LOUISVILLE MSD

WATERSHED MASTER PLAN

April 2017

msd
Safe, clean waterways

EXECUTIVE SUMMARY

The Watershed Master Plan (WMP) was developed for Louisville Metro by the Louisville and Jefferson County Metropolitan Sewer District (MSD). MSD assumed responsibility of the community's public stormwater system, along with the flood protection system, in 1987. The basis of this WMP was MSD's original Watershed Master Plan, which was created in 1988 as part of the Stormwater Drainage Master Plan, and the 2010 Stormwater Management Master Plan, which was the most recent update of that plan. The purpose of this plan is to help effectively manage present and future regional stormwater drainage in Louisville Metro.

It should be noted that the WMP is not a flood study or a floodplain management program. The primary objective for the WMP is the promotion of stormwater drainage management practices in the context of a regional program. This plan was prepared in coordination with the floodplain management plan, which is part of the Louisville Metro Hazard Mitigation Plan. Furthermore, water quality is addressed in more detail through the Water Quality Synthesis Report, which trends stream health data to support the Municipal Separate Storm Sewer System Permit (MS4) and the Integrated Overflow Abatement Plan (IOAP). The WMP can be considered a precursor to the Stormwater Master Plan that is recommended in the Draft Critical Repair and Reinvestment Plan, MSD's 20-year Comprehensive Facility Plan.

The 2017 Watershed Master Plan is comprised of three sections. The first section gives a detailed comprehensive overview of the Louisville Metro watershed. This section contains:

- General description of the watershed area, stream names, soils and land use for the entire county
- Detailed description of the regulations and policies for stormwater management including those for stormwater discharge rates, floodplain management, water quality (MS4) and the Floodplain Management and Erosion Prevention and Sediment Control Ordinances
- Description of county wide programs (Critical Repair and Reinvestment Plan (CRRP) and the Integrated Overflow Abatement Plan (IOAP)) used to recommend stormwater improvements

The second section provides an overview for each of Louisville Metro's eleven sub-watersheds. Each subsection provides the following information:

- General description including watershed area, stream names, soils and land use
- Completed stormwater improvement projects such as regional detention basins, large and small scale drainage projects
- Current hydrologic and hydraulic models available for the particular watershed
- Watershed specific requirements for new development such as 1.5:1 compensation for fill added to the floodplain or requiring post developed stormwater discharge rates to be less than pre-developed levels
- Provides a list of recommended stormwater improvement projects that correspond with the Critical Repair and Reinvestment Plan (CRRP) and the Integrated Overflow Abatement Plan (IOAP) planned for the next three years

The third section includes maps for each watershed. These maps include an aerial map, drainage map, soils map, land use map, and floodplain map for each individual watershed. Larger watersheds were broken into two or three sections for clarity in the maps.

DESCRIPTION OF STUDY AREA

All areas affecting surface water runoff in Louisville Metro, which for the purposes of this report includes all of Jefferson County, Kentucky, are included in the WMP. Louisville Metro is a river city located along the Ohio River. The area is drained by two major drainage systems: the Ohio River and the Salt River. The Salt River drains into the Ohio River at the southwestern end of Jefferson County. A large portion of

Jefferson County lies within the broad floodplain of the Ohio River; however, about 17,600 acres of this floodplain, including downtown Louisville, are protected by a 28.9 mile long flood protection system. The flood protection system, which was built by the U.S. Army Corps of Engineers, protects the area from Beargrass Creek to Pond Creek.

Four distinct topographic regions exist within Louisville Metro. These topographic regions are the Flood Plain, Knobs, Central Basin, and Eastern Uplands. The Flood Plain and Central Basin regions are both characterized as generally flat, while the Knobs and Eastern Uplands regions are both characterized as generally hilly. Elevations in Louisville Metro range from about 382 feet above sea level, which is the pool stage of the Ohio River below the McAlpine Lock and Dam, to in excess of 900 feet along the southern boundary.

STORMWATER MANAGEMENT REGULATIONS

Through the WMP, MSD Design Manual, Louisville Metro Floodplain Management Ordinance, and Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance, a watershed-by-watershed approach to regional management of stormwater drainage is taken. Other permits, such as the Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities and the MS4 permit also affect the stormwater policies in Jefferson County.

New development in Jefferson County is required to mitigate proposed stormwater discharge rates to predeveloped conditions for the 2, 10, 25 and 100 year storm events as detailed in the MSD Design Manual. The NRCS Type II, 24 hour rainfall distribution is required to be used for the modeling. In areas where adequate downstream facilities exist, especially in the lower portion of a watershed where peak flows from the new development will occur substantially prior to the overall peak of the stream, on a case-by-case basis, MSD allows increased runoff to be compensated using a regional facility fee. This regional facility fee is used to construct regional basins.

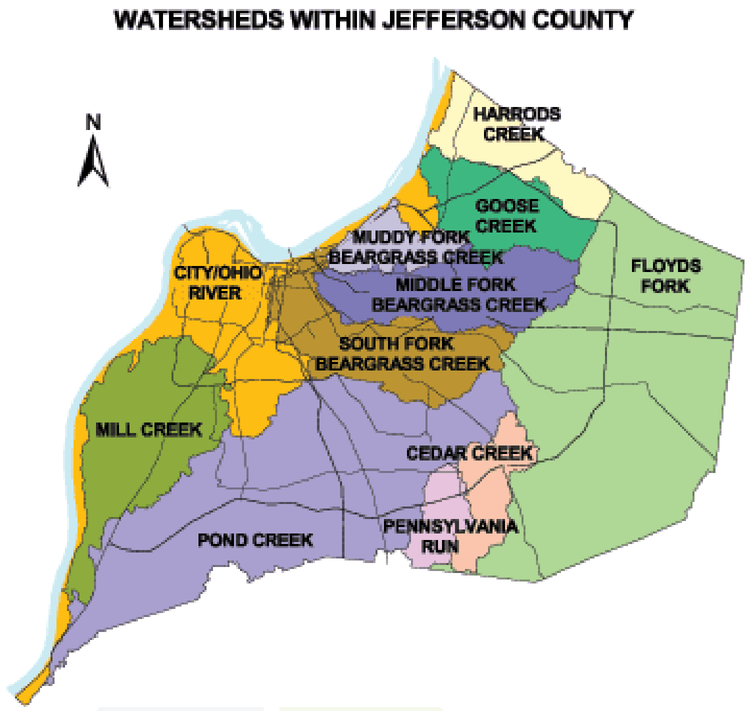
New development in the combined sewer area is restricted to detaining the post-developed 100-yr flows to the pre-developed 10-year flows in order to help alleviate the flows in the combined sewer system during rain events. Examples of mitigation techniques include building detention basins, oversizing onsite stormwater pipes, and using green solutions such as pervious pavement and rain gardens to reduce peak flows and overall runoff volumes.

Floodplain compensation is required throughout Jefferson County for any fill placed in the fully developed local regulatory floodplain as required in the Louisville Metro Floodplain Management Ordinance. Due to severe flooding problems in the Pond Creek Watershed, the Chenoweth Run Watershed of Floyds Fork, and the Big Run Watershed of Mill Creek, the ratio has been increased to 1.5:1 for any fill in the Local Regulatory Floodplain of those watersheds. The ratio may also be increased on a site-specific basis as determined by MSD.

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the Kentucky Division of Water through its KPDES General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as High Quality or Impaired Water (Non-construction related impairment). A minimum 50-foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or "soft" approaches. MSD's Design Manual outlines natural channel design requirements in Section 10.3.6.



The MS4 permit requires all developments with a disturbed area equal or greater than one acre, including projects less than one acre that are part of a larger common plan of development equal to or greater than one acre, to treat the first 0.6 inches of rainfall. This can be accomplished by infiltrating or treating the stormwater using green infrastructure practices, which are detailed in Chapter 18 of the Design Manual.

The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2000 square feet or more of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance to obtain a Site Disturbance Permit. The Site Disturbance Permit requires an EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year, 24-hour SCS Type II storm event.

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1.0 PLANNING METHODOLOGY

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1.1 Introduction

The Watershed Master Plan (WMP) was developed for Louisville Metro by the Louisville and Jefferson County Metropolitan Sewer District (MSD). MSD assumed responsibility of the community's public stormwater system, along with the flood protection system, in 1987. The basis of this WMP was MSD's original Watershed Master Plan, which was created in 1988 as part of the Stormwater Drainage Master Plan, and the 2010 Stormwater Management Master Plan, which was the most recent update of that plan. The purpose of this plan is to help effectively manage present and future regional stormwater drainage in Louisville Metro.

The WMP is intended to compile related reference and data documents. It is a process which MSD can utilize to affect present and future regional management of stormwater drainage. In doing so, stormwater drainage facilities (e.g. storm sewers, detention basins, and green infrastructure) will be employed within a comprehensive planning context.

It should be emphasized that the WMP is not a flood study or a floodplain management program. The primary objective for the WMP is the promotion of stormwater drainage management practices in the context of a regional program; however, this plan was prepared in coordination with the floodplain management plan, which is part of the Louisville Metro Hazard Mitigation Plan. Furthermore, stormwater quality is addressed in more detail through the Water Quality Synthesis Report and applicable portions of the Integrated Overflow Abatement Plan (IOAP).

The WMP can be considered a precursor to the Stormwater Master Plan that was recommended in the Critical Repair and Reinvestment Plan, MSD's 20-year Facility Plan. The Stormwater Master Plan will build on the WMP and address the following goals and objectives:

- Work towards minimum level of service for everyone in the MSD drainage service area, based on rainfall intensity duration and frequency projections anticipated to occur at the end of the 20-year planning period.
- Develop and maintain an up-to-date inventory of the stormwater infrastructure, including identified deficiencies.
- Prepare a process to develop annual ratings of stormwater infrastructure by comparing present conditions against established standards and required levels of service.
- Establish a methodology to review technical standards and design criteria for stormwater infrastructure in the MSD drainage service area within the MSD drainage service area, at least once every 10 years.
- Identify projects that conform to adopted design criteria and standards.
- Update rainfall and discharge data for watersheds and sub-basins to reflect the projected rainfall over the next 20 years.
- Look for opportunities to integrate green infrastructure into the planning of MSD projects to meet the objectives of the MS4 Program.

Downtown Louisville along the Ohio River

1.2 Watershed Study Area

1.2.1 General

The WMP includes all areas affecting surface water runoff in Jefferson County, Kentucky. Jefferson County is an approximately 375 square mile political subdivision within the much larger 203,900 square mile physiographic Ohio River Basin, which embraces parts of fourteen states. The large drainage system originates in the Allegheny Mountains, flows generally in a southwesterly direction converging with numerous tributaries, and eventually discharges into the Mississippi River. A little less than one-half (91,170 square miles) of the Ohio River Basin lies upstream of Jefferson County.

The Jefferson County area is drained by two major drainage systems: (1) the Ohio River and (2) the Salt River. The Ohio River receives discharges from Mill Creek, Beargrass Creek, Goose Creek, Harrods Creek, and the combined sewer system. Cedar Creek and Pennsylvania Run discharge into Floyds Fork, which in turn, discharges in the Salt River. The Salt River also receives discharge from Pond Creek near its confluence with the Ohio River.

In this report, eleven major watersheds are defined and are geographically shown in Figure 1.1. These watersheds are based on the drainage systems mentioned above. Table 1.1 provides a summary description of the general characteristics of each watershed. Each of these watersheds is discussed in detail in the following sections and throughout the plan.

1.2.2 Ohio River and Floodwall

A large portion of Jefferson County lies within the broad floodplain of the Ohio River; however, about 17,600 acres of this floodplain, including downtown Louisville, are protected by a 28.9 mile long flood protection system. The first phase of the system, which protects the area from Beargrass Creek to just south of Rubbertown, was completed by the U.S. Army Corps of Engineers (USACE) in 1957. A second phase was completed in the late 1980's. The second phase protects southwest Jefferson County, from Rubbertown to Pond Creek. The floodwall system is built to protect Jefferson County from floods equivalent to the historic flood event of 1937, with three feet of freeboard.


Floodwall near 10th Street

A study of the Ohio River and the floodwall system as they relate to the goal of stormwater management in the WMP was not required. As indicated in Section 1.1, the WMP is intended to address management of stormwater drainage and not floodplain management, which is directly associated with the Ohio River and the floodwall system. Floodplain management information regarding the floodwall can be found in the Louisville Metro Hazard Mitigation Plan.

1.2.3 Physiography

Jefferson County is located in the north central portion of Kentucky, as shown in Figure 1.2, on the south bank of the Ohio River, approximately 600 miles below its headwaters at Pittsburgh, Pennsylvania.

The entire county lies within the outer Blue Grass region of the Appalachian Plateau, a portion of which was once a vast plain extending from east of Lexington, Kentucky westward to Indiana. The Ohio River, with its attending streams, has eroded the plain and effectively reduced most of the surface in Jefferson County below its original elevation.

Wide valleys, broad rolling uplands, and highlands with deep, steep-sided valleys and narrow ridge crests are common. Stream beds are of fairly uniform slope and side slopes are in a constant state of change as lateral erosion increases.

Elevations in Jefferson County vary from about 382 feet above sea level, which is the pool stage of the Ohio River below the McAlpine Lock and Dam, to in excess of 900 feet along the southern boundary. Selected elevations in Louisville are shown in Table 1.2.

Table 1.2
Elevations in Louisville

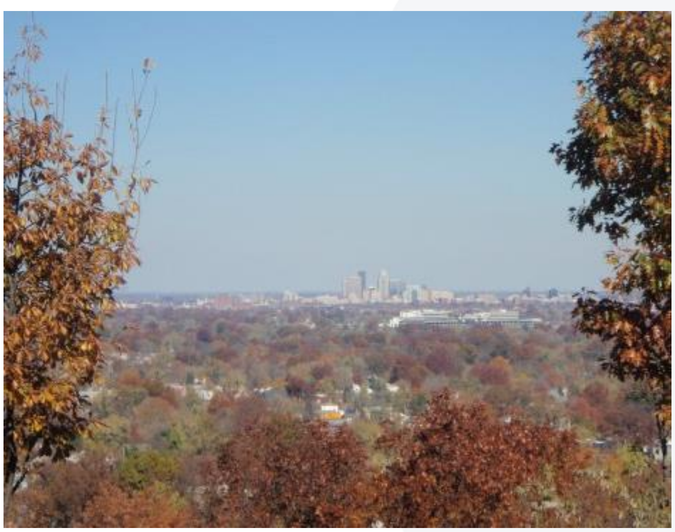
Location	Elevation (ft)
Courthouse	462
Iroquois Park	761
Louisville International Airport	475
Anchorage	720
Coral Ridge	490
Fern Creek	715
Jeffersontown	711
Kosmosdale	449
Middletown	721
Prospect	460
Valley Station	452

1.2.4 Topography

Four distinct topographic regions exist in Jefferson County as listed below and shown in Figure 1.3.

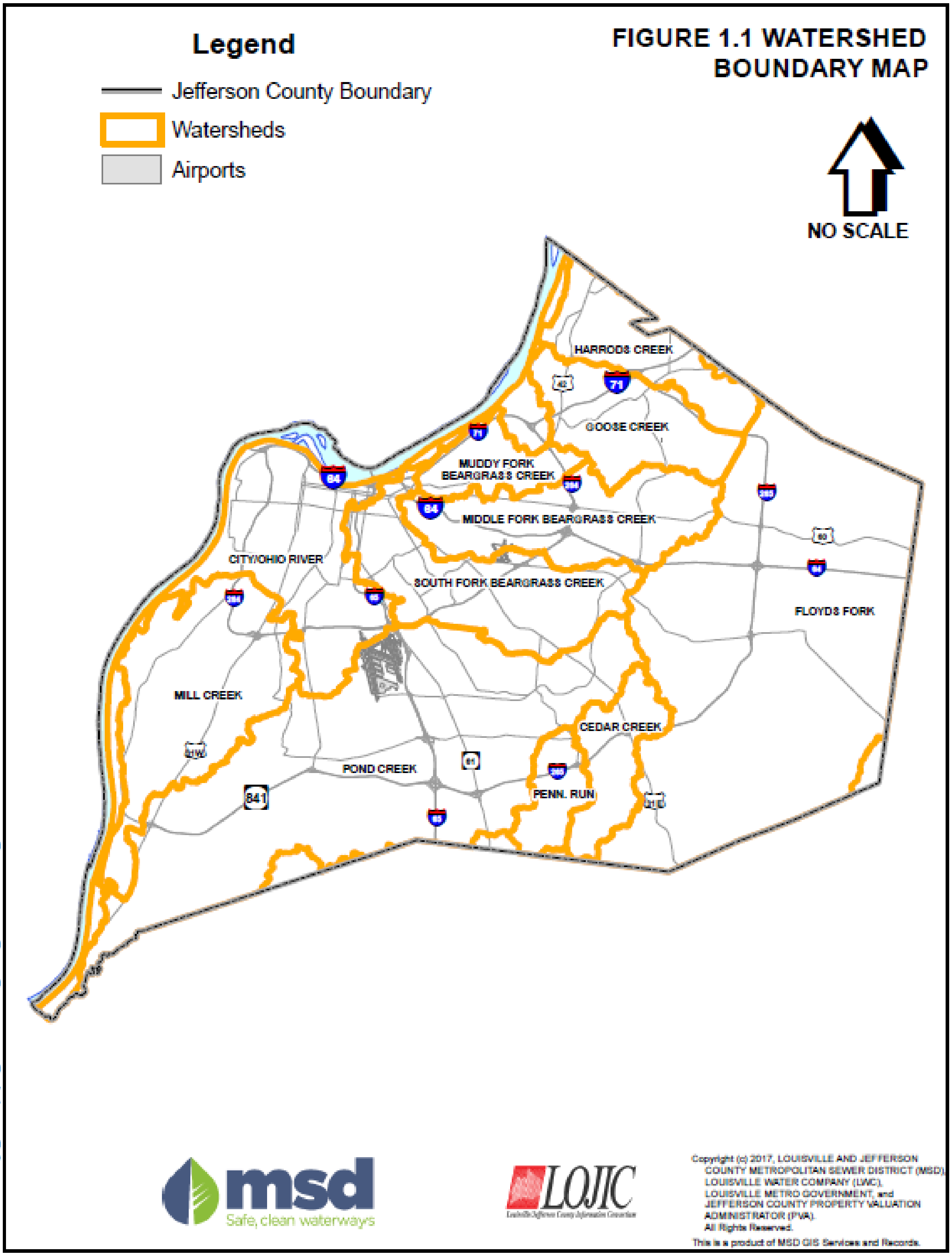
- Flood Plain
- Knobs
- Central Basin
- Eastern Uplands

The "Flood Plain" is a strip of land bordering one-half to five miles wide along the Ohio River. The Flood Plain extends from the Salt River in the southwest, north to downtown Louisville, and continues northeast to the Oldham County line. The lowest elevations in the county are found in this region and generally range from 430 to 440, with occasional terraces to 460. The area is best characterized as flat to gently rolling and with very flat sloped stream beds. Mill Creek and the combined sewer system drain the majority of this region.



Flood Plain Region as seen from Iroquois Park

The "Knobs" region covers a triangular area in the southwestern portion of the county bounded approximately by Iroquois Park on the north, South Park Hills on this southeast, and the Southern Railroad on the southwest. The hills in this region have been highly dissected by stream erosion. Side slopes of 30% to 50% are common, and this region contains the highest elevations in the county, probably approaching the level of the original Appalachian Plateau. These steep sided hills rise 300 to 400 feet above their surroundings and numerous streams originate here. The majority of these streams drain to Pond Creek, which has eroded a trench, effectively bisecting this region from east to west.


Legend
Jefferson County Boundary
Watersheds
Airports
FIGURE 1.1 WATERSHED BOUNDARY MAP
NO SCALE
HARRODS CREEK
GOOSE CREEK
MUDDY FORK BEARGRASS CREEK
MIDDLE FORK BEARGRASS CREEK
CITY/OHIO RIVER
SOUTH FORK BEARGRASS CREEK
FLOYDS FORK
MILL CREEK
CEDAR CREEK
POND CREEK
PENN. RUN
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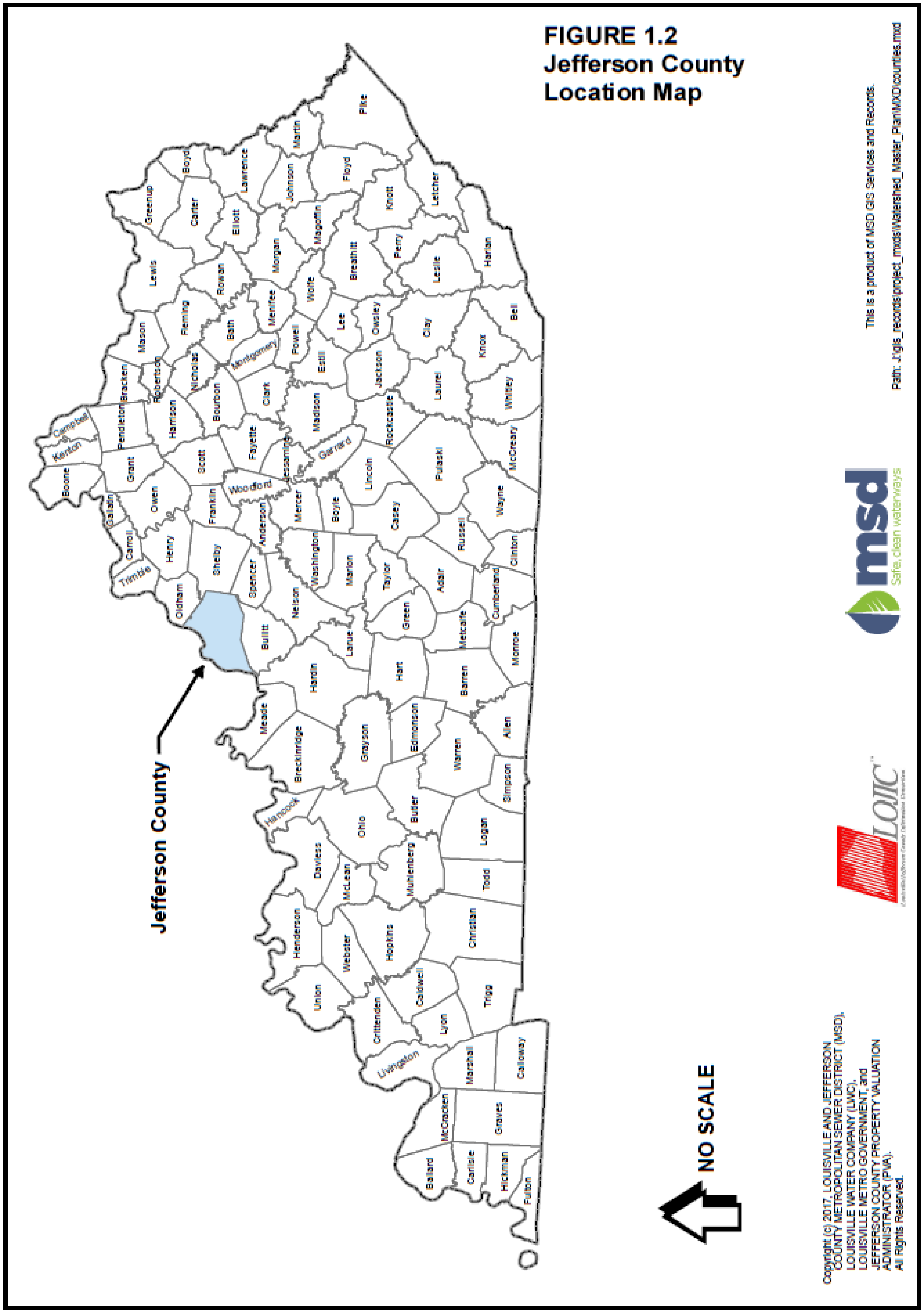

FIGURE 1.2
Jefferson County Location Map

Table 1.1
Watershed Characteristics

Watershed	Drainage Area (sq mi)	Major Stream Systems	USGS Stream Gauges
Middle Fork Beargrass Creek	25.1	Middle Fork Weicher Creek	Middle Fork @ Old Cannons Ln Middle Fork @ Lexington Rd
Muddy Fork Beargrass Creek	8.8	Muddy Fork	Muddy Fork @ Mockingbird Valley Rd
South Fork Beargrass Creek	27.1	South Fork Buechel Branch	South Fork @ Trevilian Wy South Fork @ River Rd South Fork @ Mason Ave
Cedar Creek(1)	11.2	Cedar Creek	Cedar Creek @ Thixton Rd
Floyds Fork	103.9 (Jeff Co) 257.0 (Total)	Floyds Fork Chenoweth Run Pope Lick	Floyds Fork @ Old Taylorsville Rd Floyds Fork @ Bardstown Rd Chenoweth Run @Ruckriegal Pkwy Chenoweth Run @ Gelhaus Ln
Goose Creek	18.6	Goose Creek	Goose Creek @ Old Westport Rd Goose Creek @ US Hwy 42 Little Goose Creek @ US Hwy 42
Harrods Creek	15.3 (Jeff Co) 92.0 (Total)	Harrods Creek Wolf Pen Branch South Fork Harrods South Fork Hite	N/A
Mill Creek(2)	34.2	Mill Creek Upper Mill Creek Big Run Cane Run Black Pond Creek	Mill Creek Cutoff @ Cane Run Rd Mill Creek @ Orell Rd
Ohio River/City	39.8 (Jeff Co)	Combined Sewer System	Ohio River @ Water Tower Ohio River @ McAlpine Locks Ohio River @ Louisville Ohio River @ Kosmosdale
Pennsylvania Run(1)	6.9	Pennsylvania Run	Penn Run @ Mt Washington Rd
Pond Creek	89.3 (Jeff Co) 95.5 (Total)	Pond Creek Northern Ditch Southern Ditch Fern Creek	Pond Creek @ W Manslick Rd Pond Creek @ Pendleton Rd Northern Ditch @ Preston Hwy Fern Creek @ Old Bardstown Rd Brier Creek @ Pendleton Rd

Notes:
(1) Outlets into Bullitt County to Floyds Fork Watershed.
(2) Studied in two parts in WMP. Upper Mill Creek is 19 square miles and Lower Mill Creek is 15 square miles.

The west central portion of the county, bounded approximately by I-264 on the north, Shepherdsville Road on the east, and the “Knobs” region on the south and west, is the “Central Basin.” This is a former slack-water region of shallow soils and nearly flat terrain with elevations ranging between 450 and 500. Various improvements to the Northern and Southern Ditch systems have helped alleviate the lack of natural drainage in the region.

Knobs Regions as seen from Iroquois Park

The “Eastern Uplands” cover the remainder and largest portion of the county. This region is characterized by gently rolling to hilly plains to moderate to very steep valleys. Elevations range between 500 and 800. Goose Creek, Harrods Creek, Floyds Fork, and the Beargrass Creek system drain this region.

1.2.5 Geology

1.2.5.1 Historical Geology

The rocks that underlie Jefferson County were formed several hundred million years ago during the Paleozoic Era of Geologic Time. During this period, a vast area of what is now North America was under ancient seas. Sedimentary processes allowed deposition of layers of materials onto the sea floor and shoreline. Subsequently, these sediments underwent lithification and became limestones, dolomites, shales, and siltstones.

In general, limestone and dolomite are accumulations of calcium carbonate and/or magnesium carbonate precipitated from both sea water and the remains of organic sea life which extracted carbonates from the water. Shale is formed from fine clayey particles which are either transported from land by winds or washed into the sea by the streams and then deposited on the sea floor. Siltstone is generally formed from deposits which accumulate near shorelines, such as very fine grains of quartz.

Ohio River at Cox Park

Over the last 300 million years, gentle uplifting of the continental mass has raised these sedimentary rocks to their present elevation, producing fractures and undulations of varying magnitudes.

The Quaternary glacial outwash in the “Flood Plain” is much younger than the rock it overlays. This unique formation was deposited some 15 to 30 thousand years ago when the extreme southern edge of continental glaciers were just north of the Ohio River. Great masses of mud, sand, and gravel pushed by the ice were washed into a river bed much deeper and wider than now exists. As the glaciers receded northward, leaving behind deep unconsolidated sediments, normal drainage conditions were restored, and the river formed in approximately its present location.

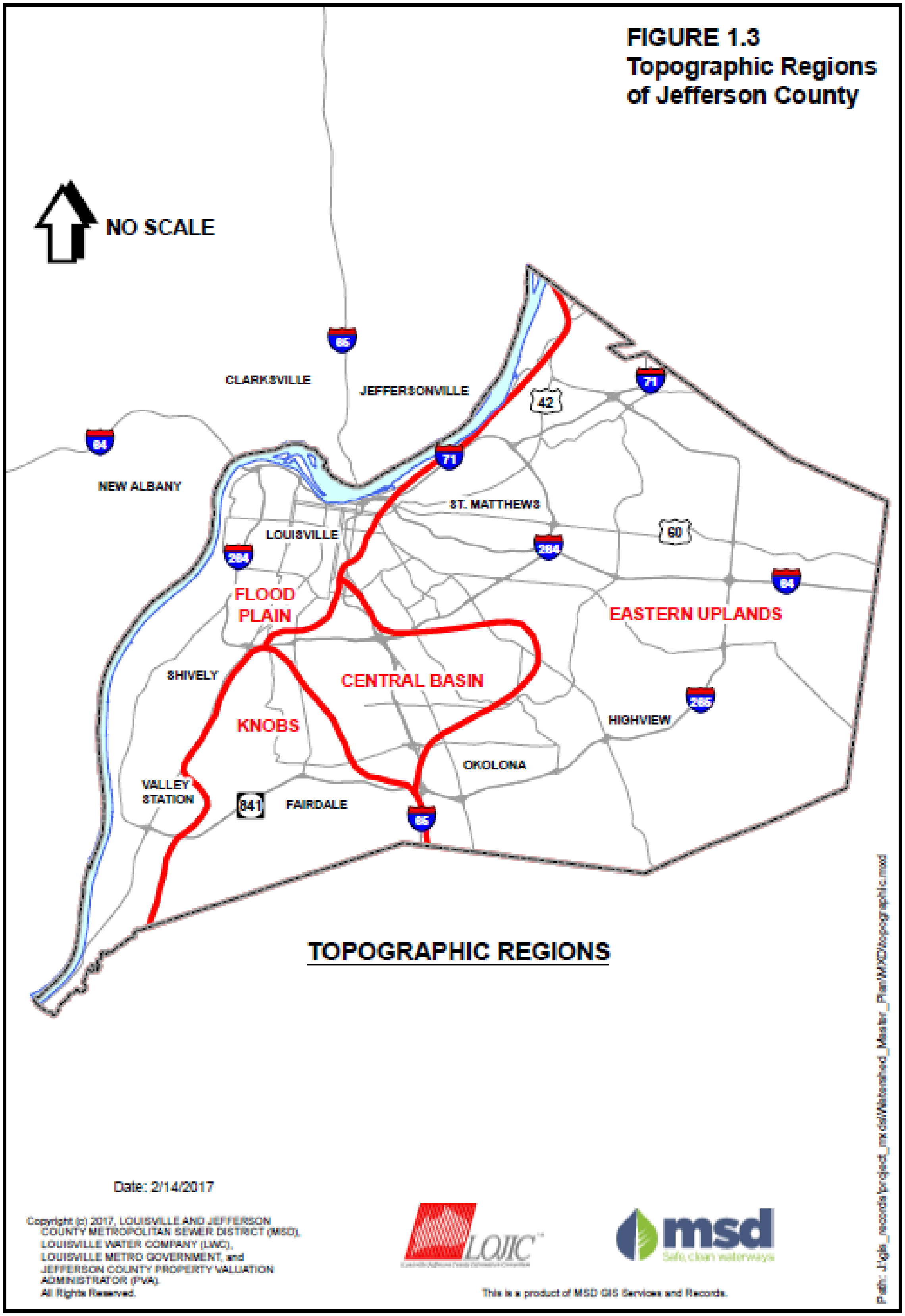
FIGURE 1.3
Topographic Regions
of Jefferson County
NO SCALE
CLARKSVILLE
JEFFERSONVILLE
NEW ALBANY
LOUISVILLE
ST. MATTHEWS
FLOOD
PLAIN
EASTERN UPLANDS
SHIVELY
CENTRAL BASIN
KNOBS
HIGHVIEW
OKOLONA
VALLEY
STATION
FAIRDALE
TOPOGRAPHIC REGIONS
Date: 2/14/2017
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1.2.5.2 General Stratigraphy

Stratigraphy is a branch of geologic study concerned with the form, arrangement, distribution, and mutual relationships of sedimentary rocks.

In Jefferson County, rock lies in nearly horizontal beds, or strata. Structurally, these beds range from a few feet to several hundred feet in thickness, and gently dip toward the southwest.

The oldest of these rocks, Ordovician, is found in the Floyds Fork area of the “Eastern Uplands.” They consist of randomly alternating layers of limestone, dolomite, and occasional thinly-bedded shales.

To the west, younger Silurian rocks outcrop in the Goose, Beargrass, and Fern Creek systems. They consist of limestone, dolomite, and occasional shale layers.

Progressing further west, and continuing into younger strata, a thin basal layer of limestone comprises the lower Devonian rock encountered near the Beargrass Creek system of the “Eastern Uplands.” Upper Devonian rock is comprised of a thick layer of black shale, which underlies most of the Central Basin.

The youngest rocks in Jefferson County are Mississippian and are found in the “Knobs” region. They consist of a very thick basal clay shale layer, a middle layer of silty shale and interbedded siltstones, and an occasional thin upper layer of limestone.

1.2.5.3 Geologic Erosion

As the continental mass of North America rose in elevation, the down-cutting action of the running water increased its relentless attack on the land surface. The various sedimentary rock types have eroded at different rates and by different processes.

The most distinctive property of limestone, and to a somewhat lesser degree, dolomite, is solubility. In general, materials in these rocks chemically react with water to gradually dissolve, yielding sinkholes, solution channels, and caverns. Fractures in rock strata serve as conduits for this activity and greatly accelerate the process.

Shale is a structurally laminated sedimentary rock which exhibits high impermeability when unexposed to the atmosphere. Once exposed, however, rapid disintegration occurs owing to contact with moisture and temperature fluctuation. In fact, shale erodes much faster than other exposed sedimentary rocks, and rarely forms any prominent topographic features.

Siltstone, much like its larger grained-size sandstone counterpart, is a very erosion resistant material. Having a very even-granular, well-stratified structure, siltstone tends to stand out in relief against over- or underlying rocks and is well documented “ridge former.”

1.2.5.4 Relationship of Erosion and Topography

The topographic regions of Jefferson County are a direct result of the selective erosional characteristics of its geologic structure, excluding the “Flood Plain” which is a product of deposition.

In the Mississippian rocks of the “Knobs” region, vast areas of the upper limestone have been totally removed by solutioning and gradual erosion. In the process, water has migrated downward into the softer shales and highly resistant siltstones. As the more easily eroded shales disintegrate, the siltstone becomes undercut, creating overhangs, which eventually fall as their weight overcomes their horizontal strength. This process has led to the formation of steep, rounded-top hills. An excellent example is observed in the road cuts along the Gene Synder Freeway just west of I-65.

The upper Devonian shale of the "Central Basin" displays the characteristic impermeability of horizontal, fissile shales. In a former geologic age, overlying rocks were eroded away and the shale's surface was subsequently subjected to inundation during the Quaternary glacial period. An alluvial mantle, 0 to 50 feet thick and deposited onto the shale in the ponded lake bed, now protects it from the atmosphere. Groundwater is unable to penetrate the nearly horizontal strata and as a result, the local water table is high and many areas are marshy.


"Big Rock" in Cherokee Park

The lower Devonian, Silurian, and Ordovician rocks which underlie the "Eastern Uplands" are being eroded in a combination of processes. Most notably, the solutioning of limestones and dolomites has deepened and widened stream valleys. Sinkholes and small caverns are common on plateaus and in cliffs of this region. These natural conduits carry surface waters into underlying rocks where chemical reactions enlarge solution channels. Eventually, much of this water finds its way back to surface streams in the form of springs. Where interbedded shales are exposed, the more resistant carbonates are undercut, leading to rock falls which widen valleys. An excellent example is the "Big Rock" locality in Cherokee Park.

1.2.5.5 Parent Material

Parent material influences the textural, chemical, and mineralogical properties of soils. In Jefferson County, parent material is extremely variable. About seventy-five percent of the county's soils developed in residuum derived from the underlying, nearly horizontal beds of sedimentary rocks. The remaining twenty-five percent developed in local alluvium.

1.2.6 Soils

1.2.6.1 Factors of Formation

Soils are formed through the complex interaction of parent material, topography, climate, living organisms, and time. A change in any one of these factors affects the soil-forming process and the resultant soil characteristics. The importance of each factor differs from place to place, even within short distances. However, in Jefferson County, parent material and topography, more than the other factors, account for differences among soils.

1.2.6.2 Topographic Factors

Topography in Jefferson County ranges from nearly level, to gently rolling, to very steep. The range of slopes is mostly from zero to twenty percent, although thirty to fifty percent is common in the "Knobs" region.

Topographic effects in areas of level terrain are such that large amounts of water can infiltrate the soil and percolate downward through it. Little or no soil is lost through geologic erosion, and there is a continuing accumulation of material. In rolling terrain, the rate of geologic erosion is slightly less than the rate of soil formation, and soils will form and mature. In steep terrain only small amounts of water can infiltrate and as a result, geologic erosion is rapid and soil material is removed as rapidly as it forms.

1.2.6.3 Relationship of Soils and Topographic Region

The General Soil Map contained in the NRCS Soil Survey of Jefferson County graphically represents the correlation between soil associations and topographic regions. Table 1.3 provides correlation between soil types and topographic regions in Jefferson County.

Table 1.3
Soil Type By Topographic Region

Region	Soil Association	Soil Type
Flood Plain	1	Wheeling-Weinbach-Huntington
Knobs	2 4	Memphis-Loring-Zanesville Westmoreland-Litz-Muskingham
Central Basin	3	Zipp-Robertsville
Eastern Uplands	5 6 7	Russellville-Crider-Dickson Crider-Corydon Beasley-Fairmont-Russellville

The NRCS Soil Survey also contains pertinent information regarding engineering properties of these soil associations. These include description, depth to rock, unified and AASHTO classifications, permeability, and depth to seasonal high water table.

The physical properties of the soils and rocks found in Jefferson County vary greatly depending upon location. Regarding surface water runoff, several implications and concerns arise.

- Lacustrine deposits and clay soils become plastic when wetted and are prone to slump and/or slide. In areas such as these, over steepened cuts should be avoided.
- Shale exposures are unstable, and once wetted, disintegrate very rapidly. Drainage ditches cutting through or into shale can be expected to undergo bank failure and channel siltation. The weight of large impoundments of water for detention purposes may induce stresses in shale which cause regional instability and, in areas of high relief, lead to landslide activity.
- Limestone and dolomite exposures are much more stable, but these rocks are susceptible to karstic-type weathering. The use of sinkholes as conduits for storm drainage should be avoided. Introduction of water accelerates the solutioning process, enlarges underground voids and leads to subsidence of overlying terrain.
- Springs within Devonian limestones and Silurian limestones and shales furnish much of the water for streams in the "Eastern Uplands" topographic region. For new channels or existing channel improvements, care must be taken to avoid accidentally sealing off existing springs, thereby, mitigating any unpredictable results due to the alteration of normal groundwater flows.

1.3 Model Methodology

Specific stream modeling details are described in further detail in the watershed chapters. Models have been developed for each of the 11 watersheds. In general, detailed modeling was accomplished using the USACE software, HEC-HMS and HEC-RAS or HEC-1 and HEC-2. The SCS Type II, 24 hour design storm was used. Where available, calibration was done using historic stream gauge data. In the absence of stream gauge data, regression equations for Jefferson County were used. These regression equations are presented in "Estimation of Peak-Discharge Frequency of Urban Streams in Jefferson County, Kentucky, U.S. Geological Survey, Water Resources Investigations Report 97-4219." The 1 percent annual chance return interval was modeled for the existing and future conditions. In some cases, the 10, 2, and 0.2 percent chance events were also modeled.

1.3.1 Topographic Mapping

The WMP has been subdivided into 11 major watersheds. Each watershed was further subdivided for modeling purposes. The watersheds and subbasins were delineated using contour information, along with combined and separate storm sewer information, from the Louisville Jefferson County Information Consortium (LOJIC).

The number of subbasins into which a watershed is divided is primarily a function of the number of locations at which drainage discharges are desired. Since the locations of interest will vary throughout the life of the WMP, the number of subbasins may increase with time.

Close inspection of various components within each watershed revealed unique features and facilities which act as hydrologic breaks, or nodes (e.g. reservoir outlets, stream confluences, major bridges, culverts). Nodes define the logical locations of the outlet point of a subbasin. A particularly important feature which can serve as a node is a gauging station, since the data that it records can be used to calibrate hydrologic models.

1.3.2 Hydrologic Soil Groups

A necessary step in determining surface runoff through use of SCS methodology concerns the location of hydrologic soil groups by watershed. The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) has performed detailed studies of Jefferson County. The Soil Survey of Jefferson County was referenced to obtain soil information for this study. Part 630, Chapter 7 of the NRCS National Engineering Handbook describes the hydrologic soils groups pertinent to Jefferson County. This information is summarized in Table 1.4.

Table 1.4
Hydrologic Soil Groups

Soil Classification	**Runoff Potential**	**Comments**
A	Very Low	Soils have high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands and gravels. These soils have a high rate of water transmission.
B	Low	Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.
C	Medium	Soils having low infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a low rate of water transmission.
D	High	Soils having very low infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soil with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material. These soils have a very low rate of water transmission.
Unclassified		Soil types will likely vary and must be checked by soil borings on a location by location basis.

Based on the NRCS survey, soil types fall into one of four NRCS categories. In the unsurveyed urban areas, soils were put into an unclassified group and were designated as "U", bringing the total number of categories to five. If a soil is assigned to a dual hydrologic group (such as B/C, B/D), the first letter is for drained areas and the second letter is for undrained areas.

1.3.3 Land Use

The SCS Curve Number method was used to determine surface runoff. This method requires a combination of soil and land use data. Land use data was obtained using information from LOJIC for both existing and proposed land uses. Future land use conditions were based on fully developed conditions based on current zoning. For more information regarding development trends in each watershed, see the Louisville Metro Hazard Mitigation Plan.

1.4 Stormwater Management Policies

1.4.1 General Policies

Through the WMP, MSD Design Manual, Louisville Metro Floodplain Management Ordinance, and Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance, a watershed-by-watershed approach to regional management of stormwater drainage is taken. Other permits, such as the Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities and the MS4 permit also affect the stormwater policies in Jefferson County.

New development in Jefferson County is required to detain proposed stormwater discharge rates to predeveloped conditions for the 2, 10, 25 and 100 year storm events through the MSD Design Manual. The NRCS Type II, 24 hour rainfall distribution is required to be used for the modeling. In areas where adequate downstream facilities exist, especially in the lower portion of a watershed where peak flows from the new development will occur substantially prior to the overall peak of the stream, on a case-by-case basis, MSD allows increased runoff to be compensated using a regional facility fee. This regional facility fee is used to construct regional basins.

New development in the combined sewer area is restricted to a 6-inch stormwater connection to the combined sewer system to help alleviate the flows in the system during rain events. Engineers must design the new development's onsite stormwater system to work with the 6-inch outlet. Examples of this include building detention basins, oversizing onsite stormwater pipes, and using green solutions such as pervious pavement and rain gardens to reduce peak flows.

Floodplain compensation is required throughout Jefferson County for any fill placed in the fully developed local regulatory floodplain as required in the Louisville Metro Floodplain Management Ordinance. Due to severe flooding problems in the Pond Creek Watershed, the Chenoweth Run Watershed of Floyds Fork, and the Big Run Watershed of Mill Creek, the ratio has been increased to 1.5:1 for any fill in the Local Regulatory Floodplain of those watersheds. The ratio may also be increased on a site-specific basis as determined by MSD.

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the KPDES General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as

High Quality or Impaired Water (Non-construction related impairment). A minimum 50 foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or "soft" approaches. MSD's Design Manual outlines natural channel design requirements in Section 10.3.6.

Green infrastructure and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Green infrastructure must be designed to manage the required water quality volume rain event of 0.6" of runoff and must manage at least 90% of the site's disturbed area. This volume is to be infiltrated, treated, or otherwise managed for new development projects that disturb at least one acre or are part of a greater common development that disturbs at least one acre.

A Site Disturbance Permit is required by the Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance for developments with 2000 square feet of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance. The Site Disturbance Permit requires an EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year 24 hour SCS Type II storm event.

1.4.2 Municipal Separate Storm Sewer System (MS4)

MSD, along with five co-permittees, has an MS4 permit (aka stormwater quality permit) through the Kentucky Division of Water (KDOW). The purpose of the MS4 program is to maintain and enhance water quality in Jefferson County. The purpose is also to protect and promote the public health, safety and welfare by preventing the introduction of harmful materials into the separate storm sewer system. The co-permittees in the permit are:

- City of Anchorage
- City of Jeffersontown
- City of Shively
- City of St. Matthews
- City of Louisville
- MSD

The MS4 permit program is the result of the 1987 amendments to the Clean Water Act (CWA), commonly referred to as the Water Quality Act of 1987. In these amendments, Congress mandated that the Environmental Protection Agency (EPA) address non-point source pollution in stormwater runoff. In essence, EPA defined urban stormwater (previously considered a non-point source) as a point source because there was a physical location (or point) of discharge. Congressional action required EPA to develop a program to permit the discharge of the stormwater from the MS4.

The Louisville MS4 Permit includes over 100 activities and is organized into several program elements including:

- Illicit Discharge Detection and Elimination
- Construction Site Runoff Controls (Erosion Prevention and Sediment Control)
- Post Construction Site Runoff Controls (Long-term Water Quality Control)
- Public Involvement and Outreach Programs
- Monitoring
- Reporting and Assessment

The MS4 program elements are accomplished by both the co-permittees and MSD. MSD has the sole responsibility for the following duties:

- Education and outreach to the general Louisville Metro area. MSD will lead selected specific elements including green infrastructure outreach and education efforts. MSD will provide opportunity for input from co-permittees;
- Investigation and enforcement upon potential illicit discharges through administration of applicable sections of the Wastewater and Stormwater Discharge Regulations;
- Hazardous material plans and inspections for qualifying industrial and commercial properties;
- Construction oversight including plan review and site inspection;
- Administration of the Erosion Prevention and Sediment Control Ordinance;
- Monitoring program and related laboratory analyses; and
- Annual compliance demonstration report preparation for MSD activities and collection of co-permittees portions.

Co-permittees of the MS4 permit have the sole responsibility for the following duties within their jurisdictional boundaries:

- Implement education and outreach at the applicable levels of neighborhood and local community that complement the education and outreach provided by MSD tailored to local waterbodies and pollutants of concern;
- Drainage system and outfall mapping;
- Drainage system operation and maintenance;
- Report and refer potential illicit discharges observations by municipal employees or other reports from residents to MSD for investigation and potential enforcement;
- Construction oversight in addition to that provided through Louisville MSD;
- Inspection, operation, maintenance and/or applicable certification that permanent (also known as post-construction) water quality devices, controls, and management practice are operating effectively;
- Road maintenance including snow and ice removal related stormwater management activities;
- Fleet and facility stormwater pollution prevention plans and their implementation; and
- Preparation and timely submittal of annual compliance demonstration report to MSD according to agreed upon formats and standards.

The SWQMP, which is a detailed business plan MSD and its co-permittees intend to use as a tool to implement the MS4 permit, is currently being updated and will be completed by August 2017. The intended purposed of the SWQMP is to improve water quality in local streams, creeks, and waterways within Jefferson County. The expected water quality benefits include reductions in pollutants of concern and more closely meeting the Clean Water Act goals for water quality.

1.4.3 Integrated Overflow Abatement Plan (IOAP)/Green Infrastructure

MSD is currently under a consent decree by the U.S. Environmental Protection Agency and the Kentucky Environmental and Public Protection Cabinet to reduce sanitary and combined sewer overflows. An Integrated Overflow Abatement Plan (IOAP) has been prepared by MSD to address the consent decree. The IOAP is a long term plan to control combined and separate sewer overflows in the community so that MSD can meet all federal and state clean water regulations. These regulations must be met by 2024 in order to avoid severe financial penalties. The goal of the program is to improve water quality and protect the health of the citizens of Louisville Metro.

1.5 Watershed Master Plans

1.5.1 General

The management of stormwater drainage is recommended to be on a watershed-by-watershed basis. Accomplishment of this approach shall be through the development of Watershed Master Plans. These plans document the hydrologic, physiographic, drainage characteristics, and planning tools pertinent to managing stormwater drainage in the watershed. Utilizing this information within the context of various policies, goals and objectives established for the WMP, specific "Action Plans" set forth recommended regional projects, special regulations for development, and requirements for further updating and upgrading the planning data and models.

Further information specifically regarding the floodplain of each watershed, including number of floodprone buildings, development trends, critical facilities located in the floodplain, natural and beneficial functions of the floodplain, and general flooding information can be found in the Louisville Metro Hazard Mitigation Plan.

1.5.2 Plan Contents

The individual watershed plans provide an overview for each of Louisville Metro's eleven sub-watersheds. Each subsection provides the following information:

- General description including watershed area, stream names, soils and land use
- Completed stormwater improvement projects such as regional detention basins, large and small scale drainage projects
- Current hydrologic and hydraulic models available for the particular watershed
- Watershed specific requirements for new development such as 1.5:1 compensation for fill added to the floodplain or requiring post developed stormwater discharge rates to be less than pre-developed levels
- Provides a list of recommended stormwater improvement projects that correspond with the Critical Repair and Reinvestment Plan (CRRP) and the Integrated Overflow Abatement Plan (IOAP) planned for the next three years

The intent of the WMP is to develop the means and methods to address management of stormwater drainage on a regionally consistent basis. The various planning tools and data in the Watershed Master Plans will be used by both MSD and the technical community. Therefore, the organization of this data was standardized to provide consistent means of cataloging and referencing the data. The following is the standardized outline for a Watershed Master Plan.

- Watershed Study Area – this section provides a general description of the watershed location, communities, and notable features. Topography, geology, soils, land use, and any regional basins or major channel improvement projects are also described in this section. This section also includes a description of any natural stormwater features located in the watershed that will be protected, such as parks, greenways, and conservation easements.
- Modeling – this section describes modeling that has been done for the watershed. Assumptions and calibrations for the models are described.
- Action Plan – this section provides recommended drainage improvement projects and regulatory control strategy for the watershed.

2.0 MIDDLE FORK BEARGRASS CREEK

2.0 MIDDLE FORK – BEARGRASS CREEK

2.1 Watershed Study Area

2.1.1 General

Middle Fork Beargrass Creek at Cherokee Park

The 25 square mile Middle Fork Beargrass Creek Watershed is located in the north central portion of Jefferson County. Its headwaters originate in Middletown and flow in a westerly direction through St. Matthews. The stream continues into the Highlands via Seneca and Cherokee Parks, to finally outlet into the South Fork Beargrass Creek just south of Main Street. The major streams in the Middle Fork Beargrass Creek Watershed are Middle Fork and Weicher Creek. An aerial map showing the Middle Fork Beargrass Creek Watershed is included as Map MLF-1. A drainage map showing the 17 subbasins for Middle Fork Beargrass Creek is included as Map MLF-2.

Communities lying in this watershed include the Highlands, Seneca Gardens, St. Regis Park, St. Matthews, Lyndon, Wildwood, Hurstbourne, Douglass Hills, and Middletown.

Notable landmarks include Cherokee Park, Seneca Park, Cave Hill Cemetery, the Southern Baptist Seminary, Bowman Field, Big Spring Country Club, Oxmoor Mall, and Hurstbourne Country Club.

Wetlands located along Middle Fork Beargrass Creek at Arthur K. Draut Park

Several parks are located along the Middle Fork of Beargrass Creek. These parks provide open space where flooding can occur without property damages and allow recreational use during drier periods. Cherokee Park, which is owned by the City of Louisville, is located along Middle Fork Beargrass Creek in the Highlands area. The City of St. Matthews also has two parks, Brown Park and Arthur K. Draut Park, located in the floodplain along Middle Fork of Beargrass Creek near Bowling Boulevard. Arthur K. Draut Park also includes wetlands, which help improve water quality for the creek. In addition, conservation easements have been created by the Peterson-Dumesnil House located in Crescent Hill.

2.1.2 Topography

The entire Middle Fork Beargrass Creek Watershed is situated in the Eastern Uplands Topographic Region. Broad steep-sided valleys and flat to gently rolling plateaus dominate the terrain. Middle Fork Beargrass Creek has cut deeply into this terrain and flows through a well entrenched channel; where near vertical cliffs are common.

Elevations range from about 425 feet, at the confluence with South Fork Beargrass Creek, to about 750 feet, in the Middletown area.

2.1.3 Geology

The major portion of this watershed is underlain by limestones of the lower Devonian and middle Silurian ages. A notable exception is the Lyndon/St. Matthews area, which is underlain by middle Devonian age shale. Middle Fork Beargrass Creek has eroded deep into these rocks, and in some instances, shales of middle Silurian age are exposed. The general dip of these rock beds, or strata, is toward the west at a little less than one foot in one-hundred feet. A northeast trending synclinal axis is observed, however, in the Lyndon/St. Matthews area. A northeast trending anticlinal axis is also observed in the Seneca Gardens/Seneca Park area. Limited karst activity is represented by some small sinkholes and springs, particularly in the Lyndon/ Oxmoor area and in the area of the Sinking Fork.

Middle Fork at Breckenridge Lane

2.1.4 Soils

Section 2.2.2 of the WMP explains in detail the five soil groups used to classify soils in this study. The soil composition in the Middle Fork Beargrass Creek Watershed is mainly Group B and unclassified. The soil groups in the Middle Fork Watershed can be found on Map MLF-3.

2.1.5 Land Use

The land use in the Middle Fork Watershed is mostly residential and commercial, with many of the commercial properties located along Shelbyville Road and Hurstbourne Lane. Some agricultural land is also located in this watershed behind the Oxmoor Mall. A map of the existing land use is included as Map MLF-4.

2.1.6 Watershed Improvements

Watershed improvements in the Middle Fork Beargrass Creek watershed include:

- The Whipps Mill Basin, which is a regional flood storage basin that is situated in the upper portion of the Middle Fork Watershed. The basin, which was built in 2000, covers a 40-acre site and provides flood protection for hundreds of residents.
- The Woodlawn Park Basin is a regional basin located on an approximately 5-acre site in the central portion of the Middle Fork Watershed.
- Combined sewer projects that will improve water quality by limiting combined sewer overflows in this watershed include:
    - CSO123 project, which disconnected downspouts for 70 properties to the combined sewer.
    - CSO 206 project, which disconnected downspouts for 931 properties to the combined sewer.
    - CSO 140 project, which upsized a downstream low flow line to gain additional inline storage and reduced overflows from the combined sewer system.

2.1.7 Local Basins

There are currently 64 local basins located in the Middle Fork Beargrass Creek watershed. These basins are shown on Map MLF-2.

2.2 Modeling

The hydrologic analysis for Middle Fork Beargrass Creek was calculated using HEC-1. Curve numbers, drainage area, and time of concentration were used to determine flows from each subbasin. Storage routings were added as needed and numerous trials were required in order to determine final discharge values. Using the discharge values from HEC-l, HEC -2 was used to create stream profiles. Cross sections and bridge elevations and geometry were field surveyed. The model was verified using two methods. High water marks were available for five floods: March 1964, April 1970, July 1973, May 1983, and February 1990. Also, discharge-frequency curves were used for the two USGS gauges located on Middle Fork Beargrass Creek.

Middle Fork at Brown Park

Large portions of the Middle Fork Watershed are served by the combined sewer system. The combined sewer system conveys sewage and stormwater through sewer lines to a wastewater treatment plant. When the capacity of the sewer system is exceeded, a portion of the water is diverted to combined sewer overflows (CSOs). A SWMM model for this area was used to create outflow hydrographs for a 10 year, 1 hour SCS Type II rainfall event to estimate these combined sewer overflows. A comparison was done between the SWMM model and a HEC-1 model created using overland flows. The flows were approximately the same and it was determined that the HEC-1 model would provide reasonably accurate results and that a SWMM model would not be required.

Weicher Creek was restudied for the 2006 Flood Insurance Study (FIS) using HEC-HMS. Models were run for the 10, 2, 1, and 0.2 percent chance events using a standard SCS Type II 24 hour design storm distribution. Hydrologic parameters, such as curve number, time of concentration, and soil groups, were developed using information from LOJIC. Several moderately sized ponds located near the Oxmoor Golf and Country Club were included in the model. Water surface elevations were determined using HEC-RAS. Cross sections were obtained from field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Roughness coefficients were determined based on field inspections and aerial photography. No stream gauges exist in Weicher Creek. Model calibration was done by comparing discharges based on regression equations for rural and urban streams in Jefferson County presented in “Estimation of Peak-Discharge Frequency of Urban Streams in Jefferson County, Kentucky, U.S. Geological Survey, Water-Resources Investigations Report 97-4219.”

The uppermost portions of Middle Fork Beargrass Creek and the tributaries were not part of a detailed study. These areas were studied using approximate methods. The floodplains were calculated using Manning’s Formula. Cross sections were determined from maps and field reconnaissance, but were not field surveyed. Bridge and culvert data were only gathered if it was expected to cause significant backwater. Bridge and culvert data were hand measured and no survey was completed. Slopes used for Manning’s Formula were based on topographic mapping.

Floodplain limits for the 1 percent annual chance flood were calculated for existing conditions and future, fully developed conditions. Existing conditions are labeled as the FEMA floodplain and future conditions are labeled as the Local Regulatory Floodplain. Map MLF-5 shows the limits of each of these floodplains.

A RiskMAP project is currently underway to update existing flood models throughout the county. Preliminary maps are expected to be public in 2017 and adopted in late 2018. These maps modernize many of flood studies and create limited detail flood models for most A zones in the county. Streams within this watershed will be updated with this effort.

2.3 Action Plan

2.3.1 Watershed Requirements

Middle Fork at Cherokee Park

New development in the Middle Fork Beargrass Creek Watershed is required to detain proposed stormwater discharge rates to predeveloped conditions for the 2, 10, 25, and 100 year storm events through the MSD Design Manual. The NRCS Type II, 24 hour rainfall distribution is required to be used for the modeling. In areas where adequate downstream facilities exist, especially in the lower portion of a watershed where peak flows from the new development will occur substantially prior to the overall peak of the stream, on a case-by-case basis, MSD allows increased runoff to be compensated using a regional facility fee. This regional facility fee is used to construct regional basins.

New development in the combined sewer area is restricted to a 6-inch stormwater connection to the combined sewer system to help alleviate the flows in the system during rain events. Engineers must design the new development's onsite stormwater system to work with the 6-inch outlet. Examples of this include building detention basins, oversizing onsite stormwater pipes, and using green solutions such as pervious pavement and rain gardens to reduce peak flows and overall runoff volumes.

Floodplain compensation is required in the Middle Fork Beargrass Creek Watershed at a ratio of 1:1 for any fill placed in the fully developed local regulatory floodplain as required in the Louisville Metro Floodplain Management Ordinance. The ratio may be increased on a site-specific basis as determined by MSD.

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the KDOW through its Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as High Quality or Impaired Water (Non-construction related impairment). A minimum 50 foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or "soft" approaches. MSD's Design Manual outlines natural channel design requirements in Section 10.3.6.

Green infrastructure and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Green infrastructure must be designed to manage the required water quality volume rain event of 0.6" of runoff and must manage at least 90% of the site's disturbed area. This volume is to be infiltrated, treated, or otherwise managed for new development projects that disturb at least one acre or are part of a greater common development that disturbs at least one acre.

The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2000 square feet of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance to obtain a Site Disturbance Permit. The Site Disturbance Permit requires an EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year 24 hour SCS Type II storm event.

2.3.2 Proposed Projects

Proposed projects in this watershed include the following:

- IOAP projects that will improve water quality by reducing combined sewer overflows include two sewer separation projects and a proposed storage basin located at I-64 and Grinstead Drive. More information regarding these projects can be found in Appendix A of this report.

- Metro Parks and the U.S. Army Corps of Engineers are partners in a planning effort entitled: "Beargrass Creek Trail Conceptual Shared Use Path and Ecological Restoration Plan." The plan area will extend generally along Beargrass Creek from its confluence with the Ohio River to the area of the Grinstead Drive/Lexington Road intersection. A watershed plan for Middle Fork is also proposed. This plan would specifically look at water quality within Middle Fork. Stakeholder meetings are currently being held to gauge interest in the project from the community. This project is grant dependent.

- Small scale drainage projects are taken care of through the program Project DRI. Beginning in 2003, MSD initiated a program to address a wide variety of drainage issues that are brought to us by our customers. This program, dubbed Project DRI (Drainage Response Initiative), assigned experienced project managers, contractors, and inspectors to address drainage problems on a "grade-to-drain" basis. Efforts under this program address problems ranging from structural flooding to alleviating minor standing water problems. Available funds are distributed across the service area based on relative levels of customer concerns and estimated costs of repairs within geographic areas. MSD has completed the first four phases of Project DRI. Currently, Phase 5 is under way. This phase is scheduled for FY17 and FY18. The project list for Phase 5 can be found in the Appendix B of this report.

- In addition to the DRI projects, the Critical Repair and Reinvestment Plan proposes the City of Hurstbourne Early Action Project, the Richlawn Early Action Project and the Woodlawn Park basin retro-fit as projects in the Middle Fork watershed. The Richlawn Early Action project has been included in the 5-year capital improvement plan; however, the Hurstbourne Early Action and Woodlawn Park basin retro-fit projects are not currently funded. FY18-FY22 projects proposed in the plan are shown in Appendix C.

3.0 MUDDY FORK BEARGRASS CREEK

3.0 MUDDY FORK – BEARGRASS CREEK

3.1 Watershed Study Area

3.1.1 General

The eight square mile Muddy Fork Beargrass Creek Watershed is located in the north central portion of Jefferson County. Its headwaters originate in the Graymoor/Devondale area. The stream then flows northwesterly to I-71, turns to the southwest, and parallels I-71 to finally outlet into South Fork Creek Beargrass Creek just downstream of the Beargrass Creek pumping station. The only major creek running through this watershed is Muddy Fork Beargrass Creek. An aerial map showing the Muddy Fork Beargrass Creek Watershed is included as Map MF-1. A drainage map showing the seven subbasins for Muddy Fork Beargrass Creek is included as Map MF-2.

Communities lying in this watershed include Graymoor, Devondale, Crescent Hill, Rolling Fields, Mockingbird Valley, Indian Hills, and Windy Hills.

Muddy Fork at Mockingbird Valley Road

Notable landmarks include the Veterans Administration (VA) Hospital and Crescent Hill Park.

3.1.2 Topography

The major portion of the Muddy Fork Watershed is situated in the Eastern Uplands Topographic Region. The remaining portion, which includes I-71 and land adjacent to the Ohio River, is in the Flood Plain.

Broad steep-sided valleys and gently rolling plateaus dominate the terrain in the Eastern Uplands Region. Muddy Fork has cut deeply into this terrain and flows though a well entrenched channel where near vertical cliffs are common.

A flat, low-lying terrain predominates in the floodplain. Stream channels of low gradient slopes tend to parallel the Ohio River.

Elevations range from about 420 feet, the pool stage of the Ohio River above the McAlpine Lock and Dam, to about 585 feet, in the Devondale area.

3.1.3 Geology

The portion of this watershed lying in the Eastern Uplands Topographic Region is predominately underlain by limestone of lower Devonian age. The major creeks, however, have eroded channels deeply into, and in many cases, through these rocks, exposing limestones, shales, and dolomites of middle Silurian age. The general dip of these rock beds, or strata, is toward the west at a little more than one-half foot in one-hundred feet. However, a northeast trending anticlinal axis is observed in the Brownsboro Village/Windy Hills area. Limited karst activity is represented by small sinkholes and springs.

The portion of this watershed lying in the Flood Plain Topographic Region is underlain by various alluvial deposits of Quaternary age. These deposits range in thickness from several feet to well over one hundred feet, and are comprised of complex layers of silts, sands, clays, and gravels. This region is a well documented aquifer and groundwater is readily available.

3.1.4 Soils

Section 2.2.2 of the WMP explains in detail the five soil groups used to classify soils in this study. The soil composition in the Muddy Fork Beargrass Creek Watershed is mainly B and C soils, with some soils in the unclassified soil group. The soil groups in the Muddy Fork Watershed can be found on Map MF-3.

Muddy Fork at Elmwood Avenue

3.1.5 Land Use

The majority of the land use in the Muddy Fork Watershed is residential. The existing land use in the Muddy Fork Watershed can be found on Map MF-4.

3.1.6 Watershed Improvements

No regional stormwater basins or major channel improvement projects are located in the Muddy Fork Watershed.

3.1.7 Local Basins

There are currently 11 local basins located in the Muddy Fork Beargrass Creek watershed. These basins are shown on Map MF-2.

3.2 Modeling

Hydraulic analyses for the Muddy Fork Watershed were developed using HEC-1. Curve numbers, drainage area, and time of concentration were used to determine flows from each subbasin. Storage routings were added as needed and numerous trials were required in order to determine final discharge values. Using the discharge values from HEC-l, HEC -2 was used to create stream profiles. Cross sections and bridge elevations and geometry were field surveyed. No discharge gauges were available for model calibration along Muddy Creek at the time the model was created.

Portions of Muddy Fork Beargrass Creek that were not studied using HEC-1 software were studied using approximate methods. The floodplains were calculated using Manning's Formula. Cross sections were determined from maps and field reconnaissance, but were not field surveyed. Bridge and culvert data were only gathered if it was expected to cause significant backwater. Bridge and culvert data were hand measured and no survey was completed. Slopes used for Manning's Formula were based on topographic mapping.

Floodplain limits for the 1 percent annual chance flood were calculated for existing conditions and future, fully developed conditions. Existing conditions are labeled as the FEMA floodplain and future conditions are labeled as the Local Regulatory Floodplain. Map MF-5 shows the limits of each of these floodplains.

A RiskMAP project is currently underway to update existing flood models throughout the county. Preliminary maps are expected to be public in 2017 and adopted in late 2018. These maps modernize many of flood studies and create limited detail flood models for most A zones in the county. Streams within this watershed will be updated with this effort.

3.3 Action Plan

3.3.1 Watershed Requirements

New development in the Muddy Fork Beargrass Creek Watershed is required to detain proposed stormwater discharge rates to predeveloped conditions for the 2, 10, 25, and 100 year storm events through the MSD Design Manual. The NRCS Type II, 24 hour rainfall distribution is required to be used for the modeling. In areas where adequate downstream facilities exist, especially in the lower portion of a watershed where peak flows from the new development will occur substantially prior to the overall peak of the stream, on a case-by-case basis, MSD allows increased runoff to be compensated using a regional facility fee. This regional facility fee is used to construct regional basins.

New development in the combined sewer area is restricted to a 6-inch stormwater connection to the combined sewer system to help alleviate the flows in the system during rain events. Engineers must design the new development's onsite stormwater system to work with the 6-inch outlet. Examples of this include building detention basins, oversizing onsite stormwater pipes, and using green solutions such as pervious pavement and rain gardens to reduce peak flows and overall runoff volumes.

Floodplain compensation is required in the Muddy Fork Beargrass Creek Watershed at a ratio of 1:1 for any fill placed in the fully developed local regulatory floodplain as required in the Louisville Metro Floodplain Management Ordinance. This ratio may be increased on a site-specific basis as determined by MSD.

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the KDOW through its Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as High Quality or Impaired Water (Non-construction related impairment). A minimum 50 foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or "soft" approaches. MSD's Design Manual outlines natural channel design requirements in Section 10.3.6.

Green infrastructure and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Green infrastructure must be designed to manage the required water quality volume rain event of 0.6" of runoff and must manage at least 90% of the site's disturbed area. This volume is to be infiltrated, treated, or otherwise managed for new development projects that disturb at least one acre or are part of a greater common development that disturbs at least one acre.

The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2000 square feet of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance to obtain a Site Disturbance Permit. The Site Disturbance Permit requires an EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year 24 hour SCS Type II storm event.

3.3.2 Proposed Projects

Proposed projects in this watershed include the following:

- One combined sewer project, which is part of the IOAP, is proposed in the Muddy Fork Beargrass Creek Watershed. This project is the Clifton Heights Storage Basin. More information regarding this project can be found in Appendix A of this report and also in the Final CSO Long-Term Control Plan document, which is part of MSD's IOAP.

- Small scale drainage projects are taken care of through the program Project DRI. Beginning in 2003, MSD initiated an aggressive program to address a wide variety of drainage issues that are brought to us by our customers. This program, dubbed Project DRI (Drainage Response Initiative), assigned experienced project managers, contractors, and inspectors to address drainage problems on a "grade-to-drain" basis. Efforts under this program address problems ranging from structural flooding to alleviating minor standing water problems. Available funds are distributed across the service area based on relative levels of customer concerns and estimated costs of repairs within geographic areas. MSD has completed the first four phases of Project DRI. Currently, Phase 5 is under way. This phase is scheduled for FY17 and FY18. The project list for Phase 5 can be found in the Appendix B of this report.

Other than the DRI program, the Critical Repair and Reinvestment Plan does not propose any projects for the Muddy Fork watershed. Future projects may be identified as a result of the Stormwater Master Plan.

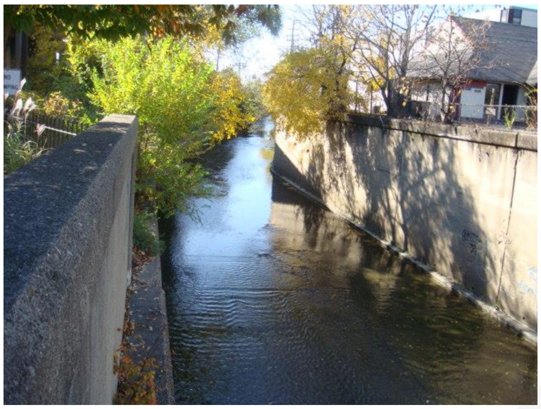
4.0 SOUTH FORK BEARGRASS CREEK

4.0 SOUTH FORK – BEARGRASS CREEK

4.1 Watershed Study Area

4.1.1 General

The 27 square mile South Fork Beargrass Creek Watershed is located in the north central portion of Jefferson County. Its headwaters originate in Jeffersontown, flow in a westerly direction to Buechel, turn northwest into the Highlands, and finally, turn slightly northeast at the Louisville and Nashville Railroad and eventually outlet into the Ohio River near Towhead Island. At about mile 0.75 of South Fork, the Louisville Local Flood Protection Project (Floodwall) crosses the stream. A large pumping station is located at this point. In addition, from approximately mile 1.4 to mile 4.1, the stream is a large concrete channel with high vertical sidewalls. Major streams in this watershed include South Fork Beargrass Creek and Buechel Branch. An aerial map showing the South Fork Beargrass Creek Watershed is included as Map SF-1. A drainage map showing the 24 subbasins for South Fork Beargrass Creek is included as Map SF-2.



South Fork Beargrass Creek at Broadway

Communities lying in the watershed include Jeffersontown, Phoenix Hill, Germantown, Audubon Park, Strathmoor, Wellington, Buechel, Highgate Springs, Houston Acres, Forest Hills, Schnitzelburg, Smoketown, Shelby Park, Tyler Park and the Highlands.

Notable landmarks include the Beargrass Creek Pumping Station, Calvary Cemetery, the Louisville Zoo, Tyler Park, and Rest Haven Memorial Cemetery. Several parks are located within the floodplain of South Fork Beargrass Creek, including Joe Creason Park and the Beargrass Creek State Nature Preserve. Buechel Park is located along Buechel Branch, a tributary of South Fork Beargrass Creek. These parks provide open space where flooding can occur without property damage, as well as recreational uses during drier periods. Conservation easements have also been granted along South Fork Beargrass Creek near Poplar Level Road and Illinois Avenue by Audubon Hospital, Calvary Cemetery, Day Spring, and the St. Joseph Home for the Aged.

Beargrass Creek Flood Pumping Station

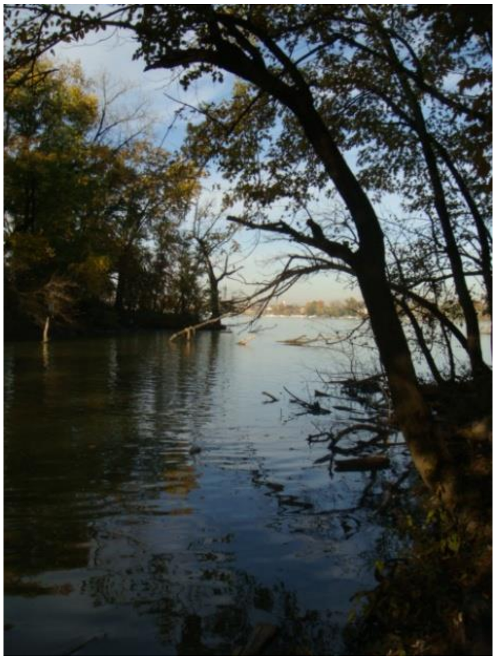
4.1.2 Topography

The major portion of the South Fork Beargrass Creek Watershed is situated in the Eastern Uplands Topographic Region. The remaining portion, which lies west of the Louisville and Nashville Railroad and adjacent to the Ohio River, is in the Flood Plain.

Broad steep-sided valleys and flat to gently rolling plateaus dominate the terrain in the Uplands Region. South Fork Beargrass Creek has cut deeply into this terrain and flows through a well entrenched channel.

A very flat, low-lying terrain predominates in the Flood Plain. South Fork Beargrass Creek flows through an improved concrete channel in this region.

Elevations range from about 420 feet, the pool stage of the Ohio River above McAlpine Lock and Dam, to about 690 feet, in the area north of Jeffersontown.



Outlet of South Fork Beargrass Creek into the Ohio River

4.1.3 Geology

The portion of this watershed lying in the Eastern Uplands Topographic Region is predominately underlain by limestones of lower Devonian and middle Silurian age. The South Fork Beargrass Creek, which flows through a well developed alluvial channel, cuts deeply into those rocks but does not expose the older, middle Silurian shales and dolomites. The general dip of these rock beds, or strata, is toward the west at a little less than one foot in one hundred feet. A north trending synclinal axis is observed in the Buechel/Highgate Springs area. A northeast trending anticlinal axis is observed in the Camp Taylor/Strathmoor area. Limited karst activity is represented by some small sinkholes and springs.

The portion of this watershed lying in the Flood Plain Topographic Region is predominately underlain by glacial outwash deposits of Quaternary age. These deposits vary in thickness from several feet to well over one hundred feet, and are comprised of complex layers of silts, sands, clays, and gravels. This region is a well documented aquifer, and groundwater is readily available.

4.1.4 Soils

Section 2.2.2 of the WMP explains in detail the five soil groups used to classify soils in this study. The soil composition in the South Fork Beargrass Creek Watershed is mainly Group B and unclassified. The soils in the South Fork Beargrass Creek Watershed can be found on Map SF-3.

4.1.5 Land Use

The majority of the land use in the South Fork Watershed is residential, however many commercial properties are located in the downtown area and along major roads such as Bardstown Road, Poplar Level, and Hurstbourne Parkway. Some industrial properties also exist in the South Fork Watershed and are mostly located near the downtown area and the Newburg Road area south of the Watterson Expressway. Map SF-4 shows the land use in this watershed.

4.1.6 Watershed Improvements

Watershed improvements include:

- The South Fork Beargrass Creek Flood Protection project, which was initiated in 2001 and completed in 2010. The project was a joint project between the USACE and MSD and included the construction of eight regional basins, ranging in size from 9 acre-feet to 160 acre-feet of storage, throughout the South Fork Watershed. The project also included 2000 feet of channel improvement, 1900 feet of floodwall around an apartment complex, and environmental features, such as construction of pools and riffles in the channels and planting 9 acres of bottomland hardwoods. The purpose of the project was to help relieve flooding in the South Fork Watershed.

The basins are located near Bashford Manor, Breckenridge Lane, Downing Way, Fountain Square, Hikes Lane, Gerald Court, Richland Ave, and Old Shepherdsville Road.

- The Dry Bed Reservoir, which is located in the upper portion of the South Fork Beargrass Creek Watershed. This basin was constructed in the 1980's to relieve flooding along South Fork.
- MSD has also completed several green infrastructure projects in this watershed to improve water quality and reduce runoff.

4.1.7 Local Basins

There are currently 58 local basins located in the South Fork Beargrass Creek watershed. These basins are shown on Map SF-2.

Bashford Manor Regional Basin

4.2 Modeling

A new hydrologic analysis for South Fork Beargrass Creek was completed for the 2006 FIS. HEC-HMS was used to model the stream. LOJIC data was used to estimate model inputs, such as curve number, time of concentration, and soil groups. Water surface elevations were determined using HEC-RAS and cross sections were obtained from field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Ineffective flow areas were included in areas with significantly reduced flow conveyance, such as inundated commercial/industrial areas, neighborhoods, and areas of floodplain storage. Roughness coefficients were determined based on field inspections and aerial photography. The two existing USGS stream gauges, located at Trevilian Way and Winter Avenue, were used to calibrate the model. Two storm events were used in the calibration, February/March 1997 and January 2000.

Large portions of the South Fork Watershed are served by the combined sewer system. The combined sewer system conveys sewage and stormwater through sewer lines to a wastewater treatment plant. When the capacity of the sewer system is exceeded, a portion of the water is diverted to combined sewer overflows (CSOs). A SWMM model for this area was used to create outflow hydrographs for a 10 year, 1 hour SCS Type II rainfall event to estimate these combined sewer overflows. A comparison was done between the SWMM model and a HEC-1 model created using overland flows. The flows were approximately the same and it was determined that the HEC-1 model would provide reasonably accurate results and that a SWMM model would not be required. This assumption was made again when the existing HEC-1 models were updated using HEC-HMS for the 2006 FIS.

Hydrologic analyses for Brooklawn Tributary and Buechel Branch, tributaries of South Fork Beargrass Creek, were completed using HEC-1. Curve numbers, drainage area, and time of concentration were used to determine flows from each subbasin. Storage routings were added as needed and numerous trials were required in order to determine final discharge values. Using the discharge values from the HEC-1 models, HEC -2 was used to create stream profiles for each stream. Cross sections and bridge elevations and geometry were field surveyed. Models were calibrated using high water marks from five floods: March 1964, April 1970, July 1973, May 1983, and February 1990.

The uppermost portions of South Fork Beargrass Creek and the tributaries were not part of a detailed study. Instead, these areas were studied using approximate methods. The floodplains were calculated using Manning's Formula. Cross sections were determined from maps and field reconnaissance, but were not field surveyed. Bridge and culvert data were only gathered if it was expected to cause significant backwater. Bridge and culvert data were hand measured and no survey was completed. Slopes used for Manning's Formula were based on topographic mapping.

Floodplain limits for the 1 percent annual chance flood were calculated for existing conditions and future, fully developed conditions. Existing conditions are labeled as the FEMA floodplain and future conditions are labeled as the Local Regulatory Floodplain. Map SF-5 shows the limits of each of these floodplains. A RiskMAP project is currently underway to update existing flood models throughout the county. Preliminary maps are expected to be public in 2017 and adopted in late 2018. These maps modernize many of flood studies and create limited detail flood models for most A zones in the county. Streams within this watershed will be updated with this effort.

A RiskMAP project is currently underway to update existing flood models throughout the county. Preliminary maps are expected to be public in 2017 and adopted in late 2018. These maps modernize many of flood studies and create limited detail flood models for most A zones in the county. Streams within this watershed will be updated with this effort.

4.3 Action Plan

4.3.1 Watershed Requirements

New development in the South Fork Beargrass Creek Watershed is required to detain proposed stormwater discharge rates to predeveloped conditions for the 2, 10, 25, and 100 year storm events through the MSD Design Manual. The NRCS Type II, 24 hour rainfall distribution is required to be used for the modeling. In areas where adequate downstream facilities exist, especially in the lower portion of a watershed where peak flows from the new development will occur substantially prior to the overall peak of the stream, on a case-by-case basis, MSD allows increased runoff to be compensated using a regional facility fee. This regional facility fee is used to construct regional basins.

New development in the combined sewer area is restricted to a 6-inch stormwater connection to the combined sewer system to help alleviate the flows in the system during rain events. Engineers must design the new development's onsite stormwater system to work with the 6-inch outlet. Examples of this include building detention basins, oversizing onsite stormwater pipes, and using green solutions such as pervious pavement and rain gardens to reduce peak flows and overall runoff volumes.

Floodplain compensation is required in the South Fork Beargrass Creek Watershed at a ratio of 1:1 for any fill placed in the fully developed local regulatory floodplain as required in the Louisville Metro Floodplain Management Ordinance. This ratio may be increased on a site-specific basis as determined by MSD.

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the KDOW through its Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as High Quality or

Impaired Water (Non-construction related impairment). A minimum 50 foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or "soft" approaches. MSD's Design Manual outlines natural channel design requirements in Section 10.3.6.

Green infrastructure and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Green infrastructure must be designed to manage the required water quality volume rain event of 0.6" of runoff and must manage at least 90% of the site's disturbed area. This volume is to be infiltrated, treated, or otherwise managed for new development projects that disturb at least one acre or are part of a greater common development that disturbs at least one acre.

The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2000 square feet of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance to obtain a Site Disturbance Permit. The Site Disturbance Permit requires an EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year 24 hour SCS Type II storm event.

4.3.2 Proposed Projects

Proposed projects in this watershed include the following:

- IOAP projects that will reduce combined sewer overflows are proposed in the South Fork Beargrass Creek Watershed. These projects include:
    - Lexington and Payne Storage Basin
    - Logan and Breckenridge Storage Basin
    - Nightingale Pump Station Replacement and Storage Project.

- Small scale drainage projects are taken care of through the program Project DRI. Beginning in 2003, MSD initiated an aggressive program to address a wide variety of drainage issues that are brought to us by our customers. This program, dubbed Project DRI (Drainage Response Initiative), assigned experienced project managers, contractors, and inspectors to address drainage problems on a "grade-to-drain" basis. Efforts under this program address problems ranging from structural flooding to alleviating minor standing water problems. Available funds are distributed across the service area based on relative levels of customer concerns and estimated costs of repairs within geographic areas. MSD has completed the first four phases of Project DRI. Currently, Phase 5 is under way. This phase is scheduled for FY17 and FY18. The project list for Phase 5 can be found in the Appendix B of this report.

- The Critical Repair and Reinvestment Plan proposes nine new projects in the South Fork watershed. Seven of the projects are basin retrofits. These projects are located at the Breckinridge Lane basin, Downing Way basin, Fountain Square basin, Gerald Court basin, Hikes Lane basin, Old Shepherdsville Road basin, and Richland Avenue basin. These basin retrofits are included in the 5-year capital improvement plan budget. There are also two proposed projects to improve the drainage at the East Brandeis Avenue and South Brook Street Viaduct (VIA11) and South Floyd Street and East Hill Street Viaduct (VIA10). These projects are currently not included in the 5-year capital improvement plan budget. FY18-FY22 projects proposed in the plan are shown in Appendix C.

5.0 CEDAR CREEK

5.0 CEDAR CREEK

5.1 Watershed Study Area

5.1.1 General

The 11 square mile Cedar Creek Watershed is located in south central Jefferson County and is bisected by the Gene Snyder Freeway. Its headwaters originate in the Fern Creek area. The stream flows in a southerly direction, passing into Bullitt County, and eventually discharges into Floyds Fork. For the purposes of this study, the Jefferson/Bullitt County line serves as the approximate southerly watershed boundary. Cedar Creek is the only major stream in this watershed. An aerial map showing the Cedar Creek Watershed is included as Map CC-1. A drainage map showing the six subbasins for Cedar Creek is included as Map CC-2.

Cedar Creek near Gene Snyder Freeway

Communities lying in this watershed include Fern Creek and Highview.

Notable landmarks include Beulah Church and Fern Creek High School.

5.1.2 Topography

The entire Cedar Creek Watershed is situated in the Eastern Uplands Topographic Region. Broad, fairly steep-sided valleys and narrow ridge crests dominate the terrain. Streams have cut deeply into this terrain and flow through the well-entrenched channels.

Elevations range from about 550 feet, at the Jefferson County/Bullitt County line, to about 740 feet, in the area north of Fern Creek.

5.1.3 Geology

The entire watershed is underlain by rocks of middle Silurian age. On higher ground, limestone is predominant. In the deeply cut stream channels, shales and dolomites are commonly exposed. The general dip of these rock beds, or strata, is toward the west at a little less than one foot in one hundred feet. Surficial features do not indicate karst activity, but springs are common on top of the Silurian shales.

5.1.4 Soils

Section 2.2.2 of the WMP explains in detail the five soil groups used to classify soils in this study. The soil composition in the Cedar Creek Watershed is mainly from soil group C and the unclassified soil group. The soils in the Cedar Creek Watershed can be found on Map CC-3.

5.1.5 Land Use

The Cedar Creek Watershed is mainly residential, with large tracts of agricultural land use, especially in the eastern portion of the watershed. A map showing existing land use in the Cedar Creek Watershed is included as Map CC-4.

Bartley Drive Stream Buffer Restoration

5.1.6 Watershed Improvements

In 2016 MSD initiated the Bartley Stream Restoration Project. The project restored the riparian stream buffer along an MSD flood mitigation property on Bartley Drive. The improvements included planting trees, shrubs and grasses along the stream buffer to improve the stream health by adding shade and habitat along Cedar Creek.

5.1.7 Local Basins

There are currently 51 local basins located in the Cedar Creek watershed. These basins are shown on Map CC-2.

5.2 Modeling

Modeling for Cedar Creek was completed using HEC-HMS. LOJIC data was used to estimate model inputs, such as curve number, time of concentration, and soil groups. Water surface elevations were determined using HEC-RAS. Cross sections were obtained from field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Roughness coefficients were determined based on field inspections and aerial photography. No stream gauges existed in the Cedar Creek Watershed at the time of the study; therefore, the model was calibrated using the regression equations for Jefferson County presented in "Estimation of Peak-Discharge Frequency of Urban Streams in Jefferson County, Kentucky, U.S. Geological Survey, Water-Resources Investigations Report 97-4219."

Floodplain limits for the 1 percent annual chance flood were calculated for existing conditions and future, fully developed conditions. Existing conditions are labeled as the FEMA floodplain and future conditions are labeled as the Local Regulatory Floodplain. Map CC-5 shows the limits of each of these floodplains.

5.3 Action Plan

5.3.1 Watershed Requirements

New development in the Cedar Creek Watershed is required to detain proposed stormwater discharge rates to predeveloped conditions for the 2, 10, 25, and 100 year storm events through the MSD Design Manual. The NRCS Type II, 24 hour rainfall distribution is required to be used for the modeling. In areas where adequate downstream facilities exist, especially in the lower portion of a watershed where peak flows from the new development will occur substantially prior to the overall peak of the stream, on a case-by-case basis, MSD allows increased runoff to be compensated using a regional facility fee. This regional facility fee is used to construct regional basins.

Floodplain compensation is required in the Cedar Creek Watershed at a ratio of 1:1 for any fill placed in the fully developed local regulatory floodplain as required in the Louisville Metro Floodplain Management Ordinance. This ratio may be increased on a site-specific basis as determined by MSD.

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the KDOW through its Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as High Quality or Impaired Water (Non-construction related impairment). A minimum 50 foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).


Cedar Creek at Thixton Lane

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or “soft” approaches. MSD’s Design Manual outlines natural channel design requirements in Section 10.3.6.

Green infrastructure and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Green infrastructure must be designed to manage the required water quality volume rain event of 0.6” of runoff and must manage at least 90% of the site’s disturbed area. This volume is to be infiltrated, treated, or otherwise managed for new development projects that disturb at least one acre or are part of a greater common development that disturbs at least one acre.

The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2000 square feet of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance to obtain a Site Disturbance Permit. The Site Disturbance Permit requires an EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year 24 hour SCS Type II storm event.

5.3.2 Proposed Projects

Proposed projects in this watershed include the following:

- Small scale drainage projects are taken care of through the program Project DRI. Beginning in 2003, MSD initiated an aggressive program to address a wide variety of drainage issues that are brought to us by our customers. This program, dubbed Project DRI (Drainage Response Initiative), assigned experienced project managers, contractors, and inspectors to address drainage problems on a "grade-to-drain" basis. Efforts under this program address problems ranging from structural flooding to alleviating minor standing water problems. Available funds are distributed across the service area based on relative levels of customer concerns and estimated costs of repairs within geographic areas. MSD has completed the first four phases of Project DRI. Currently, Phase 5 is under way. This phase is scheduled for FY17 and FY18. The project list for Phase 5 can be found in the Appendix B of this report.

- The Critical Repair and Reinvestment Plan proposes one new project in Cedar Creek, the Seatonville Early Action Project. This project is currently not included in the 5-year capital improvement plan budget. FY18-FY22 projects proposed in the plan are shown in Appendix C.

6.0 FLOYDS FORK

6.0 FLOYDS FORK

6.1 Watershed Study Area

6.1.1 General

The 460 square mile Floyds Fork Watershed is located in eastern Jefferson County, Henry, Oldham, Shelby, Spencer, and Bullitt Counties. Its headwaters originate in southwest Henry County, approximately 13 miles beyond the Jefferson County boundary line. Flow is generally southwest through Oldham, Shelby, and Jefferson Counties, and then into Bullitt county, where it outlets into the Salt River. The major streams in this watershed are Floyds Fork, Pope Lick, and Chenoweth Run. Aerial maps showing the Floyds Fork Watershed are included as Maps FFN-1 and FFS-1. Drainage maps showing the 16 subbasins for Floyds Fork are included as Maps FFN-2 and FFS-2.

Floyds Fork at Floyds Fork Park

The watershed covers a six county area: Jefferson, Bullitt, Spencer, Oldham, Henry and Shelby. For the purpose of this report, only the 104 square mile portion of this watershed which lies in Jefferson County and drains parts of Jeffersontown, Middletown, and Anchorage is given detailed study.

Fairmount Falls, a tributary to Floyds Fork

Communities in the study area include parts of Jeffersontown, Middletown, Anchorage, Berrytown, Woodland Hills, Tucker Station, and Hopewell.

Notable landmarks include Fishermens Park, Chenoweth Park, parts of Bluegrass Industrial Park, Eastern High School, and Jeffersontown High School. Existing parks along Floyds Fork include Floyds Fork Park and William F. Miles Park. Both of these parks provide open space that will be preserved along Floyds Fork. Conservation easements have also been provided in the Floyds Fork watershed near Deer Run Road and Pope Lick Road. Woodland Protection Areas in this watershed have been created for the Oakland Hills Subdivision and the Hills of Beckley Station.

6.1.2 Topography

The entire 33 square mile study area is situated in the Eastern Uplands Topographic Region. Broad, steep-sided valleys and narrow ridge crests dominate the terrain. Major streams have cut deeply into this terrain and flow through well-entrenched channels, where near-vertical cliffs are common.

Elevations range from about 490, in the area of the Seatonville Springs Country Club, to about 760 feet, in the area north of Anchorage.

6.1.3 Geology

The major portion of this study area is underlain by limestones, shales, and dolomites of middle Silurian age. Major creeks, however, have eroded channels deeply into, and in many cases, through these rocks. In these deep cuts, limestones, shales, and dolomites of upper Ordovician age are commonly exposed. The general dip of these rock beds, or strata, is toward the west at a little less than one foot in one hundred feet. Surficial features do not indicate karst activity, but springs are common on top of the Silurian and Ordovician shales.

6.1.4 Soils

Section 2.2.2 of the WMP explains in detail the five soil groups used to classify soils in this study. The soil composition in the Floyds Fork Watershed is from groups B, C, D, and the unclassified group. The soils in the Floyd Forks Watershed can be found on Maps FFN-3 and FFS-3.

6.1.5 Land Use

The majority of the land use in the Floyds Fork Watershed is residential and agricultural. The existing land use in the Floyds Fork Watershed can be found on Maps FFN-4 and FFS-4.

6.1.6 Watershed Improvements

21st Century Parks, along with the City of Louisville and Future Fund, acquired over 3,200 acres of land for the Floyds Fork Greenway. The project extends from Shelbyville Road to Bardstown Road along Floyds Fork and incorporates the existing Miles Park and Floyds Fork Park. The project restored and maintains the streamside tree buffer, added new wetlands, forest, meadow, and preserves over 80% of the parkland as natural habitat.

6.1.7 Local Basins

There are currently 277 local basins located in the Floyds Fork watershed. These basins are shown on Map FF-2.

6.2 Modeling

In the Floyds Fork Watershed, new hydrologic analyses were done for Brush Run Upper, Floyds Fork, and Long Run Creek in the 2006 FIS. HEC-HMS software was used to calculate 10, 2, 1, and 0.2 percent chance flood events using the SCS Type II, 24 hour design storm distribution. Model inputs such as curve number, time of concentration, and soil groups were determined using information from LOJIC. Water surface elevations were determined using HEC-RAS. Cross sections were obtained from field surveys and all bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry for Brush Run Upper and Floyds Fork. Cross sections for Long Run Creek were obtained using topographic mapping from LOJIC with a contour interval of 2 feet. Bridges along Long Run Creek were hand measured, but not field surveyed. Roughness coefficients were determined based on field inspections and aerial photography.

Brush Run Upper lacks any stream gauges. The model was calibrated using the regression equations for Jefferson County that can be found in “Estimation of Peak-Discharge Frequency of Urban Streams in Jefferson County, Kentucky, U.S. Geological Survey, Water-Resources Investigations Report 97-4219.” The Floyds Fork model was calibrated using data from the March 1997 flood. Long Run Creek’s model was calibrated using the regression equations for Jefferson County and also using gauge data and USGS's PEAKQ software.

Floyds Fork, the lower section of Brush Run Upper, and Long Run Creek each had detailed studies completed to develop the floodplains. Other tributaries to Floyds Fork, including Back Run, Big Run East, the upper portion of Brush Run Upper, Brush Run Middle, Brush Run Lower, Broad Run, Cane Run, Chenoweth Run Upper, Chenoweth Run Lower, Commerce Creek, Kuriger Creek, Old Mans Run, Pope Lick, Shakes Run, Shinks Branch, South Long Run, and Spotswood Creek, were studied using approximate methods. The floodplains were calculated using Manning's Formula. Cross sections were determined from maps and field reconnaissance, but were not field surveyed. Bridge and culvert data were only gathered if it was expected to cause significant backwater. Bridge and culvert data were hand measured and no survey was completed. Slopes used for Manning's Formula were based on topographic mapping.

Long Run Creek at Eastwood-Fisherville Road

Floodplain limits for the 1 percent annual chance flood were calculated for existing conditions and future, fully developed conditions. Existing conditions are labeled as the FEMA floodplain and future conditions are labeled as the Local Regulatory Floodplain. Maps FFN-5 and FFS-5 show the limits of each of these floodplains.

A RiskMAP project is currently underway to update existing flood models throughout the county. Preliminary maps are expected to be public in 2017 and adopted in late 2018. These maps modernize many of flood studies and create limited detail flood models for most A zones in the county. Streams within this watershed will be updated with this effort.

6.3 Action Plan

Floyds Fork at Miles Park

6.3.1 Watershed Requirements

New development in the Floyds Fork Watershed is required to detain proposed stormwater discharge rates to predeveloped conditions for the 2, 10, 25, and 100 year storm events through the MSD Design Manual. The NRCS Type II, 24 hour rainfall distribution is required to be used for the modeling. In areas where adequate downstream facilities exist, especially in the lower portion of a watershed where peak flows from the new development will occur substantially prior to the overall peak of the stream, on a case-by-case basis, MSD allows increased runoff to be compensated using a regional facility fee. This regional facility fee is used to construct regional basins.

Floodplain compensation is required at a ratio of

1.5:1 in the Chenoweth Run Watershed and 1:1 in the remaining area of the Floyds Fork Watershed for any fill placed in the fully developed local regulatory floodplain as required in the Louisville Metro Floodplain Management Ordinance.   This ratio may be increased on a site-specific basis as determined by MSD.

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the KDOW through its Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as High Quality or Impaired Water (Non-construction related impairment). A minimum 50 foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or “soft” approaches. MSD’s Design Manual outlines natural channel design requirements in Section 10.3.6.

Green infrastructure and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Green infrastructure must be designed to manage the required water quality volume rain event of 0.6” of runoff and must manage at least 90% of the site’s disturbed area. This volume is to be infiltrated, treated, or otherwise managed for new development projects that disturb at least one acre or are part of a greater common development that disturbs at least one acre.

The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2000 square feet of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance to obtain a Site Disturbance Permit. The Site Disturbance Permit requires an EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year 24 hour SCS Type II storm event.

6.3.2 Proposed Projects

Proposed projects in this watershed include:

- Small scale drainage projects are taken care of through the program Project DRI. Beginning in 2003, MSD initiated an aggressive program to address a wide variety of drainage issues that are brought to us by our customers. This program, dubbed Project DRI (Drainage Response Initiative), assigned experienced project managers, contractors, and inspectors to address drainage problems on a "grade-to-drain" basis.   Efforts under this program address problems ranging from structural flooding to alleviating minor standing water problems. Available funds are distributed across the service area based on relative levels of customer concerns and estimated costs of repairs within geographic areas. MSD has completed the first four phases of Project DRI. Currently, Phase 5 is under way. This phase is scheduled for FY17 and FY18. The project list for Phase 5 can be found in the Appendix B of this report.

- The Critical Repair and Reinvestment Plan proposes two new projects in the Floyds Fork watershed, the Pope Lick Early Action Project and the drainage improvements to the viaduct at Taylorsville Road and Merioneth Drive. These projects are currently not included in the 5-year capital improvement plan budget. FY18-Fy22 projects proposed in the plan are shown in Appendix C.

7.0 GOOSE CREEK

7.0 GOOSE CREEK

7.1 Watershed Study Area

7.1.1 General

The 18 square mile Goose Creek Watershed is located in northeastern Jefferson County and is drained primarily by Goose Creek and Little Goose Creek. Goose Creek's headwaters originate in Anchorage, flow in a westerly direction to the area of Westport Middle School, then turn generally northwest, and finally outlet into the Ohio River at Six Mile Island. Little Goose Creek's headwaters originate in the Freys Hill area, flow northwesterly, and eventually discharge into Goose Creek about one-half mile from its outlet on the Ohio River. The major streams are Goose Creek and Little Goose Creek. An aerial map showing the Goose Creek Watershed is included as Map GC-1. A drainage map showing the eight subbasins for Goose Creek is included as Map GC-2.

Outlet of Goose Creek into the Ohio River

Communities situated in this watershed include Anchorage, Rolling Hills, Plantation, Old Brownsboro Place, Hills and Dales, Glenview Heights, Brownsboro Farm, and Green Spring.

Notable landmarks include Kentucky Country Day School, E.P. Tom Sawyer State Park, Owl Creek Country Club, Central State Hospital, Standard Country Club, and Ballard High School. Hounz Lane Park is located along Goose Creek and provides open space and wetland areas that will be preserved. E.P. "Tom" Sawyer State Park is another park located along Goose Creek that provides open space that will be preserved. Woodland Protection Areas have also been created for the Woodstone Subdivision along Goose Creek.

7.1.2 Topography

The major portion of the Goose Creek Watershed is situated in the Eastern Uplands Topographic Region. The remaining portion, which lies adjacent to the Ohio River, is in the Flood Plain.

Broad, fairly steep-sided valleys and gently rolling plateaus dominate the terrain in the Uplands Region. Both Goose and Little Goose Creek have cut deeply into this terrain and they flow through well entrenched, channels, where near vertical cliffs are common.

A flat, low-lying terrain predominates in the Flood Plain Region. Excluding Goose Creek, stream channels of low gradient slopes tend to parallel the Ohio River.

Elevations range from about 420 feet, the pool stage of the Ohio River at the McAlpine Lock and Dam, to about 760 feet, in the area north of Anchorage.

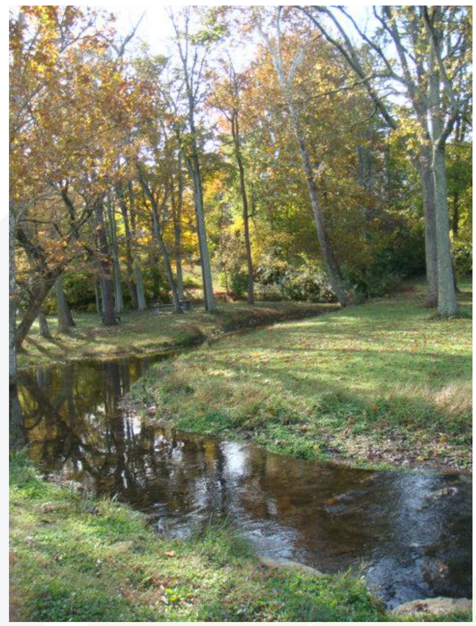
7.1.3 Geology

The portion of this watershed lying in the Eastern Uplands Topographic Region is predominantly underlain by limestones of lower Devonian and middle Silurian age. This major creek, however, has eroded channels deep into these rocks, exposing middle Silurian shales and dolomites. The general dip of these rock beds, or strata, is toward the west at a little more than one-half foot in one hundred feet. A northeast trending anticlinal axis is observed about 0.6 miles north of and parallel to County Road 1447. An east trending synclinal axis is observed in the area north of Anchorage. Limited karst activity is represented by some small sinkholes and springs.

The portion of this watershed lying in the Flood Plain Topographic Region is underlain by various alluvial deposits of Quaternary age. These deposits range in thickness from several feet to well over one hundred feet, and are comprised of complex layers of silts, sands, clays, and gravels. This region is a well-documented aquifer and groundwater is readily available.

7.1.4 Soils

Section 2.2.2 of the WMP explains in detail the five soil groups used to classify soils in this study. The soil composition in the Goose Creek Watershed is mainly from soil group B and the unclassified group. The soils in the Goose Creek Watershed are shown on Map GC-3.



Goose Creek at Hounz Lane Park

7.1.5 Land Use

The majority of the land use in the Goose Creek Watershed is residential. The existing land use in the Goose Creek Watershed can be found on Map GC-4.

7.1.6 Watershed Improvements

There are no regional basins or major channel improvement projects located in the Goose Creek Watershed.

7.1.7 Local Basins

There are currently 65 local basins located in the Goose Creek watershed. These basins are shown on Map GC-2.

7.2 Modeling

New hydraulic analyses were completed for the uppermost portion of Goose Creek, Little Goose Creek, LeFores Branch, Brownsboro Ditch, Lilac Run, Rolling Hills Branch, and Springhurst Creek for the 2006 FIS. The modeling was performed with HEC-HMS using the SCS Type II, 24-hour rainfall distribution. Hydraulic parameters such as curve number, time of concentration, and soil groups were determined using information from LOJIC. Water surface elevations were determined using HEC-RAS. Cross sections were obtained from field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Roughness coefficients were determined based on field inspections and aerial photography.

The portions of Goose Creek and Little Goose Creek that were not restudied in the 2006 FIS were studied using approximate methods. The floodplains were calculated using Manning's Formula. Cross sections were determined from maps and field reconnaissance, but were not field surveyed. Bridge and culvert data were only gathered if it was expected to cause significant backwater. Bridge and culvert data were hand measured and no survey was completed. Slopes used for Manning's Formula were based on topographic mapping.

Floodplain limits for the 1 percent annual chance flood were calculated for existing conditions and future, fully developed conditions. Existing conditions are labeled as the FEMA floodplain and future conditions are labeled as the Local Regulatory Floodplain. Map GC-5 shows the limits of each of these floodplains. A RiskMAP project is currently underway to update existing flood models throughout the county. Preliminary maps are expected to be public in 2017 and adopted in late 2018. These maps modernize many of flood studies and create limited detail flood models for most A zones in the county. Streams within this watershed will be updated with this effort.

7.3 Action Plan

7.3.1 Watershed Requirements

New development in the Goose Creek Watershed is required to detain proposed stormwater discharge rates to predeveloped conditions for the 2, 10, 25, and 100 year storm events through the MSD Design Manual. The NRCS Type II, 24 hour rainfall distribution is required to be used for the modeling. In areas where adequate downstream facilities exist, especially in the lower portion of a watershed where peak flows from the new development will occur substantially prior to the overall peak of the stream, on a case-by-case basis, MSD allows increased runoff to be compensated using a regional facility fee. This regional facility fee is used to construct regional basins.

Floodplain compensation is required in the Goose Creek Watershed at a ratio of 1:1 for any fill placed in the fully developed local regulatory floodplain as required in the Louisville Metro Floodplain Management Ordinance. The ratio may be increased on a site-specific basis as determined by MSD.

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the KDOW through its Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as High Quality or Impaired Water (Non-construction related impairment). A minimum 50 foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or “soft” approaches. MSD’s Design Manual outlines natural channel design requirements in Section 10.3.6.

Green infrastructure and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Green infrastructure must be designed to manage the required water quality volume rain event of 0.6” of runoff and must manage at least 90% of the site’s disturbed area. This volume is to be infiltrated, treated, or otherwise managed for new development projects that disturb at least one acre or are part of a greater common development that disturbs at least one acre.

The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2000 square feet of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance to obtain a Site Disturbance Permit. The Site Disturbance Permit requires an EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year 24 hour SCS Type II storm event.

7.3.2 Proposed Projects

Proposed projects within this watershed include:

- Small scale drainage projects are taken care of through the program Project DRI. Beginning in 2003, MSD initiated an aggressive program to address a wide variety of drainage issues that are brought to us by our customers. This program, dubbed Project DRI (Drainage Response Initiative), assigned experienced project managers, contractors, and inspectors to address drainage problems on a "grade-to-drain" basis. Efforts under this program address problems ranging from structural flooding to alleviating minor standing water problems. Available funds are distributed across the service area based on relative levels of customer concerns and estimated costs of repairs within geographic areas. MSD has completed the first four phases of Project DRI. Currently, Phase 5 is under way. This phase is scheduled for FY17 and FY18. The project list for Phase 5 can be found in the Appendix B of this report.

- The Critical Repair and Reinvestment Plan proposes one new project in the Goose Creek watershed, the Ten Broeck Way Early Action Project. This project is currently not included in the 5-year capital improvement plan budget. FY18-FY22 projects proposed in the plan are shown in Appendix C.

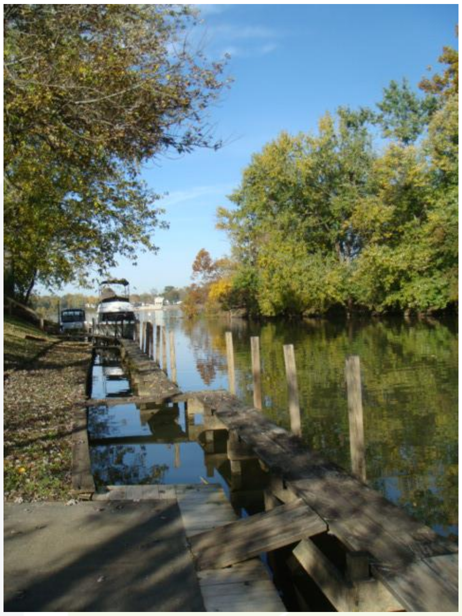
8.0 HARRODS CREEK

8.0 HARRODS CREEK

8.1 Watershed Study Area

8.1.1 General

The 180 square mile Harrods Creek Watershed is located in northeastern Jefferson County, Oldham and Henry Counties. Its headwaters originate in the area east of LaGrange, Kentucky, approximately 17 miles beyond the Jefferson County border. The creek flows generally to the southwest, converging with South Fork Harrods Creek about one-half mile outside the Jefferson County line. From this point, the flow continues southwest through Jefferson County to an outlet on the Ohio River at Guthrie Beach. Major streams in this watershed include Harrods Creek, Wolf Pen Branch, South Fork Harrods Creek, and South Fork Hite Creek. An aerial map showing the Harrods Creek Watershed is included as Map HC-1. A drainage map showing the nine subbasins for Harrods Creek is included as Map HC-2.



Outlet of Harrods Creek into the Ohio River

For the purpose of this report, only the 15.3 square mile portion of this watershed in and adjacent to Jefferson County is given detailed study.

Communities in the study area include Fincastle, Ballardsville, Pewee Valley, Lake Louisvilla, Worthington, and Prospect.

Notable landmarks include the Ford Motor Company Kentucky Truck Plant and Hunting Creek Country Club.

8.1.2 Topography

The major portion of the 15.3 square mile study area is situated in the Eastern Uplands Topographic Region. The remaining portion, which lies adjacent to the Ohio River, is in the Flood Plain.

Broad steep-sided valleys and gently rolling plateaus dominate the terrain in the Uplands Region. Harrods Creek has cut deeply into this terrain and it flows through a well entrenched channel, where near-vertical cliffs are common.

A very flat, low-lying terrain predominates in the Flood Plain, excluding Harrods Creek, stream channels of low gradient slopes tend to parallel the Ohio River.
Elevations range from about 420 feet, the pool stage of the Ohio River above the McAlpine Lock and Dam, to about 780 feet, in an area southwest of Pewee Valley.

8.1.3 Geology

The portion of this study area lying in the Eastern Uplands Topographic Region is predominantly underlain by limestones of the lower Devonian and middle Silurian ages. The major creeks, however, have eroded channels deeply into, and in some cases, though these rocks. In these deeper cuts, shales, dolomites, and limestones of middle and lower Silurian and upper Ordovician age are commonly exposed. The general dip of these rock beds, or strata, is toward the west at a little more than one-half foot in one hundred feet. Some limited karst activity is represented by small sinkholes and springs.

In the Harrods Creek channel, and in the study area portion which lies in the Flood Plain Topographic Region, various alluvial deposits of the Quaternary age are encountered. These deposits range in thickness from several feet to well over one hundred feet. They are comprised of complex layers of silts, sands, clays, and gravels. This region is a well documented aquifer and groundwater is readily available.

8.1.4 Soils

Section 2.2.2 of the WMP explains in detail the five soil groups used to classify soils in this study. The soil composition in the Harrods Creek Watershed is mainly from soil group B and the unclassified group. The soil groups in the Harrods Creek Watershed can be found on Map HC-3.

8.1.5 Land Use

The majority of the land use in the Harrods Creek Watershed is residential and agricultural. The existing land use in the Harrods Creek Watershed can be found on Map HC-4.

8.1.6 Watershed Improvements

No regional basins or major channel improvement projects are located in the Harrods Creek Watershed.

8.1.7 Local Basins

There are currently 82 local basins located in the Harrods Creek watershed. These basins are shown on Map HC-2.

8.2 Modeling

New models were completed for Harrods Creek and Hite Creek using HEC-HMS for the 2006 FIS. The standard SCS Type II, 24-hour design storm distribution was used to determine the 10, 2, 1, and 0.2 percent annual chance events. Hydraulic parameters such as curve number, time of concentration, and soil groups were determined using information from LOJIC. Water surface elevations were determined using HEC-RAS. Cross sections were obtained from field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Roughness coefficients were determined based on field inspections and aerial photography. Based on the modeling, Harrods Creek is controlled by backwater from the Ohio River for the entire length located in Jefferson County. Model calibration was done using the regression equations for Jefferson County which can be found in "Estimation of Peak-Discharge Frequency of Urban Streams in Jefferson County, Kentucky, U.S. Geological Survey, Water-Resources Investigations Report 97-4219."

Harrods Creek upstream of US Hwy 42

Wolf Pen Branch and Hunting Creek, which are tributaries to Harrods Creek, were studied using approximate methods. The floodplains were calculated using Manning's Formula. Cross sections were determined from maps and field reconnaissance, but were not field surveyed. Bridge and culvert data were only gathered if it was expected to cause significant backwater. Bridge and culvert data were hand measured and no survey was completed. Slopes used for Manning's Formula were based on topographic mapping.

Floodplain limits for the 1 percent annual chance flood were calculated for existing conditions and future, fully developed conditions. Existing conditions are labeled as the FEMA floodplain and future conditions are labeled as the Local Regulatory Floodplain. Map HC-5 shows the limits of each of these floodplains.

A RiskMAP project is currently underway to update existing flood models throughout the county. Preliminary maps are expected to be public in 2017 and adopted in late 2018. These maps modernize many of flood studies and create limited detail flood models for most A zones in the county. Streams within this watershed will be updated with this effort.

8.3 Action Plan

8.3.1 Watershed Requirements

New development in the Harrods Creek Watershed is required to detain proposed stormwater discharge rates to predeveloped conditions for the 2, 10, 25, and 100 year storm events through the MSD Design Manual. The NRCS Type II, 24 hour rainfall distribution is required to be used for the modeling. In areas where adequate downstream facilities exist, especially in the lower portion of a watershed where peak flows from the new development will occur substantially prior to the overall peak of the stream, on a case-by-case basis, MSD allows increased runoff to be compensated using a regional facility fee. This regional facility fee is used to construct regional basins.

Floodplain compensation is required in the Harrods Creek Watershed at a ratio of 1:1 for any fill placed in the fully developed local regulatory floodplain as required in the Louisville Metro Floodplain Management Ordinance. This ratio may be increased on a site-specific basis as determined by MSD.

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the KDOW through its Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as High Quality or Impaired Water (Non-construction related impairment). A minimum 50 foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or "soft" approaches. MSD's Design Manual outlines this requirement in Section 10.3.6.

Green infrastructure and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Green infrastructure must be designed to manage the required water quality volume rain event of 0.6" of runoff and must manage at least 90% of the site's disturbed area. This volume is to be infiltrated, treated, or otherwise managed for new development projects that disturb at least one acre or are part of a greater common development that disturbs at least one acre.

The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2000 square feet of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance to obtain a Site Disturbance Permit. The Site Disturbance Permit requires an EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year 24 hour SCS Type II storm event.

8.3.2 Proposed Projects

Proposed projects within this watershed include:

- Small scale drainage projects are taken care of through the program Project DRI. Beginning in 2003, MSD initiated an aggressive program to address a wide variety of drainage issues that are brought to us by our customers. This program, dubbed Project DRI (Drainage Response Initiative), assigned experienced project managers, contractors, and inspectors to address drainage problems on a "grade-to-drain" basis. Efforts under this program address problems ranging from structural flooding to alleviating minor standing water problems. Available funds are distributed across the service area based on relative levels of customer concerns and estimated costs of repairs within geographic areas. MSD has completed the first four phases of Project DRI. Currently, Phase 5 is under way. This phase is scheduled for FY17 and FY18. The project list for Phase 5 can be found in the Appendix B of this report.

- The Critical Repair and Reinvestment Plan proposes one new project in the Harrods Creek watershed, the Prospect Early Action Project. This project is currently not included in the 5-year capital improvement plan budget. FY18-FY22 projects proposed in the plan are shown in Appendix C.

9.0 MILL CREEK

9.0 MILL CREEK

9.1 Watershed Study Area

9.1.1 General

The 34 square mile Mill Creek Watershed is located in the western portion of Jefferson County. Due to the diversion of the upstream reaches of Mill Creek into a "cut-off" channel, this watershed is divided into two entirely separate sections. These are referred to as Upper Mill Creek and Lower Mill Creek. Major streams included in Upper Mill Creek include Big Run, Cane Run, and Mill Creek Cutoff. Major streams included in Lower Mill Creek include Mill Creek and Black Pond Creek. An aerial map showing the Mill Creek Watershed is included as Map MC-1. A drainage map showing the 16 subbasins for Mill Creek is included as Map MC-2.

Lower Mill Creek at Outlet to Ohio River

The 19 square mile Upper Mill Creek's headwaters originate in the area of Manslick Road and I-264. From here, they flow in a westerly direction to the western side of Shively, where several tributaries including Cane Run, Boxwood Ditch, Lynnview Ditch, and Big Run join the flow. From this point, the flow direction is to the northwest, via the cutoff channel. The stream outlets into the Ohio River just south of Riverside Gardens. A flood pumping station is located in the Riverside Gardens area near the stream outlet. This flood pumping station is part of the flood levee system that protects Jefferson County from Ohio River flooding.

Communities lying in the Upper Mill Creek section include Shively, Heatherfield, Hunters Trace, Parkwood, St. Denis, and Riverside Gardens.

Notable landmarks include Louisville Gas & Electric's Mill Creek Power Station, Western High School, Doss High School, Shively Park, Dixie Manor, and a part of Iroquois Park. Sun Valley Park is located on Mill Creek near Lower River Road. This park provides preserved open space along Mill Creek.

The 15 square mile Lower Mill Creek's headwaters originate in the area of Lower Hunters Trace and Terry Road. From here, the flow is generally to the south, paralleling the Ohio River. Several tributaries, including Black Pond Creek and Valley Creek, join this flow in the Valley Downs area. The stream eventually outlets into the Ohio River west of Valley Village. A flood pumping station is located 0.75 miles upstream of the mouth of Lower Mill Creek. This flood pumping station is part of the flood levee system that protects Jefferson County from Ohio River flooding.

Communities lying in the Lower Mill Creek section include Valley Village, Meadow Lawn, Valley Downs, parts of Valley Station and Pleasure Ridge Park, Sylvania, Greenwood, and Waverly Hills.

Notable landmarks include Sun Valley Community Park, Valley High School, Waverly Park, and the Louisville and Jefferson County Riverport Authority.

9.1.2 Topography

The major portion of the Mill Creek Watershed is situated in the Flood Plain Topographic Region. The remaining portion, which lies east of the Illinois Central Railroad, lies in the Knobs.

A very flat, low-lying terrain predominates in the Flood Plain. Stream channels with low gradient slopes tend to parallel the Ohio River. Terraces of ten to twenty feet in height are common.

Lower Mill Creek at Bethany Lane

Steep-sided, round-topped hills dominate the terrain in the Knobs. Stream channels are deeply cut into these hills and commonly have high gradient slopes.

Elevations range from about 382 feet, the pool stage of the Ohio River below the McAlpine Lock and Dam, to about 760 feet, at the top of the Iroquois Park hill.

9.1.3 Geology

The portion of this watershed lying in the Flood Plain Topographic Region is predominantly underlain by glacial outwash deposits of the Quaternary age. These deposits vary in thickness from several feet to well over one hundred feet, and are comprised of complex layers of silts, sands, clays, and gravels. This region is a well documented aquifer and groundwater is readily available.

The portion of this watershed lying in the Knobs topographic region is predominantly underlain by a hilly complex of Mississippian age siltstones and shales, whose lower flanks are covered by zero to thirty feet of an alluvial deposit of Quaternary age loess and eloian sand. The general dip of the rock beds, or strata, in this hilly area is toward the west at a little less than one foot in one hundred feet. Karst activity is not associated with this region. It should be noted, however, that Mississippian shales become plastic when wetted and even moderate slopes are prone to slump and/or slide.

9.1.4 Soils

Section 2.2.2 of the WMP explains in detail the five soil groups used to classify soils in this study. The soil composition in the Mill Creek Watershed is principally from soil groups B, C, and the unclassified group. The soil groups in the Mill Creek Watershed can be found on Map MC-3.

9.1.5 Land Use

The majority of the land use in the Mill Creek Watershed is residential, with commercial areas located along Dixie Highway and a combination of commercial and industrial uses near the river. The existing land use in Mill Creek can be found on Map MC-4.

9.1.6 Watershed Improvements

The Wheeler Basin is a regional basin located in the Mill Creek Watershed. The basin was constructed to relieve flooding from the combined sewer system. MSD and the USACE completed a study of the Upper Mill Creek Basin. The study identified one potential project to remove a portion of the old Ohio River levee that is no longer in service.

9.1.7 Local Basins

There are currently 55 local basins located in the Mill Creek watershed. These basins are shown on Map MC-2.

9.2 Modeling

Mill Creek Cutoff near outlet to Ohio River

Hydraulic analyses for Lower Mill Creek were completed using HEC-1. Curve numbers, drainage area, and time of concentration were used to determine flows from each subbasin. Storage routings were added as needed and numerous trials were required in order to determine final discharge values. Using the discharge values from the HEC-1 models, HEC -2 was used to create stream profiles for each stream. Cross sections and bridge elevations and geometry were field surveyed. Calibrations were done by comparing discharge data from the Southwest Jefferson County Local Flood Protection Project (SJCLPP) design analysis and data from the original FIS for Jefferson County. Backwater from the pumping station on Mill Creek affects Mill Creek up to Moorman Road and also the lower portions of Valley Creek and Black Pond Creek.

Upper Mill Creek was also modeled used HEC-1 and the results were verified using the discharge data from the SJCLPP design analysis and the original FIS for Jefferson County. Curve numbers, drainage area, and time of concentration were used to determine flows from each subbasin. Storage routings were added as needed and numerous trials were required in order to determine final discharge values. Using the discharge values from the HEC-1 models, HEC -2 was used to create stream profiles for each stream. Cross sections and bridge elevations and geometry were field surveyed. At the time of the study, no USGS stream gauges existed in the watershed. Backwater from the pumping station affects the Mill Creek Cutoff, Upper Mill Creek, Huff Lane Tributary, Gardens Tributary, and Lower Garrison Ditch.

Some tributaries to Mill Creek, including the uppermost section of Upper Mill Creek, small portions of Big Run Creek, and a small portion of Ponder Creek were studied using approximate methods. The floodplains were calculated using Manning's Formula. Cross sections were determined from maps and field reconnaissance, but were not field surveyed. Bridge and culvert data were only gathered if it was expected to cause significant backwater. Bridge and culvert data were hand measured and no survey was completed. Slopes used for Manning's Formula were based on topographic mapping.

Along the floodwall, areas that are inundated by backwater during pumping operations were purchased by the County and/or put into flowage easements to protect the areas from future development.

Floodplain limits for the 1 percent annual chance flood were calculated for existing conditions and future, fully developed conditions. Existing conditions are labeled as the FEMA floodplain and future conditions are labeled as the Local Regulatory Floodplain. Map MC-5 shows the limits of each of these floodplains.

A RiskMAP project is currently underway to update existing flood models throughout the county. Preliminary maps are expected to be public in 2017 and adopted in late 2018. These maps modernize many of flood studies and create limited detail flood models for most A zones in the county. Streams within this watershed will be updated with this effort.

9.3 Action Plan

9.3.1 Watershed Requirements

New development in the Mill Creek Watershed is required to detain proposed stormwater discharge rates to predeveloped conditions for the 2, 10, 25, and 100 year storm events through the MSD Design Manual. The NRCS Type II, 24 hour rainfall distribution is required to be used for the modeling. In areas where adequate downstream facilities exist, especially in the lower portion of a watershed where peak flows from the new development will occur substantially prior to the overall peak of the stream, on a case-by-case basis, MSD allows increased runoff to be compensated using a regional facility fee. This regional facility fee is used to construct regional basins.

Floodplain compensation is required in the Big Run Watershed of Mill Creek at a ratio of 1.5:1 and 1:1 for the remaining areas in the Mill Creek Watershed for any fill placed in the fully developed local regulatory floodplain as required in the Louisville Metro Floodplain Management Ordinance. The ratio may be increased on a site-specific basis as determined by MSD.

Louisville Loop Bridge over Mill Creek Cutoff

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the KDOW through its Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as High Quality or Impaired Water (Non-construction related impairment). A minimum 50 foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or “soft” approaches. MSD’s Design Manual outlines this requirement in Section 10.3.6.

Green infrastructure and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Green infrastructure must be designed to manage the required water quality volume rain event of 0.6” of runoff and must manage at least 90% of the site’s disturbed area. This volume is to be infiltrated, treated, or otherwise managed for new development projects that disturb at least one acre or are part of a greater common development that disturbs at least one acre.

The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2000 square feet of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance to obtain a Site Disturbance Permit. The Site Disturbance Permit requires an

EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year 24 hour SCS Type II storm event.

9.3.2 Proposed Projects

Proposed projects within this watershed include:

- Small scale drainage projects are taken care of through the program Project DRI. Beginning in 2003, MSD initiated an aggressive program to address a wide variety of drainage issues that are brought to us by our customers. This program, dubbed Project DRI (Drainage Response Initiative), assigned experienced project managers, contractors, and inspectors to address drainage problems on a "grade-to-drain" basis. Efforts under this program address problems ranging from structural flooding to alleviating minor standing water problems. Available funds are distributed across the service area based on relative levels of customer concerns and estimated costs of repairs within geographic areas. MSD has completed the first four phases of Project DRI. Currently, Phase 5 is under way. This phase is scheduled for FY17 and FY18. The project list for Phase 5 can be found in the Appendix B of this report.

- The Critical Repair and Reinvestment Plan proposes one new project in the Mill Creek watershed, the Valley Creek Early Action Project. This project is currently not included in the 5-year capital improvement plan budget. FY18-FY22 projects proposed in the plan are shown in Appendix C.

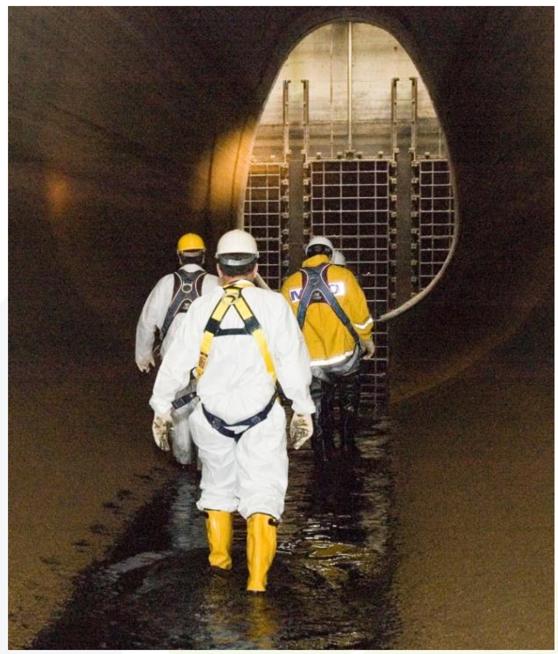
10.0 OHIO RIVER/CITY

10.0 OHIO RIVER/CITY

10.1 Watershed Study Area

10.1.1 General

The Ohio River/City Watershed is drained by a complex system of combined sewers. No open channels of any magnitude exist. An aerial map showing the Ohio River/City drainage area is shown on Maps CORE-1 and CORW-1 on the following page. A drainage map showing the six subbasins for the Ohio River/City Watershed is included as Maps CORE-2 and CORW-2.



Combined Sewer System at the Southwestern Outfall

Communities situated in this watershed include downtown Louisville, Kenwood, Southern Heights, Beechmont, Highland Park, Oakdale, Wilder Park, Parkland, South Parkland, Shawnee, and Portland.

Notable landmarks include portions of Iroquois Park, the Kentucky Fair and Exposition Center, the University of Louisville, Churchill Downs, Kentucky International Convention Center, City Hall, Shawnee Park, and Chickasaw Park. Many parks are located along the Ohio River and provide preserved open space along the Ohio River floodplain. These parks include Eva Bandman Park, Capertown Swamp, Chickasaw Park, Carrie Gaulbert Cox Park, Hays Kennedy Park, Kulmer Reserve, Lannan Park, Portland Wharf Park, Riverside Farnsley-Moorman Landing, Riverview Park, Thurman Hutchins Park, Twin Park, and Waterfront Park.

10.1.2 Topography

The major portion of the Ohio River/City Watershed is located in the Flood Plain Topographic Region. The remaining portion lies in the Central Basin. A very flat, low-lying terrain predominates both the Flood Plain and Central Basin Regions.

Elevations range from about 382 feet, the pool stage of the Ohio River below the McAlpine Lock and Dam, to about 586 feet in Glenview.

10.1.3 Geology

The portion lying in the Flood Plain Topographic Region is predominately underlain by glacial outwash deposits of Quaternary age. These deposits vary in thickness from several feet to well over one hundred feet, and are comprised of complex layers of silts, sands, clays, and gravels. This region is a well documented aquifer and groundwater is readily available.

Ohio River near Mill Creek outlet

The portion of this watershed lying in the Central Basin Topographic Region is predominately underlain by alluvial lacustrine deposits of Quaternary age. These deposits vary in thickness from zero to fifty feet, and are comprised of layers of silts, sands, clays, and gravels.

10.1.4 Soils

Section 2.2.2 of the WMP explains in detail the five soil groups used to classify soils in this study. The soil composition in the Ohio River/City Watershed is mainly unclassified. The soils in the Ohio River/City Watershed are shown on Maps CORE-3 and CORW-3.

10.1.5 Land Use

The land use in the Ohio River/City Watershed is mainly a mix of residential, commercial, and industrial land use. The existing land use in the Ohio River/City Watershed is shown on Maps CORE-4 and CORW-4.

10.1.6 Watershed Improvements

No open channels of any magnitude exist in this watershed; however, several watershed improvements have been made in this area, including:

- Two regional basins located in the Ohio River/City Watershed have been constructed to reduce combined sewer overflows. These basins are Executive Inn Basin and Brady Lake.
- Several pump station modification projects have been completed along the Ohio River such as the 34th Street, 4th Street, 27th Street, 17th Street, and the Shawnee Flood Pump Station to reduce combined sewer overflows and improve water quality.
- Other combined sewer projects that have been completed in this watershed to improve water quality and reduce combined sewer overflows include:
    - Inline storage and green storm water practices in CSO 058
    - Green infrastructure in CSO 190
    - Modified overflow weir to create inline storage in a newly constructed 72” pipe in CSO 160.

10.1.7 Local Basins

There are currently 29 local basins located in the Ohio River/City watershed. These basins are shown on Maps CORE-2 and CORW-2.

10.2 Modeling

Modeling of the Ohio River was completed by the Ohio River Division of the USACE in Cincinnati, Ohio. The USACE used the methods presented in the USACE hydrology report and historic gage records along the Ohio dating from 1832 to the present.

The area behind the floodwall is drained through the combined sewer system. No open channels of any magnitude exist within this watershed; however, many low areas are prone to flooding due to surcharging of the combined sewer system. Modeling has been completed for the combined sewer system to predict the response of the system to various rain events. This model was created using the EPA's XP-SWMM program and was calibrated using observed data during various storm conditions. The pipe network used was based on the best available data, which included as-built drawings, construction drawings, and CSO inventory records. Floodprone areas have also been delineated in the combined sewer area based on the 1% annual chance flood.

Floodplain limits for the Ohio River for the 1 percent annual chance flood were calculated for existing conditions. The limits of the FEMA floodplain and Local Regulatory Floodplain are identical along the Ohio River. Maps CORE-5 and CORW-5 show the limits of each of these floodplains.

10.3 Action Plan

10.3.1 Watershed Requirements

New development in the combined sewer area is restricted to detaining the post-developed 100-yr flows to the pre-developed 10-year flows in order to help alleviate the flows in the combined sewer system during rain events. Examples of mitigation techniques include building detention basins, oversizing onsite stormwater pipes, and using green solutions such as pervious pavement and rain gardens to reduce peak flows and overall runoff volumes.

Floodplain compensation is required in the Ohio River/City Watershed at a ratio of 1:1 for any fill placed in the fully developed local regulatory floodplain as required in the Louisville Metro Floodplain Management Ordinance. This ratio may be increased on a site-specific basis as determined by MSD.

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the KDOW through its Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as High Quality or Impaired Water (Non-construction related impairment). A minimum 50 foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or "soft" approaches. MSD's Design Manual outlines this requirement in Section 10.3.6.

Green infrastructure and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Green infrastructure must be designed to manage the required water quality volume rain event of 0.6" of runoff and must manage at least 90% of the site's disturbed area. This volume is to be infiltrated, treated, or otherwise managed for new development projects that disturb at least one acre or are part of a greater common development that disturbs at least one acre.

The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2000 square feet of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance to obtain a Site Disturbance Permit. The Site Disturbance Permit requires an EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year 24 hour SCS Type II storm event.

10.3.2 Proposed Projects

Proposed projects in this watershed include:

- IOAP projects are proposed in the Ohio River/City Watershed. These projects include storage basins, sewer separation projects, and a large offline storage project called the Ohio River Tunnel. The Ohio River Tunnel project includes a large conveyance line from multiple CSOs and 4.36 MG underground covered concrete basin to reduce overflows to 8 overflows per typical year. This project also includes weir modifications to CSO 023 and 058. Two routes and costs for the conveyance line have been identified. The first route involves microtunnelling along Main Street, and the alternate route involves traditional open cut sewer installation along River Road. A right-sizing analysis may be used to potentially reduce the size of the basins or eliminate some of the conveyance lines. More information regarding these projects can be found in Appendix A of this report and also in the final CSO Long-Term Control Plan document, which is part of MSD's IOAP.

- Small scale drainage projects are taken care of through the program Project DRI. Beginning in 2003, MSD initiated an aggressive program to address a wide variety of drainage issues that are brought to us by our customers. This program, dubbed Project DRI (Drainage Response Initiative), assigned experienced project managers, contractors, and inspectors to address drainage problems on a "grade-to-drain" basis. Efforts under this program address problems ranging from structural flooding to alleviating minor standing water problems. Available funds are distributed across the service area based on relative levels of customer concerns and estimated costs of repairs within geographic areas. MSD has completed the first four phases of Project DRI. Currently, Phase 5 is under way. This phase is scheduled for FY17 and FY18. The project list for Phase 5 can be found in the Appendix B of this report.

- The 20-year Critical Repair and Reinvestment Plan proposes 29 new projects in the Ohio River watershed The purpose of the projects is to improve drainage at 29 viaducts located throughout this watershed. These viaducts are routinely submerged during storm events which cause roadway flooding. Four of these viaduct projects have been included in the 5-year capital improvement plan budget; however, the remaining projects are currently not funded. FY18-Fy22 projects proposed in the plan are shown in Appendix C.

11.0 PENNSYLVANIA RUN

11.0 Pennsylvania Run

11.1 Watershed Study Area

11.1.1 General

McNeely Lake

The 7 square mile Pennsylvania Run Watershed is located in south central Jefferson County. Its headwaters originate in the Highview area, and the stream flows in a southerly direction, passing into Bullitt County, and eventually discharging into Cedar Creek. For the purpose of this study, the Jefferson County/Bullitt County border serves as the approximate southerly watershed boundary. Pennsylvania Run is the only major stream in this watershed. An aerial map showing the Pennsylvania Run Watershed is included as Map PR-1. A drainage map showing the 3 subbasins for Pennsylvania Run is included as Map PR-2.

Highview is the only community in the Pennsylvania Run Watershed.

Notable landmarks include McNeely Lake and McNeely Lake Park. McNeely Lake Park is located along Pennsylvania Run and provides preserved open space in the floodplain.

11.1.2 Topography

The entire Pennsylvania Run Watershed is situated in the Eastern Uplands Topographic Region. Broad, fairly steep-sided valleys and narrow ridge crests dominate the terrain. Streams have cut deeply into this terrain and flow through well-entrenched channels.

Elevations vary from about 515 feet at the Jefferson County/Bullitt County line, to about 685 feet in the Highview area.

11.1.3 Geology

The major portion of this watershed is underlain by limestone of middle Silurian age. Pennsylvania Run has eroded deeply into, and in some cases through this limestone. Middle Silurian age shales and dolomites are commonly exposed in the valley walls. The general dip of these rocks is toward the west at a little less than one foot in one hundred feet. Surficial features do not indicate karst activity, but springs are common on top of the exposed shale.

11.1.4 Soils

Section 2.2.2 of the WMP explains in detail the five soil groups used to classify soils in this study. The soil composition in the Pennsylvania Run Watershed is mainly from soil groups B and C and the unclassified soil group. The soil groups in the Pennsylvania Run Watershed can be found on Map PR-3.

11.1.5 Land Use

The majority of the land use in the Pennsylvania Run Watershed is residential. The existing land use map in the Pennsylvania Run Watershed can be found on Map PR-4.

11.1.6 Watershed Improvements

No regional basins or major channel improvement projects are located in the Pennsylvania Run Watershed; however the largest lake in Jefferson County, McNeely Lake is located within this watershed.

11.1.7 Local Basins

There are currently 38 local control basins located in the Pennsylvania Run watershed. These basins are shown on Map PR-2.

Pennsylvania Run at Mount Washington Road

11.2 Modeling

New hydrologic modeling was completed for Pennsylvania Run for the 2006 FIS. HEC-HMS was used for the modeling. Hydraulic parameters such as curve number, time of concentration, and soil groups were developed using data from LOJIC. Several storage routings were included in the model, including McNeely Lake. Water surface elevations were determined using HEC-RAS. Cross sections were obtained from field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Roughness coefficients were determined based on field inspections and aerial photography.

McNeely Lake Dam

The portion of Pennsylvania Run approximately 800' south of Mount Washington Road was studied using approximate methods. The floodplain was calculated using Manning's Formula. Cross sections were determined from maps and field reconnaissance, but were not field surveyed. Bridge and culvert data were only gathered if it was expected to cause significant backwater. Bridge and culvert data were hand measured and no survey was completed. Slopes used for Manning's Formula were based on topographic mapping.

Floodplain limits for the 1 percent annual chance flood were calculated for existing conditions and future, fully developed conditions. Existing conditions are labeled as the FEMA floodplain and future conditions are labeled as the Local Regulatory Floodplain. Map PR-5 shows the limits of each of these floodplains.

11.3 Action Plan

11.3.1 Watershed Requirements

New development in the Pennsylvania Run Watershed is required to detain proposed stormwater discharge rates to predeveloped conditions for the 2, 10, 25, and 100 year storm events through the MSD Design Manual. The NRCS Type II, 24 hour rainfall distribution is required to be used for the modeling. In areas where adequate downstream facilities exist, especially in the lower portion of a watershed where peak flows from the new development will occur substantially prior to the overall peak of the stream, on a case-by-case basis, MSD allows increased runoff to be compensated using a regional facility fee. This regional facility fee is used to construct regional basins.

Floodplain compensation is required in the Pennsylvania Run Watershed at a ratio of 1:1 for any fill placed in the fully developed local regulatory floodplain as required in the Louisville Metro Floodplain Management Ordinance. The ratio may be increased on a site-specific basis as determined by MSD.

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the KDOW through its Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as High Quality or Impaired Water (Non-construction related impairment). A minimum 50 foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or “soft” approaches. MSD’s Design Manual outlines this requirement in Section 10.3.6.

Green infrastructure and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Green infrastructure must be designed to manage the required water quality volume rain event of 0.6” of runoff and must manage at least 90% of the site’s disturbed area. This volume is to be infiltrated, treated, or otherwise managed for new development projects that disturb at least one acre or are part of a greater common development that disturbs at least one acre.

The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2000 square feet of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance to obtain a Site Disturbance Permit. The Site Disturbance Permit requires an EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year 24 hour SCS Type II storm event.

11.3.2 Proposed Projects

Small scale drainage projects are taken care of through the program Project DRI. Beginning in 2003, MSD initiated an aggressive program to address a wide variety of drainage issues that are brought to us by our customers. This program, dubbed Project DRI (Drainage Response Initiative), assigned experienced project managers, contractors, and inspectors to address drainage problems on a "grade-to-drain" basis. Efforts under this program address problems ranging from structural flooding to alleviating minor standing water problems. Available funds are distributed across the service area based on relative levels of customer concerns and estimated costs of repairs within geographic areas. MSD has completed the first four phases of Project DRI. Currently, Phase 5 is under way. This phase is scheduled for FY17 and FY18. The project list for Phase 5 can be found in the Appendix B of this report.

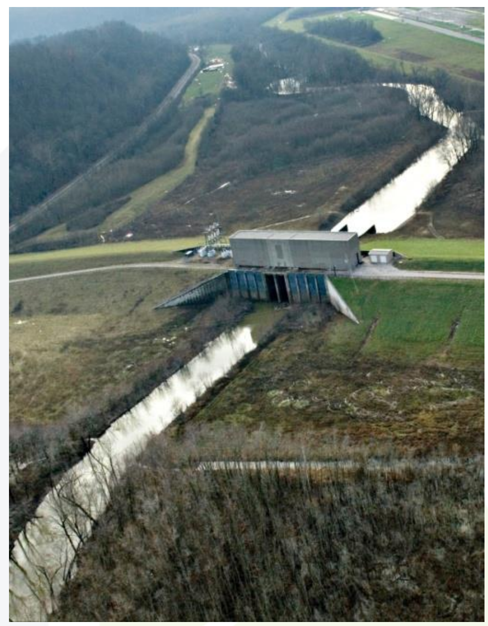
12.0 POND CREEK

12.0 POND CREEK

12.1 Watershed Study Area

12.1.1 General

The 94 square mile Pond Creek Watershed is located in south central and southwest Jefferson County. It is primarily drained by a series of natural and improved channels called Fern Creek, Northern Ditch, Southern Ditch, and Pond Creek. The headwaters of Fern Creek originate in the west side of Jeffersontown and flow southwest to Shepherdsville Road. At this point, the flow turns to the west and the improved channel is called Northern Ditch. This westerly flow continues into the vicinity of the Louisville and Nashville Railroad's Osborn Yard, where it turns southwest and finally outlets into Southern Ditch at the Outer Loop. The flow in Southern Ditch, an improved channel, originates in the Smyrna area and moves west, generally paralleling the Outer Loop. From this point, Southern Ditch flows to the west about three-quarters of a mile, then turns to the southwest and flows about one mile to Manslick Road. Downstream from Manslick Road, the natural channel is called Pond Creek. It flows in a generally southwesterly direction to its eventual outlet into the Salt River. Numerous tributaries enter these four main channels, including Fishpool Creek, Mud Creek, Wilson Creek, Bee Lick Creek, Greasy Ditch, Duck Spring Branch, Salt Block Creek, Slate Run, Bearcamp Run, Crane Run, Brier Run, and Weaver Run. Aerial maps showing the Pond Creek Watershed are included as Maps PCW-1, PCC-1, and PCE-1. Drainage maps showing the 38 subbasins for Pond Creek are included as Maps PCW-2, PCC-2, and PCE-2.



Pond Creek Flood Pumping Station

Communities situated in this watershed include parts of Jeffersontown, Fern Creek, Highview, Newburg, Smyrna, Okolona, Lynnview, Auburndale, Fairdale, Prairie Village, Medora, Orell, and part of Valley Station.

Notable landmarks include the Louisville International Airport, General Electric's Appliance Park, Jefferson Mall, part of Iroquois Park, Komosdale Cement Plant, and much of the Jefferson County Memorial Forest. Roberson Run Park is located along Roberson Run, a tributary of Pond Creek, and provides preserved open space along that tributary. A conservation easement has been created near the Outer Loop by the Trinity High School Foundation to protect existing wetlands in the Pond Creek watershed. Three floodplain compensation/wetlands mitigation banks are also located in this watershed. In addition, a Woodland Protection Area has been established in the Brookhurst Subdivision.

12.1.2 Topography

The Pond Creek Watershed is unique, in that it encompasses parts of all four of Jefferson County's Topographic Regions. Fern Creek is in the Eastern Uplands. Northern and Southern Ditch are in the Central Basin. Pond Creek has eroded a trench through the knobs and drains a portion of the Flood Plain.

In the Eastern Uplands Topographic Region, broad steep-sided valleys and gently rolling plateaus dominate the terrain. Major streams have cut deeply into this terrain and they flow through well-entrenched channels.

In the Central Basin Topographic Region, an extremely flat, low-lying terrain predominates. This was formerly a swampy area. The major streams have been greatly improved and flow in well entrenched, though very low gradient slope, channels.

In the Knobs Topographic Region, steep-sided, round-topped hills dominate the terrain. Stream channels are deeply cut into these hills and commonly have high gradient slopes.

Pond Creek

In the Flood Plain Topographic Region, a very flat, low-lying terrain predominates. Stream channels of low gradient slopes tend to parallel the Ohio River, and terraces of ten to twenty feet in height are common.

Elevations range from about 382, the pool stage of the Ohio River below the McAlpine Lock and Dam, to in excess of 900 feet, along the county's southern boundary.

12.1.3 Geology

The portion of this watershed lying in the Eastern Uplands Topographic Region is predominately underlain by limestones of lower Devonian and middle Silurian age. At the boundary with the Central Basin, an occasional exposure of middle Devonian age shale is observed. Only in a few stream beds are middle Silurian age shales exposed. The general dip of theses rock beds, or strata, is toward the west at about one and one half feet in one hundred feet. Near the boundary of the Central Basin, the general dip approached two and one half feet in one hundred feet.

The portion of this watershed lying in the Central Basin Topographic Region is predominately underlain by alluvial lacustrine deposits of Quaternary age. These deposits vary in thickness from zero to fifty feet, and are comprised of complex layers of silts, sands, clays, and gravels.

The portion of this watershed lying in the Knobs Topographic Region is predominately underlain by a hilly complex of Mississippian age siltstones and shales, whose lower flanks are covered by zero to thirty feet of alluvial deposits of Quaternary age loess, eolian sand, and terrace materials. The general dip of the rock beds, or strata, in this hilly area is toward the west at a little less than one foot in one hundred feet. Karst activity is not associated with this region. It should be noted, however, that Mississippian shales become plastic when wetted and even moderate slopes are prone to slump and/or slide.

Vulcan Regional Basin

The portion of this watershed lying in the Flood Plain Topographic Region is predominately underlain by glacial outwash deposits of

Quaternary age. These deposits vary in thickness from several feet to well over one hundred feet, and are comprised of complex layers of silts, sands, clays, and gravels. This region is a well documented aquifer and groundwater is readily available.

Melco Basin Pump Station

12.1.4 Soils

Section 2.2.2 of the WMP explains in detail the five soils groups used to classify soils in this study. The soil composition in the Pond Creek Watershed is mainly soil groups B and C and the unclassified soil group. The soils in the Pond Creek Watershed are shown on Maps PCW-3, PCC-3, and PCE-3.

12.1.5 Land Use

The majority of the land use in the Pond Creek Watershed is residential. The existing land use in the Pond Creek Watershed is shown on Maps PCW-4, PCC-4, and PCE-4.

12.1.6 Watershed Improvements

Watershed improvements in Pond Creek include:

- The first regional basin built by MSD was the Roberson Run Basin. It was built in the early 1990s and is relatively small. Although the impacts on flooding are minimal by today's standards, the basin is a multiuse facility with the incorporation of walking paths around the basin that link adjoining residential areas.
- In 1998, MSD, Jefferson County Government, and the USACE began the construction phase of the Pond Creek Flood Prevention Project. The project utilizes large basins for flood storage and channel improvements to remove an estimated 2,000 buildings from the danger of most floods. In addition, the project incorporated Greenways principles that provide pedestrian access to Pond Creek. Walking and biking paths help connect neighborhoods and introduce area residents to ever improving water quality along Pond Creek. A description of each phase of the project is listed below.

Northern Ditch widening west of Preston Hwy

  - Phase I: The Okolona Wetlands Restoration Site is an environmental restoration of 15 acres of wetlands located in a sludge lagoon near the Okolona Wastewater Treatment Plant. The restoration process included draining the area of sludge and replanting native vegetation.
  - Phase II:_The Vulcan Detention Basin included constructing a dam on Fishpool Creek, installing a low-flow pipe, and constructing an overflow structure into the basin. The basin was designed to fill during a 24-hour storm event and drain over a period of approximately eight days. This basin became operational in September 1999. The capacity of the detention basin is 450 acre-

feet. A diversion dam was constructed across the creek and an 18'' pipe was placed through the dam to maintain base flows.

- Phase III: The Melco Detention Basin behind the Ford Motor Plant was completed in 2001. It expanded an existing 15-acre borrow pit to 80 acres, which increased the storage capacity to 1,500 acre-feet.

- Phase IV: This phase included channel modifications to Northern Ditch between Preston Highway and the Melco Basin inlet. It also included widening one bank of Northern Ditch for a distance of almost 1.5 miles, replacing culverts and installing riffle structures and pools in the stream to improve aquatic habitat.

- Phase V: Channel modifications to Pond Creek and the placement of a multipurpose recreation trail alongside the creek have been completed. This phase included widening one bank of Pond Creek for a distance of 2.4 miles, replacing culverts and installing riffle structures and pools in the stream to improve aquatic habitat.

- MSD has also worked with a private company to create a floodplain and runoff compensation bank located in the Pond Creek Watershed. This compensation bank is funded though private development. It consists of three basins. Ponds 1 and 2 have been constructed. Pond 1 is located near I-65 and the Outer Loop and is 80 ac-ft. Pond 2 is located near Wilson Creek and the Gene Snyder Freeway and is 26.5 ac-ft. Pond 3 is currently under construction. This pond is located at National Turnpike and Southern Ditch and will be 234 ac-ft. These ponds also function as wetland mitigation banks.

- MSD completed a regional flood control basin on Northern Ditch near its confluence with Southern Ditch called the Aluma Basin. The basin construction was completed in 2012.

12.1.7 Local Basins

There are currently 180 local basins located in the Pond Creek watershed. These basins are shown on Maps PCW-2, PCC-2, and PCE-2.

12.2 Modeling

New hydrologic analyses was completed for the Pond Creek Watershed in the 2006 FIS, including Blue Spring Ditch, Fishpool Creek, Northern Ditch, Pond Creek, Southern Ditch, Wilson Creek, and Wet Woods Creek. HEC-HMS software was used to develop the models and determine the 10, 2, 1, and 0.2 percent annual chance events using the standard SCS Type II 24 hour design storm distribution. Hydrologic parameters, such as curve number, time of concentration, and soil groups, were developed using information from LOJIC. An unsteady state HEC-RAS model was created to determine water surface elevations. Cross sections were obtained from field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Roughness coefficients were determined based on field inspections and aerial photography.

Renaissance Basin, a side saddle basin along Southern Ditch that was constructed by private development

Ineffective flow areas were included in areas where restrictive fence lines and large or dense development exists. Storage areas considered in the unsteady state hydraulic model include Melco, Vulcan, the upper portion of Wet Woods Creek (left overbank area of Northern Ditch upstream of I-65), the lower portion of Wet Woods Creek (right overbank area downstream of I-65), Blue Spring Ditch (left overbank area near Jefferson Boulevard), Bee Lick Creek (upstream of I-265), Salt Block Creek (south of I-265 and west of West Manslick Road) and a mobile home park on Driftwood Drive. Calibration of the models was done using flow and rainfall gauges located within the watershed and the regression equations for Jefferson County. High water marks were also used to help calibrate the models.

Hydrologic analyses for Bee Lick Creek, Cooper Chapel Branch, the lower portion of Fern Creek, Filson Fork, Greasy Ditch, the lower portion of Little Bee Lick Creek, Manslick Branch, Mud Creek, the lower portion of Roberson Run, Slate Run, and Wet Woods Creek were completed using HEC-1. Hydrologic parameters such as curve number, drainage area, and time of concentration were used to determine flows for each subbasin. Using the discharge values from the HEC-1 models, HEC -2 was used to create stream profiles for each stream. Storage routings were added as needed and numerous trials were required in order to determine final discharge values. Cross sections and bridge elevations and geometry were field surveyed. Models were calibrated using high water marks from the 1964 flood and the log-Pearson Type III methodology.

Bearcamp Run, Brier Creek, Crane Run, Downs Branch, the upper portion of Fern Creek, the upper portion of Little Bee Lick Creek, Picadilly Run, Porter Branch, Rangeland Run, Reardon Hollow Ditch, the upper portion of Roberson Run, Roney Ditch, Schuff Branch, Walnut Hill Branch, and Watterson Trail Creek were studied using approximate methods. The floodplains were calculated using Manning's Formula. Cross sections were determined from maps and field reconnaissance, but were not field surveyed. Bridge and culvert data were only gathered if it was expected to cause significant backwater. Bridge and culvert data were hand measured and no survey was completed. Slopes used for Manning's Formula were based on topographic mapping.

Wetlands along Wet Woods Creek constructed by Waste Management

Along the floodwall, areas that are inundated by backwater during pumping operations were purchased by the County and/or put into flowage easements to protect the areas from future development.

Floodplain limits for the 1 percent annual chance flood were calculated for existing conditions and future, fully developed conditions. Existing conditions are labeled as the FEMA floodplain and future conditions are labeled as the Local Regulatory Floodplain. Maps PCW-5, PCC-5, and PCE-5 show the limits of each of these floodplains.

A RiskMAP project is currently underway to update existing flood models throughout the county. Preliminary maps are expected to be public in 2017 and adopted in late 2018. These maps modernize many of flood studies and create limited detail flood models for most A zones in the county. Streams within this watershed will be updated with this effort.

12.3 Action Plan

12.3.1 Watershed Requirements

The Pond Creek Watershed has significant flooding and drainage problems. A large portion of the watershed is very flat and not well drained. Due to this fact, the increased runoff volumes are generally more critical than the rate of discharge. Increases in runoff volume due to development in the Pond Creek Watershed must be mitigated at a ratio of 1.5:1 as required in the MSD Design Manual. The ratio may be increased on a site-specific basis as determined by MSD. Per the MSD Design Manual, all detention basins are required to limit the post-developed 2, 10, 25, and 100 year flows to the pre-developed peak discharge rates through the MSD Design Manual. The NRCS Type II, 24 hour rainfall distribution is required to be used for the modeling. In areas where adequate downstream facilities exist, especially in the lower portion of a watershed where peak flows from the new development will occur substantially prior to the overall peak of the stream, on a case-by-case basis, MSD allows increased runoff to be compensated using a regional facility fee. This regional facility fee is used to construct regional basins.

Floodplain compensation is also required in the Pond Creek watershed at a ratio 1.5:1 for any fill placed in the fully developed local regulatory floodplain as required in the Design Manual. The ratio may be increased on a site-specific basis as determined by MSD.

As stated in the Louisville Metro Floodplain Management Ordinance, a natural 25 foot buffer on each side of the stream bank must be preserved on all solid blueline streams as defined by the USGS 7.5 minute topographic maps. In addition, solid blueline streams may not be relocated, channelized, or stripped, with the exception of public projects such as road crossings, utilities, and detention basins that have no other viable alternative.

A minimum buffer is also required by the KDOW through its Kentucky Pollutant Discharge Elimination System (KPDES) General Permit For Stormwater Discharges Associated With Construction Activities (KYR10). A minimum 25 foot buffer is required for discharges to waters categorized as High Quality or Impaired Water (Non-construction related impairment). A minimum 50 foot buffer is required for discharges to waters categorized as Impaired Waters (Sediment impaired, but no TMDL).

In order to promote enhanced water quality and aquatic habitat, natural channel design techniques are the preferred method for the design of streams. Channel improvement projects in blueline streams are required to use natural or “soft” approaches. MSD’s Design Manual outlines this requirement in Section 10.3.6.

Green infrastructure and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Green infrastructure must be designed to manage the required water quality volume rain event of 0.6” of runoff and must manage at least 90% of the site’s disturbed area. This volume is to be infiltrated, treated, or otherwise managed for new development projects that disturb at least one acre or are part of a greater common development that disturbs at least one acre.

The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2000 square feet of disturbance and developments within 50 feet of a sensitive feature as defined by the ordinance to obtain a Site Disturbance Permit. The Site Disturbance Permit requires an EPSC plan to be developed which achieves 80% design removal of total suspended solids that are generated by the site. The design storm to be used is the 10-year 24 hour SCS Type II storm event.

12.3.2 Proposed Projects

Proposed projects in this watershed include:

- Two new regional detention basins are being considered in the Pond Creek watershed, the Laclede and Tin Dor Way Regional Detention Basins. These basins would create additional storage volume for the Pond Creek Watershed during major flooding events. Studies to determine to effectiveness of these basins are proposed to be completed in the next five years.

- Small scale drainage projects are taken care of through the program Project DRI. Beginning in 2003, MSD initiated an aggressive program to address a wide variety of drainage issues that are brought to us by our customers. This program, dubbed Project DRI (Drainage Response Initiative), assigned experienced project managers, contractors, and inspectors to address drainage problems on a "grade-to-drain" basis. Efforts under this program address problems ranging from structural flooding to alleviating minor standing water problems. Available funds are distributed across the service area based on relative levels of customer concerns and estimated costs of repairs within geographic areas. MSD has completed the first four phases of Project DRI. Currently, Phase 5 is under way. This phase is scheduled for FY17 and FY18. The project list for Phase 5 can be found in the Appendix B of this report.

- The Critical Repair and Reinvestment Plan proposes three new projects in the Pond Creek watershed, the Whispering Hills Early Action Project, the Auburndale Early Action Project, and the Newburg Early Action Project. FY18-FY22 projects proposed in the plan are shown in Appendix C.

Appendix A

IOAP Combined Sewer Projects

IOAP Combined Sewer Projects

Project Name	Watershed	Project Description	Project Start
I-64 and Grinstead Drive Storage Basin	Middle Fork Beargrass Creek	This project is to provide a 15.33 MG off-line storage facility consisting of a covered concrete basin for CSO125, 126, 127 & 166 to reduce overflows to 4 overflows per typical year. The facility will be a gravity in-pump out operation.	FY17
Clifton Heights Storage Basin	Muddy Fork Beargrass Creek	This project includes a 4.28 MG storage basin and conveyance from each CSO to achieve 4 overflows in a typical year.	FY17
CSO 190 Green Infrastructure Project	Ohio River/City	Green Infrastructure solutions for CSO190.	FY17
Southwestern Parkway Storage Basin	Ohio River/City	IOAP project, 20 MG CSO storage basin, with a level of control of 8 overflows per Typical Year and no net increase in AAOV.	FY17
Portland Storage Basin	Ohio River/City	6.7 MG CSO storage basin, with a level of control of 8 overflows per Typical Year.	FY17
Bells Lane Wet Weather Treatment Facility	Ohio River/City	CSO wet weather treatment facility, reduces overflow events to 8 times per year.	FY17
Morris Forman WQTC Headworks	Ohio River/City	Flow control improvements at the Main Diversion Structure and rehabilitation of Morris Forman WQTC Headworks in order to increase maximum treatment capacity to 330 MGD.	FY17
Ohio River Tunnel	Ohio River/City	31.8 MG tunnel. Tunnel capacity will allow a level of control of zero overflows per Typical Year for the nine CSOs previously associated with Lexington and Payne.	Conceptual design in FY17
Central Relief Drain CSO In-line Storage, Green Infrastructure & Distributed Storage	Ohio River/City	Modify weir elevations to maximize in-line storage to the extent practicable. Focused modeling and monitoring will be utilized to determine if the level of control is met. Green infrastructure and distributed storage within the CSO drainage areas will be constructed to reach the 8 overflow in a typical year.	FY17
Logan Street and Breckenridge Street CSO Basin	South Fork Beargrass Creek	Below ground CSO storage basin with open space above the basin structure.	FY17
Nightingale Pump Station Replacement & Offline Storage	South Fork Beargrass Creek	Increased basin size from 2.7 MG to 7.7 MG with a gravity in - pump out control strategy.	FY17

Appendix B

Project DRI Phase 5
Project List

Proposed DRI 5 Project List

BUDGET ID	PROJECT NAME
C16089	2534 Veronica Drive DIP
C16091	6705 Elmwood Ave DIP
C16092	6462 Ladd Ave DIP
C16097	5103 Red Oak Lane DIP
C16099	3507 Susanna Drive DIP
C16105	1400 Bernham Lane DIP
C16106	1221 W Main Street DIP
C16107	617 S 43rd Street
C16108	3235 Larkwood Ave DIP
C16113	214 Bramton Road DIP
C16115	1606 Girard Ave DIP
C16117	317 Bramton Road DIP
C16127	2926 Riedling Drive DIP
C16133	3908 Glen Oak Drive DIP
C16136	1608 Whippoorwill Road DIP
C16137	Greenhurst Drive DIP
C16139	12203 Taylorsville Road DIP
C16141	8226 St Andrews Church Road DIP
C16145	8309 Grandel Forest Way DIP
C16147	6806 Hill Peak Court
C16149	6816 Manslick Road DIP
C16153	953 Sissone Drive DIP
C16156	10200 Mitchell Hill Road DIP
C16162	6626 Bethany Lane DIP
C16163	13400 Blakely Lane DIP
C16167	9111 Aristides Drive DIP
C16170	1410 Rhonda Way DIP
C16171	4338 Sadie Lane DIP
C16174	6624 Deep Cove Court DIP
C16178	7300 Shadwell Lane DIP
C16183	11210 Vista Greens Drive DIP
C16187	10701 High grove Place DIP
C16190	2304 Janlyn Road DIP
C16197	326 Tucker Station Road DIP
C16198	Steep Ridge Court DIP
C16200	5906 Chenoweth Run Road DIP
C16202	Summer Glen Way DIP

BUDGET ID	PROJECT NAME
C16204	6402 S 3rd Street DIP
C16207	6405 Kenjoy Drive DIP
C16210	7209 Gerber Ave DIP
C16214	7708 Hall Farm Drive DIP
C16216	7008 Fontendleau Way DIP
C16218	8313 Millington Court DIP
C16221	8004 Red Bud Hill Drive DIP
C16222	10200 Morrison Road DIP
C16228	3500 Forman Lane DIP
C16231	4016 Pinecroft Drive DIP
C16232	9703 Saturn Drive DIP
C16233	7005 Shepherdsville Road DIP
C16235	3615 Susan Lane DIP
C16240	9903 Silverwood Lane DIP
C16241	4211 Tamm Court DIP
C16242	7309 Paiute Road DIP
C16245	Joe Don Court DIP
C16248	4008 Blossomwood Drive DIP
C16252	3911 SpringHill Road DIP
C16253	6005 Alvarado Way DIP
C16254	3506 Deibel Way DIP
C16093	3029 Bridwell Drive DIP
C16094	4520 Winnrose Way DIP
C16095	6600 Maravian Drive DIP
C16098	4928 Kilgore Court DIP
C16101	Bonita Court DIP
C16102	212 Spring Garden Drive DIP
C16103	2123 Ratcliffe Ave DIP
C16110	1600 Thornberry Ave DIP
C16116	7004 Norbourne Ave DIP
C16118	Alicent Road DIP
C16126	4026 Leland Road DIP
C16129	50 Pauline Road DIP
C16131	3004 Poplar Level Road DIP
C16134	257 Eldorado Ave DIP
C16138	Bristol Oaks Court DIP
C16148	1918 Farrington Drive DIP
C16150	6115 Julie Kays Way DIP
C16151	1724 Kurz Way DIP

BUDGET ID	PROJECT NAME
C16154	1101 Tallow Lane DIP
C16157	10721 Charlene Drive DIP
C16158	7613 Yorktown Road DIP
C16159	1002 Andle Court DIP
C16165	13512 Kinross Blvd DIP
C16166	11517 Deering Road DIP
C16168	13316 Girvan Ave DIP
C16172	1559 Walter Ave DIP
C16173	1400 Clara Ave DIP
C16179	107 Gunpowder Court DIP
C16180	Harrods View Circle DIP
C16182	10214 Meadow Glen Way Phase 2
C16188	8301 Doncaster Way DIP
C16189	2208 Cherian Drive DIP
C16193	1908 Myddleton Drive DIP
C16196	10611 Kinross Court DIP
C16199	4606 Dove Lake Court DIP
C16208	4802 Kingfisher Way DIP
C16209	5350 Rollingwood Trail DIP
C16211	301 E Esplanade Ave DIP
C16217	8011 Watterson Trail DIP
C16219	9016 Sagebrush Court DIP
C16223	5305 Haventree Place DIP
C16224	6801 Cliffside Court DIP
C16225	5312 Chasewood Place DIP
C16230	1583 Raydale Drive DIP
C16234	8003 Linda Road DIP
C16236	10314 Blue Lick Road DIP
C16237	4003 Sirate Lane DIP
C16244	9009 Annlou Drive DIP
C16246	4707 Flushing Way DIP
C16247	7405 Ridan Way DIP
C16250	4016 Norbourne Blvd DIP
C16251	3601 Rosemont Court DIP
C16255	2855 Nepperhan Drive DIP

Appendix C
MSD Critical Repair and Reinvestment Plan
Drainage Project List

Proposed FY18-FY22 Critical Repair and Reinvestment Plan Projects

Drainage	
X_0105 RICHLAWN EARLY ACTION PROJECT	$ 350,000.00
X_0121 VIA09 6TH & HILL ST VIADUCT FLOOD RELIEF	$ 796,800.00
X_0145 VIA16 3RD & EASTERN PKY VIADUCT FLOOD RELIEF	$ 2,982,400.00
X_0146 VIA17 4TH STREET & INDUSTRY RD VIADUCT FLOOD RELIEF	$ 5,882,400.00
X_0147 VIA32 3RD & WINKLER VIADUCT FLOOD RELIEF	$ 5,582,400.00
DRI (DRAINAGE RESPONSE INITIATIVE)	$ 16,200,000.00
Stormwater Quality (MS4)	
H14070 FY18 USGS STREAM MONITORING	$ 225,000.00
H14075 FY18 ENV'L DATA COLLECTION MS4 & IOAP	$ 1,000,000.00
H14080 FY18 WATER QUALITY MODELING MS4 &KPC	$ 37,500.00
H14100 FY18 MS4 PROGRAM	$ 1,000,000.00
H16038 FY19 MS4 PROGRAM	$ 1,000,000.00
H16043 FY19 USGS STREAM MONITORING	$ 225,000.00
H16044 FY19 WATER QUALITY MODELING - NONPOINT &	$ 37,500.00
H16049 FY20 ENV'L DATA COLLECTION-MS4 &IOAP	$ 500,000.00
H16055 FY20 MS4 PROGRAM	$ 1,000,000.00
H16059 FY20 USGS STREAM MONITORING	$ 225,000.00
H16061 FY20 WATER QUALITY MODELING - NONPOINT &	$ 37,500.00
H17016 FY21 MS4 PROGRAM	$ 1,000,000.00
H17018 FY21 ENV'L DATA COLLECTION-MS4 &IOAP	$ 500,000.00
H17023 FY21 USGS STREAM MONITORING	$ 225,000.00
X_0067 MS4 PROGRAM	$ 2,000,000.00
X_0071 USGS STREAM MONITORING	$ 180,000.00
X_0072 WTR QUALITY MODEL'G-NONPOINT & POINT FOR MS4 & KPDES DISCHARGES	$ 250,000.00
X_0106 GERALD COURT BASIN RETROFIT	$ 13,600.00
X_0107 DOWNING WAY BASIN RETROFIT	$ 24,000.00
X_0108 WOODLAWN PARK BASIN RETROFIT	$ 29,000.00
X_0109 HIKES LANE BASIN RETROFIT	$ 42,000.00
X_0110 RICHLAND AVE BASIN RETROFIT	$ 43,000.00
X_0111 BRECKENRIDGE LANE BASIN RETROFIT	$ 45,000.00
X_0112 FOUNTAIN SQUARE BASIN RETROFIT	$ 46,000.00
X_0113 OLD SHEPHERDSVILLE RD BASIN RETROFIT	$ 51,200.00

Safe, clean waterways

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