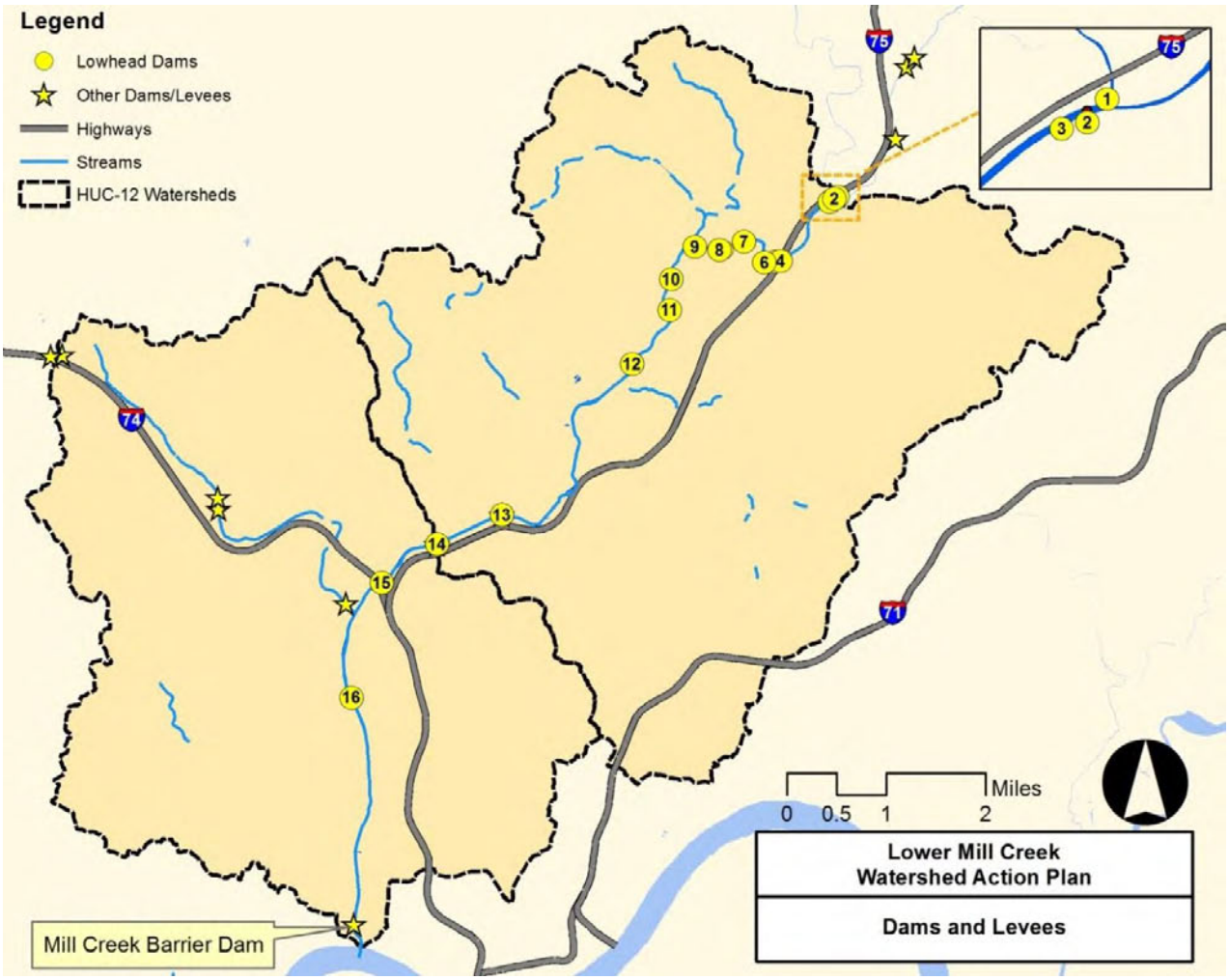


Figure 57 - Dams and Levees

Figure 57 - Dams and Levees shows the location of these hardscape features of the watershed.

1. Lowhead dam at confluence of West Fork of the Mill Creek
2. Lowhead dam just downstream of West Fork of the Mill Creek confluence
3. Lowhead dam at confluence of Amberley Creek, underneath Cross County Hwy ramp
4. I-75 Bridge
5. Lowhead dam just upstream from narrow access road bridge
6. Lowhead dam at Railroad Bridge and Anthony Wayne Ave. bridge
7. Lowhead dam at Vine St. Bridge
8. Two lowhead dams just downstream of railroad bridge by North Bend Dump
9. Lowhead Dam downstream from Caldwell Park, just upstream of Congress Run Confluence
10. Remediated lowhead dam site at North Bend Rd. bridge
11. Remediated lowhead dam site downstream from Seymour Ave. crossing
12. Lowhead dam at Center Hill Rd. bridge
13. Lowhead dam downstream from railroad crossing
14. Lowhead dam just upstream of CSO #24
15. Lowhead dam at I-74 crossing
16. Lowhead dam just downstream of Hopple St. Crossing

4.14 CHANNELIZATION IN THE LOWER MILL CREEK WATERSHED

The stream channel has been modified in some areas numerous times to accommodate development, promote drainage and control flooding.

A. Mainstem Channelization

The Mill Creek Local Protection Project began in April of 1981 and focused on the construction and development of channelization strategies from the barrier dam near the Ohio River all the way to the Butler County border with Hamilton County. The project was divided into twelve sections for a phased construction approach, as seen in *Table 38 - Mill Creek Mainstem Channelization* and *Figure 58 - Channelization in the Lower Mill Creek*. The channelization strategy focused on straightening and widening sections of the Mainstem of the Mill Creek. This flood reduction strategy predicted an increased speed of storm water flowing through the creek, thus reducing the storm water surface elevation. Therefore, the plan was initiated in 1981 with an expected completion date sometime in the year 2000.

B. An Incomplete Project

During the pre-construction planning for Section 8, the Army Corps of Engineers discovered buried hazardous waste in the path of construction. The Ohio EPA confirmed that it would be the Army Corps of Engineers responsibility to complete hazardous waste remediation that had been uncovered by pre-construction planning. Therefore in 1991, the Army Corps of Engineers leadership halted all construction to reanalyze construction and hazardous waste remediation costs. The Army Corps of Engineers cost revaluation also included updating and communicating the Mill Creek Conservancy District's share of the cost.

The Army Corps of Engineers explained that the Mill Creek Conservancy District's share would be $44 million dollars for construction, $800,000 dollars annually for maintenance, and additional costs for hazardous waste remediation. The Mill Creek Conservancy District's plan to produce their share was to reassess properties that would benefit from the Mill Creek Local Protection Project. Ultimately, the Army Corps of Engineers disagreed that the reassessment approach would work to fund their share and began to close the project down. The last construction on the project ended in 1992 and is considered indefinitely on hold.

C. U.S. Army Corps of Engineers General Re-Evaluation Report

In March 2005, the Army Corps of Engineers released their General Reevaluation Report (GRR) regarding the Mill Creek Local Protection Project. The report recommended solutions that were a continuation of the previous work and some new strategies. These include building levees, railroad closures, road closures, adding pump stations, raising road elevations, adding emergency egress routes, floodgate closures, and channelization (USACE, 2005). The new channelization proposed was approximately 7,580 linear feet in length and located in Section 7B and 7A. The work would include adding riprap at the lower elevation of the bank and adding grass, wildflowers, and trees up the bank. The GRR plan has not advanced as the Mill Creek Conservancy District has been unable to secure the funds for the project. The Mill Creek Restoration Project also opposed the plan by explaining that the project would be too expensive for local governments, sacrifice downstream properties in the LMC watershed, and eliminate any hope of restoring the Mill Creek to its natural state (Mill Creek

Restoration Project, 2005).

D. *Other Channelization*

While the Army Corps of Engineers channelization of the Mainstem of the Mill Creek was the largest occurrence of channelization, there are other histories of channelization in the Lower Mill Creek Watershed (Hedeen, 1994). The Army Corps of Engineers also conducted channelization in the West Fork Mill Creek. In the mid-to-late 19th Century, the Cincinnati metropolitan area grew tremendously, assisted by the increase of rail lines for industry. Railroad companies implemented channelization in the Mainstem of the Mill Creek to build more rail lines and rail yards. Early sewer engineers channelized portions of the lower Mainstem for the Mill Creek Interceptor. The Ohio Department of Public Works channelized portions of the Mainstem of the Mill Creek adjacent to the City of Reading after a major flood in 1945 impacted that City. In the 1950's, City of Cincinnati engineers implemented channelization in the Mainstem in areas adjacent to residential and commercial properties in flood prone areas. Finally, in the 1960's the Mainstem was channelized during the construction of the Millcreek Rd.

E. *Reverting Back*

Although millions of dollars have been spent by private business, and Local, State, and Federal governments over the last century and a half, some channelization has reverted back to its natural state. According to project managers at the Army Corps of Engineers, Section 2 and Section 3 have a lot of sediment at the bottom of the channels and are progressively returning to their natural state (Holmberg, 2010). Section 5 has almost completely reverted back to its natural state and Section 7 has completely reverted back.

Additional Channelization Sources

- Gray, William W.S., Parsons Brinkerhoff Ohio, Inc., H.C. Nutting Company, XCG Consultants, Inc., & BBS Corporation "Mill Creek Flood Control & CSO Tunnel Feasibility Study Report." Cincinnati, 2002.
- Pruitt, Richard L. "Mill Creek Ohio Deep Tunnel Plan." US Army Corps of Engineers, Louisville District, Louisville, undated.
- Rowlette Jr., Colonel Robert A. "Mill Creek, Ohio, Flood Damage Reduction Project: Final General Reevaluation Report." Vol. 5, Plan NS2A. US Army Corps of Engineers, Louisville District, Louisville, 2005.

Table 38 - Mill Creek Mainstem Channelization

Section	Location Description (South To North)	Neighborhoods/ Municipalities Impacted	Length (Miles)	Completion Status
Not Numbered	Confluence of the Ohio River and Mill Creek to the Mill Creek Barrier Dam	Queensgate & Lower Price Hill	0.25	No Construction Started
S-8	Mill Creek Barrier Dam to Western Hills Viaduct	Queensgate & Lower Price Hill	1.5	No Construction Started
S-1	Western Hills Viaduct to Hopple St.	North Fairmount, South Fairmount, & Camp Washington	1	Completed
S-2*	Hopple St. to Just North of the Intersection of Dolley By-Pass and Spring Grove Rd.	Camp Washington, South Cumminsville, Millvale, English Woods, Northside, & Clifton	2.25	Completed
S-3*	Dolley By-Pass and Spring Grove Rd. to the CSX RR Bridge Parallel Kings Run Rd.	Clifton, Spring Grove Village, & City of St. Bernard	1.5	Completed
S-4A	CSX RR Bridge Parallel Kings Run Rd. to Center Hill Rd.	Spring Grove Village, City of St. Bernard, Winton Hills, & Village of Elmwood Place	1.5	Completed
S-4B	Center Hill Rd. to Vine St.	Winton Hills, Village of Elmwood Place, Carthage, Hartwell, & Springfield Twp.	2	No Construction Started
S-5	Vine St. to the West Fork Mill Creek Just South of Galbraith Rd.	Carthage, Hartwell, Roselawn, Village of Arlington Heights, & Springfield Twp.	1.5	Partially Completed
S-6**	West Fork Mill Creek to Glendale-Milford Rd.	Village of Arlington Heights, Sycamore Twp., City of Reading, Village of Lockland, & Village of Evendale	3	No Construction Started
S-7B**	Glendale-Milford Rd. to Just North of Sharon Rd.	Village of Evendale & City of Sharonville	2	No Construction Started
S-7A**	Just North of Sharon Rd. to I-275	City of Sharonville	1.3	Partially Completed
S-7C**	I-275 to the Hamilton County and Butler County Border	City of Sharonville	1	No Construction Started

***S-2 and S-3 are considered a combined phase of the Mill Creek Local Protection Project by project managers at the U.S. Army Corps of Engineers.**
****Even though S-6 through S-7C are in the Upper Mill Creek Watershed, they are appropriate to include in this analysis because those Northern sections contribute to load volumes, velocity, and flow regimes that contribute to the urban ecology of the Mainstem of the Mill Creek due South to the Lower Mill Creek Watershed.**

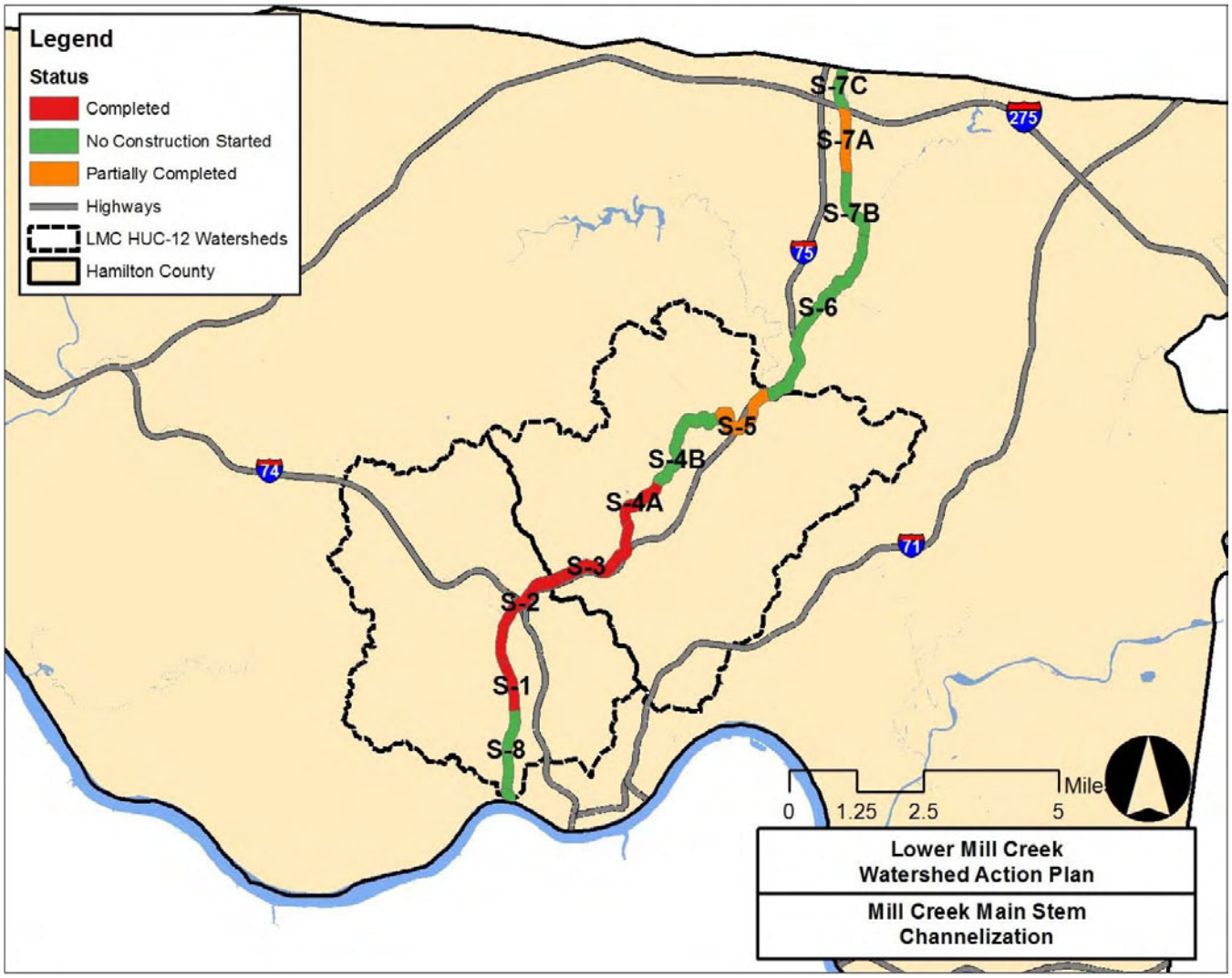


Figure 58 - Channelization in the Lower Mill Creek

Figure 58 - Channelization in the Lower Mill Creek corresponds to Table 38, which shows the Mill Creek Mainstem Channelization Plan by section. The sections in red indicate the segments of the mainstem that were fully encased in a concrete trapezoidal channel as part of the Army Corps of Engineers flood control strategy. The sections in orange were partially channelized by section, or have other major hydromodification features to redirect flooding.

4.15 STREAMS WITH UNRESTRICTED LIVESTOCK ACCESS

Site visits to agricultural use properties in the West Fork and Kings Run sub-sewersheds indicate that there are no locations within the LMC watershed where livestock have access to streams.

4.16 ERODING BANKS

Lower Mill Creek, Mill Creek Mainstem

On the mainstem Mill Creek the 6.25 miles that are fully or partially channelized are not an issue for eroding banks. In the sections of the lower Mill Creek watershed on the mainstem that are not channelized, some streambank stabilization projects have already been installed and are working as designed. At the top of Congress Run subwatershed, there is a section of the mainstem that has not been addressed and the Mill Creek Watershed Council of Communities and the Groundwork Cincinnati: Mill Creek agencies are working to get funding to stabilize the streambank.

Lower Mill Creek Tributaries

Eroding banks are prevalent in the lower Mill Creek tributaries but a complete inventory of all the tributaries has not been done yet. Site visits to the West Fork Creek, Kings Run, Congress Run and Bloody Run have revealed sections of eroding streambanks.

4.17 FLOODPLAIN CONNECTIVITY

As shown in section ***4.14 Channelization in the Lower Mill Creek Watershed*** the majority of the lower mainstem of the Mill Creek is channelized with almost no floodplain connectivity. Floodplain connectivity for headwaters is limited as well.

4.18 RIPARIAN LEVEES

Levees exist near the Barrier Dam across the Mill Creek near the mouth. There are 1,420 feet of levee and concrete wall between the western abutment of the dam and the pump house, and 5,660 feet of concrete wall forms the eastern closure of the dam.

Several private levees have been constructed throughout the years to prevent or lessen flood damages to industries along Mill Creek. Many of these private levees are located between Glendale Milford Road and Kemper Road. Industries protected by these levees include Ford Motor Company, General Electric, a site previously known as Astro Containers, Aero Blast, Sysco, General Mills, as well as other smaller industries.

4.19 EDGE CONDITIONS

Along the lower Mill Creek mainstem there are several distinct types of concrete channelization typologies (Kordenbrock, 2013). Approxmately 60% of this stretch has a man-made edge of some form (e.g. trapezoidal,

shearwall, rip-rap, cribwall, etc.). The most predeominate form is a trapezoidal concrete channel.

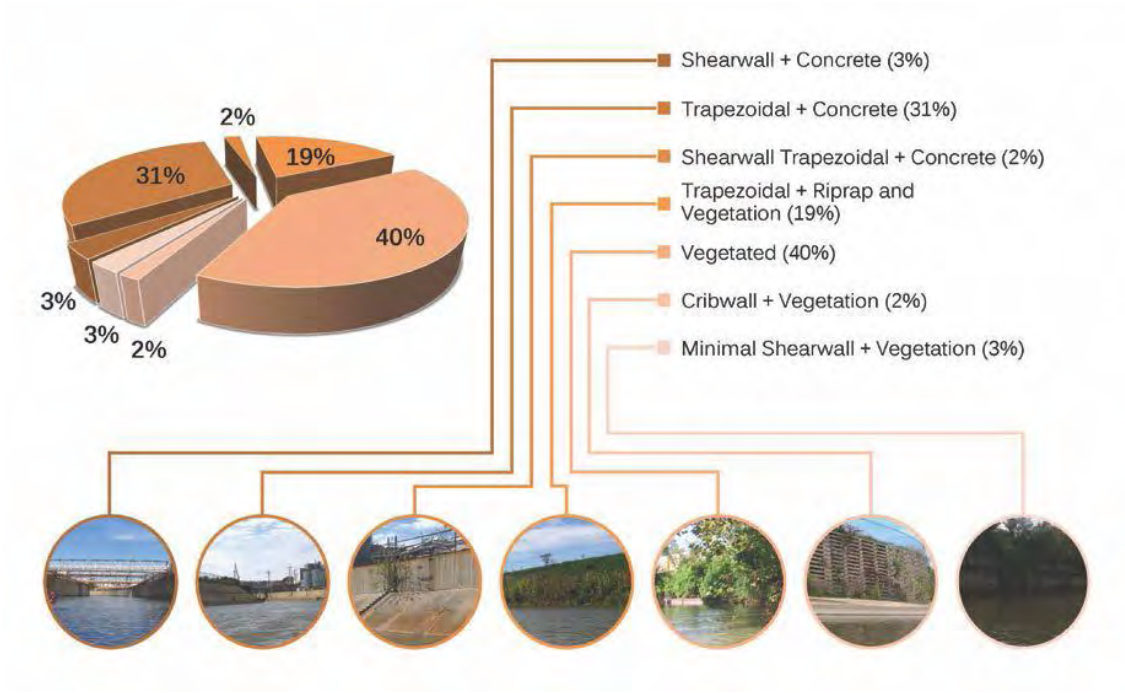


Figure 59: Edge Conditions in the Lower Mill Creek

Source: (Kordenbrock, 2013)

4.20 STATUS AND TRENDS

Residential Construction

Of the seventeen political jurisdictions in the Lower Mill Creek, only two had new residential construction permits issued in the Watershed for calendar year 2010 (January 1, 2010 to November 2, 2010). Issued permits in the Watershed include the City of Cincinnati with seventy permits and Amberley Village with one. Of these permits, all but three are single family. In total, there are seventy one occurrences of new residential construction in the Lower Mill Creek Watershed within the defined date range.

Future residential construction is not expected to have a significant impact on the already heavily impaired watershed conditions, since there just is not that much room left to grow in the Lower Mill Creek. In fact, new infill construction built to newer water quality standards should result in net watershed quality improvements over time. Furthermore, it would be better to bring additional construction to the Lower Mill Creek, an impaired watershed, than to see new development sprawl to undisturbed watersheds. This viewpoint is consistent with the Ohio Balanced Growth Plans.

Figure 60 - New Residential Construction shows clusters of new residential construction occurring in the City of Cincinnati in the Lower Mill Creek Watershed (purple dots represent the locations within the defined date range). The outlying location of new residential construction is identified with a green dot and is located in Amberley Village. This is the only other occurrence of new residential construction in the Watershed.

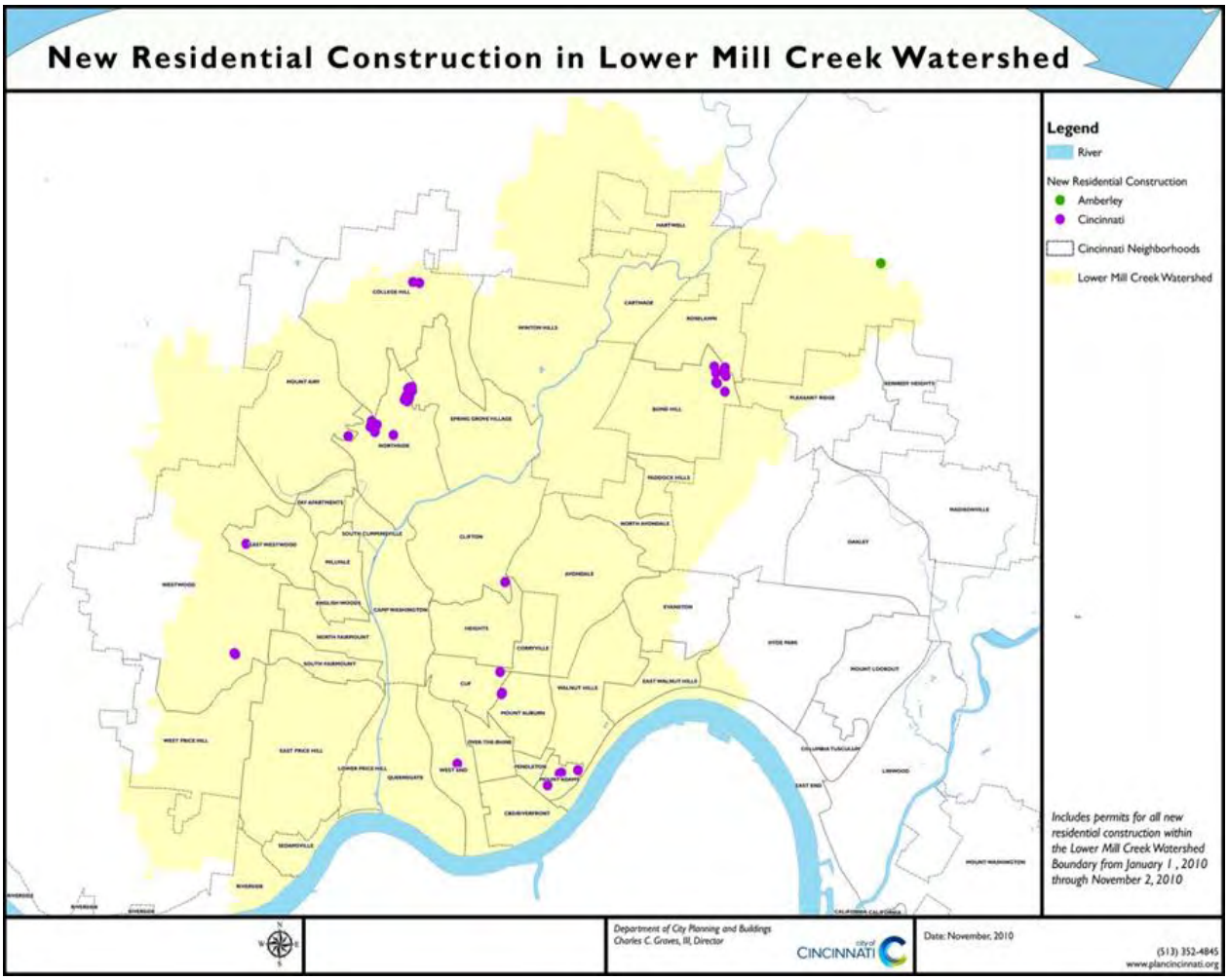


Figure 60 - New Residential Construction

5 WATER RESOURCE QUALITY

5.1.1 MILL CREEK WATERSHED WATER QUALITY MONITORING INVENTORY

Unfortunately, there is some water quality monitoring gaps created by sporadic monitoring efforts conducted by various agencies, with different levels of certification, and different needs. Due to these monitoring gaps and inconsistences, recommendations for the Mill Creek should include developing a comprehensive monitoring plan in the near future.

Institutions with vested water quality interest will need to increase the frequency of water quality sampling in the future for various reasons, including:

- Benchmarking current conditions,
- Determining causes and sources of pollutants as well as their impacts,
- Evaluating major stormwater and wastewater infrastructure projects effectiveness,
- Evaluating public sector stormwater improvement projects and policy changes,
- Validating water quality modeling programs and results,
- Various permitting requirements (e.g. NPDES Phase II permits)

Furthermore, citizen and volunteer water quality monitoring efforts will be an important facet of bridging the gaps in future water quality monitoring programs. The U.S. EPA (local Cincinnati office) is currently developing a *Citizens Water Quality Monitoring Pilot Program* that will train citizens to conduct scientifically acceptable sampling (Level 1) that could potentially be a model for the future water quality monitoring efforts.

Table 39 – Water quality monitoring efforts on the Mill Creek watershed

Source	Specific Data Types or Categories	Certifications	# Sampling Sites	Sample Timeframe	Notes
Butler County Water & Sewer	Chemical, Biological (E. Coli, Fish & Invert. Samples)	Level 3		Monthly/quarterly sampling, Bio-monitoring once/twice per year	Includes flow upstream & downstream of EFMC WWTP
Hamilton County Soil & Water	Various chemical, biological, physical	Level 3 for QHEI, Level 1 for Chemical		Six to seven samples per year in 2009, 2010, 2011, 2012	Primarily sampled around the Confluence Project area
Ohio EPA	Comprehensive chemical, physical, biological	Level 3		TMDL dependent, next Mill Creek TMDL 2014	May expand scope beyond nutrients in next TMDL 2014-2017
Butler County Stream Team	Chemical metrics mostly	Level 2	16 sites consistently, 12 sites less frequently		Can move sites to align with UMC monitoring program, could add 8 to 10 additional sample sites
Saturday Stream Snapshot	Chemical	Analyzed at Level 1 FOGM lab	Five transects from Mitchell to Ohio	Monthly grab samples at MC bridge and mouth of MC	
Metropolitan Sewer District	Many Various Chemical, and some limited Biological (E. Coli)	Soon to be Level 3	6 - 12 sites consistently, 6 additional sites for source analysis	2000 – 2010 (monthly samples)	Halted monitoring in 2011 due to MBI sampling, MBI will recommend new monitoring program to MSD in upcoming report
Midwest Biodiversity Institute	Comprehensive chemical, physical, biological	Level 3	91 sites in Mill Creek	2011 - between mid-June to mid-Oct (4 months), 2014 – return for new study	Currently developing IPS system – anticipated in 2014
Hamilton County Public Health	E. Coli to track leachate			Sampled streams in late 1990s, no longer	
USGS	Various water conditions: stage height, flow, temp., PH	Level 3	Present day: single site on Mill Creek near Carthage	Continuous discharge flow gage from 1947 to 2002, and 2011 to present	Crest stage gage only from 2002 to 2010. Past: 2-4 different locations along mainstem

Source: Mill Creek Watershed Council of Communities, *Water Quality Monitoring Assessment*, 2013

5.2 GEOGRAPHICALLY-REFERENCED USE DESIGNATION AND USE ATTAINMENT

Beneficial use designations describe existing or potential uses of water bodies. They take into consideration the use and value of water for public water supplies, protection and propagation of aquatic life, recreation in and on the water, agricultural, industrial and other purposes. Ohio EPA assigns beneficial use designations to water bodies in the state. There may be more than one use designation assigned to a water body (OEPA, Division of Surface Water, Water Quality Standards webpage, accessed May 19, 2011). Beneficial use designations for the Lower Mill Creek area are taken from Ohio Administrative Code 3745-1-30.

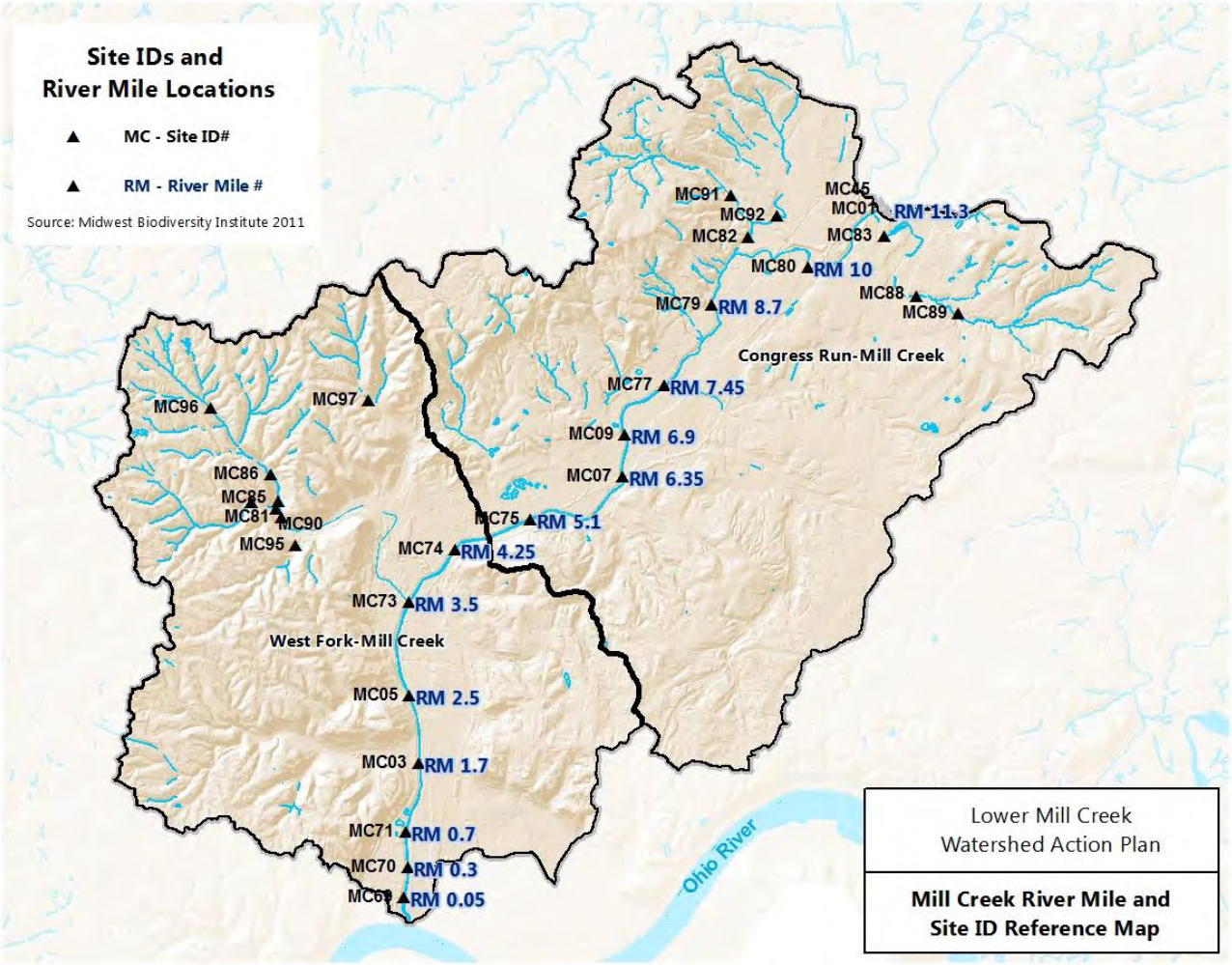


Figure 61 – Mill Creek River Mile # and Site ID #

Figure 61 – Mill Creek River Mile # and Site ID # shows the Mill Creek sampling sites used by the 2004 TMDL and 2011 MBI reports and the corresponding River Miles for reference.

Table 40 - OEPA Location and Use Designations for selected Mill Creek Segments

Location and Use Designations
Mill Creek - Center Hill Road (RM 7.9) to mouth (IP ecoregion – channel modification) Aquatic Life Habitat : MWH Water Supply: AWS, IWS Recreation: PCR
West Fork Creek (Mill Creek RM 3.45) - headwaters to Montana Avenue (RM 2.1) Aquatic Life Habitat: WWH Water Supply: AWS, IWS Recreation: SCR
West Fork Creek (Mill Creek RM 3.45) – Montana Avenue to the mouth (Small drainage-way maintenance) Aquatic Life Habitat: LRW Water Supply: AWS/IWS Recreation: SCR
Ross Run (Mill Creek RM 6.45) (Small drainage-way maintenance) Aquatic Life Habitat: LRW Water Supply: AWS/IWS Recreation: SCR
Winton Ridge Tributary (Mill Creek RM 6.85) Aquatic Life Habitat: WWH Water Supply: AWS/IWS Recreation: SCR
Bloody Run (Mill Creek RM 7.63) ((IP ecoregion – channel modification) Aquatic Life Habitat: MWH Water Supply: AWS/IWS Recreation: SCR
Key: WWH – warmwater habitat; MWH – modified warmwater habitat; LRW – limited resource waters; AWS – agricultural water supply; IWS – industrial water supply; PCR – primary contact recreation; SCR – secondary contact recreation

***Table 40 - OEPA Location and Use* Designations** presents the designations for the stream segments wholly or partially in the Lower Mill Creek. All designations are based on OEPA biological field assessments.

Table 41: MBI's *Mill Creek Bioassessment 2011* - Aquatic Life Use Attainment Status at Mill Creek basin stations sampled in summer 2011 (only Congres Run and West Fork shown)

Site ID	DA (mi^2)	Fish/ Invert. RM	IBI	MIwb	ICI	QHEI/ HHEI	Attainment Status	Causes	Sources
WAU 01-04: Congress Run – Mill Creek									
23-001 Mill Creek (WWH Aquatic Life Use–Existing)									
MC01	73.9	11.6/-^{W}	31*	6.2	-	62.50	NON	Habitat Alteration; Sedimentation; Nutrients; Chlorides	Hydromodification; Altered Hydrology; Urban Runoff
MC80	115	10.45/ 10.45^{W}	29*	6.2	MG^{ns}	50.25	PARTIAL	Habitat Alteration; Sedimentation; PAH; Nutrients; Chlorides;	Hydromodification; Altered Hydrology; Urban Runoff
MC79	124	8.75/ 8.65^{W}	25*	4.3*	36	62.00	NON	Habitat Alteration; Sedimentation; Nutrients; Chlorides	Hydromodification; Altered Hydrology; Urban Runoff
23-001 Mill Creek (MWH Aquatic Life Use – Existing; Recommend Adjusting WWH Boundary to include this reach)									
MC77	130	7.65/ 7.55^{W}	27*	6.5*	28^{ns}	57.50	NON	Habitat Alteration; Sedimentation; PAH; Nutrients; Chlorides	Hydromodification; Altered Hydrology; Urban Runoff
23-001 Mill Creek (MWH Aquatic Life Use – Existing)									
MC09	127	6.9/ 6.8^{W}	20*	4.0*	F*	27.00	NON	Habitat Alteration; Sedimentation; Nutrients;	Hydromodification; Altered Hydrology; Urban Runoff
MC07	135	6.40/ 6.35^{W}	30	6.1	22	27.00	FULL		
MC75	136	5.1/ 5.1^{W}	30	6.8	22	40.75	FULL		
23-040 Congress Run (Aquatic Life Use Undesignated / WWH Recommended)									
MC91	1.7	0.8/ 0.8^{H}	26*	NA	MG^{ns}	47.3/77	NON	Habitat Alteration; Sedimentation; Nutrients;	Hydromodification; Altered Hydrology; Urban Runoff
MC82	3.8	0.3/ 0.3^{H}	26*	NA	P*	44.50	NON	Habitat Alteration; Sedimentation; D.O.; Nutrients;	Hydromodification; Altered Hydrology; Urban Runoff
23-041 Unnamed Tributary to Congress Run at RM 0.37 (Aquatic Life Use Undesignated / WWH Recommended)									
MC92	0.8	0.3/ 0.3^{H}	18*	NA	VP*	34.0/76	NON	Habitat Alteration; Sedimentation; D.O.; Ammonia	Hydromodification; Altered Hydrology; Urban Runoff
23-042 UnnamedTributarytoMillCreekatRM10.8 (Aquatic Life Use Undesignated / WWH Recommended)									
MC89	1.8	1.65/ 1.75^{H}	28*	NA	F*	53.50	NON	Sedimentation; Chlorides	Altered Hydrology; Urban Runoff
MC88	2.5	0.95/ 0.95^{H}	34*	NA	G	64.50/-	PARTIAL	Sedimentation; Chlorides	Altered Hydrology; Urban Runoff
23-044 Unnamed Tributary to Mill Creek at RM11.51 (WWH Aquatic Life Use (Unverified)/WWH Recommended)									
MC83	3.7	0.4/ 0.4^{H}	24*	NA	MG^{ns}	50.00/-	NON	Sedimentation; D.O.; Nutrients	Altered Hydrology; Urban Runoff

Source: (Midwest Biodiversity Institute, 2011)

Table 41 continued

Site ID	DA (mi^2)	Fish/ Invert.RM	IBI	MIwb	ICI	QHEI/ HHEI	Attainment Status	Causes	Sources
WAU 01-05: West Fork – Mill Creek									
23-001 Mill Creek (MWH Aquatic Life Use – Existing)									
MC74	141	4.3/ 4.3[W]	33	8.3	20*	62.00	PARTIAL	Habitat Alteration; Sedimentation; Ammonia; D.O.; Nutrients;	Hydromodification; Altered Hydrology; Urban Runoff
MC73	154	3.5/ 3.5[W]	34	7.3	24	37.00	FULL		
MC72	155	3.2/ 3.1[W]	30	6.4	MG[ns]	32.00	FULL		
MC05	155	2.5/ 2.55[W]	31	6.7	20	32.00	PARTIAL	Habitat Alteration; Sedimentation; Ammonia; D.O.; Nutrients;	Hydromodification; Altered Hydrology; Urban Runoff
MC03	163	1.6/ 1.7[B]	33	8.8	10*	52.50	PARTIAL	Habitat Alteration; Sedimentation; Ammonia; D.O.; Nutrients; PAH	Hydromodification; Altered Hydrology; Urban Runoff; Ohio R. Backwater
MC71	165	0.80/ 0.65[B]	30	8.2	6*	51.50	PARTIAL	Habitat Alteration; Sedimentation; PAH; Ammonia; D.O.; Nutrients; Metals	Hydromodification; Altered Hydrology; Urban Runoff; Ohio R. Backwater
MC70	166	0.45/ 0.30[B]	29	8.2	6*	44.00	PARTIAL	Habitat Alteration; Sedimentation; Ammonia; D.O.; Nutrients;	Hydromodification; Altered Hydrology; Urban Runoff; Ohio R. Backwater
MC69	166	0.15/ 0.10[B]	31	7.9	6*	48.00	PARTIAL	Habitat Alteration; Sedimentation; Ammonia; D.O.; Nutrients; PAH	Hydromodification; Altered Hydrology; Urban Runoff; Ohio R. Backwater
23-002 West Fork Creek (WWH Aquatic Life Use Unverified) / PHW IIIA Recommended)									
MC96	0.90	4.0/4.0	20	NA	-	52.0/81	Class IIIA		
23-002 West Fork Creek (WWH Aquatic Life Use Unverified) / WWH Recommended)									
MC86	2.6	2.95/ 2.95[H]	16*	NA	F*	68.8/79	NON	Sedimentation;	Altered Hydrology; Urban Runoff
MC85	2.8	2.55/ 2.55[H]	22*	NA	MG[ns]	67.75	NON	Sedimentation;	Altered Hydrology; Urban Runoff
MC81	4.4	2.50/ 2.50[H]	20*	NA	F*	63.5	NON	Sedimentation; PAH	Altered Hydrology; Urban Runoff
23-027 Tributary to West Fork Creek at RM 2.54 (Aquatic Life Use Undesignated/PHW IIIA Recommended)									
MC90	1.5	0.35/ 0.30	12	NA	-	65.0/78	Class II-M		
MC93	1.7	0.10/ 0.10	12	NA	-	56.0/77	Class IIIA		
23-028 Tributary to West Fork Creek at RM 1.24 (Aquatic Life Use Undesignated/ PHW II Recommended)									
MC97	0.8	1.4/ 1.4	12	NA	-	61.0/77	Class II		
23-064 Tributary to West Fork Creek at RM 2.24 (Aquatic Life Use Undesignated/ PHW II-Modified Recommended)									
MC95	1.0	-/0.15	-	-	-	/43	Class II-M		

[a]- MIwb is not applicable to headwater streams with drainage areas < 20 mi.2.
[b] - An evaluation of the qualitative sample based on attributes such as EPT taxa richness, number of sensitive taxa, and community composition was used when quantitative data was not available or considered unreliable due to current velocities.
VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional
H – Headwater Site Type: sites draining areas <20 mi.2.
W - Wadeable Site Type: sites draining areas >20 mi.2 sampled with wading equipment.
B - Boat Site Type: sampled with boat or raft mounted electrofishing.
[ns] - Non-significant departure from the biocriteria (<4 IBI units or <0.5 MIwb units).

* - Significant departure from the biocriteria (>4 IBI units or >0.5 MIwb units).
[x]- PHWH categories do not have use attainment criteria.
ID – Insufficient data to assign a WWH use.
MC18, MC15, MC14, and MC17 were sampled for fish, macroinvertebrates, and QHEI by EnviroScience on behalf of Butler Co.

	Biological Criteria – Interior Plateau			
Index	WWH	EWH	MWH-C	
IBI – Boat	38	48	24	
IBI – Wading	40	50	24	
IBI -Headwater	40	50	24	
MIwb -Boat	8.7	9.6	5.8	
MIwb – Wading	8.1	9.4	6.2	
ICI	30	46	22	

Source: (Midwest Biodiversity Institute, 2011)

5.2.1 AQUATIC LIFE HABITAT

In the lower Mill Creek, only two designated areas – West Fork Creek (which has its mouth at Mill Creek River Mile 3.45) from its headwaters to Montana Avenue (RM 2.1) and the Winton Ridge Tributary (at Mill Creek RM 6.85) - are designated as warmwater habitat under the aquatic life habitat designation. These segments meet the baseline regulatory requirements in line with Clean Water Act "fishable goal" expectation. Both the Mill Creek from Center Hill Road (RM 7.9) to the mouth at the Ohio River and Bloody Run are designated as modified warmwater habitat. This designation allows less restrictive requirements for dissolved oxygen and ammonia and may result in less restrictive wastewater treatment requirements. The West Fork Creek from Montana Avenue to the mouth at Mill Creek (RM 3.45) and Ross Run are designated as limited resource waters. This designation has less restrictive aquatic life criteria for the majority of pollutants and may result in less restrictive wastewater treatment requirements.

A. Biological Assemblages

WAU 01-04 - Congress Run-Mill Creek

From MBI's Mill Creek Bioassessment 2011 – Biological Assemblages summary (p.80):

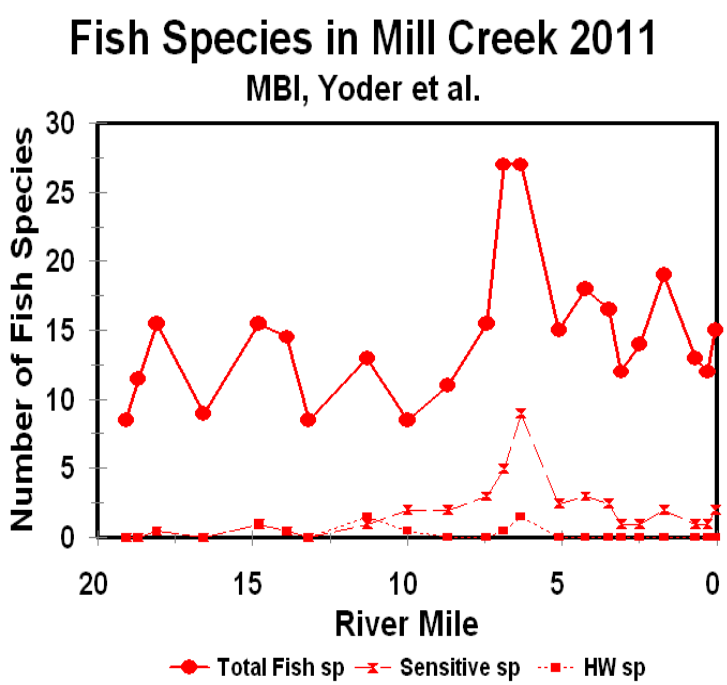
"This WAU is where the MWH reach of Mill Creek begins and where the natural channel has been replaced with a largely concrete lined and encased channel. Fish assemblage data in this reach ranged from poor (18) to fair (34). No sites attained the WWH biocriterion for fish, but three sites attained the less stringent criteria for MWH. None of the tributaries had any sensitive fish species. The mainstem Mill Creek yielded no intolerant species, but did have as many as four sensitive species (MC77, RM 7.45). This site is within the upper section of the existing MWH designated reach whose boundary is recommended to be adjusted downstream so that this site will be included in the WWH reach. As with most headwaters in other subwatersheds of Mill Creek, the impaired fish assemblages are likely a reflection of the urban character of the WAU. Here, headwater fish assemblages are dominated by tolerant species (mean=78.5%, range 57-91%)."

WAU 01-05 – West Fork-Mill Creek

From MBI's Mill Creek Bioassessment 2011 – Biological Assemblages summary (p.80):

"Mill Creek in this WAU is designated MWH due to the largely concrete channel with the lower two miles impounded by the Ohio River. The fish assemblage in Mill Creek attains both the IBI and MIwb biocriteria for MWH at all sites. DELT anomalies were detected in all but one sample (mean = 1.7%) and ranged as high as 4.8%. This indicates that some pollutional stressors are still evident and are likely derived from CSOs. There were no sensitive or headwater species in the headwater streams of this WAU and several were recommended as PHWH. There were no darter species and the sites where fish were collected almost entirely consisted of tolerant (97%) and pioneering species (99%). The urban character of the subwatershed was similar to other Mill Creek subwatersheds and is consistent with the mosaic of intensive urban stressors where increased runoff and altered hydrology result in multiple stressors related to habitat (sedimentation) and a suite of urban pollutants closely associated with chlorides and other dissolved constituents."

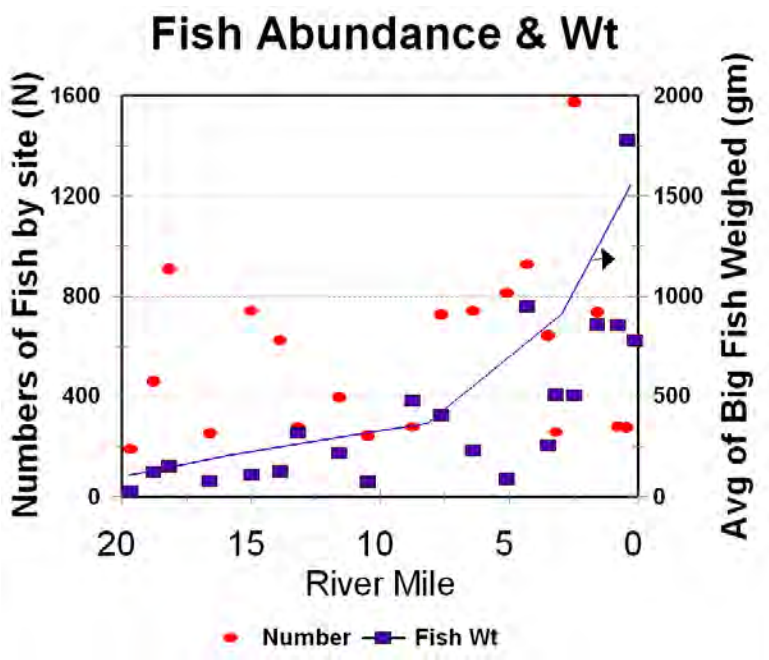
Using MBI's Mill Creek report data (2011), the following graphs were assembled by Dr. Mike Miller, University of Cincinnati, and Rivers Unlimited, to discuss the biological conditions in the Mill Creek.



Fish Species richness is greatest below Bloody Run (RM 5 – 7.5) where Ohio River species can migrate.

Figure 62 – Fish Species in Mill Creek 2011

Source: (Midwest Biodiversity Institute, 2011), graphic by Miller 2012

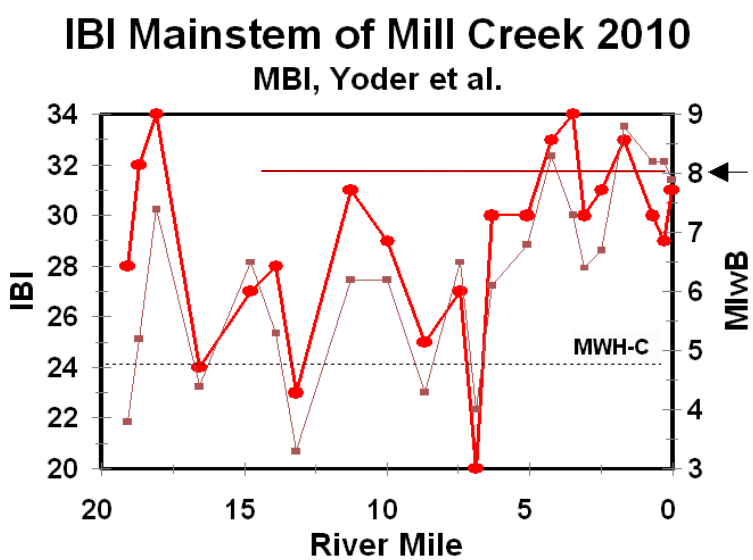


Fish Abundance is more varied by river mile, but noticeably dips at RM 10. Bigger fish (over 500gm in weight) are less likely to be found past RM 6, despite increasing total abundance from RM 12 to RM 18.

There are essentially two distinct fish habitats on the Mill Creek; they are separated by the industrial corridor and fish barriers between RM 8 and 10.

Figure 63 – Fish Abundance and Weight 2011

Source: (Midwest Biodiversity Institute, 2011), graphic by Miller 2012



The Index of Biotic Integrity (IBI) scores, between the Congress Run and West Fork-Mill Creek segments (RM 0.05 to 11.3), are all above MWH criteria at all sites except for RM 6.9.

Figure 64 – IBI Mainstem of Mill Creek 2011

Source: (Midwest Biodiversity Institute, 2011), graphic by Miller 2012

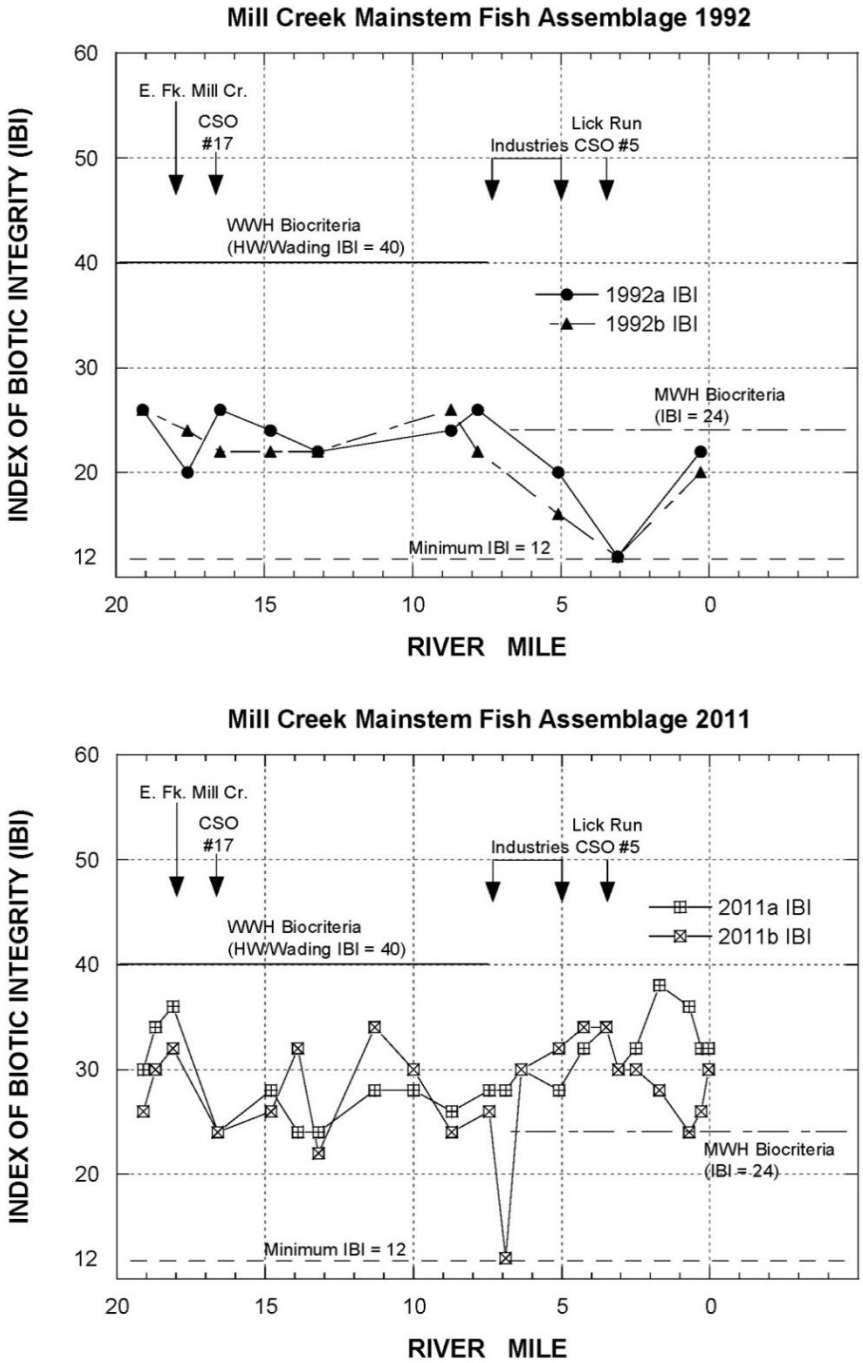


Figure 17. Fish Index of Biotic Integrity (IBI) results in the mainstem of Mill Creek in 1992 (upper) and 2011 (lower). The applicable biological criteria for the WWH and MWH designated uses are depicted.

The Index of Biotic Integrity (IBI) scores, between the Congress Run and West Fork-Mill Creek segments (RM 0.05 to 11.3), are significantly improved between the 1992 TMDL report and the 2011 MBI report.

The 2011 IBI scores, with the exception of one site, are mostly meeting the MWH biocriteria and some were close to meeting WWH biocriteria, while the 1992 IBI scores barely peaked past the MWH biocriteria.

Figure 65 – Comparing IBI Scores from 1992 to 2011

Source: (Midwest Biodiversity Institute, 2011)

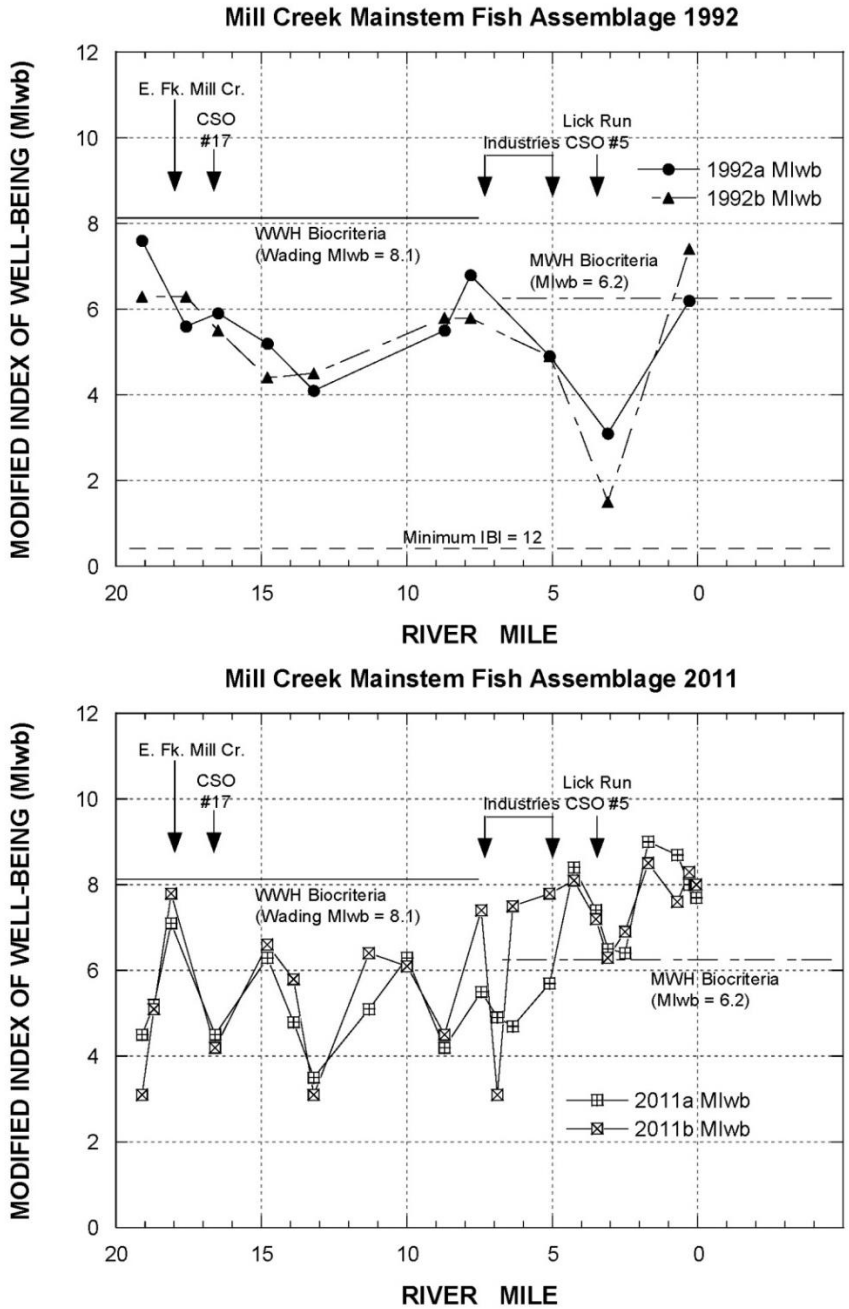


Figure 18. Fish Modified Index of Well-Being (MIwb) results in the mainstem of Mill Creek in 1992 (upper) and 2011 (lower). The applicable biological criteria for the WWH and MWH designated uses are depicted.

The Modified Index of Well-Being (MIwb) scores, between the Congress Run and West Fork-Mill Creek segments (RM 0.05 to 11.3), are also are significantly improved between the 1992 TMDL report and the 2011 MBI report.

In fact, several sites are meeting the WWH biocriteria for MIwb (equal or greater than 8.1). The exact reason for this improvement is unknown, but is likely due to a mixture of policy changes (e.g. NPDES permits) and infrastructure improvements (e.g. CSO and SSO fixes).

Figure 66 – Comparing MIwb Scores from 1992 and 2011

Source: (Midwest Biodiversity Institute, 2011)

B. Macroinvertebrate Assemblage

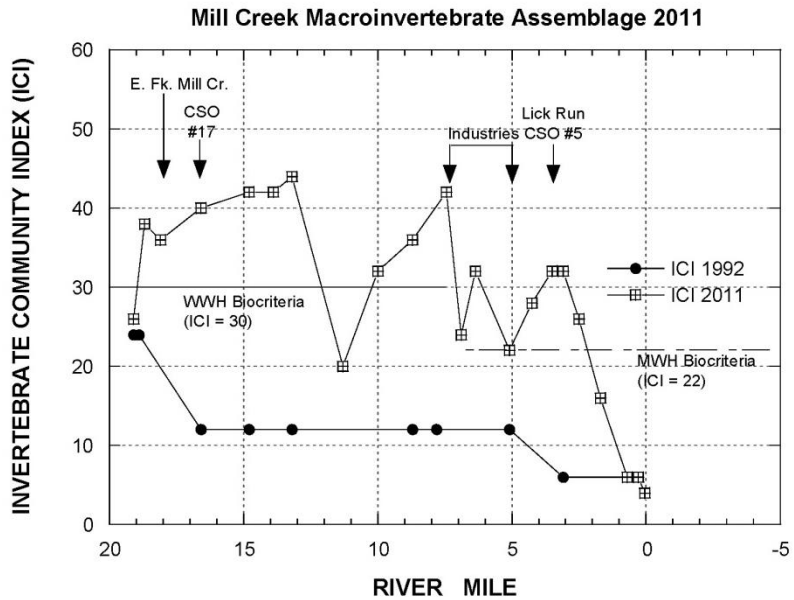


Figure 20. Macroinvertebrate Invertebrate Community Index (ICI) results in the mainstem of Mill Creek in 1992 (●) and 2011 (#). The applicable biological criteria for the WWH and MWH designated uses are depicted.

The Invertebrate Community Index (ICI) scores from 1992 and 2011 show a drastic improvement in the total average ICI scores across the entire mainstem.

Unfortunately, the final 3 river miles still show a rapid decline of ICI despite the improvements upstream.

Figure 67 – Macroinvertebrate Assemblage comparing 1992 to 2011

Source: (Midwest Biodiversity Institute, 2011)

WAU 01-04 - Congress Run-Mill Creek

From MBI's Mill Creek Bioassessment 2011 – Macroinvertebrate Assemblage summary (p.82):

"In this WAU, Mill Creek is designated as WWH from RM 11.3 to 8.7 and changes to MWH downstream from RM 7.3 to the mouth. The sites where the modified channel is most evident is at RMs 6.9 and 6.35 where the channel is completely encased in concrete with high walls a concrete bottom with a six foot wide by three feet deep trench within which the water flows under normal summer-fall flows. The remaining sections of the MWH reach consist of a mix of concrete walls and soft bottom with sand/silt embedded riffles within which some recovery is evident. The ICI scores and narrative ratings from RM 11.3 to 7.45 were marginally good to very good and in attainment or non-significant departure of WWH biocriterion. The ICI scores and narrative rating at RMs 6.9, 6.35, and 5.1 were fair, 32 (marginally good) and 22 (fair), respectively, all of which attained the MWH biocriterion.

The uppermost site on Congress Run at RM 0.8 had 5 EPT taxa with caddisflies predominating. The MC 92 tributary that enters Congress Run at RM 0.37 was evaluated as very poor with 0 EPT taxa and the subsequent downstream site on Congress Run at RM 0.2 was evaluated as poor with only 1 EPT taxa. The MC 92 site had the least number of taxa collected at any site in the study area yielding only turbellarians

and Physella sp. The other three tributaries in the 01-04 WAU at MC 88, MC 83, and MC 89 were evaluated as fair to good.''

WAU 01-05 – West Fork-Mill Creek

From MBI's Mill Creek Bioassessment 2011 – Macroinvertebrate Assemblage summary (p.82):
"Mill Creek sites located at RMs 4.25, 3.5, and 3.1 had sand/silt substrates with vegetated banks. Downstream from these sites at Mill Creek RMs 2.5 and 1.7 was comprised of a largely concrete channel and the lower two miles from RM 1.7 to the mouth are impounded by backwaters of the Ohio River. ICI scores at RM 4.25 and 2.5 ranged from 26 to 32, 5attaining the MWH biocriterion for this section of Mill creek. ICI scores in the lower two miles ranged from 16 to 4 in the fair to poor range and not attaining the MWH biocriterion. However, these scores were likely more indicative of the impounded conditions of this section of Mill Creek than necessarily by water quality conditions. Three sites located in West Fork Creek were evaluated as fair to marginally good."

	West Fork-Mill Creek	Congress Run-Mill Creek
Coldwater Habitat (CWH)	0.0	0.0
Exceptional Warmwater Habitat (EWH)	0.0	0.0
Warmwater Habitat (WWH)	2.9	6.0
Limited Resource Water (LRW)	2.2	2.4
Limited Warmwater Habitat (LWH)	0.0	0.0
Modified Warmwater Habitat (MWH)	4.6	5.3
Seasonal Salmonid Habitat	0.0	0.0

Source: ODNR, ERIN Watershed Reports, 2012

5.2.2 PUBLIC WATER SUPPLY

None of the identified segments are used as public water supplies – rather they are all designated for agricultural and industrial uses.

5.2.3 RECREATION

Designation - The Mill Creek from RM 7.9 to the mouth of the Ohio is designated for primary contact recreation as it can allow full body immersion, has high proximity to residential areas, and/or an intermediate potential for exposure to bacteria. This designation indicates an intermediate risk of swimmer's illness after exposure and calls for a baseline level of disinfection. The remaining segments are under the most restrictive category – secondary contact recreation – where water depth precludes full body immersion, has low proximity to residential areas, and/or the lowest potential exposure to bacteria. It presents the greatest risk of swimmer's illness after exposure and requires slightly less disinfection of wastewater.

Known Uses - The recreational uses of the lower Mill Creek are extremely limited as there are no deep water pools; limited access and low base flow during dry weather. Public access is limited or discouraged in the lower Mill Creek due to the predominantly industrial land use; channelized stream reaches, which do not invite

wading; and the presence of I-75 and its associated right-of-way. Widespread public awareness of the impacts caused by CSOs, SSOs and other pollutants, discourages recreation use as well.

5.2.4 WATERBODIES' MILES IN ATTAINMENT

The Ohio Clean Water Act Section 305(b) List for 2008 lists the Mill Creek with 11% of its stream miles as fully attaining applicable aquatic life uses, 5% as partially attaining, and 84% as not attaining.

5.2.5 THREATENED MILES

None of the stream segments of the Mill Creek are classified as "threatened".

5.2.6 LAKES' QUALITY

There are no monitored lakes in the Congress Run or West Fork Mill Creek watersheds.

5.2.7 WETLANDS' QUALITY

Most of the hydric soils in the lower Mill Creek Watersheds are located along the Mill Creek or near surface ponds. Nearly two-thirds of the 233 acres of hydric soils in the Lower Mill Creek Watersheds are categorized as 'Riverine', and most of the remaining third is 'Freshwater Pond'. Hydric soil locations were mapped using data from the US Fish and Wildlife Survey National Wetlands Inventory.

These wetland locations are primarily occupied by bottomland hardwoods. The majority of the Mill Creek Watershed consists of urban land-stonelick complex, frequently flooded areas designated as Ux (USACE, 2005). These areas are characterized by oxbows and sloughs.

5.2.8 GROUNDWATER QUALITY

Ground water is not currently used as a public drinking water source in the area of concern.

5.3 CAUSES AND SOURCES OF IMPAIRMENTS AND THREATS PRESENTED IN 305(B)-303(D) INTEGRATED WATER QUALITY REPORT

The Ohio EPA Integrated Water Quality Monitoring and Assessment Report indicate the general conditions of Ohio's waters and identify waters that are not meeting water quality goals. Summary reports are provided for individual Watershed assessment units (WAU) identified by their HUC code. The report satisfies the Clean Water Act requirements for both Section 305(b) water quality reports and Section 303(d) lists of impaired waters. The integrated reporting format began in 2002 and continued through 2008. Prior to that Ohio Water Resource Inventory reports were developed. The 2010 integrated report contains significant differences from its predecessors including new assessment unit sizes, methodologies, new data, and listing by beneficial use. This resulted in a substantial number of changes to the 303(d) list. The 2010 Integrated Report was approved by U.S. EPA on June 2, 2010.

Also, "A *Final 2012 Integrated Waters Quality Monitoring and Assessment Report"* was released which includes more recent TMDLs, new data on *E. coli* from facilities, new 2020 water goals for all four beneficial uses, and more. But no changes to the lower Mill Creek were noted in this report.

5.3.1 2010 INTEGRATED REPORT: SECTION 305(B)

The 2010 Watershed Assessment Summaries for West Fork (Table 42) and Congress Run (Table 43) are nearly identical in terms of causes of impairment and their corresponding sources. Both WAUs are listed as impaired and in need of a TMDL. The next monitoring for the Mill Creek (Ohio) is scheduled for 2014 and a TMDL is scheduled for 2017.

5.3.2 EARLIER REPORTS (2002 – 2008)

The earlier integrated reports (for 2002, 2004, 2006 and 2008) provide assessments for the entire Mill Creek Watershed (HUC 0509020 010) which encompasses 164.6 square miles. These earlier reports did not break the assessment into smaller subwatersheds. The entire basin is reported as impaired for all uses.

Table 42 – West Fork-Mill Creek (01-05) Watershed Assessment Unit Summary

Aquatic Life Use Assessment (sampling years 1997, 2002, 2003)		Recreation Use Assessment	Fish Tissue Assessment
Reporting Category: 5x-Impaired, TMDL needed	Aquatic Life Uses: WWH, MWH-C, LRW	Reporting Category: 3 (use attainment unknown)	Reporting Category: 5h—Impaired; TMDL needed
Causes of Impairment	**Sources of Impairment**		Causes of Impairment
• Cause Unknown • Unknown Toxicity • Unionized Ammonia • Nutrients • Organic Enrichment/DO • Flow Alteration • Direct Habitat Alterations • Oil and Grease • Taste and Odor	• Industrial point sources • Major Municipal Point Sources • Combined Sewer Overflow • Urban Runoff/Storm Sewers (NPS) • Channelization – Development • Streambank Stabilization – Development		None
Assessment Score: 11	**Priority Points: 3**	Assessment Score: Not calculated	
Next Monitoring: 2014		Next TMDL: 2017	

Table 43 - Congress Run-Mill Creek (01-04) Watershed Assessment Unit Summary

Aquatic Life Use Assessment (sampling years 1997, 2002, 2003)		Recreation Use Assessment	Fish Tissue Assessment
Reporting Category: 5x-Impaired, TMDL needed	Aquatic Life Uses: WWH, MWH-C, LRW	Reporting Category: 3 (use attainment unknown)	Reporting Category: 5h—Impaired; TMDL needed
Causes of Impairment	**Sources of Impairment**		Causes of Impairment
• Cause Unknown • Direct Habitat Alterations • Flow Alteration • Nutrients • Oil and Grease • Organic Enrichment/DO • Taste and Odor • Unionized Ammonia • Unknown Toxicity	• Channelization – Development • Combined Sewer Overflow • Industrial point sources • Major Municipal Point Sources • Streambank Stabilization – Development Urban Runoff/Storm Sewers (NPS)		None
Assessment Score: 11	**Priority Points: 3**	Assessment Score: Not calculated	
Next Monitoring: 2014		Next TMDL: 2017	

Source: (Ohio Environmental Protection Agency, 2012)

5.3.3 AQUATIC LIFE USE ASSESSMENT

Percent attainment for aquatic life use is broken down by stream size categories. The 2002 report breaks stream size into two categories while the 2004, 2006 and 2008 reports use three. In 2002, 17.5 % of small streams (< 50 square mile drainage area) were in attainment, 13.3 percent in partial attainment and 69.2 % in non-attainment. In larger streams (> 50 square mile drainage area), none were in full attainment, 5.6 % were in partial attainment, and 94.4 % in non-attainment. In 2004, 2006 and 2008, smaller streams/tributaries (< 50 square mile drainage areas) had increased to 22.5%; partial attainment went up from 0% in 2002 to 10% in 2006 and 2008; and non-attainment decreased from 77.5% to 67.5%. For larger streams ranging from 50 to 500 square miles, 100 % were in non-attainment.

5.3.4 RECREATION USE ASSESSMENT

The 2002 report listed the impairment as unknown. The 2004 through 2008 reports identify impairment with respect to primary contact.

5.3.5 PUBLIC DRINKING WATER SUPPLY ASSESSMENT

All reports indicate that the lower Mill Creek watershed is not a source of drinking water

5.3.6 FISH TISSUE ASSESSMENT/FISH ADVISORIES

All reports indicate impairment with PCBs identified as the pollutant. The 2008 report states that of the 20.40 miles sampled, 17.9 were impaired. Fish advisories were issued for all years.

5.3.7 2000 OHIO WATER RESOURCE INVENTORY

The 2002 report uses a smaller area defined as the Mill Creek from West Fork Mill Creek (RM 11.57) to the Ohio River. The aquatic life use attainment is the only use presented. One mile is identified as in partial attainment and 10.57 miles in non-attainment. The listed causes of impairment are organic enrichment/DO, other habitat alterations, unknown toxicity, pesticides, metals, priority organics, oil and grease, and unionized ammonia. Sources of impairment include combined sewer overflow, industrial point sources, landfills and contaminated sediments

5.3.8 SECTION 303(D): TMDL LIST PRIORITIZATION

Section L4 of the 2010 Integrated Report contains the Section 303(d) list of Prioritized Impaired Waters. The watershed scores for each beneficial use identified in Section 305(b) are combined to aid in assigning priority points for the watershed. As shown in Table 42 and Table 43, the priority points total for both the West Fork-Mill Creek and the Congress Run-Mill Creek (separately) is 3. This low overall score generally reflects severe basin-wide problems, comprehensive degradation that may require significant time and resources and broad scale fixes including the potential need for fundamental land use changes or policies. Guidance provided with the 2010 report indicates that emphasis on education about how water quality is impacted by various practices and on encouragement of stewardship may be more appropriate than a traditional TMDL.

5.3.9 OHIO FISH CONSUMPTION ADVISORIES

The most recent Ohio fish consumption advisory was based on sampling that took place in 2010. The advisory was for PCBs in all fish species caught from Interstate 275 to the mouth of the Mill Creek. The recommended consumption rate is once per month (Ohio 2010 Integrated Report, Section J-2).

5.4 POINT SOURCES

5.4.1 INDIVIDUAL WASTEWATER DISCHARGES

The Ohio EPA, under the National Pollutant Discharge Elimination System (NPDES) permit system, regulates point-source discharges to waters of the United States by providing permits to and enforcing permit limitations on various facilities.

The NPDES program regulates wastewater discharges directly to waters of the United States. These dischargers can include municipal wastewater treatment facilities, as well as industrial, commercial, and federal facilities that are permitted to discharge wastewater effluent to State waters. A list of Ohio EPA's individual NPDES permits for the lower Mill Creek watershed is shown in *Table 44 - Individual NPDES Permits* and displayed geographically in *Figure 68: Individual NPDES Permits 2012*.

Table 44 - Individual NPDES Permits in the Lower Mill Creek Watershed

Permit Holder	US EPA Permit ID# / OEPA Permit ID#	Permit Type	Major	Receiving Waters
AIRY POINTE CONDO ASSOC WWTP	OH0072184 / 1PW00020*ED	Municipal	No	West Fork, Mill Creek
CINCINNATI GALBRAITH ROAD MSD SITE	OH0105457 / 1PX00022*BD	Municipal	No	Mill Creek
COGNIS OLEOCHEMICALS, LLC	OH0137812 / 1IF00017*BD	Industrial	No	Mill Creek
EMERY OLEOCHEMICALS, LLC	OH0137821 / 1IF00018*AD	Industrial	No	Mill Creek
J M SMUCKER COMPANY	OH0134155 / 1IH00026*DD	Industrial	Yes	Mill Creek
MILL CREEK WWTP	OH0025461 / 1PM00001*LD	Municipal	Yes	Mill Creek
PETER CREMER NORTH AMERICA LP	OH0137651 / 1IN00286*AD	Industrial	No	Mill Creek
PROCTOR & GAMBLE	OH0009741 / 1IN00075*OD	Industrial	No	Mill Creek

Source: Ohio EPA, Accessed August 14, 2012

5.4.2 INDIVIDUAL INDUSTRIAL STORMWATER DISCHARGES

Industrial facilities have two permit options for stormwater discharges—coverage under an NPDES General Permit or under and NPDES Individual Permit. Most industrial facilities have coverage under a General Permit because it is the most efficient option for permitting large numbers of facilities with similar discharge characteristics. Industrial stormwater discharge permittees in Congress Run and West Fork subwatershed of the Mill Creek are listed in Table 45.

Table 45: Industrial Stormwater Permits

Facility Name	Address	Permit ID
	CONGRESS RUN – MILL CREEK	
AMERICAN COMPRESSED STEEL	200 W NORTH BEND RD CINCINNATI, OH 45216	1GR00645*DG
BAERLOCHER PRODUCTION USA LLC	5890 HIGHLAND RIDGE DR CINCINNATI, OH 45232	1GR00562*DG
BARRETT PAVING MATERIALS INC	24 BYRNES LAKE CT CINCINNATI, OH 45216	1GR00651*DG
BUCKLEY MFG CO	148 CALDWELL DR CINCINNATI, OH 45216	1GR00659*DG
EMERY OLEOCHEMICALS LLC	4900 ESTE AVENUE CINCINNATI, OH 45232	1GR01382*DG
ENVIRONMENTAL ENTERPRISES INC	4650 SPRING GROVE AVE CINCINNATI, OH 45232	1GR00326*BG
EPCOR FOUNDRIES	425 W NORTH BEND RD CINCINNATI, OH 45216	1GR01140*DG
FINA LLC	4700 ESTE AVE CINCINNATI, OH 45232	1GR00598*DG
IMPERIAL ADHESIVES INC	6315 WIEHE RD CINCINNATI, OH 45237	1GR00544*AG
JM SMUCKER CO - CRISCO FACILITY	5204 SPRING GROVE AVE CINCINNATI, OH 45217	1GR00599*DG
MOSKOWITZ BROS INC	5300 VINE ST CINCINNATI, OH 45217	1GR00445*DG
PEPSI BEVERAGES CO	2121 SUNNYBROOK DR CINCINNATI, OH 45237	1GR01294*DG
PETER CREMER NORTH AMERICA LP	100 JUNE ST CINCINNATI, OH 45217	1GR00662*AG
PETERMANN - GOLF MANOR FACILITY	1861 SECTION RD CINCINNATI, OH 45237	1GR01061*DG
IVORYDALE BEAUTY CARE PLANT	5201 SPRING GROVE AVE CINCINNATI, OH 45217	1GR00195*BG
CINCINNATI TRANSFER STATION-ESTE AVE	5701 ESTE AVE CINCINNATI, OH 45232	1GR01169*DG
SHERWIN-WILLIAMS CO	145 CALDWELL DR CINCINNATI, OH 45216	1GR00582*DG
ST BERNARD SOAP CO	5177 SPRING GROVE AVE CINCINNATI, OH 45217	1GR00622*AG
SUN CHEMICAL CORP	266 W MITCHELL AVE CINCINNATI, OH 45232	1GR00218*BG
SUN CHEMICAL- COLOR INTERMEDIATES	5366 ESTE AVE CINCINNATI, OH 45232	1GR00217*BG
U-PULL-AND-PAY LLC	426 W SEYMOUR AVE CINCINNATI, OH 45216	1GR00989*AG
	WEST FORK – MILL CREEK	
CITY OF CINCINNATI MILLCREEK ASPHALT PLANT	3319 MILLCREEK RD CINCINNATI, OH 45225	1GR00140*DG
QUEENSGATE YARD	3601 GERINGER AVE CINCINNATI, OH 45223	1GR00529*DG
CINCINNATI TRANSFLO TERMINAL	3601 GERINGER AVE CINCINNATI, OH 45223	1GR00657*DG
US EPA TEST 7 EVALUATION FACILITY	1600 GEST ST CINCINNATI, OH 45204	1GR00207*BG

Source: Ohio EPA, Accessed August 14, 2012

5.4.3 MUNICIPAL STORMWATER DISCHARGES

The Municipal Separate Storm Sewer Systems (MS4) program was developed by the USEPA to prevent harmful pollutants from being washed or dumped into an MS4. MS4 operators must obtain an NPDES permit and develop a stormwater management program. These permits include the required "Six Minimum Control Measures" as well as requirements for implementing construction and post-construction controls.

Table 46: MS4s Covered Under Small MS4 General Permit (OHQ000002)

Permittee	Permit ID
City of St. Bernard	1GQ00071*AG
City of Wyoming	1GQ00070*AG
Hamilton County Storm Water District and 42 co-permittees	1GQ00046*BG
Hamilton County Park District	1GQ00026*BG
Ohio Department of Transportation	4GQ00000*BG
Ohio Turnpike Commission	3GQ00022*AG/3GQ00022*BG

Source: Ohio EPA, Accessed August 14, 2012

5.4.4 SPILLS AND ILLICIT DISCHARGES

For information/reporting spills and illicit discharges:

- The Hamilton County Emergency Management Agency which prepared the Mill Creek Emergency Response Plan (2013).
    - Mill Creek Response Directory (emergency contacts, jurisdiction contacts, etc.)
    - Hazards, Injury Potential and Control measures list
    - Recommended Boom locations
- MSDGC's Department of Industrial Waste
    - Industrial Users Enforcement Response Plan (2011)
- Ohio EPA
    - Public Records Request of latest spills
    - Emergency Response Program

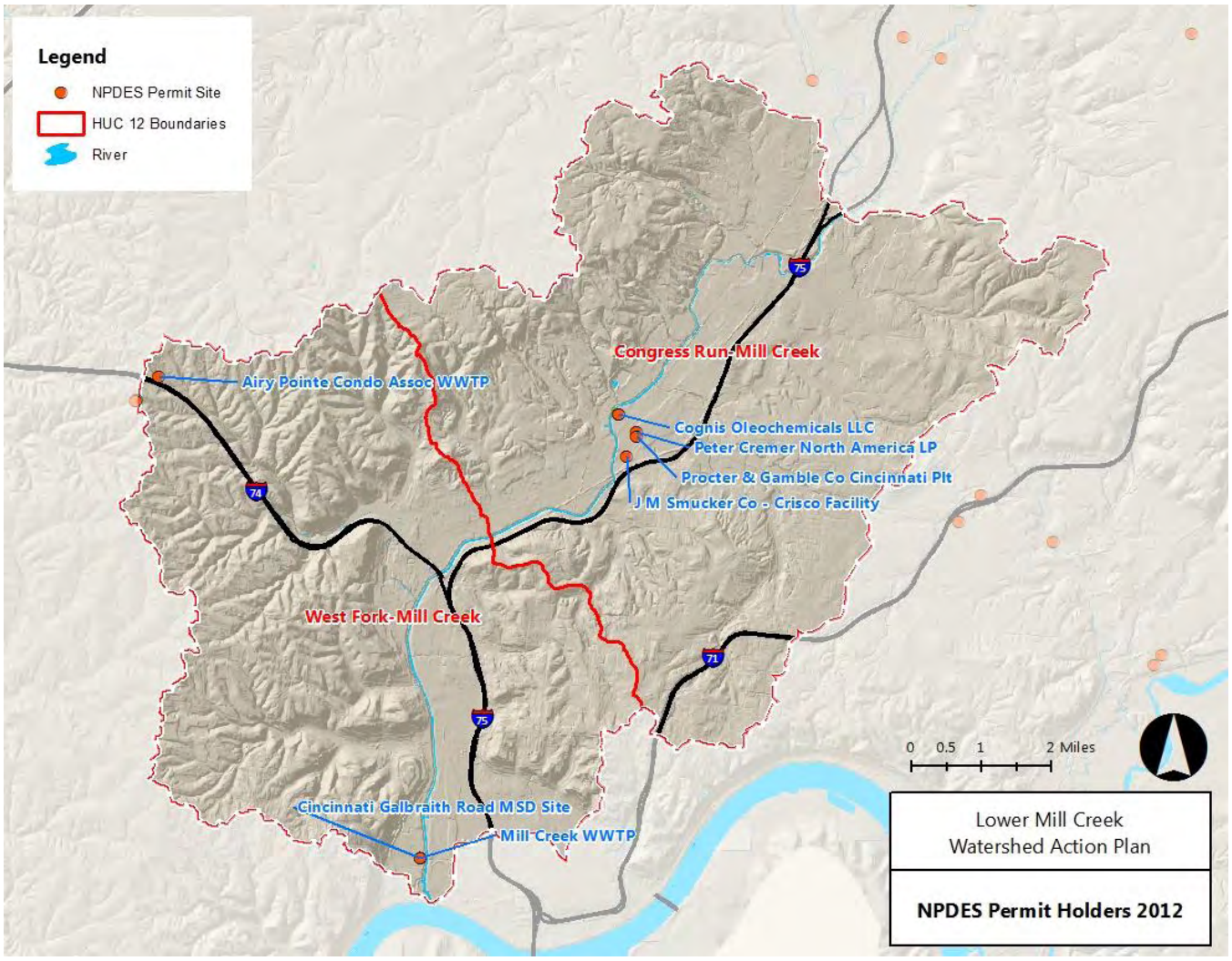


Figure 68: Individual NPDES Permits 2012 in LMC Watersheds

Source: Ohio EPA, Accessed August 14, 2012. Map created by author

5.5 NONPOINT SOURCES

5.5.1 HISTORIC LANDFILLS, DUMPS AND BROWNFIELDS

Several major historic landfills, dumps and brownfields in the Mill Creek watershed were identified by the EPA in the *EPA's 2004 Mill Creek TMDL - Appendix C – "Summary of Non-Point Sources"* (p. 33 – 57). Many of these sites are still responsible for legacy water quality problems. (See *Appendix F* of this document for a summary of Brownfields, Dump Sites, and Superfund Sites in Congress Run and West Fork HUC-12 Watersheds.)

5.5.2 INVENTORY OF HOME TREATMENT SEWAGE SYSTEMS AND PROJECTED NUMBER OF FAILING SYSTEMS

In Hamilton County, 1541 homes have on-site sewage systems in Mill Creek Watershed which are authorized by the Hamilton County and City of Sharonville Departments of Health. When functioning and maintained correctly, HSTS can provide adequate reduction of nutrients and bacteria. HSTS can, however, become clogged or stop functioning if not maintained. In this condition, they can be sources of high levels of organic matter, nutrients, and bacteria.

Figure 69, shows the location of failing HSTS systems in the lower Mill Creek. Currently, no failing HSTS are within 1000 ft. of a perennial stream, but as Figure 44 shows, there are many non-failing HSTS systems that can be found within close proximity to perennial streams.

Table 47 – Septic System Estimates from 2002 Ohio EPA TMDL report

Septic Systems	Assumed Distribution	HUC-4 (Congress Run)	HUC-5 (West Fork)
#of Septic systems		70	574
Direct Discharge	1 %[B]	1	6
Short Circuited	3 %[C]	2	17
Ponded	16 %[D]	11	92
Normal	80 %[E]	56	459
# of people (total)[A] (1S.S.=2.6 people)		182	1,492
Direct Discharge[B]		3	16
Short Circuited[C]		5	44
Ponded[D]		29	239
Normal[E]		145	1,193

A - Assume 2.6 persons/Septic System
B - Direct Discharge: Illegal systems discharge effluent directly into surface waters. Assume 1% have a Direct Discharge
C - Short-circuited: Systems are close enough to surface water (< 15 meters) that negligible absorption of phosphorus takes place. Assume 3% are within 15 m of streams
D - Ponded: System failure results in surfacing of effluent. Assume 16% are ponded
E - Normal: Septic systems conform to EPA standards and operating effectively. Assume 80% are normal

Source: (Ohio EPA, 2004)

Table 48 - Failing Septic Systems near Mill Creek

LICENSE #	Parcel #
007203	021800590038
009476	022000560019
009493	022000560042
008691	021800590169
011859	022000560122
003086	020200410107
003106	020200410108
012611	021500700092
012727	021500700193
003398	020100390015
008493	020200420016

Source: Hamilton County Public Health Department

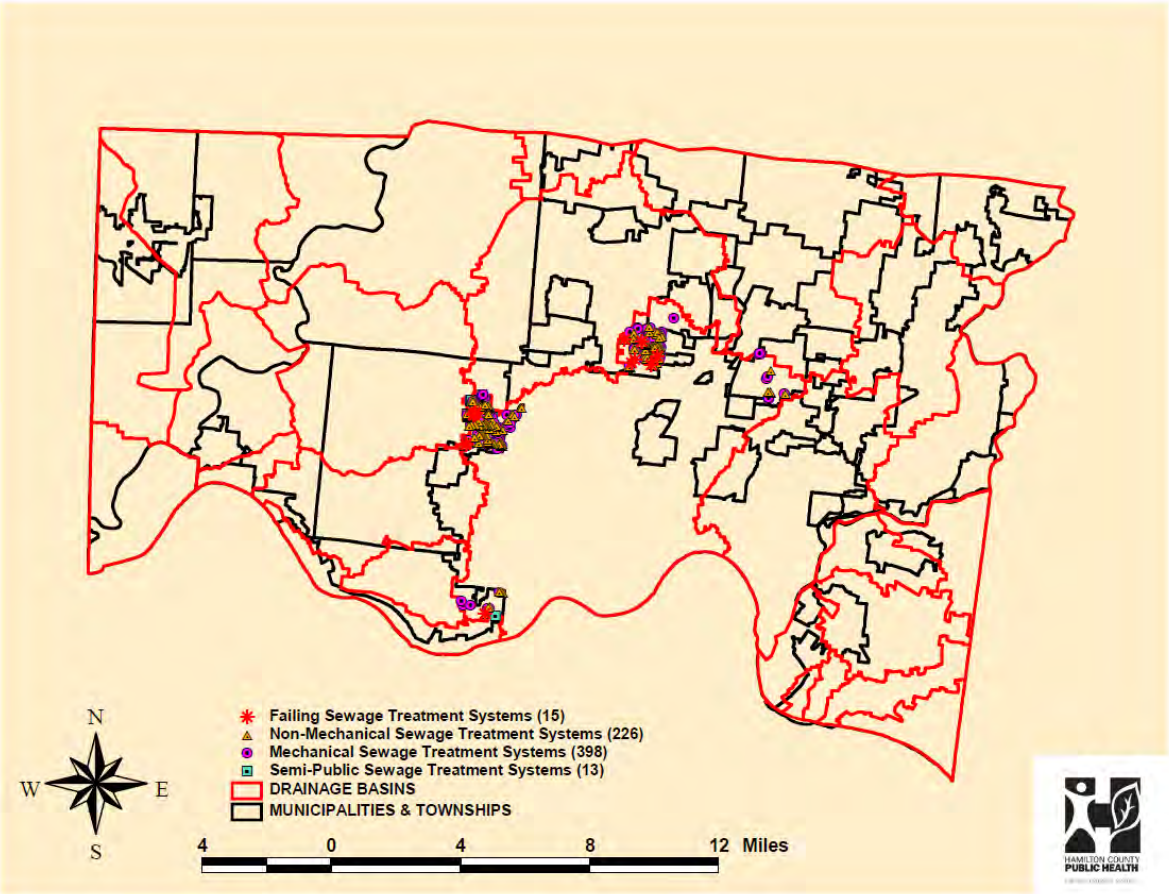


Figure 69 - Failing HSTS Systems

Source: Hamilton County Public Health Department

5.5.3 NUMBER AND SIZE OF ANIMAL FEEDING OPERATIONS

Section *4.5.4 Agriculture* on page 94 shows the location, number and size of Agriculture land uses, including livestock locations. Overall, animal feeding operations present a minimal concern to water quality issues in the Lower Mill Creek watershed.

5.5.4 ACRES OF HIGHLY ERODIBLE LAND AND POTENTIAL SOIL LOSS

The lower Mill Creek watershed is situated within a very unique topographic and geologic setting. Landslides present a major risk to soil loss. Many natural factors combine to make the hillsides of Hamilton County particularly susceptible to landslides. Add to this the large population and the accompanying amount of land development activity and conditions become susceptible for troublesome, costly and destructive landslides.

At the base of Hamilton County's geologic setting is the bedrock native to the area, which is comprised of Ordovician age (about 450 million years old) shale and limestone. Of particular interest with respect to landslides is a formation known as the Kope. The exposed Kope formation is roughly 200-ft thick, extending up from the general level of the Ohio River, forming the valley walls that surround many of the County's deeper river and stream valleys. The shale portion of the Kope weathers easily to a rather weak soil, so that where the Kope is exposed, it develops a "skin" of soil, known as "colluvium", which is highly prone to slippage and landslides.

Next is the fact that Hamilton County has experienced three major glacial advances through its geologic history. Prior to the advance of these glaciers, a large, ancient river called the Teays flowed north through Hamilton County. The earliest glacier to advance into Hamilton County (the Kansan) occurred about 1.2 million years ago. Glaciers are continental sheets of ice as much as two miles thick, which gouge the earth and move great quantities of earth and rock. On their retreat, these glaciers melt, creating rivers of muddy water which erode and carve the landscape and carry and deposit large quantities of rock, gravel and earth. This earliest glacier dammed the ancestral Teays River and its tributaries, creating great lakes where fine sediments were able to settle and deposit. These deposited sediments, called "lakebed clays", are known to be troublesome, forming a soft base over which overlying soil is particularly susceptible to slippage. These "lakebed clays" were subsequently buried by the action of future glacial advances and retreats.

Two more such glaciers advanced and retreated from the region: the second (the Illinoin), was present about 400,000 years ago and the most recent (the Wisconsinan) about 70,000 years ago. When the ancient lakes finally broke free west of Cincinnati, the current course of the Ohio River and the general landscape that we know today was largely in place.

The study of the geologic history of Hamilton County can occupy many courses of study. However, in very simple terms, the bedrock of the area in conjunction which the glacial history, have created both a geology (that is, the soil and rock which underlie the area) and a topography (the surface form of the land, including the many steep hillsides) that make the region particularly susceptible to landslides.

The final piece of the puzzle is the fact that Hamilton County is a center of population. In preparing land to

accept roads, houses and structures, land development requires new cuts and fills in the earth, altering the natural topography and affecting the natural surface and subsurface drainage patterns. In doing so, it is man who in many instances tips the critical balance of forces and unknowingly triggers or sets the stage for future earth movement.

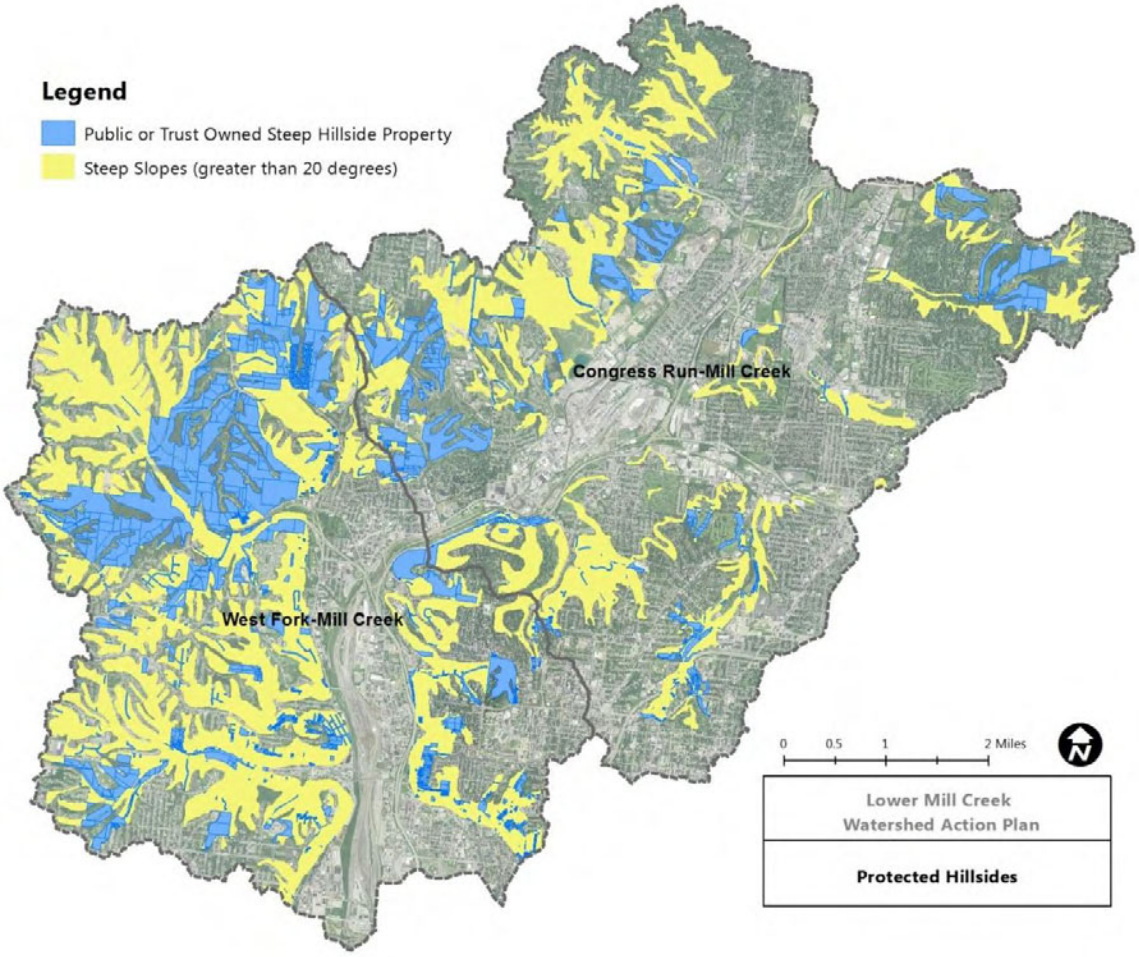


Figure 70: Steep Slopes Public or Trust Ownership

Table 49: Steep Hillsides and Trust or Public Ownership

	Steep Hillside Area (acres)	Steep Hillside Ownership by Trust or Public Agency (acres)	% of Ownership
Congress Run	4,228	977	23%
West Fork	7,277	2,248	31%
Total	**11,505**	**3,225**	

Table note: steep slopes defined as slopes 20 degrees or greater

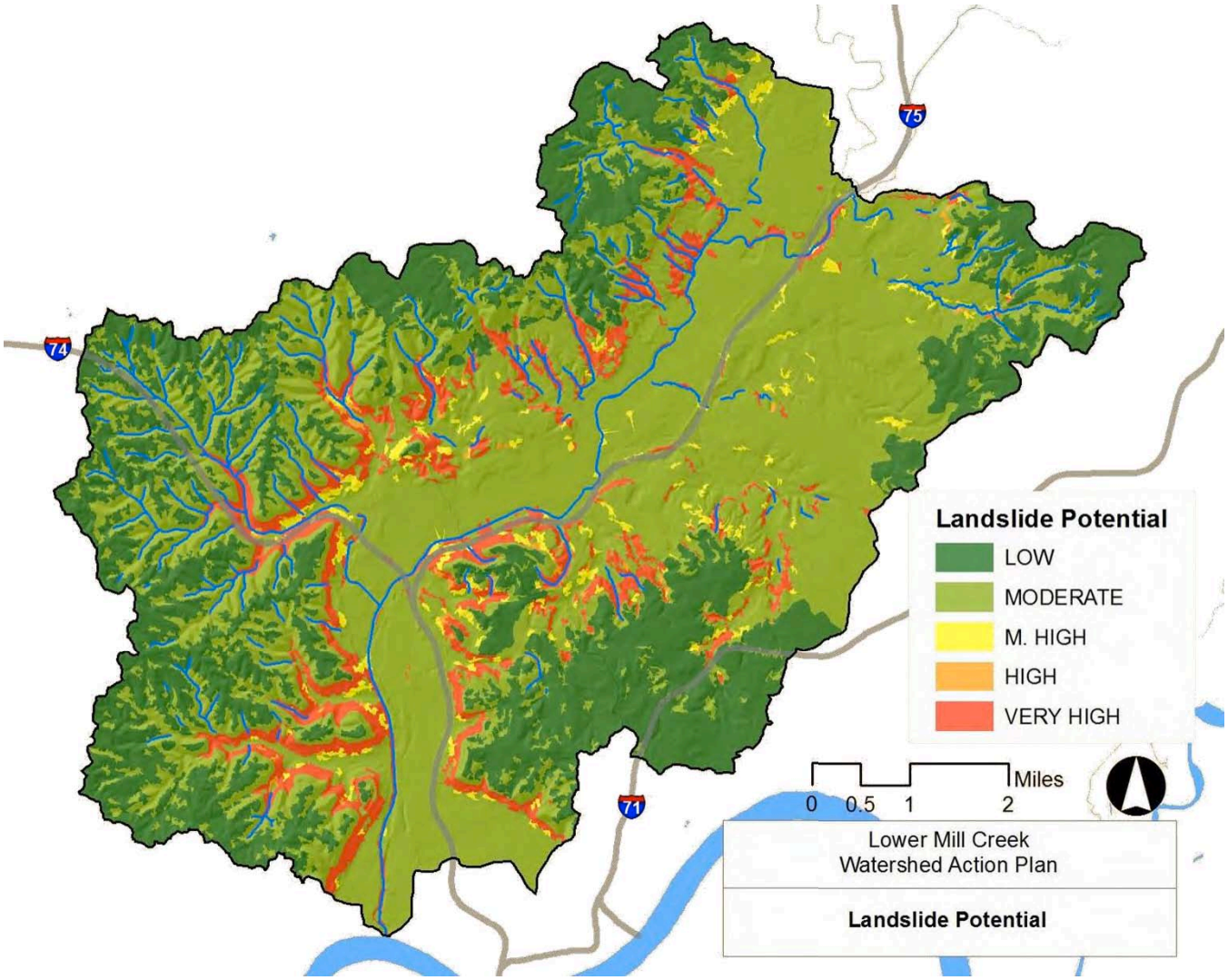


Figure 71 - Landslide Potential

Figure 71 - Landslide Potential shows the areas with high and very high landslide potential in the Lower Mill Creek watershed. Targeting these areas may be of special interest to reduce sediment downstream. Stormwater controls above susceptible areas can reduce and slow stormwater runoff, reducing sediment erosion. Stormwater controls below these areas can greatly reduce sediment transport because many controls are effective in capturing sediment from contribution areas.

5.5.5 CULVERTED STREAMS

Natural flow patterns have been severely altered in many parts of the Mill Creek watershed. Significant channelization and rerouting through manmade conveyance systems has occurred as the watershed became urbanized. It's not unusual to see perennial streams that have been rerouted to storm or combined sewer pipes as they are conveyed thru natural open space and public parks. As part of MSDGC's Project Groundwork, they are looking for opportunities to "daylight" these former streams to reduce the volume of stormwater entering the sewer system that they would have to treat as influent or which could lead to CSO events during intense wet weather.

Table 50: Surface Stream Length Modification Summary

Watershed	Existing Stream Length (Miles)	Historical Stream Length (Miles)	% Remaining
Congress Run	42	165	25%
West Fork	38	123	31%
Total	**80**	**288**	**28%**

Source: (CAGIS, 2012)

Table 50 compares the length of currently defined streams in CAGIS to the pre-development hydrology. The differences between these two give some estimate to the length of culverted and piped streams in the lower Mill Creek.

5.5.6 CHANNELIZED STREAM

See sections *4.14 – Channelization in the Lower Mill Creek Watershed*, starting on page 115, for more information on channelization in the Lower Mill Creek.

Table 51: Channelization Summary

Watershed	Miles of Full Channelization	Miles of Partial Channelization	Miles of No Channelization
Congress Run	3	1.5	2
West Fork	4.75	0	0
Total	**7.75**	**1.5**	**2**

Table 51 is a summary of channelization on the lower mainstem of the Mill Creek. Typically on the Mill Creek, full channelization is an open concrete trapezoidal channel while partial channelization indicates a single bank crib wall.

6 WATERSHED IMPAIRMENT

Excerpted from 2004 TMDL for the Mill Creek Basin

"The study area for the 2004 TMDL for the Mill Creek Basin was from Mill Creek's headwaters in Butler County to the confluence with the Ohio River, including the Cincinnati urban area.

The lower 17 miles of Mill Creek have been impacted from old industrial and municipal landfills, hazardous waste sites, industry, combined sewer overflows, raw sewage discharges, leaking sewer lines and general urban runoff. In 1992, water chemistry impairments in Mill Creek were mainly found in the lower 17 miles of the mainstem and included elevated concentrations of heavy metals, organic compounds, pesticides, ammonia, nutrients, and bacteria from sewage contamination. Sediment analysis indicated moderate toxicity and elevated concentrations of heavy metals, PCBs, organic compounds and pesticides in the same section of Mill Creek. Contaminated fish tissue has prompted the State of Ohio to issue a limited consumption advisory for all fish species.

In addition to chemical pollution impacts, permanent stream channel modifications to the lower eight miles of Mill Creek made it improbable that this section can achieve the WWH use and therefore, a modified warmwater habitat (MWH) use designation was determined to be appropriate. While the 1997 survey suggested some improvement in mainstem chemical quality and macroinvertebrates following improvements in East Fork Mill Creek, the lower 17 miles remained almost consistently in non-attainment of the WWH and MWH use designations.

Many of the sewers in the lower half of the basin were designed to carry combinations of domestic sewage, storm water, and industrial wastes. Combined sewer overflows occur at 98 locations in the basin (R. D. Zande and Associates, 2000) and generally discharge to the lower 14 miles of the mainstem. These overflow points were originally incorporated into the collection system by design to discharge during higher flow events resulting from precipitation. Overflows contribute fecal bacteria, BOD, COD, nutrients, solids, and industrial wastes to the streamflow.

Pollutant and habitat modification impacts in Mill Creek have reduced the biological community composition to a predominance of pollution tolerant species based on data gathered in 1992, 1995, 1997, and 2002 as shown in Table 52. Toxic conditions in certain areas of Mill Creek resulted in high percentages of external anomalies in fish and tissue analyses identified PCB concentrations in some species in exceedence of maximum FDA recommended levels. Fish communities throughout the lower half of Mill Creek were generally poor. However, in the lower five miles, communities were severely degraded by toxic stresses as well as oxygen demanding wastes conditions based on data collected in 1992 and 1997.

Macroinvertebrate community health echoed the results of the fish biosurvey. Assessment in the urban and industrialized areas of Mill Creek indicated declining quality with poor to very poor macroinvertebrate communities in 1992 (based on qualitative sampling) and marginally good to poor communities in 1997 (based on artificial substrate sampling). Most improvements in the macroinvertebrates between the 1992 and 1997 surveys were attributable to water quality improvements in East Fork Mill Creek because of the

upgrades made to the Butler County Upper Mill Creek Water Reclamation Facility. Differences in sampling methodologies (natural substrate vs. artificial substrate sampling) may have also contributed to some differences in the assessment of macroinvertebrate community health. During both surveys, 1992 and 1997, poorest quality macroinvertebrates were found in the lower three to five miles of the mainstream. Obvious evidence of raw sewage discharges was also observed in this same reach in 1992 and 1997."

Table 52: Aquatic Life Use Attainment Status For Stations Sampled In The Mill Creek Watershed Based On Data Collected July-September, 1988-2003*

RIVER MILE Fish/Invert.	IBI	MIWB	ICI[a]	QHEI[b]	Attainment Status[c]	Comments
Mill Creek (2002)						
		Interior Plateau - WWH Use Designation (Existing)				
26.2(H)/26.3	42	na	G	74.5	FULL	Liberty-Fairfield Rd.
21.0(W)/21.1	23*	na	F*	47.5	NON	Rialto Rd. (channelized)
18.7(W)/18.9	25*	na	F*	67.5	NON	Windisch Rd.
17.5(W)/17.6	22*	5.0*	32	51.5	NON	Kemper Rd.
16.5(W)/16.5	14*	2.8*	22	62.5	NON	Sharon Rd.
14.8(W)/14.9	19*	4.7*	28ns	62.0	NON	Formica Entrance
-- /13.3	--	--	38	--	(FULL)	Koenig Park
– / 8.0	–	–	26ns	–	(FULL)	North Bend Rd.
Mill Creek (1997)						
		Interior Plateau - WWH Use Designation (Existing)				
26.2(H)/26.4	43	na	MG	60.0	FULL	Liberty-Fairfield Rd.
21.0(W)/21.0	26*	6.1*	28ns	40.0	NON	Rialto Rd.
18.9(W)/18.8	29*	6.0*	44	49.5	PARTIAL	Windisch Rd.
17.5(W)/17.6	26*	5.0*	26ns	59.0	NON	Kemper Rd.
16.5(W)/16.5	24*	4.1*	30	67.5	NON	Sharon Rd.
14.8(W)/14.9	27*	5.3*	22*	61.5	NON	Formica Entrance
13.5(W)/13.3	25*	5.0*	30	70.5	NON	Koenig Park
		Interior Plateau - MWH Use Designation (Existing)				
3.1(W)/3.1	18*	4.3*	14*	38.0	NON	ust. Hopple St.
0.7(B)/0.6	30	8.2	6*	34.0	PARTIAL	dst. Lowhead Dam
0.3(B)/0.3	22*	8.0	6*	--	PARTIAL	ust. Barrier Dam

*- Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns- Nonsignificant departure from ecoregion biocriterion (<4 IBI or ICI units; <0.5 MIwb units).
[a]- A narrative evaluation based on the qualitative sample (MG-marginally good, F-fair, P-poor, VP-very poor) is used in lieu of the ICI when artificial substrate data are not available.
[b]- All Qualitative Habitat Evaluation Index (QHEI) values are based on the most recent version (Rankin 1989).
[c]- biocriteria do not apply in mixing zones.
W- Wading site typeH- Headwater site type
B- Boat site type

Table continued on next page

Table 52 (continued)

RIVER MILE Fish/Invert.	IBI	MIWB	ICI[a]	QHEI[b]	Attainment Status[c]	Comments
Mill Creek (1995-Jordan, Jones & Goulding)						
		WWH Use Designation (Existing)				
19.1(W)/19.1	24*	5.9*	10*	55.0	NON	Windisch Rd. (ust. E. Fk.)
		WWH Use Designation (Existing)				
17.6(W)/17.6	26*	5.4*	6*	55.5	NON	Kemper Rd. (dst. E. Fk)
16.6(W)/16.6	26*	5.0*	8*	52.0	NON	Sharon Rd.
Mill Creek (1992)						
WWH Use Designation (Existing)						
26.4(H)/26.4	39ns	--	MG	64.0	FULL	Liberty-Fairfield Rd.
19.1(W)/19.1	26*	6.9*	F*	60.0	NON	Windisch Rd.
		WWH Use Designation (Existing)				
17.6(W)/17.6	22*	6.0*	F*	62.5	NON	Kemper Rd.
16.5(W)/16.6	24*	5.7*	P*	63.0	NON	Sharon Rd.
14.8(W)/14.8	23*	4.8*	P*	60.0	NON	Formica Entrance
13.2(W)/13.3	22*	4.3*	P*	60.5	NON	Koenig Park
8.7(W)/8.7	25*	5.7*	P*	66.0	NON	SR 561
		MWH Use Designation (Existing)				
7.8(W)/7.8	24	6.3	P*	64.5	PARTIAL	Center Hill Road
5.1(W)/5.1	18*	4.9*	P*	52.0	NON	Salway Park
3.1(W)/3.1	12*	2.3*	VP*	40.0	NON	ust. Hopple St.
Mill Creek (1992)						
0.3(B)/0.3	21*	6.8	VP*	26.0	NON	ust. Barrier Dam
Mill Creek (1988)						
		WWH Use Designation (Existing)				
17.7(W)/ --	20*	6.1*	--	59.5	(NON)	Kemper Rd.
14.8(W)/ --	20*	2.5*	--	63.0	(NON)	Sharon Rd.
13.3(W)/ --	22*	5.6*	--	63.5	(NON)	Formica Entrance
12.2(W)/ --	20*	3.7*	--	71.0	(NON)	Koenig Park

Source: (Ohio EPA, 2004, pp. 16-18)

Table 53: Median chemical results from the Ohio EPA 2002 and 1997 biological and water quality surveys of the Upper Mill Creek Watershed*

Stream Site Location	RM	Phosphorus-T (mg/l) 2002 / 1997	NO3-NO2-N (mg/l) 2002 / 1997	NH3-N (mg/l) 2002 / 1997	TKN (mg/l) 2002 / 1997	Conductivity (µmhos/cm) 2002 / 1997
Mill Creek						
Liberty Fairfield Rd	26.35	0.07 / 0.05	0.33 / 0.1	< 0.05 / < 0.05	0.42 / 0.2	823 / 776
Rialto Rd	20.98	0.10 / 0.14	0.22 / 0.44	0.05 / < 0.05	0.51 / 0.26	461 / 642
Crescentville Rd	18.69	0.09 / 0.28	0.27 / 0.91	0.06 / 0.05	0.54 / 0.40	515 / 642
East Fork Mill Creek confluence with Mill Creek RM 17.95						
Kemper Rd	17.61	1.00 / 1.99	0.57 / 3.42	0.31 / 0.10	1.98 / 0.80	1250 / 1032
Town Run confluence with Mill Creek RM 16.93						
Sharon Rd	16.57	0.99 / 1.28	1.11 / 1.99	0.49 / 0.31	1.85 / 0.75	1170 / 890
Formica entrance	14.75	0.89 / 1.34	0.84 / 2.19	0.11 / 0.12	1.00 / 0.70	1095 / 915
West Columbia Rd	13.35	0.34 / 0.65	1.65 / 2.15	0.07 / 0.07	0.78 / 0.4	902 / 826
North Bend Rd	8.90	0.18 / -	1.19 / -	0.07 / -	0.61 / -	875 / -
East Fork Mill Creek						
Barrett Rd	4.69	0.08 / 0.14	0.12 / 0.1	< 0.05 / < 0.05	0.45 / 0.20	831 / 652
West Chester Rd	3.19	0.10 / -	0.12 / -	< 0.05 / -	0.34 / -	819 / -
Allen Rd	1.85	0.13 / 0.19	0.1 / 0.17	< 0.05 / < 0.05	0.39 / 0.20	695 / 678
Butler County Upper Mill Creek WRF effluent	1.07	1.65 / 3.07	0.41 / 4.83	0.15 / 0.17	1.83 / 1.10	1360 / 1220
Crescentville Rd	0.77	1.54 / 3.12	0.32 / 3.89	0.21 / 0.16	1.83 / 1.05	1360 / 1165
near mouth	0.01	1.65 / 2.97	0.72 / 3.76	0.31 / 0.14	2.00 / 0.75	1380 / 1115
Town Run						
Upstream Glendale WWTP	0.93	0.16 / -	0.545 / -	0.05 / -	1.03 / -	2585 / -
Downstream Glendale WWTP (Chester Rd)	0.70	1.69 / -	1.525 / -	3.35 / -	5.70 / -	1018 / -

- Location not sampled in 1997.
* Per the USGS gage on Mill Creek at Carthage, lower flows were recorded in 2002 on specific water chemistry sampling days with respective median and maximum flows of 26.5 cfs and 96 cfs compared to 1997 median and maximum flows of 35.5 cfs and 300 cfs.

Source: (Ohio EPA, 2004, p. 11)

6.1 POLLUTANT LOADING

6.1.1 OHIO EPA'S MILL CREEK TMDL (2004) - MODELED POLLUTANT LOADING

The Ohio EPA's 2004 TMDL (Total Maximum Daily Load) for the Mill Creek Basin calculated loading controls for nutrients necessary to meet water quality standards. The following: Table 55, Table 56, Table 57, and Table 53, were all extracted from the EPA's 2004 TMDL report.

*"**Table 55** - Mill Creek basin nutrient TMDL targets compared to State-wide and ecoregion targets and the range considered protective of aquatic life uses in Mill Creek"*, shows the basis of the TMDL's methodology for calculating the loading reduction targets based on Ecoregion and State specific targets. The Mill Creek Basin's targets were relatively higher by comparison to State-wide targets and Ecoregion targets for a modified warmwater habitat. These targets are based on the unique features and challenges of the Mill Creek, including stream habitat, flood protection measures and varied aquatic life use designations that collectively support the selection of basin specific set of nutrient targets.

"The [Nitrogen] target value selected, 2.5 mg/l NO3+NO2, provides an adequate margin of safety and a reasonable expectation that the WWH biocriteria will be met in this given situation (Ohio EPA, 2004, p. 35)."

"The [Phosphorus] target values used, 0.25 mg/l TP, is at the upper limit or threshold where we can reasonably expect attainment of the WWH biocriteria. In other words, other similar sized streams in the ecoregion are attaining the WWH use designation when total phosphorus concentrations are at 0.25 mg/l, but it is very unusual the find WWH attainment at higher TP concentrations. Therefore, the margin of safety provided through the selection of the TP target value is small (Ohio EPA, 2004, p. 35)."

"Table 54 – TMDLs and Allocations for the Mill Creek Watershed"*, shows the existing loads, the needed reduction, the TMDL value, and the allocations for total phosphorus and dissolved nitrogen for each of the five nutrient impaired subwatersheds (HUCs) in the Mill Creek watershed. The existing NPS category covers agricultural runoff, urban runoff, and septic systems. The loading capacity (TMDL) was separated into wasteload (WLA) allocations for point sources, load allocations (LA) for nonpoint sources, and natural background for groundwater sources (Ohio EPA, 2004, p. 42). This table does not include CSO and SSO load allocations, which are shown on the following tables, Table 56 and Table 57.

Table 54 – TMDLs and Allocations for the Mill Creek Watershed*

Subwatershed	Existing Conditions			Percent Reduction	TMDL	TMDLs for existing discharge flow			TMDLs for point sources at design flow		
	NPS	PS**	Total			Natural	WLA***	LA	Natural	WLA****	LA
											Dissolved Nitrogen (kg/year)
HUC 1	28,840	61,260	90,100	24%	68,476	13,980	46,558	7,938	13,980	74,195	7,938
HUC 2 (1+2)	42,860	63,250	106,110	13%	92,316	20,940	55,028	16,348	20,940	82,665	16,348
HUC 3	Existing concentration is below target level; therefore, No reduction is necessary										
HUC 4 (1+2+3+4)	Existing concentration is below target level; therefore, No reduction is necessary										
HUC 5 (Total)	Existing concentration is below target level; therefore, No reduction is necessary										
Total Phosphorus (kg/year)											
HUC 1	18,530	23,200	41,730	88%	5,008	540	2,784	1,684	540	5,548	1,684
HUC 2 (1+2)	24,520	24,447	48,967	67%	16,159	860	8,067	7,232	860	13,184	7,232
HUC 3	Existing concentration is below target level; therefore, No reduction is necessary										
HUC 4 (1+2+3+4)	33,400	24,447	57,847	42%	33,551	1,250	14,179	18,122	1,250	18,989	18,122
HUC 5 (Total)	35,900	24,447	60,347	34%	39,829	1,310	16,135	22,384	1,310	20,840	22,384

* The CSOs, SSOs loadings are not included (see Section 4.5).
**Upper Mill Creek and Glendale WWTPs Mean annual reported value (1994 to 2001). Assume Glendale WWTP has TP concentration as Butler County.
*** To achieve this WLA at existing condition (8 MGD discharge flow for Upper Mill Creek WWTP and 0.5 MGD for Glendale WWTP) dissolved N should be limited to 4.2 mg/l, and TP should be limited to 0.25 mg/l.
**** Butler County WWTP has a design flow of 16 MGD. To maintain the nutrient target values, the nutrient concentration in the final increased discharged flow from existing to 16 MGD may have to be limited to target values (dissolved N 2.5 mg/l, TP 0.25 mg/l).

Source: (Ohio EPA, 2004, p. 43) "Table 12"

Table 55 - Mill Creek basin nutrient TMDL targets compared to State-wide and ecoregion targets and the range considered protective of aquatic life uses in Mill Creek

	Nitrate + Nitrite (mg/l)	Total Phosphorus (mg/l)
Mill Creek Basin Specific Targets	2.5	0.25
State-wide Targets		
Warmwater Habitat	1.0	0.10
Modified Warmwater Habitat	1.6	0.28
Interior Plateau Ecoregion Targets		
Warmwater Habitat	0.54	0.15
Modified Warmwater Habitat	1.4	0.50
Range of values considered protective	0.5 - 4.0	0.1 - 0.5

Source: (Ohio EPA, 2004), "Table 9"

"Table 56 – Average Annual CSO Loads" shows the predicted annual average CSO loads for nitrogen and phosphorus by subwatershed. *"Table 57 – Average Annual SSO Loads"* shows the predicted annual average SSO loads for nitrogen and phosphorous by subwatershed. Details of how these loads were determined are shown in the Mill Creek TMDL's Appendix A. These tables are separated from Table 54 because there are comprehensive plans for addressing SSOs and CSOs as required in the Interim Partial Consent Decree and the Global Consent Decree.

Table 56 – Average Annual CSO Loads

Subwatershed	Nitrogen (kg-N/yr)	Phosphorus (kg-P/yr)
1	0	0
2	8,969	2,283
3	7,140	1,821
4 – Congress Run	56,592	14,398
5 – West Fork	149,984	37,921
Total	**2.2E+5**	**5.6E+4**

Source: (Ohio EPA, 2004), "Table 13"

Table 57 – Average Annual SSO Loads

Subwatershed	Nitrogen (kg-N/yr)	Phosphorus (kg-P/yr)
1	0	0
2	83,003	12,456
3	15,117	2,324
4 – Congress Run	1,443	222
5 – West Fork	40	3
Total	**1.0E+5**	**1.5E+4**

Source: (Ohio EPA, 2004), "Table 14"

6.1.2 UPDATED POLLUTANT LOADING USING MODIFIED "SIMPLE METHOD" MODEL

A. Lower Mill Creek Pollutant Load Estimation Methodology

Annual pollutant loads from five sources were calculated: stormwater runoff, CSO discharge, SSO discharge, failing HSTS discharge, and point-source loading. Eight pollutant parameters were considered: total suspended solids, total nitrogen, total phosphorus, lead, zinc, copper, fecal coliform, and biochemical oxygen demand. The sum of the five calculations is considered the total annual load for each pollutant parameter.

While the Congress Run and West Fork Creek HUC-12 watersheds (collectively referred to as Lower Mill Creek) are the focus of this WAP, the pollutant loading calculations were run for the entire Mill Creek watershed in order to estimate the contribution of the middle and upper portions of the Mill Creek watershed. Pollutant loading in the upper Mill Creek watersheds impacts in-stream pollutant concentrations in the Lower Mill Creek watershed, so accounting for this pollutant loading will help set the context in which BMPs and load reductions will be evaluated.

The methods used only calculate loads to the stream, and do not simulate in-stream processes such as decay. The result is likely an overestimation of what is present in the water column, and the additional load represents an implicit margin of safety.

Stormwater Runoff and Combined Sewer Overflow Pollutant Load Estimation Methodology

The Simple Method is used to estimate storm-event pollutant loads in the Mill Creek watershed. The Simple Method has been shown to give reasonable results in urban watersheds compared to more complex pollutant loading models, but with less substantial data requirements and requiring less expertise to complete (Randolph, 403-4). The analysis is designed for use as a preliminary planning and screening tool to assist with characterization of pollution sources in the watershed and facilitate the process of goal-setting for pollutant load reduction. The analysis is appropriate to the level of detail required for planning purposes, but a more detailed model may be necessary for projects requiring a higher-resolution analysis.

The pollutant load equation for chemical contaminants is the following:

$$L = 0.226 * R * C * A$$

Where

L = Annual load (lbs)
R = Annual runoff (inches)
C = Pollutant Concentration (mg/L)
A = Area (acres)
0.226 = Unit conversion factor

The modified equation for bacteria is the following:

$$L = 103 * R * C * A$$

Where

L = Annual load (Billion Colonies)
R = Annual runoff (inches)
C = Bacteria concentration (1,000/mL)

A = Area (acres)
103 = Unit conversion factor

The annual runoff (***R***) is the product of annual rainfall and a runoff coefficient (R_v):

$$R = P * P_j * R_v$$

Where

R = Annual Runoff (inches)
P = Annual rainfall (inches)
P_j = Fraction of annual rainfall events that produce runoff (typically 0.9)
R_v = Runoff coefficient

The runoff coefficient (Rv) is calculated based on impervious cover:

$$Rv = 0.05 + 0.9I_a$$

Where

I_a = Impervious fraction

The methodology was modified to account for the impact of CSOs on pollutant loads. Each HUC-12 area was divided into combined sewer and sanitary sewered areas. Pollutant event mean concentration values for combined sewer areas were chosen to reflect measured pollutant concentrations from combined sewer outfall samples in the LMC study area, and values reflecting stormwater samples were used in all other locations. All CSO flow volumes were multiplied by a CSO volumetric control factor to account for the volume of CSO flow which is captured and treated by the Mill Creek Wastewater Treatment Plant before being discharged directly into the Ohio River (thus bypassing the Mill Creek). The CSO volumetric control factor was set at 0.61, a value obtained from the MSDGC Wet Weather Improvement Program Volume II: CSO LTCP Update Report, page 8-172.

Data from the National Land Cover Dataset 2006 was used for impervious surfaces. The dataset has a resolution of 30 meters and was chosen because it is uniformly available throughout the watershed. Each HUC-12 watershed was divided into categories of imperviousness, ranging from %0 to 100% in increments of 10%. Acreage values for each of the 11 categories of imperviousness were calculated for use as inputs into the Simple Method calculation. Map 1 shows the impervious surface data and categories used.

Event mean concentrations (EMCs) from inside the watershed were used wherever such sampling data was available. Many of the EMCs come from sample data collected by MSDGC and documented in the CSO Long Term Control Plan Update Report, Volumes II and VI. TABLE 1 lists the EMC value and source used for each pollutant parameter.

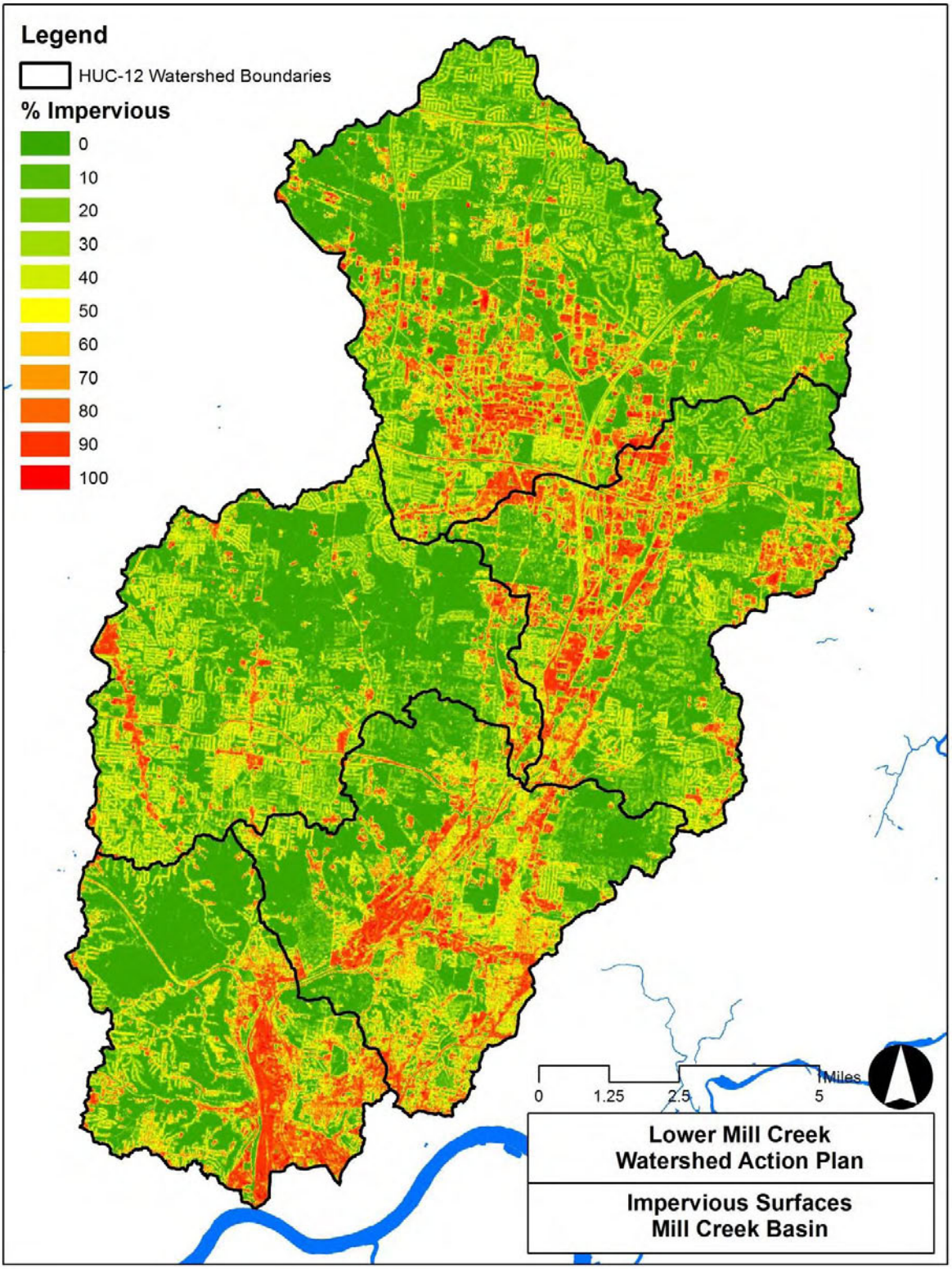


Figure 72: Impervious surface data input for Simple Method calculations

Table 58: Sources and EMC values for pollutants in CSO discharge and storm water runoff

Parameter	Event Mean Concentration	Source Description
Total Suspended Solids (TSS) – Stormwater	154 mg/L	MSDGC stormwater sampling – from Wet Weather Improvement Program Volume II: CSO Long Term Control Plan Update Report p. 3-6
Total Suspended Solids (TSS) – CSO discharge	283.2 mg/L	MSDGC discharge sampling results for 5 CSOs within the Mill Creek watershed (Mean of values for CSO # 010, 024, 181, 482, 487) – from Wet Weather Improvement Program Volume VI: Water Quality Data Report p. 4-4
Total Nitrogen – Stormwater	2.59 mg/L	MSDGC stormwater sampling (sum of TKN, Nitrate, and Nitrite) – from Wet Weather Improvement Program Volume II: CSO Long Term Control Plan Update Report p. 3-6
Total Nitrogen – CSO discharge	6.06 mg/L	MSDGC discharge sampling results for 5 CSOs within the Mill Creek watershed (Mean of values for CSO # 010, 024, 181, 482, 487; sum of TKN, Nitrate and Nitrite) – from Wet Weather Improvement Program Volume VI: Water Quality Data Report p. 4-4
Total Phosphorus – Stormwater	0.38 mg/L	MSDGC stormwater sampling – from Wet Weather Improvement Program Volume II: CSO Long Term Control Plan Update Report p. 3-6
Total Phosphorus – CSO Discharge	0.832 mg/L	MSDGC discharge sampling results for 5 CSOs within the Mill Creek watershed (Mean of values for CSO # 010, 024, 181, 482, 487) – from Wet Weather Improvement Program Volume VI: Water Quality Data Report p. 4-4
Lead – Stormwater	0.18 mg/L	National average figure from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy
Lead – CSO Discharge	0.37 mg/L	National average figure from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy
Copper – Stormwater	0.05 mg/L	National average figure from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy
Copper – CSO Discharge	0.03 mg/L	National average figure from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy
Zinc – Stormwater	0.02 mg/L	National average figure from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy
Zinc – CSO Discharge	0.17 mg/L	National average figure from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy
BOD – Stormwater	130 mg/L	National average figure from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy (mean of value range)
BOD – CSO Discharge	62.5 mg/L	National average figure from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy (mean of value range)
e. Coli – CSO Discharge	846×10^3 cfu/100mL	MSDGC SSO discharge sampling – from Wet Weather Improvement Program Volume II: CSO Long Term Control Plan Update Report p. 3-6
e. Coli – Stormwater	56.3×10^3 cfu/100mL	MSDGC stormwater sampling – from Wet Weather Improvement Program Volume II: CSO Long Term Control Plan Update Report p. 3-6

Sanitary Sewer Overflow Pollutant Load Estimation Methodology

Pollutant loading estimates for SSO load contributions were calculated by multiplying annual flow at each SSO outfall by pollutant concentration values. Total annual overflow volumes were obtained from the MSDGC WWIP CSO Long Term Control Plan Vol. II from 2006. Many of the EMCs for SSO discharge come from SSO outfall sampling in the Mill Creek watershed conducted by MSDGC. TABLE 2 shows the EMC values and

corresponding data sources used in the SSO loading calculations. Table 3 shows total annual overflow volumes for active SSOs in the Mill Creek basin.

Table 59: Sources and EMC Values for SSO discharges

Pollutant	SSO Discharge EMC	Source Description
TSS	117 mg/L	MSDGC SSO discharge sampling – from Wet Weather Improvement Program Volume II: CSO Long Term Control Plan Update Report p. 3-6
Total Nitrogen	28.86 mg/L	MSDGC SSO discharge sampling – from Wet Weather Improvement Program Volume II: CSO Long Term Control Plan Update Report p. 3-6 (Sum of TKN, Nitrate, and Nitrite)
Total Phosphorus	2.39 mg/L	MSDGC SSO discharge sampling – from Wet Weather Improvement Program Volume II: CSO Long Term Control Plan Update Report p. 3-6
Copper	0.22 mg/L	National average figure for untreated domestic wastewater from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy
Lead	0.1 mg/L	National average figure from for untreated domestic wastewater from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy
Zinc	0.28 mg/L	National average figure from for untreated domestic wastewater from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy
E. coli	$2{,}160 \times 10^3$ cfu/100mL	MSDGC SSO discharge sampling – from Wet Weather Improvement Program Volume II: CSO Long Term Control Plan Update Report p. 3-6
BOD -5day	250 mg/L	National average figure from for untreated domestic wastewater from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy (Mean of value range)

Table 60: Discharging SSOs used to calculate SSO pollutant loading

SSO Outfall ID	HUC-12 Watershed	Annual Overflow Volume (MG)
225A	West Fork Creek	2
645	West Fork Creek	2
1064	Congress Run	7
603	Sharon Creek	2
700	Sharon Creek	52
612	West Fork of Mill Creek	1

Note: The MSDGC source document only includes volume estimates for SSOs which overflow at least 1 million gallons per year, so active SSOs contributing less than 1 MG per year are not included in the loading analysis.

Failing Home Sewage Treatment System (HSTS) Pollutant Load Estimation Methodology

Pollutant load contributions from failing septic systems were calculated by multiplying septic overcharge EMCs by estimated annual septic overcharge flow rates. Annual septic overcharge flow rates were estimated using a methodology adopted from the STEPL model (Tetra Tech 2010, via USEPA web page) and input values from the Mill Creek 2006 TMDL. It is assumed that, on average, each failing HSTS will serve 2.6 people with an overcharge flow rate of 50 gallons/day per capita (Mill Creek TMDL Appendix A p. 13). The numbers and locations of failing HSTS in Hamilton County were provided by Hamilton County Public Health. No information was available on the number of failing systems in the portion of the watershed in Butler County, so an estimate was derived by multiplying the total failure rate in Hamilton County (6.4%) by the estimated total of 100 systems in the East Fork of the Mill Creek HUC-12 (Upper Mill Creek WAP 2005 p. 7; Mill Creek TMDL Appendix A p. 13). Table 4 shows the number of failing HSTS in each HUC-12 watershed used for load estimations, and Table 5 details the septic overcharge EMC values and sources.

Table 61: Failing Home Sewage Treatment Systems (HSTS) in the Mill Creek watershed (Source: Hamilton County Public Health)

HUC-12 Watershed	Number of failing HSTS
West Fork Creek	11
Congress Run	37
Sharon Creek	3
East Fork of Mill Creek	6 (estimated)
West Fork of Mill Creek	38
Mill Creek Total	**95**

Table 62: STS Overcharge EMCs and data sources

Pollutant Parameter	HSTS overcharge EMC	Source Description
Total Suspended Solids	95 mg/L	Mean of collector line sample values provided by HCPH
Total Nitrogen	60 mg/L	Default value for STEPL septic loading tool (USEPA 2010)
Total Phosphorus	23.5 mg/L	Default value for STEPL septic loading tool (USEPA 2010)
Lead	0.1 mg/L	National average figure for untreated domestic wastewater from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy
Copper	0.22 mg/L	National average figure for untreated domestic wastewater from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy
Zinc	0.28 mg/L	National average figure for untreated domestic wastewater from USEPA 2001 Report to Congress: Implementation and Enforcement of the CSO Control Policy
BOD-5day	25 mg/L	Mean of collector line sample values provided by HCPH
Pathogen	3.25×10^7 cfu/100mL	Mean of collector line sample values provided by HCPH

Point-Source Discharge Loading Methodology

The USEPA's Discharge Monitoring Report Pollutant Loading Tool was used to estimate the annual contribution of permitted NPDES point-source discharges in each HUC-12 area. Values for reporting year 2011 were the most up-to-date available. The tool was designed for the purpose of estimating load contributions from point-source discharges at the HUC-12 scale, and more information can be found on the USEPA DRM webpage at the following URL: http://cfpub.epa.gov/dmr/ez_search.cfm. Table 6 provides an overview of the facilities included in the loading analysis. Discharging facilities with no reported pollutant loads for the eight pollutant parameters considered were excluded from the analysis.

Table 63: Permitted discharging facilities contributing to pollutant loads in the Mill Creek watershed

Facility Name	NPDES ID	HUC-12 Watershed
Upper Mill Creek Water Reclamation Facility	OH0072087	East Fork of the Mill Creek
Formica Corp Evendale Plant	OH0009296	Sharon Creek
General Electric Co	OH0010286	Sharon Creek
Timber Ridge Apartments	OH0047376	Sharon Creek
XTEK Inc. Plant No. 2	OH0048798	Sharon Creek
Pentecostal Holiness Tabernacle WWTP	OH0137383	West Fork of the Mill Creek
Wyoming Water Works	OH0029866	West Fork of the Mill Creek
Henkel Corporation Chemicals Group	OH0137812	Congress Run
J.M. Smucker LLC	OH0134155	Congress Run
Procter & Gamble Co	OH0009741	Congress Run
Glendale WWTP	OH0020141	Sharon Creek
Airy Pointe Condo Assoc. WWTP	OH0072184	West Fork Creek

Source: USEPA Discharge Monitoring Report Pollutant Loading Tool, via web.

B. Lower Mill Creek Pollutant Loading Modeling Results by Source

Table 64: Mill Creek Pollutant Loading Modeling Results by Source

West Fork (01-05)								
	Pollutant Load							
	T-N (lbs/year)	**T-P** (lbs/year)	**TSS** (lbs/year)	**T-Pb** (lbs/year)	**T-Cu** (lbs/year)	**T-Zn** (lbs/year)	**BOD 5-Day** (lbs/year)	**E.Coli** (billion colonies/year)
Urban Runoff	107,820	15,819	6,410,902	666	666	4,871	358,011	10,681,583
CSO	136,091	18,691	6,362,014	1,078	899	3,504	965,984	111,278,410
SSO	963	80	3,905	3	7	5	1,402	327,060
Septic	261	102	414	0	1	1	109	642,134
NPDES Dischargers	3	-	37	-	-	-	41	
Totals	245,139	34,692	12,777,273	1,748	1,573	8,382	1,325,547	122,929,186

Congress Run (01- 04)								
	Pollutant Load							
	T-N (lbs/year)	**T-P** (lbs/year)	**TSS** (lbs/year)	**T-Pb** (lbs/year)	**T-Cu** (lbs/year)	**T-Zn** (lbs/year)	**BOD 5-Day** (lbs/year)	**E.Coli** (billion colonies/year)
Urban Runoff	147,311	21,613	8,759,022	910	910	6,655	489,140	14,593,924
CSO	76,943	10,567	3,596,949	610	508	1,981	546,147	62,914,465
SSO	1,686	140	6,835	6	13	9	2,453	572,354
Septic	879	344	1,392	1	3	4	366	2,159,904
NPDES Dischargers	201	176	84,437	-	0	0	6,075	
Totals	227,020	32,840	12,448,634	1,527	1,434	8,650	1,044,182	80,240,647

Sharon Creek (01-03)								
	Pollutant Load							
	T-N (lbs/year)	**T-P** (lbs/year)	**TSS** (lbs/year)	**T-Pb** (lbs/year)	**T-Cu** (lbs/year)	**T-Zn** (lbs/year)	**BOD 5-Day** (lbs/year)	**E.Coli** (billion colonies/year)
Urban Runoff	153,228	22,481	9,110,846	947	947	6,922	508,788	15,180,119
CSO	-	-	-	-	-	-	-	-
SSO	13,005	1,077	52,724	45	99	72	18,926	4,415,305
Septic	71	28	113	0	0	0	30	175,127
NPDES Dischargers	9,274	1,404	37,717	16	56	132	14,795	
Totals	175,578	24,990	9,201,400	1,007	1,102	7,126	542,539	19,770,551

West Fork of the Mill Creek (01-02)

	Pollutant Load							
	T-N (lbs/year)	**T-P** (lbs/year)	**TSS** (lbs/year)	**T-Pb** (lbs/year)	**T-Cu** (lbs/year)	**T-Zn** (lbs/year)	**BOD 5-Day** (lbs/year)	**E.Coli** (billion colonies/year)
Urban Runoff	129,392	18,984	7,693,551	799	799	5,845	429,640	12,818,680
CSO	11,981	1,646	560,103	95	79	309	85,044	9,796,799
SSO	241	20	976	1	2	1	350	81,765
Septic	903	354	1,429	2	3	4	376	2,218,280
NPDES Dischargers	1	-	95	-	-	-	-	
Totals	142,518	21,003	8,256,154	897	884	6,159	515,410	24,915,524

East Fork of the Mill Creek (01-01)

	Pollutant Load							
	T-N (lbs/year)	**T-P** (lbs/year)	**TSS** (lbs/year)	**T-Pb** (lbs/year)	**T-Cu** (lbs/year)	**T-Zn** (lbs/year)	**BOD 5-Day** (lbs/year)	**E.Coli** (billion colonies/year)
Urban Runoff	197,133	28,923	11,721,444	1,218	1,218	8,905	654,574	19,529,790
CSO	2,224	305	103,985	18	15	57	15,789	1,818,815
SSO	-	-	879	344	1,392	1	3	4
Septic	143	56	226	0	1	1	59	350,255
NPDES Dischargers	125,724	19,585	94,561	3	96	2,312	49,524	
Totals	325,224	48,869	11,921,095	1,583	2,721	11,277	719,950	21,698,864

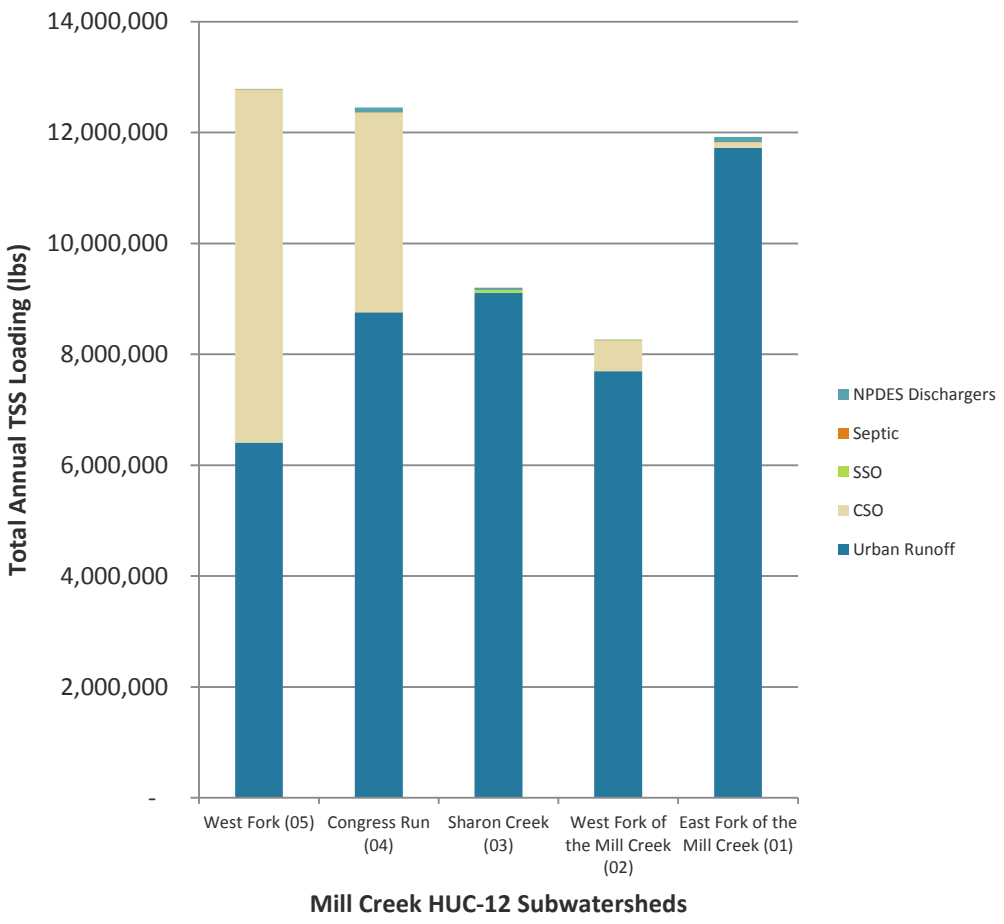


Figure 73: TSS Loading Results Summary

Figure 73: TSS Loading Results Summary shows that on the Mill Creek watershed the majority of the TSS loading comes from stormwater runoff sources. TSS coming from point sources, home sewage treatment systems, and sanitary sewer overflows is minimal.

In the West Fork (05) subwatershed, the majority of TSS comes from CSOs, but this is primarily due to the fact that the CSOs are capturing large volumes of stormwater runoff. MSD's Project Groundwork could have minimal impact on TSS reduction, if the TSS reductions from CSO wasterwater capture are offset by increases in TSS from stormwater that will be diverted away from CSOs.

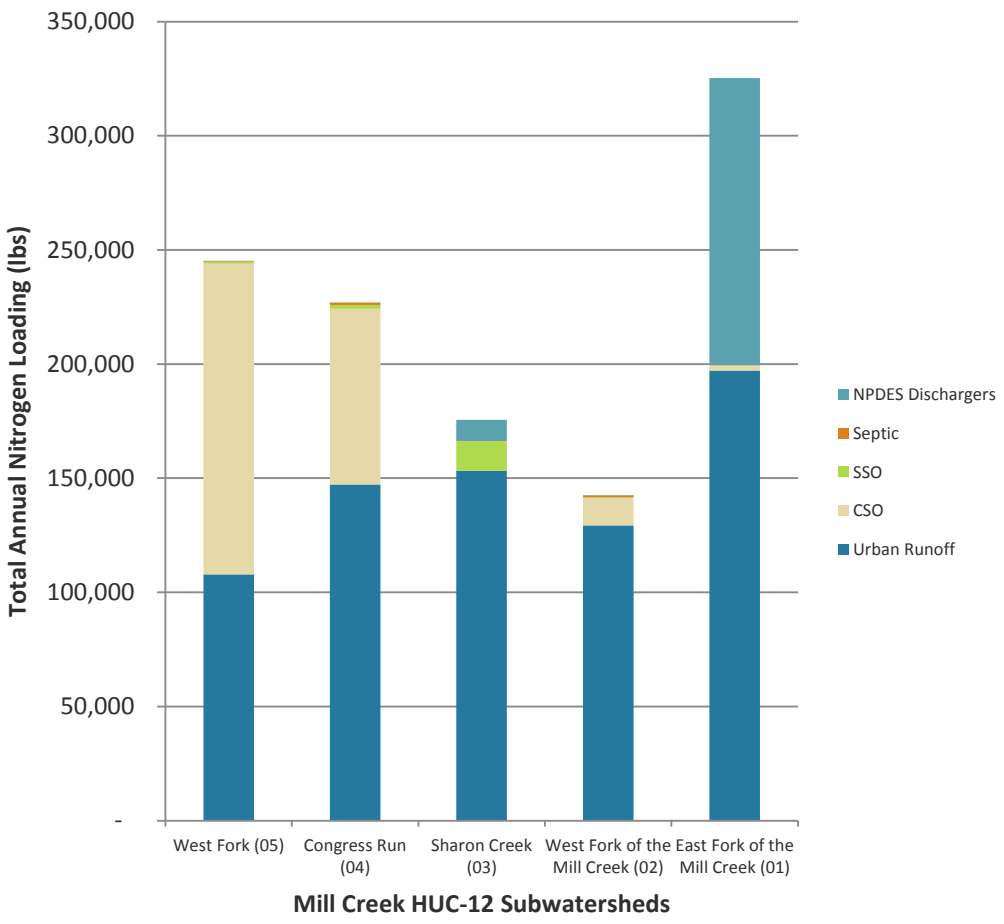


Figure 74: Total Nitrogen Loading Results Summary

Figure 74: Total Nitrogen Loading Results Summary shows that the primary sources of Total Nitrogen (TN) are varied by Mill Creek subwatershed. In Congress Run and West Fork subwatersheds, CSOs are the primary sources of TN loading. On the East Fork of the Mill Creek subwatershed, point sources are a large contributor to TN loading. Stormwater sources of TN are a concern in all subwatersheds of the Mill Creek.

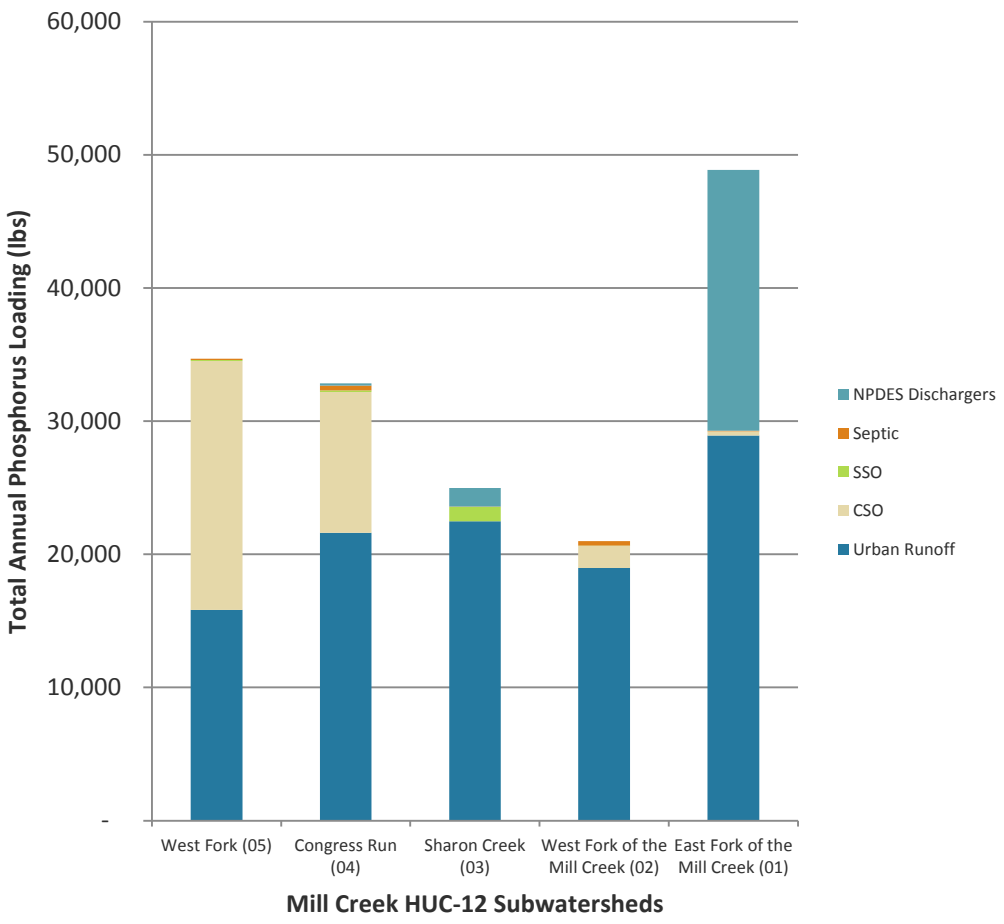


Figure 75: Total Phosphorus Loading Results Summary

Figure 75: Total Phosphorus Loading Results Summary shows similar results to the Total Nitrogen loading values on the Mill Creek. Point sources in the East Fork of the Mill Creek subwatershed are a large contributor to upstream TP loading.

The Midwest Biodiversity Institutes's *Mill Creek Bioassessment 2011*, measured reduced Total Phosphorus levels but the sampling measured dry weather flows to determine chronic water quality conditions, whearas, Total Phosphorus loading on the Mill Creek comes primarily from wet-weather events.

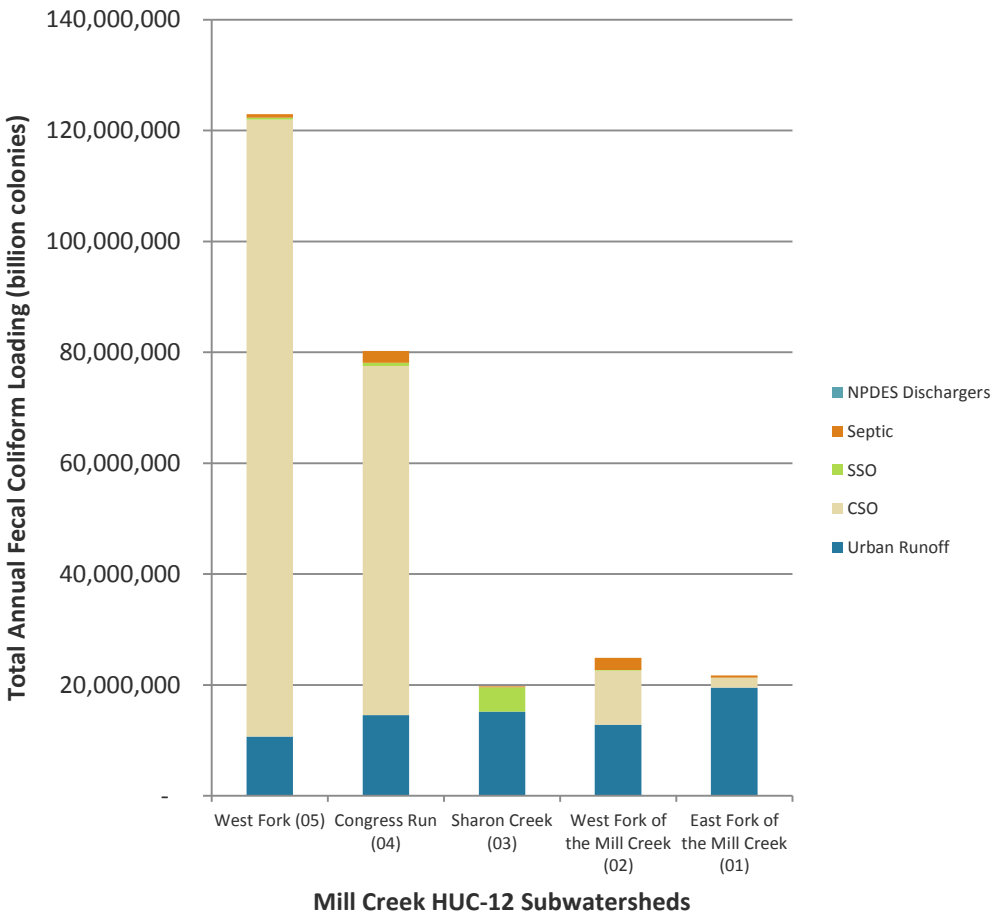


Figure 76: Pathogen Loading Results Summary

Figure 76: Pathogen Loading Results Summary shows that the West Fork and Congress Run subwatersheds are the largest source watersheds for pathogen loading due to the high volume of CSOs. Sharon Creek subwatershed shows the highest pathogen loading due to SSOs, largely attributable to a single SSO #700. HSTS systems are also responsible for some pathogen loading, especially in Congress Run and West Fork of the Mill Creek subwatersheds.

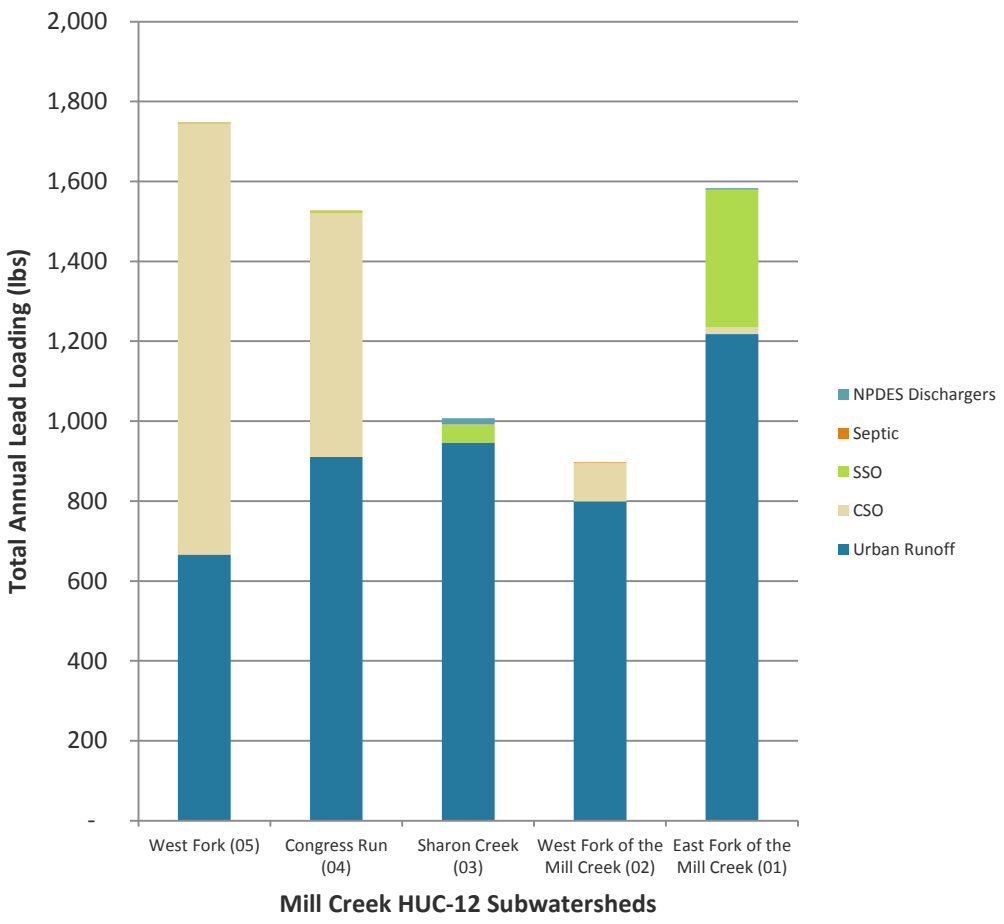


Figure 77: Lead (Pb) Loading Results Summary

Figure 77: Lead (Pb) Loading Results Summary shows the expected levels of annual lead loading based on the national Event Mean Concentrations (EMCs) discussed in the modeling methodology. Actual lead loadings in the Mill Creek could vary depending on local conditions, such as proximity to landfills, brownfields, toxic dumps, heavy industrial zones, automobile junkyards, etc. Corroding metal junk in the river could potetnially be responsible for eleveated lead concentrations. Lead based paints are also a legacy source of elevated lead concentrations in the Mill Creek.

MBI's *Mill Creek Bioassessment Report* 2011, confirms the presence of eleveated lead concentrations in the Mill Creek watershed.

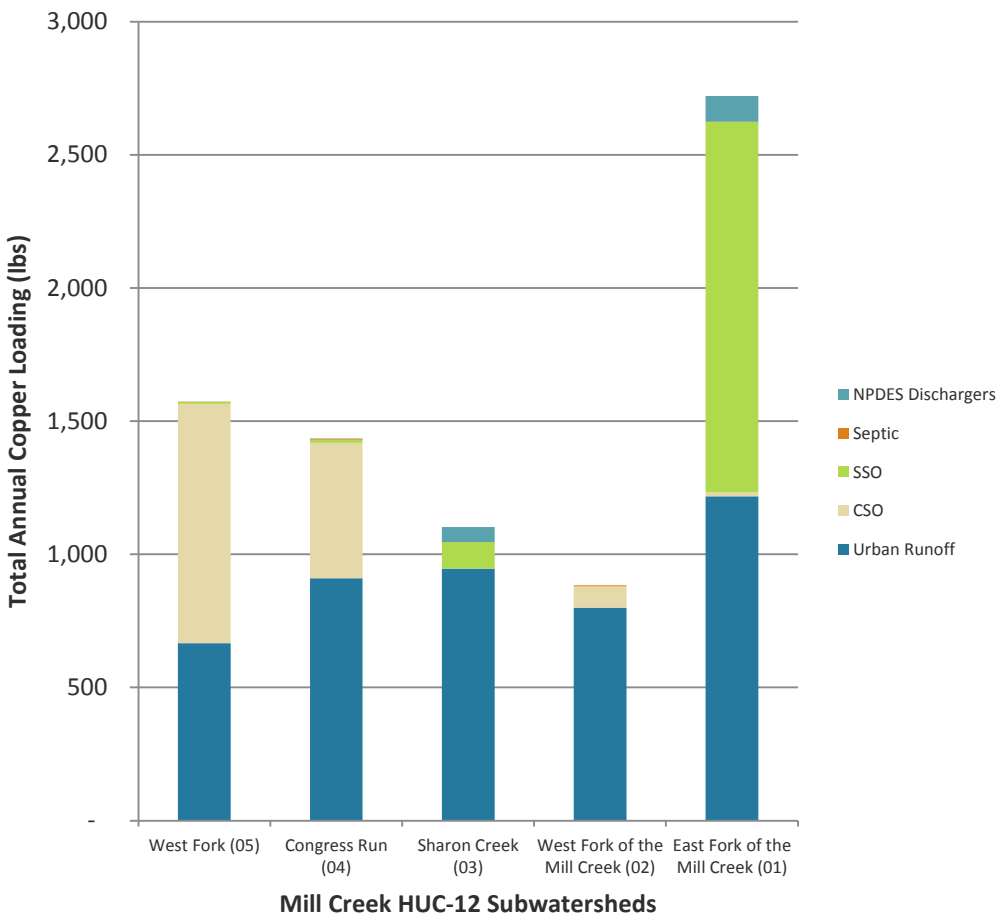


Figure 78: Copper (Cu) Loading Results Summary

Figure 78: Copper (Cu) Loading Results Summary shows the expected levels of annual copper loading based on the national Event Mean Concentrations (EMCs) discussed in the modeling methodology. Actual copper loadings in the Mill Creek could vary depending on local conditions, such as proximity to landfills, brownfields, toxic dumps, heavy industrial zones, automobile junkyards, etc. Other sources of copper include the electroplating industry, smelting and refining, mining, and biosolids (ATSDR, 2004).

MBI's *Mill Creek Bioassessment Report* 2011, confirms the presence of eleveated copper concentrations in the Mill Creek watershed.

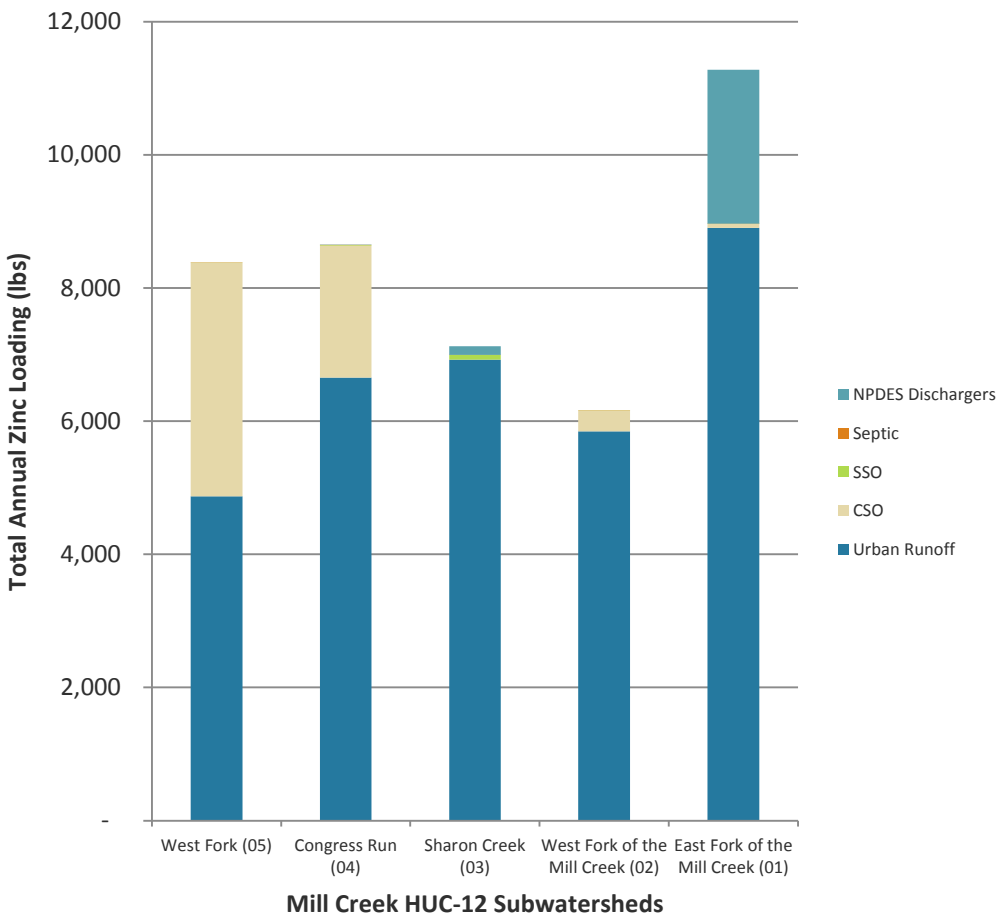


Figure 79: Zinc (Zn) Loading Results Summary

Figure 79: Zinc (Zn) Loading Results Summary shows the expected levels of annual zinc loading based on the national Event Mean Concentrations (EMCs) discussed in the modeling methodology. Actual zinc loadings in the Mill Creek could vary depending on local conditions, such as proximity to landfills, brownfields, toxic dumps, heavy industrial zones, automobile junkyards, etc. Specific sources of zinc include the electroplating industry, smelting and refining, mining, biosolids, and brake and tire wear (EPA, 1980).

MBI's *Mill Creek Bioassessment Report* 2011, confirms the presence of eleveated zinc concentrations in the Mill Creek watershed.

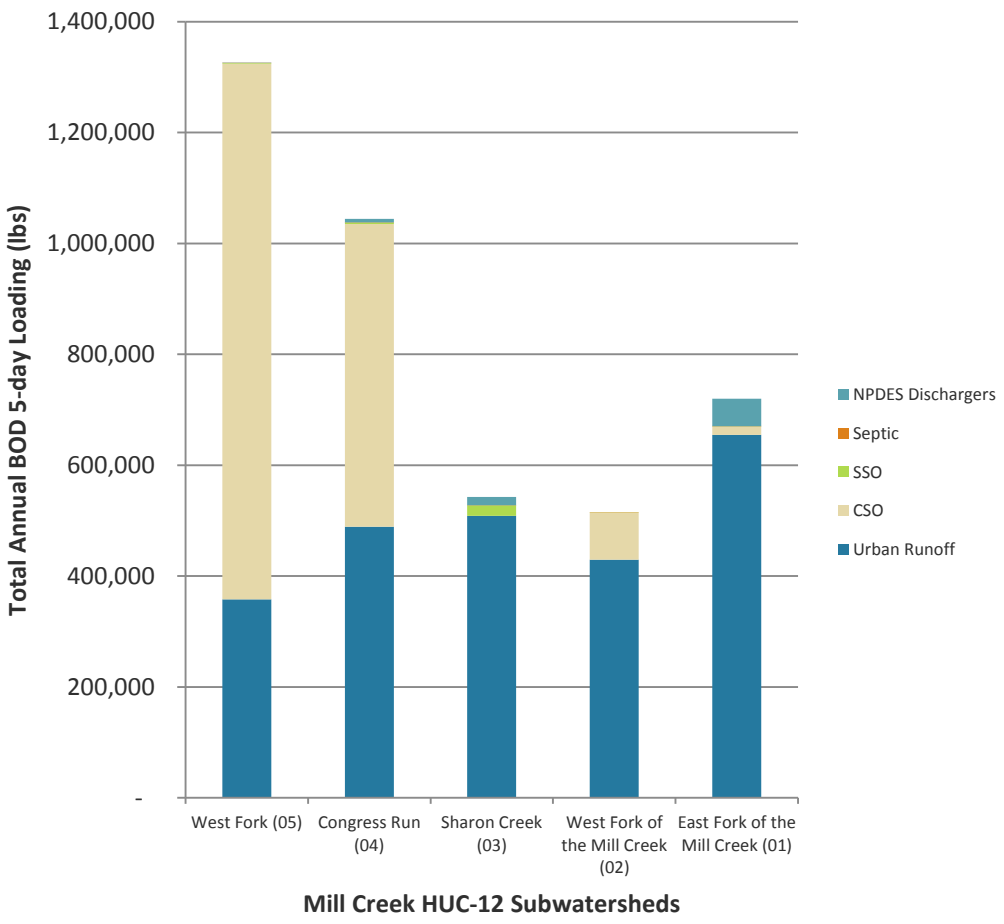


Figure 80: Biochemical Oxygen Demand (BOD) 5-Day Loading Results Summary

As expected, ***Figure 80: Biochemical Oxygen Demand (BOD) 5-Day Loading Results*** Summary shows an annual loading result pattern similar to both Total Nitrogen and Total Phosphorus. Given that BOD is a measure of the amount of oxygen required for metabalism of organic compounds in water; the abudance of nutrients like TN and TP is the "fuel" for microbial growth that causes BOD to increase. Other factors of BOD growth include temperature and the enzymes available to indigenous microbial populations, but they are assumed to be constants in this model.

6.2 REVIEW AND ASSESS HABITAT MODIFICATION INVENTORY

The Mill Creek has been heavily manipulated by man over the course of history; major modifications include; irrigation for agriculture, canals for transportation, land clearance for urbanization, and channelization for flood control. The modern day Mill Creek has been straightened and entrenched by channelization, designed to mitigate high water volumes and to transfer the pollutants from human development further downstream.

The impacts of increasing urbanization and the resulting increase of impervious areas are:

- Increase in peak discharges
- Increase in volume of stormwater runoff
- Increase in frequency and severity of flooding
- Increase in runoff velocity
- Decrease in base flow during dry periods

Table 65: QHEI Summary

Watershed	QHEI Average (Main Stem)	QHEI Average (Tributaries)	# of Sites below 45	# of Sites 45 - 60	# of Sites >60
Congress Run	44	49	5	5	2
West Fork	44	61	4	6	6

Source: (Midwest Biodiversity Institute, 2011)

7 LOWER MILL CREEK WATERSHED PROBLEM STATEMENTS

Definitions

Impairments:

Causes: the specific chemical, biological or physical condition or disorder that threatens water quality (e.g. nutrients, low-flow, sedimentation, altered hydrology, altered chlorides, PAH, etc.)

Sources: the point or non-point sources of pollution causing the measured impairments (e.g. altered hydrology, hydromodification, urban runoff, etc.)

Defining Problems to Setting Goals

Problem Statement: A statement that links a single "Cause" with multiple "Sources" of water quality impairment in a given watershed

Goals: broadly defined change driven by problem statement, in other words, a campaign that addresses the source of impairment

Objectives: specific changes driven by Goals

Actions: specific controls or management strategies to achieve the Objectives

Indicators: milestones for measuring Action's progress

7.1 BACKGROUND

The most common source of water quality data and analysis for defining problem statements is the state TMDL reports which use consistent and verifiable water quality data to detail the many impairments of a given water body. The Mill Creek was tested for water quality by the OEPA in 2004, and scheduled to be tested again in 2017.

Excerpted from OEPA's Total Maximum Daily Load Report for the Mill Creek Basin (2004):

"The September 2004 TMDL for the Mill Creek Basin stated that basin-wide, the causes for non-attainment of Aquatic Life Uses included phosphorus, nitrogen, and habitat modification. In some segments of Mill Creek there is impairment of aquatic life caused by toxicity attributed to ammonia and other chemicals. These toxicity problems related to ammonia are being addressed through permit actions and [were] not covered in the TMDL. The other sources of toxicity will be addressed through additional iterations of the TMDL process.

A number of factors signal the need for a creative solution to the impairments of the Mill Creek Watershed and the possibility of the solution coming to fruition:

- *an excessive amount of nutrients (phosphorus and nitrogen)*
- *poor stream habitat that compounds the unwanted consequences (degraded fisheries) of elevated*

nutrients

- *large established urbanized/industrial areas*
- *rapidly developing urbanization of the upper Watershed*
- *stream monitoring that reflects the presence of high nutrient concentrations, compromised stream habitat conditions in some areas, and associated biological impacts*
- *existing water quality criteria in the State's Water Quality Standards (WQS, administrative regulations) for nitrogen and phosphorus do not effectively address these problems*
- *local parties interested in planning and carrying out necessary nutrient reductions and stream habitat restoration plans*

The lower 17 miles of Mill Creek have been impacted from old industrial and municipal landfills, hazardous waste sites, industry, combined sewer overflows, raw sewage discharges, leaking sewer lines and general urban runoff. Major causes of impact included habitat alteration (channelization and concreted stream channels), organic and nutrient enrichment, (CSOs, SSOs, WWTPs, urban runoff), sediment contamination, and impacts associated with heavy metals, pesticides, priority organics, and oil and grease.

The lower 17 miles of the mainstem have remained in non-attainment for virtually its entire length. Since 1988, 75 percent of biological index scores and evaluations between RM 17.7 and the mouth (n=56) have reflected poor or very poor quality (see Table 4 of TMDL report).

Most Mill Creek tributaries are extensively urbanized and many drain areas of current or historic industrial land usage. All tributaries sampled in 1992, 1997, and 2002 exhibited some type of pollution problem and many were impacted by stream channel modification. Tributaries in the lower reaches exhibited contamination indicative of industrial activity and combined sewer overflows (Ohio Environmental Protection Agency, 2004).*"*

7.2 LINK CAUSE AND SOURCE OF IMPAIRMENTS AND ESTIMATE LOAD

The Midwest Biodiversity Institute's report "Biological and Water Quality Study of the Mill Creek and Tributaries" (Draft-2011) is the most recent source of Mill Creek water quality data and analysis to understand and identify where impaired waters exist along the Mill Creek and its tributaries, combined with the kinds of stressors acting on a given stream segment. Using this information, MBI is in the process of developing an Integrated Priority System (IPS) to help us better understand the types and magnitudes of each stressor, whether they are caused by anthropogenic activities, if they are limiting stressor for meeting water quality goals, and more. In lieu of this report for now, MBI has provided the following preliminary list of impairments/stressors to enable us to continue working on the problem statements for the Mill Creek Watershed Action Plan.

MBI quick assessment of impairments ranked

1. Sedimentation
2. Nutrients
3. Chlorides
4. Habitat Alteration
5. Low Dissolved Oxygen
6. Ammonia
7. PAH Compounds
8. Low Flow
9. Organic Enrichment

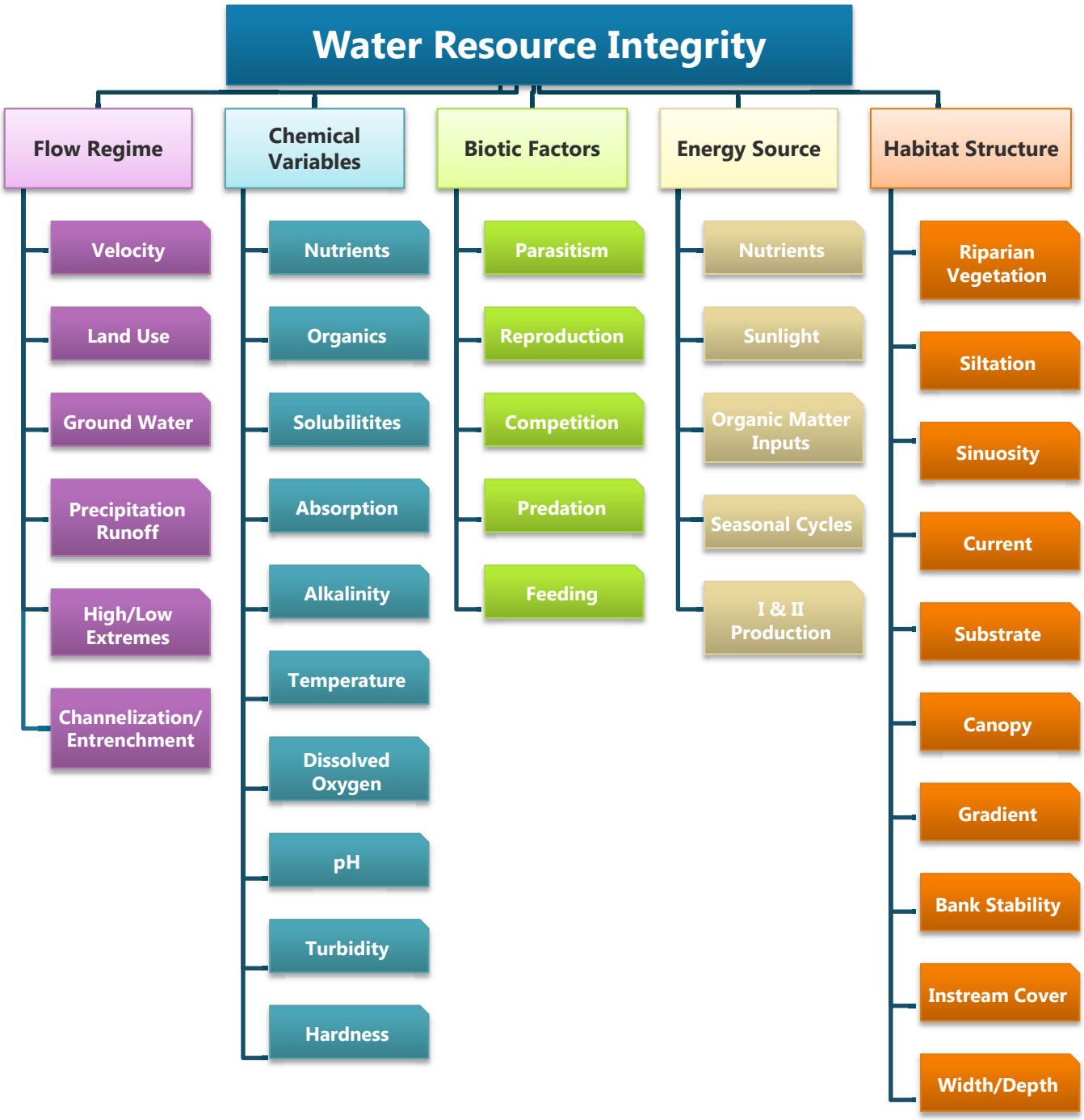
Thru the LMC-WAP group meetings the MBI quick assessment of impairments was modified to the following to reflect the terminology of the EPA's 2004 TMDL and to address recreational use attainment by including pathogens. Other impairments were combined due to similarity and overlap.

LMC-WAP Modified Ranking of Impairments/Stressors

1. Sedimentation
2. Nutrients (Nitrogen and Phosphorous), (also includes Ammonia, Low-Dissolved Oxygen, Organic-Enrichment)
3. Pathogens
4. Habitat Alterations/Hydromodification
5. Chlorides
6. Toxics – PAH compounds and Metals

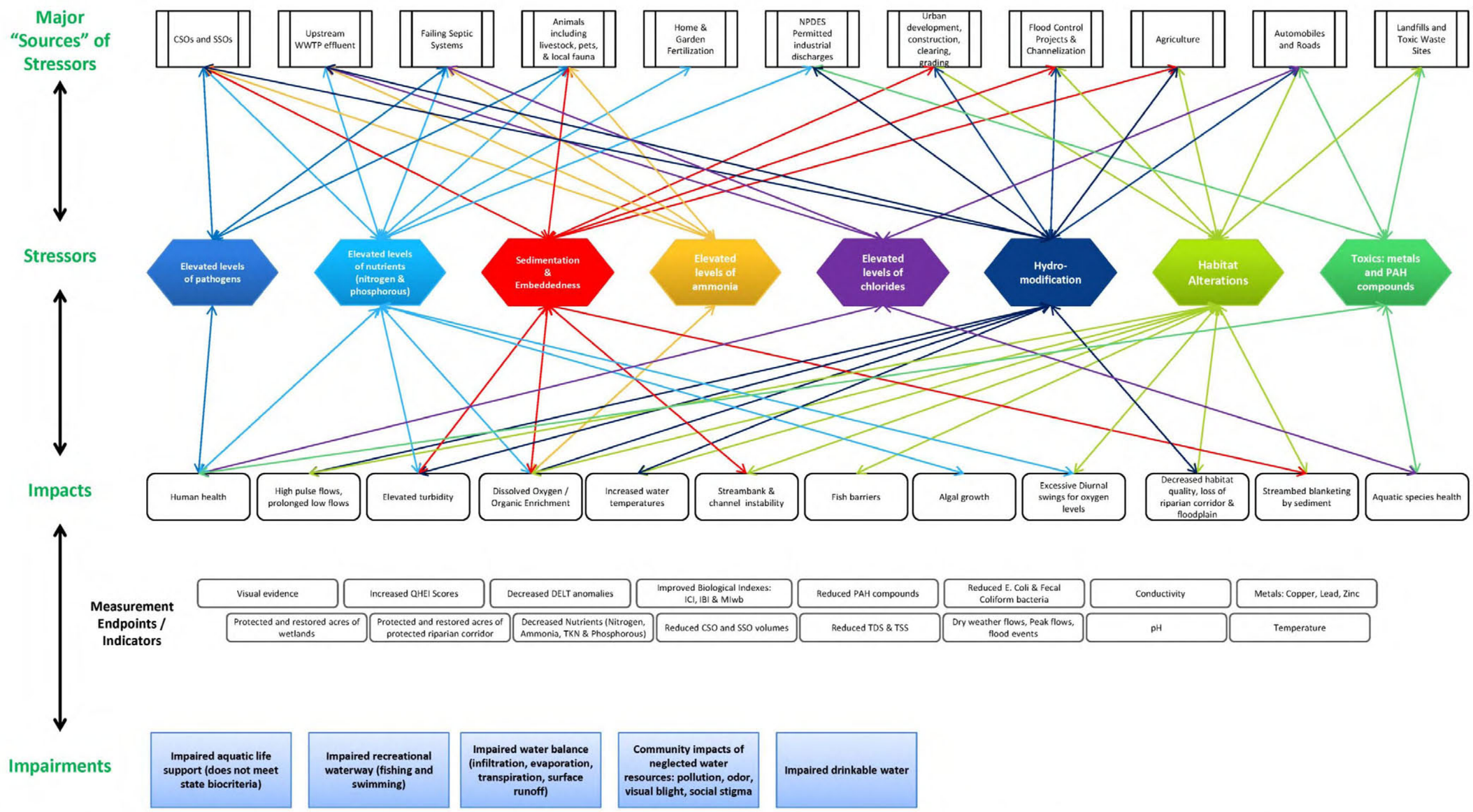
Problem Statement Development

Each of the impairments is broken down into individual problem statements on the following pages. Following the EPA's guidelines for developing WAPs, problem statements are created by combining measurable impairments to water quality (i.e. MBI data or Modeled Load Estimate) with known or probable sources (e.g. point or nonpoint sources of pollution). Impairments to water quality can be identified by an imbalance in any of the factors shown on the graphic below (modified from Karr et al. 1986).



Modified from Karr et al. 1986

Draft Conceptual Model for Lower Mill Creek, Cincinnati, Ohio



Notes: Based on U.S EPA's "*Handbook for Developing Watershed Plans to Restore and Protect Our Waters*", Chapter 4 – Define Scope of Watershed Planning Effort. This diagram is a graphic representation of cause and effect, linking sources and impairments.

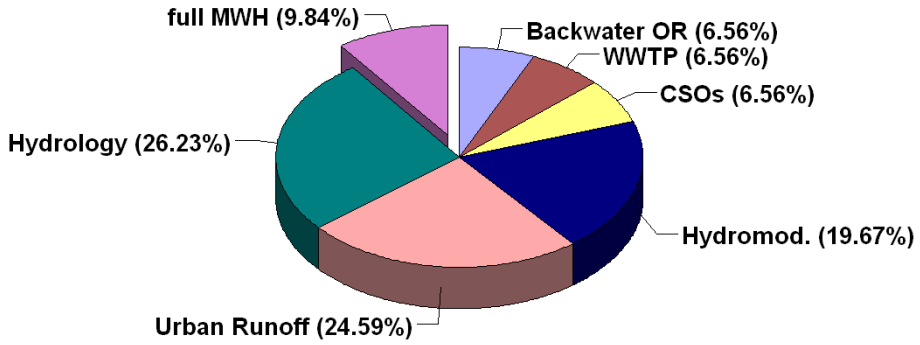


Figure 81: Sources of Impairment Most Frequently Listed by Site – Mill Creek main stem

Source: (data from (MBI, 2011), graphic prepared by (Miller, 2012))

On the Mill Creek mainstem the most frequently listed **sources of impairment** are hydrology, urban runoff and hydromodification.

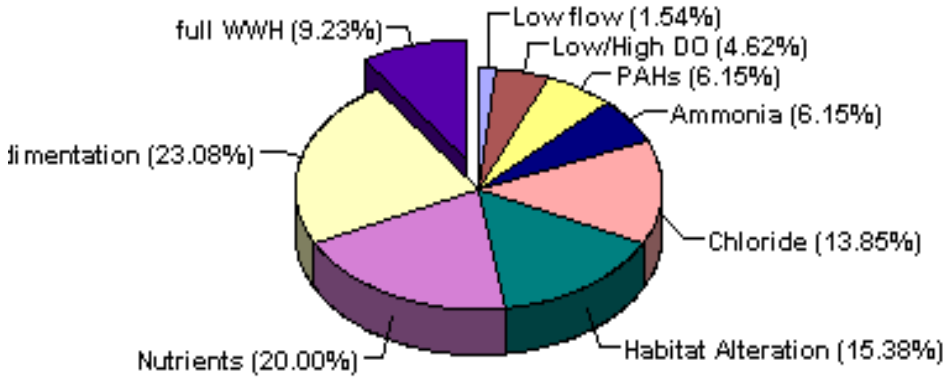


Figure 82: Causes of Impairment Most Frequently Listed by Site – Mill Creek main stem

Source: (data from (MBI, 2011), graphic prepared by (Miller, 2012))

On the Mill Creek mainstem the most frequently listed **causes of impairment** are sedimentation, nutrients, habitat alteration, and chlorides.

7.3 GENERAL PROBLEM STATEMENT BACKGROUND FOR LMC WATERSHED

7.3.1 SEDIMENTATION

A. Problem Overview

By volume, sediment is the largest water pollutant in the Mill Creek watershed. Sedimentation causes many negative environmental impacts, including: reduced water storage and flow capacity, streambed blanketing, excess aquatic weed and algae growth, degraded habitat for fish and invertebrate populations, silting and embeddedness in key riffle habitats, degraded appearance of water, and more. Suspended sediment can reduce aquatic plant life and alter a stream's ecology. Sediments also act as carriers of other pollutants which cling to the suspended particles, contributing further to degraded water quality.

Sediment intrusion into streambeds has been linked to very high mortality rates for freshwater mussels living in gravel-bedded or sand-bedded channels. These findings have been empirically supported by hundreds of subsequent studies.

Sedimentation can be increased beyond natural rates through surface erosion (sheetwash), fluvial erosion (gullying and stream bank erosion) and mass wasting (landsliding). These types of erosion can be accelerated by land management activities and construction practices such as channelization, hillside developments, impervious surfaces, and degradation of riparian vegetation.

B. Point Sources

Point sources of sedimentation in the Lower Mill Creek includes: manufacturing companies, legacy mining operations, sewage treatment plants, agricultural sites, and more. Wastewater treatment facilities contribute through combined sewers overflows and sanitary sewer overflows, which are regulated by NPDES MS4 permits. Dams, channelization, and other in-stream structures designed for water storage, diversion, and flood control, can also interrupt sediment transport and aggravate undesirable sedimentation processes. Low-head dams in the Lower Mill Creek can create barriers to bedload transport, which induces aggradation upstream, while simultaneously encouraging erosion immediately downstream from the barrier.

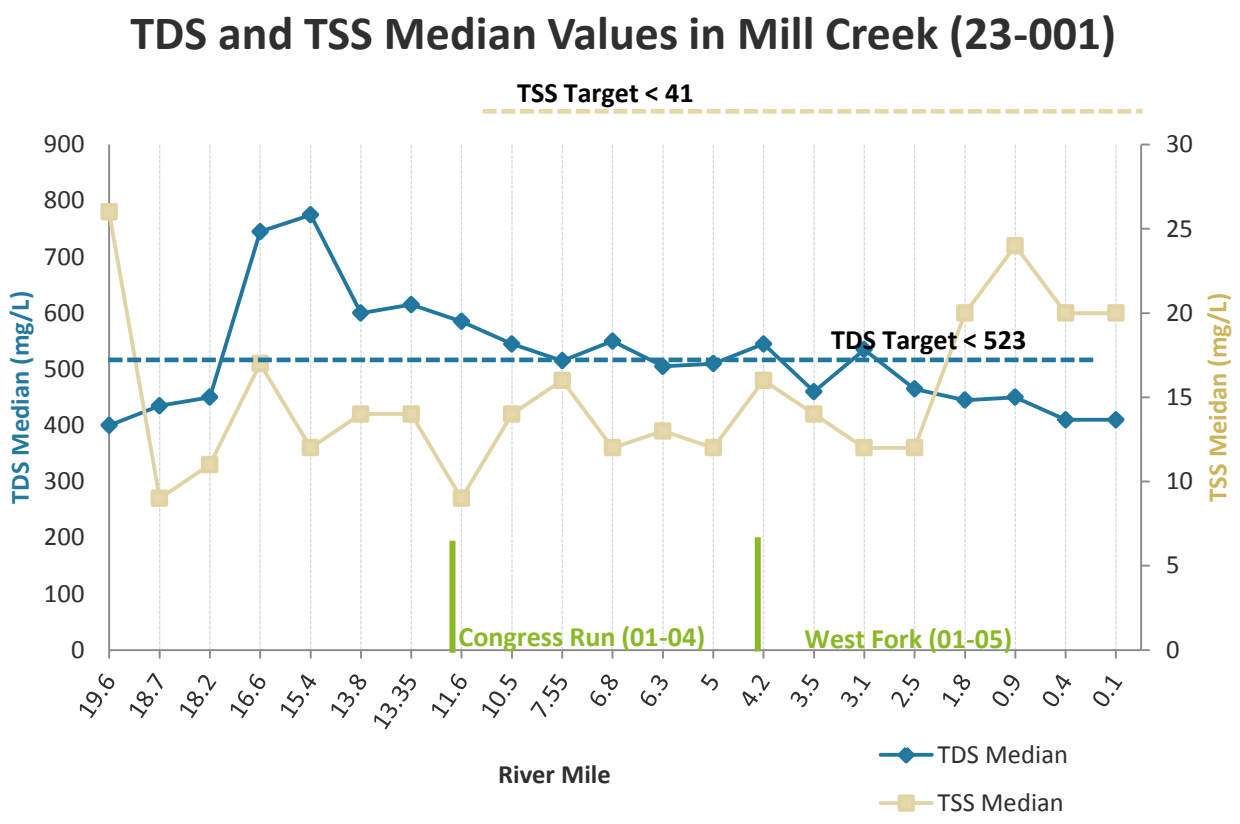
C. Nonpoint Sources

The primary nonpoint sources of sedimentation in the LMC watershed include general construction activities (both instream and throughout the Watershed), in-stream erosion, mass wasting or landslides, utility and roadway excavations, and more.

In the LMC watershed, increased fluvial erosion is caused by hydromodification and excessive storm water runoff. Hydromodification refers to any change in the magnitude and/or frequency of stream flows (including volume, velocity, and timing of runoff), resulting from changes in the hydrologic regime, most notably land use changes. Urbanization and associated increases in impervious surface area can result in significant changes to watershed hydrology and impacts on receiving channels, including flooding, erosion, sedimentation, and degradation of in-stream habitat.

Streams exist in a condition known as “dynamic equilibrium” in which the forces that influence channel form are balanced by resisting forces. The driving force of gravity influences the rate at which water and sediment move through a stream channel, while the resisting forces are the boundary materials (substrate, soils, and vegetation) and resulting friction, expressed as the channel geometry. The degree of erosion or mass wasting is a function of both driving and resisting forces. When the driving forces exceed the resisting forces, the stress applied by both water and sediment exceeds the channel strength, and the channel responds by altering its’ channel shape (planform, longitudinal profile and/or cross section) to accommodate the change in flow and applied shear.

Through this process, streams eventually re-establish an equilibrium condition. However, simply allowing the process to “run its course” in an urban setting can have dangerous consequences, and the process of channel adjustment, left unabated, often poses a threat to infrastructure, property, and public safety. Rapid runoff rates come from high percentages of impervious surface in the subwatersheds and limited storm water detention. Also, urban encroachment leads to channel constriction, which causes an increase in tractive stress (boundary shear stress) that may lead to erosion and sedimentation problems.



Source: Modified from MBI, Yoder et al. 2011

Construction site best management practices (BMPs) can serve to reduce sedimentation in the preconstruction

phase of a project. In-tact riparian corridors and water quality storm water basins can help reduce sedimentation in the post construction phase. For construction site grading over 1 acre, pre and post construction BMPs are regulated under Phase II of the NPDES Storm Water Rule.

D. Sedimentation Metrics

Chemical Metrics

- TDS and TSS scores (# sites exceeding biocriteria standards)
- # miles of stream impacted (using the defined upstream assumption)

Physical Metrics

- Land Use (using the ODNR modeling)
- QHEI (sites with high embeddedness)
- Bank Erosion and Riparian Zone scores (item #4 on the QHEI form) for 4 target sites that are proposed for restoration or known to be changing
- Pebble Counts or Substrate scores (item #1 on QHEI form) at 4 target sites that are proposed for restoration or known to be changing
- Acres of impervious surface in the riparian corridor
- Acres of impervious surface in the HUC-12 watershed
- Number of sites for which constructive comments on this impairment are submitted to Ohio EPA for anti-degradation, permit-to-install or Section 401/404 reviews
- Linear feet of streambank to which a riparian buffer setback ordinance, if adopted, is applied
- Additional acres of settling ponds, detention ponds, infiltration areas, rain gardens and constructed wetlands (factor the number of acres with a sediment removal coefficient)
- Linear feet of daylighted streams
- Linear feet of streambank stabilized by bioengineering techniques
- Pounds of sewage sludge intercepted by the High Flow Treatment Facility in Reading
- Additional acres of floodplain connectivity
- Bank Erosion Height Index(BEHI) scores of severely eroding streambank

Biological Metrics

- ICI scores

7.3.2 NUTRIENTS

A. Problem Overview

Nutrients are a primary pollutant of concern for all five sub-watersheds in the Mill Creek. The Mill Creek TMDL (2004) focused solely on the nutrients of Nitrate-Nitrite-(NO3+NO2) and Total Phosphorus (TP). For this Lower Mill Creek Watershed Action Plan, the definition of nutrients includes a discussion of the parameters: Ammonia (NH3), Nitrate-Nitrite-N, Total Kjeldahl Nitrogen (TKN), and Total Phosphorus as well as an awareness of associated impacts to dissolved oxygen, which were measured by MBI's Mill Creek Bioassessment report (2011).

Excessive nutrients can limit a waterbody's ability to support healthy communities of fish and macroinvertebrates. The presence of large concentrations of nutrients in a stream or lake combined with sunlight, warmer temperatures and carbon dioxide, can lead to sudden and intense algal blooms. When these algal blooms run out of fuel (nutrients) and start to die, bacteria break them down in a process called eutrophication, which uses a large amount of the limited oxygen in the water; this can suffocate fish and other aquatic life.

Algal blooms are more likely to happen in the lower Mill Creek channelized sections, due to the excessive amounts of nutrients, limited riparian canopy, shallow depth, and the heat absorbent concrete channel. Having a riparian canopy can effectively block sunlight and shade water to cool down the water temperature, slowing or limiting algal growth. The existing concrete channel – designed to contain the largest flood events – is normally at a shallow water depth which is easy for sunlight to penetrate to reach the stream bottom surface. The concrete materials of the channel absorb heat from direct sunlight and release it slowly, keeping the water at a higher temperature much longer into the night than in a traditional stream. With these conditions, there is no surprise that the water quality experiences widely fluctuating diel (24 hour cycle – day and night) swings of dissolved oxygen in the Modified Warmwater Habitat section of the Mill Creek, as discussed in MBI's Mill Creek Bioassessment report.

B. Point Sources

The major point sources of nutrients along the Mill Creek include major and minor municipal point source dischargers and industrial dischargers, and during wet weather events - combined sewer overflows and sanitary sewer overflows.

There are several major Municipal Separate Storm Sewer System (MS4) permits along the Mill Creek, the Metropolitan Sewer District of Greater Cincinnati, the Glendale Wastewater Treatment Plant, and the Butler County Upper Mill Creek Water Reclamation Facility. The Mill Creek WWTP is located at RM 0.51, near the confluence with the Ohio River, there are also approximately 120 combined sewer overflow locations scattered throughout MSD's service area; the Butler County UMC WRF is located on East Fork creek at RM 1.07 which meets with the Mill Creek at RM 17.45; and the Glendale WTP is located at Mill Creek RM 16.5.

C. Nonpoint Sources

Urban runoff and malfunctioning home sewage treatment systems are major nonpoint sources of the excess nutrients. Other sources include leaking sanitary sewer lines, illicit discharges, storm sewers, agricultural and residential fertilizers, eroding streambanks or constructions sites, streamside compost heaps and leaf piles, dumps and landfills, street gutter disposal of grass clippings and leaves, and growing populations of Canada geese and deer. The magnitude of any single one of these nutrient sources is unknown.

D. Nutrient Metrics

Chemical Metrics:

- NO3, NO2, TKN, P (# sites exceeding biocriteria standards)

- # miles of stream impacted (using the defined upstream assumption)
- Biological Oxygen Demand (BOD)
- Nutrient loads from the effluents of the Upper Mill Creek Water Reclamation Facility in Butler County
- Nutrient loads from the effluents of the Glendale Wastewater Treatment Plant
- Nutrient loads from the effluents of dischargers with NPDES public permits
- Nutrient loads from the effluents of dischargers with NPDES industrial permits
- Gallons of sewage intercepted by the High Flow Treatment Facility in Reading (factor the gallons with a coefficient for the removal of non-soluble nutrients by flocculation)
- Number of malfunctioning home sewage treatment systems that are maintained or repaired (factor this number with coefficients for nitrogen and phosphorus found in home sewage)
- Number of malfunctioning home sewage treatment systems that are upgraded (factor this number with coefficients for nitrogen and phosphorus found in home sewage)
- Number of malfunctioning home sewage treatment systems that are replaced (factor this number with coefficients for nitrogen and phosphorus found in home sewage)
- Number of malfunctioning home sewage treatment systems that are eliminated by connection to a centralized sewage collection network (factor this number with coefficients for nitrogen and phosphorus found in home sewage)
- Estimated additional gallons of hauled septage that is disposed properly
- (factor this number with coefficients for nitrogen and phosphorus found in hauled septage)
- Pronounced Diehl (diurnal) swings(?)
- Dissolved oxygen levels at three or more consistent monitoring sites
- Dissolved oxygen in effluents of the Upper Mill Creek Water Reclamation Facility in Butler County
- Dissolved oxygen in effluents of the Glendale Wastewater Treatment Plant
- Dissolved oxygen in effluents of dischargers with NPDES public permits
- Dissolved oxygen in effluents of dischargers with NPDES industrial permits
- Ammonia (# sites exceeding biocriteria standards)
- # miles of stream impacted (using the defined upstream assumption)
- Ammonia in effluents of the Upper Mill Creek Water Reclamation Facility in Butler County
- Ammonia in effluents of the Glendale Wastewater Treatment Plant
- Ammonia in effluents of dischargers with NPDES public permits
- Ammonia in effluents of dischargers with NPDES industrial permits
- Total Organic Carbon (not measured by MBI report)
- CSOs – tracked by MSD?
- Biological Oxygen Demand of effluents of the Upper Mill Creek Water Reclamation Facility in Butler County
- Biological Oxygen Demand of effluents of the Glendale Wastewater Treatment Plant
- Biological Oxygen Demand of effluents of dischargers with NPDES public permits
- Biological Oxygen Demand of effluents of dischargers with NPDES industrial permits

<u>Physical Metrics</u>:

- Acres of additional settling ponds, detention ponds, infiltration areas, rain gardens and constructed wetlands (factor the number of acres with nutrient removal coefficients for nitrogen and phosphorus)

- Areas (length times width) and flows of manmade riffles with substrates that serve as habitat for organisms that feed on nitrogen in the water
- Square feet of floating wetlands installed (factor the square feet with nutrient removal coefficients for nitrogen and phosphorus)
- Number of malfunctioning home sewage treatment systems that are maintained or repaired
- Number of malfunctioning home sewage treatment systems that are upgraded
- Number of malfunctioning home sewage treatment systems that are replaced
- Number of malfunctioning home sewage treatment systems that are eliminated by connection to a centralized sewage collection network
- Number of sites detected and eliminated by illicit nutrient discharge enforcement
- Acres of impervious surface in the riparian corridor (same as a metric for Sedimentation)
- Acres of impervious surface in the HUC-12 watershed (same as a metric for Sedimentation)
- Number of sites for which constructive comments on this impairment are submitted to Ohio EPA for anti-degradation, permit-to-install or Section 401/404 reviews
- Estimated additional gallons of hauled septage that is disposed properly
- Square feet (length times width) of manmade riffles that oxygenate water (with a coefficient for riffle diversity and roughness)
- Number of sites detected and eliminated by illicit organic discharge enforcement
- Number of sites for which constructive comments on this impairment are submitted to Ohio EPA for anti-degradation, permit-to-install or Section 401/404 reviews
- Acres of additional settling ponds, detention ponds, infiltration areas, rain gardens and constructed wetlands (factor the number of acres with organic removal coefficients)
- Lengths and acreages of streamside composting sites placed under management practices)

Biological Metrics:

- Additional acres of herbaceous vegetation that is planted or allowed to thrive in the bank full stream corridor
- Number of shrubs, willows, dogwoods or other live stakes planted in the bank full stream corridor
- Number of trees planted in the bank full stream corridor

7.3.3 PATHOGENS

A. Problem Overview

Recreation in the Mill Creek and its tributaries is limited by pathogens. Primary-contact recreation, such as swimming, is strongly discouraged, but unfortunately, Mill Creek canoeists have observed on occasion children swimming in the Creek. Secondary-contact recreation, such as boating and fishing, is far more common. Most of the boating is attributable to the Mill Creek Yacht Club, which has engaged nearly 500 different canoeists or kayakers on nearly 100 outings since 1994. Most of the Mill Creek fishing excursions are done by individuals, though the Buckeye United Fly Fishers has lately shown interest in organizing Mill Creek events under the guise of the Mill Creek Wilderness Society. Both the Yacht Club and the Wilderness Society are tongue-in-cheek expressions of urban stream recreation, but the human health hazard posed by Mill Creek pathogens are no

joking matter.

Bacteria are relatively harmless in most cases, but their presence indicates that the water has been contaminated with feces from a warm-blooded animal. Although intestinal organisms eventually die off outside the body, some will remain virulent for a period of time and may be dangerous sources of infection. This is especially a problem if the feces contained pathogens or disease producing bacteria and viruses. Reactions to exposure can range from an isolated illness such as skin rash, sore throat, or ear infection to a more serious wide spread epidemic.

Bacteria of concern include:

- Salmonella, which cause typhoid fever and gastroenteritis (food poisoning)
- Shigella, which cause severe gastroenteritis or bacterial dysentery
- Escherichia coli (E. coli), which cause diarrhea and urinary tract infections

Viruses of concern include:

- polio
- hepatitis A
- and encephalitis

The problem with pathogens also includes single-cell, disease-causing microorganisms, such as cryptosporidium and giardia.

Indicator bacterial groups are measured to determine the potential presence of pathogens that can cause communicable diseases. Coliform bacteria groups are useful indicators because they are easily detected and their numbers of colonies generally correlate with the extent of contamination. One of these indicator coliform bacteria is *Escherichia coli (E. coli)*, which is a bacteria naturally found in the fecal matter of warm-blooded animals and has been used as an indicator of unsafe water conditions (Ishi et al, 2008).

Bacterial levels in the Lower Mill Creek Watershed are being influenced in opposite directions by salinity and urban land use. E. coli has been shown to be inversely proportional to salinity (Mallin et al, 2000). Because the Mill Creek has elevated chloride levels (Midwest Biodiversity Institute, 2011), salinity may be reducing *E. coli* contamination of the lower Mill Creek. On the other hand, E. coli is positively correlated to the percentage of impervious cover within the watershed (Mallin et al, 2000). Given the fact that the Lower Mill Creek Watershed has more than 34 percent impervious cover, elevated bacteria levels are to be expected.

B. Sources of Pathogens in the Mill Creek

Pathogen sources in the Lower Mill Creek Watershed are numerous and diverse. Some of these sources defy clear-cut classification because they straddle the distinctions between point source and nonpoint source pollution. Sewer overflows are commonly classified as point sources of pathogen pollution, but once were classified as intermittent sources of pollution because they usually occur intermittently during periods of wet

weather (*Regional Water Quality Management Plan*, OKI Regional Council of Governments, 1977).

The text that follows addresses the types of pathogen sources. Each different type is signified by **boldface text**. Aside from sewer overflows, all or nearly all of the types can be categorized as nonpoint source pollution.

Combined sewer overflows (CSOs) and **sanitary sewer overflows** (SSOs) are the Lower Mill Creek Watershed's most prominent sources of pathogens. CSOs and SSOs flare up during rain storms. On a more continuous basis, pathogens also emanate from **sewage system failures**. Such failures are caused by sewer line cracks, breaks or collapses; sewer system blockages; loose joints or ineffective gaskets; unprotected outlets; malfunctioning bypasses; and open manholes. The watershed's aging sewer infrastructure is subject to significant infiltration/inflow problems.

Ineffective home sewage treatment systems are another major source of Mill Creek pathogens. Some classify ineffective home systems as point sources of pollution because they have pipe discharges. Others classify home systems as nonpoint sources of pollution because they tend to be diffuse throughout a watershed.

Either way, home sewage treatment systems become a pathogen problem for one or more of these reasons:

- Poor design for the type of usage or the type of soil in the leachate absorption field
- Placement of the home sewage system in a location where it cannot function fully
- Inadequate treatment system capacity and increasing flows
- Infrequent pumping of the treatment system's contents by a septage hauler
- Poor operation due to the disposal of substances detrimental to system microbes
- Poor maintenance of the treatment system's pumps, grinders or filtration hardware
- Impervious surface encroachment upon the system's leachate absorption field
- Continuing reliance on an old system beyond the length of its useful life expectancy
- Reliance upon a septage hauler who does not comply with disposal regulations
- Bypasses, cross connections or illicit discharges from disconnected, inoperable, overwhelmed or faultily plumbed treatment systems

With its heavy clay soils, aging housing stock, economic challenges and diverse demographics, the Lower Mill Creek Watershed has a substantial number of home sewage treatment systems with one or more of the problems listed above.

Yet another major source of pathogens is **contaminated sediment**. The wet, nutrient-rich sediments of the Lower Mill Creek Watershed are ideal habitat for bacteria and other pathogens. Such microbes are re-introduced to the water column whenever stream bottom sediments are disturbed by turbulent, high-volume flows. That is why high pathogen levels correlate with high turbidity in streams. Given the Mill Creek's tendency for flash flooding and muddy waters during wet weather, the Lower Mill Creek Watershed is frequently subject to elevated pathogen levels from contaminated sediment.

Other sources of pathogens in the Lower Mill Creek Watershed include:

1. **Illicit discharges** – The lower Mill Creek and its tributaries have a variety of small pipes, tubes, gutters, drainage ditches, seepages and hidden outlets indicative of illicit sewage discharges that evade a sewage treatment fees by the Metropolitan Sewer District of Greater Cincinnati.
2. **Dumping** – Though it is mostly urbanized, the Lower Mill Creek Watershed still has plenty of secluded places that attract septage haulers and others who dump their raw sewage payloads for free rather than pay to have the wastes treated at an authorized wastewater treatment plant.
3. **Wildlife** –City pigeons, winter crows and growing numbers of Canada geese are generating considerable amounts of wildlife feces rich in pathogens. The Lower Mill Creek Watershed also has reviving mammal populations of deer, coyotes, squirrels, possums, raccoons, groundhogs, muskrats and beavers. In addition to wildlife fecal matter, it is not uncommon to find decomposing animal bodies in or along the Mill Creek. Rat feces may also become more of a problem because the City of Cincinnati is on the verge of laying off city employees who bait sewers for rats.
4. **Pet populations** – The increasing popularity of household pets results in a rising amount of pathogen-laced fecal matter polluting the neighborhoods, parks and gutters of the Lower Mill Creek Watershed.
5. **Agricultural animals** – Though the Mill Creek Watershed is mostly urban, it still has pockets of agricultural land use where pathogens are generated by chickens, caged rabbits, goats, sheep, horses, dairy cows and cattle. Most of these animals are located in the Upper Mill Creek Watershed, but their waste byproducts ultimately drain to the Lower Mill Creek Watershed.
6. **Dumps and landfills** – Much of the lower Mill Creek and its tributaries are lined with abandoned dumps and landfills. Eroding streambanks are exposing some of those sites to stream waters. Even the stable streambanks allow landfill leachate to eventually drain to the stream. Fecal matter is a legacy waste in some, if not most, of these old solid waste sites.
7. **Urban runoff** – The Lower Mill Creek Watershed has many potential sources of pathogens to its stormwater. For example, day care centers, nursing homes, hospitals and other health care facilities dispose many soiled diapers, wound dressings and other bio-hazardous wastes that can be a problem if not properly handled with leak-proof bags and solid waste bins. Another source of pathogens in urban runoff is rotting food waste, specifically fecal coliform from decomposing meat products, which often end up in garbage bins behind supermarkets, neighborhood grocery stores or butcher shops.
8. **Manure** – Lawn care, gardening and landscaping are common throughout much of the Lower Mill Creek Watershed, and manure remains a popular substance to fertilize plant growth for these activities.
9. **Streamside soils** – Once E. coli is established in the soil, the soil can be a continuous source of bacteria for nearby streams (Whitman et al, 2006). Given the fact that the lower Mill Creek had "gassing sludge banks" during the 1960s (Metropolitan Sewer District newsletter), the watershed's soils should be regarded as a source of Mill Creek pathogens. Erosion remains active in the Lower Mill Creek Watershed, which leads to the release of soil pathogens into the Mill Creek or its tributaries.

C. Goal for Reducing Pathogens in the Lower Mill Creek Watershed

A shorter-term goal for managing pathogens is to put the Lower Mill Creek Watershed in compliance with Ohio EPA's *E. coli* standards for Secondary Contact Recreation by 2020.

Objective A

Once the Lower Mill Creek Watershed is in compliance with *E.* coli standards for Secondary Contact Recreation, its stakeholders should focus on putting both of the watershed's HUC-12 areas in compliance with bacteria criteria for Class C, Primary Contact Recreation (PCR) by 2030.

Objective B

Once the Lower Mill Creek Watershed is in compliance with *E.* coli standards for Class C, Primary Contact Recreation, its stakeholders should focus on putting both of the watershed's HUC-12 areas in compliance with bacteria criteria for Class B, Primary Contact Recreation (PCR) by 2040.

Though the lower Mill Creek main stem is now designated for Class B, Primary Contact Recreation, secondary contact standards are temporarily more appropriate for three reasons:

1. Over the years, U.S. EPA has required each state to adopt water quality standards that provide a level of protection for water bodies sufficient for full-immersion swimming (Primary Contact Recreation or PCR). The assumption that all water bodies are used for swimming became the default condition, regardless of whether or not swimming occurs, or is even possible, in a given body of water. (Frequently Asked Questions, Contact Recreation and Bacteria Criteria, Texas Commission on Environmental Quality). Because the Mill Creek is mostly insufficient and wholly inappropriate for "full immersion swimming," it is more befitting for Secondary Contact Recreation.

2. The designation of Secondary Contact Recreation is not unprecedented for the lower Mill Creek. Such a designation was granted by Ohio EPA in the late 1970s, after adoption of the Regional Water Quality Management Plan (OKI Regional Council of Governments, 1977). OKI petitioned Ohio EPA for a secondary contact designation because the urbanized Mill Creek was not viewed as a recreation destination.

3. For the foreseeable future, the E. coli criteria for Primary Contact Recreation are unattainable in the Lower Mill Creek Watershed. Though the Metropolitan Sewer District of Greater Cincinnati s undertaking an extensive program to reduce combined and sanitary sewer overflows to the Mill Creek, it is abiding by federal court orders to reduce sewer overflow volumes, not to comply with bacteria criteria. The shorter-term pursuit of Secondary Contact Recreation standards is a significantly more feasible goal. Accomplishment of that goal will place the Lower Mill Creek Watershed much closer to the ultimate goal: compliance with the bacteria criteria for Class B, Primary Contact Recreation, which is defined by the Ohio Administrative Code (OAC) as: "waters that support, or potentially support, occasional primary contact recreation activities." The OAC says Primary Contact Recreation is applicable to "waters that, during the recreation season, are suitable for one or more full-body contact recreation activities such as, but not limited to, wading, swimming, boating, water skiing, canoeing, kayaking, and scuba diving." In the Lower Mill Creek Watershed, water-based recreation is limited to occasional canoeing, kayaking and wading.

Given the many sources of pathogens to the Lower Mill Creek Watershed, the ultimate objective of Class B, Primary Contact Recreation must await the following:

- extensive improvements to the centralized sewage collection system to prevent sewage overflows
- upgrades, replacements or eliminations of the watershed's malfunctioning home sewage treatment systems
- increasingly common installations of stormwater management and infiltration practices to reduce urban runoff while improving watershed hydrology
- innovation of better source-control technologies to address the many types of pathogen sources innovation of better treatment technologies for the pathogens that still manage to reach the Mill Creek

D. Pathogen Metrics

Chemical Metrics:

- Pathogens in effluents of the Upper Mill Creek Water Reclamation Facility in Butler County
- Pathogens in effluents of the Glendale Wastewater Treatment Plant
- Pathogens in effluents of dischargers with NPDES public permits
- Pathogens in effluents of dischargers with NPDES industrial permits
- MSD monitoring results
- Mill Creek Watershed Council monitoring results
- Estimated additional gallons of hauled septage that is disposed properly
- (factor this number with coefficients for nitrogen and phosphorus found in hauled septage)

Physical Metrics:

- Pounds of sewage sludge intercepted by the High Flow Treatment Facility in Reading
- Number of sites detected and eliminated by illicit organic discharge enforcement
- Number of malfunctioning home sewage treatment systems that are maintained or repaired
- Number of malfunctioning home sewage treatment systems that are upgraded
- Number of malfunctioning home sewage treatment systems that are replaced
- Number of malfunctioning home sewage treatment systems that are eliminated by connection to a centralized sewage collection network
- Volumetric reduction in combined sewer overflows by MSD
- Number of sites for which constructive comments on this impairment are submitted to Ohio EPA for anti-degradation, permit-to-install or Section 401/404 reviews
- Estimated additional gallons of hauled septage that is disposed properly

Combined Metrics:

- E. coli and total coliform levels for selected stream segments in comparison to primary and secondary contact recreation standards

7.3.4 HABITAT ALTERATION AND HYDROMODIFICATION

A. Habitat Alteration Problem Overview

In-stream habitat includes a combination of structural, chemical, and biological characteristics that provide ideal living conditions for aquatic organisms (and their various life stages) within the riverine ecosystem. Physical habitat impairments include primarily geomorphic and vegetative parameters that effect habitat structure, including channel morphology, bed profile (pools and riffles), erosion, substrate quality, and in-stream cover.

Alterations to any and all of these parameters can have significant adverse effects on the populations of aquatic organisms. Channel morphology, bed profile, erosion, and substrate determine the availability and diversity of habitats for macrophytes, epilithic, benthic, and interstitial organisms. The condition of these parameters also affects the availability of cover for small fish and amphibians.

Riparian vegetation also plays an essential role in providing healthy in-stream habitat. Trees, shrubs, and recruitment of woody debris plants along the stream banks provide habitat cover, food for macroinvertebrates, shading for moderation of water temperature, hydraulic roughness and energy dissipation.

The Qualitative Habitat Evaluation Index (QHEI) was developed as a procedure for relating stream potential to habitat quality to provide some insight into how habitat might affect biological expectations in a given waterbody (Rankin, E., The Qualitative Habitat Evaluation Index (QHEI) Rationale, Methods, and Application, EPA Division of Surface Water, 1989). QHEI scores from around the state have indicated that values greater than 60 are generally able to support a warmwater faunas whereas scores less than 45 generally cannot support warmwater assemblage consistent with baseline Clean Water Act goal expectations (MBI, 2011).

B. Point Sources

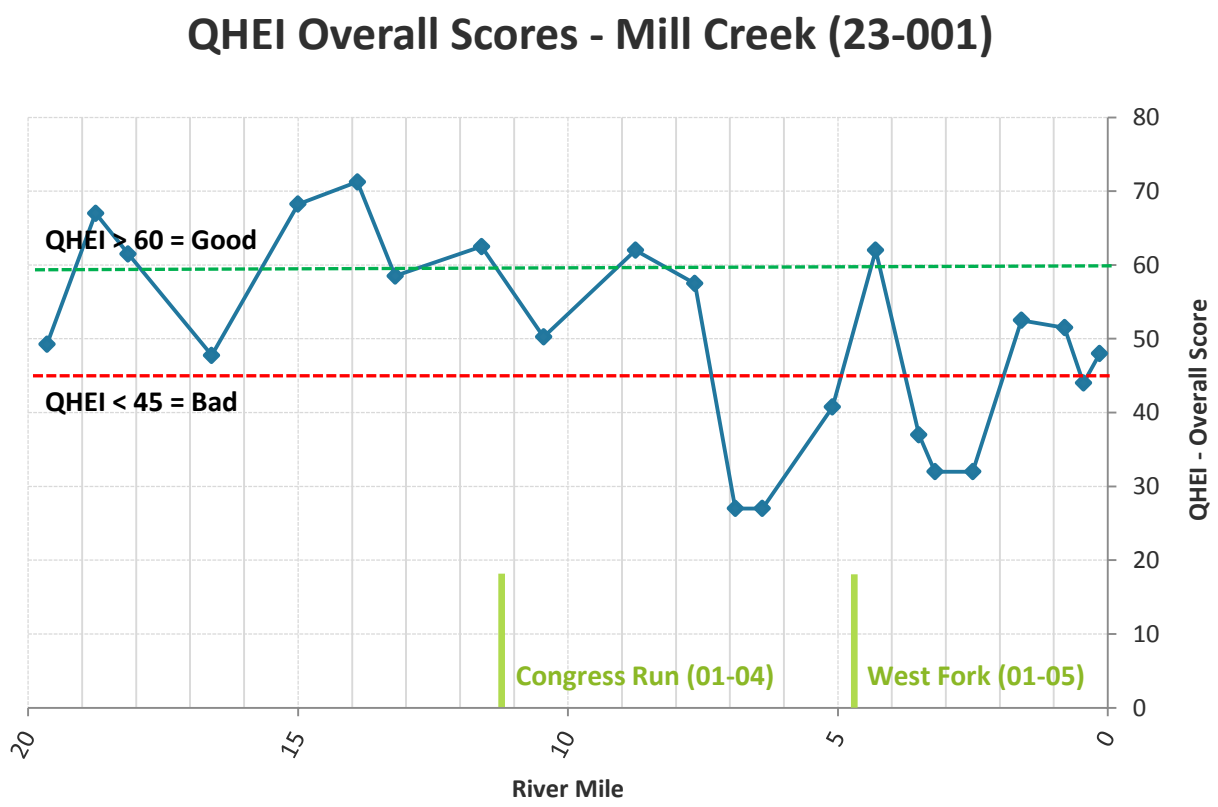
Habitat modifications in the Lower Mill Creek watershed include hardscape features such as channelization, dams, stream burial and culverting, exposed water/sewer pipes and CSOs. Specific examples of major historical habitat modifications: the Miami and Erie Canal built in the late 1820s, the Mill Creek Barrier Dam built in 1948, and the channelization of the Mill Creek beginning in the 1980s.

The USACE created a concrete trapezoidal over-widened channel in the lower Mill Creek from RM 1.7 to Town Avenue above Cognis Chemical and P&G production facilities. The channel has a cement bottom and side over the rectangular channel through P&G production facilities that has no habitat quality and is likely a fish barrier except for carp. The fish above this barrier are mostly lake/pond and small stream fish species (eg. Largemouth bass, sunfish, crappie found in the pool below Town Avenue.

C. Nonpoint Sources

Nonpoint sources of habitat modifications include: loss of riparian cover; removal of cobbles from the stream bed that provide habitat for fish; sedimentation build-up; and encroaching urban development. The riparian

zone has been systematically cleared of trees in the USACE channelized reach (RM 1.7-7.5) by cutting and coating with roundup. The systematic removal of trees and shrubs keeps the Mill Creek in the industrial reach open to sunlight, starved of rock (boulders and cobble sized material). Any of the larger rock comes from asphalt and concrete junks thrown into the channel. However, massive amounts of silt, sand and small gravel does move with the wash load and is deposited either in new banks along the stream from Mill Creek Bridge to Hopple Street Bridge. Then below Hopple Street bridge sand is deposited over the entire bottom making it into a braided stream at low flow only an inch or two deep (2.5-5 cm). The simplification of the in-stream substrate with sand and the lack of riparian zone means there is no effective autumn/winter leaf packs for macroinvertebrate growth.



Source: Modified from (Midwest Biodiversity Institute, 2011)

The Qualitative Habitat Evaluation Index (QHEI) was developed as a procedure for relating stream potential to habitat quality to provide some insight into how habitat might affect biological expectations in a given waterbody (Rankin, E., The Qualitative Habitat Evaluation Index (QHEI) Rationale, Methods, and Application, EPA Division of Surface Water, 1989). QHEI scores from around the state have indicated that values greater than 60 are generally able to support a warmwater faunas whereas scores less than 45 generally cannot support warmwater assemblage consistent with baseline Clean Water Act goal expectations (MBI, 2011).

D. *Hydromodification Problem Overview*

Hydromodification refers to any change in the magnitude and/or frequency of stream flows (including volume, velocity, and timing of runoff), resulting from changes in the hydrologic regime, most notably land use changes. Urbanization and associated increases in impervious surface area can result in significant changes to watershed hydrology and impacts on receiving channels, including flooding, erosion, sedimentation, and degradation of in-stream habitat.

Streams exist in a condition known as "dynamic equilibrium" in which the forces that influence channel form are balanced by resisting forces. The driving force of gravity influences the rate at which water and sediment move through a stream channel, while the resisting forces are the boundary materials (substrate, soils, and vegetation) and resulting friction, expressed as the channel geometry. The degree of erosion or mass wasting is a function of both driving and resisting forces. When the driving forces exceed the resisting forces, the stress applied by both water and sediment exceeds the channel strength, and the channel responds by altering its' channel shape (planform, longitudinal profile and/or cross section) to accommodate the change in flow and applied shear.

Through this process, streams eventually re-establish an equilibrium condition. However, simply allowing the process to "run its course" in an urban setting can have dangerous consequences, and the process of channel adjustment, left unabated, often poses a threat to infrastructure, property, and public safety.

Hydromodification also includes changes in the driving or resisting forces that can significantly reduce the flow of water and sediment, such as low head dams, bridges and culverts, and other modifications to hydraulic gradient. Reductions in flow can aggravate the effects of water pollution. According to the USEPA:
"Dilution is the primary mechanism by which the concentrations of contaminants discharged from industrial facilities and other point and some nonpoint sources are reduced. However, during a low flow event, there is less water available to dilute effluent loadings, resulting in higher in-stream concentration of pollutants. Additionally, winds, bank storage, spring seepage, tributary streams, and the warming effect of the sun have greater impacts on stream water temperatures during low-flow periods. The exaggerated effects of these factors could be additional stressors on aquatic life." (USEPA)

The variables that affect low flow include:

- Rainfall and snowmelt patterns
- Land use/land cover (e.g., the permeability or imperviousness of surrounding land)
- Water control structures (e.g., reservoirs and dams)
- Water intakes (e.g., for drinking water and industrial cooling)
- Water discharges (e.g., from industries, utilities, and wastewater treatment plants)
- Geological characteristics (e.g., groundwater flow and stream slope)

Primary sources of low-flow volumes on the Mill Creek

- Industrial users

- Potable Water from Ohio River and Great Miami River
- WWTP effluent
- Groundwater

Low Flow Characteristics in the Mill Creek

Tributary streams underlain by sewers or storm sewers frequently crack the bedrock and allow low flow to seep down around the sewer pipes, drying the stream. These dried streams are common in Mt Airy forest. Since 1992 an Ohio EPA ruling has moved sewer pipes out of the stream channel and above the low water flow for that reason. However, most of the existing sewers on these older sections of Cincinnati have been laid in that manner, often drying the stream shortly after a rainfall event.

MSD as part of the consent decree is separating many sewers into storm and sanitary. In these cases the new sewer lines would have to be laid above the level of the stream low water flow. Lick Run, West Fork Creek, and Laughing Creek had sewer separation as part of the Consent Decree Lower Mill Creek Partial Hybrid Remedy.

The mainstem of the Mill Creek at Carthage, site of the longest measurement of discharge, shows that the minimum annual discharge has been increasing consistently since the 1940s as the sewage disposal into the creek has grown with the population. The low flow discharge has a base of about 8 million gallons per day, the discharge from the Upper Mill Creek Water Reclamation facility in Butler County. Hence there is more wetted habitat year around from treated water put into the stream. There are about 17 million gallons per day permitted in all the NPDES permits (1992), but that is runoff during rain events, not in dry weather (Ohio Environmental Protection Agency, 1992).

Much of the low flow water originates from surface water taken from the Ohio River and treated in southeast Cincinnati by the Richard Miler Treatment Plant of Greater Cincinnati Water Works (GCWW) or from groundwater taken from the Great Miami Buried Valley Aquifer System and treated in Fairfield by GCWW's Charles M. Bolton Water Plant (McCoy-Smiandle, Buchberger, & Yang, 2011).

Low flow waters are also boosted by industrial process waters discharged by Mill Creek Valley Industries (such as General Electric, Formica, and Procter and Gamble), which receive millions of gallons of groundwater from the Southwestern Ohio Water Company (SOWC). The SOWC operates a deep well with lateral collection lines near a sweeping bend of the Great Miami River in Colerain Township, next to Heritage Park. In Butler County, sewage flowing to the Upper Mill Creek Water Reclamation Facility in West Chester Township orginates as:

- Groundwater pumped from City of Hamilton drinking water wells in the Great Miami Buried Valley Aquifer System, outside the Mill Creek watershed, at an average rate of 8 million gallons per day
- A combination mostly surface water and some groundwater pumped to the Butler County Water and Sewer Department by Greater Cincinnati Water Works' Miller Treatment Plant and Bolton Plant, at an average rate of 5 to 6 million gallons per day

In addition, the Upper Mill Creek Water Reclamation Facility relies on lift stations to collect a good portion of its sewage from Great Miami watershed areas that are outside the upper Mill Creek watershed. Thus, much if not most of the water in the Mill Creek in the summer period is not from the Mill Creek watershed, but from

the Ohio River, and the Great Miami River watersheds. Mill Creek watershed contributions to Mill Creek flows are further reduced by combined sewers, which transfer a significant portion of Mill Creek watershed stormwater runoff to the Mill Creek Wastewater Treatment Plant for discharges as treated effluent to an outlet pipe at the bottom of the Ohio River.

In the past, well fields along the Mill Creek were used until layers of the watershed were polluted by industrial wastes (including PCBs). As a result little water is taken from the Mill Creek aquifer today even though the water table is rising, once even flooding the basements at the GE facility in Evendale.

Loss of Hyporheic Exchange in Concrete Channelized Sections

The hyporheic zone is defined as a subsurface volume of sediment and porous space adjacent to a stream through which stream water readily exchanges. Although the hyporheic zone physically is defined by the hydrology of a stream and its surrounding environment, it has a strong influence on stream ecology, stream biogeochemical cycling, and stream-water temperatures. Thus, the hyporheic zone is an important component of stream ecosystems.

Hyporheic exchange is unique because the stream water that enters the subsurface (the hyporheic zone) eventually reenters the stream at some point downstream. Short hyporheic flow paths (centimeter to meter scale) may be induced by streambed roughness features, such as sediment waves or rough gravel texture. Longer hyporheic flow paths (meter to several meter scale) are influenced by larger stream geomorphic features that exist within the stream reach, such as pool–riffle reach sequences, stream meanders, point bars, and boulder (or log) steps.

Water that enters the hyporheic zone moves at a much slower rate than water in the stream channel. Thus, hyporheic exchange increases the residence time of water within a stream system.

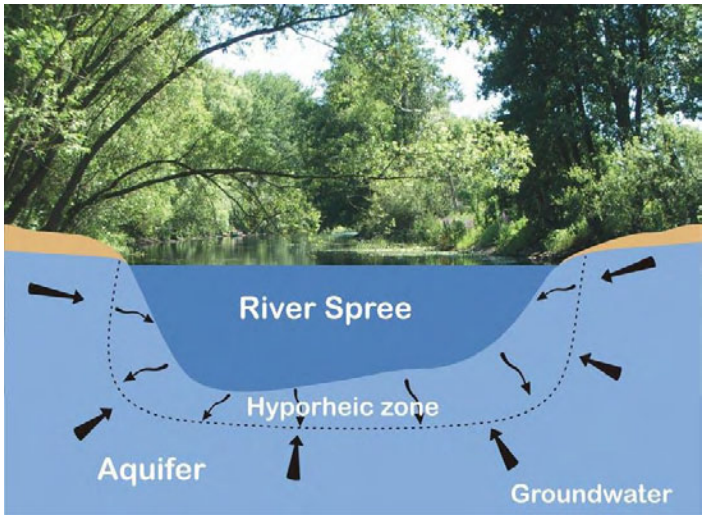


Image: Leibniz-Institute of Freshwater Ecology and Inland Fisheries

The **hyporheic zone** provides an ideal habitat for a wide array of microbes and invertebrates. The hyporheic zone helps regulate stream temperatures, particularly in small streams.

The concrete channelized sections of the Mill Creek are disconnected from their groundwater sources, and depleted of the water quality benefits and unique habitat provided by the hyporheic zone. Hydrologic improvements on the Mill Creek must focus on restoring natural streambeds and reconnecting with the hyporheic zone.

E. Habitat Metrics

Physical Metrics

- Use of QHEI scores
  - # of bad sites
  - # of impacted river miles (using the defined upstream assumption)
- Temperature
- Additional acres of constructed wetlands and other bio-infiltration areas in the bank full stream corridor (similar to a metric for Sedimentation)
- Linear feet of daylighted streams (same as a metric for Sedimentation)
- Linear feet of streambank to which a riparian buffer setback ordinance, if adopted, is applied
- Number of native riparian shrubs and trees planted in the bank full stream corridor with coefficients for plant sizes (e.g., seedling, 1-gallon container, 3-gal. container, 5-gal. container, balled and burlapped signature tree)
- Acres of honeysuckle infestations replaced with native plant communities with coefficients for native plant community characteristics (densities, diversities, woody or herbaceous, seedings)
- Linear feet of streambank protected from herbicide treatment with a coefficient for width of the streambank
- Fish barriers
  - # of low-head dams (factor this with height of each dam above normal flow height)
- Rock barriers
  - "rock deficient stream"
  - Ivorydale area is a big barrier
  - Pebble Counts or Substrate scores (item #1 on QHEI form) at 4 target sites that are proposed for restoration or known to be changing (same as a metric for Sedimentation)
- # feet/miles "piped" underground
- # miles channelized (i.e., straightened stream segments with weak riffle-pool-run structure) with coefficients for the segments that have partially regained natural stream structure over time (e.g., the recovering segments adjacent to Ronald Reagan Highway and its ramps)
- Linear feet of hard-armored banks (with coefficients for concrete, grouted rip rap, ungrouted rip rap, vegetated crib wall, un-vegetated crib wall)
- Linear feet of hard-armored channel (i.e. the concrete bottoms through Ivorydale)
- Acres of additional bio-retention ponds and constructed wetlands, provided these areas are in the

riparian corridor or can serve as ecological refuges along tributaries or headwaters
- Number of sites for which constructive comments on this impairment are submitted to Ohio EPA for anti-degradation, permit-to-install or Section 401/404 reviews
- Linear feet of streambank to which a riparian setback ordinance, if adopted, is applicable

Biological Metrics
- Fish scores (IBI)
- Macro-invertebrate scores (ICI)
- Modified Index of Well-Being (MIWB)

F. Hydromodification Metrics

Physical Metrics
- Create a proportional water budget
    - Average concentration x (average discharge x days)
    - Or multiply by a factor – decrease in change in area
- Utilize the Steve Buchberger "Evolution of Water Balance" report
- Strong evaporation component in summer
    - Strongly linked to riparian cover
        - Square feet of natural canopy gained from plantings alongside stream segments, tributaries, floodplain wetlands or floodplain detention ponds
        - Square feet of semi-natural shading gained from floating wetlands
        - Square feet of artificial shading gained from new bridges or streamside buildings
- Gallons of stormwater re-directed to separate storm sewers rather than combined sewers
- Gallons of stormwater re-directed to infiltration practices rather than combined sewers
- Gallons subject to strategically timed releases of stormwater from retention and detention ponds (factor in the number of releases during dry seasons)
- Gallons subject to strategically timed releases of stormwater from Winton Lake and Sharon Woods Lake (factor in the number of releases during dry seasons)
- Number of sites for which constructive comments on this impairment are submitted to Ohio EPA for anti-degradation, permit-to-install or Section 401/404 reviews

Biological Metrics
- IBI and ICI scores(?)

7.3.5 CHLORIDES

A. Problem Overview

Chlorides are not usually harmful to people, but they can contaminate fresh water streams and lakes. Fish and aquatic communities cannot survive in high levels of chlorides. Chloride is very high in the Mill Creek from point and nonpoint sources, as a physiological stressor on fish and macroinvertebrates.

Results of chloride sampling for the Lower Mill Creek main stem, displayed in Figure 83, show that the chloride

concentrations range from a peak of nearly 300% above the target value to a low of around 50% above the target value. No other impairment investigated in this WAP exceeded its respective target value by a greater margin than chloride at any of the 13 main stem sampling points. Sampled conditions upstream of the Lower Mill Creek were even higher at some locations, specifically the confluence of the main stem with the East Fork, where the sampled chloride value was nearly 5 times higher than the target value, likely corresponding to the East Fork discharge point of the Butler County Upper Mill Creek Water Reclamation Facility. The general trend displayed in Figure 83 is decreasing chloride levels as the distance downstream from the Butler County WRF increases, with the lowest concentration in the Lower Mill Creek observed at the last sampling point before the watershed drains into the Ohio River.

The MBI report suggests that, based on a 2011 study of a similar urban watershed near Chicago, chloride is a "variable correlated with biological impairment in small urban streams and derived environmental thresholds for fish (112 mg/L) and macroinvertebrates (140 mg/L)". Depending on the use designation, the target chloride value for the Lower Mill Creek was either 31 or 35 mg/L.

B. Point Sources

The point sources that are most responsible for the observed chloride levels include discharges from wastewater treatment plants and industries that release into the Mill Creek. Additional point sources likely include discharge from water softening systems and exposed piles of road salt at regional storage facilities.

Based on the sampling results, the Butler County Upper Mill Creek Water Reclamation Facility appears to be one of the most critical point sources of chloride in the Mill Creek. The treatment plant receives wastewater from contributing areas of the watershed upstream of Lower Mill Creek. The treatment plant discharges 8 MGD into the East Fork which is a tributary of Mill Creek (Ohio EPA et al., 2004). The summer mean concentration of chloride being discharged from the plant is 176 mg Cl/L (equivalent to 291 mg NaCl/L), for a total load of around 4,600kg NaCl per day. This impact is confirmed by the drastic increase in the chloride levels at the first sampling site south of river mile 17.45 where East Fork joins the main stem of the Mill Creek. Concentrations of chlorides appear to remain elevated in areas that are close to industrial locations. For example, there is a spike in chloride concentration where the Borden Chemicals facility is located and another close to Proctor & Gamble.

C. Nonpoint Sources

In urban waterways like the Mill Creek, the primary nonpoint source of chloride is runoff from freeways, highways, and local roads containing road salt. Other major sources of chloride are from private residential applications and commercial surface parking lots, and chloride can also be released from the natural weathering of certain rock formations (Sprague et al., 2007). Accordingly, chloride levels in urban runoff are highest in winter and early spring (Ohio EPA, 2012).

Potential nonpoint sources of chloride include; road de-icing runoff, private de-icing, agriculture runoff, wastewater from industries and municipalities, wastewater from water softening, produced water from gas and oil wells, and others. Street cleaning reduces the particulate, organic, and nutrients from being washed in

to the storm sewers and CSOs.

In the Lower Mill Creek, non-point sources include leaking septic tanks at low flow and road salt during the winter snow season. Cincinnati used 30,000 tons of salt on the roads in the average winter prior to the beginning of the use of beet juice/salt solution. We have 2,000 curb miles of roadway in Cincinnati much of which is in the Mill Creek watershed. This would be 6.8 kg per mile of lane or 13.6 kg per mile assuming all are roads are two lane. Much of the soluble salts run off very directly into the Mill Creek from I-75 and its interchanges. Some goes into CSO's and goes directly to the WWTPs, except during rainfalls greater than 0.4" which open the CSOs into the Mill Creek.

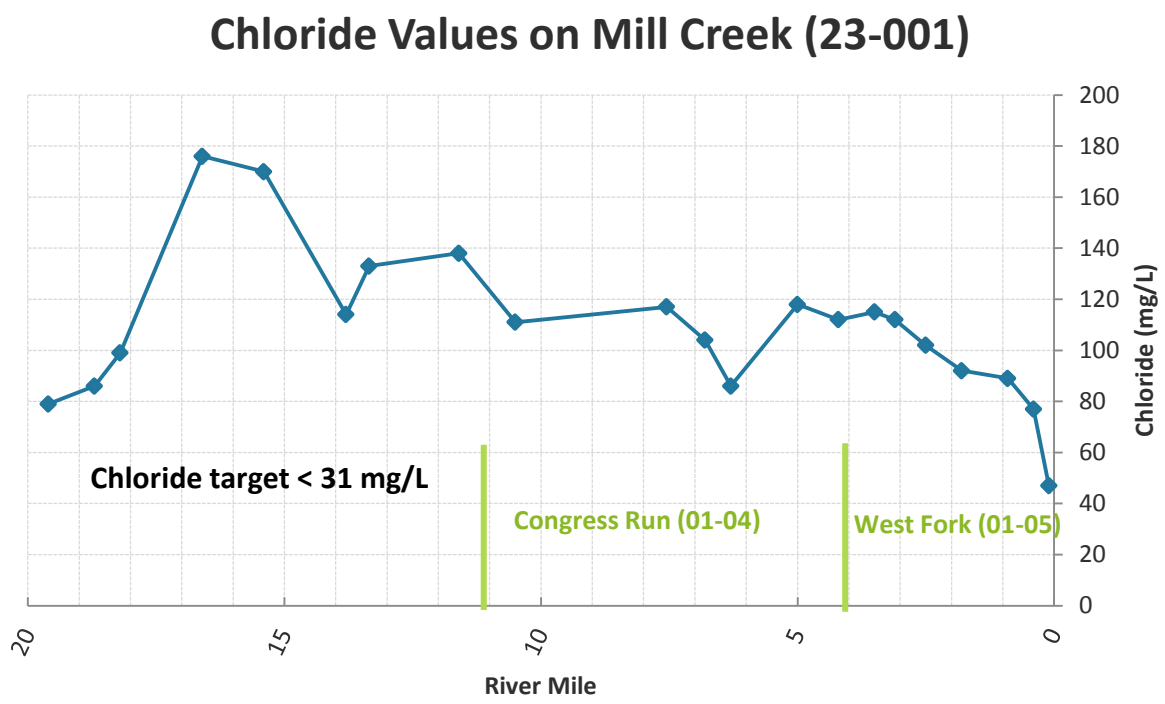


Figure 83: Chloride Values on Mill Creek Mainstem (23-001)

Source: Modified from MBI, Yoder et al. 2011

D. Chloride Metrics

Chemical Metrics:

- Chloride scores (# sites exceeding biocriteria standards)
- # miles of stream impacted (using the defined upstream assumption)
- Chlorides from effluents of the Upper Mill Creek Water Reclamation Facility
- Chlorides from the effluents of the Glendale Wastewater Treatment Plant
- Chlorides from the effluents of dischargers with NPDES public permits

- Chlorides from the effluents of dischargers with NPDES industrial permits
- Conductivity (with an adjustable coefficient to factor out metals)

Physical Metrics:

- Street miles x (chloride street runoff factor?) x time
- Estimated tons of road salt not applied due to the use of alternative materials
    - Sand
    - Ashes
    - Kitty litter
    - Eco Traction
    - Alfalfa meal
    - Calcium magnesium acetate
    - Beet juice
    - Mixtures (such as road salt, sand and beet juice)
    - Brine, which may reduce the amount of salt applied
- Miles of riparian buffer streets given an extra street cleaning when road salt remnants are more likely to be found in the gutters
- Square feet of road salt storage placed under roof or within the confines of drainage containment
- Number of sites detected and eliminated by illicit chloride discharge enforcement
- Number of malfunctioning home sewage treatment systems that are maintained or repaired
- Number of malfunctioning home sewage treatment systems that are upgraded
- Number of malfunctioning home sewage treatment systems that are replaced
- Number of malfunctioning home sewage treatment systems that are eliminated by connection to a centralized sewage collection network
- Acres of additional settling ponds, detention ponds, infiltration areas, rain gardens and constructed wetlands (factor the number of acres with chloride removal coefficients)
- Number of sites for which constructive comments on this impairment are submitted to Ohio EPA for anti-degradation, permit-to-install or Section 401/404 reviews

7.3.6 TOXICS: PAH COMPOUNDS AND METALS

A. Problem Overview

In the Lower Mill Creek Watershed Action Plan, the term "toxics" is a reference to the hazardous substances of polycyclic aromatic hydorcarbons (PAH compounds) and the heavy metals of lead (Pb), copper (Cu) and zinc (Zn).

Polycyclic Aromatic Hydrocarbons (PAHs) are common byproducts of fossil fuel burning and also oil and tar industries and/or products. As a pollutant, they are a concern because some compounds have been identified as carcinogenic, mutagenic, and teratogenic. PAHs in the environment are found primarily in the soil, as opposed to water or air. These compounds can threaten the health of both humans and aquatic species while being resistant to environmental breakdown, creating legacy problems for stream management.

Toxic metals can be present in industrial, municipal, and urban runoff, which can be harmful to humans and aquatic life. Increased urbanization and industrialization are responsible for increased levels of trace metals, especially heavy metals, in our waterways.

B. Sources of Impairment

PAH contaminants can come from a variety of point and nonpoint sources including mining operations, vehicle emissions, fossil fuel combustion, urban runoff, industrial operations and landfills. PAHs are one of the most widespread organic pollutants. In addition to their presence in fossil fuels they are also formed by incomplete combustion of carbon-containing fuels (e.g. wood, coal, diesel, fat, tobacco, and incense).

Heavy metals can be present in industrial, municipal, and urban runoff, which can be harmful to humans and aquatic life. Increased urbanization and industrialization are to blame for an increased level of trace metals, especially heavy metals, in our waterways. Heavy metals in the environment can be caused by air emissions from coal-burning plants, smelters, and other industrial facilities; waste incinerators; process wastes from mining and industry; and lead in household plumbing and old house paints.

Specific sources of copper include electroplating industry, smelting and refining, mining, and biosolids (Liu et al., 2005). Specific sources of lead include mining and smelting of metalliferous ores, burning of leaded gasoline, municipal sewage, industrial wastes enriched in lead, and paints (Gisbert et al., 2003; Seaward and Richardson, 1990). Specific sources of zinc include electroplating industry, smelting and refining, mining, biosolids, and brake and tire wear (Liu et al., 2005).

C. Toxics Metrics

Chemical Metrics:

- Zn, Pb, Cu (# sites exceeding biocriteria standards)
- # miles of stream impacted (using the defined upstream assumption)
- Toxics in effluents of the Upper Mill Creek Water Reclamation Facility in Butler County
- Toxics in effluents of the Glendale Wastewater Treatment Plant
- Toxics in effluents of dischargers with NPDES public permits
- Toxics in effluents of dischargers with NPDES industrial permits
- Sites or general locations listed in the National Sediment Quality Survey
- Sediment samplings reported for the Mill Creek Flood Damage Reduction Project
- Toxic compounds reported by Ohio EPA assessments

Biological Metrics:

- Fish DELTs/anomalies

Physical Metrics:

- Army Corp study - # of streambank miles that are potentially toxic (?)
- Number of sites detected and eliminated by illicit toxic discharge enforcement
- Acres of impervious surface in the riparian corridor (same as a metric for Nutrients and Sedimentation)
- Acres of impervious surface in the HUC-12 watershed (same as a metric for Nutrients and

Sedimentation)

- Acres of additional settling ponds, detention ponds, infiltration areas, rain gardens and constructed wetlands (factor the number of acres with toxic removal coefficients)
- Number of sites for which constructive comments on this impairment are submitted to Ohio EPA for anti-degradation, permit-to-install or Section 401/404 reviews

8 WATERSHED RESTORATION AND PROTECTION GOALS

8.1 GOALS, OBJECTIVES, AND ACTIONS CHAPTER FORMAT

The Goals, Objectives and Actions chapter is divided into five sections; (1) *Introduction*, (2) *Project Groundwork's Impact on Goal Setting for the Lower Mill Creek Watershed*, (3) *Measurable Goals thru Modeling*, (4) *Measurable Goals thru Monitoring*, and (5) *Overarching Goals*.

1. Introduction (p.204) – A separate introduction was created for this chapter to efficiently discuss the findings from the Plan's inventory and analysis work.

2. Project Groundwork's Impact on Goal Setting for the Lower Mill Creek Watershed (p.211) – The work of Metropolitan Sewer District of Greater Cincinnati to remediate combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) thru Project Groundwork was separated into its own section since it is such a milestone project in the history of the Mill Creek. When estimating the pollutant reductions necessary to meet goals in this plan, the CSO and SSO pollutant load reductions were subtracted first from the total modeled pollutant loads so that we knew approximately the amount of pollutant loads remaining for other solutions.

3. Measurable Goals through Modeling (p.213) – This section discusses the goals for reducing pollutant loads, as modeled in the previous chapter. The water quality parameters that were modeled include total suspended solids (TSS), nitrogen, phosphorus, and fecal coliform. The model used was a modified "Simple Method" with local event mean concentrations to improve accuracy.

4. Measurable Goals through Monitoring (p.242) – This section addresses the goals for the water quality pollutant parameters that prevent biocriteria attainment but could not be modeled with the simple method. This data is derived from the Midwest Biodiversity Institute [MBI], Biological and Water Quality Study of the Mill Creek, (2011).

5. Overarching Goals (p.250) – Some of the goals that the watershed action team wanted to address were outside of the typical scope of water quality parameters and/or not necessarily quantifiable, so an *Overarching Goals* section was created to allow their inclusion.

8.2 INTRODUCTION

The overriding goal of this plan is to initiate a process that restores an urban stream system to its former standing as a vibrant regional asset. That goal supports the plan's purpose statement:

> *"The purpose of the Lower Mill Creek Watershed Action Plan is to document current conditions; to identify effective strategies, programs and projects that are needed and can be employed; and to craft a roadmap for improving water quality and ecological health in the Lower Mill Creek Watershed that will, in turn, create more livable neighborhoods and provide public health, environmental, social, and economic benefits for many years to come."*

Fulfilling the plan's overriding goal and purpose is most challenging because the Mill Creek and its tributaries have been subject to more than two centuries of development and intensive land use. Nevertheless, the long-abused urban stream system shows signs of resilience and recovery. Urban hydrology, degraded habitat and polluted stormwater complicate matters, but restoration can be achieved. Implementation of this Watershed Action Plan (WAP) will increase the stream miles of lower Mill Creek main stem and tributaries in attainment of their designated aquatic life and recreational uses.

Significant improvement is already under way. The Metropolitan Sewer District of Greater Cincinnati (MSD) has concluded consent decree negotiations with the U.S. EPA, the U.S. Department of Justice and the State of Ohio to reduce by 85% the volume of combined sewer overflows (CSOs) throughout the Mill Creek watershed by the year 2022. The CSO reductions will enhance parallel efforts to improve biological conditions throughout the watershed.

Major influences on a stream's bio-criteria include habitat quality, hydrologic pulse flows, dry periods, channelization, other physical damages, high water temperatures and, of course, water chemistry. Hence the WAP has a more comprehensive goal than just limiting CSO discharges and density of E. coli, an indicator of human fecal contamination. E. coli comprises only a tiny fraction of all stream bacteria and E. coli density does not necessarily harm many of the stream's filter feeding organisms. But untreated sewage in the creek does pose a public health threat to people who come in contact with Mill Creek waters during or soon after heavy rainfalls. Overall this plan seeks to improve health conditions for not only aquatic life, but also for people. We want to attain state and federal water quality standards in a way that increases public enjoyment of urban waterways.

As required by Ohio EPA and the Ohio Department of Natural Resources, this plan addresses goal, objectives, actions and indicators for the two subwatersheds that comprise the Lower Mill Creek Watershed. Named after their major tributary and the receiving Mill Creek main stem, those two subwatersheds are:

- Congress Run-Mill Creek, which has a 12-digit Hydrologic Unit Code (HUC-12) of 050902030104 assigned to it by the U.S. Geological Survey

- West Fork-Mill Creek, which has a HUC-12 of 050902030105

Basic Facts on the Congress Run-Mill Creek subwatershed

The Congress Run-Mill Creek subwatershed drains 30 square miles and has land uses in these proportions*:

- Developed – 79.4%
- Forest – 17.8%
- Grass/Pasture – 2.3%
- Row Crops – 0.1%
- Other – 0.4%

(* As reported by the Ohio EPA in its Watershed Assessment Unit Summary.)

Impervious surfaces cover 35.6% of the Congress Run-Mill Creek subwatershed. ǂ The drainage area, therefore, clearly surpasses the 25% impervious cover level at which the Center for Watershed Protection expects streams to be non-supporting of their aquatic life uses.

The subwatershed is laced with more than 102 miles of busy roads that drain polluted stormwater runoff to the Mill Creek or its tributaries. The major thoroughfares include ǂ:

- Interstate Highways and Ramps – 27.6 miles
- U.S. Highways – 12 miles
- State Routes – 19.9 miles
- County Roads – 42.8 miles

(ǂ As reported by the OKI Regional Council of Governments in its Impervious Surface Analysis for the Watersheds of Butler, Clermont, Hamilton and Warren Counties, Ohio.)

Basic Facts on the West Fork-Mill Creek subwatershed

The West Fork-Mill Creek subwatershed drains 30 square miles and has land uses in these proportions*:

- Developed – 66.8%
- Forest – 31.0%
- Grass/Pasture – 1.2%
- Row Crops – 0.3%
- Other – 0.6%

(* As reported by the Ohio EPA in its Watershed Assessment Unit Summary.)

Impervious surfaces cover 33.5% of the West Fork-Mill Creek subwatershed. This also surpasses the 25% impervious cover level at which the Center for Watershed Protection expects streams to be non-supporting of their aquatic life uses.

The subwatershed has more than 93 miles of busy roads that include ǂ:

- Interstate Highways and Ramps – 24.9 miles
- U.S. Highways – 9.8 miles
- State Routes – 2.4 miles
- County Roads – 56.2 miles

(ǂ As reported by the OKI Regional Council of Governments in its Impervious Surface Analysis for the Watersheds of

Butler, Clermont, Hamilton and Warren Counties, Ohio.)

Basic Facts on the Mill Creek main stem in the Lower Mill Creek Watershed

The lower Mill Creek is functionally divided into three major environments:

1) **lower Mill Creek estuary** to the Ohio River, a tree-lined segment with mostly natural banks, surprisingly abundant wildlife, a relatively deep channel and the Mill Creek Barrier Dam. It normally extends from the stream's mouth to the Western Hills Viaduct at River Mile 1.7

2) **hard-armored channel** in many, but not all, stream reaches between River Mile 1.7 to River Mile 7.8, and occur again in the vicinity of the highway interchanges for Interstate 75 at the Ronald Reagan Highway (State Road 126) from about River Mile 11.1 to River Mile 11.7. Though hydromodification is a major issue, it's important to note that the Lower Mill Creek channel (streambed and streambanks) is not continuously lined with concrete, grouted rip rap or other hard armoring. Some stream reaches are biologically recoverable, as demonstrated by the significant biological improvements in water quality, aquatic and terrestrial habitat, wetlands and streambank made by Groundwork Cincinnati/Mill Creek and the Metropolitan Sewer District of Greater Cincinnati. These recoverable reaches also have been enhanced by improvements in maintenance practices within the stream corridor.

3) **more natural channel** and streambanks between River Mile 7.8 and River Mile 11.1. Though this segment benefits from wide sweeping meanders between Anthony Wayne Avenue and North Bend Road, it is cut off from other somewhat natural segments by the channelization and fish-barriers that predominate upstream near Ronald Reagan Highway and downstream through Ivorydale.

The **lower Mill Creek estuary** can vary in length, depending on recent precipitation and associated waterway stage. Estuary conditions extend 1.7 miles from the Mill Creek's mouth on the Ohio River during low flow, but can reach up to 6 miles long when the Ohio River stage is high enough to back water into the lower Mill Creek Valley. During such periods, the Ohio River backwater is hardly flowing, allowing sedimentation by fine sands and silts onto the Mill Creek's bankfull bench between Mitchell Avenue and the Mill Creek Barrier Dam. The Ohio River backwater also allows Ohio River fish to move easily in and out of the Mill Creek channel.

The Ohio EPA has not developed bio-criteria for non-flowing waters in estuaries. This puts the lower Mill Creek and other estuaries at a disadvantage for attaining their designated aquatic life use standards, which are more appropriate for flowing waters than non-flowing estuary backwaters. Nevertheless, estuaries are critical to river ecology as nursery areas for river species (Gizzard Shad, Skipjack Herring and Emerald Shiners). The young-of-the-year of these species are critical food for all the fish-eating birds: Great Blue Herons, Green Herons, Black-Crown Night Herons, Kingfishers, and occasional Osprey, all seen in the lower Mill Creek corridor (RM 0 to RM 2). The green way of the wooded last 1.7 miles of the Mill Creek is the home of beaver, ground hogs, raccoon, and white tailed deer. Many ducks make the estuary home year around. We encourage the OEPA to develop criteria for estuaries of the Ohio River and Lake Erie.

The **hard armored channel** is gradually recovering from concrete streambanks constructed in the 1970s for Ronald Reagan Highway interchanges with I-75. Additional streambank alteration occurred from 1989 to 1991 for the Mill Creek Flood Damage Reduction Project. This work over-widened the stream to store water and transport 50- to 100-year flood events within the bounds of concrete or rip-rap streambanks. The pool of the Ohio River is 26.4 feet. The concrete channel fills at about 44 feet and still has earthen levy above that.

Despite its habitat deficiencies, the concrete channel of Ivorydale has raised its bio-criteria scores since the Ohio EPA's watershed assessment in 1992. Much of this improvement can be credited to the Global Consent Decree that Metropolitan Sewer District of Greater Cincinnati (MSD) negotiated with the U.S. EPA, the U.S. Department of Justice and the State of Ohio. Under this decree, MSD is reducing combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs), particularly SSO 700 in Reading.

Stream health is improving along most of the hard armored channel. Evidence of this can be found in *Biological and Water Quality Study of Mill Creek and Tributaries 2011* (Midwest Biodiversity Institute [MBI], June 2012). Some of this improvement is attributable to a stream's self-healing properties, as well as CSO reductions by MSD and ecological improvements by local stakeholders. During the two decades between Ohio EPA's 1992 study and MBI's 2011 study, the lower Mill Creek has gradually accumulated more rock, developed meanders in its over-widened channel, and deposited a bank-full floodplain in some places. These incremental processes create better habitat in the riparian corridor.

Improvement can also be attributed to the removal of two barriers to fish movement near the Hopple Street Viaduct and the Gest Street bridge. This allows Ohio River fish species to populate up to seven miles of the lower Mill Creek during high flows.

Constancy of water flow is another reason for Mill Creek revival. The Upper Mill Creek Water Reclamation Facility in Butler County has significantly increased its daily discharge of treated effluent over the past two decades with the development of West Chester and Liberty townships. Constant flows also are contributed by:

- Glendale Wastewater Treatment Plant along Town Run
- a high flow treatment facility that MSD installed in Reading for SSO 700
- a series of Mill Creek Valley industries that discharge treated process water originating from Southwest Ohio Water Company's deep lateral well next to a bend of the Great Miami River in north west Hamilton County. The Mill Creek's constancy of flow is further supported by groundwater during dry weather. Now that Mill Creek industries draw their process water from the Great Miami aquifer rather than the Mill Creek aquifer, the water table is rising beneath the Mill Creek in Evendale and Reading. The relocation of Lockland's drinking water wellfield and the closure of Reading's wellfield have also played a part in this trend. In 2002, the U.S. Geological Survey reported that "water levels in the lower (Mill Creek) aquifer are 65 to 105 feet higher than they were in 1955."

The **more natural channel** has been restored with a rocked slopeway, a cross-vane weir and two J-hook weirs between Center Hill Avenue and North Bend Road. The streambed has been stabilized and fish habitat has been improved with large rip rap boulders at water level. Above the water line, the streambanks have been restored with native tree and willow plantings while existing native trees have been preserved for their canopy. This stream reach has healthy biodiversity, especially in the vicinity of Caldwell Nature Preserve's wooded slopes along the right descending bank and Caldwell Playground's floodplain recreational areas along the left descending bank.

In all three of the lower Mill Creek's major environments, sedimentation, siltation and embeddedness remain major obstacles to attainment of designated aquatic life uses. Significant reaches are rock-starved from channelization, especially through Ivorydale. West Fork Creek also is deficient in gravel, cobble and boulders because its lower reach has been paved.

Where they exist, rocky sections have different reasons for being. Some are there by design, some are there by accident and some are there by natural deposition. The rocky sections by design include the cross-vane weirs installed by the U.S. Army Corps of Engineers next to Salway Park, the rocked slopeway installed just downstream of Hopple Street Viaduct by Metropolitan Sewer District (MSD), and the Newbury riffle that MSD installed just upstream of Gest Street bridge. Among the rocky sections by accident is the riffle just below the confluence of West Fork Creek and the Mill Creek. This riffle consists largely of rip rap blown out from a bridge built across an upstream segment of West Fork in Mount Airy Forest. The naturally deposited rocky sections are fed by the erosion of un-armored streambanks during peak flows.

More rocky sections are needed. Rocked slopeways would significantly improve aquatic habitat at the four lowhead dams that impede lower Mill Creek fish movement between Ronald Reagan Highway and Millcreek Road bridge. Though they certainly impose grade control, the dams have no hydrological function. They were installed to protect sewer lines that cross beneath the stream channel. These dams can be mitigated in such a way that underlying sewers are still protected but fish barriers are eliminated.

Remaining above ground tributary streams suffer from high pulsed flows and low flows because of impervious surfaces and channel modification. The cement channel of West Fork Creek is a corridor that offers no habitat for aquatic organisms downstream of Mount Airy Forest, where unchannelized headwaters still flow. But a U.S. EPA's case study still found problems with nutrients, bacteria and flash flows despite the installation of rain barrels and rain gardens on perhaps 5 % of the properties in the Shepherd Creek drainage area of West Fork's watershed. Recent burial of the West Fork under the Colerain/ I-74 interchange will continue this downgrade.

Much of Congress Run has been channelized and part of it flows underground in a large culvert beneath Hartwell Golf Course. Pulse flows from the Ronald Reagan Highway corridor continue to incise the Congress Run channel and deposit massive amounts of cobble, gravel and sand in the tributary's lower reaches.

Bloody Run and Ross Run are largely underground and enter the Mill Creek through concrete confluences that provide no functional habitat. Part of the Lick Run and some of its tributaries will be daylighted and connected to the lower Mill Creek at River Mile 1.7, near the Western Hills Viaduct. This will benefit fish and macroinvertebrates if the Lick Run outfall is not to a concrete basin but to a structure that is more compatible with Mill Creek habitat.

Like the Mill Creek main stem, the Mill Creek's tributaries need more rock weirs, meanders, naturalized fish passages, stormwater retrofits, stabilized streambanks, native plantings and restored habitats. These improvements are gaining greater public interest through the efforts of many organizations, including:

- Groundwork Cincinnati/Mill Creek, which is educating students, installing best management practices and expanding the Mill Creek Greenway Trail network to the extent that it is steadily building a constituency for a healthier Mill Creek
- Metropolitan Sewer District of Greater Cincinnati, which has sponsored a series of open houses and community design workshops to involve the public in major work planned for Lick Run, Kings Run, Bloody Run and West Fork
- Mill Creek Watershed Council of Communities, formed to build consensus among the 37 political jurisdictions in the Mill Creek watershed, which works on watershed action planning, implementation of improvement projects, engagement with the business community and educational canoe trips to improve water quality while raising public awareness

The biggest unknown will be the impact of combined sewer separations. This is necessary to reduce the volume of combined sewer overflows to the lower Mill Creek and its tributaries. As the Metropolitan Sewer District replaces combined sewers with separate sanitary sewers, storm sewers and surface waters, more stormwater runoff will go directly into the stream system, which is already stressed by pulsed flows, incised channels, and massive sediment movement. Less of the runoff will go through the existing interceptor sewers to the Mill Creek Wastewater Treatment Plant at Gest Street. The runoff reaching the Mill Creek will have less contamination from raw sewage overflows, but will still be impacted by the nonpoint source pollutants usually found in stormwater. In addition, the volume of stormwater discharges to the Mill Creek main stem and tributaries will probably grow MSD replaces combined sewers with separate sewers.

Watershed action planning is necessary to moderate the additional stormwater. Without moderation, wet weather stream flows will swell to harmful torrential flows that erode streambanks, choke out aquatic habitats with sediments, scour away macroinvertebrate communities, and cause flash flooding. Upon separation from combined sewers, much of the runoff must be directed to facilities that detain, retain, evaporate, transpirate or infiltrate stormwater. Ideally, the Lower Mill Creek Watershed would be able to withstand the largest annual rainstorm without major disturbance to fish, macroinvertebrates or their habitat.

Nearly 35% of the Lower Mill Creek Watershed is covered with impervious surfaces. This exceeds the

25% impervious cover level at which streams usually fail to attain their aquatic life uses. Paved streets and parking lots comprise a large part of the impervious surfaces, exposing the watershed to a variety of vehicular pollutants, including hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), and heavy metals. Many of these pollutants can be intercepted by curbside best management practices, such as infiltration trenches, vegetated swales, vegetated "bump-outs", rain gardens, and bioretention ponds.

Several large transportation projects are under way or scheduled for the Lower Mill Creek Watershed. The I-75 Mill Creek Expressway Project began construction in 2010 and has been split into eight phases that schedule some of the work for as late as 2024. The massive, complex project extends from the Western Hills Viaduct interchange in the West Fork-Mill Creek subwatershed to the Paddock Road interchange in the Congress Run-Mill Creek subwatershed. It provides opportunities for the Ohio Department of Transportation to install highway stormwater management practices and for the Metropolitan Sewer District to improve sewers.

The Lower Mill Creek Watershed also is subject to the Metropolitan Sewer District's court-ordered program to reduce sanitary sewer overflows and combined sewer overflows (CSOs) by 85%. MSD is compelled to strategically separate stormwater flow from sanitary sewage flow in many places. This will convey stormwater runoff from streets, parking lots and other impervious surfaces directly to receiving streams rather than a wastewater treatment plant. To prevent the introduction of contaminated runoff to receiving streams, this watershed action plan recommends curbside best management practices for transportation and combined sewer separation projects.

Habitat Restoration

Restoration of aquatic and riparian habitats includes any measures that improve or restore the ecological functions of the Lower Mill Creek, its tributaries, and associated riparian zone. Restoration is needed throughout the lower Mill Creek Watershed to provide habitat, improve water quality, prevent in-stream erosion and sedimentation, improve floodplain connectivity, and provide enhanced site aesthetics.

Some of the major sources of habitat impairments in the Lower Mill Creek include:

- Channelization, realignment, and armoring of the streambed and banks
- Loss of floodplain connectivity or floodplain encroachment,
- Loss of riparian forest, wetlands, and vegetated buffer zones
- Systemic channel erosion
- Low head dams and impediments to fish passage, including velocity and depth barriers
- Alien/invasive vegetation

It should also be noted that most Mill Creek soils are heavily compacted, often contain buried demolition debris, have a high clay content, and could be contaminated. Therefore due diligence and soil preparation and amendments are critical before habitat restoration occurs.

Restoration projects should aim to reverse these and other sources of impairment. In-stream

improvements should be coupled with the enhancement and management of adjacent riparian areas to provide ecological benefits, such as shading and water temperature moderation, recruitment of organic matter and woody debris, root reinforcement of streambank soils, and filtration of stormwater pollutants. In-stream restoration should provide varied, heterogeneous habitat, including pools, riffles, submerged habitat, and woody structure where appropriate. In-stream structures and bank treatments should be designed to mitigate systemic instability by understanding the dominant fluvial process and facilitating recovery to a stable, equilibrium condition. Fish passage and removal of barriers to fish migration should be incorporated into restoration designs to the maximum extent practicable.

Monitoring and evaluation of ecological lift can be based on a visual-based habitat evaluation, such as the EPA's Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (Barbour et al, 1999). The habitat assessment protocol addresses ten parameters that rate in-stream habitat, channel morphology, bank stability and riparian vegetation, rating each parameter on a scale of 0 to 20. The total score or sum of all ten data parameters is then used to determine whether the reach is classified as "optimal", "suboptimal", "marginal", or "poor".

8.3 PROJECT GROUNDWORK'S IMPACT ON GOAL SETTING FOR THE LMC WATERSHED

Combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) are prominent pollutant sources in the Lower Mill Creek Watershed and are being addressed by the Metropolitan Sewer District of Greater Cincinnati (MSDGC). This work is required under a consent decree approved by U.S. District Court Judge S. Arthur Spiegel in 2004 and a Final Wet Weather Implementation Program approved by U.S. EPA, Ohio EPA and the Ohio River Valley Water Sanitation Commission (ORSANCO) in 2010.

The basis of the consent decree is volumetric control, not specific in-stream water quality targets. However, CSO and SSO volume reductions are expected to have water quality benefits for the Lower Mill Creek Watershed. Sewer separation is a major component of the Lower Mill Creek Partial Remedy (LMCPR), but even with the introduction of untreated stormwater flows directly into local waterways, the loading calculations for this watershed action plan estimate a range of water quality improvements for key impairments. Loading reductions achieved before 2018 are not figured into this plan's measurable goals because such reductions are more the result of regulatory compliance than voluntary plan implementation.

The anticipated water quality benefits resulting from the LMCPR can be attributed to a number of factors. For certain impairments, such as bacteria, it is simply due to the fact that bacteria concentrations in CSO discharges are much higher than traditional stormwater discharges, so reducing CSOs – when reintroducing similar volumes of separated stormwater – leads to a bacteria load

reduction. At a project-specific scale, particular LMCPR components such as detention basins, stream restoration, and streambank stabilization will create additional water quality benefits for a variety of impairments. These estimated impacts were calculated for each LMCPR BMP using the same methodology as the proposed best management practices proposed elsewhere in this plan.

Table 66: LMCWAP Pollutant Modeling Results Summary shows how the anticipated reductions from the LMCPR projects contribute to overall load reductions in the Lower Mill Creek. Although it is clear that further reductions are needed in both the West Fork-Mill Creek subwatershed and the Congress Run-Mill Creek subwatershed to attain water quality targets, there are significant estimated reductions attributable to the LMCPR projects.

Although the LMCPR projects will not entirely reduce pollutant loads to target values, the Lower Mill Creek Watershed will still derive significant benefits from the:

- reduction of CSO volume by a projected 1.78 billion gallons per year
- lower frequency of CSO events
- decreased severity of CSO events, when and where they still occur

These improvements may reduce the annual number of days that the lower Mill Creek is not attaining the water quality standards for its designated recreational and aquatic life uses.

8.4 MEASURABLE GOALS

Estimating Load Reductions for Goals, Objectives and Actions

LMCPR Phase 1 - Measureable goals for both targeted subwatersheds will be influenced by Consent Decree solutions to reduce the volume of peak CSO runoff by 85% and thereby reduce E. coli bacteria, total suspended solids, nitrates, and phosphorus. Most of these reductions will be achieved by separation of stormwater and sanitary sewage and by managing stormwater runoff at its source.

The short-term impact of most of the plans may actually increase storm water discharges to tributary creeks and the Mill Creek because less runoff will flow to existing sewers. That makes this plan more dependent on CSO reduction measures over the next decade. The CSO reduction program and this watershed action plan are both intent upon improving stream conditions, but they measure progress in different ways. The CSO reduction program focuses upon fecal bacteria levels and sewer overflow volumes. This plan, on the other hand, concentrates on Ohio EPA's bio-criteria for determining the health of fish and macroinvertebrate communities and assessing the quality of riparian habitat. The expenditures for one initiative may have little benefit for the other initiative, but efforts are being made to maximize crossover benefits between both initiatives where possible.

Currently, the estimated reductions from CSOs and SSOs are based solely on the EPA approved LMCPR Phase 1 projects. This includes any CSO and SSO volumetric reductions resulting from those projects, but does not account for any additional water quality benefits that may be accomplished by green infrastructure solutions that improve stream water quality through filtration, infiltration, evaporation, transpiration and other processes. These estimated/modeled reductions also do not include MSD's Early Success Projects, which are expected to have achieved additional volumetric reductions in CSOs and SSOs and provided other water quality benefits. Therefore the estimated water quality benefits from CSO and SSO improvement projects are considered to be conservative.

The EPA Watershed Treatment Model - The Lower Mill Creek Watershed Action Plan Load Reduction Plan Results and Summary on next two pages are calculated using a modified version of the EPA's Watershed Treatment Model 3.1 (WTM 3.1). The model was calibrated to incorporate available data. The Watershed Treatment Model helps to estimate the pollutant load reductions for various treatment programs and best management practices.

The WTM 3.1 model helped to guide the goals, objectives and actions in this plan for several reasons. It allowed estimation of the impact of different causes and sources of watershed impairment. In turn, this focused our strategies and enabled us to better understand and prioritize solutions, by allowing some scenario analysis for meeting the target load. Also, the results of the Model helped to guide more realistic expectations of pollutant load reduction effectiveness for selected watershed management programs. And then in the following "Implementation" chapter, the focus is on identifying resources, partners, and other needs to implement the programs or projects to achieve these quantified goals, objectives and actions.

Table 66: LMCWAP Pollutant Modeling Results Summary

West Fork

	T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.Coli (billion colonies/year)
Current Load	245,139	34,692	12,777,273	1,748	1,573	8,382	1,325,547	122,929,186
Acceptable Watershed Pollutant Load to Meet Water Quality Standard	113,232	11,656	1,914,945	167	416	1,478	199,820	10,681,583
Needed Reduction	131,907	23,036	10,862,328	1,582	1,157	6,904	1,125,726	112,247,603
Needed Reduction %	54%	66%	85%	90%	74%	82%	85%	91%
LMCPR Phase 1 Load Reductions	40,494	5,561	1,893,007	321	267	1,043	287,427	33,110,701
Estimated Load Reductions from Proposed LMC-WAP BMPs (Table 67)	30,687	14,764	7,959,324	36	53	522	3,477	1,705,302
Total Load Reductions	71,181	20,326	9,852,330	357	321	1,565	290,904	34,816,003
Total Load Reduction %	29%	59%	77%	20%	20%	19%	22%	28%
Remaining Load after Total Load Reductions	173,958	14,366	2,924,943	1,392	1,252	6,817	1,034,643	88,113,183
Additional Load Reductions Needed to Meet Water Quality Standard	60,726	2,710	1,009,998	1,225	836	5,339	834,823	77,431,600

Congress Run

	T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.Coli (billion colonies/year)
Current Load	227,020	32,840	12,448,634	1,527	1,434	8,650	1,044,182	80,240,647
Acceptable Watershed Pollutant Load to Meet Water Quality Standard	154,705	15,925	2,616,331	228	569	2,019	273,008	14,593,924
Needed Reduction	72,315	16,915	9,832,303	1,299	865	6,630	771,173	65,646,724
Needed Reduction %	32%	52%	79%	85%	60%	77%	74%	82%
LMCPR Phase 1 Load Reductions	17,795	2,444	831,883	141	117	458	126,310	14,550,520
Estimated Load Reductions from Proposed LMC-WAP BMPs (Table 67)	41,902	18,911	9,882,134	70	71	659	12,115	3,658,564
Total Load Reductions	59,697	21,355	10,714,017	211	189	1,117	138,425	18,209,084
Total Load Reduction %	26%	65%	86%	14%	13%	13%	13%	23%
Remaining Load after Total Load Reductions	167,323	11,485	1,734,617	1,316	1,245	7,532	905,756	62,031,563
Additional Load Reductions Needed to Meet Water Quality Standard	12,619	0	0	1,089	677	5,513	632,748	47,437,639

Table 67: LMCWAP Load Reductions from Future Watershed Management Practices

West Fork

	Pollutant Load Reduction							
	T-N (lbs/year)	**T-P (lbs/year)**	**TSS (lbs/year)**	**T-Pb (lbs/year)**	**T-Cu (lbs/year)**	**T-Zn (lbs/year)**	**BOD 5-Day (lbs/year)**	**E.coli (billion colonies/year)**
Lawn Care Education	5,688	114	0	n/a	n/a	n/a	n/a	0
Pet Waste Education	1,592	208	0	n/a	n/a	n/a	n/a	13,848
Downspout Disconnection of 5% of Total Watershed Building Footprint	1,018	149	60,504	6	6	46	3,379	100,809
Impervious Cover Reduction thru Land Use/Policy Changes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
LMCPR Phase 1 - CSO Abatement	40,494	5,561	1,893,007	321	267	1,043	287,427	33,110,701
LMCPR Phase 1 - SSO Abatement	0	0	0	0	0	0	0	0
Failing Septic System discharge volume reduced by 90%	235	92	372	0	1	1	98	577,920
Urban Stream Restoration	4,598	1,563	7,126,280	n/a	n/a	n/a	n/a	n/a
Reforestation	11,310	11,310	18,850	n/a	n/a	n/a	n/a	n/a
Street Sweeping Regime Improvements	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Stormwater Management BMPs	6,246	1,328	753,317	29	46	475	n/a	1,012,724
Totals	**71,181**	**20,326**	**9,852,330**	**357**	**321**	**1,565**	**290,904**	**34,816,003**

Congress Run

	Pollutant Load Reduction							
	T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/year)
Lawn Care Education	9,681	194	0	n/a	n/a	n/a	n/a	0
Pet Waste Education	2,482	324	0	n/a	n/a	n/a	n/a	21,585
Downspout Disconnection of 5% of Total Watershed Building Footprint	3,549	521	211,047	22	22	160	11,786	351,638
Impervious Cover Reduction thru Land Use/Policy Changes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
LMCPR Phase 1 - CSO Abatement	17,795	2,444	831,883	141	117	458	126,310	14,550,520
LMCPR Phase 1 - SSO Abatement	0	0	0	0	0	0	0	0
Failing Septic System discharge volume reduced by 90%	791	310	1,253	1	3	4	330	1,943,914
Urban Stream Restoration	5,660	1,924	8,773,310	n/a	n/a	n/a	n/a	n/a
Reforestation	14,250	14,250	23,750	n/a	n/a	n/a	n/a	n/a
Street Sweeping Regime Improvements	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Stormwater Management BMPs	5,488	1,389	872,774	47	47	495	n/a	1,341,427
Totals	59,697	21,355	10,714,017	211	189	1,117	138,425	18,209,084

n/a – load reduction estimate is not available/applicable due to lack of data

Table 68: Stormwater Management BMPs – Breakdown of Estimated Load Reductions

Stormwater Management BMPs

WEST FORK		Effective Treatment Area** (Acres)of Proposed Projects	BMP Pollutant Removal Efficiency						
BMP Type* **	**# of Proposed Projects**		**TN**	**TP**	**TSS**	**T-Pb***	**T-Cu***	**T-Zn***	**Bacteria**
Dry Water Quantity Pond		0	5%	19%	3%	n/a	n/a	n/a	10%
Dry Extended Detention Pond	3	150	25%	19%	47%	49%	47%	58%	60%
Wet Pond		0	33%	51%	80%	67%	48%	60%	70%
Wetland	1	10	30%	49%	76%	40%	36%	54%	78%
WQ Swale	2	250	38%	34%	81%	15%	-6%	32%	0%
Filters	5	1200	38%	59%	86%	33%	55%	75%	37%
Infiltration	9	3000	51%	70%	90%	33%	55%	75%	90%
Total		**4610**	**46%**	**63%**	**87%**	**32%**	**51%**	**72%**	**70%**
% of watershed area		31%							

CONGRESS RUN		Effective Treatment Area** (Acres) of Proposed Projects	BMP Pollutant Removal Efficiency						
BMP Type* **	**# of Proposed Projects**		**TN**	**TP**	**TSS**	**T-Pb***	**T-Cu***	**T-Zn***	**Bacteria**
Dry Water Quantity Pond	5	300	5%	19%	3%	n/a	n/a	n/a	10%
Dry Extended Detention Pond	1	100	25%	19%	47%	49%	47%	58%	60%
Wet Pond	1	100	33%	51%	80%	67%	48%	60%	70%
Wetland	17	5000	30%	49%	76%	40%	36%	54%	78%
WQ Swale		0	38%	34%	81%	15%	-6%	32%	0%
Filters	3	1000	38%	59%	86%	33%	55%	75%	37%
Infiltration	4	10	51%	70%	90%	33%	55%	75%	90%
Total		6510	30%	49%	74%	38%	38%	55%	68%
% of watershed area		34%							

*Load Reduction efficiencies for lead, copper and zinc are derived from the International Stormwater BMP Database

**Effective treatment area is the cumulative total (rounded to nearest tenth digit) of all upland drainage areas to all proposed BMPs, derived using ODNR's Stream Stats application. This is a very rudimentary method for estimating effective treatment areas. More complex load reduction estimates will be assessed for individual projects as they filter thru evaluation.

***See BMP Type definitions on following page

BMP Type Definitions

The BMP types were taken directly from the Watershed Treatment Model 3.1, which corresponds to the EPA's Stormwater Menu of BMPs. The collaborative watershed mapping exercise to find BMPs was used to determine the group of potential BMPs to improve water quality and quantity conditions. These BMPs were then placed into the corresponding BMP type categories to give some basic load reduction estimates.

- Dry Water Quantity Pond – a basic detention pond that captures stormwater for a limited amount of time (less than 24 hours) and releases later to reduce peak stormwater flows
- Dry Extended Detention Pond - like a dry water quantity pond but is designed for smaller storms, holds stormwater for more than 24 hours, which gives stormwater more time to infiltrate. This results in slightly better water quality treatment.
- Wet Pond - basins that have a permanent pool of water throughout the year (or at least throughout the wet season). Ponds treat incoming stormwater runoff by allowing particles to settle and algae to take up nutrients. The primary removal mechanism is settling as stormwater runoff resides in this pool, and pollutant uptake, particularly of nutrients, also occurs through biological activity in the pond.
- Stormwater Wetland - (a.k.a. constructed wetlands) are structural practices similar to wet ponds that incorporate wetland plants into the design. As stormwater runoff flows through the wetland, pollutant removal is achieved through settling and biological uptake within the practice. Wetlands are among the most effective stormwater practices in terms of pollutant removal and they also offer aesthetic and habitat value.
- Water Quality Swale (e.g. grass swale or similar) - a vegetated, open-channel management practices designed specifically to treat and attenuate stormwater runoff for a specified water quality volume. As stormwater runoff flows along these channels, it is treated through vegetation slowing the water to allow sedimentation, filtering through a subsoil matrix, and/or infiltration into the underlying soils.
- Filters (e.g. bioretention, sand and organic filters, vegetated filter strips) – a stormwater management BMP designed to filter stormwater for pollutants such as sediments, nutrients or other, before it leaves the site. Filters are often seen in the form of bioretention basins or swales, commonly known as rain gardens that are landscaping features adapted to provide on-site treatment of stormwater runoff. They are typically placed adjacent to impervious areas to capture and treat the runoff from smaller storms.
- Infiltration (e.g. grassed swales, infiltration basin or trench, pervious pavement) – a stormwater management BMP designed to infiltrate stormwater into the soil. This practice is believed to have a high pollutant removal efficiency and can also help recharge the ground water, thus increasing baseflow to stream systems.

Table 69: Stormwater Management BMPs – Undiscounted Load Reduction Results

	Undiscounted Load Reductions						
	N (lbs/year)	P (lbs/year)	TSS (lbs/year)	T-Pb	T-Cu	T-Zn	Bacteria (billion colonies/year)
West Fork	49,618	10,042	5,580,127	215	341	3,519	7,511,400
Congress Run	44,309	10,538	6,464,992	345	345	3,666	9,951,218

Table 70: Stormwater Management BMPs – Discounts and Treatability Factors

Treatability Discount (D1)	Capture Discount (D2)	Design Discount (D3)	Maintenance Discount (D4)
0.20 (default)	0.75	1	0.9

Table 71: Discount Method Explanations – WTM 3.1 documentation

Discount Method	Calculation Method
Treatability Discount (D1)	Fraction of watershed's impervious cover captured by stormwater treatment practices
Capture Discount (D2)	Fraction of annual rainfall captured by the structure(s) (estimated using the WQ_v design storm and rainfall runoff spectrum)
Design Discount (D3)	Factor applied based on the adequacy of existing design standards Specific, Legally Binding Standards =(1.2) Specific Standards, not Legally Binding =(1.0) Less specific Standards, legally binding =(1.0) No Standards =(0.8)
Maintenance Discount (D4)	Factor based on the type of maintenance conducted on treatment practices Regular Maintenance Specified and Enforced =(0.9) Maintenance Specified but Poorly Enforced =(0.6) No guidance for Maintenance =(0.5)

Table 72: Stormwater Management BMPs – Discounted Load Reduction Results

	Discounted Load Reductions						
	N (lbs/year)	**P (lbs/year)**	**TSS (lbs/year)**	**T-Pb**	**T-Cu**	**T-Zn**	**Bacteria (billion colonies/year)**
West Fork	6,246	1,328	753,317	29	46	475	1,012,724
Congress Run	5,488	1,389	872,774	47	47	495	1,341,427

Load reductions were calculated using a variety of methods and data sources as shown in the table below:

Table 73: Load Reduction Best Management Practices – Definitions and Qualifying Conditions

Management Practice	Source of Load Reduction Equation and/or Removal Rates	Notes
Lawn Care Education	Center for Watershed Protection, Watershed Treatment Model 3.1	
Pet Waste Education	Center for Watershed Protection, Watershed Treatment Model 3.1	
Downspout Disconnection	Center for Watershed Protection, Watershed Treatment Model 3.1	Calculated as land use/impervious cover change.
Impervious Cover Reduction thru Land Use/Policy Changes	Center for Watershed Protection, Watershed Treatment Model 3.1	Not calculated.
LMCPR Phase 1 - CSO Abatement	Volumetric CSO and SSO reductions in the Phase 1 LMCPR (December 2012).	Does not include water quality improvements from source control BMPs.
LMCPR Phase 1 - SSO Abatement	Volumetric CSO and SSO reductions in the Phase 1 LMCPR (December 2012).	Does not include water quality improvements from source control BMPs.
Failing Septic Systems abatement	Center for Watershed Protection, Watershed Treatment Model 3.1	
Urban Stream Restoration projects	Chesapeake Stormwater Network, Technical Bulletin No 9: Nutrient Accounting Methods to Document Local Stormwater Load Reductions (Version 1.0, 2011)	See *Urban Stream Restoration Qualifying Conditions* below.
Reforestation	Chesapeake Stormwater Network, Technical Bulletin No 9: Nutrient Accounting Methods to Document Local Stormwater Load Reductions (Version 1.0, 2011)	Calculated as removal rate per acre; does not factor in runoff reduction benefits.
Street Sweeping Regime Improvements	Center for Watershed Protection, Watershed Treatment Model 3.1	Not calculated due to lack of data.
Stormwater Management BMPs	CWP Watershed Treatment Model 3.1; International Stormwater BMP Database - reduction rates for metals: lead, copper and zinc)	All BMPs calculated using removal rate per acre; does not factor in runoff reduction benefits.

Urban Stream Restoration Qualifying Conditions: Stream restoration projects that reduce bank erosion and create in-stream habitat features have the capability to reduce both sediment and nutrient export in urban watersheds. To use the Chesapeake pollutant reduction rates the stream restoration project must meet the following minimum qualifications:

- Stream restoration projects that are primarily designed to protect public infrastructure by bank armoring or rip rap do not qualify for a reduction credit.
- The stream reach must be greater than 100 feet in length and be still actively enlarging or degrading in response to upstream development or adjustment to previous disturbances in the watershed (e.g., a road crossing and failing dams). Most projects will be located on first- to third-order streams, but if larger fourth and fifth order streams are found to contribute significant and uncontrolled amounts of sediment and nutrients to downstream waters, consideration for this BMP would be appropriate, recognizing that multiple and/or larger scale projects may be needed or warranted to achieve desired watershed treatment goals.
- The project must utilize a comprehensive approach to stream restoration design, addressing long-term stability of the channel, banks, and floodplain.
- Special consideration is given to projects that are explicitly designed to reconnect the stream with its floodplain or create wetlands and instream habitat features known to promote nutrient uptake or denitrification.

Table 74: Chesapeake Bay Edge-of-Stream 2011 Interim Approved Removal Rates per Linear Foot of Qualifying Stream Restoration (lb/ft/yr)

Source	TN	TP	TSS*
New Interim CBP Rate	0.20	0.068	310

Source: Chesapeake Stormwater Network, Technical Bulletin No 9: Nutrient Accounting Methods to Document Local Stormwater Load Reductions (Version 1.0, 2011)
Note: A newer, more refined, stream restoration removal rate method is available from the *Chesapeake Stormwater Network* at: http://www.chesapeakebay.net/documents/Final_CBP_Approved_Expert_Panel_Report_on_Stream_Restoration.pdf. Unfortunately, this report was published after the LMCWAP model was completed.

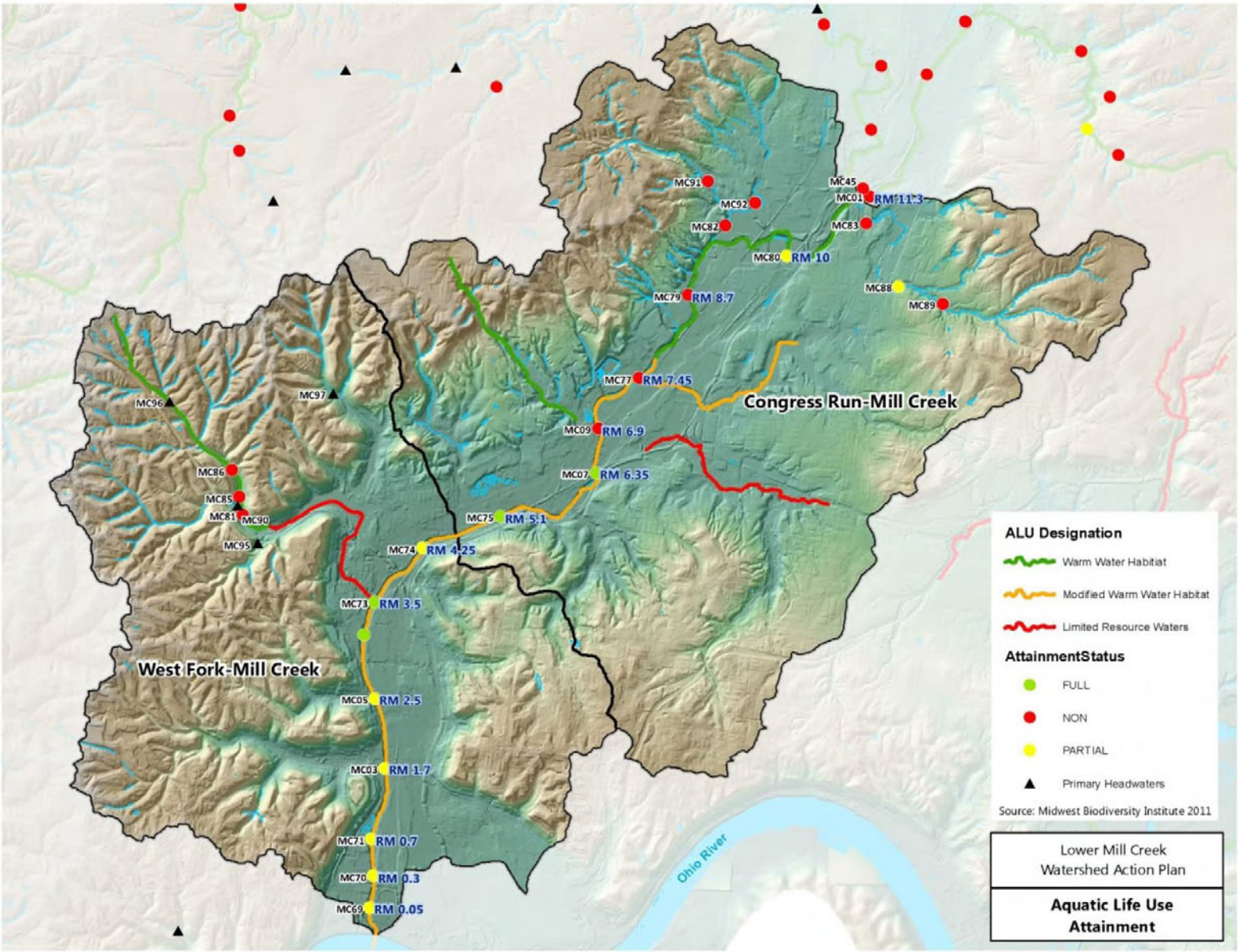


Figure 84: Lower Mill Creek - Aquatic Life Use Attainment (MBI, 2011)

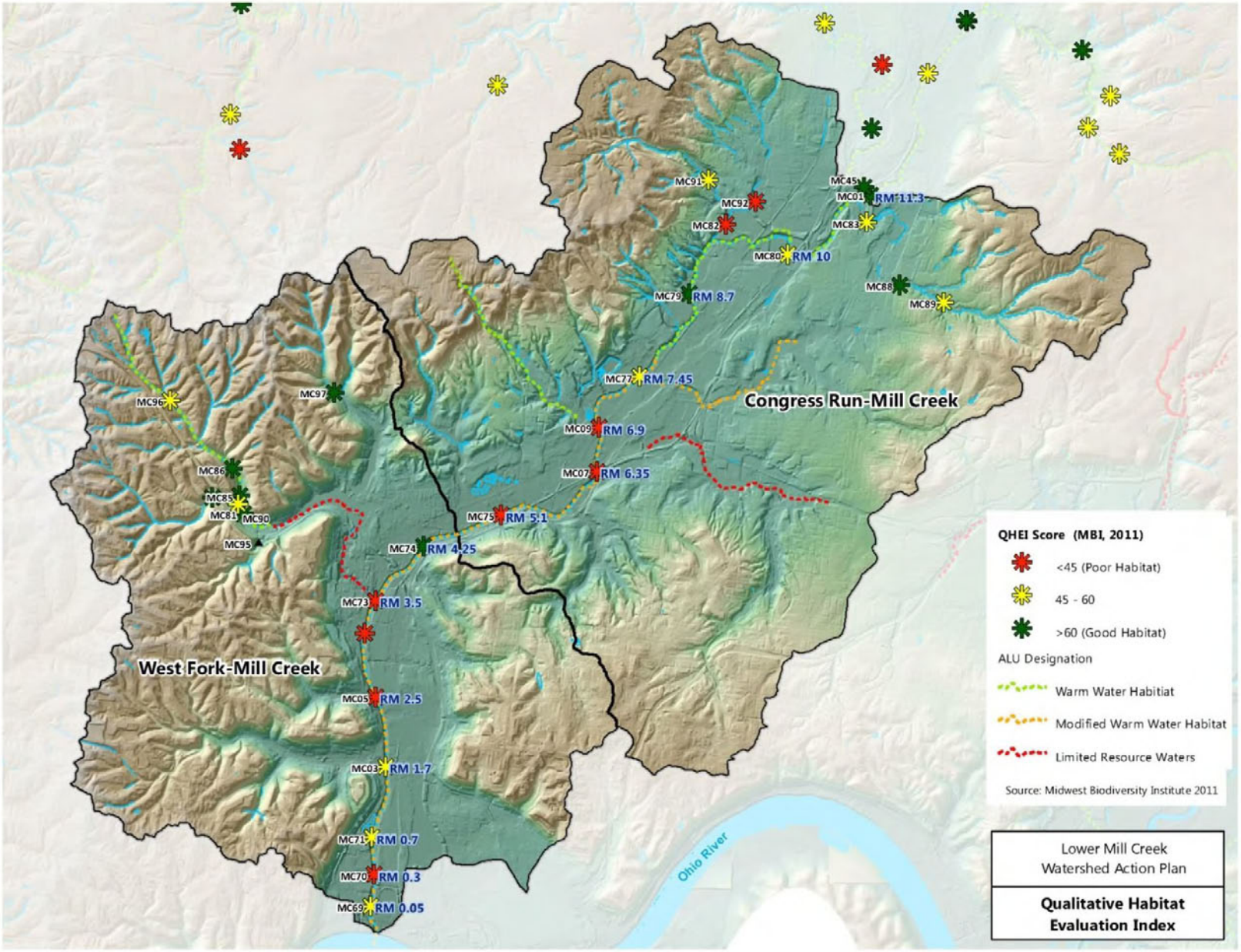


Figure 85: Lower Mill Creek – Qualitative Habitat Evaluation Index Scores (MBI, 2011)

8.5 CONGRESS RUN – MILL CREEK SUBWATERSHED

HUC-12:0509020301-04
OEPA Streams: Mill Creek, Ross Run, Bloody Run, Winton Ridge Tributary
Drainage Area: 19,204.3 acres, 30.0 square miles
Use Designation: WWH – 6.0 miles, LRW – 2.4 miles, MWH – 5.3 miles

Impervious cover types: defined using CAGIS shapefiles (2013)
Buildings footprint: 2,118 acres (11% of watershed area)
Streets footprint: 1,399 acres (7.3% of watershed area)
Tree canopy: 6,797 acres (35.4% of watershed area)

Watershed % Impervious Cover: defined using *Multi Resolution Land Characteristics Consortium* (MRLC) National Land Cover Database (NLCD) raster data (2011)

% Impervious	Land Cover/Land Use Equivalent	Runoff Coefficient	Acreage
0	Forest/Open	0.05	5,209
10	Managed Turf (A & B soils)	0.14	2,393
20	Managed Turf (C & D soils)	0.23	1,550
30	Residential (total site average)	0.32	1,684
40	Barren/compacted soil	0.41	1,647
50		0.5	1,523
60		0.59	1,379
70	Industrial/commercial (total site average)	0.68	1,268
80		0.77	1,363
90	Compact urban (total site average)	0.86	1,058
100	Parking lot/roof top	0.95	100
			19,174

The MBI report states, "***Designated Aquatic Life Uses in WAU 01-04*** – Congress Run and Mill Creek Subwatershed Mill Creek (23-001) in subwatershed WAU 01-04 has verified aquatic life use designations based on prior Ohio EPA bioassessments (Ohio EPA 1994) and is where the aquatic life use changes from WWH to MWH at Center Hill Rd. (RM 7.9. The 2011 results indicate fair-good habitat in the WWH reaches and poor-very poor habitat in the concreted and heavily modified MWH reaches downstream. It is recommended that the WWH/MWH boundary be moved downstream from Center Hill Rd. to RM 7.3 where the concrete encased channel begins.

Congress Run had two sites at RM 0.2 (MC82) and RM 0.8 (MC 91). QHEI scores were in the mid-40s (fair/poor) largely because of urban land use encroachment. The habitat features included good substrates at the upstream site. WWH is recommended despite having impacts from the urban character of the subwatershed. An unnamed tributary to Sharon Run (23-041 Unnamed Tributary to Congress Run at RM 0.37, MC92) was also sampled. It had poor habitat because of urban impacts, but retained a natural channel thus it is recommended for WWH.

Two sites (MC88, MC89) in an unnamed direct tributary to Mill Creek at RM 10.8 (23-042) in this subwatershed had fair-good habitat (QHEI 53.5-64.5). These sites had deep to moderately deep pools, good substrates, and natural channels thus WWH is recommended. Another direct Tributary to Mill Creek (23-044 Unnamed Tributary to Mill Creek at RM 11.51) had a single site (MC83) that had fair habitat with deep pools and is also recommended for WWH."

Table 75 below shows the Midwest Biodiversity Institute's evaluation of the State's existing Aquatic Life Use designations for local streams in Congress Run. Some of the small tributaries did not have listed uses in the State's WQS, but MBI evaluated them based using the developing "Primary Headwater" classification system.

Table 75: Assessment of Existing Aquatic Life Use (ALU) designations in Congress Run – Mill Creek (01-04)

Stream	No. of Sites	Size (mi^2)	Habitat Evaluation	Fish Evaluation	Macroinv. Evaluation	Existing ALU	Recommended ALU
WAU (01-04) Congress Run - Mill Creek							
Mill Creek (23-001)	7	136	Very Poor-Good	Very Poor-Fair	Fair- Good	MWH/ WWH	MWH/ WWH
Congress Run (23-40; MC82,91)	2	1.7 - 3.8	Poor-Fair	Poor	Poor-Marg.-Good	None	WWH
Unnamed Trib to Congress Run at RM0.37 (23-041; MC92)	1	1.7	Poor	Poor	Very Poor	None	WWH
Unnamed Trib to Mill Creek at RM10.8 (23-042; MC88,89)	2	1.8	Fair-Good	Poor-Fair	Fair-Good	None	WWH
Unnamed Trib to Mill Creek at RM 11.51 (23-044; MC83)	1	3.7	Fair	Poor	Marg. Good	None	WWH

Source: MBI, Mill Creek Bioassessment 2011

8.5.1 SEDIMENTATION

Measured Water Quality Impairment:

According to the Mill Creek TMDL and MBI data, Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) are found in excess concentrations at several sample sites that indicate major water quality impairments. High concentrations tend to correspond with lower habitat quality.

In Congress Run (including all measured stream segments), the TDS median measurement exceeds target parameters at 5 of 10 locations (MC92 not listed), and exceeds TSS target parameters at 3 of 11 locations. At site MC91, the TSS exceeds target parameters by a significant margin (median 84, target 25.0).

Estimated Loading Values and Loading Reduction to Meet State Water Quality Standards:
The estimated annual loading value of TSS in the Congress Run-Mill Creek is **12,448,634** lbs. per year. To meet attainment, this loading value needs to be reduced by 79% to **2,616,331** lbs. per year. The LMCPR Phase 1 CSO and SSO volumetric reductions are estimated to reduce this load by **832,000** lbs. per year. Therefore, the remaining load reduction necessary to meet water quality standards would be **9,000,000** lbs. per year.

Watershed Goals:

Goal 1: Reduce TSS in Congress Run-Mill Creek subwatershed by **9,000,000** lbs. per year

Objective 1.1: **Stream and Riparian Restoration**: Improve 28,000 feet of eroding streams using in-stream stabilization and restoration techniques and by adding or protecting them with a suitable riparian corridor to reduce total suspended solids (TSS) by **8,000,000** lbs. per year

Action 1.1.1: Develop stream and riparian corridor inventory, restoration plans, and identify funding opportunities

Action 1.1.2: Restore 2,700 feet of eroding streams and riparian corridor on Congress Run

Action 1.1.3: Restore 4,200 feet of stream and riparian corridor on King's Run

Action 1.1.4: Restore 7,800 feet of stream and riparian corridor on Ludlow Run

Action 1.1.5: Restore 5,000 feet of stream and riparian corridor on Mill Creek main stem

Action 1.1.6: Restore 6,900 feet of stream and riparian corridor on Amberley Creek

Action 1.1.7: Restore 1,400 feet of stream and riparian corridor on Bloody Run

Objective 1.2: **Trees**: Increase tree canopy by **950** acres (5%)to reduce TSS by **23,750** lbs. per year

Action 1.2.1: Continue reforestation efforts on city and county parks and schools

Action 1.2.2: Support efforts by the Taking Root campaign to plant 2 million trees in the Tri-State by 2020

Action 1.2.3: Work with Ohio Department of Transportation to encourage reforestation of highways

Objective 1.3: **Stormwater Management BMPs**: Reduce TSS from urban runoff sources by installing structural stormwater BMPs to capture **900,000** lbs. per year

Action 1.3.1: Install structural BMPs in upstream areas of the watershed that reduce or retain storm water runoff to reduce peak flows and prevent stream bank erosion

Action 1.3.2: Install structural BMPs that capture and assimilate sedimentation

Action 1.3.3: Search for locations to install sedimentation "hotspot" BMPs, such as parking lot drains, curbs cuts, etc.

Objective 1.4: **Roads and Parking**: Reduce TSS from streets and parking lots sources by increasing miles or acres of street sweeping (there are approx. 1,400 acres (7.3% of total watershed area) of streets in Congress Run)

Action 1.4.1: Increase miles of public street sweeping efforts

Action 1.4.2: Advocate for private sector parking lot sweeps

Objective 1.5: **Disconnect Downspouts** of 5% of building footprint (106 acres) to grass surfaces or water quality BMPs to reduce TSS by **210,000** lbs. per year

Objective 1.6: **Failing Septic Systems**: Reduce discharge from failing septic systems by 90% to reduce TSS by **1,200** lbs. per year

8.5.2 PATHOGENS

Measured Water Quality Impairments:

Impairment of recreation uses in the Mill Creek watershed was pervasive throughout all of the subwatersheds that were sampled. The Primary Contact 30-day (geometric mean) criterion was exceeded at 44 of 45 sites sampled in the Mill Creek watershed (MBI, Mill Creek Bioassessment report, 2011). In Congress Run, the E. coli geometric mean was elevated beyond the E. coli criteria of Primary Contact Recreation – Class B, for all nine sampled sites in this subwatershed.

Estimated Pollutant Loading Value:

The estimated annual loading value of E. coli in the Congress Run-Mill Creek is **80,240,000** billion colonies per year. To meet attainment, this loading value needs to be reduced by 82% to **14,590,000** billion colonies per year. The LMCPR Phase 1 CSO and SSO volumetric reductions are estimated to reduce this load by **14,550,000** billion colonies per year. Therefore, the remaining load reduction necessary to meet water quality standards would be **65,690,000** billion colonies per year.

Watershed Goals:

Goal 1: Reduce E. coli levels in Congress Run-Mill Creek subwatershed by **65,690,000** billion colonies per year

Objective 1.1: **Pet Waste**: Reduce E.coli from pet waste sources by **21,600** billion colonies/year by initiating a pet waste education campaign

Action 1.1.1: Develop a pet waste education and marketing plan

Action 1.1.2: Monitor pet waste at dog parks to study program effectiveness

Action 1.1.3: Increase access to pet waste "baggies" and trash receptacles in public parks and trails

Objective 1.2: **Stormwater Management BMPs**: Reduce E.coli from urban runoff sources by installing structural stormwater BMPs to capture **1,350,000** billion colonies per year

Action 1.2.1: Infiltration (e.g. bioretention cells), filtration (e.g. media filter), and retention (e.g. wet-pond) based BMPs have demonstrated good potential for bacteria reduction if properly designed and maintained. Find locations for these types of BMPs.

Objective 1.3: **Failing Septic Systems**: Reduce E. coli from failing septic systems by **1,943,000** billion colonies per year

Action 1.3.1: Reduce E. coli from failing HSTS systems by fixing or remediating **37** systems

Action 1.3.2: Convert HSTS systems to sewer systems where possible

Objective 1.4: **Additional Actions Needed**: Reduce E.coli by an additional **47,500,000** billion colonies per year to meet water quality standards

Action 1.4.1: Pursue additional CSO and SSO volumetric reductions thru Phase II Consent Decree remediation projects

Action 1.4.2: Advocate for septic system updates and conversions

Action 1.4.3: Monitor and remediate illicit discharges to the storm sewer system

Action 1.4.4: Monitor nuisance waterfowl populations and habitat

Action 1.4.5: Carefully inspect sewer crossings over/under waterways and report faulty lines immediately

8.5.3 NUTRIENTS

Measured Water Quality Impairment:

The results of nutrient sampling in the lower Mill Creek watershed show that nitrate-nitrite and TKN occur in concentrations at some locations that exceed state and federal chemical water quality guidelines. All sample sites from the lower Mill Creek mainstem consistently exceeded TKN target parameters, up to 73% above target value. Nitrate-Nitrite starts at approximately 120% above target value as it enters Congress Run at RM 11.6, but trends downward to 50% below target as it reaches the Ohio River. Total Phosphorus and Ammonia sampling showed that concentration values are well below target values on most of the Mill Creek mainstem, but there were a couple of exceedences of both on unnamed tributaries in the lower Mill Creek. However, the MBI sampling represents dry weather conditions, while nutrients can become significantly elevated during wet-weather events.

Based on the MBI data, TP does not appear in concentrations that would prohibit attainment of WWH or MWH biological criteria for the Mill Creek sections in Congress Run and West Fork. The Mill Creek TMDL selected 0.25 mg/l TP as the upper threshold limit where WWH designation can reasonably expect attainment; no Mill Creek samples exceeded this value. However, there were two TP target infringements in West Fork (01-05) primary headwaters, one at MC97-Trib to West Fork Creek at RM 1.24 and the other at MC96-West Fork Creek

at RM 3.5.

In Congress Run (including all measured stream segments), the nitrate-nitrite (mg/l) median measurement values exceeded target parameters at 2 of 12 locations. The ammonia (mg/l) median measurement values exceeded target parameters at only 2 of 12 locations, none on the Mill Creek mainstem, but one of those sites in the primary headwaters (MC92) was significantly elevated (median 0.57, target 0.06). Elevated TKN concentrations exceeding target values were found at 10 of 12 locations.

Estimated Loading Values and Loading Reduction to Meet State Water Quality Standards:

Total Nitrogen:

- The estimated annual loading value of Total Nitrogen-TN (Nitrate-Nitrite-N + Kjeldahl-N) in the Congress Run-Mill Creek is **227,000** lbs. per year
- To meet attainment, this loading value needs to be reduced by 32% to **155,000** lbs. per year
- The LMCPR Phase 1 CSO and SSO volumetric reductions are estimated to reduce this load by **18,000** lbs. per year
- Therefore, the remaining load reduction necessary to meet water quality standards would be **54,000** lbs. per year

Total Phosphorus:

- The estimated annual loading value of Total Phosphorus-TP in the Congress Run-Mill Creek is **33,000** lbs. per year
- To meet attainment, this loading value needs to be reduced by 52% to **16,000** lbs. per year
- The LMCPR is estimated to reduce this load by **2,500** lbs. per year
- Therefore, the remaining load reduction necessary to meet water quality standards would be **14,500** lbs. per year

Watershed Goals:

Goal 1: Reduce total nitrogen (TN) inputs in Congress Run by **54,000** lbs./year ; Reduce total phosphorus (TP) inputs in Congress Run by **14,500** lbs./year

Objective 1.1: **Stream and Riparian Restoration**: Improve 28,000 feet of eroding streams using in-stream stabilization and restoration techniques and by adding or protecting them with a suitable riparian corridor to reduce TN by **5,500** lbs/year and TP by **2,000** lbs/year.

Action 1.1.1: Restore 2,700 feet of stream and riparian corridor on Congress Run

Action 1.1.2: Restore 4,200 feet of stream and riparian corridor on King's Run

Action 1.1.3: Restore 7,800 feet of stream and riparian corridor on Ludlow Run

Action 1.1.4: Restore 5,000 feet of stream and riparian corridor on Mill Creek mainstem

Action 1.1.5: Restore 6,900 feet of stream and riparian corridor on Amberley Creek

Action 1.1.6: Restore 1,400 feet of stream and riparian corridor on Bloody Run

Objective 1.2: **Trees**: Increase tree canopy by **950** acres (5%) to reduce TN by **14,250** lbs./year and TP by **14,250** lbs./year

Action 1.2.1: Continue reforestation efforts on City and County Parks and Schools

Action 1.2.2: Support efforts by the Taking Root campaign to plant 2 million trees in the Tri-State by 2020

Action 1.2.3: Work with ODOT to encourage reforestation of highways

Objective 1.3: **Stormwater Management BMPs**: Reduce nutrients from urban runoff sources by installing structural stormwater BMPs to reduce TN by **5,500** lbs./year and TP by **1,500** lbs./year

Action 1.3.1: Utilize bioretention and detention to detain and infiltrate peak flows of more common storm events

Objective 1.4: **Pet Waste**: Reduce nutrients from pet waste sources by **2,500** lbs./year of TN and **350** lbs./year of TP by initiating a pet waste education campaign

Action 1.4.1: Develop a pet waste education and marketing plan

Action 1.4.2: Monitor pet waste at dog parks to study program effectiveness

Action 1.4.3: Increase access to pet waste "baggies" and trash receptacles in public parks, trails and areas close to water ways

Objective 1.5: **Lawn Care Education**: Reduce nutrients from lawn care management by **10,000** lbs. per year of TN and **200** lbs. per year of TP by initiating a lawn care education campaign

Objective 1.6: **Streets**: Reduce nutrients from urban runoff sources by increasing miles or acres of street sweeping

Objective 1.7: **Disconnect Downspouts** of 5% of building footprint (106 acres) to grass surfaces or water quality BMPs to reduce TN by **3,500** lbs. per year and TP by 500 lbs. per year

Objective 1.8: **Additional Actions Needed**: Reduce TN by an additional **12,500** lbs. per year to meet water quality attainment

8.5.4 HABITAT

Measured Water Quality Impairment:

"The QHEI scores show that the habitat in Congress Run ranged from very poor to good (27 – 64.5). Five of the six tributary sites sampled had natural channels, but most had moderate-high embeddedness and poor-fair riffle pool development related to the urban nature of the subwatershed. The location and degree of encroachment had a strong effect on habitat quality in the tributaries with habitat ranging from poor (3 high influence negative attributes, QHEI=38 at MC92) to good (no high influence negative attributes, QHEI=64.5 at MC88)." (Midwest Biodiversity Institute, 2011)"

Watershed Goals:

Goal 1: Restore and protect fish and wildlife habitat in Congress Run to raise QHEI scores at all sites to above **45**

Objective 1.1: **Stream and Riparian Restoration**: Improve **28,000** feet of eroding streams using in-stream stabilization and restoration techniques and by adding or protecting them with a suitable riparian corridor

Action 1.1.1: Restore 2,700 feet of stream and riparian corridor on Congress Run

Action 1.1.2: Restore 4,200 feet of stream and riparian corridor on King's Run

Action 1.1.3: Restore 7,800 feet of stream and riparian corridor on Ludlow Run

Action 1.1.4: Restore 5,000 feet of (non-channelized) stream and riparian corridor on Mill Creek mainstem

Action 1.1.5: Restore 6,900 feet of stream and riparian corridor on Amberley Creek

Action 1.1.6: Restore 1,400 feet of stream and riparian corridor on Bloody Run

Action 1.1.7: Inventory assessment of stream bank erosion

Action 1.1.8: Daylighting streams and removing concrete channels for natural channels sized and stabilized to handle expected runoff events

Action 1.1.9: Bank stabilization using soil bioengineering practices

Action 1.1.10: Grade control, stabilization of stream bed/reduce entrenchment

Action 1.1.11: Joint plantings, rip-rap banks along stream

Action 1.1.12: Low-head dam remediation/removal

Action 1.1.13: Culvert retrofits

Action 1.1.14: Outfall modifications/capture/trash and debris/trash "racks/nets"

Action 1.1.15: Enforcement of infill violations, concrete trash heaps

Action 1.1.16: Vegetative buffers

Action 1.1.17: Create habitat structures to develop riffles and pools where needed.

Action 1.1.18: Use joint plantings where streambanks are now covered with riprap.

Action 1.1.19: Use soil bioengineering systems for streambank stabilization and restoration

Objective 1.2: **Habitat Barriers**: Reduce, eliminate or remediate the in-stream barriers for fish migration

Action 1.2.1: Identify all locations of fish barriers (e.g., sewer crossings and dams) and work with appropriate parties to modify or remove the barriers.

Action 1.2.2: Mitigate the **8** low-head dams present in Congress Run

Action 1.2.3: Maintain the **2** existing low-head dam mitigation projects in Congress Run

Objective 1.3: **Channelization**: Begin exploring a long-term plan for naturalizing the **3** miles of concrete channelized sections and the **1.5** miles of partially channelized sections of the main stem Mill Creek in Congress Run.

Action 1.3.1: Allow for natural successional breakdown of the concrete channel; do not remove sedimentation build up from past decade.

Action 1.3.2: Discontinue tree removal and applications of pesticide within the channel and riparian corridors.

Action 1.3.3: Analyze these stream areas to determine opportunities for potential restoration of aquatic habitat.

Action 1.3.4: Develop plans and designs and implement re-naturalization of stream segments.

Action 1.3.5: Remove concrete walls on MVCD properties

Action 1.3.6: Remove concrete channel bottom and stabilize with type A rip-rap and/or modify to manage deposition areas for plantings and add two stage channel

Objective 1.4: **Trees**: Currently 6,797 acres (35.4%) of Congress Run have a tree canopy. Increase tree canopy by **950 acres (5%)**.

Action 1.4.1: Continue reforestation efforts on city and county parks and schools

Action 1.4.2: Support efforts by the Taking Root campaign to plant 2 million trees in the Tri-State by 2020

Action 1.4.3: Work with Ohio Department of Transportation to encourage reforestation of highways

Objective 1.5: **Wetlands**: Protect and restore the existing **143.2** acres of riparian wetlands in Congress Run

Action 1.5.1: Ensure proper land-use controls in local jurisdictions

Action 1.5.2: Delineate wetlands to help ensure future protection.

Action 1.5.3: Restore and expand existing wetlands

Action 1.5.4: Retrofit existing detention basins into constructed wetlands

Action 1.5.5: Remove invasive species and reintroducing native vegetation

Objective 1.6: **Ecological Restoration and Bioengineering**

Action 1.6.1: Plant trees and other vegetation on streambanks and within riparian zones to provide shade and vegetative debris for aquatic habitat.

Action 1.6.2: Reintroduce native species into existing habitats

Action 1.6.3: Utilize native plant species in BMP design

Action 1.6.4: Conduct invasive plant species removal on public properties

Action 1.6.5: Responsible pesticide and herbicide use thru Integrated Pest Management Systems

Action 1.6.6: Implement more "Edible Forest Gardens" as demonstrated by Groundwork Cincinnati: Mill Creek

Action 1.6.7: Look for ways including public and private partnerships to connect migratory corridors of wildlife

Action 1.6.8: Encourage builders to retain areas of native vegetation and to use natural techniques to manage stormwater

Action 1.6.9: Help streamside property owners to control erosion and improve habitat

Action 1.6.10: Protect or restore existing high quality riparian corridor habitat by planting appropriate trees and understory shrubs

Action 1.6.11: Protect or restore rock riffle instream habitats

Action 1.6.12: Encourage native plant use and control invasive species in the riparian corridor

8.6 WEST FORK – MILL CREEK

HUC-12: 0509020301-05
OEPA Streams: Mill Creek (23-001), West Fork Creek (23-002)
Drainage Area: 15,141.7 acres, 23.7 square miles
Aquatic Life Use: WWH – 2.9 miles, LRW – 2.2 miles, MWH – 4.6 miles

Impervious cover types: defined using CAGIS shapefiles (2013)
Building footprint: 1,467 acres (9.7% of watershed area)
Streets footprint: 1,157 acres (7.6% of watershed area)
Tree canopy: 7,062 acres (46.7% of watershed area)

Watershed % Impervious Cover: defined using *Multi Resolution Land Characteristics Consortium* (MRLC) National Land Cover Database (NLCD) raster data (2011)

% Impervious	Land Cover/Land Use Equivalent	Runoff Coefficient	Acreage
0	Forest/Open/Water	0.05	5,841
10	Managed Turf (A & B soils)	0.14	1,324
20	Managed Turf (C & D soils)	0.23	855
30	Residential (total site average)	0.32	1,013
40	Barren/compacted soil	0.41	1,082
50		0.5	994
60		0.59	894
70	Industrial/Commercial (total site average)	0.68	982
80		0.77	1,089
90	Compact urban (total site average)	0.86	973
100	Parking lot/rooftop	0.95	67
			15,114

The MBI report states about West Fork – Mill Creek, "**Designated Aquatic Life Uses in WAU 01-05 – West Fork Creek and lower Mill Creek Subwatershed –** The lower Mill Creek (23-001) in WAU 01-05 has a verified MWH aquatic life use designation based on a prior Ohio EPA bioassessment (Ohio EPA 1994) and the 2011 data supports continuing this use (mostly poor-very poor highly modified habitat based on QHEI scores and metrics).

West Fork Creek is a direct tributary in the lower section of Mill Creek and is currently undesignated. The 2011 assessment suggests the WWH use is appropriate for the three lower sites on West Fork Creek (RM 3.0-2.5) based on good habitat conditions. The uppermost site is too small to support a WWH assemblage and the presence of Northern two-lined salamanders and macroinvertebrate assemblages indicate this should be classified as a Class IIIA PHWH stream. The lower two miles are presently designated as a Limited Resource Water (LRW) due to a concrete encased channel and low flows (Ohio EPA 1994). Habitat conditions in the WWH reaches were sufficient to support WWH, although some QHEI attributes were consistent with high peak flows from storm events.

The unnamed tributary to West Fork Creek at RM 2.41 (23-013, MC90) had larval Northern two lined salamanders and good habitat conditions which suggests a PHW-IIIA classification. Another unnamed tributary to West Fork Creek (23-027 - Tributary to West Fork Creek at RM 2.54, MC93) is a small, fishless stream which had a good HHEI (78), EPT taxa, and adult and larval Northern two-lined salamanders thus it is a PHW–Class IIIA stream. A third tributary to West Fork Creek at RM 2.24 (02-064, MC95) had a drainage area just under 1 mi.2. Based on habitat features (e.g., substrates) and a lack of salamanders it is a PHW Class II stream. A fourth tributary to West fork Creek enters downstream (RM 1.24; 23-028, MC97) and has good habitat (QHEI = 61) and good PHWH habitat (HHEI=77), 4 EPT taxa, 2 cold water taxa, but no fish. This stream also is a PHW-Class II stream."

Table 76 below shows the Midwest Biodiversity Institute's evaluation of the State's existing Aquatic Life Use designations for local streams in West Fork. Some of the small tributaries did not have listed uses in the State's WQS, but MBI evaluated them based using the developing "Primary Headwater" classification system.

Table 76: Assessment of Existing Aquatic Life Use (ALU) designations in West Fork – Mill Creek (01-05)

Stream	No. of Sites	Size (mi2)	Habitat Evaluation	Fish Evaluation	Macroinv. Evaluation	Existing ALU	Recommended ALU
WAU (01-05) West Fork - Mill Creek							
Mill Creek (23-001)	8	165	Fair-Good	Poor-Fair	Poor-Marg. Good	MWH	MWH
West Fork Creek (23-002)	4	4.4	Fair-Good	Very Poor-Poor	Fair-Marg. Good	WWH	PHW,WWH
Trib to Wes Fork Creek at RM 2.41 (23-013; MC90)	1	1.5	Fair	Poor	-	None	PHW-IIIA
Trib to West Fork Creek at RM 2.54 (23-027; MC93)	1	1.5	Good	Very Poor	-	None	PHW-IIIA
Trib to West Fork Creek at RM 1.24 (23-028; MC97)	1	0.8	Good	Very Poor	-	None	PHW-II
Trib to West Fork at RM 2.24 (MC95)	1	0.97	-	-	-	None	PHW-IIM

Source: MBI, Mill Creek Bioassessment 2011

8.6.1 SEDIMENTATION

Measured Water Quality Impairment:

According to the Mill Creek TMDL and MBI data, total suspended solids (TSS) and total dissolved solids (TDS) are found in excess concentrations at several sample sites that indicate major water quality impairments. High

concentrations of sediments tend to correspond with lower habitat quality and embeddedness.

In West Fork (including all measured stream segments), the TDS median measurement exceeded target parameters at 5 of 14 locations (MC93 not listed), and exceeded TSS target parameters at 2 of 15 locations. At site MC97, the TSS exceeded target parameters by a significant margin (median 246, target 25.0).

The QHEI scores from the MBI report also indicate excessive sedimentation through high scores in the "moderate-extensive embeddedness", which were indicated at 13 of 15 sites in the West Fork.

Estimated Loading Values and Loading Reduction to Meet State Water Quality Standards:
The estimated annual loading value of TSS in the West Fork-Mill Creek is **13,000,000** lbs. per year. To meet attainment, this loading value needs to be reduced by 76% to **1,900,000** lbs. per year. The LMCPR Phase 1 is estimated to reduce this load by **1,900,000** lbs. per year. Therefore, the remaining load reduction necessary to meet water quality standards would be **9,000,000** lbs. per year.

Watershed Goals:

Goal 1: Reduce TSS in West Fork by **9,000,000** lbs./year

Objective 1.1: **Stream and Riparian Restoration**: Improve 23,000 feet of eroding streams using in-stream stabilization and restoration techniques and by adding or protecting them with a suitable riparian corridor to reduce TSS by **7,200,000** lbs. per year

Action 1.1.1: Develop stream and riparian corridor inventory, restoration plans, and funding opportunities

Action 1.1.2: Daylight 8,000 feet of stream and riparian corridor on lower West Fork Creek

Action 1.1.3: Restore 10,000 feet of stream an riparian corridor on upper West Fork Creek

Action 1.1.4: MSDGC will daylight approx. 2,200 feet of stream on Lick Run, and restore 4,400 feet of stream in Lick Run tributaries

Objective 1.2: **Trees**: Increase tree canopy by 754 acres (5%) to reduce TSS by **18,850** lbs. per year

Action 1.2.1: Continue reforestation efforts on City and County Parks and Schools

Action 1.2.2: Support efforts by the Taking Root campaign to plant 2 million trees in the Tri-State by 2020

Action 1.2.3: Work with ODOT to encourage reforestation of highways

Objective 1.3: **Stormwater Management BMPs**: Reduce TSS from urban runoff sources by installing structural stormwater BMPs to capture **755,000** lbs. per year

Action 1.3.1: Install structural BMPs in upstream areas of the watershed that reduce or retain storm water runoff to reduce peak flows and prevent stream bank erosion

Action 1.3.2: Install structural BMPs that capture and assimilate sedimentation

Action 1.3.3: Search for locations to install sedimentation "hotspot" BMPs, such as parking lot drains, street side curbs cuts, etc.

Objective 1.4: **Streets and Parking**: Reduce TSS from streets and parking lots by increasing miles/acres of street sweeping (there are approx. 1,160 acres (7.6% of total watershed area) of streets in West Fork)

Action 1.4.1: Advocate for private sector parking lot sweeps

Objective 1.9: **Disconnect Downspouts** of 5% of building footprint (73 acres) to grass surfaces or water quality BMPs to reduce TSS by **60,500** lbs. per year

Objective 1.10: **Additional Actions Needed**: Find additional measures for removing **1,000,000** lbs. per year

8.6.2 PATHOGENS

Measured Water Quality Impairment:

Impairment of recreation uses in the Mill Creek watershed was pervasive throughout all of the subwatersheds that were sampled. The Primary Contact 30-day (geometric mean) criterion was exceeded at 44 of 45 sites sampled in the Mill Creek watershed (MBI, Mill Creek Bioassessment report, 2011). In West Fork, the E. coli geometric mean was elevated beyond the E. coli criteria of Primary Contact Recreation – Class B, for all eleven sampled sites in this subwatershed.

Estimated Loading Values and Loading Reduction to Meet State Water Quality Standards:

The estimated loading of E. coli in the West Fork-Mill Creek is **123,000,000** billion colonies per year. To meet attainment, this loading value needs to be reduced by 91% to **10,700,000** billion colonies per year. The LMCPR Phase 1 is estimated to reduce this load by **33,100,000** billion colonies per year. Therefore, the remaining load reduction necessary to meet water quality standards would be **90,000,000** billion colonies per year.

Watershed Goals:

Goal 1: Reduce E. coli levels in West Fork by **90,000,000** billion colonies per year

Objective 1.1: **Pet Waste**: Reduce E.coli from pet waste sources by **14,000** billion colonies/year by initiating a pet waste education campaign

Action 1.1.1: Develop a pet waste education and marketing plan

Action 1.1.2: Monitor pet waste at dog parks to study program effectiveness

Action 1.1.3: Increase access to pet waste "baggies" and trash receptacles in public parks, trails and areas close to water ways

Objective 1.2: **Stormwater Management BMPs**: Reduce E.coli from urban runoff sources by installing structural stormwater BMPs to capture **1,000,000** billion colonies/year

Action 1.2.1: Infiltration (e.g. bioretention cells), filtration (e.g. media filter), and retention (e.g. wet-pond) based BMPs have demonstrated good potential for bacteria reduction if properly designed and maintained.

Action 1.2.2: Find locations for these types of BMPs.

Objective 1.3: **Failing Septic Systems**: Reduce E. coli from failing septic systems by **600,000** billion colonies per year

Action 1.3.1: Reduce E. coli from failing HSTS systems by fixing or remediating **11** failing systems

Action 1.3.2: Convert HSTS systems to sewer systems where possible

Objective 1.4: **Additional Actions Needed**: Reduce E.coli by an additional **77,000,000** billion colonies/year to meet water quality standards

Action 1.4.1: Pursue additional CSO and SSO volumetric reductions thru Phase II Consent Decree remediation projects

Action 1.4.2: Advocate for septic system updates and conversions

Action 1.4.3: Monitor and remediate illicit discharges to the storm sewer system

Action 1.4.4: Monitor nuisance waterfowl populations and habitat

Action 1.4.5: Carefully inspect sewer crossings over/under waterways and report faulty lines immediately

8.6.3 NUTRIENTS

Measured Water Quality Impairment:

The results of nutrient sampling in the lower Mill Creek watershed show that nitrate-nitrite and TKN occur in concentrations at some locations that exceed state and federal chemical water quality guidelines. All sample sites from the lower Mill Creek mainstem consistently exceeded TKN target parameters, up to 73% above target value. Nitrate-Nitrite starts at approximately 120% above target value as it enters Congress Run at RM 11.6, but trends downward to 50% below target as it reaches the Ohio River. TP and Ammonia sampling showed that concentration values are well below target values on most of the Mill Creek mainstem, but there were a couple of exceedences of both on unnamed tributaries in the lower Mill Creek. However, MBI sampling represents dry weather conditions, while nutrients can become significantly elevated during wet-weather events.

Based on the MBI data, TP does not appear in concentrations that would prohibit attainment of WWH or MWH biological criteria for the Mill Creek sections in Congress Run and West Fork. The Mill Creek TMDL selected 0.25 mg/l TP as the upper threshold limit where WWH designation can reasonably expect attainment; no Mill Creek samples exceeded this value. However, there were two TP target infringements in West Fork (01-05) primary headwaters, one at MC97-Trib to West Fork Creek at RM 1.24 and the other at MC96-West Fork Creek at RM 3.5.

In West Fork (including all measured stream segments), the nitrate-nitrite (mg/l) median measurement values exceeded target parameters at only 1 of 15 locations. The ammonia (mg/l) median measurement values exceeded target parameters at only 1 of 12 locations. Elevated TKN concentrations exceeding target values were found at 9 of 15 locations.

Estimated Loading Values and Loading Reduction to Meet State Water Quality Standards:

Total Nitrogen:

- The estimated annual loading value of Total Nitrogen (Nitrate-Nitrite-N + Kjeldahl-N) in the West Fork-Mill Creek is **245,000** lbs. per year.
- To meet attainment, this loading value needs to be reduced by 54% to **113,000** per year.
- The LMCPR Phase 1 is estimated to reduce this load by **40,500** lbs. per year.
- Therefore, the remaining load reduction necessary to meet water quality standards would be **91,000** lbs. per year.

Total Phosphorus:

- The estimated annual loading value of Total Phosphorus-TP in the West Fork-Mill Creek is **34,500** lbs. per year.
- To meet attainment, this loading value needs to be reduced by 66% to **11,500** lbs. per year.
- The LMCPR Phase 1 is estimated to reduce this load by **5,500** lbs. per year.
- Therefore, the remaining load reduction necessary to meet water quality standards would be **17,500** lbs. per year.

Watershed Goals:

Goal 1: Reduce total nitrogen (TN) inputs in West Fork by **91,000** lbs. per year; Reduce total phosphorus (TP) inputs in West Fork by **17,500** lbs. per year.

Objective 1.1: **Stream and Riparian Restoration**: Restore 23,000 feet of altered streams and riparian corridor to reduce TN by **4,600** lbs. per year and TP by **1,600** lbs. per year

Action 1.1.1: Develop stream and riparian corridor inventory, restoration plans, and funding opportunities

Action 1.1.2: Daylight 8,000 feet of stream and riparian corridor on lower West Fork Creek

Action 1.1.3: Restore 10,000 feet of stream an riparian corridor on upper West Fork Creek

Action 1.1.4: MSDGC will daylight approx. 2,200 feet of stream on Lick Run, and restore 4,400 feet of stream in Lick Run tributaries

Objective 1.2: **Trees**: Increase tree canopy by 754 acres (5%) to reduce TN by **11,310** lbs. per year and TP by **11,310** lbs. per year

Action 1.2.1: Continue reforestation efforts on City and County Parks and Schools

Action 1.6.13: Support efforts by the Taking Root campaign to plant 2 million trees in the Tri-State by 2020

Action 1.2.2: Work with ODOT to encourage reforestation of highways

Objective 1.3: **Stormwater Management BMPs**: Reduce nutrients from urban runoff sources by installing structural stormwater BMPs to reduce TN by **6,500** lbs. per year and TP by **1,500** lbs. per year

Objective 1.4: **Pet Waste**: Reduce nutrients from pet waste sources by **1,600** lbs. per year of TN and **200** lbs. per year of TP by initiating a pet waste education campaign

Action 1.4.1: Develop a pet waste education and marketing plan

Action 1.4.2: Monitor pet waste at dog parks to study program effectiveness

Action 1.4.3: Increase access to pet waste "baggies" and trash receptacles in public parks, trails and areas close to water ways

Objective 1.5: **Lawn Care**: Reduce nutrients from lawn care management by **5,700** lbs. per year of TN and **120** lbs. per year of TP by initiating a lawn care education campaign

Objective 1.6: **Streets and Parking**: Reduce nutrients from urban runoff sources by increasing miles/acres of street sweeping

Objective 1.7: **Additional Actions Needed**: Find additional strategies to reduce nitrogen by an additional **60,000** lbs. per year and phosphorus by an additional **2,000** lbs. per year to meet water quality standards.

Action 1.7.1: MSDGC to implement LMCPR Phase 2 solutions

Action 1.7.2: Continue to research and encourage new policy and programmatic solutions to achieve additional load reductions over time.

8.6.4 HABITAT

Measured Water Quality Impairment:

From the MBI report:

"The West Fork Watershed is a Modified Habitat reach with a largely concreted channel and the lower two miles impounded by backwaters of the Ohio River. The habitat in the West Fork watershed ranged from poor to good (32 – 68.5). Three of the seven tributary sites sampled had natural channels, but most had moderate-high embeddedness and poor-fair riffle pool development related to the urban nature of the subwatershed."

Watershed Goals:

Goal 1: Restore and protect fish and wildlife habitat in West Fork to raise QHEI at all sites to above **45**

Objective 1.1: **Stream and Riparian Restoration**: Improve **22,000** feet of eroding streams using in-stream stabilization and restoration techniques and by adding or protecting them with a suitable riparian corridor

Action 1.1.1: Develop stream and riparian corridor inventory, restoration plans, and funding opportunities

Action 1.1.2: Daylight 8,000 feet of stream and riparian corridor on lower West Fork Creek

Action 1.1.3: Restore 10,000 feet of stream an riparian corridor on upper West Fork Creek

Action 1.1.4: MSDGC will daylight approx. 2,200 feet of stream on Lick Run, and restore 4,400 feet of stream in Lick Run tributaries

Action 1.1.5: Inventory assessment of stream bank erosion

Action 1.1.6: Daylighting streams and removing concrete channels for natural channels sized and stabilized to handle expected runoff events

Action 1.1.7: Bank stabilization using soil bioengineering practices

Action 1.1.8: Grade control, stabilization of stream bed/reduce entrenchment

Action 1.1.9: Joint plantings, rip-rap banks along stream

Action 1.1.10: Low-head dam remediation/removal

Action 1.1.11: Culvert retrofits, restore streambank by naturalizing them

Action 1.1.12: Outfall modifications/capture/trash and debris/trash “racks/nets”

Action 1.1.13: Enforcement of infill violations, concrete trash heaps

Action 1.1.14: Restore vegetative buffers in the riparian corridor

Action 1.1.15: Plant trees, shrubs and/or live stakes in riparian areas

Action 1.1.16: Plant native grasses in riparian areas

Action 1.1.17: Create habitat structures to develop riffles and pools where needed

Action 1.1.18: Use joint plantings where streambanks are now covered with riprap.

Action 1.1.19: Use soil bioengineering systems for streambank stabilization and restoration.

Objective 1.2: **Channelization**: Begin exploring a long-term plan for naturalizing the **3.25** miles of concrete channelized sections of the main stem Mill Creek in West Fork.

Action 1.2.1: Allow for natural successional breakdown of the concrete channel; do not remove sedimentation build up from past decade.

Action 1.2.2: Discontinue tree removal and applications of pesticide within the channel and riparian corridors.

Action 1.2.3: Analyze these stream areas to determine opportunities for potential restoration of aquatic habitat.

Action 1.2.4: Develop plans and designs and implement re-naturalization of stream segments.

Action 1.2.5: Remove concrete walls on MVCD properties

Action 1.2.6: Remove concrete channel bottom and stabilize with type A rip-rap and/or modify to manage deposition areas for plantings and add two stage channel

Objective 1.3: **Habitat Barriers**: Eliminate or remediate the in-stream barriers for fish migration

Action 1.3.1: Identify all locations of fish barriers (e.g., sewer crossings and dams) and work with appropriate parties to modify or remove the barriers.

Action 1.3.2: Mitigate the 3 low-head dams present in West Fork

Objective 1.4: **Trees**: Currently 7,062 acres (46.7%) of West Fork have a tree canopy. Increase tree canopy by **754** acres (5%).

Action 1.4.1: Continue reforestation efforts on City and County Parks and Schools

Action 1.4.2: Support efforts by the Taking Root campaign to plant 2 million trees in the Tri-State by 2020

Action 1.4.3: Work with ODOT to encourage reforestation of highways

Objective 1.5: **Wetlands**: Protect and restore the existing **100.3** acres of wetlands in West Fork

Action 1.5.1: Ensure proper land-use controls in local jurisdictions

Action 1.5.2: Delineate wetlands to help ensure future protection.

Action 1.5.3: Restore and expand existing wetlands

Action 1.5.4: Retrofit existing detention basins into constructed wetlands

Action 1.5.5: Remove invasive species and reintroducing native vegetation

Objective 1.6: **Ecological Restoration and Bioengineering:**

Action 1.6.1: Plant trees and other vegetation on streambanks and within riparian zones to provide shade and vegetative debris for aquatic habitat.

Action 1.6.2: Remove invasive species and reintroduce native species into existing habitats

Action 1.6.3: Utilize native plant species in BMP design

Action 1.6.4: Conduct invasive plant species removal on public properties

Action 1.6.5: Responsible pesticide and herbicide use thru Integrated Pest Management Systems

Action 1.6.6: Implement more "Edible Forest Gardens" as demonstrated by Groundwork Cincinnati: Mill Creek

Action 1.6.7: Look for ways including public and private partnerships to connect migratory corridors of wildlife

Action 1.6.8: Encourage builders to retain areas of native vegetation and to use natural techniques to manage stormwater

Action 1.6.9: Help streamside property owners to control erosion and improve habitat

Action 1.6.10: Protect or restore existing high quality riparian corridor habitat by planting appropriate trees and understory shrubs

Action 1.6.11: Protect or restore rock riffle instream habitats

Action 1.6.12: Encourage native plant use and control invasive species in the riparian corridor

8.7 GOALS MEASURED BY MONITORING

The water quality pollutant parameters that prevent biocriteria attainment but were unable to be modeled were placed into this section. This data is derived from the Midwest Biodiversity Institute [MBI], *Biological and Water Quality Study of the Mill Creek* [Mill Creek Bioassessment 2011], (2011).

8.7.1 HEAVY METALS (LEAD, COPPER, ZINC)

Measured Water Quality Impairment:
Metals were above the TEC at 6 of 8 sites on the mainstem Mill Creek and at the West Fork Creek Tributary (MC81).

West Fork-Mill Creek (01-05):

- 4 sites exceeded zinc standards
- 4 sites exceeded copper standards
- 1 site exceeded lead standards

Congress Run-Mill Creek (01-04):

- 3 sites exceeded zinc standards
- 2 sites exceeded copper standards
- 1 site exceeded lead standards

Watershed Goals:

Goal 1: Reduce heavy metals (lead, copper, zinc) at all sites in Congress Run and West Fork to below Probable Effect Concentrations (PEC)

Objective 1.1: **Trash**: Remove rusting and decaying trash objects from the Mill Creek which could be sources of metal pollutants

Action 1.1.1: (see Trash Goal in Overarching Goals)

Objective 1.2: **Roads/Automobiles**: Investigate solutions for mitigating metal pollutants from automotive sources such as roads and parking lots, which are zinc "rich" from brakes and tires

Action 1.2.1: Implement storm water runoff infiltration and filtration BMPs that collect road and parking lot runoff

Action 1.2.2: Recommend policies and code changes to local jurisdictions that reduce parking lot sizes

Action 1.2.3: Capture runoff from roads and highways and funnel to water quality treatment BMPs

Objective 1.3: **Urban Development**:

Action 1.3.1: Increase downspout disconnection of building roofs (a source of metals pollutants), and reroute to water quality treatment BMP for increased removal rates

Action 1.3.2: Investigate heavy metals sources hot spots (e.g. storage/junk yards, rail yards, etc.) for proper on-site pollution prevention controls

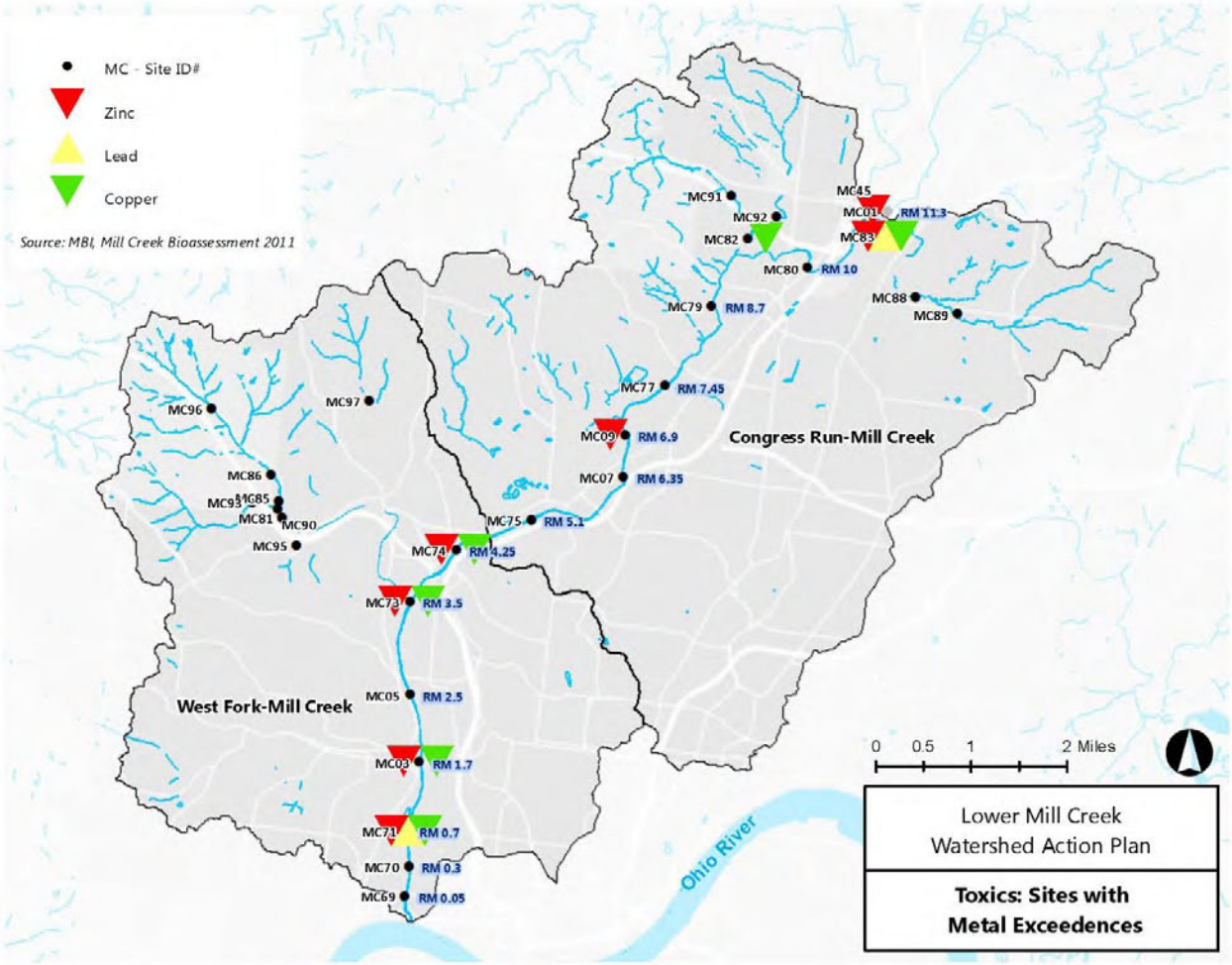


Figure 86: Sites with Metal Exceedences of State Water Quality Standards

Source: (MBI, 2011)

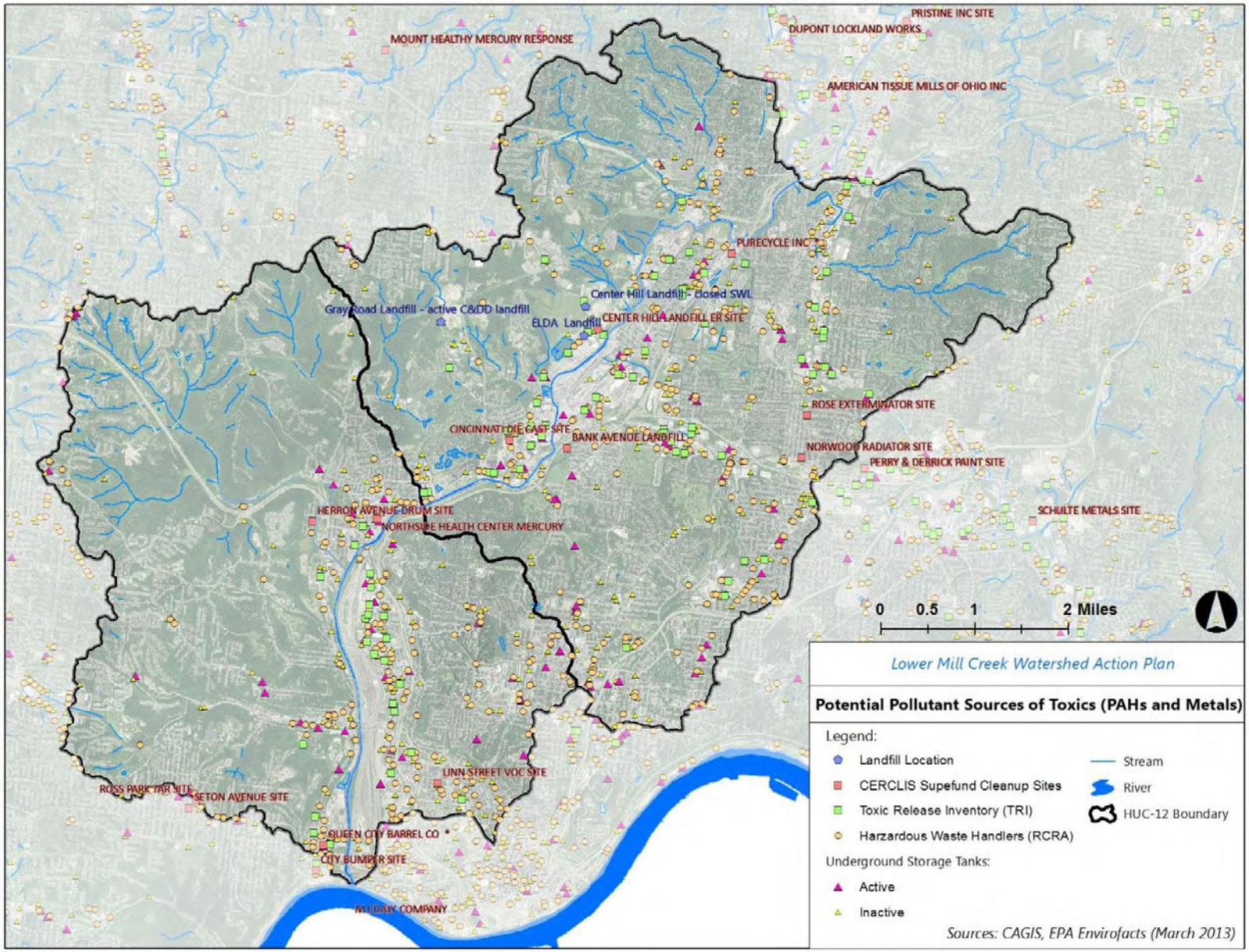


Figure 87: Potential Pollutant Sources

Images of toxics from Altech's *Mill Creek Toxics Study* (2000)

8.7.2 CHLORIDES

Measured Water Quality Impairment:

In West Fork, median chloride levels exceeded Regional target values at 14 of 15 MBI sampling sites. The only sampling site that did not exceed target levels did not have available sampling data for chlorides. The highest median chloride value recorded in the West Fork basin was 129 mg/L in a tributary to West Fork creek, or 270% higher than the target for that site of 35 mg/L.

In Congress Run, 11 of 12 MBI sampling sites exceeded Regional target values of chloride values.

Watershed Goals:

Goal 1: Reduce chlorides in Congress Run and West Fork to below Regional Water Quality Targets

Objective 1.1: **Winter related Road Treatments**:

Action 1.1.1: Develop educational materials targeted at the residential application of salt during winter

Action 1.1.2: Encourage alternative de-icing materials such as beet juice, sand, and other replacement substitutes

Action 1.1.3: Educate and train maintenance authorities on road treatment practices

Action 1.1.4: Upgrade salt storage facilities where necessary

Action 1.1.5: Develop a voluntary Commercial Applicator Certification Program that provides education and training on the proper methods and rates for applying deicing chemicals.

Action 1.1.6: Offer salt credit trading and other incentives to consider that would provide options to the private sector as they work to bring their maintenance activities into compliance.

Objective 1.2: **Waste Water Treatment**:

Action 1.2.1: Investigate systems to reduce chloride at wastewater treatment plant

Objective 1.3: **Urban Development Runoff:**

Action 1.3.1: Expand the existing Riparian Buffer to capture and filter chloride pollutants (select salt tolerant species in BMPs)

Action 1.3.2: Encourage reduced road widths and new miles thru design standards

Action 1.3.3: Encourage smaller parking lots thru design standards

Action 1.3.4: Encourage porous pavement thru design standards

Action 1.3.5: Implement storm water runoff infiltration and filtration BMPs that collect road and parking lot runoff

8.7.3 POLYCYCLIC AROMATIC HYDROCARBONS (PAH COMPOUNDS)

Measured Water Quality Impairment:

The MBI report analyzed sediment samples in the Mill Creek for heavy metals and organic compounds. MBI used the MacDonald et al. (2000) criteria of consensus-based levels for potential adverse effects to aquatic life to evaluate PAH results.

From the MBI report: *"Up to 6 PAH compounds exceeded the PED at all except 2 sites with the most numerous occurring at RM 7.45 (MC77) and RM 5.1 (MC75). Exceedences of the TEC were more numerous at all 6 sites. The first exceedences of the PEC for 4,4'-DDT was observed at RMs 7.45 and 5.1".*

PAH compounds from industrial, municipal and urban runoff sources were above the TEC at 9 of 9 sites on the mainstem Mill Creek. The MBI report states: "*Exceedences of the PEC for up to 12 different PAH compounds were observed among the 8 sites. Ten (10) compounds in excess of the PEC were observed at RM 2.5 (MC05; downstream Lick Run CSO) and included some PAHs not observed anywhere else in the study area. In addition 4,4'-DDT was observed in excess of the PEC at RM 3.5 (MC73) and RM 0.7 (MC71). Exceedences of the PEC for 8 PAHs were observed in West Fork Creek at RM 2.5 (MC81).*"

Watershed Goals:

Goal 1: Reduce PAH compounds at all sites in Congress Run and West Fork to below Probable Effect Concentrations (PEC)

Objective 1.1: **Increase Monitoring**: Develop a PAH compounds water quality testing program

Objective 1.2: **Identify Sources**: Identify PAH compounds pollutant sources and develop appropriate remediation plans

Objective 1.3: **Pesticides**: Reduce pesticide use along the Mill Creek riparian corridors as a source of PAH compounds

Action 1.3.1: Work with the Mill Valley Conservancy District to evaluate pesticide use along riparian corridor

Action 1.3.2: Work with the Army Corp of Engineers to evaluate pesticide use along riparian corridor

Objective 1.4: **Brownfields**: Evaluate legacy brownfields as a source of PAH compounds

Table 77: Assessment of Congress Run and West Fork-Mill Creek in 2011 for Sediment Organic Compounds

Site ID	River Mile	Organics Tested	#Above Detectable Limit	Parameters Exceeding Threshold Effect Concentration	Parameters also exceeding Probable Effect Concentration
WAU (01-04) Congress Run - Mill Creek					
MC01	11.60	20	6	Benz(a)anthracene (520); Benzo(a)pyrene (691); Chrysene (675); Fluoranthene (1470); Pyrene (1250)	Phenanthrene (591)
MC80	10.50	20	6	Benz(a)anthracene (665); Chrysene(842)	Benzo(a)pyrene (781); Fluoranthene (2000); Phenanthrene (833); Pyrene (1610)
MC77	7.55	20	7	Benz(a)anthracene (666); Chrysene (828)	4,4'- DT (5.1); Benzo(a)pyrene (774); Fluoranthene (1860); Phenanthrene (1020); Pyrene (1990)
MC09	6.80	20	7	Benz(a)anthracene (313); Benzo(a)pyrene (434); Bis(2-ethylhexyl)phthalate (1460); Chrysene (385); Fluoranthene (1060); Phenanthrene (450); Pyrene (838)	
MC07	6.30	20	7	Benz(a)anthracene (372); Benzo(a)pyrene; (510); Bis(2-ethylhexyl)phthalate (405); Chrysene (454); Fluoranthene (1240); Phenanthrene (516); Pyrene (1010)	
WAU (01-05) West Fork - Mill Creek					
MC75	4.80	20	8	Bis(2-ethylhexyl)phthalate(558)	4,4'-DDT(47.3); Benz(a)anthracene (1160); Benzo(a)pyrene (1300); Chrysene (1400); Fluoranthene (3030); Phenanthrene (1350); Pyrene (2940)
MC74	4.20	20	6	Benz(a)anthracene(336); Benzo(a)pyrene (443); Chrysene (387); Fluoranthene (1050); Phenanthrene (445); Pyrene (767)	
MC73	3.45	20	7	Benz(a)anthracene (536); Benzo(a)pyrene (681); Chrysene (646); Fluoranthene (1490); henanthrene (523); Pyrene (1360)	4,4'-DDT(121)
MC72	3.20	20	8	Bis(2-ethylhexyl)phthalate(577)	Anthracene (396); Benz(a)anthracene (1840); Benzo(a)pyrene (1930); Chrysene (2060); Fluoranthene (4310); Phenanthrene (2270); Pyrene (4570)
MC05	2.50	20	11		2-Methylnaphthalene(1210); Acenaphthylene (5190); Anthracene (14300); Benz(a)anthracene (16800); Benzo(a)pyrene (14200); Chrysene (15600); Dibenz(a,h)anthracene (1530); Fluoranthene (46600); Fluorene (7880); Phenanthrene (740)
MC03	1.90	20	6	Benz(a)anthracene(624); Chrysene(757)	Benzo(a)pyrene (764); Fluoranthene (1820); Phenanthrene (736); Pyrene (1540)
MC71	0.50	20	8	4,4'-DDD(6.1)	4,4'-DDT (95.9); Benz(a)anthracene (954); Benzo(a)pyrene (1060); Chrysene (1090); Fluoranthene (2620); Phenanthrene (1310); Pyrene (2110)
MC70	0.20	20	6		Benz(a)anthracene(1170); Benzo(a)pyrene(1290); Chrysene(1300); Fluoranthene(3320); Phenanthrene(1570); Pyrene(2680)
MC69	0.10	20	6	Benz(a)anthracene(675); Pyrene(1310)	Benzo(a)pyrene(853); Chrysene(886); Fluoranthene(1970); Phenanthrene(751)

Source: (Midwest Biodiversity Institute, 2011)

8.8 OVERARCHING WATERSHED GOALS AND RECOMMENDATIONS

Overarching Goals, Objectives and Actions captures the wide-ranging strategies necessary for meeting the comprehensive Lower Mill Creek Watershed Action Plan Mission Statement:

> *"The purpose of the Lower Mill Creek Watershed Action Plan is to document current conditions; to identify effective strategies, programs and projects that are needed and can be employed; and to craft a roadmap for improving water quality and ecological health in the Lower Mill Creek Watershed that will, in turn, create more livable neighborhoods and provide public health, environmental, social, and economic benefits for many years to come."*

The overarching goals go beyond the WAP's primary environmental focus of achieving full attainment of water quality standards, and include complementary social and economic objectives. Overarching Goals are applicable throughout the Lower Mill Creek Watershed and can extend to the whole Mill Creek watershed. Unlike the Measurable Goals above, these overarching goals are not necessarily quantified, but are expected to make a significant impact on the Measurable goals.

8.8.1 IMPROVE WATER QUALITY

-These goals, objectives and actions are captured in the *Measured Goals thru Modeling and Monitoring* section

8.8.2 RESTORE AND IMPROVE AQUATIC AND TERRESTRIAL HABITATS

-These goals, objectives and actions are captured in the *Measured Goals thru Modeling and Monitoring* section

8.8.3 IMPROVE NATURAL WATERSHED HYDROLOGY

As noticed in Figure 82: Causes of Impairment Most Frequently Listed by Site – Mill Creek main stem, hydrology is listed as the most frequent cause of impairment on the Mill Creek mainstem. Dysfunctional watershed hydrology characteristics are typically linked to habitat alterations such as increased impervious cover, loss of floodplain, channel hardening, loss of tree canopy, and other associated impacts.

As urban development increases within any given watershed, so does the amount of stormwater runoff volumes. Increased stormwater runoff volumes create more harmful pulse flows and peak flow velocities, while reducing groundwater infiltration capabilities. This also leads to accelerated streambank destabilization and sedimentation loss. We must address hydrology and habitat impairments as interconnected issues.

Hydrology changes due to evaporation loss are another growing concern. Chandler McCoy-Simandle, Steven G. Buchberger and Y. Jeffrey Yank in 2011 computed the hydrology of the Mill Creek watershed in 1701, when the Mill Creek Watershed was mostly forests and swamps, and compared that to 2001 when the population of

the Mill Creek was 475,000. The water balance model used a precipitation of 104.1 cm/yr, same for each time period. The water balance model showed that imported drinking water and interbasin transfers of water had increased by 27%, causing a net increase in the watershed's inflow. The reduction in tree cover and increase in urbanization from 1701 to 2001 had led to decreased evapotranspiration by 14.3 cm/yr (21%). This decrease in evapotranspiration and increase in interbasin transfer is accompanied by a 7.3 cm/yr (21%) increase in stream flow and 35.7 cm/yr increase in wastewater flow.

In addition to the impact of increased surface flow from decreased evapotranspiration, the decreased net radiation removed by the latent head of vaporization and the increase of sensible heat on impervious surfaces have caused an increase in temperature over 3 F over the year or 7 F over the 6 warmest months. In other words, increases in the Urban Heat Island (ULI) effect, are partly caused by decreases in tree canopy and evapotranspiration over that time.

We must protect the existing green infrastructure, which in Congress Run and West Fork include the many ridges and valleys that are existing greenspace, either undeveloped or reforested (e.g., Mt. Airy Forest on West). These natural areas reduce peak flows by interception, infiltration, and evapotranspiration better than any modified surface. We must also identify the existing wetland and hydric soils for protection status.

Clearly, a major goal on the lower Mill Creek should be to plant more trees where possible, including street trees, parking-lot trees, and construction of green roofs and urban gardens. The Taking Root goal to plant 2 million trees in our region is consistent with this goal. Both Great Parks of Hamilton County (formerly Hamilton County Park District) and Cincinnati Parks are planting new trees to reduce the impacts of the Ash borer epidemic in Hamilton County. Hamilton County Soil and Water Conservation District promotes tree planting to stabilize land and reduce runoff, even providing trees to citizens to plant.

Also, other green best management projects (BMPs) that hold water at its source, such as rain barrels and raingardens, would have similar beneficial impacts. These green BMPs will reduce peak flows, and allow percolation to increase dry weather flows.

Floodplains are sensitive flood storage areas that, if conserved and restored, reduce economic losses from flooding. It's critical that local governments practice sound floodplain management, including prohibition of new development in the 100-year floodplain of Mill Creek and its tributary streams. In addition, local governments can restore floodplains when property owners sell, abandon, or otherwise vacate their flood prone land through right-of-first-refusal agreements and land banking.

Impact of CSO and SSO Projects on Hydrology: The elimination of SSOs and reduction in CSO volume by sanitary sewer separation could increase the stormwater flows in the lower reaches of both sub-watersheds. If so, bank stability, channel width and riparian zone improvements will be even more necessary in post Consent Decree landscape. Both subwatersheds have varied topography that ensures much of the slope area is undeveloped and covered in forests. However, the steep wooded slopes make stream channel stabilization is more challenging.

Indicators: Reduced peak flows, increased base dry weather flows, increased groundwater infiltration, increased streambank stability, reduced flood events, reduced CSO and SSO events, improved recreational opportunity.

Watershed Goals:

Goal 1: Improve Natural Watershed Hydrology

Objective 1.1: **Impervious Surfaces**: Reduce impervious surfaces with land use tools to the extent practical to restore the natural hydrologic balance of the watershed

Action 1.1.1: Advocate to local watershed jurisdictions for Form Based Codes – (smaller parking lots, street widths, required street trees, required parking lot trees, etc.)

Action 1.1.2: Advocate to local watershed jurisdictions for Conservation Design

Action 1.1.3: Finish and endorse the Hamilton County Storm Water District's *Post Construction Storm Water Design Manual* to provide guidance on means to reduce sediment and water runoff from new construction

Action 1.1.4: Advocate to local watershed jurisdictions for Low Impact Design

Action 1.1.5: Advocate to local watershed jurisdictions for Green Streets (i.e. BMPs in the street right of way, curb cutouts, infiltration trenches, etc.)

Objective 1.2: **Reforestation**: Find reforestation opportunities – trees provide a runoff reduction effect thru transpiration, infiltration and detention processes

Objective 1.3: **Riparian Corridor/Floodplain Restoration and Reconnection**: Restore or protect riparian buffer areas. Reconnect streams with their floodplains.

Action 1.3.1: Utilize appropriate vegetation – slope planting, etc.

Action 1.3.2: Find disconnected floodplains for remediation

Objective 1.4: **Stormwater Management BMPs**: Manage storm water volumes more effectively

Action 1.4.1: Encourage and support MSDGC's use of "green infrastructure" thru "source control" in Project Groundwork

Action 1.4.2: Control peak flows, reduce pulse flows

Action 1.4.3: Restore water balance thru infiltration

Action 1.4.4: For new BMPs, control the 1 year 24 hour storm event, or ¾" design event

Action 1.4.5: Encourage the use of storm water best management practices that capture and detain surface runoff for the first 0.75" of a rain event

Objective 1.5: **Channelization/Flood Controls**: Restore stream channels from rectangular concrete channels to natural streams with meanders, flood way and flood plains where possible

Action 1.5.1: Modify the concrete channel to include a more naturalized two-stage design

Action 1.5.2: Instead of solid concrete, investigate the use of crushed concrete

Action 1.5.3: Use joint plantings in streambank areas covered with rip rap and grouted rip rap

Action 1.5.4: Use soil bioengineering systems to replace concrete-lined streambanks

8.8.4 REDUCE THE JUNK, TRASH AND LITTER

Trash is more than just an aesthetic problem for the Lower Mill Creek Watershed. Ultimately it is a stream stressor that increases water pollution, habitat degradation and public apathy. The Clean Water Act does not provide numeric standards for this problem, but it does have narrative criteria calling for the absence of trash as well as the scum, sludge, odors or toxic substances often associated with trash.

The process of allowing an urban stream such as the Lower Mill Creek to become a trashy waterway has many parallels to the process of letting an urban neighborhood become a magnet for crime. This degenerative process is aptly described by the broken windows theory, which is a criminological hypothesis about the norm-setting effect that urban disorder and vandalism have on additional crime and anti-social behavior. The theory states that maintaining and monitoring urban environments in a well-ordered condition can stop further vandalism and escalation into more serious crime. (from the Wikipedia article on broken windows theory, as described by social scientists James Q. Wilson and George L. Kelling in the March 1982 edition of The Atlantic Monthly). The broken windows theory can be applied as justification for efforts to clean up the Mill Creek because even harmless collections of paper and plastic litter can be a signal that the dumping of more harmful trash – such as rusting metal, leaking machinery, decomposing yard litter, or used oil filters – will not be policed or punished.

Throughout the Mill Creek Watershed, tattered plastic bags are the most prolific source of trash. Plastic bottles, foam plastic containers and a variety of fast-food plastic accessories add to plastic's overwhelming presence in stream trash. Though initially inert, plastic eventually degrades into smaller, more interactive components that can cause problems for aquatic life.

In the Lower Mill Creek Watershed, plastic is but one of the many trash problems that degrade stream health. Mill Creek Yacht Club paddlers, on more than 50 occasions, have observed these trash problems for the Lower Mill Creek Watershed:

Tires – Hundreds of tires have found their way to the stream channel. They are so numerous in some places

that stream paddlers speak half-seriously of "tire riffles." Many of the tires are still on metal rims that are corroding and contributing to the stream's load of heavy metal pollutants. Most of the tires are deeply embedded in stream sediments and substrates, indicating they have been in place long enough for pollution by rubber degradation.

Asphalt – Large piles of asphalt occupy the riparian corridor near the Wayne Avenue Bridge, the Millcreek Road Bridge and other locations. Usually, the asphalt is ground up and granulated but it is not hard to also find collections of asphalt chunks. Besides ruining the streamside habitat, the degrading asphalt piles leach petrochemical byproducts and other pollutants into the stream.

Concrete – Though concrete is largely chemically inert, it is dumped alongside the Lower Mill Creek to the extent that it chokes out natural vegetation and other streamside habitat. In some places, the concrete piles artificially narrow the stream channel, which increases stream flow velocity and aggravates erosion.

Coal Tar – Just downstream of the Wayne Avenue bridge, the banks of the Mill Creek are lined with hardened chunks of previously viscous coal tar, degrading rolls of tar paper and crumbling piles of shingles. They are sources of stream pollution by polycyclic aromatic hydrocarbons and petrochemical byproducts. Piece by piece, parts of the streamside tar trash is breaking off and migrating to downstream reaches of the Lower Mill Creek.

Machinery and Household Appliances – Metal rust is not the only pollutant emanating from the auto parts, motorcycles, bicycles, factory machines, refrigerators, air conditioners and other household appliances cast into the Lower Mill Creek. Machinery contains lubricants, the source of oil and grease pollutants. Gasoline, antifreeze, brake fluid, power steering fluid, hydraulic fluid and other liquids also leak from junk seen along the Mill Creek. Old refrigerators and air conditioners pose the added threat of chlorofluorocarbons (CFCs).

Floatables – It is only natural that the Lower Mill Creek receives most of the bottles, balls, foam plastic and other floatable trash cast into the 28-mile-long stream or one of its tributaries. Much of this floatable trash tends to accumulate in the vicinity of the Gest Street Bridge in what Mill Creek Yacht Club enthusiasts call the "trash equalization zone." The zone can shift location, depending on the countervailing forces of the Mill Creek's downstream current versus the upstream pressure from Ohio River's backwater. Within that zone, one can easily spot violation of the Clean Water Act's narrative standard for having public waterways free from floatable trash, scum, odor and perhaps toxic substances.

Blight – From the societal point of view, this is the most damaging impact of stream trash. Blight generates apathy and a general sense of futility. People tend to lose hope and turn their backs on trashy streams, denying the public waterway of a champion constituency to take on the complicated web of problems that lead to urban stream impairment. Without public support, regulatory agencies, watershed groups and other stakeholder have a much tougher time putting the stream back in attainment of the water quality standards for its designated uses.

Watershed Goals:

Goal 1: Reduce the junk, trash and litter (e.g. tires, dishwashers, motorbikes, shingle piles, concrete piles, etc.)

Objective 1.1: **Inventory**: Conduct a stream corridor inventory of junk, trash and litter

Action 1.1.1: Record inventory locations with hyperlinked photographs on a GIS map

Action 1.1.2: Report inventory results to appropriate Community Councils in an effort to recruit cleanup volunteers and supporters

Objective 1.2: **Caretaker**: Hire a Mill Creek Caretaker, who will regularly identify, remove and work to prevent accumulations of litter, trash and junk in the riparian corridor

Action 1.2.1: Research and develop grant applications for the position of Mill Creek Caretaker

Action 1.2.2: Develop a program to have the Mill Creek Caretaker collaborate with MSD, Cincinnati Division of Sanitation, Cincinnati Health Department, Hamilton County Storm Water District, Cincinnati Department of Public Works and streamside property owners to provide workers or cost sharing for cleanup efforts

Action 1.2.3: Collaborate with government agencies and nonprofit organizations to publicize activities of the Mill Creek Caretaker through social media, websites, emails and traditional media

Objective 1.3: **Program**: Initiate a program to consistently remove floating trash and litter from Lower Mill Creek whenever it accumulates

Action 1.3.1: Continue implementing river clean-up stream cleanup events (e.g. *Make A Difference Day*, *Great American Cleanup*)

Action 1.3.2: Include trash equalization zone maintenance in MSD's periodic maintenance schedule

Action 1.3.3: Collaborate with the Mill Creek Caretaker to identify trash accumulations and to remove them when they occur

Objective 1.4: **Pollution Prevention**: Advocate for pollution prevention initiatives

Action 1.4.1: (See Non-point Source Pollution Prevention Goal in Overarching Goals)

Objective 1.5: **End-of-Pipe Solutions**: While source control of rain water and non-point source pollution is the ideal solution, there remains a need to devise some end-of-pipe collection methods for reducing trash, debris, and other pollutants that will continue to be discharged to the Mill Creek.

Action 1.5.1: Complete an inventory of CSO and stormwater discharge pipe locations to the Mill Creek where there are currently no filtration. Study the use and locations for gross pollutant traps.

Action 1.5.2: Implement end-of-pipe trash filtration and capture

Action 1.5.3: Plant vegetative buffers between CSOs and the creek

Action 1.5.4: Install trash nets

Objective 1.6: **Enforcement**: Work with the Cincinnati Solicitor's Office, the Hamilton County Prosecutor's office as well as city, county and state law enforcement personnel to strengthen vigilance, enforcement and prosecution of violators of anti-litter and anti-dumping laws and regulations

Objective 1.7: **Publicize**: Incorporate junk, trash and litter as one of the parameters for a yearly "State of the Mill Creek" report

Action 1.7.1: Publicize the "State of Mill Creek" report through websites, emails and social media

Action 1.7.2: Present the "State of the Mill Creek" at an annual banquet and meeting open to the public after working hours

<u>Trash Indicators:</u>

- Estimated tonnage of trash, junk and litter removed from stream corridors of the Lower Mill Creek Watershed
- Estimated volume of trash, junk and litter removed from stream corridors of the Lower Mill Creek Watershed
- Stream miles benefitting from a cleanup event at least once a year

- Numbers, locations and lengths of stream cleanups
- Estimated tonnages, volumes and miles still in need of stream cleanups (to be reported annually in "State of the Mill Creek"
- Monthly summary of cleanup activities by the Mill Creek Caretaker (see Objective 8.3)
- Numbers and locations of trash maintenance activities performed (see Objective 8.4)
- Numbers and locations of gross pollutant traps (see Objective 8.6)
- Numbers and types of anti-littering cases opened by Cincinnati Solicitor's Office, the Hamilton County Prosecutor's office as well as city, county and state law enforcement personnel (see Objective 8.7)

8.8.5 CELEBRATE THE CULTURAL, RECREATIONAL, AND HISTORIC RESOURCES OF THE WATERSHED

By framing the Mill Creek as a product of the whole watershed, we can highlight the many resources that exist to make this a wonderful waterway.

The continuing mission and work of the *Mill Creek Watershed Council of Communities* and *Groundwork Cincinnati: Mill Creek* exemplify the best continuing efforts to revise the long-standing bias against the Mill Creek. Whether it is through:

- the Mill Creek Watershed Council of Communities' annual stream cleanups via the Mill Creek Yacht Club,
- the water quality sampling of the Mill Creek Volunteer Water Quality Monitoring Program,
- the annual Mill Creek ReCreation Celebration,
- the major wetland construction and stream restoration projects like the Twin Creek Preserve
- Groundwork Cincinnati: Mill Creek's Environmental Education Program (15,000 students since 1994),
- implementation of the Mill Creek Greenway Program,
- the new Edible Forest Garden
- the "Freedom Trees" (planted to celebrate the Mill Creek's role in the Underground Railroad system),
- and plenty more

These vital regional non-profit organizations are showing our community that the Mill Creek is an amazing cultural, natural, recreational and historic resource.

Watershed Goals:

Goal 1: Celebrate the Cultural, Natural, Recreational, and Historic Resources of the Watershed

Objective 1.1: Create and improve recreational amenities in the watershed

Objective 1.2: Continue and expand Mill Creek Watershed Council of Communities recreational activities…e.g. *Mill Creek ReCreation Celebration*

Objective 1.3: Continue implementation of Groundwork Cincinnati Mill Creek's Greenway Trail

Objective 1.4: Continue the collaboration with local communities and park districts to connect with each other and the Mill Creek Greenway Trail

Objective 1.5: Create new ball fields as part of a flood control/storm water detention requirement, similar to those along the West Fork near Beekman Interchange (Revive Cincinnati: Neighborhoods of the Mill Creek Valley-April 2010)

Objective 1.6: Utilize City owned lands, vacated railroad corridors and utility easements to create trails from neighborhoods to the Mill Creek (Revive Cincinnati: Neighborhoods of the Mill Creek Valley-April 2010)

Objective 1.7: Incorporate community art into watershed trails and parks

Objective 1.8: Build on the success of Groundwork Cincinnati Mill Creek's Laughing Brook wetland, public art and stormwater demonstration project

Objective 1.9: Preserve historic resources in the watershed

Objective 1.10: Incorporate cultural heritage signage into watershed trails

Objective 1.11: Create watershed awareness thru environmental education and training

8.8.6 INTEGRATE ECONOMIC REDEVELOPMENT INTO WATERSHED PLANNING OBJECTIVES

Historically, the Mill Creek valley has served as the city of Cincinnati's industrial corridor due to the flat land, access to water, and eventually, the proximity to highways and railroads. Not much has changed in this regard, as the Mill Creek valley is still a highly desirable location for industrial activities as noted in Figure 88: Plan Cincinnati: "Guiding Geographic Principles - #4 Maximize industrial reinvestment in existing industrial areas" (2012) and also the GO Cincinnati: Growth and Opportunities Study for the City of Cincinnati (2008).

On the other hand, a growing Mill Creek constituency has been advocating for a more natural, accessible and enjoyable Mill Creek with better water quality, which, generally speaking, has been at odds with economic growth. The juxtaposition of these Mill Creek visions requires a balanced approach that includes opportunities for jobs and increased tax revenues with the need for a clean environment and recreational assets.

Thankfully, a recent plan illustrated a cohesive vision that combines economic growth with a sustainable environment: *Revive Cincinnati: Neighborhoods of the Mill Creek Valley* (2010). This plan envisioned the I-75 Mill Creek corridor with restored floodplains and open space within greenway corridors, trails for recreation, alternative transportation options, the development of eco-industrial parks that would need to meet "building regulations which codify the goals of zero-emissions and LEED certification". It furthers states, "By properly managing these huge investments, the city will leverage additional investment in the creation of sustainable ecosystems, new forms of mobility, preservation of unique neighborhoods, and transformation of underutilized land into centers of research and commerce".

The plan was commissioned by the City of Cincinnati to discuss opportunities to leverage several multi-billion dollar infrastructure projects in the lower Mill Creek including the I-75 upgrades by the Ohio Department of

Transportation and MSD's Project Groundwork improvements to sanitary and storm sewers using an integrated management approach. These projects are funded by local ratepayers and taxpayers who will feel the burden of additional costs and perhaps daily construction inconveniences, so it is imperative that the project's benefits are thoroughly communicated, risks are mitigated, and inconveniences minimized.

Another major economic opportunity in the lower Mill Creek is the "*Confluence*" - Water Technology Innovation Cluster (WTIC) of the Ohio River Valley Region. The vision of the Confluence is a large geographic cluster of interconnected water technology firms - innovators, researchers, product producers and suppliers, entrepreneurs, testers and early adopters, etc. – that work together in an organized manner to leverage and promote economic sector growth and technology innovation.

Watershed Goals:

Goal 1: Integrate economic redevelopment into watershed planning objectives

Objective 1.1: Promote brownfield restoration and remediation

Objective 1.2: Repurpose legacy landfills

Objective 1.3: Market based solutions / economic Incentives (lot by lot, property owners, rain gardens – incentives: future storm water utility owners to reduce fee, volumetric based credit to meet objectives)

Objective 1.4: Transformation of blighted properties

Objective 1.5: Rebrand / re-vision the Mill Creek corridor, Soften the Industrial Edges

Objective 1.6: Look for opportunities to transform old vacant industrial structures into something the community would embrace thru opportunities such as: industrial art, neon lights, rock-climbing silos, etc.

Objective 1.7: Implement existing plans – Revive I-75, GO Cincinnati, Mill Creek Greenway Master Plan, etc. (link to Matrix of Plans)

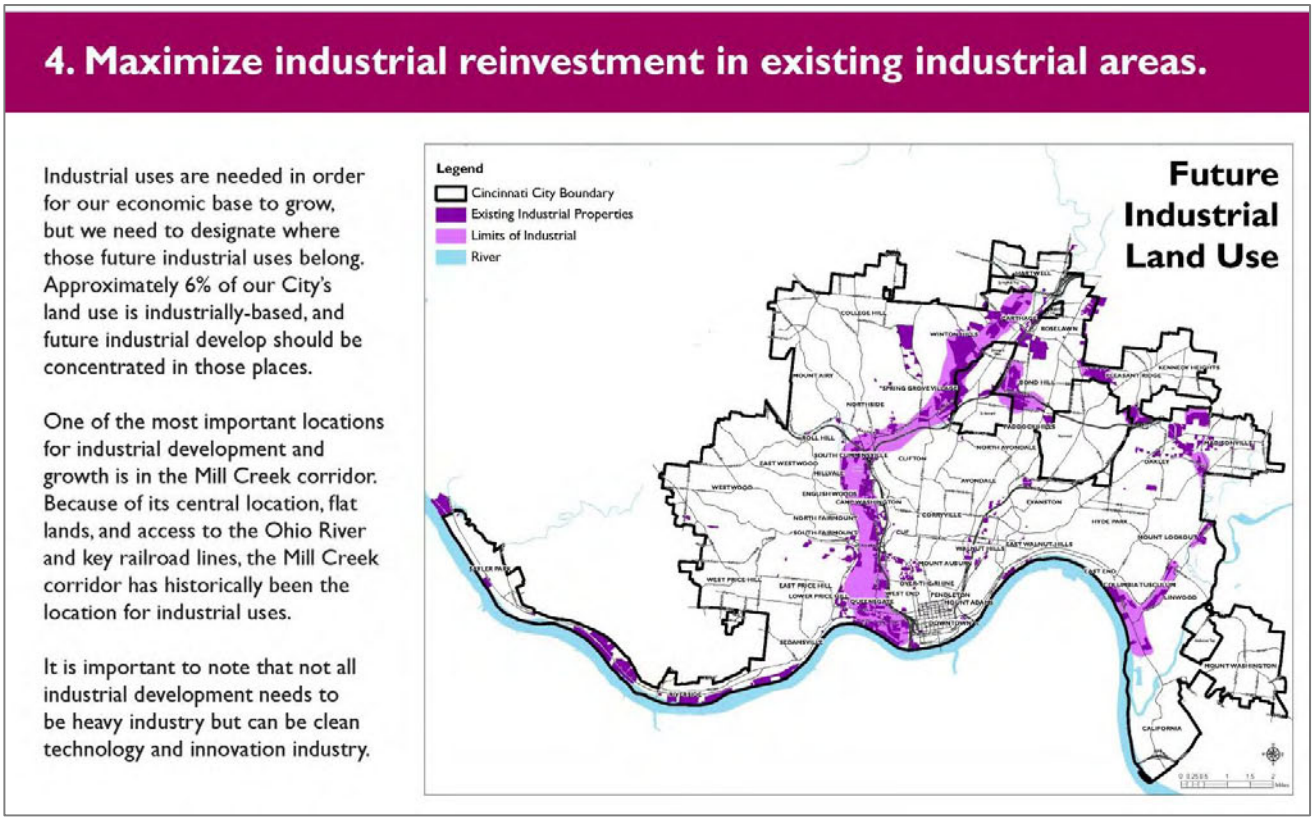


Figure 88: *Plan Cincinnati*: "Guiding Geographic Principles - #4 Maximize industrial reinvestment in existing industrial areas" (2012)

8.8.7 WATERSHED PLAN IMPLEMENTATION AND STEWARDSHIP

Throughout this Plan, there is recommendation for many Best Management Practices, policy directions and programs for the Lower Mill Creek Watershed area. There are several organizations already working towards achieving these goals. Some of these programs and policies are already underway, many are not. The Implementation Section details out the strategies and actions steps for implementing the recommendations of this Plan. It identifies potential funding source and partner organization that would play a vital role in making the Plan happen.

An **Implementation Committee** consisting of key members from partner agencies and organizations will be formed for the Lower Mill Creek Watershed Action Plan. It will consist of individuals with varied technical expertise and skills required for implementing the Watershed Action Plan. The Implementation Committee will be responsible for monitoring the progress of the Plan. Identified partner agencies, both public and private will be responsible for the maintenance of the BMPs and monitoring of water quality and flow.

Groundwork Cincinnati/Mill Creek should continue to implement the City of Cincinnati's Mill Creek Greenway Program and the Healthy People/Healthy River Program that include ecological restoration of aquatic and terrestrial habitat, streambanks, wetlands, and riparian zones for Mill Creek and its tributary streams in the

Lower Mill Creek Watershed. The Program also includes planting edible forest gardens, creating eco-friendly solutions for urban stormwater management, providing year-round environmental education programming for thousands of students each year, actively engaging affected Lower Mill Creek residents and cross sector partners, and developing the Mill Creek Greenway Trail.

Watershed Goals:

Goal 1: Create and implement a comprehensive long-term plan for Watershed Stewardship

Objective 1.1: **Inventory BMPs and Success Stories**

Action 1.1.1: Create an inventory of types of BMP facilities present with the watershed area

Action 1.1.2: Identify the agency responsible for maintenance of each BMPs

Action 1.1.3: Identify the facilities characteristics and inspection needs for different types of BMPs

Action 1.1.4: Conduct periodic reviews and distribute "lessons learned" to watershed stakeholders

Action 1.1.5: Publicize new BMPs - "success stories"

Objective 1.2: **Ensure Effective Operation and Maintenance of Structural Solutions**

Action 1.2.1: Develop inspection and maintenance checklist for structural BMPs

Action 1.2.2: Educate watershed stakeholders on good BMP operation and maintenance practices

Objective 1.3: **Increase Water Quality Monitoring**: Increase water quality monitoring and flow monitoring capabilities

Action 1.3.1: Increase frequency, parameters, # of sites of water quality monitoring

Action 1.3.2: Develop a shared database for water quality data collected by different entities where citizens can input their data

Action 1.3.3: Increase the number of Flow Gage Stations as needed to determine real-time reductions in wet-weather peak flows from implementation programs and projects

Action 1.3.4: Work with the EPA's *Citizen Water Quality Monitoring Pilot Program* to address water quality monitoring gaps

Objective 1.4: **Watershed Stewardship**:

Action 1.4.1: Ensure that all future infrastructure maintenance and new public works projects are ecologically sound and protective of water quality and aquatic life.

Action 1.4.2: Increase responsiveness and effectiveness in addressing water quality issues and threats, evaluate future management actions, chart annual trends in key quality indicators,

Action 1.4.3: Provide LMCWAP information and recommendations to all parties responsible for maintenance of river reaches modified by the Army Corps of Engineers.

Action 1.4.4: Provide LMCWAP information and recommendations to all entities responsible for future public works projects within the riverine-riparian corridors (e.g., bridges, roads, gas/sewer/water utilities).

Action 1.4.5: Plan for natural watershed "succession"

8.8.8 NON-POINT SOURCE POLLUTION PREVENTION

Unlike big pollution that is discharged directly from pipe into the surface water at specific areas of the stream, non-point source pollutants comes from many diffuse sources, and have more than one point of origin. This type of pollution is much more difficult to isolate and control. Non-point source pollutants can be natural such as sediments or human made such as chemicals and toxics. For an urban watershed such as West Fork and Congress Run, the most common sources of nonpoint pollutants are urban stormwater runoff, agriculture, forestry and mining. Ignorant and careless household management activities also contribute to non-point source pollution.

Non-point source pollutants include soil particles, fertilizers, animal manure, pesticides, oil, road salt, failing septic systems, pet wastes and debris from paved areas (OKI 2013). These pollutants reach rivers and streams by stormwater runoff, snow melt and wind. Today, nonpoint source pollution is the Nation's leading source of water quality degradation (US EPA). Since non-point source pollution is generated from dispersed land surfaces and varied activities, efforts to control this pollution must consider individual, household and public behaviors and actions that generate these pollution.

Desired Impacts: - Address "hotspots" of water quality pollutants, reduce non-point sources of pollution,

Watershed Goals:

Goal 1: Non-point Source Pollution Prevention

Objective 1.1: Reduce **Residential** non-point pollutant sources

Action 1.1.1: Properly dispose of pet waste

Action 1.1.2: Mulch leaves instead of bagging them for disposal

Action 1.1.3: Don't pour toxics down drains

Action 1.1.4: Use non-toxic chemicals

Action 1.1.5: Ensure proper pharmaceutical disposal

Action 1.1.6: Reduce chemical usage for maintaining lawns, gardens and pools

Action 1.1.7: Reduce water usage - encourage the purchase of water-efficient showerheads, faucets, and toilets.

Action 1.1.8: Maintain septic system

Objective 1.2: Reduce **Commercial/Industrial** non-point pollutant sources

Action 1.2.1: Capture runoff on site

Objective 1.3: Reduce **Public/Infrastructure** non-point pollutant sources

Action 1.3.1: Street Sweeping

Action 1.3.2: Site Disturbance Erosion Control: Construction Debris / No Dumping Regulations Enforcement

Additional Maps:

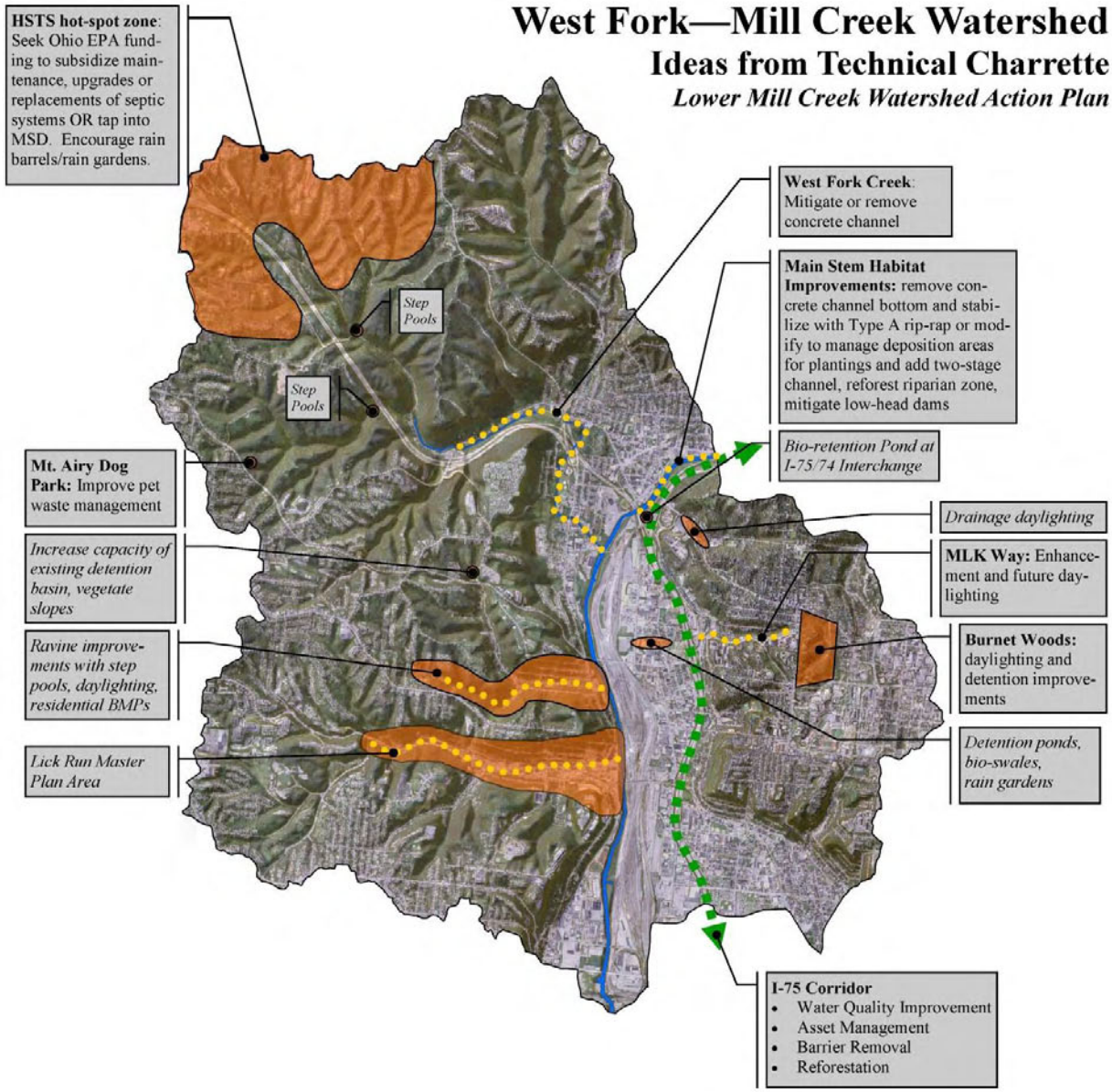


Figure 89 – Technical Charrette Concepts

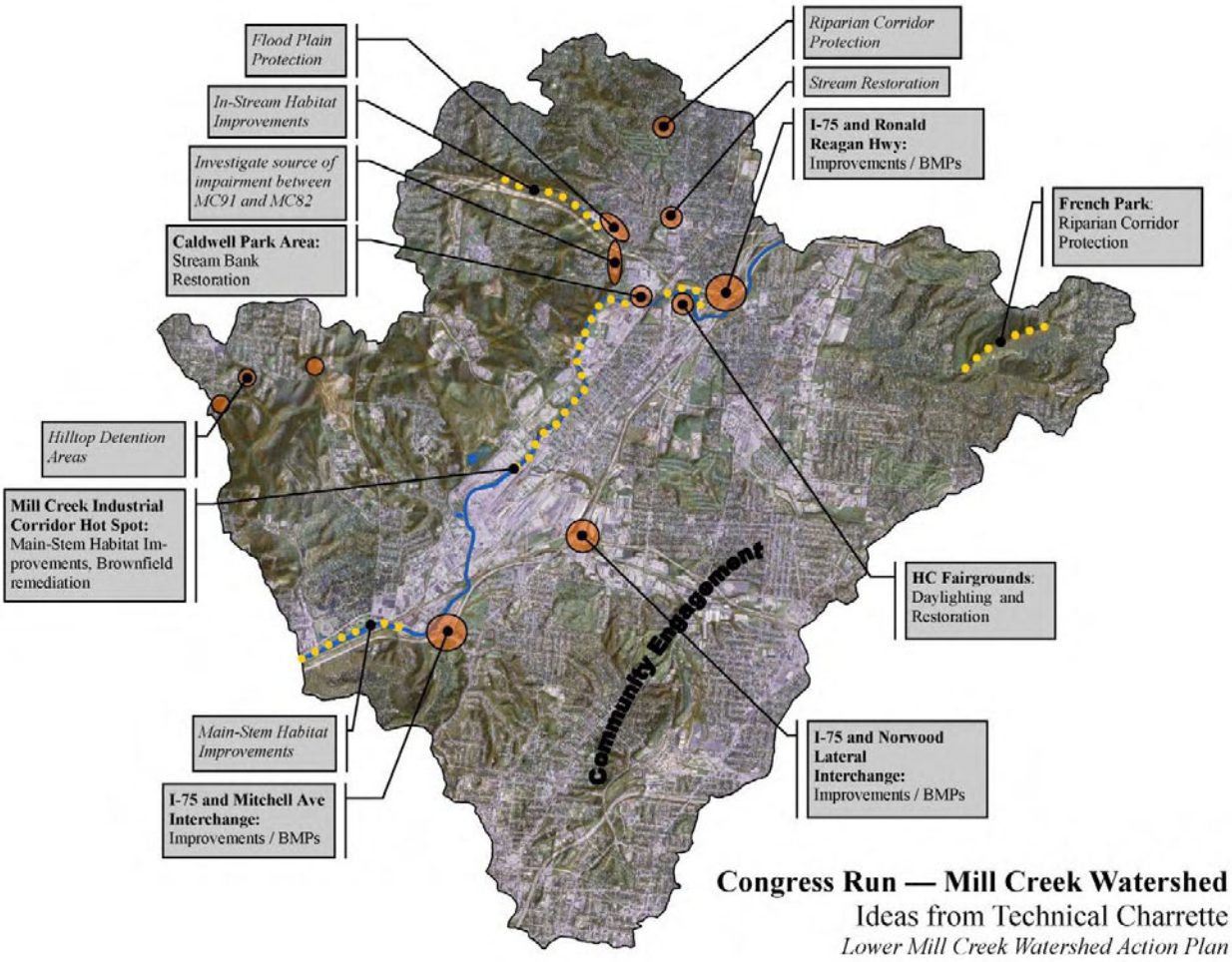


Figure 90 – Congress Run Charrette Concepts

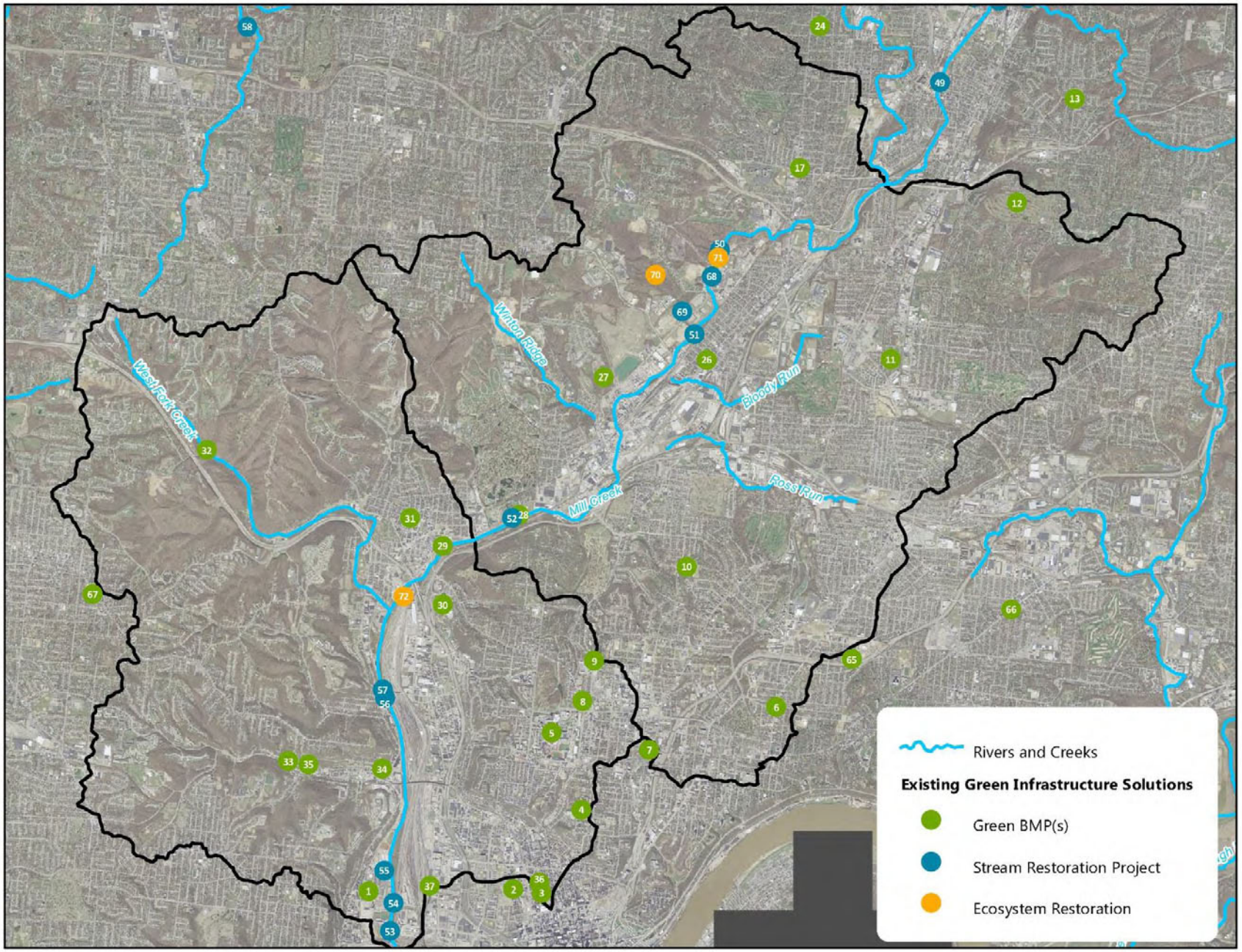


Figure 91: Existing Green Infrastructure Solutions

Table 78: Congress Run – Existing Green Infrastructure Solutions

#	Type	Description
6	Green BMP(s)	Evanston Aquatic Center: Pervious concrete; 1.23 million gallons
10	Green BMP(s)	CPS North Avondale Montessori: Green roof; 10,000 gallons
11	Green BMP(s)	Roselawn Park: bio-infiltration areas; 10,000 gallons
12	Green BMP(s)	Amberley Village Walking Track: Rain Garden
17	Green BMP(s)	CPS - Hartwell Elementary School: Pervious Concrete; 614,000 gallons
26	Green BMP(s)	Elmwood Place Square: Rain Garden at Gateway
27	Green BMP(s)	BASF: 6 bio-filtration basins with curb cuts over 85,000 sq. ft.
28	Green BMP(s)	Groundwork Cincinnati/Mill Creek Laughing Brook, Salway Park: Constructed wetland and rain gardens
50	Stream Corridor Restoration	Caldwell Park: Streambank - Soil Bio-engineering,
51	Stream Corridor Restoration	Center Hill Landfill: Streambank stabilization, stream restorations
52	Stream Corridor Restoration	Salway Park: Streambank bio-engineering, cross-vane weirs
68	Stream Corridor Restoration	J-Hooks, Aquatic Habitat, pool structure and stream bank stabilization via MSD Consent Decree
69	Stream Corridor Restoration	Groundwork Cincinnati
70	Ecosystem Restoration	Groundwork Cincinnati Mill Creek - wetland, stream restoration, grade controls
71	Ecosystem Restoration	Floodplain restoration and Stream bank stabilization using soil bio engineering systems by Groundwork Cincinnati Mill Creek

Table 79: West Fork – Existing Green Infrastructure Solutions

#	Type	Description
1	Green BMP(s)	MSDGC extensive green roof, bio-infiltration, pervious parking lot, native plant gardens, and more
3	Green BMP(s)	MSD ESP - Washington Park: Dry wells, Green Roof 7.73 million gallons
4	Green BMP(s)	MSD ESP - Christ Hospital: Rain Gardens with bio-infiltration areas; 243,000 gallons
5	Green BMP(s)	UC Campus: Green sewer separation, pavers, bio-infiltration basin; 14.5 million gallons
8	Green BMP(s)	U.S. EPA's Breidenbach Research Center: Green Roof
9	Green BMP(s)	Cincinnati Zoo: Rainwater harvesting & reuse, pervious pavers, enhanced turf system, storm sewer separation, tree wells, cisterns; 29 million gallons
29	Green BMP(s)	Groundwork Cincinnati/Mill Creek, Freedom Trees: Grove Stream-side native plants
30	Green BMP(s)	MSD ESP - Cincinnati State Technical & Community College: Cistern tanks, level spreader, bioswale, bio-infiltration basin & trench, pervious pavers; 12.6 million gallons
31	Green BMP(s)	McKie Community Center: Rain garden, rain barrels, native plant nursery
32	Green BMP(s)	Shepherd Creek: Rain gardens, rain barrels; U.S EPA is studying gallons infiltrated
33	Green BMP(s)	San Antonio Church: Pervious pavers, bio-infiltration areas; 900,000 gallons
34	Green BMP(s)	Immanuel Christ Church: Pervious pavers; 10,000 gallons
35	Green BMP(s)	St. Francis Court Apartments: Bio-infiltration areas; 400,000 gallons
36	Green BMP(s)	MSD ESP - Cincinnati Department of Transportation & Engineering - Comer & Osborn Alleys: Pervious pavers; 378,000 gallons
37	Green BMP(s)	MSD ESP - Union Terminal/Museum Center: Green Roof; 95,000 gallons
53	Stream Corridor Restoration	Mill Creek Barrier Dam: Removes 30,000 cubic yards of sediment
54	Stream Corridor Restoration	Gest Street: Removing defective stream crossing stabilizing streambank
55	Stream Corridor Restoration	Mill Creek WWTP: Major treatment upgrades, new incinerators, new de-watering process

56	Stream Corridor Restoration	North Fairmount Health Center: Prairie habitat restoration
57	Stream Corridor Restoration	Hopple Street Viaduct: Replacing lowhead dam with man-made riffle
72	Ecosystem Restoration	Reforestation and habitat restoration, Groundwork Cincinnati Mill Creek

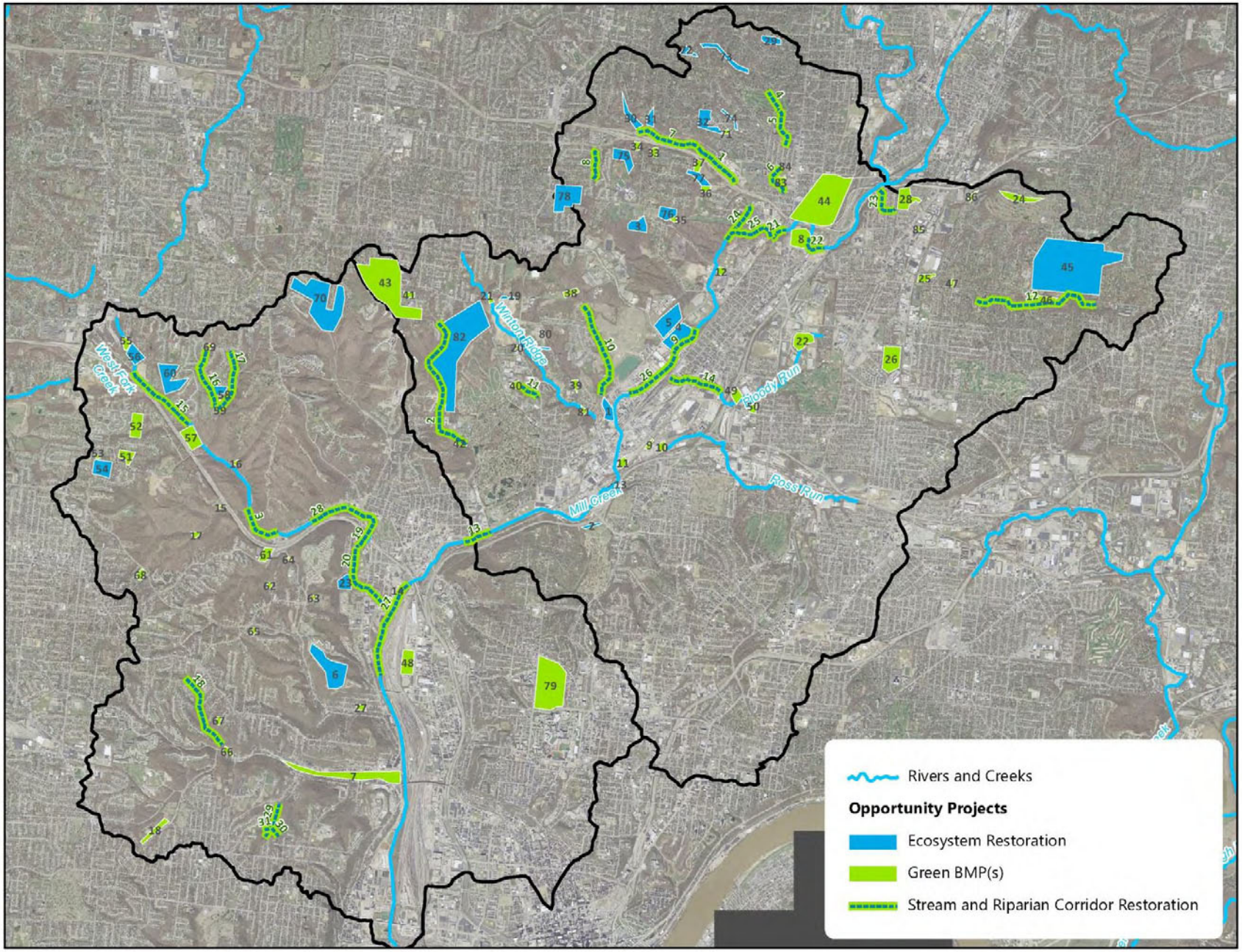


Figure 92: Coarse Evaluation Opportunity Projects from Watershed Mapping Exercise

Table 80: Coarse Evaluation Opportunity Projects – Ecosystem Restoration and Green BMP(s)

#	Name	Project Concept
1	Ecosystem Restoration	riparian corridor restoration and/or Regional BMP, concern (brownfield site)
2	Ecosystem Restoration	tree canopy restoration, concern active land sliding!
3	Ecosystem Restoration	tree canopy restoration
4	Ecosystem Restoration	tree canopy restoration, city owned brownfield
5	Ecosystem Restoration	tree canopy restoration, city owned brownfield
6	Ecosystem Restoration	tree canopy restoration
7	MSDGC	Lick Run Daylighted Stream Corridor, proposed greenway trail, Groundwork Cincinnati
8	Green BMP(s)	Regional BMP, Hamilton County Fairgrounds, wetland BMP
9	Green BMP(s)	Regional BMP - collects runoff from parking and roof
10	Green BMP(s)	Regional BMP - collects runoff from parking, contiguous street, and grassed area
11	Green BMP(s)	Regional BMP
12	Green BMP(s)	Regional BMP, vacant site, high degree of imperviousness converted to tree canopy and bio-retention;
13	Ecosystem Restoration	Tree Canopy Restoration
14	Green BMP(s)	Regional BMP, floodplain protection, 100 to 200 ft. buffer (recommended by GCMC)
15	Green BMP(s)	stream enhancement, step-pools
16	Green BMP(s)	Mt. Airy step pool
17	Green BMP(s)	Mt. Airy step pool
18	MSDGC	Rapid Run Park Regional BMP
19	Ecosystem Restoration	Landslide causing sedimentation and nutrient loading
20	Green BMP(s)	Regional BMP opportunity site, potential MSDGC project?
21	Green BMP(s)	Regional BMP opportunity, potential MSDGC project?
22	Green BMP(s)	Potential wetland Phase II
23	Ecosystem Restoration	BMP area/length: 9.5 acres
24	Green BMP(s)	Potential area for Retention Pond BMPs
25	Green BMP(s)	Potential area for large scale BMP
26	Green BMP(s)	Roselawn Park BMPs
27	MSDGC	regional BMP, bioswale & underground storage
28	Green BMP(s)	Reforestation area, retention basin retrofit, stream channel stabilization, wetland, etc. private ownership, Identified in MBI report as TSS "hotspot"
29	Ecosystem Restoration	Cilley Creek Stream Restoration at Stearns Woods: low-head dam removal, 400ft of stream restoration, 3 acres of invasive species removal and reforestation with native plants; submitted for funding in Summer 2014; City of Wyoming and Green Area
30	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation.
31	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation.
32	Ecosystem Restoration	Headwaters protection, invasive vegetation removal, and reforestation with native species throughout large contiguous parcel, with tributaries to Congress Run. Potential to couple restoration efforts with regional bmp/retrofit project upstream.
33	Green BMP(s)	Regional stormwater wetland, or other biological bmp. Carthage Apostolic Church.
34	Green BMP(s)	Regional stormwater wetland, or other biological bmp.
35	Green BMP(s)	Regional stormwater wetland, or other biological bmp. Single property owner of 25.76 acres.
36	Green BMP(s)	Regional stormwater wetland, or other biological bmp, at Hillside Park.
37	Green BMP(s)	Regional stormwater wetland, or other biological bmp. Property owned by Hamilton County.
38	Green BMP(s)	Regional stormwater wetland, or other biological bmp.
39	Green BMP(s)	Regional retention/detention or stormwater pond at Cincinnati Housing Authority/Ironworkers Local property.
40	Green BMP(s)	Regional stormwater wetland, or other biological bmp. Single property owner.

41	Green BMP(s)	Stormwater retention/detention at Cincinnati Children's Hospital.
42	Green BMP(s)	Regional stormwater wetland, or other biological bmp, in the vicinity of CSO 162.
43	Green BMP(s)	Street side green infrastructure, including curbside bmps, pervious pavers, bioswales, etc.
44	Green BMP(s)	Hartwell Circle street side bmps: stormwater retrofit including green infrastructure, pervious pavers, curbside bioretention, vegetated swales, street trees, etc.
45	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation w/in French Park.
46	Green BMP(s)	BMP area/length:
47	Green BMP(s)	BMP area/length:
48	Green BMP(s)	Green Roof? City owned brownfield looking for redevelopment
49	Green BMP(s)	BMP area/length: 6.7 acres
50	Green BMP(s)	BMP area/length: 5.24 acres
51	Green BMP(s)	Water quality swale?
52	Green BMP(s)	Infiltration?
53	Green BMP(s)	Existing stormwater basin retrofit.
54	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation.
55	Green BMP(s)	Retrofit of existing stormwater basin.
56	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation.
57	Green BMP(s)	Adjacent to West Fork stream, filtration
58	Ecosystem Restoration	BMP area/length: 5.4 acres
59	Green BMP(s)	Stormwater treatment wetland at confluence of Shepherds Creek and tributary.
60	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation.
61	Green BMP(s)	Strategic location; Infiltration
62	Green BMP(s)	Montana Ave, infiltration
63	Green BMP(s)	Brokaw Ave, infiltration
64	Green BMP(s)	Retrofit of existing stormwater basin.
65	Green BMP(s)	BMP area/length: 1.20 acres
66	Green BMP(s)	Water quality swale
67	Green BMP(s)	step pool, filters
68	Green BMP(s)	Reforestation?
69	Green BMP(s)	Retrofit of existing pond into bioretention basin.
70	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation w/in Fox Preserve
71	Green BMP(s)	Regional bmp / retrofit of existing basin. Potential stormwater wetland or bioretention basin to capture runoff from high-density residential property.
72	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation at Chisholm Park. Greenspace owned and maintained by City of Wyoming.
73	Ecosystem Restoration	Headwaters protection by greenspace preservation/conservation easement. Several individual parcels already owned by Wyoming Green Areas Trust.
74	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation along Congress Run tributary.
75	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation. St. Xavier High School property.
76	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation. Large property owned by one landowner.
77	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation.
78	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation.
79	Green BMP(s)	Burnet Woods, retention basin retrofit, bio-swales,
80	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation.
81	Green BMP(s)	Regional stormwater detention/retention basin.
82	Ecosystem Restoration	Headwaters protection, invasive veg removal, and reforestation.
83	Green BMP(s)	Regional stormwater wetland or other biological bmp. City of Cincinnati property.
84	Green BMP(s)	Regional stormwater wetland or other biological bmp. City of Cincinnati property.
85	Green BMP(s)	Regional stormwater detention/retention basin.

86	Green BMP(s)	Retrofit of existing pond to bioretention basin or stormwater wetland.

Table 81: Coarse Evaluation Opportunity Projects – Stream and Riparian Corridor Restoration

#	Description/Concept
1	Streambank Restoration, entrenched stream with major landslide issues. Includes MC91.
2	Ludlow Run stream restoration.
3	Highly entrenched stream susceptible to eroding banks
4	Establish riparian buffer along Cilley Creek, through Wyoming Golf Club. Propose low profile shrubs and/or mesic prairie as buffer through golf course.
5	Channel stabilization to address systemic channel widening, prevent erosion and sedimentation, and enhance floodplain connectivity, along reach of Cilley Creek, downstream of Wyoming Golf Course.
6	Restoration of widening channel. Mass wasting in the vicinity of Shadybrook Drive. Includes MC92.
7	Restoration of deeply incised channel to reduce erosion and sedimentation, between Galbraith Road and Cross County Hwy.
8	Restoration of upper Congress Run to address erosion, located on Central Park Community Association property.
9	Streambank stabilization, contiguous to MSD Seps project upstream, to Center Hill Avenue. City of Cincinnati greenspace.
10	BMP area/length: 4,200 ft
11	Stream stabilization upstream of Winton Road. Single property owner.
12	
13	Removal of low-head dam and restoration of in-stream habitat, near CSO #24.
14	BMP area/length: 1,350 ft
15	Restoration of upper West Fork Creek.
16	Restoration of Shepherd Creek tributary.
17	Restoration of Shepherd Creek.
18	MSDGC potential project
19	BMP area/length: 8,632 ft
20	concern, currently a concrete lined channel
21	
22	
23	
24	daylight stream going under Hartwell Golf Course
25	Streambank stabilization and riparian restoration and Hartwell Golf Course; WRRSP project to be submitted to OEPA in August 2013; Duke Energy and Byer Steel local project partners with Council
26	BMP area/length: 2994
27	
28	Bioretention basin, reforestation, and stream restoration. Groundwork Cincinnati Mill Creek, MSDGC, Clean Ohio Grant
29	MSD Quebec Road
30	
31	MSD Quebec Road

9 IMPLEMENTATION: PRIORITY PROJECTS

Using the Coarse Evaluation Projects identified in the previous section (see Table 80, Table 81, Figure 91, Figure 92), more focus was placed upon identifying "priority projects" to proceed with further evaluation and implementation. Priority projects were chosen based on potential pollutant removal, community visibility, habitat restoration, costs, feasibility, property acquisition factors and more. These projects were then placed within the following project "snapshot" framework.

Project Timeline/Status

(1) Conceptual
(2) Planning/design
(3) Seeking implementation and funding
(4) In-construction
(5) Completed

Estimated Project Level of Effort

➲ - 2 years or less, small number of stakeholders

➲➲ - 2 years or less, large number of stakeholders

➲➲➲ - More than 2 years to implement, large number of stakeholders

➲➲➲➲ - More than 2 years to implement, large number of stakeholders, other challenges

Estimated Project Costs

$ - $0 to $150,000 (roughly pegged to Surface Waters Improvement Fund (SWIF) Grant or less)

$$ - $150,000 to $300,000 (roughly pegged to 319 Grant or less)

$$$ - $300,000 to $500,000

$$$$ - $500,000 to $1,000,000

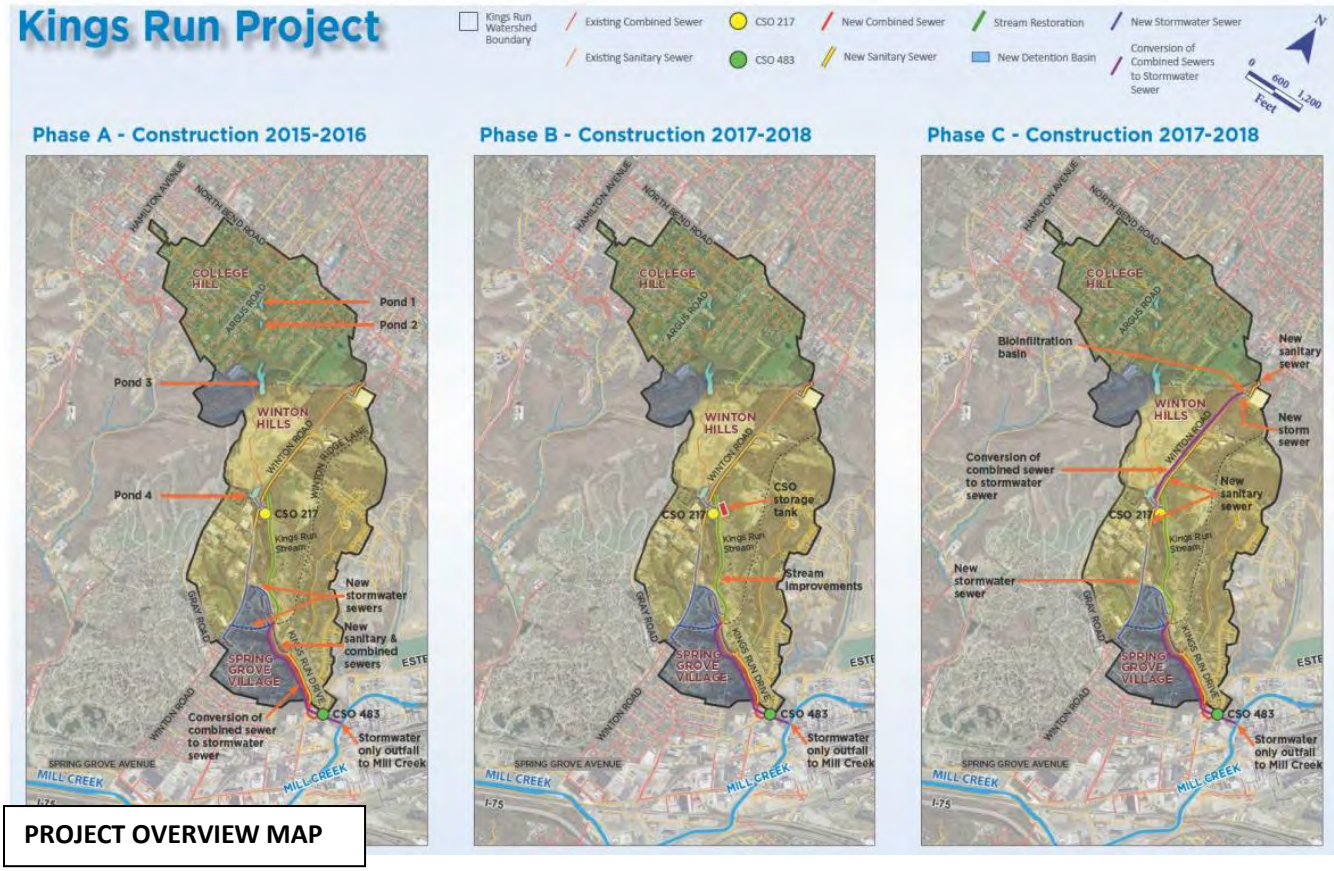
$$$$$ - $1,000,000 or more

9.1 PRIORITY PROJECT- KINGS RUN RESTORATION

Property Owner(s): Hamilton County, City of Cincinnati, private ownership
Political Jurisdiction: City of Cincinnati – Spring Grove Village, College Hill, Winton Hills
Nearest Road(s): Winton Road, Kings Run Drive
River Mile: upper watershed – King's Run
Latitude/Longitude: 39.1867/-84.5218
Drainage Area: Congress Run-Mill Creek
Land Use(s): residential, vacant, landfill, road
Access: Winton Road and Kings Run Drive
Potential Partners: MSDGC, Mill Creek Watershed Council of Communities, CDOTE, Cincinnati Park Board
Benefits: streambank stabilization/erosion control, habitat improvement
Timeline/Status: 3 Phases: (A) 2015-16, (B) 2016-18, (C) 2017-18
Level of Effort: ➲➲➲➲
Costs: $$$$$

BRIEF SUMMARY:
The Kings Run Project will eliminate about 156 million gallons of CSOs through a mix of green and gray infrastructure projects that will be constructed between 2015 and 2018.

This project includes new or enhanced stormwater detention ponds, new separate stormwater sewers, stream stabilization along Kings Run to help reduce erosion, and a bioinfiltration basin.



PROJECT OVERVIEW MAP

DETAILED PROJECT DESCRIPTION:

The watershed was named after the Kings Run stream, which is an historical tributary of the Mill Creek. The stream flows aboveground south of Dutch Colony Drive at Winton Road and is then piped back into the combined sewer system. During rains, when the system is overwhelmed by stormwater, it overflows through CSO 217 into Kings Run and through CSO 483 into the Mill Creek.

The Kings Run Project will eliminate about 156 million gallons of CSOs through a mix of green and gray infrastructure projects. The Kings Run Project includes three phases (A, B, and C) that will be constructed between 2015 and 2018. The projects will reduce overflows at CSOs 217 and 483 by decreasing the amount of stormwater that enters the combined sewer system during rainstorms and redirecting it to the Mill Creek.

Phase A includes four stormwater detention ponds, new combined and sanitary sewers, new stormwater sewers, and the conversion of a combined sewer to a stormwater sewer. Phase B includes plans to install a 1.5 million gallon storage tank to capture and store overflows at CSO 217 during rain storms. This phase also includes stream stabilization along Kings Run to help reduce erosion. Phase C includes the installation of new stormwater sewers, new sanitary sewers, and the conversion of an existing combined sewer to a stormwater sewer along Winton Road. Also included in Phase C is the installation of a bioinfiltration basin (e.g. rain garden) on the grounds of the Greater Cincinnati Water Works property off Winton Road.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
X	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
X	CSO and SSO volumetric reductions
X	peak flow/flood reduction
	prevents/reduces NPS pollution
X	social/recreational benefits
	other:

WATERSHED CONTEXT MAP

9.2 PRIORITY PROJECT- ROBERTS ACADEMY "FRONT YARD" STORMWATER DEMONSTRATION

Property Owner(s): Cincinnati Public School District
Political Jurisdiction: City of Cincinnati
Nearest Road(s): Grand Avenue
River Mile: upper watershed – Lick Run
Latitude/Longitude: 39.1173/-84.5591
Drainage Area: West Fork-Mill Creek
Land Use(s): public school
Access: Grand Avenue
Potential Partners: MSDGC, Mill Creek Watershed Council of Communities, Cincinnati Public Schools, Community Learning Center Institute, Cincinnati Park Board
Benefits: Increased stormwater retention, public amenity, water quality improvements
Timeline/Status: Design – 2013, Construction - 2014
Level of Effort: ➲➲➲➲
Costs: $$$$$

BRIEF SUMMARY:
The proposed Roberts Academy "Front Yard" Stormwater Demonstration project manages both water quantity, diverting 1.25 million gallons of stormwater runoff that would otherwise enter the combined sewer system, and water quality through reduced loads of nitrogen (40%), phosphorus (60%) and sediment loads (79%) to the Mill Creek.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
19	3	4,200					#

PROJECT OVERVIEW MAP

DETAILED PROJECT DESCRIPTION:

The 13-acre Roberts Academy (RA) campus includes the former school building (4.25 acres), 6 acres of permanently paved/roof top surfaces including the new RA building, and approximately 3 acres of pervious surfaces (grassed areas, parking islands, and an existing detention basin). Stormwater runoff is currently managed by conventional stormwater controls which eventually discharge to CSO 5. A planned demolition of the old school in summer 2012 will provide 4.25 acres of open space, a portion of which is proposed here for sustainable stormwater controls.

Benefits

1. Reduction in annual stormwater volume to CSO 5 of approximately 1.25 million gallons per year.
2. Reduction in N load by 40% (19lbs per year), P load by 60% (3lbs per year) and sediment load by 79% (2.1 tons per year) based on pre and post-construction N, P and sediment load estimates.
3. Complement to strategic sewer separation improvements and CSO volume reduction being achieved by the Grand Avenue and Selim Avenue Sewer Project, an infrastructure investment currently under design for the RA campus by MSD separate of the proposed project but within the same vicinity.
4. A new partnership between CPS and the Mill Creek Watershed Council of Communities (Council) to improve water quality, meet neighborhood priorities, and educate community residents about the value of the Mill Creek.
5. High visibility to the public through community events, school activities, and daily school traffic.

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
X	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
X	CSO and SSO volumetric reductions
X	peak flow/flood reduction
	prevents/reduces NPS pollution
X	social/recreational benefits
	other:

WATERSHED CONTEXT MAP

9.3 PRIORITY PROJECT- AMBERLEY CREEK CONSTRUCTED WETLAND & REFORESTATION (CONCEPTUAL)

Property Owner(s): single-lot private ownership
Political Jurisdiction: Sycamore Township
Nearest Road(s): Reading Rd
River Mile: upstream – Amberley Creek
Latitude: 39.208772 **Longitude:** -84.453687
Drainage Area: Amberley Creek (Congress Run-Mill Creek)
Land Use(s): vacant-residential
Access: from Reading Rd
Potential Partners: Sycamore Township
Benefits: increased floodplain, improved water quality, community amenity
Timeline/Status: Conceptual – exploring feasibility
Level of Effort: ➲➲➲➲
Costs: $$$$$

BRIEF SUMMARY:
The Amberley Creek Constructed Wetland & Reforestation project would address water quality and flooding issues by extending the floodplain thru the creation of a constructed wetland and by also adding 15 acres of tree canopy to the Congress Run watershed.

In addition, it could provide a community amenity in the form of a park or preserve.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)

Project Overview & Vicinity Map

DETAILED PROJECT DESCRIPTION:

The Amberley Creek Constructed Wetland & Reforestation project would address water quality and flooding issues by extending the floodplain thru the creation of a constructed wetland and by also adding 15 acres of tree canopy to the Congress Run watershed. Water quality sampling indicates that this area was a total suspended solids (TSS) "hotspot" (MBI, 2011).

Water quality testing: Site# - **MC83**; QHEI – 50; IBI - 24*; ICI – marginally-good non-significant departure; Attainment Status: NON-[WWH recommended]; Causes: sedimentation, dissolved oxygen, nutrients; Sources: altered hydrology, urban runoff; "fair habitat with deep pools, recommended for WWH" (MBI, 2011))

CSO status: CSOs #191, 651, 306 further upstream. No CSOs downstream before Mill Creek.

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
	CSO and SSO volumetric reductions
X	peak flow runoff reduction
	prevents/reduces NPS pollution
X	social/recreational benefits
X	other: air quality/carbon sequestration

WATERSHED CONTEXT MAP:

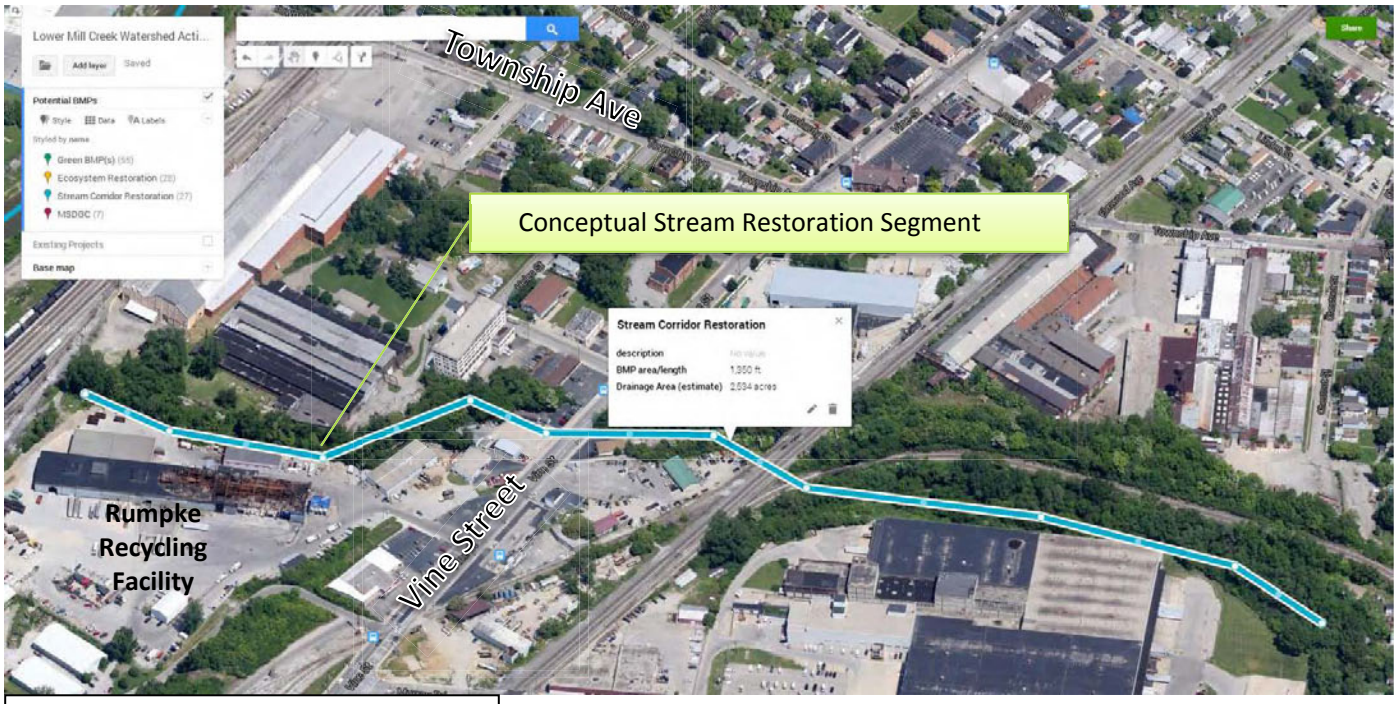
9.4 PRIORITY PROJECT- BLOODY RUN STREAM RESTORATION (CONCEPTUAL)

Property Owner(s): Norfolk-Western Railway, several private owners
Political Jurisdiction: Saint Bernard, Elmwood Place
Nearest Road(s): Vine Street
River Mile:
Latitude: 39.182656 **Longitude:** -84.493630
Drainage Area: Bloody Run (Congress Run-Mill Creek)
Land Use(s): industrial, commercial, vacant
Access: limited – from Vine Street
Potential Partners: Saint Bernard, Elmwood Place
Benefits: streambank stabilization/erosion control, habitat improvement,
Timeline/Status: Conceptual – exploring feasibility
Level of Effort: ➲➲➲➲
Costs: $$$$$

BRIEF SUMMARY:
The Bloody Run stream restoration project would address the streambank stability of this heavily impacted urban stream. This stream corridor is heavily encroached upon by high density urban development.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)



Project Overview & Vicinity Map

DETAILED PROJECT DESCRIPTION:

Within this Bloody Run stream segment from Prosser Ave to the Mill Creek, there are three railroad crossings and one major road overpass (Vine Street). The land uses around this stream segment are mostly industrial with some commercial on Vine Street and some residential on Prosser Ave. The stream itself is highly entrenched and constricted, with very little riparian corridor on its sides.

The goals of this project are to reduce streambank erosion, possibly capture and pretreat some runoff from adjacent properties before it enters the creek, reforestation, and other instream habitat improvements.

Water quality testing: N/A

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
	CSO and SSO volumetric reductions
X	peak flow runoff reduction
X	prevents/reduces NPS pollution
X	social/recreational benefits
	other:

WATERSHED CONTEXT MAP:

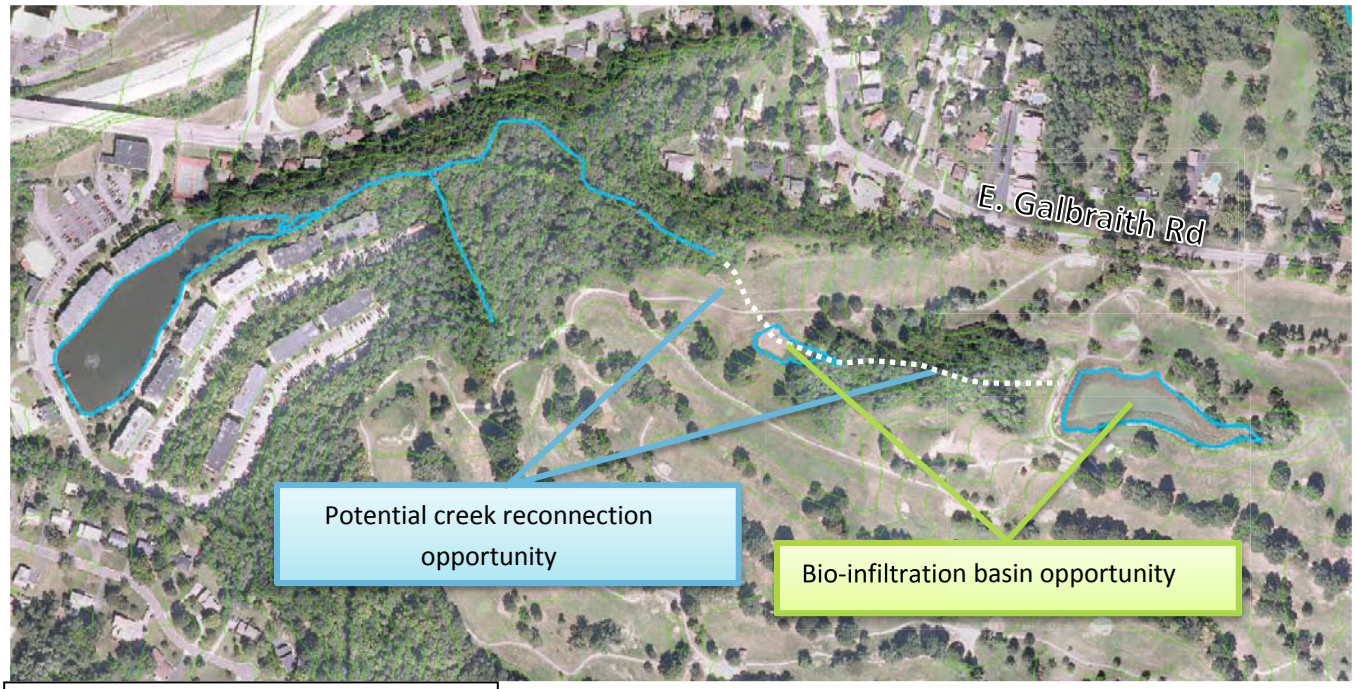
9.5 PRIORITY PROJECT- FORMER RIDGEWOOD GOLF COURSE (CONCEPTUAL)

Property Owner(s): Amberley Village
Political Jurisdiction: Amberley Village
Nearest Road(s): E. Galbraith Rd
River Mile: upper watershed – Amberley Creek
Latitude: 39.209221 **Longitude:** -84.432337
Drainage Area: Congress Run-Mill Creek
Land Use(s): vacant, park
Access: E. Galbraith Rd, Ridge Rd
Potential Partners: Amberley Village
Benefits: increased stormwater retention, improved water quality, community amenity
Timeline/Status: Conceptual – exploring feasibility
Level of Effort: ➲➲➲➲
Costs: $$$$$

BRIEF SUMMARY:
The former Ridgewood Golf Course contains a great opportunity to enhance an existing detention basin and turn it into a more effective bio-infiltration basin. Utilizing the existing topography, the basin could spill into a restored surface water-way that could further treat water quality.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#



Project Overview & Vicinity Map

DETAILED PROJECT DESCRIPTION:

The former Ridgewood Golf Course in Amberley Village contains a great opportunity to enhance an existing detention basin and turn it into a more effective **bio-infiltration basin**. Utilizing the existing topography, the basin could spill into a **restored surface water-way** that could further treat water quality. R**eforestation** would greatly enhance the effectiveness of this project in reducing stormwater volumes and providing additional environmental benefits.

Water quality testing: N/A

CSO status: No CSOs in this area

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
	CSO and SSO volumetric reductions
X	peak flow runoff reduction
X	prevents/reduces NPS pollution
X	social/recreational benefits
	other:

WATERSHED CONTEXT MAP:

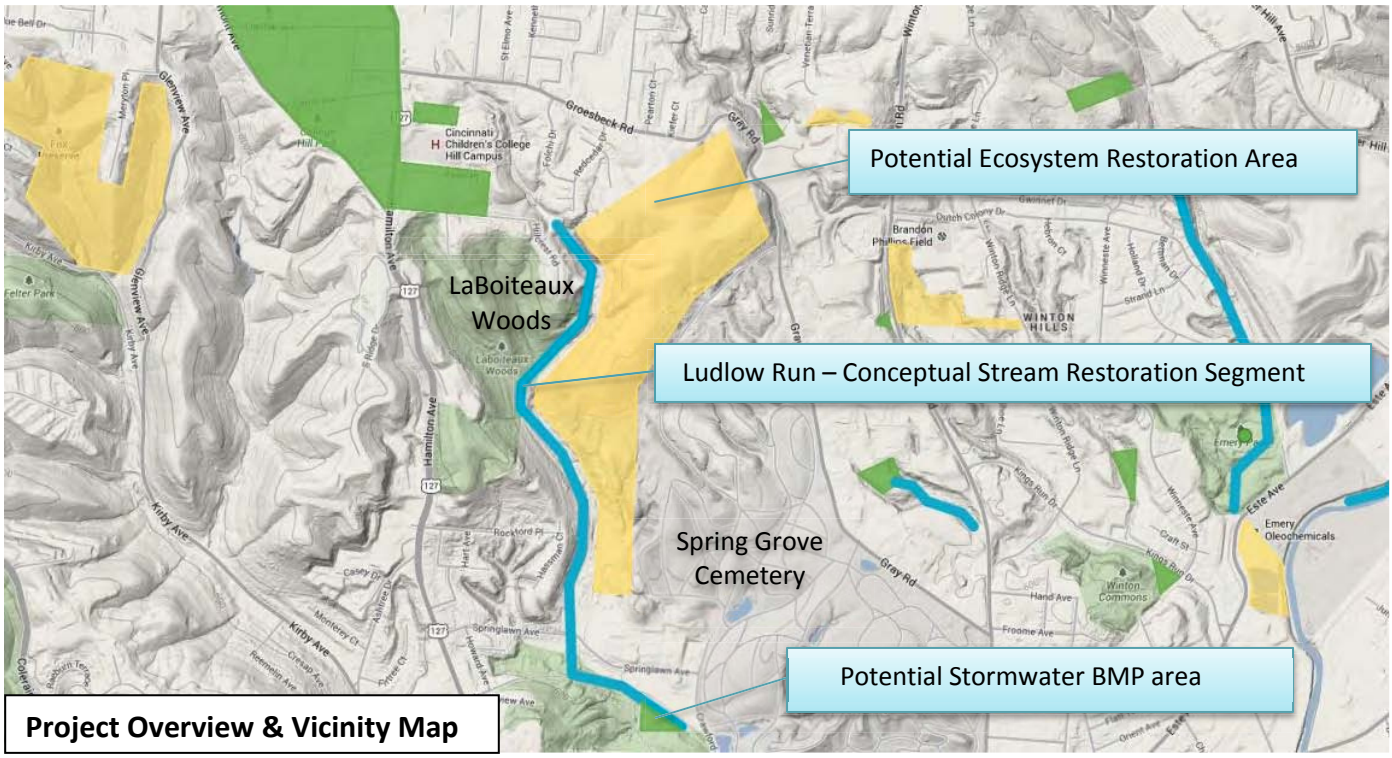
9.6 PRIORITY PROJECT- LUDLOW RUN STREAM RESTORATION (CONCEPTUAL)

Property Owner(s): City of Cincinnati, Spring Grove Cemetery, Private Owners
Political Jurisdiction: City of Cincinnati – Spring Grove Village
Nearest Road(s): Springlawn Ave, Hamilton Ave to west
River Mile:
Latitude: 39.180377 **Longitude:** -84.537296
Drainage Area: King's Run (Congress Run– Mill Creek)
Land Use(s): Park, Vacant, Cemetery, Residential
Access: from LaBoiteaux Woods
Potential Partners: Cincinnati Parks, Spring Grove Cemetery
Benefits: streambank stabilization/erosion control, habitat improvement, improved water quality
Timeline/Status: Conceptual – exploring feasibility
Level of Effort: ➲➲➲➲
Costs: $$$$$

BRIEF SUMMARY:
Ludlow Run stream restoration project would address the health of this impacted urban stream. While many segments of this stream have a good riparian corridor, the increase in urbanization in this watershed has caused increased stream velocities which are impacting its long term health. Invasive species have also been an issue in this corridor, requiring some intervention already in LaBoiteaux Woods.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#



Project Overview & Vicinity Map

DETAILED PROJECT DESCRIPTION:

Ludlow Run originates from the Children's Hospital/College Hill Area, and flows south through Spring Grove Cemetery property, passing under Springlawn Avenue, and eventually entering a culvert at Crawford Avenue. A large Duke utility easement runs East-West, traversing perpendicular to Ludlow Run. This area is a largely forested hillside that provides Ludlow Run with a nice riparian buffer zone.

Ludlow Run is directly affected by CSO issues. Above Ludlow Run, in the College Hill neighborhood, are CSO #151 and #109. CSO #151 is responsible for 64 CSO events and 62 million gallons of CSO overflow per year. CSO #109 is responsible for 25 CSO events and 2 million gallons of CSO overflow per year. Further down Ludlow Run, close to where it meets Springlawn Avenue, is CSO #162 that is responsible for 63 CSO events and 7 million gallons of overflow per year. Near the confluence of Ludlow Run to Mill Creek is CSO #24, which is responsible for 66 CSO events per year and 133 million gallons per year. Ludlow Run water quality sampling: N/A.

Ludlow Run is affected by CSOs, urban runoff, hydromodification, and habitat alterations. Invasive species have also been a threat. Despite these issues, many consider Ludlow Run to be one of the best "unknown" headwater streams in the Lower Mill Creek watershed.

Conceptual solutions include restoration of in-stream habitat, increased floodplain connectivity and flood storage, and riparian buffer enhancement. Ecosystem restoration practices would help mitigate changes in hydrological characteristics and habitat loss. Streambank stabilization of up to 7,700 linear ft. would help prevent erosion. Areas for additional tree canopy could be explored. A stormwater BMP could potentially mitigate or remove CSO events at #162.

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
X	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
X	CSO and SSO volumetric reductions
X	peak flow runoff reduction
	prevents/reduces NPS pollution
X	social/recreational benefits
	other:

WATERSHED CONTEXT MAP:

9.7 PRIORITY PROJECT- MILL CREEK FROM TOWNSHIP AVE TO PROCTOR & GAMBLE BRIDGE (CONCEPTUAL)

Property Owner(s): ACOE, MCVCD
Political Jurisdiction: Saint Bernard, City of Cincinnati
Nearest Road(s): Center Hill Ave
River Mile: 7.6
Latitude: 39.182855 **Longitude:** -84.498921
Drainage Area: Congress Run-Mill Creek
Land Use(s): industrial, railroad
Access: limited
Potential Partners: Saint Bernard, City of Cincinnati
Benefits: habitat and hydromodification improvements, community amenity, reduce water temperatures
Timeline/Status: Conceptual – exploring feasibility
Level of Effort: ➲➲➲➲
Costs: $$$$$

BRIEF SUMMARY:
This conceptual project proposes to restore approximately 3,000 linear feet of the Mill Creek. This segment is just downstream from a previously restored segment of the Mill Creek. This segment is channelized mostly using rip-rap on the edges instead of concrete.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#

Project Overview & Vicinity Map

DETAILED PROJECT DESCRIPTION:
Restoration of the Mill Creek has been incremental, taking advantage of resources and opportunities as they become available. This segment is great segment to approach next because instead of dealing with a concrete trapezoidal channel it has rip-rap edges only, except for around the bridges and storm outlets. This segment has very little tree canopy so reforestation would be a great first step to lower stream temperatures and begin establishing a riparian zone. This segment contains a low-head dam just beneath the Center Hill Bridge, which is planned for remediation or removal. Some instream restoration techniques could help reestablish the riffle-pool structure and create some new and improved habitat.

Water quality testing: Site# - **MC77**; QHEI – 57.5; IBI - 27*; ICI – 28 non-significant departure; Attainment Status: NON-[MWH]; Causes: habitat alteration, sedimentation, PAH, nutrients, chlorides; Sources: hydromodification, altered hydrology, urban runoff; (MBI, 2011))

CSO status: No CSO outlets are located within this segment, but several large storm sewer outlets are.

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
	CSO and SSO volumetric reductions
	peak flow runoff reduction
	prevents/reduces NPS pollution
X	social/recreational benefits
	other:

WATERSHED CONTEXT MAP:

9.8 PRIORITY PROJECT- LOW HEAD DAM MITIGATION

Property Owner: State of Ohio
Political Jurisdiction: City of Cincinnati, Elmwood Place
Nearest Road(s): Spring Grove Ave west of Clifton Ave (A & B); Center Hill Ave west of Vine St (C)
River Mile: Mill Creek RM 4.7 (A); RM 5.3 (B); RM 7.8 (C)
Latitude/Longitude: A: 39.159/-84.531; B: 39.164/-84.519; C: 39.186/-84.495
Drainage Area: Congress Run-Mill Creek
Land Use(s): N/A
Access: Limited (In-stream)
Potential Partners: MSDGC, Duke Energy, Mill Creek Watershed Council of Communities, Groundwork Cincinnati: Mill Creek
Benefits: Habitat restoration, water quality improvement
Timeline/Status: Awaiting Implementation
Level of Effort: ➲➲➲➲
Costs: $$$$$

BRIEF SUMMARY:
There are multiple low head dams located along the main stem of the Mill Creek. These dams are barriers to fish passage and pose a risk of significant water quality impairment if they are not well maintained and leaks occur. Low head dams along the Mill Creek have been removed or mitigated in the past, and this project proposes to remediate an additional three dams for which no plans or provisions for removal currently exist. Removal/mitigation of these dams would improve oxygenation and allow for increased rates of microbial processing, while also allowing fish passage.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#

LOW HEAD DAMS PROPOSED FOR REMEDIATION IN THE MILL CREEK MAINSTEM **(Continued on next page)**

DETAILED PROJECT DESCRIPTION:
Low head dams are barriers to fish passage in the Mill Creek and pose a risk of catastrophic failure deleterious to water quality and requiring costly repairs to aging infrastructure.

Many such structures on the Mill Creek and its tributaries have been effectively stabilized by installation of Newbury riffles. These grade control structures consist of placed stone on top of and downstream of the dam. This pools water behind the low head dam, removing the pressure of stream flow on infrastructure, and improves water quality through increased oxygenation of water as it runs over the riffle and increased surface area for microbial processing. Newbury riffles also allow for fish passage.

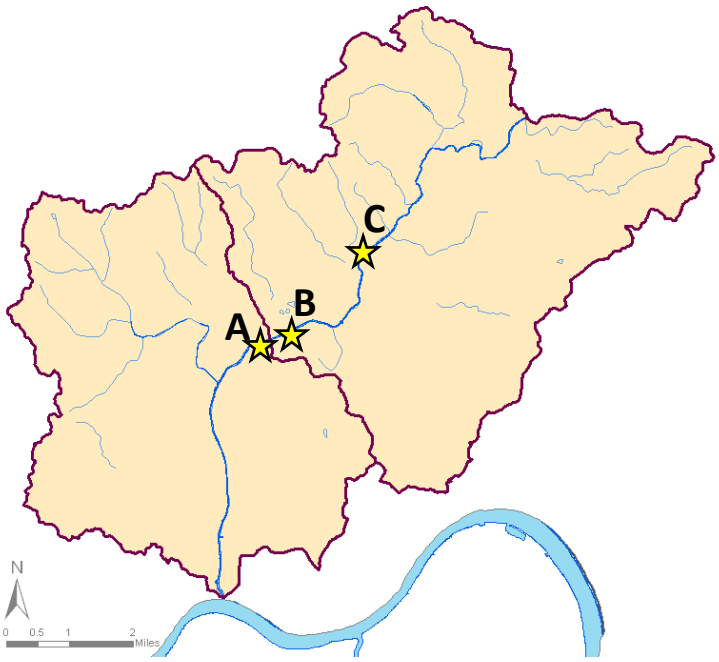
These are relatively inexpensive to design, construct and install and have been used effectively in the Mill Creek Watershed and elsewhere. Three low head dams remain on the main stem in the lower Mill Creek Watershed for which there is no provision to remediate them. Grant funds from the Ohio EPA are available for this type of stream restoration. However, significant local match requirements make these projects cost-prohibitive as there is no local entity with the mandate or funds to provide such a match at this time.

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
	CSO and SSO volumetric reductions
	flood reduction
	prevents/reduces NPS pollution
X	social/recreational benefits
X	other: additional water quality benefits

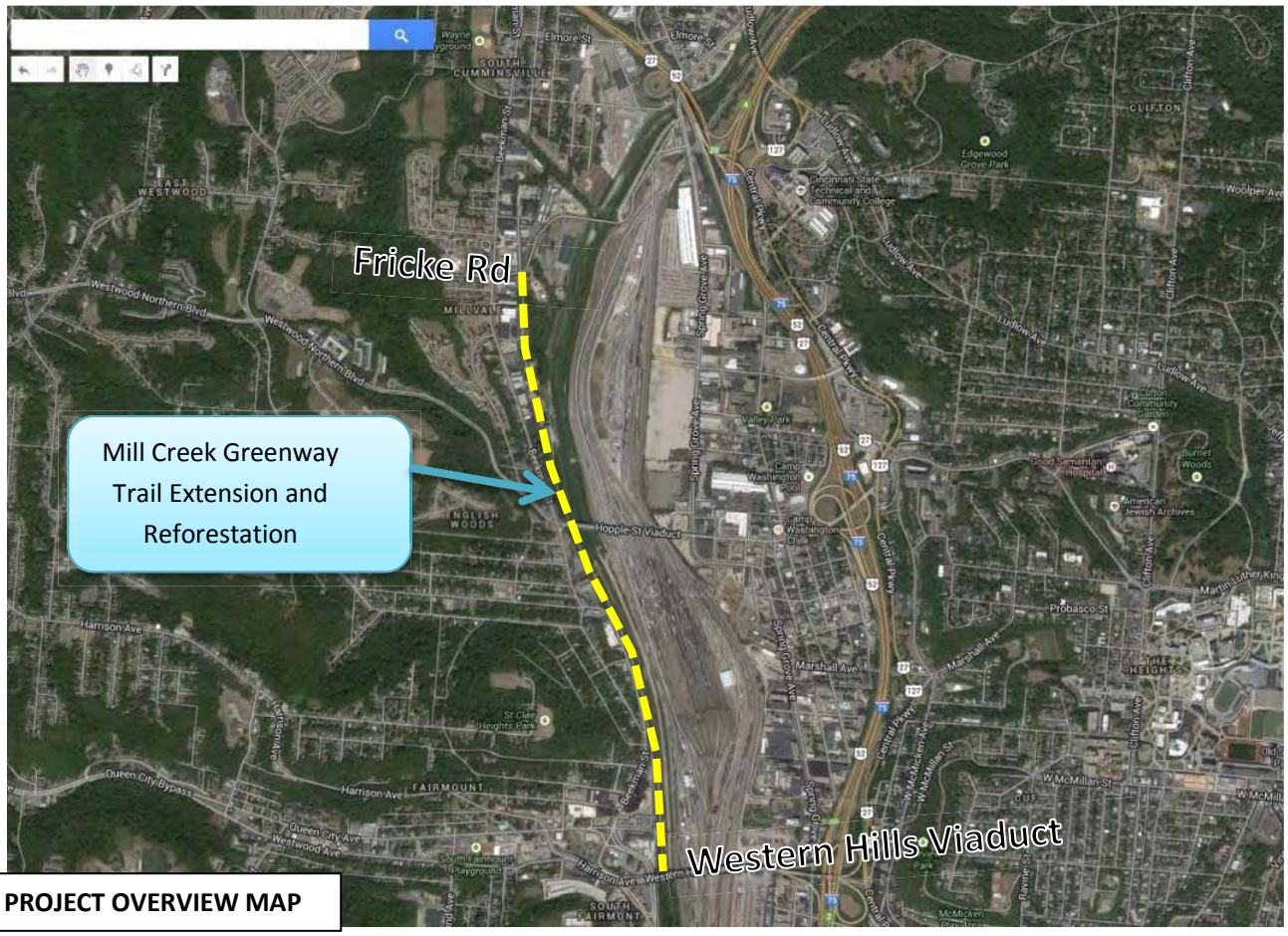
WATERSHED CONTEXT MAP



9.9 PRIORITY PROJECT- MILL CREEK RIPARIAN CORRIDOR FROM SOUTH CUMMINSVILLE TO SOUTH FAIRMOUNT

Property Owner:	City of Cincinnati, CSX, the Mill Creek Valley Conservancy District
Jurisdiction:	City of Cincinnati
Nearest Road(s):	Beekman St, Westwood Northern Blvd
River Mile:	Mill Creek (RM 2.5)
Latitude/Longitude:	39.13777/-84.5474
Drainage Area:	West Fork- Mill Creek
Land Use(s):	manufacturing, residential, greenway trail
Access:	Beekman St, Mill Creek Rd,
Potential Partners:	Groundwork Cincinnati: Mill Creek, MSDGC, Cincinnati Park Board, Ohio EPA, Safe Routes to School
Benefits:	Improved water quality, community amenity
Timeline/Status:	proposed seeking funding for implementation
Level of Effort:	➲➲➲➲
Costs:	$$$$$

BRIEF SUMMARY:
In conjunction with the extension of the Mill Creek Greenway Trail systems Phase 5, this project will help with the reforestation of 100 trees along the Mill Creek, the removal of invasive species in the corridor, and the implementation of green infrastructure projects along the trail.



PROJECT OVERVIEW MAP

DETAILED PROJECT DESCRIPTION:

This project will concentrate on ecological improvements to wildlife habitat and the riparian corridor on the west side of Mill Creek, between Mill Creek Road in South Cumminsville and Queen City Avenue in South Fairmount, where it will connect to the Western Hills Viaduct and the future MSD Lick Run daylighting project. The project will include reforestation of approximately two-linear-miles of the riparian corridor, removal of trash and debris, eradication of invasive species, and improvements to aquatic and terrestrial habitat. In addition, GWC will extend the Mill Creek Greenway Trail through this project site.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
X	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

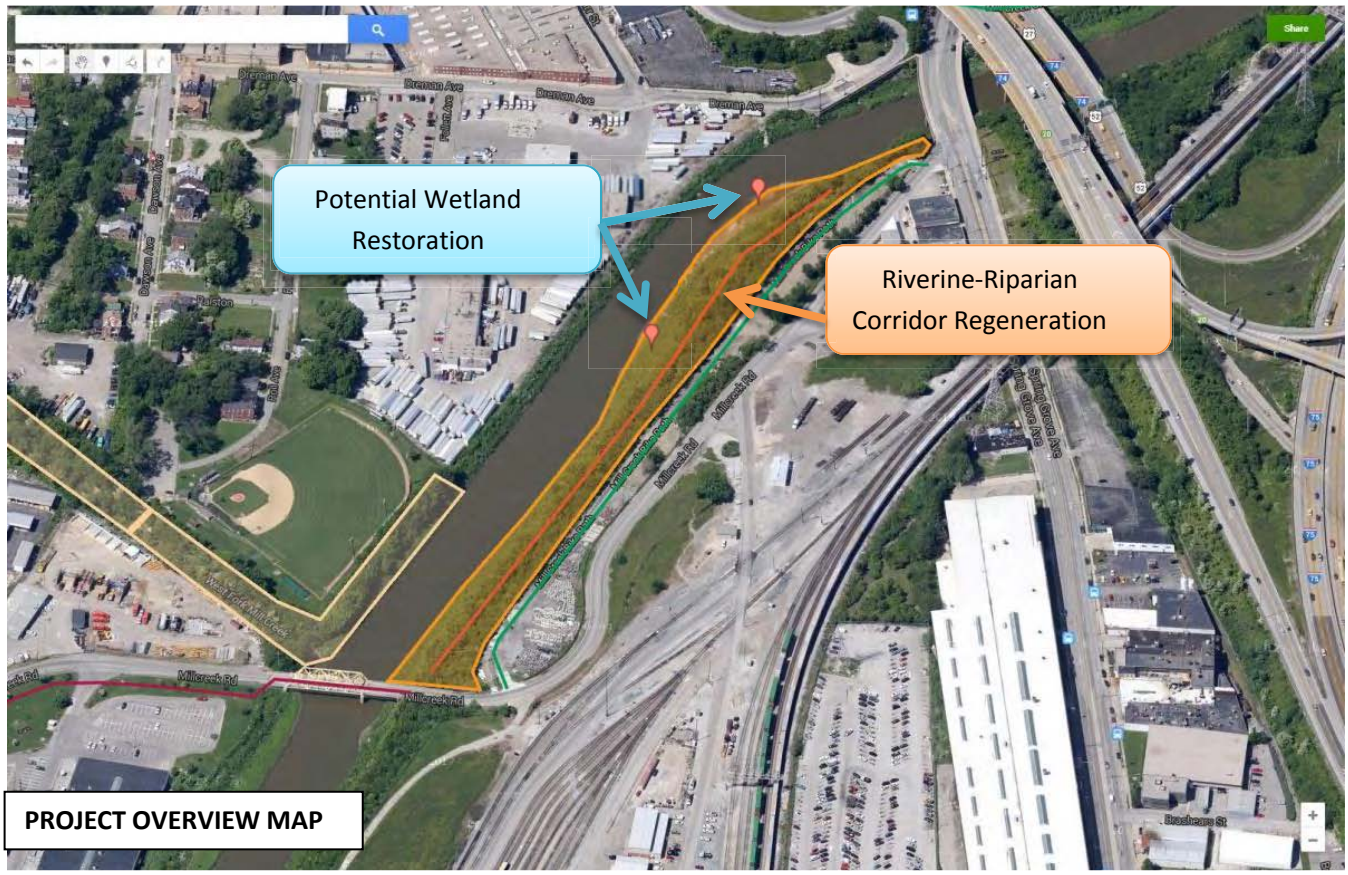
Additional Community Benefits:	
	CSO and SSO volumetric reductions
X	peak flow runoff reduction
X	prevents/reduces NPS pollution
X	social/recreational benefits
X	other: air quality/carbon sequestration

WATERSHED CONTEXT MAP

9.10 PRIORITY PROJECT- MILL CREEK RIVERINE-RIPARIAN CORRIDOR – VICINITY OF MILL CREEK ROAD BRIDGE

Property Owner:	Mill Creek Valley Conservancy District
Jurisdiction:	City of Cincinnati
Nearest Road(s):	Mill Creek Road
River Mile:	Mill Creek (RM 3.5)
Latitude/Longitude:	39.150987/-84.544424
Drainage Area:	West Fork- Mill Creek
Land Use(s):	trail
Access:	Mill Creek Road (Greenway Trail access)
Potential Partners:	Groundwork Cincinnati: Mill Creek, MSDGC, Cincinnati Park Board,
Benefits:	Improved water quality, wetland restoration, aquatic/terrestrial habitat, community amenity
Timeline/Status:	2014-2015; seeking funding
Level of Effort:	➲➲➲➲
Costs:	$$$$$

BRIEF SUMMARY:
The project will improve water quality and ecological functioning by restoring wetlands, enhancing aquatic and riparian habitat, eradicating invasive species, and reintroducing Ohio native vegetation. Further, the project will provide multiple community benefits and serve as an environmental education learning station for observing wildlife by GWC students, neighborhood residents, and trail users.



PROJECT OVERVIEW MAP

DETAILED PROJECT DESCRIPTION:

Project will occur on publicly owned land between the Spring Grove Avenue and Mill Creek Road bridges and the old grain silo downstream of the City Sanitation Garage. Project will include enhancing aquatic and terrestrial habitat; eradicating invasive species; reintroducing Ohio native trees, shrubs, and plants; planting an edible forest garden in the upland riparian zones; removing trash and debris from the channel and streambanks, and delineating and restoring wetlands within the river channel. Project may also include stabilizing eroding streambanks using soil bioengineering systems on the west side of Mill Creek, dependent on property owner permission. In addition to the water quality and ecological improvements, the project will provide an outdoor environmental education site for thousands of students participating in GWC's program each year, and provide a wildlife viewing opportunity for people of all ages who use the Mill Creek Greenway Trail that adjoins the project.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
X	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

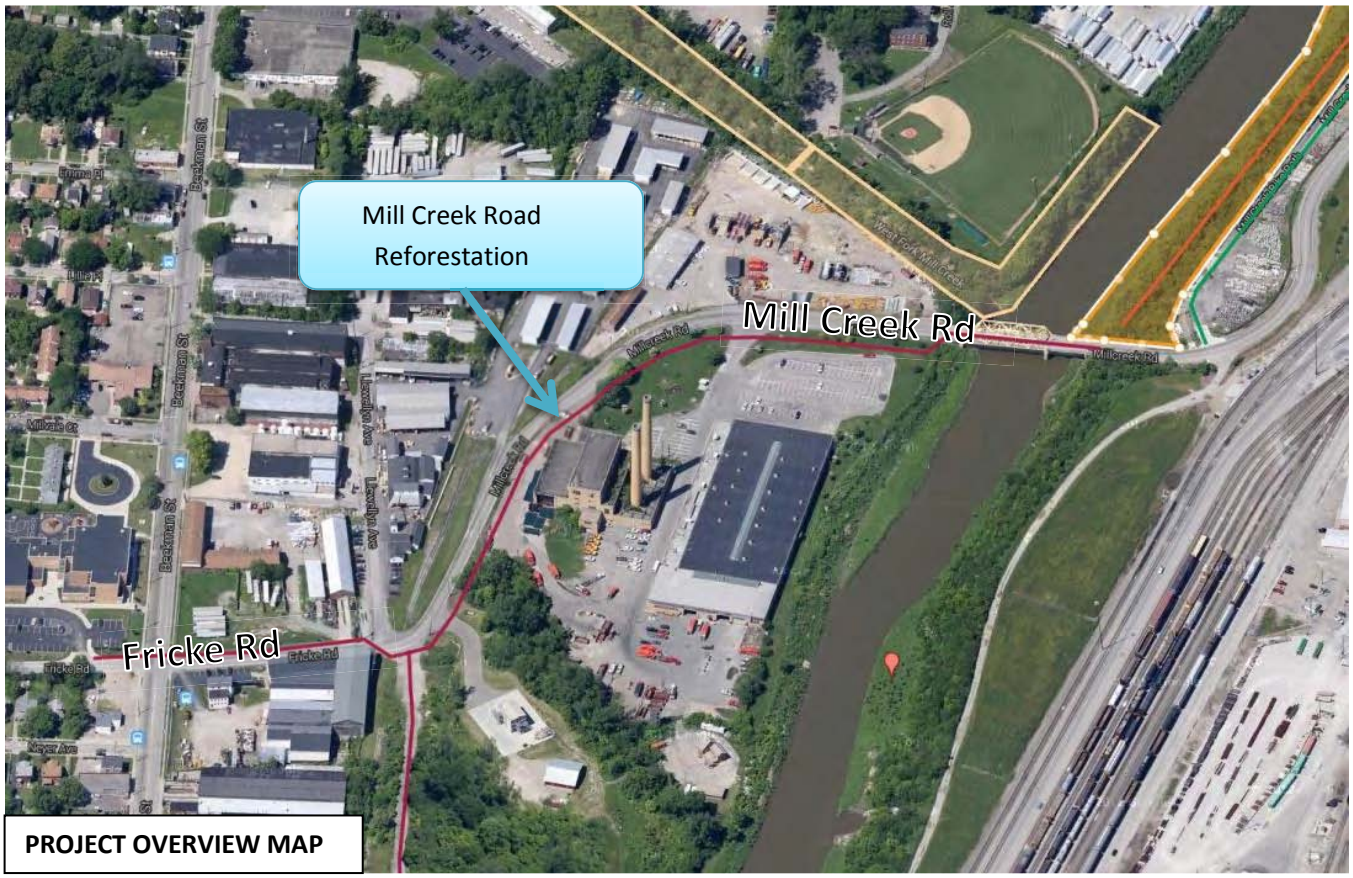
Additional Community Benefits:	
	CSO and SSO volumetric reductions
X	peak flow runoff reduction
X	prevents/reduces NPS pollution
X	social/recreational benefits
X	other: air quality/carbon sequestration

WATERSHED CONTEXT MAP

9.11 PRIORITY PROJECT- MILL CREEK ROAD REFORESTATION

Property Owner: City of Cincinnati and C W Wood Manufacturing
Jurisdiction: City of Cincinnati
Nearest Road(s): Mill Creek Road Bridge and Fricke Rd
River Mile: Mill Creek (RM 3.5)
Latitude/Longitude: 39.14736/-84.5496
Drainage Area: West Fork- Mill Creek
Land Use(s): government operations, manufacturing, greenway trail
Access: Mill Creek Rd, Fricke Rd
Potential Partners: Groundwork Cincinnati: Mill Creek, MSDGC, Cincinnati Park Board, Ohio EPA, USGS, Safe Routes to School
Benefits: Improved water quality, community amenity
Timeline/Status: proposed 2014; seeking funding for implementation
Level of Effort: ➲➲➲➲
Costs: $$$$$

BRIEF SUMMARY:
Project will remove invasive species and reintroduce Ohio native vegetation along the Mill Creek Road Bridge and Beekman Avenue. The Green Infrastructure will filter, infiltrate, and evapotranspirate stormwater runoff from Mill Creek Road and provide habitat.



PROJECT OVERVIEW MAP

DETAILED PROJECT DESCRIPTION:

Project will include planting 50 Ohio native trees, as well as native shrubs and plants, along the Mill Creek Greenway Trail in 2014. This will improve air quality by filtering particulates, increase carbon sequestration, create terrestrial habitat, and filter and infiltrate local stormwater runoff. The added benefits of the project, particularly for economically distressed neighborhoods, will include new opportunities for outdoor exercise, recreation, and human-powered transportation. In addition, the project will provide immediate and long-term opportunities for environmental education programming for students from the low income North Fairmount, Millvale, and South Cumminsville neighborhoods. The students will conduct educational monitoring of Mill Creek and complete service learning projects within this portion of the Lower Mill Creek Watershed.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
	CSO and SSO volumetric reductions
X	peak flow runoff reduction
X	prevents/reduces NPS pollution
X	social/recreational benefits
X	other: air quality/carbon sequestration

WATERSHED CONTEXT MAP

9.12 PRIORITY PROJECT- RAPID RUN PARK

Property Owner: City of Cincinnati
Political Jurisdiction: City of Cincinnati- West Price Hill
Nearest Road(s): Rapid Run Pike, North of Glenway Avenue
River Mile: Upper watershed- Lick Run
Latitude/Longitude: 39.117/-84.589
Drainage Area: Stormwater to feed the Lick Run Valley Conveyance System (VCS)
Land Use(s): Park
Access: Public access from Rapid Run Pike
Potential Partners: MSDGC, Cincinnati Parks, Cincinnati Recreation Commission
Benefits: Bioinfiltration, CSO reduction
Timeline/Status: In Construction (to be completed Fall 2014)
Level of Effort: ➲➲➲➲
Costs: $$$$$

BRIEF SUMMARY:
This project is one in a suite of a dozen projects in the 2,900-acre Lick Run watershed that the Metropolitan Sewer District of Greater Cincinnati (MSDGC) is conducting to partially address Phase I of its federal consent decree. The Rapid Run Park project will reduce stormwater volumes into the combined sewer by 15 million gallons per year through a combination of bioswales, bioretention basins, disconnected downspouts, and the separation of some existing combined sewer to storm and sanitary sewer lines.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
115	174	18,717					3E+07

PROJECT OVERVIEW MAP

Design Concept Map prepared by Human Nature for MSDGC

* Load reductions estimated using methods outlined in Section x.x.x

DETAILED PROJECT DESCRIPTION:

This project is one of a dozen projects that MSDGC is undertaking in the Lick Run watershed to partially address its Phase 1 federal consent decree obligations to reduce combined sewer overflows. This suite of projects in Lick Run will collectively reduce combined sewer overflows into the Mill Creek by an estimated 624 million gallons per year.

About 1,600 linear feet of bioswale will be constructed on the park grounds parallel to Rapid Run Pike. A bioswale is similar to a regular drainage swale but includes features to allow the stormwater to pool in areas (to slow it down) and also absorb into the ground. The bioswale will carry stormwater runoff from the park,

Rapid Run Pike and the hillsides/grounds on the south side of Rapid Run Pike, including the CRC playground and ball field. Stormwater sewers will be constructed along the project route to carry stormwater to the bioswale and under the park's parking lot. Two small bioretention basins on the south side of Rapid Run Pike will also collect stormwater for the bioswale.

The project also includes disconnecting the park shelter/restroom area from the combined sewer system. Downspouts will be allowed to flow onto the ground. The existing combined sewer will be converted to a stormwater sewer that will capture overflow from the park pond and runoff from the park grounds and carry it to the bioswale. A new sanitary line will be constructed to convey sanitary sewage to the combined sewer in Rapid Run Pike.

In total, this project will keep 15 million gallons of stormwater out of the combined sewer system. Construction will occur between the winter of 2013 and the fall of 2014.

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

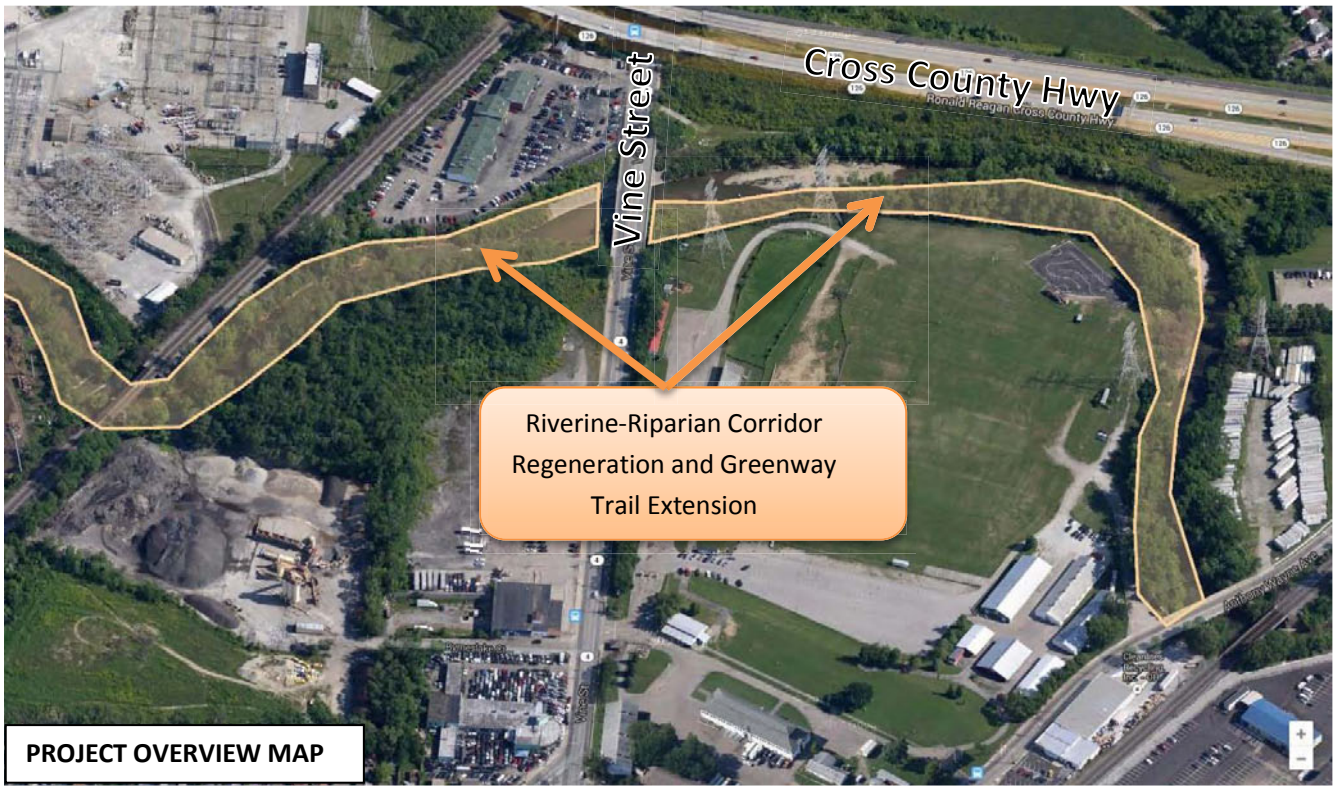
Additional Community Benefits:	
X	CSO and SSO volumetric reductions
X	flood reduction
	prevents/reduces NPS pollution
X	social/recreational benefits
	other:

WATERSHED CONTEXT MAP

9.13 PRIORITY PROJECT- ECOLOGICAL REGENERATION AND GREENWAY TRAIL: RAILROAD BRIDGE THROUGH HAMILTON COUNTY FAIRGROUNDS

Property Owner:	Mill Creek Valley Conservancy District, Hamilton County, Duke Energy, Byer Steel
Jurisdiction:	City of Cincinnati
Nearest Road(s):	West North Bend Rd and Vine St
River Mile:	Mill Creek (RM 9.5)
Latitude/Longitude:	39.20323/-84.485561
Drainage Area:	Congress Run- Mill Creek
Land Use(s):	fairground/park, landfill, manufacturing
Access:	thru Fairground, Vine Street, or Caldwell Recreation Park
Potential Partners:	Groundwork Cincinnati: Mill Creek, MSDGC, Cincinnati Park Board, Mill Creek Valley Conservancy District, City of Cincinnati, Mill Creek Watershed Council, landfill owners
Benefits:	Improved water quality, community amenity
Timeline/Status:	proposed 2015-2017; seeking funding for implementation
Level of Effort:	➲➲➲➲
Costs:	$$$$$

BRIEF SUMMARY:
The project will be closely coordinated with MSD and include aquatic and riparian habitat restoration, streambank stabilization using soil bioengineering systems, a constructed wetland or bio-infiltration basin, and other Green Infrastructure solutions for stormwater runoff. Additional benefits will include improved air quality from additional tree canopy and further extension of the Mill Creek Greenway Trail from Caldwell Park to the Fairgrounds. The project will also provide access to Mill Creek for environmental education purposes.



PROJECT OVERVIEW MAP

DETAILED PROJECT DESCRIPTION:

Project will restore Mill Creek riverine/riparian health between the railroad bridge over Mill Creek, just east of the Hartwell Golf Course project and the Hamilton County Fairgrounds, along the south side of Mill Creek. Work will be closely coordinated with MSD and other partners and will include stabilizing streambanks using soil bioengineering systems, improving aquatic habitat, removing invasive species and reintroducing native species in the riparian corridor, and creating a wetland or bio-infiltration basin at the Hamilton County Fairgrounds to filter and infiltrate stormwater runoff and provide source control to reduce CSOs. An added feature will be the extension of the Mill Creek Greenway Trail between the Caldwell recreational park and Fairgrounds. This will result in almost seven miles of continuous multi-purpose hike and bike trail that will increase opportunities, particularly for economically distressed Mill Creek neighborhoods, for outdoor exercise, recreation, and human-powered transportation.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
X	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
X	CSO and SSO volumetric reductions
X	peak flow runoff reduction
X	prevents/reduces NPS pollution
X	social/recreational benefits
X	other: air quality/carbon sequestration

WATERSHED CONTEXT MAP

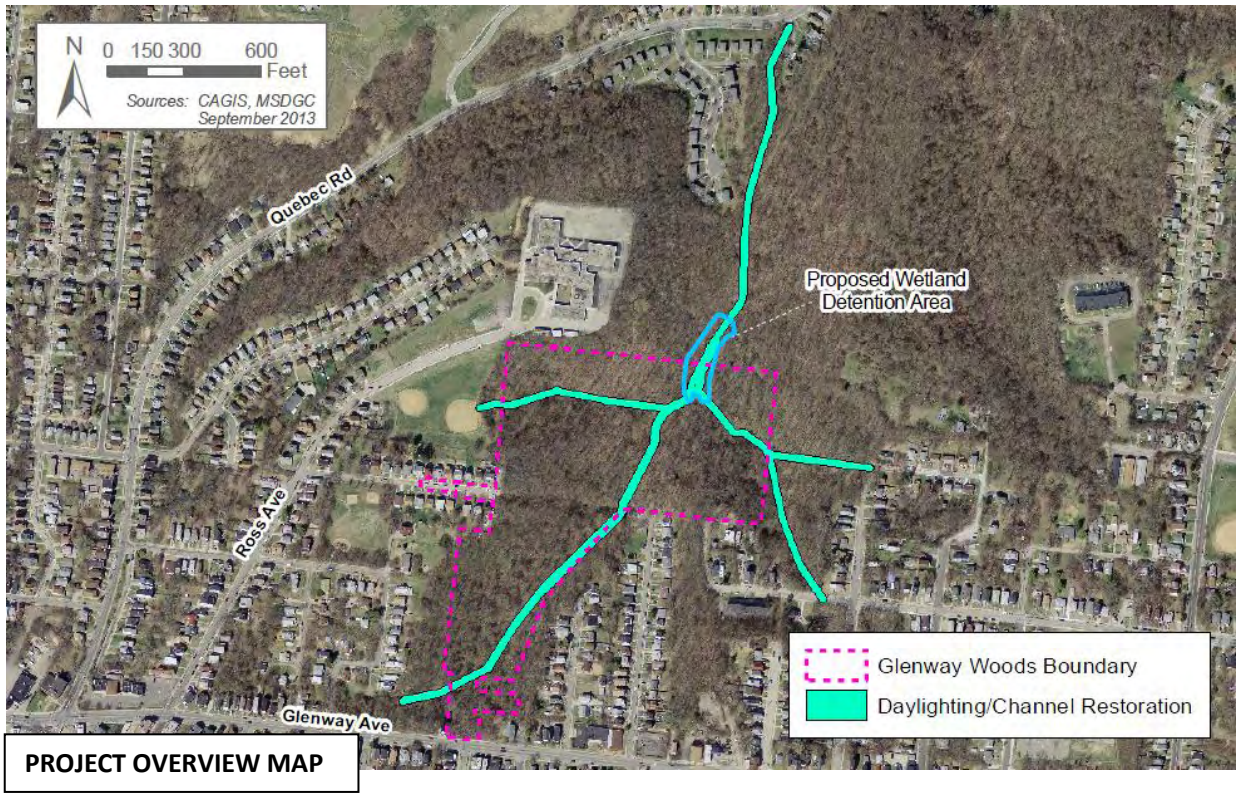
9.14 PRIORITY PROJECT- GLENWAY WOODS BASIN

Property Owner: City of Cincinnati
Political Jurisdiction: City of Cincinnati – Price Hill
Nearest Road(s): Glenway Ave and Purcell Ave
River Mile: Upper watershed – Lick Run
Latitude/Longitude: 39.118/-84.567
Drainage Area: Stormwater to feed the Lick Run Valley Conveyance System (VCS)
Land Use(s): Park
Access: Pedestrian access from four corners of lot
Potential Partners: Project Groundwork: Mill Creek, MSDGC, Cincinnati Park Board, Hamilton County, Ohio EPA, USGS
Benefits: CSO Reduction, Improved Air and Water Quality, Community Amenity
Timeline/Status: Construction to begin Fall 2014
Level of Effort: ➲➲➲➲
Costs: $$$$$ Grant funds sought to cover some project components

Brief Summary:
This project is one in a suite of a dozen projects in the 2,900-acre Lick Run watershed that the Metropolitan Sewer District of Greater Cincinnati (MSDGC) is conducting to partially address Phase I of its federal consent decree. The Glenway Woods Basin project is an element of MSD's Quebec Heights Sewer Separation project. The project will combine stream daylighting, green BMPs, forested wetlands, invasive plant control, tree planting, and forest restoration to reduce the amount of polluted run-off that enters the combined sewer system.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
38	99	23,393					3E+07



PROJECT OVERVIEW MAP

DETAILED PROJECT DESCRIPTION:

The watershed that contains Glenway Woods is heavily urbanized with impervious surfaces comprising 29% of the land area. Stormwater runoff is the number one cause of stream impairment in urban areas. Highly urbanized areas result in a much greater amount of runoff as compared to the amount resulting from highly forested areas. The large volume of runoff is swiftly carried to the combined sewers, to the Mill Creek, and then to the Ohio River and causing flooding and erosion that washes away important wildlife habitat and sedimentation in the Ohio. Trees slow down and temporarily store runoff, which further promotes infiltration, and decreases runoff. They also reduce pollutants by taking up nutrients and other pollutants from soils and water through their roots, and by transforming pollutants into less harmful substances.

The Glenway Woods project includes planting a significant number of forest canopy and understory trees that will be used to restore the park after construction. A 2011 iTree Hydro analysis of the Lick Run watershed found that a 20% increase in forested canopy would result in a reduction in overland flow of 6.2 million gallons, or 6.3% of total flow. The project will slow and filter 48 million gallons of stormwater by channeling it through a constructed forested wetland. Forested wetlands carry out critical hydrological, biochemical, and ecological water management roles, as well as enhancing wildlife habitat. They are also excellent carbon sinks and reduce nutrient loads and sedimentation that would ultimately reach the Ohio River.

A vegetation survey of Glenway Woods found that 19.5 acres of the park are populated by invasive species, 13 acres of which are dominated by Lonicera. The 2011 iTree Hydro study found that removal of Lonicera species and restoration of the forest floor reduces stormwater runoff. New Trails will improve community access to the park and offer enhanced recreational opportunities. The Glenway Woods project will provide community education and outreach opportunities through the use of informational signage.

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
	CSO and SSO volumetric reductions
	flood reduction
	prevents/reduces NPS pollution
X	social/recreational benefits
	other:

WATERSHED CONTEXT MAP

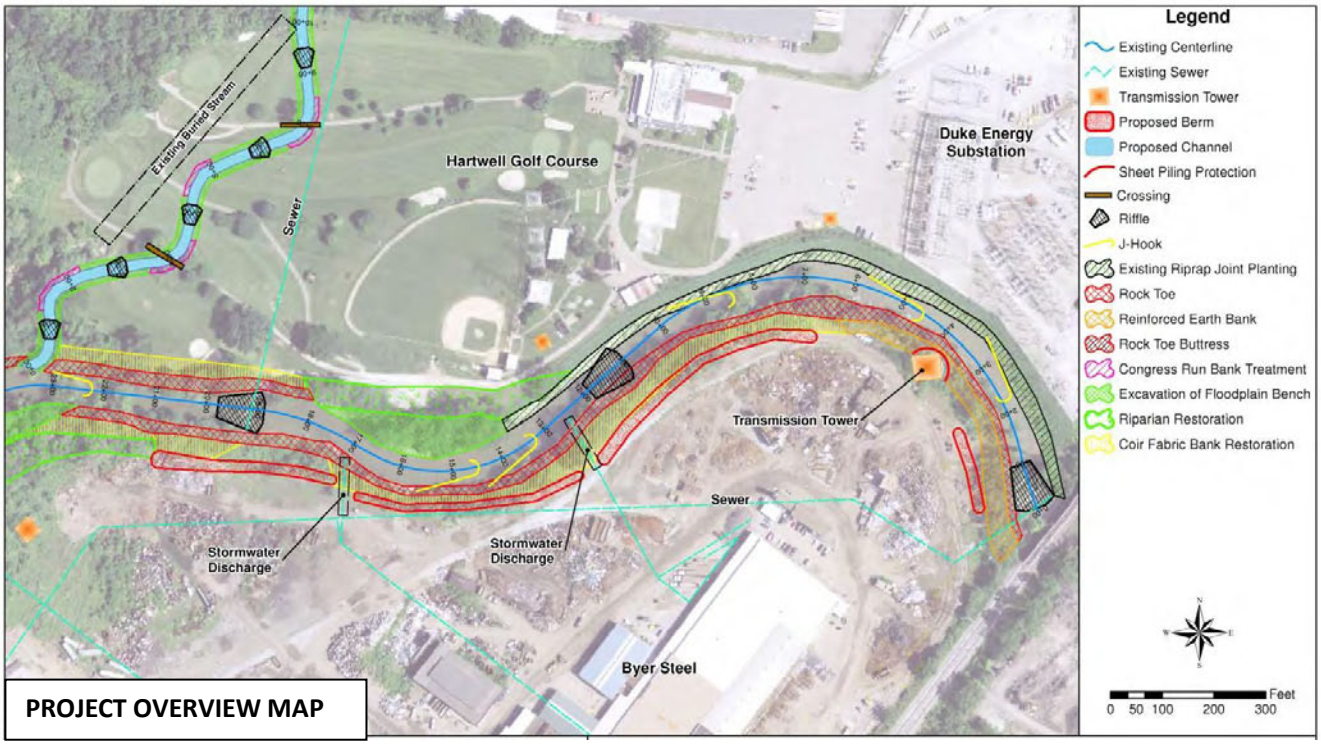
9.15 PRIORITY PROJECT- HARTWELL GOLF COURSE

Property Owner: Hartwell Golf Club, Duke Energy, Byer Steel
Political Jurisdiction: City of Cincinnati – Carthage
Nearest Road(s): Caldwell Drive west of Vine Street
River Mile: Mill Creek RM 9.5
Latitude/Longitude: 39.203/-84.483
Drainage Area: Congress Run-Mill Creek
Land Use(s): Riparian Zone
Access: Limited- Mill Creek Greenway Trail nearby
Potential Partners: Mill Creek Watershed Council of Communities, MSDGC, Cincinnati Park Board, Duke Energy, Hartwell Golf Club, Byer Steel
Benefits: Habitat creation/restoration, water quality improvements
Timeline/Status: Seeking funding for construction in 2016
Level of Effort: ➲➲➲➲
Costs: $$$$$ $3.368M Total Project Costs, includes $2.625M grant request from WRRSP

BRIEF SUMMARY:
This project is a collaborative effort between multiple public and private agencies to restore 3,600 feet of stream bank along the main stem of the Mill Creek near the intersection of I-75 and Cross County Highway. Additional project elements include 600 feet of stream daylighting along Congress Run, the removal of two sewer encasements acting as dams in the Mill Creek. Over 75 percent of the funding for the project is being provided by a grant from Water Resource Restoration Sponsor Program (WRRSP) from the Ohio Environmental Protection Agency (OEPA).

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#



PROJECT OVERVIEW MAP

DETAILED PROJECT DESCRIPTION:

The Mill Creek Restoration at the Hartwell Golf Course is a collaborative effort between the Mill Creek Watershed Council of Communities (Council), Metropolitan Sewer District of Greater Cincinnati (MSDGC), City of Cincinnati through the Cincinnati Park Board (CPB) and private landowners Duke Energy, the Hartwell Golf Club and Byer Steel. The proposed stream restoration runs 3,600' along the main stem Mill Creek at the confluence with Congress Run and extends up Congress Run 1,000'. Situated in the City of Cincinnati's urban core, the stream corridor in this area is highly impacted by urban development, industrial legacy pollutants and sewer and energy infrastructure. The proposed project will bring the restored stream reaches into attainment with Warm Water Habitat (WWH) Aquatic Life Use standards. Project features on the Mill Creek include bank restoration using bioengineering techniques to provide a robust and sustainable slope design; installation of in-stream riffles and J-hook vanes to increase habitat, oxygenation, nutrient uptake, and metal sequestration; and extensive planting of native vegetation to stabilize stream banks and improve aquatic habitat. Congress Run, currently in a culvert for 600'under the Hartwell Golf Course, will be daylighted and given a natural meander pattern with pool-riffle-run complexes and a floodplain bench. These measures will restore, to the maximum extent possible, the natural function of both streams and repair degraded habitat while reducing erosion, sedimentation and nutrient enrichment. Additional bank shaping, stabilization and solid waste removal, funded separately by Duke Energy and Byer Steel, further the return on investment made with WRRSP funds and boost the water quality benefits of the project.

This project offers a unique opportunity to improve highly impaired reaches of both the Mill Creek and Congress Run and bring both streams into attainment with the WWH criteria in the project area. The restoration meets multiple goals held by project partners including improved water quality, restored habitat, protection of infrastructure, and increased recreational utility, all of which support the vision of a healthy Mill Creek as an asset to the region that improves the quality of life for everyone in the watershed.

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

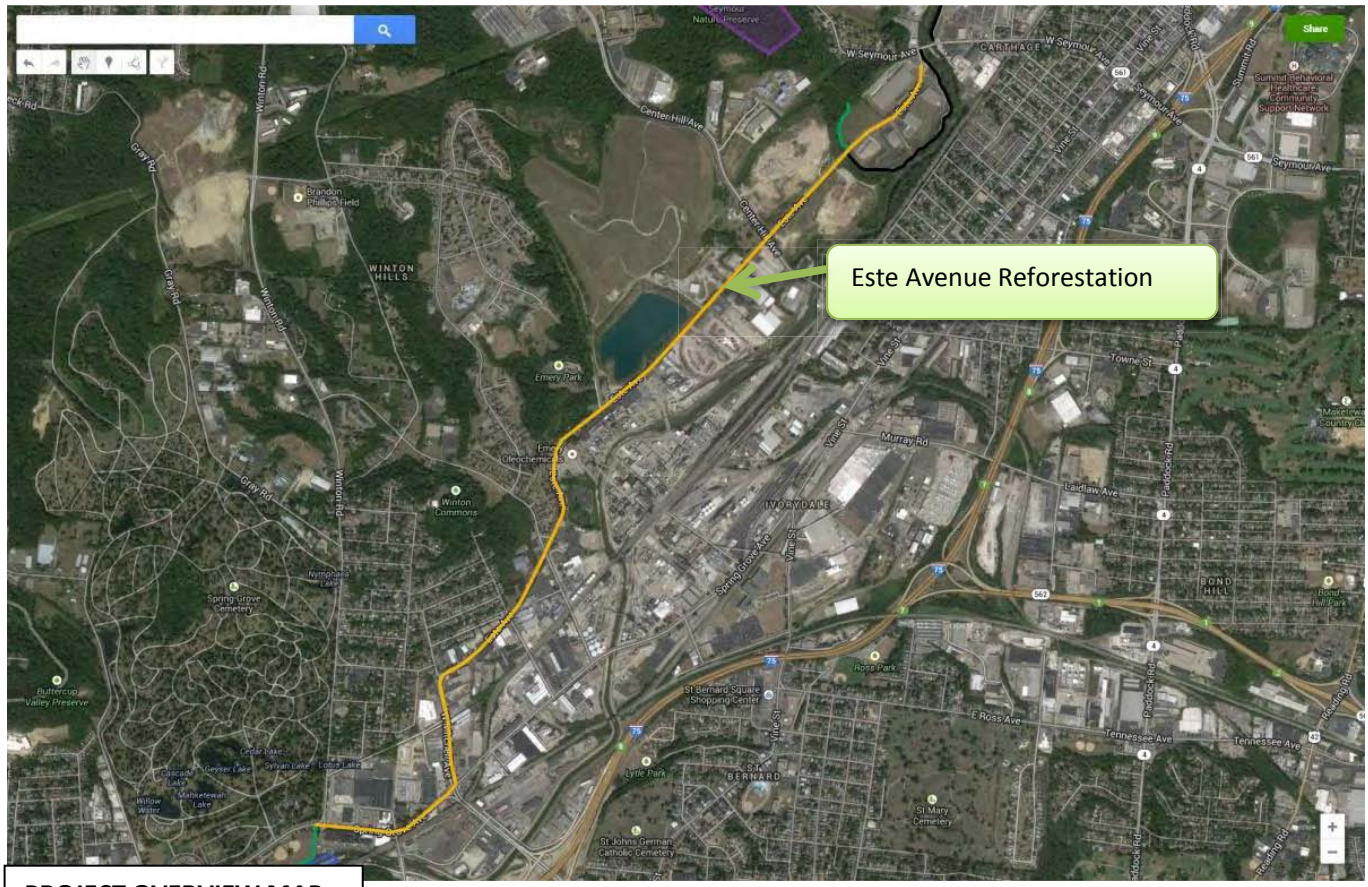
Additional Community Benefits:	
	CSO and SSO volumetric reductions
	flood reduction
	prevents/reduces NPS pollution
X	social/recreational benefits
	other:

WATERSHED CONTEXT MAP

9.16 PRIORITY PROJECT- REFORESTATION OF ESTE AVENUE

Property Owner: City of Cincinnati and property owners adjacent to the public right of way
Jurisdiction: City of Cincinnati
Nearest Road(s): Este Ave, Center Hill Road
River Mile: N/A
Latitude/Longitude: 39.17718/-84.5082
Drainage Area: Congress Run & West Fork – Mill Creek
Land Use(s): manufacturing, residential, trail, vacant
Access: Este Avenue
Potential Partners: City of Cincinnati, Groundwork Cincinnati: Mill Creek, MSDGC, Cincinnati Park Board, Safe Routes to School, Taking Root
Benefits: green infrastructure for storm water runoff, habitat, improved air quality, community amenity
Timeline/Status: 2015; seeking funding
Level of Effort: ➲➲➲➲
Costs: $$$$$

BRIEF SUMMARY:
The project includes planting 200 - 400 native trees along Este Ave between its intersection with Mitchell Ave and the Ridgewood Industrial Park. Work will be done in tandem with an extension of the Mill Creek Greenway Trail that will connect the existing trail at Winton Road and Spring Grove to the Caldwell Seymour parks. Since this part of the watershed has a low percentage of tree canopy, the reforestation will help to filter, infiltrate, evapotranspirate stormwater runoff, provide habitat, and help to moderate the heat island effect.



PROJECT OVERVIEW MAP

DETAILED PROJECT DESCRIPTION:

The Reforestation of Este Avenue project will entail planting over 200 Ohio Native trees, in addition to shrubs, and plants, along the Mill Creek Greenway Trail, between the intersection of Winton Road and Spring Grove Avenue and the Este Avenue industrial park. There it will connect to the Seymour Creek spur trail and floodplain restoration site and the Caldwell-Seymour Trail restoration sites, connecting Seymour Preserve to Caldwell Recreation Park and Caldwell Preserve. There is a critical need for reforestation and Green Infrastructure (e.g., bio-swales and rain gardens) that will help to filter and infiltrate stormwater runoff from the streets, thereby helping to improve water quality and reduce CSOs. In addition the trees will improve air quality by filtering particulates, increase carbon sequestration as the trees mature; and create terrestrial habitat in an area that has one of the lowest percentages of tree canopy in the city, as well as within the Congress Run sub-basin.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
	sediments
	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
	CSO and SSO volumetric reductions
	peak flow runoff reduction
X	prevents/reduces NPS pollution
X	social/recreational benefits
X	other: air quality/carbon sequestration

WATERSHED CONTEXT MAP

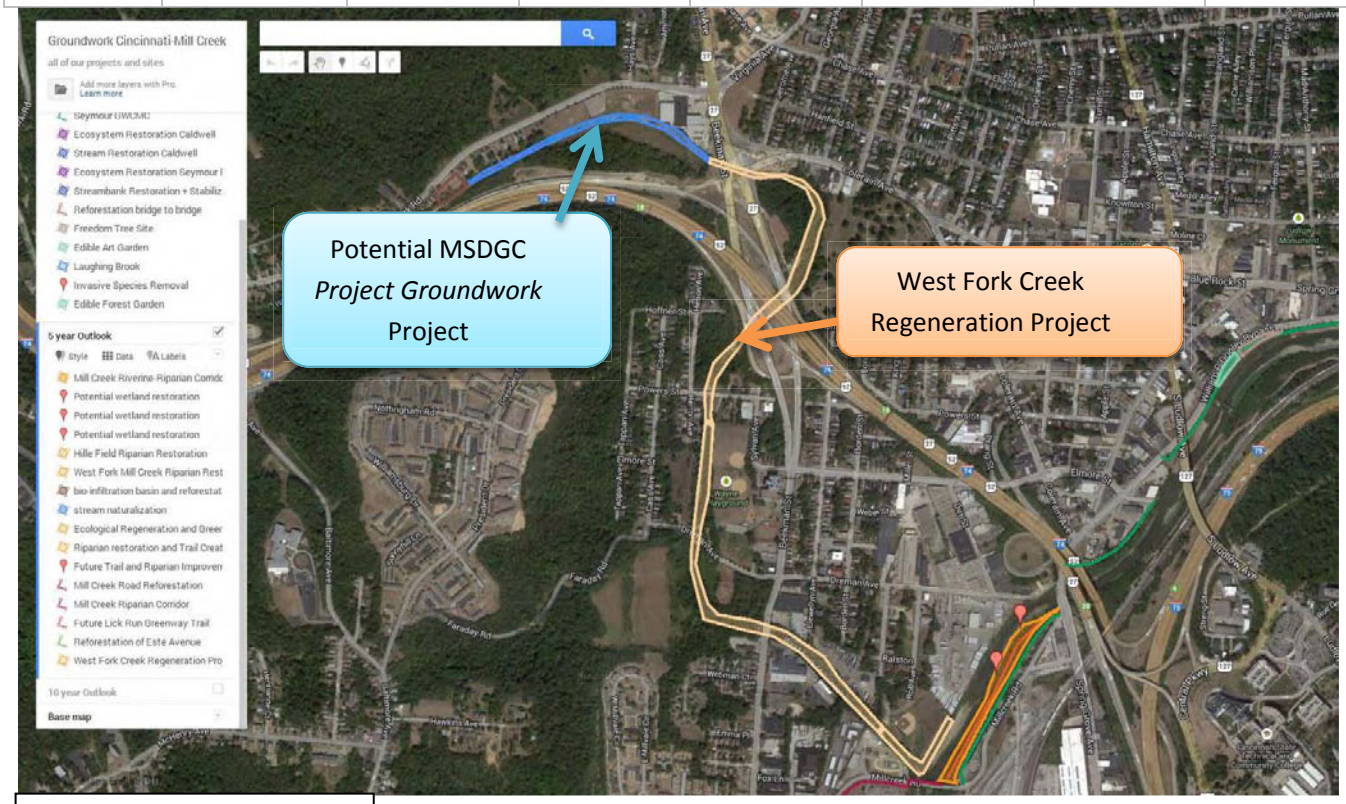
9.17 PRIORITY PROJECT- WEST FORK CREEK REGENERATION PROJECT

Property Owner: City of Cincinnati, Hamilton County (MSD), Truckway Leasing, ODOT
Jurisdiction: City of Cincinnati
Nearest Road(s): West Fork Road, Mill Creek Rd, Beekman St.
River Mile: West Fork Creek (RM 3.5)
Latitude/Longitude: 39.15127/-84.5491
Drainage Area: West Fork Creek (West Fork- Mill Creek)
Land Use(s): manufacturing, park, vacant
Access: Hille Field, Wayne Playground, Beekman Street, West Fork Rd
Potential Partners: Groundwork Cincinnati: Mill Creek, MSDGC, Cincinnati Park Board, Ohio EPA, Northside Community Council,
Benefits: CSO Reduction, improved water and air quality, community amenity, green infrastructure for stormwater runoff, habitat creation
Timeline/Status: 2014-2017; seeking funding
Level of Effort: ➲➲➲➲
Costs: $$$$$

BRIEF SUMMARY:
The West Fork Creek has suffered ecological damages from channelization and hydromodification that has transformed the tributary into a trapezoidal channel. The West Fork Creek Regeneration Project will take a comprehensive approach to re-naturalization of this urban stream and will improve its riparian corridor. A coalition of groups will develop a comprehensive approach to reclaiming this urban water and implementation will occur in phases over multiple years

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#



PROJECT OVERVIEW MAP

DETAILED PROJECT DESCRIPTION:

The urban West Fork Creek has suffered ecological damages from channelization and hydromodification that has transformed the tributary into a trapezoidal concrete channel. The West Fork Creek Regeneration Project will address a host of interrelated problems impacting riverine/riparian health from Mt Airy Forest in Northside downstream to the confluence with Mill Creek at Mill Creek Road Bridge in South Cumminsville. The problems include lack of aquatic habitat, high concentrations of sediments, CSOs that discharge pathogens, lack of tree canopy and terrestrial habitat in some locations, invasive species, high peak flows, low flows in the downstream reaches, hard armoring of the creek bed and streambanks, and disconnection from the floodplain.

GWC, MSD, Parks, and the Northside Community Council are currently working on a West Fork Creek floodplain restoration and CSO reduction project in the upper reaches of West Fork Creek, and MSD is completing two major bio-infiltration basins within the upper West Fork Creek sub-basin in Northside. In addition, MSD has expressed interest in a potential re-naturalization of part of WFC along an existing soccer field, potentially in Phase 2 of Project Groundwork/the MSD Consent Decree. GWC, MSD, Parks, Working in Neighborhoods, the Northside and South Cumminsville Community Councils, and the Niehoff Studio are initiating work to develop a comprehensive stream and riparian regeneration plan, integrating MSD's current and future Project Groundwork plans for this subwatershed and addressing local interest in creating a future West Fork Creek Greenway Trail that will connect to the Mill Creek Greenway Trail and into the neighborhoods.

The multi-phase WFC project will include removal of invasive species; reintroduction of Ohio trees, shrubs, and plants; aquatic and terrestrial habitat improvements; replacement of concrete-lined streambanks with soil bioengineering systems; replacement of concrete-lined stream beds and improved substrate; and development of the WFC Greenway Trail to connect from Mt. Airy Forest in Northside to Mill Creek in South Cumminsville.

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
X	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
X	CSO and SSO volumetric reductions
X	peak flow runoff reduction
X	prevents/reduces NPS pollution
X	social/recreational benefits
X	other: air quality/carbon sequestration

WATERSHED CONTEXT MAP

9.18 PRIORITY PROJECT- WEST FORK CREEK BIOINFILTRATION BASIN

Property Owner: Hamilton County (MSDGC)
Political Jurisdiction: City of Cincinnati (Northside)
Nearest Road(s): West Fork Road & Colerain Avenue
River Mile: Upper watershed- West Fork Channel
Latitude/Longitude: 39.162/-84.560
Drainage Area: West Fork Channel- (West Fork- Mill Creek)
Land Use(s): Vacant land (floodplain)
Access: Pedestrian access possible from West Fork Rd
Potential Partners: Groundwork Cincinnati: Mill Creek, MSDGC, Cincinnati Park Board, Ohio EPA, Northside Community Council
Benefits: CSO Reduction, Habitat Creation, Community Amenity
Timeline/Status: In Construction
Level of Effort: ➲➲➲➲
Costs: $$$$$ OEPA grant funds plus in-kind/partner funds

BRIEF SUMMARY:
A bio-infiltration basin will be constructed on vacant land along West Fork Road in Northside to capture stormwater during rain events. It will prevent about 500,000 gallons of stormwater from entering the combined sewer system each year, thereby reducing CSOs into the West Fork Channel.

The basin, which will be about 0.8 acres in size and 2-3 feet deep, will use native plant species, special soils and layers of gravel to absorb, cleanse, and store stormwater during a rain event.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#

DETAILED PROJECT DESCRIPTION:

The West Fork Road Water Quality Floodplain Enhancement Project is located in the Cincinnati, OH neighborhood of Northside, within the West Fork subwatershed in the Mill Creek basin. The project is being installed through a partnership of MSDGC, the Cincinnati Park Board, and Groundwork Cincinnati: Mill Creek as part of the overall watershed-based strategy for MSDGC to manage wet weather and improve water quality of receiving streams in the Greater Cincinnati area. Situated within the West Fork Channel tributary area, along West Fork Road, across from the Mount Airy Forest, the project will manage stormwater through green infrastructure and serve as a gateway feature and community asset to Northside and the surrounding areas.

The project is located on approximately 0.8 acres of vacant land, comprised of four parcels (1759, 1763, 1769 and 1773 West Fork Road), owned by MSDGC. In 2011, MSDGC successfully obtained a Pre-Disaster Mitigation grant from the Ohio Emergency Management Agency (OEMA) to voluntarily acquire and demolish several properties located in the West Fork Channel floodplain and floodway. In 2013, a Clean Ohio Green Space Conservation grant was also awarded. As part of MSDGC's watershed strategy, this floodplain enhancement project site will be part of the long-term vision for renaturalization of the existing concrete-lined channel and enhance the channel corridor and floodplain. Specifically, this project will manage stormwater runoff diverted from West Fork Road through the stormwater features to the Channel, incorporate native species of plants, provide dual purpose access trail and include educational signage for interpretive education and community outreach. It is currently anticipated that in addition to providing a multi-purpose community area, this project will help reduce the amount of runoff that enters the combined sewer by approximately 510,000 gallons in a typical year.

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
	CSO and SSO volumetric reductions
	flood reduction
	prevents/reduces NPS pollution
X	social/recreational benefits
	other:

WATERSHED CONTEXT MAP

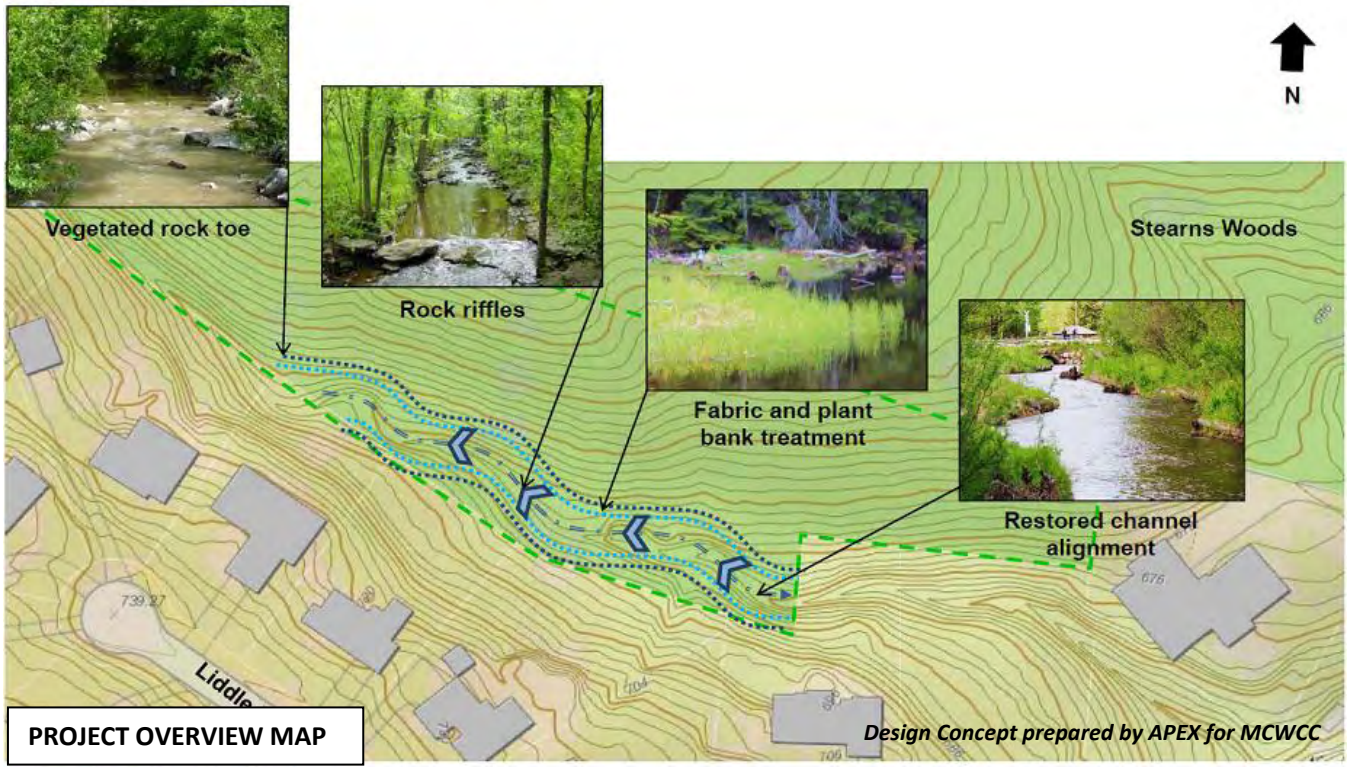
9.19 PRIORITY PROJECT- STEARNS WOODS & CILLEY CREEK RESTORATION

Property Owner: City of Wyoming
Political Jurisdiction: City of Wyoming
Nearest Road(s): Oliver Road & Glenway Avenue
River Mile: Upper watershed- Upper South Branch MC
Latitude/Longitude: 39.231/-84.479
Drainage Area: Cilley Creek (trib to Congress Run-Mill Creek)
Land Use(s): Park
Access: Public access via Glenway Ave or Oliver Road
Potential Partners: City of Wyoming, Mill Creek Watershed Council of Communities, Green Area Foresters
Benefits: Dam removal, stream restoration, canopy restoration
Timeline/Status: ???
Level of Effort: ➲➲➲➲
Costs: $$$$$ $451,409 Total Project Costs, includes $296,844 Section 319 grant request from OEPA

BRIEF SUMMARY:
This project includes a combination of 400' of stream restoration, dam removal, and 3 acres of riparian corridor restoration, invasive plant removal, and reforestation. When successfully completed, these project outcomes will bring this reach of stream into attainment of the State of Ohio's Aquatic Life Use Standards for Warm Water Habitat. Work is being conducted with the assistance of separate grants from OEPA's Section 319 and Clean Ohio programs.

Estimated Load Reductions:

T-N (lbs/year)	T-P (lbs/year)	TSS (lbs/year)	T-Pb (lbs/year)	T-Cu (lbs/year)	T-Zn (lbs/year)	BOD 5-Day (lbs/year)	E.coli (billion colonies/yr)
							#



PROJECT OVERVIEW MAP

DETAILED PROJECT DESCRIPTION:

The Cilley Creek Stream Restoration at Stearns Woods will implement full-scale restoration of 400 feet of degraded stream channel, along Cilley Creek, within the City of Wyoming's Stearns Woods Preserve. Removal of an historic concrete dam will prevent the adverse impact of dam failure and the attendant release of an estimated 7,500 cubic feet of sediment, currently stored in the historic reservoir area behind the dam. This project will rely on Natural Channel Design methods to restore natural stream flow, in-stream habitat, and native riparian vegetation along an otherwise high-quality headwater stream in the Congress Run Watershed. Stream restoration will consist of a combination of bank grading, to establish stable channel dimensions (in plan form, profile and cross section), application of bank treatments, and installation of in-stream structures.

In addition to the active channel restoration, approximately three acres of riparian corridor will be restored by removing invasive vegetation and replanting with native trees, shrubs and herbaceous vegetation. Dedicated groups of concerned residents and volunteers, such as the Green Area Foresters (GAFs), have already begun reforestation efforts within the park, starting with the removal of non-native, invasive vegetation.

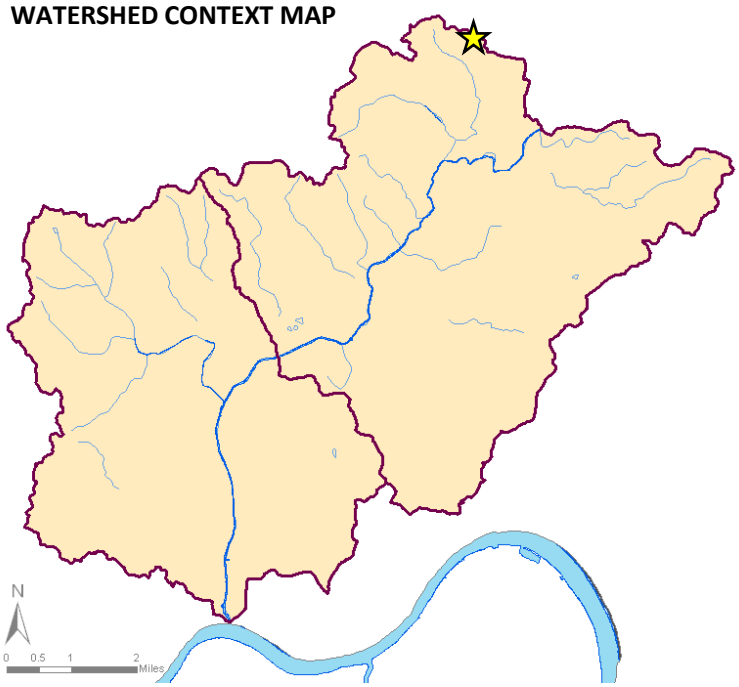
The project couples the restoration of Cilley Creek with reforestation efforts throughout the Stearns Woods Preserve. The proposed restoration of Cilley Creek will complement the Stearns Woods Reforestation project, currently under review for Clean Ohio Greenspace funding.

WAP GOALS ADDRESSED:

Causes of Impairment Addressed:	
X	habitat or hydromodification
X	nutrients
X	sediments
	pathogens (E. coli)
	chlorides
	PAH compounds
	metals

Additional Community Benefits:	
	CSO and SSO volumetric reductions
	flood reduction
	prevents/reduces NPS pollution
X	social/recreational benefits
	other:

WATERSHED CONTEXT MAP



10 NON-STRUCTURAL RECOMMENDATIONS

10.1.1 IDENTIFY AND INVENTORY EXISTING MANAGEMENT EFFORTS IN THE WATERSHED

The table below inventories some of the known existing management efforts in the watershed. These include programs, management strategies, and municipal ordinances working towards meeting water quality goals. The purpose of this table is to identify pollutants which may not be adequately addressed by these existing programs or to prevent suggesting new solutions that overlap existing efforts.

Stakeholder	Existing Program or Policy	Pollutant Addressed
Hamilton County Storm Water District (HCSWD) and Hamilton County Soil & Water Conservation District (HCSWCD)	Riparian Buffer Regulations	nutrients, sediments, hydrologic flow, habitat alterations
	Earthwork Regulations	sediments
	Post Construction Regulations	hydrologic flow, sediments
	Illicit Discharge Detection and Elimination Regulations	nutrients, toxics
	Public Information & Education	nutrients, toxics
	Storm Drain Labeling	nutrients, toxics
	Watershed Signage	nutrients, toxics
	Pollution Prevention & Good Housekeeping	nutrients, toxics
	Conservation Education	nutrients, sediments
	USDA Farm Bill Programs in Hamilton County	nutrients, sediments
City of Cincinnati (Municipal Code)	Adopted NPDES Rules and Regulations	All
	Adopted Rain Water Harvesting Ordinance	hydrologic flow, sediments
	Adopted Downspout Disconnection Ordinance	hydrologic flow
	Working on riparian corridor protection policy/code	All
	Conservation Development Ordinance	All
	Hillside Overlay District Ordinance	nutrients, sediments, hydrologic flow, habitat alterations
City of Cincinnati (Form Based Codes)	Parking maximum limit	hydrologic flow, nutrients, sediments
	Parking area limit (cellular design encouragement)	hydrologic flow
	Urban Infill	All*
Hillside Trust	Hillside conservation program	hydrologic flow, sediments, nutrients
Hamilton County Park District	Reforestation, natural resources management	All
Cincinnati Parks	Reforestation, natural resources management	All
Western Wildlife Corridor	Greenway corridor protection and enhancement	All
Mill Creek Watershed Council of Communities	Capital projects – stream restoration, stormwater management BMPs, wetlands, and more	All
	Stakeholder education and awareness	All
	Water Quality Monitoring	All

	Watershed Action Planning	All
Groundwork Cincinnati: Mill Creek	Capital projects – stream restoration, stormwater management BMPs, wetlands, edible gardens and more	All
	Stakeholder education and awareness	All
	Greenway Trails, corridor protection and enhancement	All
	Watershed Action Planning	All
Hamilton County Public Health Department	Septic System testing	E. Coli, nutrients, sediments, chlorides
Metropolitan Sewer District of Greater Cincinnati	CSO and SSO remediation	E. Coli, nutrients, sediments
	Industrial Permits	All
	Early Success Projects and Green Demonstration Projects	sediments, nutrients, hydrologic flow
	Lick Run Master Plan	hydrologic flow, sediments, nutrients, habitat alterations, E. Coli, heavy metals
	Sewage disposal	All
Cincinnati Stormwater Management Utility (SMU)	Clean Streams Monitor	All
	Flood Management and Safety Monitor	hydrologic flow
	Pollution Prevention ("Six Minimum Controls")	All
	Stormwater Pipe Management	hydrologic flow
Other? contact jeismeier@millcreekwatershed.org		

***pollutant reductions occur in other watersheds in the form of reduced development demand that would preserve habitat and hydrology**

10.1.2 LAND USE AND PUBLIC POLICY RECOMMENDATIONS

A. Riparian Buffer Protections

Forested riparian buffers have been shown to reduce pollutant loadings from stormwater sheet runoff. The acquisition and preservation of these areas can be extremely important to water quality protection and decrease the cost of implementing structural BMPs.

The benefits of forested riparian buffers include:

- reducing sedimentation by stabilizing streambanks with their root systems
- shading and cooling water, which can help to limit algal growth
- providing economic value as they limit land erosion along streambanks
- increasing property values from the inherent aesthetic benefits

Riparian buffers in the lower Mill Creek are required for members of the Hamilton County Storm Water District. The Rules and Regulations of the Hamilton County Storm Water District, Article IV – Stream Corridor Regulations, adopted by the County Commissioners on June 14, 2009, requires a riparian buffer zone ranging from 10 to 50 feet from the top of the stream bank depending on drainage area and other factors. There are additional riparian corridor protections for areas adjacent to wetlands and steep slopes to protect these extra

sensitive areas.

The County code is viewed as the standard, but is not in alignment with what the City can enforce, e.g. buried streams and highly development channel corridors. The City Municipal Code: Chapter 1415 – Riverfront Districts, does include a required 50-foot riparian buffer but this only applies in areas zoned to "riverfront district". There is also a floodplain development permit, see City Municipal Code: Chapter 1109 – Flood Damage Reduction, which potentially limits development in flood prone areas.

Draft riparian corridor regulations have been postponed in the City of Cincinnati for the time being, in order to allow further discussion and resolution on this regulation and the impacts on the existing highly developed corridors in the City. In the meantime, the use of an interim development control (IDC) is being explored as a reasonable exemption to the County code. The City's Land Development Code effort would be a good opportunity to address this issue long term.

RECOMMENDATION: Continue exploring the issues of riparian corridor protection in the City of Cincinnati with potential solutions added to the Municipal Code in the Land Development Code process (expected to be completed in 2014).

B. Low Impact Development (LID) and on-site stormwater retention practices

A Low Impact Development (LID) strategy implements engineered hydrologic controls to replicate the pre-development hydrologic regime of watersheds through infiltration, evaporation, filtration, detention, and retention of runoff close to its source. LID strategies are often implemented through the creation of vegetated areas and are beneficial in reducing the runoff of sedimentation, pollutants, and heavy metals. These strategies can also work to reduce flooding, and speed of water flow. By implementing LID practices, water can be managed in a way that reduces the impact of built areas and promotes the natural movement of water within an ecosystem or watershed.

LID strategies can include bioretention basins, grassed swales, green roofs, landscaping with native plants, parking lot filter strips, pervious surfaces, rain barrels, rain gardens, underground storage, and curb extensions.

RECOMMENDATION: Support the adoption of the Light Impact Development chapter into the City of Cincinnati's Form Based Codes. Find opportunities to discuss Low Impact Development best management practice with other Hamilton County jurisdictions.

C. Stormwater Post Construction Best Management Practices Design Manual

A locally-based storm water post construction BMP design manual was identified as a needed resource during MSDGC's Sustainable Infrastructure Policy Gap Analysis (2012). A post construction stormwater BMP helps to educate developers about BMPs to reduce some of the site sedimentation runoff and improve water quality during and after development.

RECOMMENDATION: Finish and promote the usage of the Hamilton County Storm Water District's Design

Procedures and Criteria for Post-Construction Stormwater Controls manual, being developed in partnership with MSDGC and SMU.

D. Rainwater Harvesting Rules and Regulations

In April 10, 2013 the City of Cincinnati adopted changes to the Municipal Code to allow rainwater harvesting. These provisions were made to Chapter 1105, "Plumbing Code" where they enacted a new Section 1105-08, Rainwater Harvesting.

Rainwater Harvesting is the acquisition of rainwater before it seeps into the aquifer in order to be reused for other water dependent processes. These uses can include, but are not limited to: water for gardens, agriculture, livestock, and if filtered or percolated, drinking.

RECOMMENDATION: Promote the usage of rainwater harvesting systems. Advocate for all newly constructed publicly owned properties to incorporate rainwater harvesting systems. Market the benefits of rainwater harvesting to homeowners and businesses to increase adoption practices.

E. Cooperative Code Enforcement

A cooperative code enforcement program uses volunteers to report noticeable water quality impairments. Cooperative code enforcement is a way to supplement the effectiveness of local regulators in identifying temporal sources of water quality impairment, which can sometimes go unnoticed. The framework for cooperative code enforcement in the Lower Mill Creek is supported by the Hamilton County Soil and Water Conservation District, which already has a contact phone "hotline" and email to report occurrences of water quality impairment. From there, the Hamilton County Soil and Water District can study the reported water quality issue to identify the sources of impairment and determine what actions need to be taken and which agencies need to be involved.

RECOMMENDATION: Expand the usage of cooperative code enforcement by increasing knowledge of the existence and importance of the Hamilton County Soil and Water Conservation District's reporting/inquiry program and the Ohio EPA's complaint hotline. Investigate the utility of developing new cooperative code enforcement mechanisms.

F. Green Streets

The City of Cleveland, Ohio adopted a Complete and Green Streets Ordinance in 2012, to increase safe and reliable travel options and provide green infrastructure strategies to reduce the environmental impact of streets. Green Streets refer to usage of transportation right-of-way to incorporate "green infrastructure" techniques, such as tree trenches, pervious pavement, bioswales, and more, to capture stormwater and treat water quality, while also providing air quality improvements and other environmental, social and economic benefits.

Back in January 2009, the City of Cincinnati's Vibrant Neighborhoods Committee motioned for a Complete Streets/Green Streets policy that was never adopted. However, Council did pass a resolution supporting the

federal Complete Streets Act of 2009 in April. Unfortunately, green streets have not been approached by Council since then.

RECOMMENDATION: Advocate for a Green Streets policy/amendment to the City of Cincinnati codes and regulations. The ongoing Land Development Code is a great time to be raising this issue. Encourage other jurisdictions to adopt a Complete Streets/Green Streets ordinance.

G. Parking Standards

Parking lots standards are typically based on required minimum levels of parking based on type and size of land uses. While these requirements may be appropriate for some uses, in many cases they far exceeded actual demand. Excess parking provision results in underutilization of land, higher development and maintenance costs, and an increase in impervious surface and stormwater runoff. Significant amounts of land within the city are allocated to unused or underused parking.

Recently, the City of Columbus, Ohio adopted revisions to the Parking Code, which include:

- Reduced parking requirements along with parking "caps" for some uses to prevent excessive parking provision.
- Inclusion of bike parking requirements.
- Increased emphasis on pedestrian circulation.
- Increased requirements for landscaping and screening.
- Encouragement of green infrastructure solutions.
- Organizational changes including updated graphics
- Creation of a general site development standards chapter, consolidating relevant elements from throughout the zoning code.

RECOMMENDATION: Encourage a parking code review by the jurisdictions in Hamilton County who have not done so already. Encourage a parking maximum for some land uses to prevent excessive parking provision.

H. Tree Ordinance

Trees save jurisdictions money in many ways, cleaning the air, reducing stormwater runoff, improving water quality, reducing energy consumption, and more as highlighted by the Tree and Sidewalk Report, prepared by the City of Cincinnati Park Department in 2011. Tree ordinances protect trees in the right-of-way from being destroyed without proper considerations and permits. They also help to expand tree canopy by mandating right-of-way reforestation practices. The City of Cincinnati already has a tree ordinance in place, as defined by Chapter 743: Urban Forestry in the City Municipal Code.

RECOMMENDATION: Encourage all jurisdictions in the lower Mill Creek to consider Tree Ordinances for the publicly owned right-of-ways.

I. Incentivize Stormwater BMPs

The City of Portland launched The Clean River Rewards Program in 2006, which was designed to provide

monetary incentives to residents who are implementing BMPs on their property and managing their stormwater. The program is designed to provide up to a 100% rebate on their stormwater utility tax, which has been in effect since 1977 in order to pay for the increasing cost of managing the urban watershed. A 100% rebate is available only to those homes that retain all their roof runoff on site through and partial credit is available on a sliding scale for properties that manage any portion of stormwater on their site.

Residents must sign up for the program in order to receive the tax rebates, but it is available to both residential and commercial units. The idea is that with proper "on site" stormwater management, public management of stormwater will be less costly and more manageable. There are several BMPs which enable a resident to be eligible for this program, these include but are not limited to, disconnecting your downspouts and directing roof drainage to landscaped areas or rain gardens, installing drywells and soakage trenches, rain barrels, and tree coverage.

Incentivizing personal stormwater management through a rebate or tax reduction is a great way to improve the stormwater quality and health of the watershed throughout an area. Not only will this program have initial positive impacts on the cleanliness of the watershed, but it will also save on public infrastructure and monies because that water would no longer be channeled into the public stormwater system.

RECOMMENDATION: Promote local programs that incentivize the "on site" management of stormwater practices and educate the public on easily implementable BMPs for residential and commercial buildings.

10.1.3 LAND OR DEVELOPMENT RIGHTS ACQUISITION PRACTICES RECOMMENDATIONS

A. Fee simple acquisition/conservation easements

RECOMMENDATION: Collaborate with local land trust to continue the use of fee simple acquisition and conservation easements to protect existing riparian corridors, wetlands, steep hillsides and other high value environmental assets.

B. Transfer of Development Rights

The basic concept of Transfer of Development Rights (TDR) is to provide financial compensation to property owners in areas that society wants to impose land use regulation to control growth or preserve sensitive environment. This approach involves severing the right to develop an area that the public wishes to preserve in low density or open space and transferring those rights to another site where higher than normal density would be tolerated and desirable. The development right is independent of land ownership. The development right becomes a separate article of private property and can be shifted from one area to another and can be sold for economic profit.

RECOMMENDATION: Collaborate with local jurisdictions to determine the efficacy and desirability of a TDR program for protection and acquisition of sensitive habitats including; riparian corridors, old growth forest, and wetlands.

C. Hamilton County Land Reutilization Corporation Partnership

The Hamilton County Land Reutilization Corporation (HCLRC) is a non-profit community improvement corporation with a special tool at its disposal called a "landbank", which is designed to return vacant, tax foreclosed and underutilized residential and commercial property back to productive use in Hamilton County. The HCLRC is being administered by the Port of Greater Cincinnati Development Authority.

The HCLRC is currently in the process of developing guiding policies, including the strategy for acquisition and disposition of properties, which could include policies for acquiring vacant foreclosed land along the Mill Creek to return back to productive uses. Perhaps the "landbank" tool could be used to reacquire parcels or easements for sensitive environmental areas, such as riparian corridors and wetlands, as was done with the Genesee County Land Bank in Flint, Michigan on the 130-acre property known as "Chevy in the Hole".

RECOMMENDATION: Work with the Hamilton County Land Reutilization Corporation (HCLRC) to see if the landbank tool could be used to reacquire parcels or easements for sensitive environmental areas, such as riparian corridors and wetlands. Pursue a partnership with the HCLRC, to study the efficacy of using the land bank to acquire vacant and/or underutilized properties with the end intention of converting them for public benefit-stormwater management uses.

10.1.4 PUBLIC WORKS RECOMMENDATIONS

A. Salt Storage

Following a 2011/2012 winter that did not see much inclement weather, many municipalities were left with excessive salt capacity on hand to deal with. The Ohio EPA issued a memo "Interim Guidance for Temporary Salt Storage Associated with 2011/2012 Deicing Season" (April 18, 2012), which provides guidance for properly protecting water resources until a more comprehensive guidance document on this matter is created.

RECOMMENDATION: A brief summary of the recommendations are as follows:

- At the end of the deicing seasons, consider selling excess salt to other entities with proper storage facilities such as universities, school districts, large commercial sites, etc.
- Store salts in well-designed, existing structure if possible. Temporary salt storage facilities should be properly sited and designed. Structures are preferable to waterproof tarps.
- Siting evaluation: a minimum buffer of 300 feet from all streams, wetlands, storm sewers, roadside ditches, private wells and/or sensitive areas where high infiltration rates are expected (i.e. dry wells and permeable soils).
- Run-off/Run-on considerations: minimize run-off and run-on potential by limiting the drainage area where excess salt is stored to the maximum extent possible. Earthen berms may be used to divert water away from piles and provide containment, if necessary, of potentially contaminated storm water.
- Storage Pad: all excess salt should be stored on impervious pad to prevent salt from infiltrating into

subsurface. Pad should be capable of supporting the pile and the associated heavy equipment, thereby preventing cracking. Asphalt or concrete are preferred.

INDICATORS: All municipally/institutionally owned salt piles using proper storage procedures to reduce chlorides in the Mill Creek. For all other types of ownership, proper salt pile guidance procedures are distributed and communicated.

B. Street Sweeping

Street sweeping can effectively and efficiently collect trash debris and the small particles known to carry stormwater pollutants. Street sweeping is considered a best management practice by the EPA, and can be an important measure for fulfilling the "Six Minimum Controls" for NPDES Phase II municipal permit.

RECOMMENDATION: Encourage local jurisdictions to continue to improve street sweeping operations. Develop a list of street sweeping recommendations for stormwater best management. Target increased street sweeping to streets parallel to streams. Increase street sweeping activity in the days following the application of salt to roadways. Increase the amount of annual miles of street sweeping to reduce sedimentation, nutrient and chloride loading.

C. Vegetation Management

A vegetation management plan is focused on the control and removal of invasive species, the limited use of pesticides, and establishing positive successional vegetation growth. In some areas of the Mill Creek riparian corridor, aggressive vegetation control to protect infrastructure such as the concrete channel, nearby bridges, roads and railroads is unfortunately limiting riparian growth potential. A discussion on this topic might help to reveal opportunities that would increase the tree canopy in the Mill Creek riparian corridor.

RECOMMENDATION: Collaborate with the Cincinnati Parks District, Great Parks of Hamilton County, Mill Valley Conservancy District, the Army Corps of Engineers-Louisville and other key riparian corridor property owners on a vegetative management strategy that improves the Mill Creek's riparian corridor, controls invasive species, and establishes positive successional vegetative growth. Implement the Ohio Department of Natural Resource's Ohio Statewide Forest Resource Strategy -2010 plan, which fully supports and compliments the objectives of this watershed action plan.

10.1.5 STREAMBANK POLLUTION AND TRASH COLLECTION

Pollution and trash debris are a constant threat to the health of the Mill Creek. The visible presence of pollution and trash will reinforce the negative perceptions about the Mill Creek, making future restoration efforts more difficult if the public believes that Mill Creek is "a lost hope".

A. Catch Basin Cleaning and Maintenance

Non-point pollution is difficult to control when it is coming off the roads and going through the pre-existing

stormwater infrastructure. One way to reduce some of the sediment and trash from making its way from roads to streams is through cleaning out catch basins that channel water. There are some municipalities that recognize the importance of this and implement it within their maintenance plan, but this is not the norm.

In urban areas catch basins on average should be cleaned every eight months to ensure proper stormwater flow. The cleaning of catch basins can increase the life of the infrastructure and reduce a potential block in the system, contributing to stormwater runoff from roads without any best management filtration.

RECOMMENDATION: Create recommendations for townships and municipalities to develop stormwater infrastructure maintenance and cleaning plan.

10.1.6 CITIZEN INVOLVEMENT AND EDUCATION RECOMMENDATIONS

A. Citizen Water Quality Monitoring

Citizen Water Quality Monitoring programs are important means to filling the gap between institutional monitoring efforts from MSDGC, SMU and others.

RECOMMENDATION: Work with agencies like the Mill Creek Watershed Council of Communities, the Butler County Stream Team, Rivers Unlimited, and Green Acres' Saturday Stream Snapshot to continue the volunteer water quality monitoring programs across the Mill Creek region.

B. Residential Education and Outreach on Lawn Care Practices

RECOMMENDATION: Develop recommendations for proper lawn care practices to maintain a high quality lawn while protecting water resources. Target education efforts first to high nutrient areas identified thru water quality source monitoring assessments then work to watershed wide.

C. Encouragement Program for Voluntary "On Site" Stormwater BMP Installation

RECOMMENDATION: Develop an innovative program to encourage voluntary installation of stormwater BMPs. Encouragement program actions could include incentives, such as recognition awards, identified cost savings, improved public image, and increased property values. Target areas in the riparian corridor first , then expanding watershed-wide. Develop strategic campaigns, one to residential properties and the other to industrial and commercial properties.

INDICATORS: 500 rain-gardens or rain barrels installed on residential properties. Fifty stormwater best management practices retrofitted to large-scale parking lots on industrial and commercial properties.

10.1.7 RECREATION AND CULTURAL ASSETS RECOMMENDATIONS

A. Mill Creek Greenway Trail

The Mill Creek Greenway Trail is a tremendous recreational and cultural asset for the Mill Creek region. The trail provides many benefits; a pathway for recreation, riparian corridor protection and restoration, aquatic and terrestrial habitat, and in some strategic places - streambank stabilization and instream restoration. The trail when finished will connect several parks along the way making for an all-day adventure.

RECOMMENDATION: The ultimate goal is the expansion of the Mill Creek Greenway trail to achieve a continuous connection from the headwaters in Butler County to the mouth in Downtown Cincinnati. But the process of implementation requires an incremental approach that relies on the availability of funding, property, and stakeholder involvement.

B. Mill Creek Artwork Initiative

Artwork is a wonderful way to attract people back to the Mill Creek to remember why this community asset is worth saving. The Mill Creek Greenway Trail is already decorated with artfully designed benches and signage that create a theme and provide information about the trail.

***RECOMMENDATION*:** Establish a Mill Creek Artwork program to beautify bland infrastructure along the creek and Greenway Trail. Form partnerships with organizations such as Artworks Cincinnati, Keep Cincinnati Beautiful, and other potential sponsors to identify funding, resources, manpower, and more. Expand the number of Mill Creek Greenway trail benches along the trail.

C. Mill Creek Yacht Club

The Mill Creek Yacht Club (MCYC) is simply a group of individuals that have braved the waters of the Mill Creek on one or more canoe trip expeditions. MCYC reached its 100th outing and hit over 600 crewmates on May 4, 2014. These intrepid paddlers have covered 26 of the 28 miles of the Mill Creek mainstem by canoe! Canoeing is the best way to experience Mill Creek oddities while learning about the stream. The maiden voyage in April 1994 was an antidote to all the board room meetings and devoted hours to Mill Creek discussion but nary a minute to Mill Creek experience. Some of the voyages have triggered corrective actions by the U.S. Army Corps of Engineers, Ohio EPA, MSDGC, the Village of Glendale and others. Paddlers have been out during every month of the year in sun, rain, wind and snow, and have started before sunrise and finished after sunset.

***RECOMMENDATION*:** Keep paddling! The number of crewmates is growing with monthly floats open to people of all ages along West Fork Mill Creek and the Mill Creek mainstem. Build the fleet of canoes for outings, create permanent public access points for paddlers to access the Mill Creek safely and legally, and obtain National Water Trail status for the Mill Creek through the National Park Service.

10.2 IMPLEMENTATION SUMMARY MATRIX

Priority Projects

Estimated Project Costs

$ - $0 to $150,000 (roughly pegged to Surface Waters Improvement Fund (SWIF) Grant or less)

$$ - $150,000 to $300,000 (roughly pegged to 319 Grant or less)

$$$ - $300,000 to $500,000

$$$$ - $500,000 to $1,000,000

$$$$$ - $1,000,000 or more

Acronyms

CDOTE – Cincinnati Department of Transportation and Engineering
CPB – Cincinnati Park Board
CPS – Cincinnati Public School District
CRC – Cincinnati Recreation Commission
GU – Green Umbrella
GWC – Groundwork Cincinnati Mill Creek
GWCC – Greater Cincinnati Water Works
HCSWCD – Hamilton County Soil and Water Conservation District
HCSWD – Hamilton County Stormwater District
MCWCC – Mill Creek Watershed Council of Communities
MSDGC– Metropolitan Sewer District of Greater Cincinnati
MVCD – Mill Valley Conservancy District
OEPA – Ohio Environmental Protection Agency
SMU – Greater Cincinnati Stormwater Management Utility
USGS – United States Geological Survey

Water Quality Performance Metrics

Water quality performance metrics are included on the table if they are known or able to be calculated/estimated using the information available. We hope to have project specific load reduction estimates for every project that reaches the construction phase.

	Priority Projects		Costs	Potential Sources of Funding	Lead Agency & Potential Project Partners	Measurable Milestones	Performance Indicators	Water Quality Performance (Annual Pollutant Load Reduction)			
								Total Phosphorus (lbs)	Total Nitrogen (lbs)	Total Suspended Solids (lbs)	Bacteria (billion colonies)
Construction Phase	9.2	Roberts Academy "Front Yard" Stormwater Demonstration	$$$ - $300,000 to $500,000	OEPA: Section 319, MSDGC Project Groundwork	CPS, MSDGC, MCWCC, CPB, Community Learning Center Institute,	Construction 2014	CSO mitigation, nutrients and sediments load reductions	19	3	4,200	
	9.12	Rapid Run Park	$$$$$ - $1,676,000 (total project costs), includes $200,000 U.S. Forest Service's Grant	MSDGC Phase 1	MSDGC, CPB, CRC	Construction 2014	CSO mitigation, nutrients and sediments load reductions	115	174	18,717	3E+07
	9.14	Glenway Woods Basin	$$$$$ - $3,716,000 (total project costs), includes $150,000 U.S. Forest Service's Grant	MSDGC Phase 1	MSDGC, CPB, MCWCC, GWC, USGS	Construction Early 2015	CSO mitigation, nutrients and sediments load reductions	38	99	23,393	3E+07
	9.18	West Fork Creek Bioinfiltration Basin	$$$ - $350,000 (total project costs)	MSDGC Phase 1, Pre-Disaster Mitigation Grant from OEMA, Clean Ohio Greenspace Conservation Grant	GWC, MSDGC, CPB, OEPA, Northside Community Council	Construction 2014-2015	CSO mitigation, nutrients and sediments load reductions				
Design & Engineering Phase	9.1	Kings Run Reforestation	$$$ - $300,000 to $500,000	MSDGC Project Groundwork	MSDGC, MCWCC, CDOTE, CPB	3 Phases: (A) 2015-16, (B) 2016-18, (C) 2017-18	Improved QHEI scores				
	9.19	Stearns Woods & Cilley Creek Restoration	$$$ - $451,409 Total Project Costs, includes $296,844 Section 319 grant request from OEPA	OEPA: Section 319	City of Wyoming, MCWCC, Green Area Foresters	Proposed 2014	Improved QHEI scores				

	Priority Projects		Costs	Potential Sources of Funding	Lead Agency & Potential Project Partners	Measurable Milestones	Performance Indicators	Water Quality Performance (Annual Pollutant Load Reduction)			
								Total Phosphorus (lbs)	Total Nitrogen (lbs)	Total Suspended Solids (lbs)	Bacteria (billion colonies)
	9.15	Hartwell Golf Course (daylighted stream)	$$$$$ - $3.368M Total Project Costs, includes $2.625M grant request from WRRSP	OEPA: WRRSP funds	MCWCC, MSDGC, CPB, Duke Energy, Hartwell Golf Club, Byer Steel	Proposed 2015-2016	Improved QHEI scores				
	9.8	Low Head Dam Mitigation	$$$ - $300,000 to $500,000	OEPA: SWIF grants, WRRSP funds	MSDGC, Duke Energy, MCWCC, GWC,	Proposed 2014	Improved QHEI scores				
	9.9	Mill Creek Riparian Corridor From South Cumminsville To South Fairmount	$$ - $150,000 to $300,000	OEPA: SWIF grants, Safe Routes to Schools	GWC, MSDGC, CPB, OEPA, Safe Routes to School	Proposed 2014-2015	Improved QHEI scores, increased tree canopy	84	84	140	n/a
	9.10	Mill Creek Riverine-Riparian Corridor – Vicinity Of Mill Creek Road Bridge	$$ - $150,000 to $300,000	OEPA: SWIF grants, WRRSP funds	GWC, MSDGC, CPB, OEPA, USGS	Proposed 2014	Improved QHEI scores, increased tree canopy	188	188	313	n/a
	9.11	Mill Creek Road Reforestation	$$ - $150,000 to $300,000	Safe Routes to Schools	GWC, MSDGC, CPB, OEPA, USGS, Safe Routes to School	Proposed 2014	Improved QHEI scores				
	9.13	Ecological Regeneration And Greenway Trail: Railroad Bridge Through Hamilton County Fairgrounds	$$$$$ - $1,000,000 or more	OEPA: SWIF grants, WRRSP funds, U.S. Forestry grants, Safe Routes to Schools	GWC, MSDGC, CPB, City of Cincinnati, MVCD, MCWCC	Proposed 2015-2017	Improved QHEI scores				
	9.16	Reforestation Of Este Avenue	$$ - $150,000 to $300,000	Safe Routes to Schools, Taking Root (tree donations)	City of Cincinnati, GWC, MSDGC, CPB, Safe Routes to Schools, Taking Root	Proposed 2015	CSO mitigation, nutrients and sediments load reductions				

	Priority Projects		Costs	Potential Sources of Funding	Lead Agency & Potential Project Partners	Measurable Milestones	Performance Indicators	Water Quality Performance (Annual Pollutant Load Reduction)			
								Total Phosphorus (lbs)	Total Nitrogen (lbs)	Total Suspended Solids (lbs)	Bacteria (billion colonies)
	9.17	West Fork Creek Regeneration Project	$$$$$ - $1,000,000 or more	OEPA: SWIF grants, WRRSP funds, U.S. Forestry grants, MSDGC Phase 2	GWC, MSDGC, CPB, OEPA, Northside Community Council	Proposed 2014-2017	Improved QHEI scores				
Concept Evaluation & Planning Phase	9.3	Amberley Creek Constructed Wetland & Reforestation (Conceptual)	Further evaluation needed	OEPA: SWIF grants, WRRSP funds	Sycamore Township, MSDGC, MCWCC, GWC	Evaluate Concept: 2014-15	CSO mitigation, nutrients and sediments load reductions				
	9.4	Bloody Run Stream Restoration (Conceptual)	Further evaluation needed	OEPA: SWIF grants, WRRSP funds	Saint Bernard, Elmwood Place, MSDGC, MCWCC, GWC	Evaluate Concept: 2014-15	Improved QHEI scores				
	9.5	Former Ridgewood Golf Course (Conceptual)	Further evaluation needed	OEPA: SWIF grants, WRRSP funds	Amberley Village, MSDGC, MCWCC, GWC	Evaluate Concept: 2014-15	CSO mitigation, nutrients and sediments load reductions				
	9.6	Ludlow Run Stream Restoration (Conceptual)	Further evaluation needed	OEPA: SWIF grants, WRRSP funds	City of Cincinnati, CPB, Spring Grove Cemetery, MCWCC, GWC	Evaluate Concept: 2014-15	Improved QHEI scores				
	9.7	Mill Creek From Township Ave To Proctor & Gamble Bridge (Conceptual)	Further evaluation needed	OEPA: SWIF grants, WRRSP funds	Saint Bernard, City of Cincinnati, P&G, MCWCC, GWC	Evaluate Concept: 2014-15	Improved QHEI scores				

Non-Structural Recommendations

Most of the "Non-Structural Recommendations" are on-going processes that require public education each and every year. Other non-structural recommendations are policy amendments which only need to be done once to become active.

Implementation Team

To implement pieces of the Lower Mill Creek Watershed Action Plan, the formation of ***Implementation Team*** is necessary. This team will meet **twice per year** to discuss progress on the defined goals, objectives, and actions of the LMCWAP and determine next efforts.

Non-Structural Recommendations		First Step	Lead Agency & Potential Project Partners	Milestone Date	Result of Effort	Follow-Up Effort Needed?
10.1	Riparian Buffer Protections – incorporate into City of Cincinnati's Land Development Code effort	City Staff – continue effort	MSDGC, City of Cincinnati Department of Planning and Buildings	August 2014	Protection to Riparian areas	
10.2	Finish the "Stormwater Post Construction Best Management Practices Design Manual" and promote usage	Already underway	HCSWD, MSDGC, GCWW, SMU	2014 - ongoing	Completed manual	*Implementation Team*
10.3	Promote the usage of rainwater harvesting	Establish plan review guidance document/factsheet, develop promotional opportunities	MSDGC, GCWW, SMU	Ongoing	Easier for property owners to implement RWH	*Implementation Team*
10.4	Promote and expand the usage of the HCSWCD water quality reporting "hotline"	Develop promotional opportunities	HCSWCD, MSDGC	Ongoing		*Implementation Team*
10.5	Investigate the need and development of new cooperative code enforcement mechanisms	*Implementation Team* to meet and discuss	HCSWD	2014	Determination of necessity	*Implementation Team*
10.6	Advocate for green streets policy/amendment to the City of Cincinnati codes and regulations	City Staff – continue effort	CDOTE, City of Cincinnati Department of Planning and Buildings	August 2014	Greener streets	
10.7	Advocate for tree ordinances to protect trees in the right-of-way in local jurisdictions	Draft language for "model" Tree Protection Ordinance and send to all Mill Creek jurisdictions	All jurisdictions, ODNR, CPB, Green Umbrella-Taking Root	2014 - ongoing		*Implementation Team*
10.8	Educate the public on easily implementable BMPs for residential and commercial buildings	Develop promotional opportunities	MSDGC	Ongoing		*Implementation Team*
10.9	Investigate the feasibility of establishing a Transfer of Development Rights (TDR) program in Hamilton County	*Implementation Team* to meet and discuss	to be determined	2014	Determination of feasibility	

Non-Structural Recommendations		First Step	Lead Agency & Potential Project Partners	Milestone Date	Result of Effort	Follow-Up Effort Needed?
10.10	Pursue land bank partnership to utilize vacant properties for storm water management	MSDGC and Port Authority meeting	Port Authority, MSDGC	2014	Partnership with Port Authority	Development of partnership
10.11	Encourage all jurisdictions to follow proper salt storage guidance as provided by the EPA	Draft email on proper salt storage and send to all Mill Creek jurisdictions	All jurisdictions,	2014 - ongoing		*Implementation Team*
10.12	Encourage all jurisdictions to improve street sweeping operations	Draft email on importance of street sweeping and send to all Mill Creek jurisdictions	All jurisdictions,	2014 - ongoing		*Implementation Team*
10.13	Work with local agencies and organizations to identify better vegetative management strategies for riparian corridors	*Implementation Team* to meet and discuss	All jurisdictions,	Ongoing		*Implementation Team*
10.14	GIS inventory of existing detention basins in Hamilton county. Analyze potential for reducing first flush pollutants	Talk to CAGIS and HCSWD about this	CAGIS, MSDGC, HCSWD	2014		*Implementation Team*
10.15	Continue and promote citizen led water quality monitoring programs	*Implementation Team* to meet and discuss	GWC, MCWCC, Mill Creek Yacht Club, Butler County SWD, OEPA, MSDGC	Ongoing		*Implementation Team*
10.16	Program to educate about Lawn care practices	*Implementation Team* to meet and discuss	MSDGC	Ongoing	Education Program	*Implementation Team*
10.17	Program to increase voluntary BMPs	*Implementation Team* to meet and discuss	MDSGC	Ongoing	Education Program	*Implementation Team*
10.18	Expand the Mill Creek Greenway	GWC ongoing	GWC	Ongoing		
10.19	Establish a Mill Creek Artwork Initiative	Draft email to potential partners	Keep Cincinnati Beautiful, Artworks	2014	Initiating an Mill Creek Artwork Program	*Implementation Team*
10.20						

11 EVALUATION AND REVISION

11.1 EVALUATION CRITERIA

The success of the Lower Mill Creek Watershed Action Plan will be evaluated by the ability of the plan to meet its stated mission statement:

"The purpose of the Lower Mill Creek Watershed Action Plan is to document current conditions; to identify effective strategies, programs and projects that are needed and can be employed; and to craft a roadmap for improving water quality and ecological health in the Lower Mill Creek Watershed that will, in turn, create more livable neighborhoods and provide public health, environmental, social, and economic benefits for many years to come."

This success will be measured primarily by improvement to the water quality parameters and goals set forth in previous chapters, particularly Chapter 7: Lower Mill Creek Watershed Problem Statements and Chapter 8: Lower Mill Creek Watershed Action Plan Restoration and Protection Goals. The success of meeting our watershed restoration and protection goals will depend on our ability to implement the projects, programs and policies defined in Chapter 9: Implementation Priority Projects and Chapter 10: Non-Structural Recommendations.

Since things never go as planned, an organic and flexible approach to implementation will help to achieve more success. To do this, the **LMCWAP will establish a bi-annual LMCWAP implementation committee** to regularly reassess, plan and then adjust the implementation components.

11.2 RESPONSIBLE AGENCIES

11.2.1 CONSTITUENCY BUILDING

Science and engineering are only part of the formula for reviving the Mill Creek watershed. The human factor cannot be overlooked. It will take patience and political will to make things right.

Acceptable water quality and healthy habitat will come at no small expense or use of time. Mill Creek degradation has occurred for more than 200 years; restoration will take decades.

Public support for the long-term effort has a promising start, but an uncertain future. This calls for more public outreach, education and constituency building. Without them, the Mill Creek and its tributaries will continue serving as "the martyr of the onward progress of civilization," which is how the Cincinnati Chamber of Commerce described the stream about 100 years ago.

In this context, constituency building refers to collective efforts for cultivating a variety of people,

organizations and interests to care about the Mill Creek. Such constituents are not alike. As a matter of fact, their diversity is a strength because it reflects the many reasons that Mill Creek stakeholders want or need watershed improvements. A constituency encompasses many levels of commitment, which may range from active advocacy to passive willingness not to oppose watershed improvement efforts.

Stakeholders of the Mill Creek Watershed have long recognized the need for constituency building. They had this in mind in 1993 when the Hamilton County Environmental Action Commission released a report titled "Creating a New Vision for the Mill Creek". Written primarily by Robin Corathers, then executive director of The Hillside Trust, the 44-page report asked the reader to imagine the Mill Creek "as it once was, and as it could be again."

> *"If its waters were pure and its banks forested, the Mill Creek could be a seventeen-mile greenway, a park that would link our communities, our east and west, extending downtown to the Ohio River. It could offer fishing (and the fish would be edible) and other forms of recreation. It would in many spots be a refuge of quiet beauty in the urban environment, not unlike Rock Creek Park or the C&O Canal in Washington, D.C. It would increase land values in the communities through which it flows. It would buffer and mitigate the transportation corridor's noise and exhaust gas pollution and enhance the quality of life in Hamilton and Butler counties. It could be a source of pride."*

Two decades later, this vision still motivates a variety of public outreach and education efforts. The campaign to make people care about the Mill Creek ranges from serious scientific analyses and engineering studies to light-hearted banter about all the perfectly weird situations that one encounters on our surprising urban stream. Among the stakeholders that are most involved in public outreach, education and constituency building for the Mill Creek are:

- **Groundwork Cincinnati/Mill Creek** reaches thousands of students each year with stream sampling, field demonstrations, lectures, volunteer projects and the Student Congress. It also has a good record of gaining an audience with decision-makers who can provide resources to Mill Creek improvement. Robin Corathers, Executive Director of Groundwork Cincinnati/Mill Creek (formerly Mill Creek Restoration Project), has stated, "The organization carries out its mission by collaborating with people most affected by Mill Creek conditions, by forging diverse public/private partnerships, and by building community capacity through education and training. Simply put, MCRP's work centers around youth, environmental education, clean water, planting trees, building trails and meaningful public engagement." Since 1994, the nonprofit organization has led the construction of 3½ miles of streamside bike trails while undertaking many initiatives to provide environmental education programming to more than 25,000 Greater Cincinnati students from about 60 schools within the watershed. MCRP has also successfully completed 33 projects to repair damage and improve floodplains, streambanks, natural habitats and wetlands. "What we want," said Corathers "is a transformation. We want a lot more people involved and understanding the value of this natural asset we have right in the heart of our city."
- **Mill Creek Watershed Council of Communities** often works through its member local governments, giving it educational access to elected officials, department heads and public service employees. As

membership-sustained organization, the Watershed Council sponsors the full menu of public outreach efforts to engage industries, businesses, non-profit organizations, residents, families and students as dues-paying supporters. Along with fundraising and recreation, education is a major goal of the Watershed Council's yearly Mill Creek ReCreation Celebration. To promote the 2014 Celebration, the Watershed Council expects to reach more than 250,000 watershed residents through its event marketing. The outreach will employ the Watershed Council website (www.millcreekwatershed.org), Green Umbrella (www.greenumbrella.org), Great Outdoor Weekend (www.greatoutdoorweekend.org), radio promotion and press releases, bulk emails sent through our partner organizations, and the Community Press. The Watershed Council also educates and builds a constituency through its Mill Creek Volunteer Water Quality Monitoring Program. The program's main goal is to gather baseline data to understand, at the watershed scale, how investments in improvement projects pay off in improved water quality and habitat, reduced flooding, and increased property value associated with recreational amenities. The program also builds awareness of our shared water resources among watershed residents.

- **University of Cincinnati, Miami University and Cincinnati State Technical & Community College** have sponsored undergraduate and graduate coursework to educate college students while building the body of knowledge on Mill Creek Watershed conditions.
- **Hamilton County Soil & Water Conservation District** (SWCD) and Butler SWCD perform field and classroom presentations and put volunteers to work with storm drain labeling, tree plantings and invasive plant eradication. Hamilton County SWCD also sponsors Caring for Our Watersheds, a competitive project proposal process for high school students, and Butler SWCD facilitates the Butler County Children's Water Festival, an ideal venue for student education at Miami University's Hamilton Campus.
- **Metropolitan Sewer District of Greater Cincinnati** (MSD) has organized, promoted and staffed dozens of public meetings, open houses, guided tours, community breakfasts and multi-media outreaches to educate its ratepayers and the general public. The prime topic of most of MSD's educational effort is the series of proposals, plans and projects to comply with court-ordered consent decree for eliminating sanitary sewer overflows and significantly reducing combined sewer overflows to the Mill Creek and other waterways. MSD is investing a lot of time and money in a hybrid approach that not only fortifies the sewage system infrastructure but also employs a variety of green infrastructure solutions to pollution source control. Any stakeholder serious about improving the Mill Creek watershed ultimately turns to MSD for collaborative support. Internally, MSD commits a lot of resources to education by providing a student intern program for high school students and a student co-op employment program for college undergraduates.
- **Mill Creek Yacht Club** started out as running gag line for people who couldn't resist seeing the curiosities of a long-abused urban stream by paddling it in canoes and kayaks. It has evolved into an effective organization that happily works for Mill Creek appreciation through "fun with a purpose." The Yacht Club's philosophy is an ancient Chinese proverb:

Tell me, I forget.
Show me, I remember
Involve me, I understand.

With staff and financial support from the Mill Creek Watershed Council of Communities, the Yacht Club has endured 20 years. During that time, it has sponsored 100 voyages, including 27 stream cleanups. The Yacht Club has paddled the urban stream with more than 600 people, including a state representative, a former state senate president, two congressmen, two county commissioners four public works directors, five mayors, a dozen municipal council members, several agency directors, a variety of university professors, birdwatchers, ecologists, engineers and many others from all walks of life.

11.2.2 CONNECTED SOLUTIONS AND COORDINATED EFFORTS

Simply stated, the watershed protection approach best ensures that the Lower Mill Creek Watershed Action Plan will:

- offer solutions connected with upstream sources and causes of water quality impairment
- coordinate efforts to make downstream solutions more effective given upstream problems

The watershed protection approach has been the guiding light for Mill Creek watershed improvement stakeholders for more than 20 years. Fragmented effort is avoided through the continuing collaboration of such key stakeholders:

- Metropolitan Sewer District of Greater Cincinnati
- Hamilton County Planning and Development
- Mill Creek Watershed Council of Communities
- Groundwork Cincinnati/Mill Creek (formerly Mill Creek Restoration Project)
- Hamilton County Public Health (formerly Hamilton County General Health District)
- Cincinnati Parks
- Hamilton County Environmental Action Commission
- Butler County Water and Sewer Department
- Butler County Storm Water District
- Hamilton County Storm Water District
- Hamilton County Soil & Water Conservation District
- Butler Soil & Water Conservation District
- OKI Regional Council of Governments
- Mill Creek Yacht Club
- Ohio EPA
- Ohio Department of Natural Resource
- U.S. EPA

Most of these stakeholders are engaged in the latest coordinated effort, namely the Lower Mill Creek Watershed Action Plan.

As explained by the U.S. EPA in its December 1991 report titled The Watershed Protection Approach: An

Overview, the watershed protection approach is built on three main principles:

First Principle: The target watersheds should be those where pollution poses the greatest risk to human health, ecological resources, desirable uses of the water, or a combination of these.

Second Principle: All parties with a stake in the specific local situation should participate in the analysis of problems and the creation of solutions.

Third Principle: The actions undertaken should draw on the full range of methods and tools available, integrating them into a coordinated, multi-organization attack on the problems.

Here's how the Mill Creek watershed's collaborative network abides by the three principles above:

First Principle: Though the entire Mill Creek watershed consists of five sub-watersheds in the federal government's categorization scheme of drainage areas with 12-digit hydrologic unit codes (HUC-12 watersheds), the collaborative network normally addresses the major issues from a watershed-wide perspective. Some division of labor occurs by political jurisdiction, agency service area or watershed group mission, but not enough to blot out connected solutions and coordinated efforts. Based on the report titled "Creating a New Vision for the Mill Creek" (April 1993, Hamilton County Environmental Action Commission), the Mill Creek Watershed Council of Communities was organized to serve the entire drainage area for the Mill Creek and its tributaries. *Groundwork Cincinnati: Mill Creek* also works to the benefit of the entire watershed.

Second Principle: It takes more time, but multiple stakeholders are nearly always involved in the analysis and solution of Mill Creek problems. Collaboration is an overriding goal, even when some Mill Creek stakeholders find themselves competing for grants from the same funding sources.

Third Principle: Given the number and variety of stakeholders working on Mill Creek watershed improvement, a full range of methods and tools is inevitable. In an effort to fulfill regulatory requirements with cost-effective practices, both the Butler County Water and Sewer Department and the Metropolitan Sewer District of Greater Cincinnati are contracting green infrastructure projects to supplement the more traditional gray infrastructure solutions. To improve their chances for grants, both Groundwork Cincinnati/Mill Creek and the Mill Creek Watershed Council of Communities pursue innovative solutions with multiple project partners.

Though it is served by two county sewer districts and three municipal sewage systems, the Mill Creek watershed still has about 1,600 home sewage treatment systems (HSTS). The Lower Mill Creek Watershed has 612 HSTS and upstream drainage areas have about 1,000. This generates concerns that addressing the Lower Mill Creek Watershed's home sewage treatment systems may not have sufficient impact on downstream water quality because of upstream home sewage treatment systems (HSTS). This challenge has not gone unnoticed by proponents of the Lower Mill Creek Watershed Action Plan. They have listened to citizen complaints about defective HSTS concentrated in the West Fork-Mill Creek sub-watershed. They also have collaborated with Hamilton County Public Health to address a malfunctioning HSTS along the West Fork Mill Creek in the Village of Woodlawn. Watershed plan proponents must continue responding to state and citizen concerns about HSTS

by collaborating more with the four local health agencies: (1) Butler County Health Department, (2) Sharonville City Health Department, (3) Hamilton County Public Health, and (4) City of Cincinnati Health Department.

Stakeholder collaboration is already extensive with Metropolitan Sewer District and Butler County Water and Sewer Department, which help the health departments eliminate insufficient HSTS by extending centralized wastewater collection and treatment service to neighborhoods without sewers. Two other stakeholders that can help address HSTS are:

- Mill Creek Yacht Club, which has reported illicit discharges and other public nuisances spotted during past canoe and kayak outings along the Mill Creek
- Ohio Department of Health, which can provide guidance for tackling this issue

Mill Creek stakeholders have not contracted work for home sewage treatment system solutions because few if any state or federal grants are available for such private treatment systems. These stakeholders, however, have accomplished 35 stream corridor restoration projects and 43 green infrastructure demonstration projects. The distribution of these projects throughout the Mill Creek watershed supports connected solutions and coordinated effort. Most of the stream corridor restoration projects are along the Mill Creek main stem. Most of the green demonstration projects are not next to the Mill Creek main stem, but closer to tributaries and storm sewers.

The maps in this document starting on page 37, titled "***Figure 19 - Green Demonstration Projects in the Mill Creek Watershed, Figure 20 - Stream Corridor Restoration Projects in the Mill Creek Watershed, and Figure 21 - Parks and Greenways in the Mill Creek Watershed***" shows that 22 of the 35 stream corridor restoration projects were accomplished upstream of the Lower Mill Creek Watershed, which lessens the likelihood that lower watershed efforts will be spoiled by pollution from upstream areas.

Cumulatively, the projects depicted on the maps address all or nearly all of the sources and causes of water quality impairment in the Mill Creek watershed. These sources and causes of impairment lend themselves to connected solutions and coordinated efforts because many types of sources and causes are recurrent throughout the Mill Creek watershed. The recurring sources and causes are documented by the Watershed Assessment Unit Summaries available through the draft Ohio 2014 Integrated Water Quality Monitoring and Assessment Report (January 29, 2014, Ohio EPA, Division of Surface Water). The unit summaries list the following causes and sources of impairment in the West Fork-Mill Creek sub-watershed (HUC-12 number 050902030105) and Congress Run-Mill Creek sub-watershed (HUC-12 number 050902030104), which jointly comprise the Lower Mill Creek Watershed:

Sources and Causes of Water Quality Impairment in the Lower Mill Creek Watershed	
Sources of Impairment	**Causes of Impairment**
Industrial point source discharges	Unionized ammonia
Combined sewer overflows	Taste and odor
Channelization	Direct habitat alterations
Urban runoff/storm sewers	Nutrients
Streambank modification/destabilization	Organic enrichment/dissolved oxygen
Municipal point source discharges	Flow alteration
	Cause unknown
	Oil and grease
	Unknown toxicity

Watershed Assessment Unit Summaries list the following causes and sources of impairment in the Sharon Creek-Mill Creek sub-watershed (HUC-12 number 050902030103), West Fork Mill Creek sub-watershed (HUC-12 number 050902030102) and East Fork Mill Creek-Mill Creek sub-watershed (HUC-12 number 050902030101), which jointly comprise the upper Mill Creek Watershed:

Sources and Causes of Water Quality Impairment in the Upper Mill Creek Watershed	
Sources of Impairment	**Causes of Impairment**
Industrial point source discharges	Unionized ammonia
Combined sewer overflows	Taste and odor
Channelization	Direct habitat alterations
Urban runoff/storm sewers	Nutrients
Streambank modification/destabilization	Organic enrichment/dissolved oxygen
Municipal point source discharges	Flow alteration
	Cause unknown
	Oil and grease
	Unknown toxicity
	Other flow regime alterations

"Other flow regime alterations" is highlighted in yellow because it is the only cause of impairment not common to both the Lower Mill Creek Watershed and the upstream watersheds. By having all the same sources and nearly all the same causes of impairment, the upper and lower portions of the Mill Creek watershed set the basis for connected solutions and coordinated efforts.

Common sources and causes of impairment throughout the entire Mill Creek watershed should come as no great surprise because development is prevalent throughout the entire drainage basin. The Watershed Assessment Unit Summaries report the following percentages of developed land use in the Mill Creek watershed's five HUC-12 sub-watersheds:

- West Fork-Mill Creek sub-watershed (HUC-12 # 050902030105) is 66.8% developed.
- Congress Run-Mill Creek sub-watershed (HUC-12 # 050902030104) is 79.4% developed.
- Sharon Creek-Mill Creek sub-watershed (HUC-12 # 050902030103) is 84.5% developed.
- West Fork Mill Creek sub-watershed (HUC-12 # 050902030102) is 75.1% developed.
- East Fork Mill Creek-Mill Creek sub-watershed (HUC-12 # 050902030101) is 74.5% developed.

When combined, the two sub-watersheds that comprise the Lower Mill Creek Watershed jointly have 73.9% of their land areas developed. The three sub-watersheds that comprise upstream drainage areas have 74.1% of

their land areas developed. Fairly even division of developed land use between lower and upper parts of the Mill Creek watershed eases the way for connected solutions and coordinated efforts. Stakeholders throughout the watershed are addressing most if not all of the same problems.

The Mill Creek watershed's upper and lower portions also have comparable shares of impervious surface, which "has emerged as a key paradigm to explain and sometimes predict how severely stream quality indicators change in response to different levels of watershed development." (Impacts of Impervious Cover on Aquatic Systems, Center for Watershed Protection, 2003).

Appendix C to Water Quality Management Plan for Butler, Clermont, Hamilton and Warren Counties, Ohio: June 2011 Update (OKI Regional Council of Governments) has analyzed the following percentages of land area covered with impervious surface in the Mill Creek watershed's five HUC-12 sub-watersheds:

- West Fork-Mill Creek sub-watershed (050902030105) has 33.5% impervious surface.
- Congress Run-Mill Creek sub-watershed (050902030104) has 35.6% impervious surface.
- Sharon Creek-Mill Creek sub-watershed (050902030103) has 36.9% impervious surface.
- West Fork Mill Creek sub-watershed (050902030102) has 25% impervious surface.
- East Fork Mill Creek-Mill Creek sub-watershed (050902030101) has 27.7% impervious surface.

When combined, the two sub-watersheds that comprise the Lower Mill Creek Watershed jointly have 35.6% of their land areas under impervious surfaces. The three sub-watersheds that comprise upstream drainage areas have 29.4% of their land areas under impervious surfaces. This shows that the Lower Mill Creek Watershed has a moderately higher percentage of land under impervious surface. The most important factor, however, is the finding that both the lower and upper portions of the Mill Creek watershed have more than 25% impervious surface, the level at which streams are expected to have poor water quality and are unable to support aquatic habitat.

In short, the Center for Watershed Protection's Impervious Cover Model indicates severe degradation throughout the Mill Creek watershed, lower and upper portions alike. This calls for connected solutions and coordinated efforts from these major ongoing initiatives:

- Metropolitan Sewer District's growing body of work to comply with its consent decree to eliminate sanitary sewer overflows and drastically cut combined sewer overflows
- Hamilton County's program to achieve more efficiency in eliminating Sanitary Sewer Overflow #700 upstream of the Lower Mill Creek Watershed
- Ohio EPA's work to update and expand the Mill Creek watershed's Total Maximum Daily Loads (TMDL) guidelines in collaboration with a variety of stakeholders
- Stakeholders' work to implement the Lower Mill Creek Watershed Action Plan

11.3 DISSEMINATION METHODS

The LMCWAP will be promoted and distributed by several means including emails, websites, word-of-mouth, printed newsletters and brochures, educational booths, and more. The LMCWAP report and appendix will be available for download at MCWCC's website and MSDGC's website, and possibly other websites. Members of the LMCWAP core team will find opportunities to discuss the LMCWAP at events such as community gatherings, environment forums and events, and more. The LMCWAP has already been featured at booths for the Green Umbrella's *Land and Water Forum* (2014), the City of Cincinnati's *Neighborhood Summit* (2013), discussed at the Ohio Stormwater Conference (2013) and more.

11.4 MONITORING COMPONENTS

Existing monitoring efforts in the Lower Mill Creek are shown *Table 39 – Water quality monitoring efforts on the Mill Creek watershed* on page 123. Additional or future monitoring components for the Lower Mill Creek Watershed Action Plan include:

<u>EPA's TMDL 2014-2015</u>
An upcoming Total Maximum Daily Load (TMDL) program report for the Mill Creek Watershed is expected in 2015.

<u>Integrated Prioritization System</u>
The Metropolitan Sewer District, in partnership with the Midwest Biodiversity Institute (MBI), is currently developing an Integrated Prioritization System (IPS) to identify watershed stressors, improve conditions for aquatic life, and identify, prioritize and implement cost effective projects. The IPS will consider chemical and physical metrics in-stream as well as other factors in the surrounding watersheds such as land use, population, and public safety. Many of these factors are already being monitored or are proposed for monitoring in a comprehensive monitoring and assessment plan developed by MBI in 2011. The IPS will be able to conduct complex statistical analyses of the thousands of data points gathered by MSD monitoring activities- combined with other regional and baseline data and stakeholder input- to identify the stressors that are most limiting in receiving streams.

<u>Mill Creek Watershed Council of Communities</u>
The Mill Creek Watershed Council of Communities, through its Water Resources Committee, has convened a workgroup of researchers and technical experts to implement a well-developed and scientifically rigorous water quality monitoring program that achieves the following goals:

1) Provides a baseline of watershed-wide and comprehensive water chemistry and flow data collected to no less than Level II standards under the Ohio Credible Data Law.
2) Furthers researches initiatives at various scales conducted by various local research entities, which we are fortunate to have concentrated in our region.
3) Allows us to proactively respond to Federal mandates and changes to Clean Water Act requirements, specifically with regard to stormwater management, in a manner that meets the mandate but takes into

account our unique soils and hydrologic conditions (instead of being subjected to a broad national standard which may prove onerous).

4) Gives us sound and publishable data that give us the confidence to articulate to communities, stakeholders, grant funders, regulators and others the specific environmental and economic benefits achieved by implementation of specific projects and policies. We want to know what works, why it works, and be confident about enumerating return on investment not just in terms of water quality improvement but also economic vitality and community development.
5) Aids watershed planning efforts, already under way throughout the watershed with the Council's leadership, to identify and prioritize the projects and initiatives that will make our vision a reality. We want to be responsive to opportunities as they arise with projects and programs at the ready that we know will be effective and why.
6) Establishes solid working partnerships with partners in implementation from a wide range of industries and disciplines so that we have technical knowledge and the skills to effectively accomplish our goals. This includes the wealth of talent in local engineering firms like CDM Smith, Cardno-JF New, AMEC, Strand, Human Nature and others as well as local resources in conservation districts; stormwater and public utilities; community public works, recreation and economic development departments; municipal and elected officials; and local industry leaders from General Electric, General Mills, Procter & Gamble, Dow Chemical, Duke Energy and others.
7) Achieves the vision of a restored Mill Creek that makes Cincinnati a fine place to live with healthy vibrant neighborhoods, recreational opportunity, clean water, and functioning ecosystems.

MCWCC currently conducts monthly water quality sampling at 46 sites throughout the Mill Creek Watershed. Samples are analyzed at Butler County Water and Sewer's Level III-certified laboratory at LeSourdsville. Measured parameters include pH, turbidity, conductivity, nitrates, total phosphorous and E. coli. Over 50 volunteers participate in the program. Additionally, MCWCC conducts pre and post-construction and event-based monitoring at its project sites including the Wildermuth wetland enhancement in Butler County and at Roberts Academy in Price Hill. MCWCC will continue to expand its monthly sampling network and is committed to pre and post-construction monitoring at all of its future projects.

<u>Mill Creek Yacht Club – Pollution and Trash Monitoring</u>

Excursions of the Mill Creek Yacht Club will occasionally monitor projects proposed by the Lower Mill Creek Watershed Action Plan. Crewmates of the Yacht Club have already documented and reported unusual conditions along the Mill Creek main stem and a few major tributaries. Such sightings have resulted in the investigation, cessation and resolution of unpermitted filling, illicit wastewater discharges, residue sedimentation, erosive logjams and failing sewage system infrastructure.

The organizers of Mill Creek Yacht Club outings are willing to accept assignments for inspecting, photographing and noting the condition of watershed improvement projects that are located along the route for planned canoe and kayak outings. In some cases, the Yacht Club has devoted trips to the express purpose of surveillance. This was done for the City of Springdale along Beaver Run, for the City of Sharonville along the upper Mill Creek, for the Hamilton County Soil & Water Conservation District along the middle Mill Creek and for the Metropolitan Sewer District of Greater Cincinnati along the lower Mill Creek. The Yacht Club aims for fun with a purpose, so it welcomes the opportunity to make educational paddling trips even more useful.

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13 APPENDIX