

2023 Louisville and Jefferson County Floodplain Management Plan



Table of Contents

1.0	INTRODUCTION.....	1
1.1	Background	1
1.2	Topography	3
1.3	Land Use.....	5
1.4	Development, Redevelopment and Population Trends	5
1.5	Other Hazards	6
2.0	PLANNING PROCESS	7
2.1	Planning Approach	7
2.2	Public Outreach.....	7
2.3	Coordination with Agencies	8
2.4	Review of Existing Studies.....	8
3.0	FLOOD RISK ASSESSMENT	15
3.1	Precipitation in Louisville Metro	16
3.2	Flood Risks.....	17
3.3	Flood Studies.....	19
3.4	Historical Flooding	22
3.5	Repetitive Loss Areas	26
3.6	Future Flood Risk and Climate Assessment	27
3.7	Flood Impacts.....	28
3.8	Life Safety and Flood Warning Systems	34
3.10	Public Health	34
3.11	Critical Facilities and Infrastructure	34
3.12	Economy and Major Employers	35
3.13	Buildings Impacted by Flooding	37
3.13	Natural and Beneficial Areas.....	38
3.14	Risk by Watershed	41
4.0	GOALS AND OBJECTIVES.....	64
4.1	Goals	64
5.0	PREVENTATIVE MEASURES.....	65

5.1	Preventative Activities	65
5.2	Property Protection Activities	66
5.3	Natural Resource Protection Activities	68
5.4	Emergency Services Measures	70
5.5	Structural Projects.....	71
5.6	Public Information Activities.....	73
5.7	Action Plan	75
6.0	Adoption and Implementation	77

LIST OF APPENDICES

Appendix A	Outreach Project Schedule
Appendix B	Action Plan

1.0 INTRODUCTION

1.1 Background

The Floodplain Management Plan includes the area defined as the Louisville and Jefferson County Metro Government (Louisville Metro), Kentucky. Louisville Metro is an approximately 375 square mile political subdivision within the much larger 203,900 square mile Ohio River Basin, which embraces parts of fourteen states. This 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 Louisville Metro.

Flooding is the most significant natural hazard in Kentucky. Major flooding occurs in the state almost every year, and it is not unusual for multiple floods to occur in the Louisville Metro area in a single year. Flooding is Kentucky's most costly natural disaster. The economic, social, and physical damage resulting from floods can be severe.

Floods are natural events for rivers and streams, resulting in an overflow of water onto dry land. The floodwaters can be slow- or fast-rising. Thunderstorms, snow melt, tropical systems, or decayed hurricanes can all cause waterways to overflow banks and inundate the surrounding areas.

The Floodplain Management Plan was created using the Community Rating System's 10-Step Planning Process. The plan is an extension of the Louisville Metro 2023 Hazard Mitigation Plan. The purpose of the Hazard Mitigation Plan is to help to reduce or eliminate potential losses from future disasters, such as flooding, tornadoes, and earthquakes. Hazard mitigation planning helps to establish and maintain a process that leads to the implementation of hazard mitigation actions. The Floodplain Management Plan specifically focuses on hazards related to flooding.

The Louisville Metro 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.

Louisville Metro is made up of eleven majors watersheds, which are named after the largest stream located within the watershed. A watershed map for Louisville Metro is shown as Figure 1.

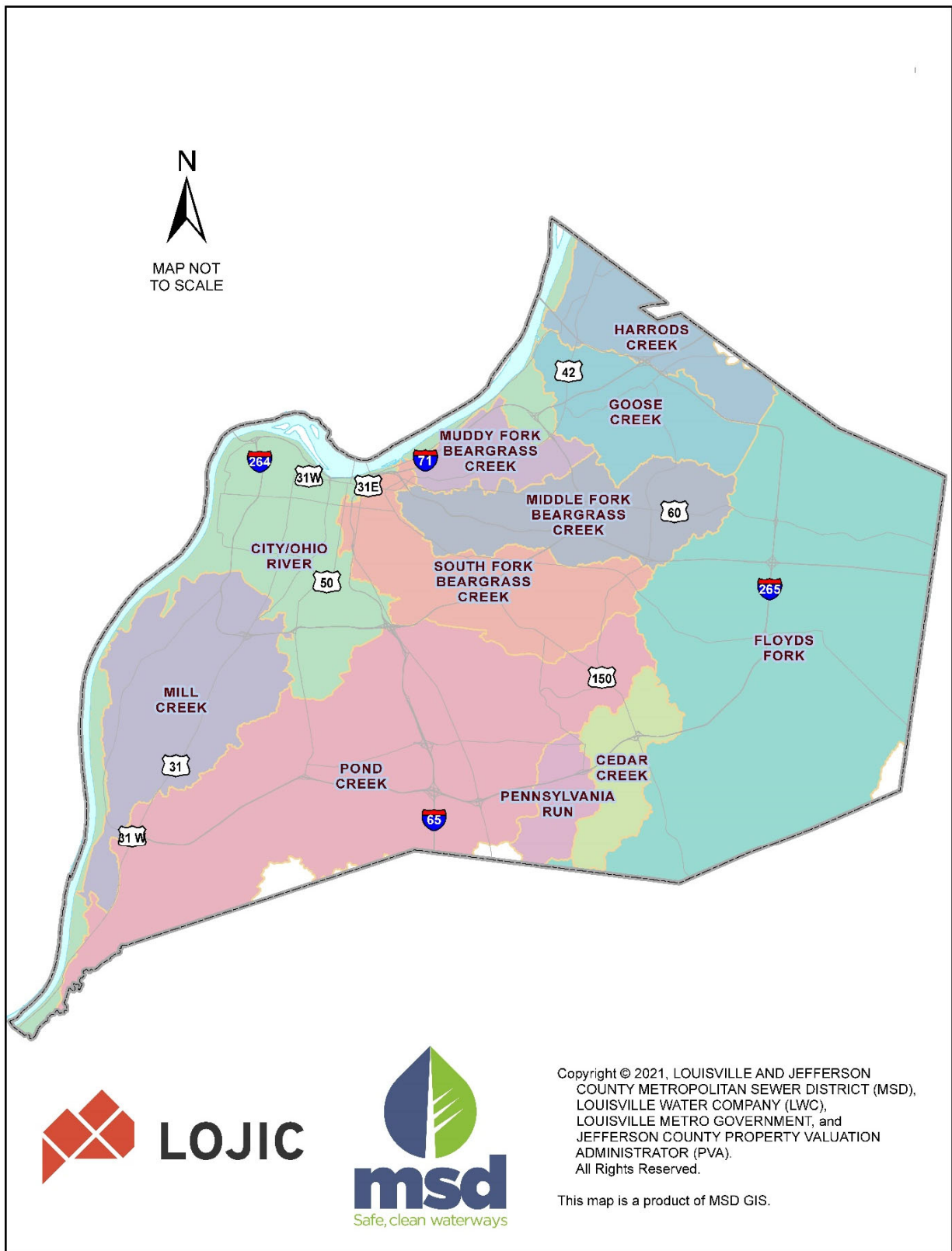


Figure 1. Watershed Map

1.2 Topography

Four distinct topographic regions exist in Jefferson County: Floodplain, Knobs, Central Basin, and Eastern Uplands. The topographic regions are shown in Figure 2.

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 feet to 440 feet, with occasional terraces to 460 feet. The area is best characterized as flat to gently rolling, 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 the 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, likely 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.

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 feet and 500 feet. Various improvements to the Northern and Southern Ditch systems have helped alleviate the lack of natural drainage in the region.

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

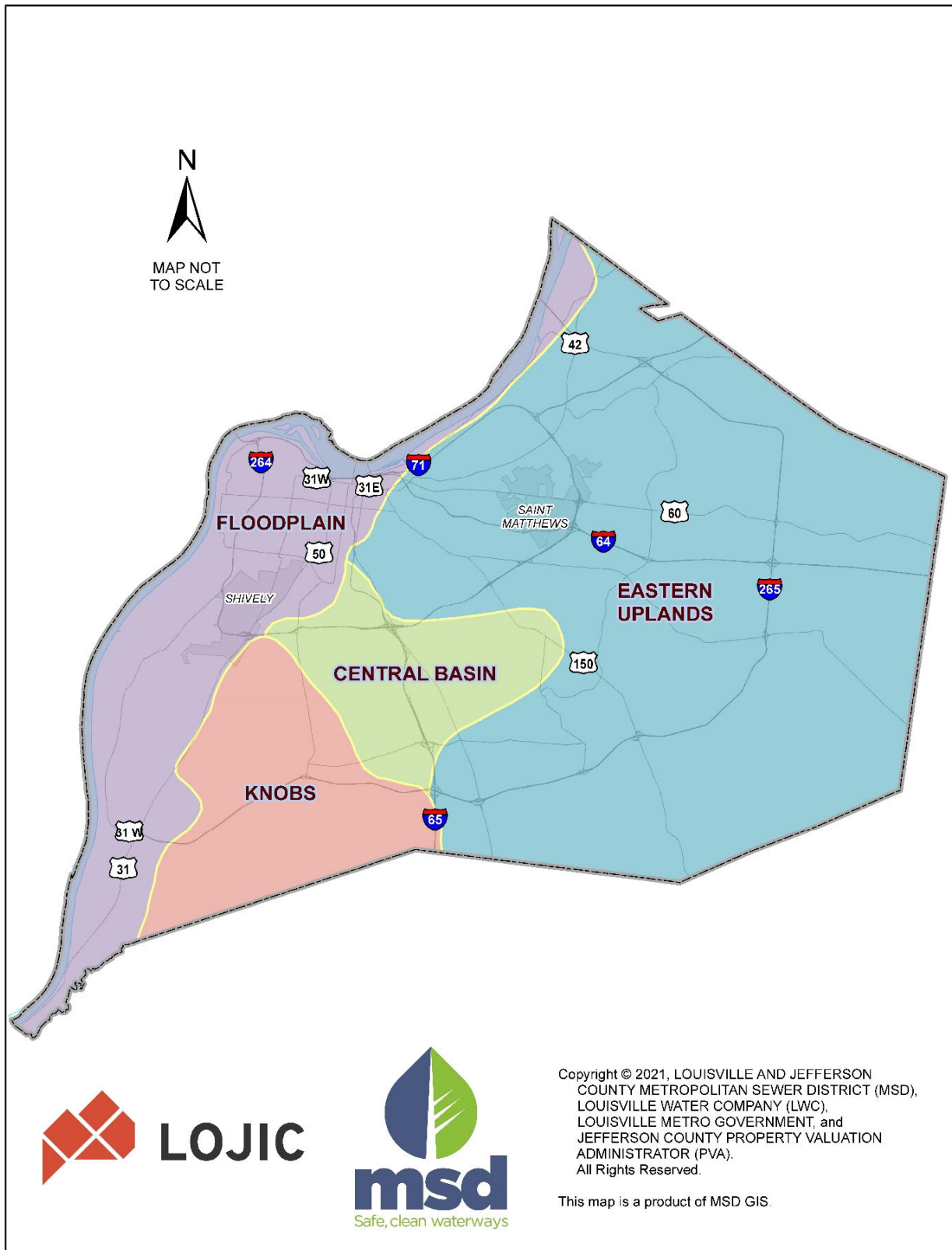


Figure 2. Topographic Regions

1.3 Land Use

Land use in the Louisville Metro area is typical of most American cities and counties. Commercial uses (approximately 8%) are concentrated in downtown areas, in a few suburban nodes, and along primary transportation corridors. Single-family homes are the largest category of land use at just over 33%, while multi-family space occupies approximately 3%. Industrial uses (approximately 7%) are primarily concentrated in Louisville Metro's western and southwestern parts, while the eastern area is home to a majority of farmland (12%). Figure 3 represents county's current land use map and the percentage breakdown of land uses by type.

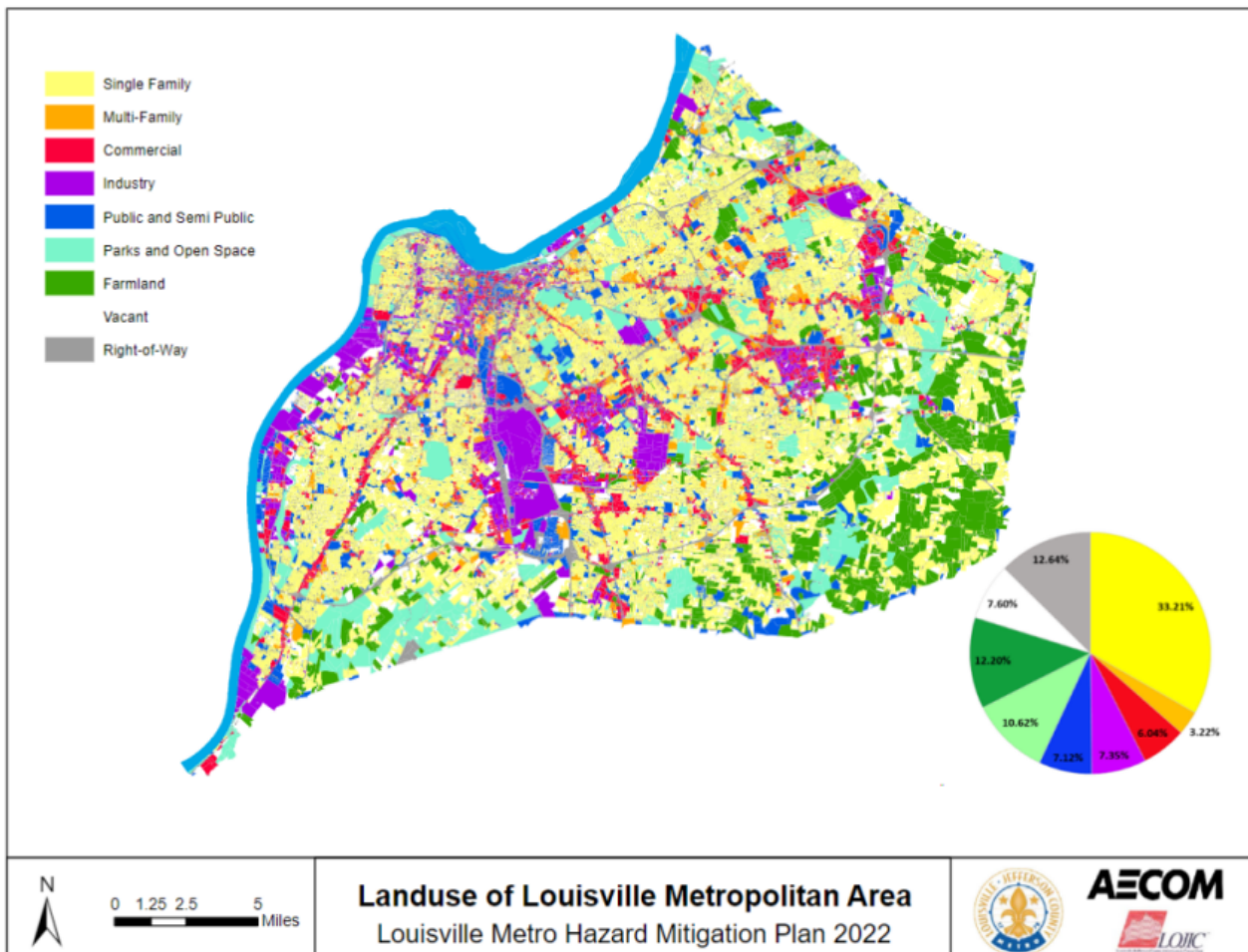


Figure 3. Louisville Metro Land Use Data (Source: Louisville Metro 2023 Hazard Mitigation Plan)

1.4 Development, Redevelopment and Population Trends

Louisville Metro's population has increased by roughly 5.6% between 2010 and 2020 according to the U.S. Census, going from 741,096 to 782,969. The current population is about 51.7% female and almost 16.7% are 65 or older. Approximately 22.4% of the population identifies as African American, 3.0% as Asian, and 5.9% as Hispanic. To better anticipate and plan for future demands on land, and in turn prepare for mitigation activities, decision makers must understand whether or not growth in population,

housing units, and/or jobs is expected over the planning horizon. Utilizing the expertise of the Kentucky State Data Center and the University of Louisville's Urban Studies Institute, "Plan 2040 – A Comprehensive Plan for Louisville Metro" dated 2019, provided demographic and economic projections for Louisville Metro and its region through 2040. This report indicates that the population of Louisville Metro and its region are expected to grow. Between 2010 and 2040, the population of the 12-county Louisville Metropolitan Statistical Area is projected to increase to 1,551,542. Jefferson County is forecasted to experience the largest share of the predicted growth of the Metropolitan Statistical Area, accounting for 42% of projected population growth. The population of Jefferson County alone is projected to increase to 872,231. This projected growth is consistent with a steady increase in Jefferson County's population since 1990, after two decades of population decline between 1970 and 1990.

According to Plan 2040, by the year 2040, the number of households will increase by 31% in the Louisville Metropolitan Statistical Area and 21% in Jefferson County. The largest amount of growth is anticipated to be in the eastern and southern portions of the county, with the area labeled as East Metro having the largest anticipated growth. The Northwest Core area is anticipated to have the least growth. The Northwest Core area is currently densely populated and has a very high level of impervious areas.

As development continues, it will be important to follow existing ordinances to protect natural resources and waterways. Requirements for post-construction water quality treatment, erosion prevention and sediment control during construction, and stream buffers are each examples of methods to reduce impacts of development and redevelopment on waterways and natural resources. For information about regulatory policies related to stormwater and floodplain management, see Section 5.1 Preventative Activities and the Louisville and Jefferson County Watershed Management Plan.

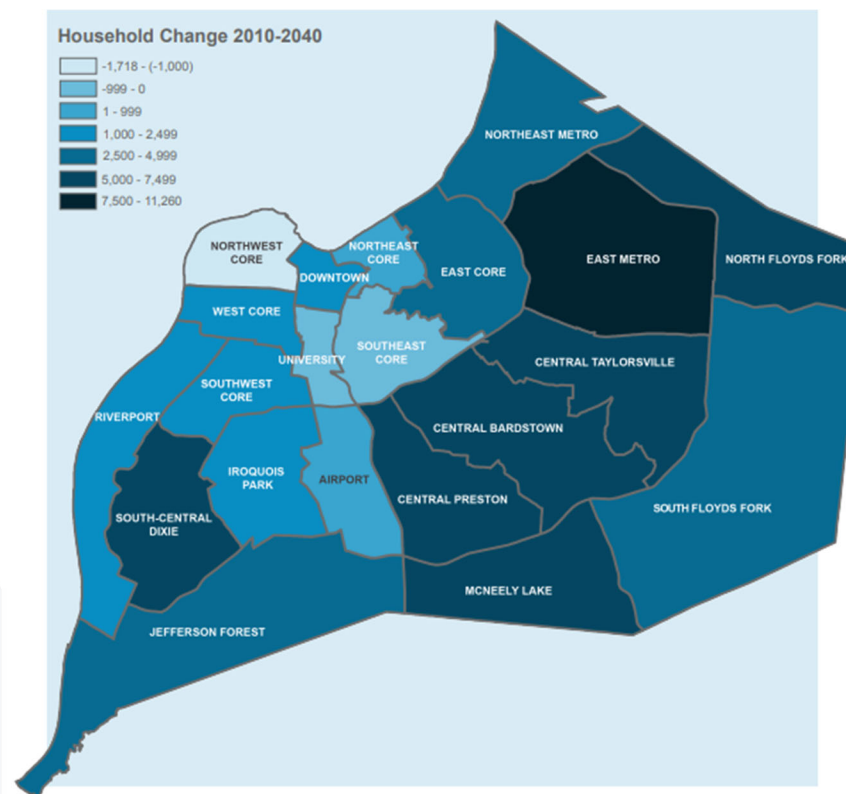


Figure 4. Population Trends for Jefferson County (Source: Plan 2040: Comprehensive Plan for Louisville/Jefferson County)

1.5 Other Hazards

Hazards other than flooding, such as earthquakes, wildfires, or tornados are addressed in the [Louisville Metro 2023 Hazard Mitigation Plan](#). The Hazard Mitigation Plan meets the Disaster Mitigation Act of 2000 (DMA 2000) requirement that state, local, and tribal governments have an adopted Federal Emergency Management Agency (FEMA)-approved hazard mitigation plan to be eligible for federal hazard mitigation and certain federal disaster recovery funding programs. DMA 2000 requires that these plans be updated on a 5-year cycle. Louisville Metro's latest hazard mitigation plan was adopted in 2023.

2.0 PLANNING PROCESS

2.1 Planning Approach

The Floodplain Management Plan was prepared by a planning committee that was comprised of staff from departments that implement or have expertise in the following categories:

Preventive Measures - Gary Muller, Louisville Metro Building/Codes
Property protection – Lori Rafferty, MSD and Jennifer Caummisar-Kern, MSD
Natural resource protection – Jessica Kane, Louisville Metro Parks & Recreation, Natural Areas Division
Emergency Services – Amy Rose, Louisville Metro Emergency Management
Structural flood control projects – Meghan Brown, MSD
Public Information – Sheryl Lauder, MSD and Harold Adams, MSD
Land use and Comprehensive Planning – Yu Liu, Metro Planning and Design Services
Public Works – Jason Brandt, Jeffrey Brown, and Angela Richardson, Louisville Public Works

The public was also invited to participate as planning committee members. These meetings were held in-person, but also had a virtual option for attendance. Meetings were advertised to the public on MSD's website. Public participants of the planning meetings included:

- David Wicks
- J.P. Carstone
- Teena Halbig
- Brad Allgeier
- Bethany Shain
- Joshua Hunn
- Tony Arnold
- Tyler Mahoney
- Becca Trueman
- Patricia Jennings
- Zach Dettlinger
- Tommy Edwards
- Lucas Frazier
- Kasey Frazier
- Tim Corrigan
- Scott Hagan
- Jeff Frank
- Liz McQuillen
- Marilyn Coffey
- Mark Long
- Juva Barber
- Scott Hagan
- Layson Hagan

Five planning meetings were conducted, with the following topics covered:

- January 18, 2023 3-4pm (Assess the Hazard)
- February 1, 2023 3-4pm (Assess the Problem)
- February 15, 2023 3-4pm (Set Goals)
- March 1, 2023 3-4pm (Review Possible Activities)
- March 15, 2023 3-4pm (Draft Action Plan)

2.2 Public Outreach

Public involvement in the planning process was encouraged through the public meetings, MSD's website, and a public survey.

All planning meetings were open to the public and were advertised on MSD's website. Meetings were in person, as well as virtual, to encourage as much participation as possible. Twenty-three people from the public attended the planning meetings.

MSD created a website for the Floodplain Management Plan planning process. This website included information about the Floodplain Management Plan, dates of the public meetings, meeting minutes and presentations, a copy of the draft plan, and a link to the flood survey.

The purpose of the flood survey was to better understand the drainage and flooding problems in the community and people's experience with flooding. The survey requested information regarding the impacts of flooding on people's property and neighborhood. The survey link was sent to all property owners in the floodplain and was also made available on the MSD website.

2.3 Coordination with Agencies

Agencies and organizations that potentially have information related to existing plans, studies, and reports on flooding were contacted to request available information that could impact the Floodplain Management Plan. Agencies and organizations were asked to share any information or data related to flood hazards in Jefferson County that may be helpful in preparing the plan and if the agency had any future projects that may affect flooding, properties in flood-prone areas, or Jefferson County's Floodplain Management Plan. Agencies and organizations contacted include:

- 21st Century Parks
- Center for Mollusk Conservation
- Federal Emergency Management Agency, Region 4
- Future Fund Inc.
- Jefferson County Soil and Water Conservation District
- Kentucky Department of Fish and Wildlife Resources
- Kentucky Division of Water
- Kentucky Natural Lands Trust
- Kentucky State Nature Preserves Commission
- Kentucky Waterways Alliance
- Louisville and Jefferson County Environmental Trust
- Louisville Nature Center
- Louisville Parks and Natural Areas
- The Nature Conservancy
- Salt River Watershed Watch
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service - Kentucky Ecological Services Field Office
- Olmstead Parks,
- Oldham County
- Kentucky Regional Planning & Development Agency
- National Weather Service
- Kentucky Emergency Management
- Louisville Metro Emergency Management Agency
- National Resources Conservation Service, Shelbyville Service Center
- Building Industry Association
- Parks for All

2.4 Review of Existing Studies

The following local plans and programs were examined and integrated into Floodplain Management Plan planning process and 2023 update.

Table 1. Existing Studies

Plan/Program	Type	Owner	Status
Louisville Metro 2023 Hazard Mitigation Plan	Hazard Mitigation Plan	Louisville Metro Emergency Services	Active, adopted January 2023
Watershed Master Plan	Promotion of stormwater drainage management practices	Louisville and Jefferson County Metropolitan Sewer District	Active July 2022
Flood Mapping/Models	Floodplain maps and modeling for streams	Louisville and Jefferson County Metropolitan Sewer District	Active, latest FIRMs adopted February 26, 2021
Floodplain Management Ordinance	Land development regulation	Louisville Metro & Louisville Metropolitan Sewer District	Active, Amended August 31, 2022
Plan 2040	Comprehensive Plan	Louisville Metro, Louisville Forward	Active, Adopted January 1, 2019
Greenhouse Gas Emissions Reduction Plan	Framework for achieving climate action goals that Louisville Metro committed to under the Global Covenant of Mayors for Climate & Energy on Earth Day 2016	Office of Advanced Planning and Sustainability	Active April 2020
Urban Heat Management Study	Study to enhance livability, health, and sustainability in the Louisville Metro region	Office of Advanced Planning and Sustainability	Active April 2016
Tree Canopy Assessment	Provides planning of green infrastructure through tree canopy mapping and analytics	Office of Advanced Planning and Sustainability	Active October 11, 2021
Sustain Louisville	Comprehensive sustainability plan	Office of Advanced Planning and Sustainability	Active 2013
Louisville Metro Climate Hazard Identification	A Climate Change Addendum to the 2016 Louisville Hazard Mitigation Plan	Office of Advanced Planning and Sustainability	Published June 30, 2019
Climate Trends Primer	Assessment and conclusions	Office of Advanced Planning and Sustainability	Published May 1, 2019
Program for Public Information Plan	Plan of outreach efforts made in Louisville Metro related to flood and water quality topics	Louisville and Jefferson County Metropolitan Sewer District	Active 2022 Update
Emergency Preparedness and Operational Resiliency Program	Emergency Operations Plan	Louisville and Jefferson County Metropolitan Sewer District	Active 2022

Table 1. Existing Studies (continued)

Plan/Program	Type	Owner	Status
Erosion Prevention Sediment Control Ordinance	Metro Ordinance	Louisville Metro, Louisville and Jefferson County Metropolitan Sewer District	Active Adopted November 21, 2000
Hazardous Materials Ordinance	Metro Ordinance	Louisville Metro, Louisville and Jefferson County Metropolitan Sewer District	Active Amended July 2, 2007
Move Louisville	Long range strategic multimodal transportation plan	Louisville Metro, Louisville Forward	Active Updated December 1, 2021
Louisville/ Jefferson County Emergency Operation Plan	Emergency Operations Plan	Louisville Metro, Emergency Services	Active Updated 2020
KIPDA Regional Hazard Mitigation Plan	Hazard mitigation plan	KIPDA	Active Update 2021
KIPDA Regional Climate Change Report	Climate change impacts	KIPDA	June/August 2020

The most common themes in these plans and programs are related to hazard mitigation, land use ordinances, floodplains, climate change, and emergency management. Many address Louisville Metro's susceptibility to climate change, including flooding concerns due to increased storm frequency and severity. A description of each plan, policy, or program reviewed is presented below.

2.4.1 Louisville Metro Hazard Mitigation Plan

DMA 2000 requires state, local, and tribal governments to have an adopted, Federal Emergency Management Agency approved hazard mitigation plan to be eligible for federal hazard mitigation and certain federal disaster recovery funding programs. DMA 2000 requires that these plans be updated on a 5-year cycle. Hazard mitigation planning helps to establish and maintain a process that leads to the implementation of hazard mitigation actions. Louisville Metro is intimately familiar with the impacts of hazards on its residents, visitors, infrastructure, and economy. This plan includes a summary of historical flood events, including damage reports. This Floodplain Management Plan is an extension of the Louisville Metro Hazard Mitigation Plan, with a specific focus on the hazards related to flooding.

2.4.2 Metropolitan Sewer District Watershed Master Plan

The Watershed Master Plan (WMP) is intended to compile related reference and data documents. It is a process that MSD can use to guide present and future regional management of stormwater drainage. In doing so, stormwater drainage facilities (e.g., storm sewers, detention basins, and post-construction water quality practices) 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. This plan was used in coordination with the Floodplain Management Plan to identify key actions/mitigation projects that are associated with each of the 11 watersheds identified within the Louisville Metro area. In addition, MSD will likely reference the 2023 Hazard Mitigation Plan in future versions of their Watershed Master Plan, specifically as it deals with mitigation strategies associated with flooding and dam/levee failures.

2.4.3 Flood Mapping/Models

Existing flood mapping and models for Louisville-Jefferson County were reviewed. Flood Insurance Rate Maps for the community were adopted on either December 5, 2006 or February 26, 2021, depending on the location in the county. Modeling has been developed for all streams with a drainage area of 1 square mile or larger. In addition to the FEMA Special Flood Hazard Area, MSD has developed local regulatory floodplains for streams that considered the fully developed condition and floodplains for the combined sewer area. This information was used to help identify flood risks throughout the community.

2.4.4 Louisville Metro Floodplain Management Ordinance

Louisville Metro participates in the National Flood Insurance Program (NFIP) so that community members can purchase flood insurance to protect themselves from flood losses while making the community eligible to receive federal disaster assistance. To participate in the NFIP, the community is required to adopt and enforce a floodplain ordinance. Louisville Metro's Floodplain Management Ordinance, adopted in 2006 and amended in 2022, outlines specific development standards for areas within the floodplain. The purpose of the ordinance is to maximize the wise and safe use of the flood-prone areas of Jefferson County, to ensure that flood levels are not increased, and to minimize public and private losses from flooding. This ordinance was used to supplement the Mitigation Strategies section of this plan.

2.4.5 Louisville Metro Plan 2040

Plan 2040 builds on recent initiatives like Vision Louisville, Sustain Louisville, and Move Louisville to make Louisville a more connected, competitive, creative, and compassionate place to live, work, and create. Plan 2040 provides land use vision to both grow and maintain the beauty and urban fabric of Louisville using five guiding principles—connected, healthy, authentic, sustainable and equitable—to strategically manage all the benefits and challenges that come from adding more people. This plan was used in calculating future growth trends and in determining potential future vulnerabilities.

2.4.6 Prepare Louisville – Building a Climate Resilient City for All

Prepare Louisville was developed to identify a roadmap towards minimizing Louisville's contribution to climate change and increase resilience to extreme weather events and other climate impacts. This plan helps fulfill the commitment made through the Global Covenant of Mayors for Climate and Energy for Louisville to uphold the Paris Agreement by reducing emissions 80 percent by 2050, and take steps to protect community members and businesses from changing climate conditions. This plan was issued in 2020, and according to Advanced Planning representatives, is already slightly out of date with key metrics. This plan will be updated as needed through 2050, or until plan goals are met.

2.4.7 Greenhouse Gas Emissions Reduction Plan

Louisville's Greenhouse Gas Emissions Reduction Plan (ERP) establishes a framework for achieving the climate action goals that Louisville Metro committed to under the Global Covenant of Mayors for Climate and Energy on Earth Day 2016. As the first part of this commitment, Louisville Metro updated its community-wide greenhouse gas (GHG) inventory in 2016 to describe the current sources of GHG emissions generated within its political boundaries. As the second part of the commitment, Louisville Metro joined cities across the globe in setting a target to reduce its community-wide GHG emissions by 80% by 2050. This target was chosen in December 2018, because it aligned with the Paris Agreement and the scientific consensus of what was required to avoid the most damaging effects of climate change at that time. The ERP builds on a history of past work completed by Louisville Metro to understand the level of GHG emissions generated in our community.

2.4.8 Urban Heat Management Study

Commissioned by the Louisville Metro Office of Sustainability, the Urban Heat Management Study was the first comprehensive heat management assessment undertaken by a major U.S. city, and constitutes one component of a broader effort to enhance livability, health, and sustainability in the Louisville Metro region. This report assesses the extent to which Louisville Metro is warming due to urban development and deforestation, estimates the extent to which rising temperatures are impacting public health, and presents a series of neighborhood-based recommendations for moderating the pace of warming. The study provides an overview of the science of the urban heat island phenomenon, its implications for human health, and how urban temperatures can be moderated through urban design and other regional strategies. It also presents a methodology for estimating the potential benefits of specific heat management strategies for lowering temperatures across Louisville, and lowering the risk of heat illness during periods of extreme heat. The report presents the results of a heat management assessment, and includes neighborhood-specific findings on the potential for lessened heat risk through the adoption of cool materials, vegetative, and energy efficiency strategies. Finally, the report presents a set of metro-wide and neighborhood-level recommendations for managing Louisville's rising heat risk.

2.4.9 Tree Canopy Assessment

This study assessed tree canopy for Louisville over the 2012-2019 time period. Tree Canopy Assessment protocols are helping Louisville Metro better understand their green infrastructure through tree canopy mapping and analytics. Tree canopy is defined as the layer of leaves, branches, and stems that provide tree coverage of the ground when viewed from above. When integrated with other data, such as land use or demographic variables, this assessment provides vital information to help Louisville Metro and its residents chart a greener future. This plan was used to supplement the Mitigation Strategies section.

2.4.10 Sustain Louisville

Sustain Louisville is the city's first sustainability plan. Sustain Louisville is a vital element for ensuring an environmentally sound, vibrant, and prosperous future for Louisville and its citizens. The plan was prepared by the Office of Sustainability with the input of city government employees and community stakeholders. Sustain Louisville is intended to be a living document that celebrates Louisville's strengths and identifies goals for future success. As the city makes progress toward meeting Sustain Louisville's goals, or as priorities change, the plan will evolve and remain fluid. Implementation of the initiatives and progress toward achieving Sustain Louisville's goals will be reported to the community on an annual basis. This plan was used to supplement the Mitigation Strategies section for this floodplain management plan.

2.4.11 Louisville Metro Government Office of Sustainability and Office of Advanced Planning Climate Hazard Identification

The Climate Hazard Identification assessment combined the best available information on climate change trends and projections, as well as research, into potential changes in hazards in response to those trends and projections. The assessment covered all 13 of the hazards identified in the 2016 Hazard Mitigation Plan, in addition to air quality. Report findings indicate that of the 13 original hazards, 10 are expected to worsen with climate change, one may potentially lessen over longer time frames (Severe Winter Weather), and two are not associated with substantial climate change responses, although they remain significant hazards to the region (earthquakes and hazardous material releases). This assessment was used in developing future conditions in the Risk Assessment section of this plan.

2.4.12 Louisville Metro Government Office of Sustainability and Office of Advanced Planning Climate Trends Primer

The Climate Trends Primer provides information on the trends and impacts expected with climate change specific to Louisville and the 12- county region surrounding the Metro area. Understanding climate

change trends and impacts is the first step in identifying climate-related risks and vulnerabilities. The next step will be to develop strategies that build overall resilience for both people and natural resources of the region. This plan was used in developing future conditions in the Risk Assessment section for this floodplain management plan.

2.4.13 Metropolitan Sewer District Program for Public Information Plan

This document is the 2022 Update of the Program for Public Information Plan (PPI) that was originally completed for Louisville Metro, Kentucky in 2014. This update includes information about outreach efforts being made in Louisville Metro related to flood and water quality topics. It also includes information on MSD actions to reduce and mitigate against flood risk. This plan was used to identify the various methods of outreach conducted by MSD to promote flood mitigation activities in the Louisville Metro area. Specific activities referenced included newsletters, social media outlets, presentations, brochures, and even newspaper advertisements.

2.4.14 Metropolitan Sewer District Emergency Preparedness and Operational Resiliency (EPOR) Program

The EPOR Program develops resilient business practices to perform mission-critical functions and return to "normal" service post emergencies. Bolstering emergency preparedness through incident command structure-based planning, trainings and exercises, and after-action reporting, the program complements existing safety, security, planning, and grant pursuits. This plan was used in formulating mitigation strategies for this floodplain management plan. In addition, MSD will likely reference the Hazard Mitigation Plan to identify actions needed to reduce risks and increase system resiliency.

2.4.15 Metropolitan Sewer District 20-Year Comprehensive Facility Plan

The Metropolitan Sewer District 20-Year Comprehensive Facility Plan accomplishes the following tasks: consolidation of MSD's planning and prioritization for facility rehabilitation, renewal, replacement, upgrade, and expansion across all its service areas and recommendations and prioritization of projects and programs. The plan objectives include protecting the public health and safety of the community, protecting our aquatic and terrestrial environment, meeting customer expectations for a consistent level of service, and complying with all federal and state laws, regulations, orders, and standards. This plan was used in formulating mitigation strategies in this floodplain management plan.

2.4.16 Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance

The Louisville and Jefferson County Erosion Prevention and Sediment Control Ordinance outlines erosion prevention and sediment control requirements for land disturbance in Louisville Metro. The purpose of this ordinance is to control soil erosion and sedimentation from development and other land disturbing activities to prevent adverse impacts and offsite degradation. This ordinance was used to develop information in the Risk Assessment section of this plan.

2.4.17 Louisville Metro Hazardous Materials Ordinance

The purpose of this chapter is for the protection of public health and safety in Louisville Metro, through prevention and control of hazardous materials incidents and releases, and to require the timely reporting of releases thereto. This ordinance was used to develop information on Hazardous Material regulations in the Risk Assessment section of this plan.

2.4.18 Move Louisville

Move Louisville is a long-range strategic multi-modal transportation plan. Move Louisville was in progress at the time of the 2016 Hazard Mitigation Plan update, and was finalized in 2021. It outlines strategic planning efforts that could be impacted by future hazards.

2.4.19 Louisville/ Jefferson County Emergency Operation Plan

Louisville Metro Emergency Services leads emergency planning activities and develops the basic planning policies, guidelines, and Emergency Operations Plan (EOP). The EOP is updated in accordance with KRS Chapter 39, KAR 109, and guidelines from the Kentucky Division of Emergency Management. The EOP is adopted by resolution of the Louisville Metro Government Metro Council. The EOP outlines primary organizational structure, roles, and responsibilities of partner agencies. The plan is supported by All-Hazards Mitigation Strategies, Standard Operating Procedures (SOPs), and independent agency plans, and the State EOP. The EOP is updated as changes occur or according to state requirements. It provides direction and control during any large-scale disaster, to include preparedness, response, recovery, and mitigation. This plan was used in formulating Consequence Analysis tables.

2.4.20 KIPDA Regional Hazard Mitigation Plan

The KIPDA Regional Hazard Mitigation Plan serves as a regional hazard mitigation plan for surrounding counties to include Trimble, Henry, Oldham, Shelby, Spencer, and Bullitt in Kentucky. This plan covers each of the Kentucky counties in the Kentuckiana Metropolitan Statistical area, and each borders Jefferson County. Hazards covered include Dam Failure, Drought, Earthquake, Extreme Cold, Extreme Heat, Flooding, Hail, Karst, Sinkholes, Landslides, Severe Storm and Severe Winter Storm. These hazards align closely with the Louisville Metro Hazard Mitigation Plan. This plan was used to supplement hazard data used in the Risk Assessment portion of this plan.

2.4.21 KIPDA Regional Climate Change Report

The KIPDA Regional Climate Change Report, like the Louisville Metro Government Office of Sustainability and Office of Advanced Planning Climate Trends Primer, takes the standard model for identifying hazard mitigation risk and revises predictions based on a changing climate. With more recent research on climate change, it is evident that the likelihood of hazards occurring will not remain the same, making historical data unreliable. Although hazards are influenced in the same ways that they were fifty years ago, influencing factors themselves are undergoing changes due to climate change. Therefore, climate change needs to be taken into consideration when discussing hazard mitigation because it is causing the likelihood of hazards occurring to change. This report provides a summary and analysis of the most relevant climate change research that applies to the Kentuckiana region, as well as recommendations for what to consider in terms of hazard mitigation. This plan was used in a similar manner to other climate change reports. It was reviewed to provide information on future conditions in the Risk Assessment section of this floodplain management plan.

3.0 FLOOD RISK ASSESSMENT

Flooding is the most significant natural hazard in Kentucky. Major flooding occurs in the state almost every year, and it is not unusual for multiple floods to occur in the Louisville Metro area in a single year. Flooding is Kentucky's most costly natural disaster. The economic, social, and physical damage resulting from floods can be severe.

Floods are natural events for rivers and streams, resulting in an overflow of water onto dry land. The floodwaters can be slow- or fast-rising, but generally develop over a period of days. Thunderstorms, snow melt, tropical systems, or decayed hurricanes can all cause waterways to overflow banks and inundate the surrounding areas.

Floodwater currents are also extremely dangerous and destructive forces that can demolish or weaken buildings and infrastructure; cause extreme erosion issues; and sweep automobiles off roads. Debris and hazardous materials such as chemicals or sewage can contaminate floodwaters. The severity of a flood is impacted by several variables, such as stream and river basin topography and physiography, precipitation and weather patterns, recent soil moisture conditions, and the degree of vegetative clearing.

Periodic flooding of lands adjacent to rivers and streams is a natural and inevitable occurrence that can be expected to occur based on established recurrence intervals. The recurrence interval of a flood is defined as the average time interval, in years, expected between a flood event of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence interval. A "floodplain" is the lowland area adjacent to a river, lake, or ocean.

Floodplains are designated by the frequency of the flood that is large enough to cover them. One way of expressing the flood frequency is the chance of occurrence in a given year, which is the percentage of the probability of flooding each year. For example, the 100-year flood has a 1% chance of occurring in any given year.

Floods can occur due to a multitude of naturally occurring and human-induced factors, but all floods can broadly be defined as the accumulation of excess water in a short amount time in a concentrated area. There are several types of floods that occur in Louisville Metro, which include Ohio River flooding, flash flooding from streams, combined sewer flooding, pluvial flooding, and flooding that could occur from dam or levee failure.

- Ohio River flooding generally occurs when winter or spring rains, coupled with melting snow, quickly fill river basins with an excess of water. If the ground is frozen, the infiltration into the soil is reduced, thereby increasing runoff. Extended wet periods during the year can saturate the soil, sending runoff from any additional rainfall into streams and rivers until capacities are exceeded. This type of flooding is generally the result of long periods of excessive rainfall and high runoff volumes in a river or stream's watershed and usually takes days for the river to rise and overflow its banks rather than hours like a flash flood. Ohio River flooding generally occurs for an extended period of time and often lasts as long as a month or longer.
- Inland stream floods may occur within minutes or hours of heavy rains, and with little warning to residents. Factors that may contribute to inland stream flooding can include rainfall intensity, rainfall duration, surface conditions, and topography and slope of the receiving basin. These floods can be deadly due to the rapid rises in water levels and devastating velocity of flows. Slow-moving thunderstorms, decayed hurricanes, tropical storms, or heavy rains in a localized area are often the source of this type of flood event. Inland stream flooding is associated with a stream or river overflowing its banks.
- Pluvial flooding occurs when an intense rainfall event causes flash flooding that is not associated with an overflowing stream or river. Examples of pluvial flooding include when streets become

swift-moving rivers and basements fill with water due to intense rainfall events. This type of flooding can be exacerbated by vegetative debris and other types of debris blocking storm drains and inlets, causing additional, localized flooding. Urban areas are more susceptible to pluvial floods because a high percentage of the surface area is composed of impervious streets, roofs, and parking lots where runoff occurs very rapidly.

- Combined sewer flooding occurs when an intense rainfall event causes surcharging of the combined sewer system. The combined sewer system was constructed to convey stormwater and sanitary sewer and replaced many streams that historically existed. This type of flooding may occur within minutes or hours of heavy rains, and with little warning to residents. Flooding in the combined sewer system is more polluted than typical flood water due to the higher concentration of sanitary sewer mixed with the rainfall. Combined sewer flooding only occurs within the combined sewer system. Combined sewer flooding heavily impacts roadway flooding and structure flooding, especially basement flooding.
- Although dams and levees have many benefits, they can also pose a risk to communities if not designed, operated, and maintained properly. Factors that may cause a dam or levee to fail include:
 - Hydraulic Failure. Hydraulic failures result from the uncontrolled flow of water over the dam or levee, around the dam or levee, and adjacent to the dam or levee, and the erosive action of water on the dam or levee and its foundation. Earth dams and levees are particularly vulnerable to hydraulic failure, because earth erodes at relatively small velocities.
 - Seepage Failure. All dams and levees exhibit some seepage that must be controlled in velocity and amount. Seepage occurs both through the dam/levee and the foundation. If uncontrolled, seepage can erode material from the foundation of an earth dam/levee to form a conduit through which water can pass. This passing of water often leads to a complete failure of the structure, known as piping.
 - Structural Failure. Structural failures involve the rupture of the dam/levee and/or its foundation.

3.1 Precipitation in Louisville Metro

The Louisville Metro area has a humid subtropical climate typical of the Upper South, and is in United States Department of Agriculture hardiness zones 6b and 7a. Springlike conditions typically begin in mid-to-late March, summer is typically from mid-to-late May through late September, fall is typically the October through November period, and winter is typically December through mid-March. Seasonal extremes in both temperature and precipitation are not uncommon during early spring and late fall; severe weather is not uncommon, with occasional tornado outbreaks in the region. Winter typically brings a mix of rain, sleet, and snow, with occasional heavy snowfall and icing. Summers are typically hazy, hot, and humid, with long periods of 90–100 degree Fahrenheit (°F) temperatures, and drought conditions at times. Louisville averages 38 days a year with high temperatures at or above 90°F.

Based on information from the National Weather Service (NWS), monthly precipitation normals for Louisville, KY between 1990 and 2020 are shown in the Table 2. The National Oceanographic and Atmospheric Administration's (NOAA) Atlas 14 lists precipitation frequencies based on historic data. Precipitation estimates for the Louisville International Airport (Louisville WSO Airport) are shown in Table 3.

Table 2. Monthly Precipitation Normals 1991-2020		
Month	Precipitation	Snow
January	3.39"	4.5"
February	3.41"	4.1"
March	4.60"	2.1"
April	4.80"	0
May	5.18"	0
June	4.27"	0
July	4.05"	0
August	3.71"	0
September	3.66"	0
October	3.72"	0.1"
November	3.42"	0.3"
December	4.13"	2.2"

Table 3. NOAA Atlas 14 Estimated Point Precipitation at the Louisville International Airport				
Storm Duration	Average recurrence interval			
	2	10	25	100
1-hour	1.38"	1.96"	2.29"	2.84"
6-hour	2.20"	3.15"	3.77"	4.84"
24-hour	3.11"	4.49"	5.39"	6.97"

3.2 Flood Risks

3.2.1 Ohio River Flooding

Low-lying areas directly adjacent to the Ohio River experience significant flood depths and velocities from Ohio River flooding. Flood depths typically range from 10-20 feet along low-lying areas along the riverfront. Velocities average 4-6 feet per second along the length of the river. These higher velocities are found along the floodway of the river. Areas further from the river experience much lower velocities. Floods along the Ohio River are forecasted by the National Weather Service Ohio River Forecast Center. Flood events along the Ohio River are typically forecasted with 3 days of warning time.

The main flood season for the Ohio River is between the months of January and May. All of the highest floods on record have resulted from general heavy rains throughout the Ohio River Basin. The average duration of Ohio River floods of record in Louisville Metro is about 12 days. However, the sustained flood duration in 1937 was 23 days, in 1945 it was 18 days, and in 1964 and 1997 it was 14 days. The rate of rise at levels above flood stage varies in relation to rainfall and runoff rates for specific storms. Typical rates of rise for the Ohio River, at levels above flood stage, range from 2.5 to 5 inches per hour, with the record rate of rise being 4.7 feet in 12 hours and 8.4 feet in 24 hours in 1964.

3.2.2 Inland Stream Flooding

Inland stream flooding occurs as a flash flood with little to no warning time. The National Weather Service issues flood watches and warnings for these types of floods. Flood depths are generally less than 6 feet and are frequently less than 2 feet deep; however, along larger creeks, such as Harrods

Creek and Floyds Fork, depths can be much higher. For example, in Broad Run Park near Bardstown Road, the flood depths in the low-lying areas next to Floyds Fork are approximately 15 feet deep. Flood durations are typically short, with floods usually receding within 1 to 2 days. Floods along larger streams tend to last longer, while streams with smaller watersheds often last a few hours. Velocities vary greatly within each stream depending on the location, stream flow and geometry of the stream. Examples of stream velocities are included in Table 4.

Watershed	Stream	Location	Velocity (ft/s)
Beargrass Creek	Hurstbourne Creek	South Lyndon Lane	4.3
	Middle Fork Beargrass Creek	Grinstead Drive	3.5
	Muddy Fork Beargrass Creek	Northwind Road	6.2
	South Fork Beargrass Creek	Bashford Manor Lane	3.0
	South Fork Beargrass Creek	Broadway	6.6
Floyds Fork	Brush Run Upper	Johnson Road	3.9
	Chenoweth Run	Taylorsville Road	4.7
	Floyds Fork	Shelbyville Road	5.5
	Floyds Fork	Bardstown Road	2.8
Goose Creek	Goose Creek	Brownsboro Road	1.2
	Little Goose Creek	US 42	2.2
Harrods Creek	Hite Creek	Ballardsville Road	3.1
	Harrods Creek	US 42	7.5
Mill Creek	Black Pond Creek	Johnsontown Road	3.2
	Mill Creek	Bethany Lane	2.7
	Upper Mill Creek	Rockford Lane	2.1
Pond Creek	Fern Creek	Hurstbourne Parkway	4.4
	Fishpool Creek	Cooper Chapel Road	4.7
	Pond Creek	Stonestreet Road	3.9

3.2.3 Combined Sewer Area Flooding

Flooding in the combined sewer area is a result of surcharged sewer systems flooding onto the surface through manholes and catch basins. The surcharging generally results in low velocities as the water often pools and returns to the system in the same location or a nearby location. Flooding depths are generally less than 2', but in some areas, due to the topography, flood depths are significantly greater than 2'. This type of flooding occurs as a flash flood with little to no warning time. The National Weather Service issues flood watches and warnings for these types of floods. Flood duration is generally less than a day and often a few hours or less.

3.2.4 Pluvial Flooding

Because pluvial flooding occurs when an intense rainfall event causes flash flooding that is not associated with an overflowing stream or river, this type of flooding is very flashy. Floods occur with very little warning and the duration is generally short, lasting a few hours or less. The National Weather Service issues flood watches and warnings for these types of floods. Due to the small drainage areas associated with this flooding, flood depths are usually shallow. Velocities vary depending on geographic conditions.

3.2.5 High-Hazard Dams

Flooding related to a dam can occur due to dam failure. Flooding impacts would depend on the type and severity of the dam failure. For example, if the failure occurs during a heavy rainfall event, flooding may already be occurring and the dam failure could exacerbate the impacts of the flooding. Velocities associated with this type of flooding are likely very high. Flood depths would vary significantly, but would

be deepest closer to the dam failure. Warning time could range from no warning to several days warning depending on the type of failure. Flood duration would be short, less than a day and likely a few hours or less.

3.2.6 Levee/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 the first phase of the flood protection system to Pond Creek. The flood protection system is built to protect Jefferson County from floods equivalent to the historic flood event of 1937, with three feet of freeboard.

Levees are built for flood protection. If one fails, areas within the 100-year floodplain that were protected become vulnerable. The levee/floodwall is protecting to the 1937 flood plus three feet, which is significantly higher than the 100-yr flood. The 1937 flood was more than nine feet higher than the 100-yr flood elevation, so the top of the wall is more than twelve feet higher than the 100-yr flood elevation. Impacts of a levee/floodwall failure would depend on the river level and rainfall at the time of the failure. Warning time could range from no warning to several days warning. Flood depths could be very significant in low-lying areas near the river, but would generally be shallower further from the river. Velocities would generally be low, although the area directly adjacent to the failure would likely experience high velocities. Flood duration would be dependent on the Ohio River flooding, which can often last weeks.

3.2.7 Flood-Related Special Hazards

The Community Rating System defines seven other special flood-related hazards: uncertain flow paths (alluvial fans, moveable bed streams), closed-basin lakes, ice jams, land subsidence, mudflow hazards, coastal erosions, and tsunamis. Based on the geography of the area, these types of special flood-related hazards are unlikely to occur in Louisville Metro.

3.3 Flood Studies

3.4.1 Flood Insurance Rate Maps/Flood Insurance Study

The FEMA Flood Insurance Rate Maps (FIRM) depict flood zones, floodplain boundaries, and base flood elevations. In 2006, the FIRMs were updated and consolidated to include all communities within Jefferson County under one community name, Metropolitan Government of Louisville and Jefferson County, KY and Incorporated Areas. In 2021, the FIRMs in several areas within Louisville Metro were also updated. These maps depict flood risk due to stream and Ohio River flooding, as well as residual risk due to the floodwall and levee system, throughout Jefferson County. The Special Flood Hazard Area is based on a 1% annual chance flood event and on the existing development conditions at the time of the study and is shown on Figure 5. The Flood Insurance Study Report provides floodplain data, which may include a combination of the following: 10-, 4-, 2-, 1-, and 0.2-percent annual chance flood elevations; delineations of the 1% annual chance and 0.2% annual chance floodplains; and 1% annual chance floodway. All streams with at least one square mile of drainage area have been mapped and included in the FIRMs. Copies of individual studies that were completed to create the FIRMs and Flood Insurance Study report are available upon request. Floodplain mapping is available locally at www.lojic.org, as well as at www.msc.fema.gov.

3.4.2 Local Regulatory Floodplains

The local regulatory floodplain is defined as the flood having a 1% likelihood of being equaled or exceeded in any given year based on a fully developed watershed. The local regulatory floodplain is similar to the FEMA Special Flood Hazard Area; however, the Special Flood Hazard Area is based on existing development conditions and the local regulatory floodplain is based on the future condition of a fully developed watershed. In addition to streams mapped on the FIRMs, some smaller streams have also been studied to determine the local regulatory floodplain. The local regulatory floodplain is shown on Figure 5 and can be viewed at www.lojic.org. Copies of the flood studies are available upon request.

3.4.3 Combined Sewer Floodprone Area

The combined sewer floodprone area is the area delineated as having a 1% annual chance or greater of flooding due to surcharging of the combined sewer system. Limits of the combined sewer floodprone area can be found on Figure 5 and on the LOJIC Online Map at www.lojic.org. The combined sewer floodprone area was determined using two dimensional hydraulic modeling software (Innovyze InfoWorks ICM) to determine the surcharge from the combined sewer system during a 1% annual chance or greater storm. Due to the size of the model, model changes are coordinated through MSD.

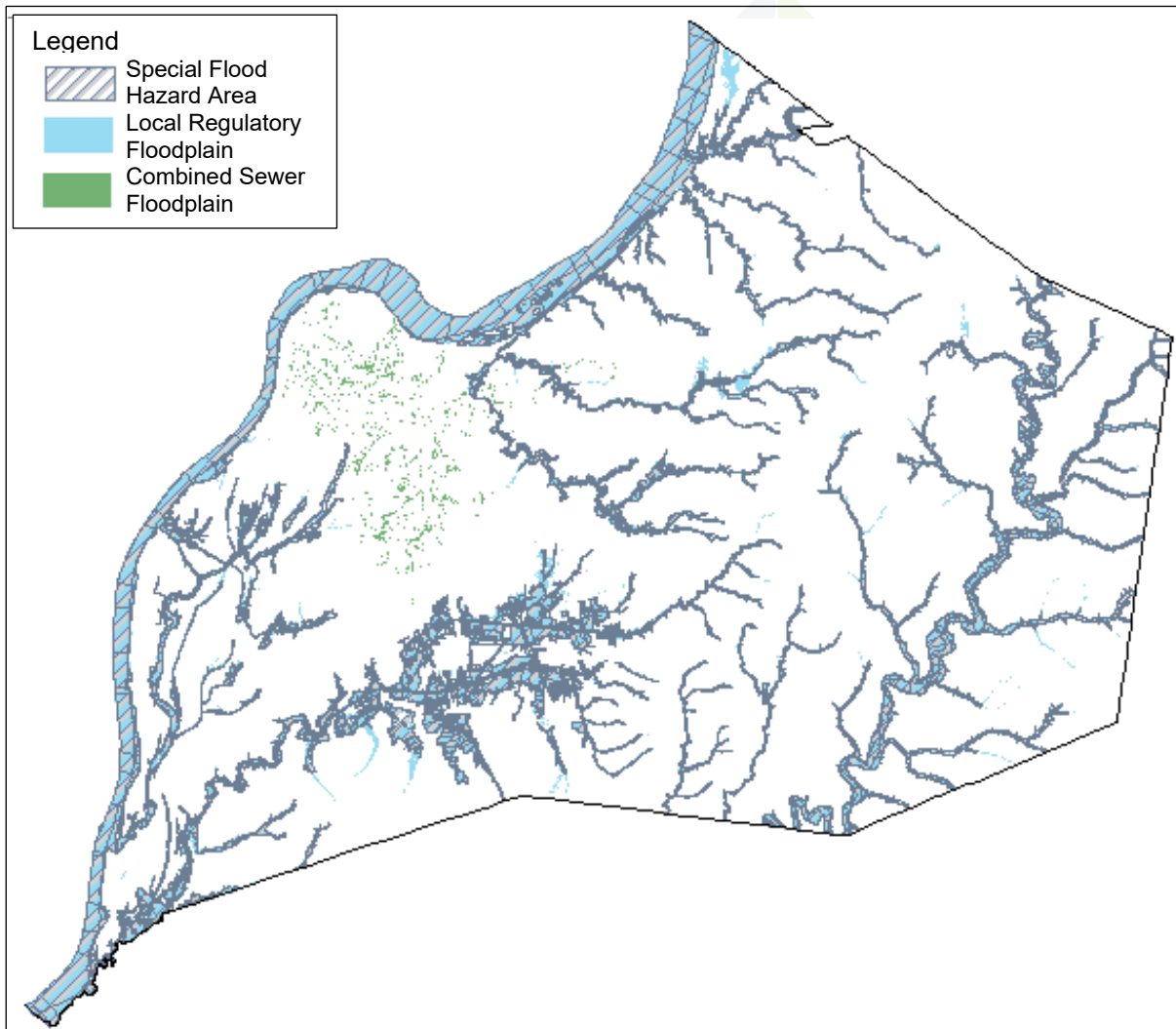


Figure 5. Flooding Impacts

3.4.4 First Street/Flood Factor Data

MSD purchased the First Street Foundation Flood Factor data for Jefferson County and has used this data for various flood mitigation and planning projects. The Flood Factor data provides flood information at the property level for future climate scenarios as well as risks associated with pluvial flooding that are not included in the FIRM and local regulatory floodplain mapping that is based on riverine flooding.

3.4.5 High-hazard Dams

Modeling has been completed to create inundation mapping for each of the high-hazard dams in Jefferson County using unsteady HEC-RAS modeling software. Mapping shows potential inundation areas and travel time.

3.4.6 Levee/Floodwall

Figure 6 describes the area that would become inundated if the levee system failed. This inundation area assumes Ohio River flooding to the top of the Ohio River Flood Protection System. The floodwall was constructed three feet above the 1937 flood, which was significantly higher than the 1% annual chance flood.

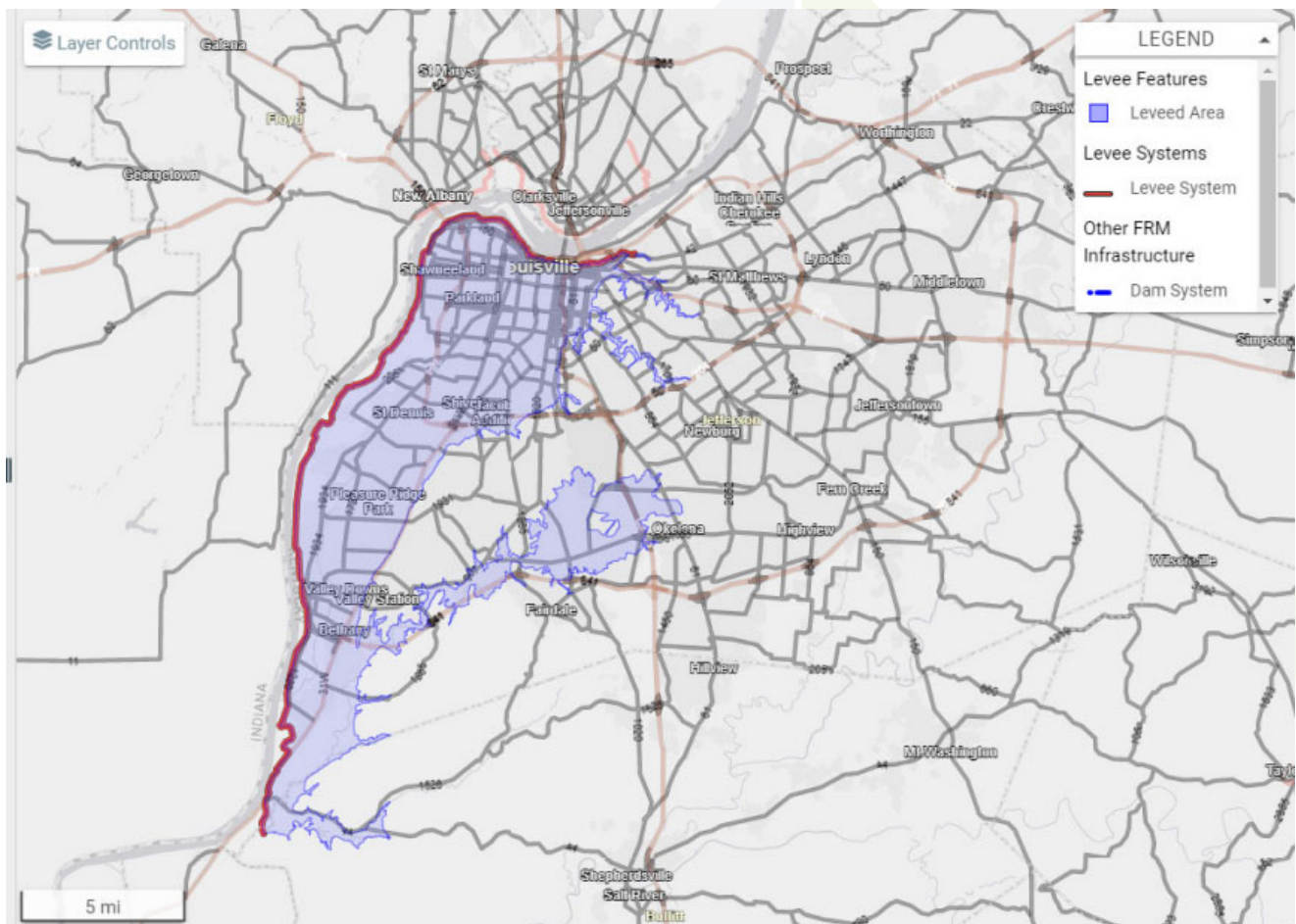


Figure 6. Levee Failure Impact (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.4 Historical Flooding

The Louisville area has been subject to flooding for thousands of years. Low-lying land along the Ohio River is covered frequently in the winter and spring. Ohio River floods typically occur over days or weeks and waters rise relatively slowly. The highest river levels are shown in Table 5.

Rank	Crest Level	Date
1	52.15 ft	1/27/1937
2	42.10 ft	3/8/1945
3	41.70 ft	2/16/1884
4	41.20 ft	3/12/1964
5	39.50 ft	2/16/1883
6	39.40 ft	4/2/1913
7	38.76 ft	3/7/1997
8	36.40 ft	1/22/1907
9	36.00 ft	4/19/1948
10	35.72 ft	2/26/2018

Louisville is also prone to flash flooding from interior streams. Heavy rains can also cause intense flash flooding along local streams and in developed areas. Flash floods can also occur due to a dam or levee failure. Large expanses of flatlands, lowlands and former swamplands can be quick to flood and slow to drain.

3.4.1 Largest Ohio River Flood Events

1937 Flood



Broadway flooded, Louisville, Kentucky, 1937.

Photograph Source:

<http://digital.library.louisville.edu/cdm/ref/collection/potter/id/70>

was above flood stage. Louisville, where light and water services had failed, was the hardest hit city along the Ohio River. On January 27, the river reached its crest at 460 feet above sea level or 40 feet above its

In 1937, the worst Ohio River flood in history covered 60 percent of the City of Louisville and 65 square miles of Jefferson County outside the old city limits. About 23,000 people were evacuated. Damages totaled more than \$1 billion in today's dollars. In January of 1937, rains began to fall throughout the Ohio River Valley; eventually triggering what is known today as the "Great Flood of 1937". Overall, total precipitation for January was four times its normal amount in the areas surrounding the river. In fact, there were only eight days in January when the Louisville station recorded no rain. These heavy rains, coupled with an already swollen river, caused a rapid rise in the river's level.

In Louisville, the river rose 6.3 feet from January 21-22. By the morning of January 24, the entire Ohio River

normal level, which is well over a 100-year event. The U.S. Weather Bureau reported that total flood damage for the entire state of Kentucky was \$250 million, an incredible sum in 1937. The number of flood-related deaths rose to 190. The flood completely disrupted the life of Louisville, inundating 60 percent of the city and 65 square miles.

1945 Flood

While the 1937 is the flood of record at Louisville, 1945 is in second place (albeit a distant 2nd), with a peak stage at Louisville of 42.10 feet. This stage is about ten feet below the 1937 stage. The flood drove 50,000 people from their homes, and caused millions of dollars of damage.

As is almost always the case with massive Ohio River floods, snow melt had very little impact. The deepest snow cover at Louisville between New Year's Day and the flood was only 3 inches on the 29th of January, and that melted away in a few days. The bulk of the heavy rain that caused the flood fell during a three week period leading up to the flood. Rainfall during that time was over 500% of the normal rainfall in southern Indiana, and around 400% of the normal rainfall along the length of the Ohio River.

1884 Flood

The third largest Ohio River flood occurred in February of 1884, when nearly the entire country experienced above average rainfall. The heavy rains and melting snow caused major problems along the Ohio River. On February 14th, the river was rising one inch every hour before it crested on February 16th. This was the largest Ohio River flood on record at the time. Because the river rose relatively slowly, property owners had warning of the flood and some property was able to be saved; however, the total losses to the City were still estimated to be \$100,000 dollars, equal to over \$3 million in today's dollars. The flood crested at 41.70 feet on the Upper McAlpine gauge on February 16, 1884.



1884 Flood along Broadway east of Shelby Street

Photograph Source:
<http://digital.library.louisville.edu/cdm/ref/collection/potter/id/115>

1964 Flood

In 1964, the community experienced its third greatest flood of the 20th century. This flood approximated the 100-year base flood. Most of the flood damage occurred in the southwest section of the county with about 1,200 homes being flooded. Property damage was estimated at \$3,600,000. The flood crested at 41.20 on the McAlpine Upper Gauge on March 12, 1964. The first phase of the floodwall and levee system had been completed in 1957 and protected Downtown and the West End from this flood.

1883 Flood

The flood of 1883 was the fifth largest flood Louisville has experienced. Unlike usual flooding along the Ohio River, this flood impacted the community suddenly due an embankment that burst. The embankment had been built to protect the city from flooding around an area of the city called "The Point," which was located north of Main St and east of 1st Street. The embankment was intended to protect the area from flooding of the Ohio River; however on February 13, 1883 around midnight, the embankment suddenly broke, flooding the area with 10-30 feet of water in 30 minutes. Some houses were swept off the foundations and people were forced to swim or wade through the floodwaters to escape. Thirty people

were rescued from trees they had climbed to escape the water. Hundreds of livestock were lost. Thousands were left homeless, one-fifth of the city was under water, and approximately 30 people lost their lives in this flood.

2018 Flood

The flood of 2018 was the most recent significant flood event and the highest river crest since the 1997 Ohio River flood. The 2018 flood was the 10th largest flood Louisville has experienced. The Ohio River Flood Protection System protected much of the area that would have flooded without the system, but areas along the riverside of the flood protection system and areas in the northeast portion of the county experienced significant flooding. Many homes and businesses experienced significant flood damage. The flood crested at 35.72 feet on February 26, 2018.



2018 Ohio River Flood

3.4.2 Recent Inland Flood Events

1997 Flood

March 1997 brought the worst local flooding in more than 50 years. Heavy rains dropped up to twelve inches of water in less than two days. Numerous strong thunderstorms along a stalled-out warm front triggered a record 24-hour rainfall for Louisville Metro. On March 1, Louisville Metro area received 7.22 inches of rain, the highest total on record for one-day. On March 7, 1997, the Ohio River also crested, causing additional flooding from the river. Rain from this storm was concentrated in the southern portion of the county.

The hardest hit areas were in the southwestern section of Louisville Metro along the Ohio River. Two other inland areas hit hard were in the Pond Creek watershed south of Louisville and along Floyds Fork in the east. More than 50,000 residences experienced some level of flooding. In addition, high water briefly closed Interstates 64 and 65, as well as scores of secondary roads. The flood pump station at the mouth of Pond Creek alone moved 2.6 billion gallons of water a day, draining the flood-ravaged neighborhoods of Okolona and Fairdale. During the first few days of the flood, MSD received more than 7,000 calls mostly about sewer backups and surface flooding. MSD estimated that as many as 25,000 customers may not have reported basement backups during the March 1997 flood.

Damage was estimated at \$65 million not including the river flooding on the Ohio River. The Ford factory on Fern Valley Road had damage to up to 1,500 Explorers. 24-hour rainfall totals beginning around February 28 to March 1 ranged from around 6 inches along the Ohio River to 11.5 inches across the communities of Okolona and Fairdale in the southern part of the county. The previous record 24-hour total was 6.97 inches. An estimated 2,500 homes in numerous subdivisions in Okolona and Fairdale and across other parts of the county had to be evacuated with hundreds relocated in temporary shelters. Okolona and Fairdale lie in the Pond Creek floodplain, which was formerly swampland.

The National Guard evacuated many people by boat and dump trucks. Thousands of cars were evacuated or stalled out due to the high waters. Numerous rescues were made with people trapped in cars and in houses. Bloated storm sewers popped off manhole covers that left cars quickly inundated in advancing high water. Several roads were closed around the Jefferson County Memorial Forest due to mudslides. A 16-year-old boy was killed near Jeffersontown as his van was swept off the road by the swollen Chenoweth Creek. Numerous roads including parts of Interstate 65 and 64 were closed through

the morning of March 2. Because of all the damage, the County-Judge Executive declared the county a state of emergency.

2006 Flood

A slow-moving storm system brought torrential rains to the region on September 22 and 23, 2006, resulting in widespread flash flooding. Up to 10 inches of rain fell on parts of Jefferson County in 24 hours. The northern portion of the county saw the largest concentration of rain from this storm. Six people were killed in the Louisville NWS office's area of responsibility. It was the worst general flood since the March 1997 flood. In Buechel, the Bent Creek Apartments were flooded and more than 100 residents had to be evacuated to an area shelter. Interstate 64 between Cannons Lane and Interstate 71 was closed. Water covered many roads in the vicinity of Veteran's Hospital in Louisville. Three feet of water covered 29th Street and two to three feet of water covered Brownsboro Road about half a mile east of the Mellwood Avenue intersection. Water rescues were conducted in the Lake Forest area and in Jeffersontown. Old Henry Road was flooded and impassable.

2009 Flood

On August 4, 2009 record-breaking heavy rains fell on the Louisville Metropolitan area causing widespread flash flooding. Rainfall intensities as high as 8.5-inches per hour and rainfall totals up to 8 inches were recorded in 75 minutes, which overwhelmed many portions of MSD's drainage system. The intense rainfall created massive flash flooding issues across the northwest and central part of Louisville Metro and caused millions of dollars in damage in Louisville.

Nearly 200 people were rescued by emergency workers from the tops of cars and houses. About 50 people were rescued by boat from a University of Louisville administrative office building. Two children were pulled from a swollen creek when neighbors saw them get swept away as they walked too close to the stream.



August 4, 2009 Flooding at Eastern Parkway and Third Street at the University of Louisville Campus

Photograph Source:
<http://digital.library.louisville.edu/cdm/ref/collection/flood/id/344>

Water was reported up to several feet deep in parts of Louisville. Many homes were flooded, especially in the western part of Louisville. Numerous commercial buildings downtown had damage and roads were flooded with several feet of water. Major flooding affected Churchill Downs and surrounding neighborhoods. Floodwaters poured into homes and engulfed Louisville's main public library downtown, several area hospitals, the horse barns at Churchill Downs, and the University of Louisville campus. The entire basement of the Louisville Free Public Library was inundated with water causing damage to books, computers, vehicles, and other items. Thousands of books were destroyed at the Louisville downtown library, with a million dollars in damage.

The University of Louisville campus had several buildings damaged by the flood and

water rescues had to be performed. Four University of Louisville classroom buildings were closed for more than a month, resulting in a shuffling of numerous classroom locations.

Interstates 64, 65 and 264 were all closed for a period of time due to high water. Other water rescues were performed downtown as people became stranded in vehicles during rush hour traffic.

2013 Flood

On October 5-6, 2013, Louisville Metro received up to 6.5 inches of rain in 24 hours. The most intense rainfall fell in the central part of the county causing flooding in areas such as Buechel, Hikes Point, Newburg, and Okolona. Hundreds of residents were affected by the flash flood. Twelve boat rescues were reported and 166 basement backups were reported to MSD. Many streets were closed due to the high water. The American Red Cross opened a shelter at Atherton High School for displaced residents.

2015 Flood

Three flood events occurred in 2015. In March there was moderate flooding along the Ohio River and in April and July flash flooding occurred. These events caused extensive damage and caused several homes to be declared substantially damaged.

Heavy rains dropped between 2 and 8 inches on Jefferson County on Friday April 3, 2015, resulting in more than 200 road closures due to flash flooding, which caused Jefferson County Public Schools to close. A washed-out culvert left Highway 22 in eastern Jefferson County closed for several months.

Louisville Metro Emergency Management Agency opened three different shelters for displaced residents. In addition to flash flooding, the storm caused widespread sewer back-ups. Jefferson County was designated for individual assistance only, and received 666 applications, including those for housing assistance and other needs, totaling more than \$1.7M of funding.

Severe weather occurred again in July, when thunderstorms brought very heavy rainfall to Louisville Metro. The worst flooding occurred July 13th and 14th, but the 7-day totals were up to 9 inches in the northeast portion of the county. The flood damage from the July storm was less significant than the April flood, but still caused property damage and many road closures.



April 2015 Flooding near Newburg Road

3.5 Repetitive Loss Areas

As of October 2022, Louisville Metro has 3,162 flood insurance policies in force and has had 3,797 paid flood losses since 1978. There have been 435 properties identified as repetitive loss properties within Louisville Metro; however, 105 of those properties have been mitigated, leaving 330 unmitigated repetitive loss properties. A Repetitive Loss property is a property for which two or more National Flood Insurance Program losses of at least \$1,000 each have been paid within any 10-year rolling period.

Repetitive loss structure locations are a trigger to the community that other adjacent properties may be at risk, and can provide the community an opportunity to designate a repetitive loss area that reflects the vulnerability of a street or neighborhood. As the floodplain administrator, MSD uses the Louisville Metro's official repetitive loss list to determine repetitive loss areas. The official repetitive loss list is provided through FEMA according to data from flood insurance claims.

There are approximately 3,000 primary structures located in the repetitive loss areas. The majority of the repetitive loss areas are located within a mapped floodplain. There are 2,821 structures located in the local regulatory and/or Special Flood Hazard Area and nine structures located within the combined sewer

floodplain. There are 141 structures located outside a mapped floodplain. Repetitive loss areas outside of a mapped floodplain are generally flat, poorly drained lots or lots with low areas near the structures that contribute to the potential for flooding. Based on PVA records, the value of the structures within the repetitive loss areas is approximately \$4.5 million.

3.6 Future Flood Risk and Climate Assessment

3.6.1 Changes in Development and Demographics

The local regulatory floodplain is defined as the 1% annual chance flood based on fully developed conditions of the watershed. Modeling is completed assuming all vacant or underdeveloped properties will be developed as the properties are zoned. All new development is required to build based on the local regulatory floodplain elevations, which are the same or higher than FEMA's base flood elevations. Although new development is required to elevate to the local regulatory floodplain elevations (plus freeboard requirements), stormwater and floodplain management policies are in place to ensure the floodplain elevations do not change due to changes in development. Any fill in the floodplain is required to be compensated at 1.5 to 1. Stream buffers are required on all perennial and intermittent streams. Detention and/or runoff compensation is required for projects and the capacity of the downstream system is reviewed to ensure there is capacity for the runoff. No-rise certifications are required for any projects located within the floodway of a stream.

3.6.2 Climate Change

The southeastern portion of the U.S. has experienced an increase in frequency and intensity for extreme rainfall. This trend is expected to continue as the Earth continues to warm. For each degree of warming, the air can hold about 7% more water vapor. This can lead to larger storms with more precipitation, which is already being seen. The region has experienced a 16% increase in the amount of rain falling during extreme storms. The number of days with more than 3 inches of precipitation has also increased across the region.

According to the National Climate Assessment (<https://nca2018.globalchange.gov/>), there is high confidence (based on high model agreement) that extreme rainfall will continue to worsen over time with climate change. With continued higher emissions, model projections show a doubling in the number of heavy rainfall events and 21% increase in the amount of rain falling during those events.

The average annual number of days with more than 3 inches of precipitation has been increasing across the Southeast, especially in the most recent decade. Similar to the rest of the region, precipitation has been increasing in Louisville since about the 1980's. Data from the Louisville International Airport weather station shows that all three of the wettest years on record have occurred within the last decade. When comparing the most recent 30-year period (1989-2018) with the historical period of 1961-1990, the amount of precipitation in the largest storm has increased by 12% in Louisville.

A study assessing flood risk at the national level provided data on potential flood risk for Louisville Metro. Of note is the fact that these data provide only rough estimates of the potential increase in flood frequency based on climate change model projections. Because of the national scale of the analysis, this dataset does not include localized specificity that is needed to map local trends. However, the data can be used to get an idea about the overall magnitude of change that is projected in this area.

With continued higher greenhouse gas emissions, the 1% annual chance flood events are expected to become 2.5 times to 3.5 times more frequent, as compared to the baseline (1950-2000) throughout much of the Louisville Metro region. Of note is the fact that 100-year flood frequencies can be limited to 1.0 to 1.5 times more frequent if emissions are reduced, saving \$4 billion per year in flood damages at the national level.

Using the available scientific information and climate trends, flood risk will continue to increase in frequency and intensity due to climate change. The more extreme flooding experienced has been associated with relatively short, geographically isolated rainfalls, which cause flash flooding, not Ohio River flooding. This increase in intensity of flooding will cause existing buildings in the floodplain to flood more frequently and will increase the area impacted by flooding causing additional structures to flood. Environmental impacts will include increased erosion and degraded habitat due to extreme storms.

3.7 Flood Impacts

3.7.1 Ohio River, Inland Stream, Combined Sewer and Pluvial Flood Impacts

Based on the Louisville Metro 2023 Hazard Mitigation Plan, flooding is the most significant hazard in Kentucky. Approximately 5% of structures in Jefferson County are in a mapped floodplain, and they account for approximately 4% of estimated property values. Flood vulnerability was calculated and mapped in the Louisville Metro 2023 Hazard Mitigation Plan. Overall, areas near the Ohio River and its tributaries are more vulnerable to flooding. The Louisville Metro area has a variety of elevations; therefore, those areas with a higher elevation are less likely to experience flooding. To create vulnerability maps, risk was assigned to grid cells based upon the percentage of the area of the cell covered by 1% annual change floodplain – including the effective FEMA Special Flood Hazard Area, local regulatory floodplain and MSD combined sewer area. The resulting map is shown in Figure 7.

Pluvial flooding is less well-defined and was not included in the vulnerability assessment map. The pluvial flooding data from First Street will be compared to existing flood studies to determine if additional flood studies should be conducted to show the risk of this type of flooding. Pluvial flooding generally impacts areas upstream of existing flood studies. Currently, flood mapping has been completed for all watersheds within Jefferson County with at least one-square mile of drainage area. In areas with known flooding issues, flood maps have been extended to smaller drainage areas to show the flood risk and are included in the flood vulnerability map.

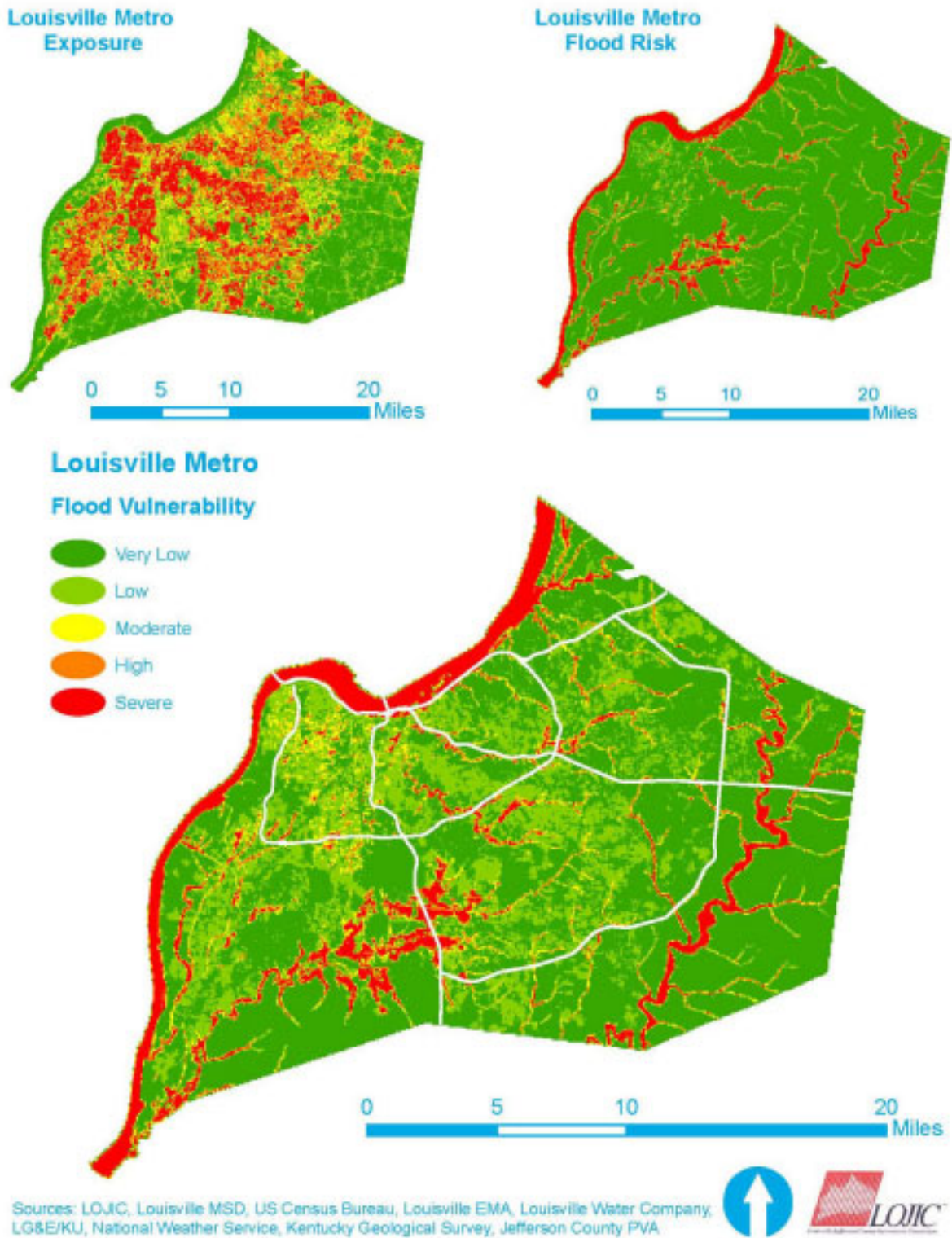


Figure 7. Flood Exposure, Risk and Vulnerability (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.7.2 Levee and Dam Failure Flood Impacts

A dam failure is usually the result of neglect, poor design or structural damage caused by a major event such as an earthquake. When a dam fails, an excess amount of water is suddenly let loose downstream, potentially destroying anything in its path. According to FEMA's Data Visualization Tool, there have been no Declared Disasters in Louisville Metro area related to dam or levee failures.

Dams in Kentucky are classified by the Kentucky Division of Water as one three hazard types:

- High Hazard (C): Structures located such that failure may cause loss of life or serious damage to houses, industrial or commercial buildings, important public utilities, main highways or major railroads.
- Moderate Hazard (B): Structures located such that failure may cause significant damage to property and project operation, but loss of human life is not envisioned.
- Low Hazard (A): Structures located such that failure would cause loss of the structure itself but little or no additional damage to other property.

High- and moderate-hazard dams are inspected by Kentucky Division of Water every two years. Low-hazard dams are inspected every five years. If the structure meets all the necessary requirements, a Certificate of Inspection is issued to the owner. Otherwise, the owner is notified of any deficiencies. During each inspection, dams are assigned as one of the following four conditions: Satisfactory, Fair, Poor, and Unsatisfactory

Per the U.S. National Inventory of Dams, Kentucky has approximately 1,107 dams, with almost 200 dams being identified by FEMA as High Hazard – or Class C—dams. Forty of these dams, including nine identified as High Hazard, are in the Louisville Metro area. The list of Louisville Metro's 40 dams according to the Kentucky Division of Water (KDOW) is presented in Table 6 below:

Dam #	Name of Dam	Hazard Class	Owner Type	Location	Height	Area (sq mile)
1	Tom Wallace Lake Dam	(Class C) High	MUN	Valley Station	31	2.5
2	Pine Hill Lake No. 1	(Class C) High	PRI	Louisville West	27	2.8
3	Windsor Forest Dam	(Class C) High	PRI	Louisville West	29	4
4	Mitchell Hill Lake Dam	(Class C) High	PRI	Valley Station	20	1.9
5	LG&E Waste Water Dam	(Class C) High	PRI	Lanesville	12	40
6	S Fork Beargrass Creek Dry Bed Dam	(Class C) High	MUN	Jeffersontown	UNK	13.9
7	Roberson Run (Dry Impoundment)	(Class C) High	MUN	Louisville East	17	0
8	Whipps Mill Rd Dry Dam	(Class C) High	MUN	Anchorage	21	0
9	Norton Commons Dam	(Class C) High	PRI	Anchorage	16	2.4
10	Waterstone Park Dame	(Class B) Moderate	PRI	Louisville East	32	0
11	Silver Crystal Dam	(Class B) Moderate	PRI	Brooks	15	10.2

Table 6. Louisville Metro Dams (continued)

Dam #	Name of Dam	Hazard Class	Owner Type	Location	Height	Area (sq mile)
12	Lake McNeely Dam	(Class B) Moderate	DOWF	Brooks	32	45
13	Long Run Park Lake Dam	(Class B) Moderate	MUN	Crestwood	43	27
14	Big Horn Lake Dam	(Class B) Moderate	PRI	Valley Station	28	3.7
15	Waverly Park Dam	(Class B) Moderate	PRI	Louisville West	20	4.9
16	Mirror Lake (Lower) Dam	(Class B) Moderate	PRI	Jeffersontown	28	3.7
17	Joe Guy Hagan Dam	(Class B) Moderate	PRI	Jeffersontown	28	4.5
18	LG&E Mill Creek Station Ash Dam A	(Class B) Moderate	PRI	Kosmosdale	77	56.91
19	NTS Detention Dam Section 6b	(Class B) Moderate	PRI	Jeffersontown	21	4.2
20	Polo Fields	(Class B) Moderate	PRI	Crestwood	27	13.3
21	AS Properties Dam No. 2	(Class B) Moderate	PRI	Jeffersontown	24	2
22	Vulcan Quarry Dam	(Class B) Moderate	MUN	Brooks	16	0
23	Riggs Lake Dam	(Class A) Low	PRI	Jeffersontown	18	8.9
24	Fern Creek Sportsman Club Dam	(Class A) Low	PRI	Waterford	25	2.8
25	Dreamland Dam	(Class A) Low	PRI	Louisville West	13	5
26	Woodhaven Country Club	(Class A) Low	PRI	Louisville East	18	4.6
27	Lowry Dam	(Class A) Low	PRI	Jeffersontown	35	2
28	Wildwood Country Club	(Class A) Low	PRI	Jeffersontown	18	4.6
29	Sampson Dam	(Class A) Low	PRI	Fisherville	40	7.9
30	Willow Dam	(Class A) Low	PRI	Anchorage	33	7.4
31	Putneys Pond	(Class A) Low	PRI	Anchorage	15	7.3
32	Logan Lake Dam	(Class A) Low	PRI	Fisherville	36	5.8
33	Bill McMahan Lake Dam	(Class A) Low	PRI	Jeffersontown	35	Unk
34	Twin Lakes Lower Dam	(Class A) Low	PRI	Fisherville	Unk	Unk
35	Du Pont Fly Ash	(Class A) Low	PRI	Louisville West	18	20

Table 6. Louisville Metro Dams (continued)

Dam #	Name of Dam	Hazard Class	Owner Type	Location	Height	Area (sq mile)
36	Glenmary Dam	(Class A) Low	PRI	Mount Washington	25	4.21
37	Lake Forest Golf Course No 2	(Class A) Low	PRI	Crestwood	21	6.5
38	Lake Forest Golf Course No 1	(Class A) Low	PRI	Crestwood	23	5
39	Springhurst Lake Dam	(Class A) Low	PRI	Anchorage	18	5.7
40	Gault Eastpoint LLC Dam	(Class A) Low	PRI	Anchorage	20	5.4

Dam failures may cause flooding that is more impactful than riverine flooding. Floodwaters from a dam failure may arrive before warning or evacuation can occur and the resulting environmental impacts can be devastating. Potential flooding impacts from the nine high hazard dams have been mapped to determine the extents of the potential flooding. The largest potential impact of flooding would be from the South Fork Beargrass Creek Dry Bed Dam, which was constructed as a flood control structure in the 1970's.

Levees are built for flood protection. If one fails, areas within the 100-year floodplain that were protected become vulnerable. There are two levee systems located in Louisville Metro: the Ohio River Flood Protection System and the Willowbrook Floodwall. Both projects were constructed and certified by the U.S. Army Corps of Engineers. MSD maintains both flood protection systems.

The Ohio River Flood Protection System protect Louisville Metro from Ohio River flooding. The system protects more than 200,000 people, 137,000 structures, and \$34 billion in property throughout 110 square miles of Louisville Metro. It includes 26.1 miles of floodwall and earthen levee, 16 flood pumping stations, nearly 150 floodgates and 79 floodwall closures.

In the event of a levee failure, floodwaters may ultimately inundate the protected area landward of the levee. The extent of inundation is dependent on the flooding intensity. Failure of a levee during a one percent annual chance flood will inundate the approximate 100-year floodplain previously protected by the levee. Residential and commercial buildings located nearest the levee overtopping or breach location will suffer the most damage from the initial embankment failure.

To determine structures that are vulnerable and estimated to be damaged during a Dam/Levee Failure, the Hazard Boundary Overlay methodology was used. The hazard boundary used as the overlay was the Levee inundation map that was created during the update of the DFIRMs for Louisville Metro. This inundation map displays areas that would be flooded if the levee was not in place; therefore, it was used to showcase risk in this model. The exposure, risk, and vulnerability are shown in Figure 8.

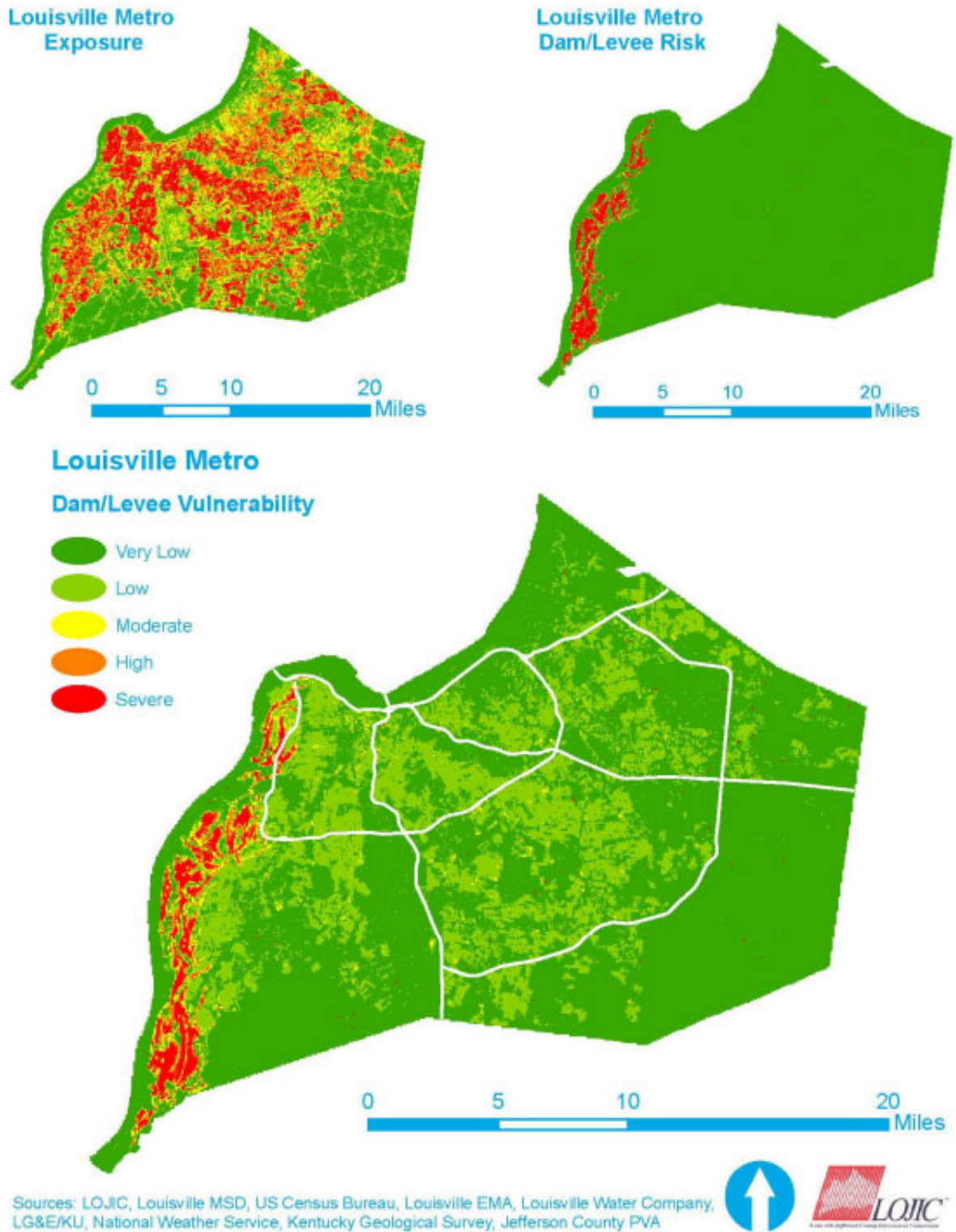


Figure 8. Levee/Dam Failure Risk & Vulnerability (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.8 Life Safety and Flood Warning Systems

The river forecasting services for the Ohio River at Louisville are provided by the National Weather Service River Forecast Center. With normal rainfall distribution over the Ohio River Basin, forecasts of stages and flood crests can be made several days in advance. A river stage forecast is issued daily under normal conditions, and more frequently during periods of an emergency. River forecasts are available on MSD's and NOAA's website and in the local newspaper. Due to the relatively long warning time for Ohio River flooding, residents are generally able to evacuate and move belongings to higher ground before flooding occurs.

Flash flooding occurs in a very short period of time. Flash flood alerts are issued by the National Weather Service. There is typically approximately a one-hour lead-time for flash floods. Evacuations are typically done on an emergency basis for flash flooding events by the police and fire departments. Flash flooding is particularly dangerous for people driving on flooded roads, as well as residents in flooded homes due to the sudden nature of the flooding. To provide emergency warnings, Jefferson County has outdoor sirens, an emergency alert system, a telephone notification system, direct notification from police and fire, a dedicated AM radio station, and websites available to the public.

3.10 Public Health

Floods can be very dangerous during the flood and after. Drowning is the number one cause of flood deaths. Six inches of moving water can knock an adult off their feet and one foot of flowing water can move a car. Electrocution is the number two cause of flood deaths. Electrical current will travel through water and can cause injury or death. If possible, avoiding floodwaters is the best way to stay safe.

After a flood it's important to be careful when cleaning up due to slippery surfaces and debris. Stream banks also can become unstable due to floodwaters. Property owners should check for gas leaks and be that electricity is turned off before entering a building.

Anything that comes into contact with flood waters should be washed thoroughly and disinfected if possible. Floodwaters can carry chemicals and germs that could be harmful to your health. Spoiled food, flooded cosmetics, and medicines are health hazards and should be thrown away. It is important to remove flooded drywall, insulation, carpeting, and other impacted building materials to prevent mold growth, which can have harmful health impacts.

3.11 Critical Facilities and Infrastructure

Critical Facilities are essential to the health and wellbeing of a community and play a large role during natural disaster events. Table 7 identifies selected critical facilities in the Regulatory Floodplain that were used in determining the Exposure Score for flood hazards. Understanding and identifying which facilities are in the floodplain will provide the Louisville Metro area a list potential hazard mitigation projects, as well as highlight which facilities may be severely impacted in a disaster.

Table 7. Critical Facilities in the Floodplain (Source: Louisville Metro 2023 Hazard Mitigation Plan)	
Facility Type	Number
Schools	9
Hospitals	0
Nursing Homes	4
Prison	1
Police	2
Fire	2
EMS Facilities	0
Emergency Operations Center	1
Siren	12
HazMat	39
Flood Pump Station	3
Sewer Pump Station	52
Drainage Pump Station	5
Sewer Treatment Plant	0
Louisville Water Company Facilities	1
Water Pressure Station	4
Electric Station	7
Electric Tower	15
LG&E Gas Station	16
Totals	173

The current floodplain ordinance does not allow new critical facilities to be constructed in the local regulatory floodplain; however, based on the summary of critical facilities in the floodplain, there are many existing facilities that could be impacted by flood events. For example, nine schools are located within the floodplain, which would impact their ability to hold classes during a flood and after a flood if there is damage. Several emergency services are located in floodplains, such as police and fire stations. These stations would not be operational during a large flood event. There are four nursing homes located in the floodplain. These facilities would likely need to be evacuated during a flood. Some of these facilities are designed to be functional during a flood event, such as the flood pump stations and sewer pump stations.

3.12 Economy and Major Employers

The Louisville Metro area has a vibrant and growing economy. The region is currently home to two Fortune 500 companies; Humana at No. 40 and Yum Brands at No. 490. Louisville's transportation, warehousing, and wholesale trade industries are some of the strongest in the nation, with United Parcel Service's (UPS) air operations headquarters located at the Louisville International Muhammad Ali International Airport. The area also continues to have a strong manufacturing base, highlighted by two Ford Motor Company assembly plants and the Haier home appliance manufacturing facility. The city has a robust health care sector due to Humana headquarters being located downtown, along with several large senior care providers, including Kindred Healthcare and Atria Senior Living. Tourism has also become a significant business, with the Kentucky Derby and bourbon tours leading a \$3.5B industry. Finally, the University of Louisville, just south of the downtown area, is a major employer and economic engine for the community, as well as the Commonwealth of Kentucky. Because of these factors, Louisville's overall economic picture reflects its position as the state's economic leader.

Income, poverty, education, insurance coverage levels, and unemployment rates outperform the state as a whole. The cost of living in Louisville is more than 10 percent below the national average, and more affordable than nearly all of its peers.

A listing of the Louisville Metro's largest employers per Greater Louisville Inc, Louisville Metro's Chamber of Commerce, is presented below in Table 8.

Company	No. of Local Employees	Product Service
United Parcel Service	25,090	Package delivery, transportation, and logistics
Jefferson County Public Schools	14,484	Education
Norton Healthcare	13,828	Health care services
Ford Motor Co. (2 plants)	13,020	Automotive production
Humana Inc.	12,360	Health and well-being
UofL Health	12,000	Health care services
The Kroger Co.	9,300	Retailer
Baptist Healthcare System Inc.	7,346	Health care services
Walmart Inc.	6,650	Retailer
University of Louisville	6,000	Research university, education
GE Appliances, a Haier Company	6,000	Home appliances
Amazon.com	5,700	Logistics and customer service
Louisville-Jefferson County Metro Government	5,646	Metropolitan government
Spectrum	2,330	Call center, cable, internet
Manna Inc.	2,300	Quick service and casual dining restaurants
LG&E and KU Energy LLC	2,240	Gas and electric generation and distribution
Archdiocese of Louisville	2,202	Catholic schools, churches, agencies
U.S. Census Bureau	2,113	Government
Robley Rex VA Medical Center	1,922	Health care services
U.S. Postal Service	1,691	Mailing and shipping
Samtec Inc.	1,601	Electronic connectors and microelectronics
Texas Roadhouse	1,452	Food service
Brown-Forman Corp	1,300	Producer & marketer of alcoholic beverages
Papa John's International Inc.	1,485	Pizza restaurants
Anthem Blue Cross and Blue Shield	1,320	Health insurance
Faurecia	1,200	Hospitality
JBS USA	1,200	Pork products
Kindred Healthcare Inc.	1,200	Health care services
BrightSpring Health Services	1,058	Health and human services provider
ADP Inc.	1,000	Healthcare management, call center
Churchill Downs	1,000	Racing, gaming and online entertainment

Flooding can cause significant property damage and, on average, one foot of water in an average size home can cause over \$50,000 in damage. Without flood insurance, this level of damage can overwhelm a family's finances. And those without many financial resources will be severely impacted by flood damage to their home and/or belongings.

Flooding also affects those who work in floodplains or commute through them. Businesses in floodplains also will shut down during flooding, particularly if buildings and access roads are damaged. After the 1993 Midwest Flooding, FEMA found that over 40% of small businesses do not reopen after being flooded.

Flooding will affect certain industries like production, chemical manufacturing and distribution more heavily because of their presence and reliance on floodplain locations for their facilities. Rubbertown, a major industrial center for Jefferson County, is located along the banks of the Ohio River just southwest of downtown Louisville. This location alone represents risk in the billions of \$USD, along with thousands of jobs if a flood were to damage or destroy those facilities.

3.13 Buildings Impacted by Flooding

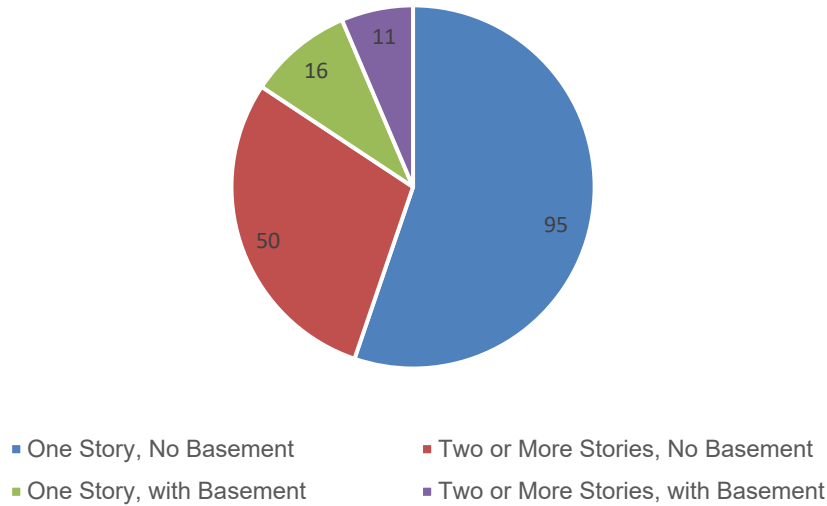
Throughout the Louisville Metro area, there is at least \$1.4 billion of building value in floodplains. Approximately 5% of structures in Jefferson County are in the floodplain, and they account for approximately 4% of estimated property values. Of note is that just over 10% of industrial structures and approximately 10% of commercial structures are in the floodplain. One of Louisville's two Ford assembly plants is in the floodplain, as are several major commercial and industrial structures in the Rubbertown area. Table 9 shows the number of buildings in each flood zone and the National Flood Insurance Policy coverage for Louisville Metro.

Flood Zone	Total # of Buildings	# of Buildings w/ Building Coverage	% of Buildings Covered
0.2% Annual Chance Flood Hazard	22,664	65	0.3%
1% Future Conditions	1,626	108	6.6%
AE Zone	8,475	2,378	28.1%
A Zone	145	36	24.8%
X Zone	227,798	534	0.2%
X Protected by Levee	10,152	41	0.4%
Total	270,860	3,162	1.2%

A Substantial Damage Management Plan was completed in 2023 that reviewed all of the properties in the floodplain and identified which structures have the potential to be substantially damaged (i.e. the damage is more than 50% of the value of the building and would need to be elevated or otherwise mitigated before it can be repaired). The plan is used for planning purposes to help proactively plan for future disasters and potentially mitigate flood prone areas before they have a significant issue. The majority of the structures that were identified as having potential for substantial damage are located along the Ohio River.

One hundred seventy-two buildings were determined to likely experience substantial damage in Louisville Metro in the event of a 1% annual chance flood. Of the 172 potentially substantially damaged buildings, 149 are residential and 23 are non-residential. Eighty seven percent (150 buildings) are located within the Ohio River floodplain, with the remaining 22 properties subject to flash flooding along a tributary. More than half of the properties (95) are 1-story structures with no basement. The remaining structures include 50 structures that are 2-story with no basement, 16 structures that are 1-story with a basement, and 11 structures that are 2-story structures with a basement.

Types of Potential Substantially Damaged Structures



3.13 Natural and Beneficial Areas

Flooding is a natural process and supports unique ecosystems and habitats. Natural floodplain functions typically result in slower-moving floodwaters with less intense flood height peaks because they provide enough open space to store floodwater until it returns to the water source or is absorbed by the ground. The Louisville Metro area has incorporated natural functions into the design of flood mitigation projects, which helps reduce flood risk as well as protect and restore ecosystems. Reconnecting rivers to their historic floodplains through setbacks, creating side channels, and removing obstructions help restore natural functions and bring flood risk reduction benefits as well.

Louisville Metro contains approximately 26,000 acres of floodplain. Approximately 9,100 acres of the floodplain is located in open space (i.e. MSD easements, parks, deed restricted open space or wetlands, etc.). Louisville Metro is home to a diverse treasure of terrestrial and aquatic plant and animal species including certain endangered species that are listed federally. Table 10 shows the threatened and endangered species within Louisville Metro based on information available on FEMA's Flood Risk and Endangered Species Habitat (FRESH) website.

The majority of identified species are freshwater mussels. Freshwater mollusks are considered one of the most imperiled group of organisms in North America and are extremely sensitive to unstable, altered stream and river conditions. Mussels partially bury themselves in the substrates of streams and rivers and filter water during their life span, which makes them highly susceptible to chemical pollutants and habitat degradation. Causes of degradation to water chemistry and habitat are often the result of channelization, deforestation, urbanization, and the presence of dams. In addition, exotic species in waterways competes with native mussels for habitat and food, causing stress to localized populations. For more information about endangered species within the floodplain, see the Louisville-Jefferson County Floodplain Species Assessment.

Table 10. Threatened and Endangered Species in Louisville Metro

Fauna	Species Common Name	Scientific Name	Status	Agency
Birds	Least tern	<i>Sterna antillarum</i>	Endangered	FWS
	Eastern black rail	<i>Laterallus jamaicensis</i>	Proposed Threatened	FWS
Mammals	Gray bat	<i>Myotis grisescens</i>	Endangered	FWS
	Indiana bat	<i>Myotis sodalis</i>	Endangered	FWS
	Northern long-eared bat	<i>Myotis septentrionalis</i>	Endangered* (*March 31, 2023)	FWS
Mussels	Clubshell	<i>Pleurobema clava</i>	Endangered	FWS
	Fanshell	<i>Cyprogenia stegaria</i>	Endangered	FWS
	Fat pocketbook	<i>Potamilus capax</i>	Endangered	FWS
	Longsolid	<i>Fusconaia subrotunda</i>	Proposed Threatened	FWS
	Orangefoot pimpleback	<i>Plethobasus cooperianus</i>	Endangered	FWS
	Pink mucket	<i>Lampsilis abrupta</i>	Endangered	FWS
	Rabbitsfoot	<i>Quadrula cylindrica cylindrica</i>	Threatened	FWS
	Rayed bean	<i>Paetulonio fabalis</i>	Endangered	FWS
	Ring pink	<i>Obovaria retusa</i>	Endangered	FWS
	Rough pigtoe	<i>Pleurobema plenum</i>	Endangered	FWS
	Round Hickorynut	<i>Obovaria subrotunda</i>	Proposed Threatened	FWS
	Sheepnose mussel	<i>Plethobasus cyphus</i>	Endangered	FWS
	Snuffbox mussel	<i>Epioblasma triquetra</i>	Endangered	FWS
	Spectaclecase	<i>Cumberlandia monodonta</i>	Endangered	FWS
Plants	Kentucky gladeceess	<i>Leavenworthia exigua</i> var. <i>lacinata</i>	Threatened	FWS

* FWS – U.S. Fish & Wildlife Service

The Louisville Metro Floodplain Management Ordinance includes three statements of purpose that relate to the natural and beneficial functions of floodplains. The floodplain ordinance reduces impacts to the floodplains by:

- Controlling the alteration of natural floodplains, stream channels, and natural protective barriers that are involved in the accommodation of flood waters,
- Controlling filling, grading, dredging and other development which may increase flood damage or erosion and
- Preventing or regulating the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards to other lands.

The floodplain ordinance states that a natural 25 foot buffer on each side of the stream bank must be preserved on all perennial and intermittent streams as defined by the USGS 7.5 minute topographic

maps. In addition, perennial and intermittent 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.

Chapter 4 Part 8 of the Louisville Metro Land Development code establishes minimum buffer areas along protected waterways, including: perennial and intermittent streams or rivers, wetlands, and other water bodies. The “Jefferson Protected Waterways” and “Jefferson Potential Wetlands (Hydric Soil)” LOJIC GIS mapping layers are used to identify these sensitive features during preliminary development planning. The delineation of wetland boundaries is established using Hydric Soils as a preliminary indicator of potential wetland areas and the need for further investigation. Development standards encourage areas of sensitive features to be preserved and dedicated as open space. Many residential subdivision projects within Jefferson County include the reservation of open space and/or woodland protection areas to further protect sensitive features such as wetlands, steep slopes, and floodplain and stream buffers. Table 11 shows natural floodplain functions in each watershed.

Table 11. Key Natural Floodplain Functions (Source: Metro Louisville Metro 2023 Hazard Mitigation Plan)									
Watershed	Total Acres	Hydric Soils		Open Space		Wetlands		Floodplain	
		Acres	%	Acres	%	Acres	%	Acres	%
Cedar Creek	7,187	243	3.37%	169	2.36%	2	0.02%	271	3.77%
City/Ohio River	25,485	280	1.10%	2,2263	8.88%	479	1.88%	5,443	21.36%
Floyds Fork	66,499	519	0.78%	6,393	9.61%	316	0.47%	6,838	10.28%
Goose Creek	11,894	299	2.51%	1,361	11.44%	3	0.02%	896	7.54%
Harrods Creek	9,789	184	1.88%	1,344	13.73%	43	0.44%	857	8.75%
Middle Fork Beargrass Creek	16,082	48	0.30%	2,128	13.23%	7	0.04%	986	6.13%
Mill Creek	21,902	1,373	6.27%	1,785	8.15%	543	2.48%	2,183	9.97%
Muddy Fork Beargrass Creek	5,643	63	1.12%	562	9.96%	1	0.03%	696	12.33%
Pennsylvania Run	4,452	160	3.59%	932	20.93%	7	0/17%	236	5.31%
Pond Creek	57,150	7,828	13.70%	6,774	11.85%	1,005	1.76%	8,921	15.61%
South Fork Beargrass Creek	17,334	191	1.10%	1,083	6.25%	48	0.28%	1,767	10.20%
Total	243,416	11,188	4.60%	24,795	10.19%	2,453	1.01%	29,095	11.95%

3.14 Risk by Watershed

In Jefferson County, all streams eventually drain into the Ohio River. A Risk Assessment was performed for all eleven watersheds and provided data for the following:

- Identifying Critical/Essential Facilities and Infrastructure located in the Regulatory Floodplain
- Assessing and quantifying natural and beneficial function areas
- Mapping known hazard areas (Regulatory Floodplain, Repetitive Loss Properties, Severe Repetitive Loss, Historic Claim Properties, Flood Hotspots, and the Combined Sewer Flood-prone area zones)
- Assessing the impact flood will have on life, safety and health facilities, and the effects on the community's economy through loss estimation
- Providing a description of known flood hazards, including source of water, depth of flooding, velocities, and identifying key warning time gauges.

3.14.1 City/Ohio River

The City/Ohio River Watershed has an area of approximately 39.8 square miles, and contains 49.5 stream miles, most of which are the Main Stem of the Ohio River. This watershed is drained by a complex system of combined sewers. No open channels of any magnitude exist.

The Ohio River flows through Louisville Metro area, and is located along the northwestern border of Jefferson County; the far side of the river is in Indiana. A levee and floodwall system separates the river from the rest of Louisville Metro. The flood protection system includes pump stations and dams at all stream crossings and combined sewer overflow (CSO) outfalls.

The following communities are situated in this watershed: Downtown Louisville, Kenwood, Southern Heights, Beechmont, Oakdale, Wilder Park, Parkland, South Parkland, Shawnee, and Portland. Regionally notable landmarks in the watershed include the Kentucky Fair and Exposition Center, the University of Louisville, Churchill Downs, Kentucky International Convention Center, City Hall, portions of Iroquois Park, Shawnee Park, and Chickasaw Park.

Along the Ohio River is preserved open space in 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.

Most of the Louisville Metro area lies in the floodplain of the Ohio River; however, about 17,600 acres of this floodplain are protected by a 28.9-mile-long flood protection system, which includes downtown Louisville. The floodwall system was built to protect Louisville Metro from floods equivalent to the historic flood event of 1937, with 3 feet of freeboard. The flood protection system includes pump stations and dams at all stream crossings and combined sewer overflows (CSO) outfalls to protect populations, critical infrastructure, critical facilities, and neighborhoods. Due to repetitive flooding, many residents living in this watershed have participated in flood acquisition programs. These homes were demolished and the properties have been deed restricted to remain as open space to mitigate the flooding.

Figure 9 depicts the Ohio River/City Watershed Vulnerability Score. This map details areas of high vulnerability based on several different factors, such as Regulatory Floodplain, Combined Sewer Flood-prone Areas, Repetitive Loss Properties, Severe Repetitive Loss, and Historical Claims data. These variables provide a detailed Risk Score that displays areas at risk based on mapped floodplains and mapped occurrence hotspots. These two factors provide Louisville Metro with a comprehensive understanding of where flooding is occurring, and potentially causing damage. In addition, Figure 9 displays critical facilities and the natural and beneficial functions for open space and wetlands locations.

For more information about where vulnerable populations are located in the Louisville Metro Area, please refer to the Climate Change Vulnerability in Louisville, Kentucky.

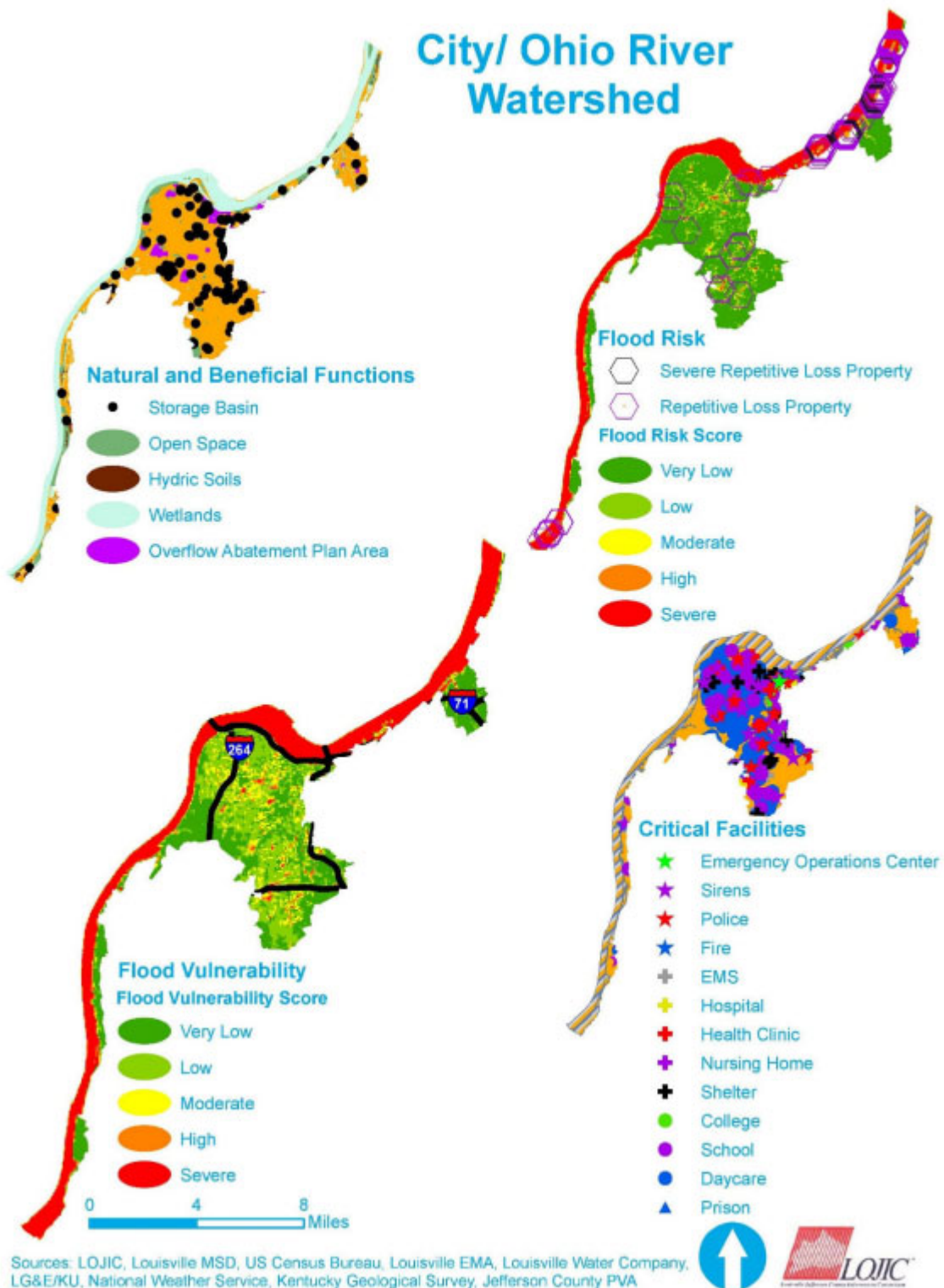


Figure 9. Ohio River Watershed (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.14.2 Middle Fork of the Beargrass Creek Watershed

The Middle Fork of the Beargrass Creek Watershed is in the north-central portion of Louisville Metro and covers about 25 square miles. The 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 of the Beargrass Creek just south of Main Street.

The Middle Fork headwaters run through residential neighborhoods, apartment and condominium complexes, three golf courses, a farm, two shopping malls, two parks in St. Matthews, and past hospitals and shopping centers. The creek parallels I-64 as it passes through Seneca Park, flows on down through Cherokee Park and beside a well-traveled greenway, where it converges with the South Fork, then the Muddy Fork, of the Beargrass Creek. The Middle Fork is the least-modified of the urban streams, has a bedrock or stone bed with riffles and pools in the Olmsted parks, and is fed by small groundwater springs for much of the year.

The major streams in the Middle Fork of the Beargrass Creek Watershed are Middle Fork and Weicher Creek. Communities lying in this watershed include the Highlands, Seneca Gardens, St. Regis Park, St. Matthews, Lyndon, Wildwood, Hurstbourne, Douglass Hills, and Middletown. Regionally notable landmarks in the watershed include Cherokee Park, Seneca Park, Cave Hill Cemetery, the Southern Baptist Seminary, Bowman Field, Big Spring Country Club, Oxmoor Mall, and Hurstbourne Country Club.

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, owned by Louisville Metro, is along Middle Fork Beargrass Creek in the Highlands area. The City of St. Matthews owns two parks, Brown Park and Arthur K. Draut Park, located in the floodplain along Middle Fork of Beargrass Creek near Bowling Boulevard. The Draut Park includes wetlands, which help improve the natural and beneficial functions of the floodplains, as well as water quality for the creek.

The Whipps Mill Basin 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 in Cherokee, Seneca, Bonnycastle, and Cherokee Gardens. The Woodlawn Park Basin is another regional basin in the Middle Fork Watershed.

Figure 10 depicts the Middle Fork Beargrass Creek Watershed Vulnerability Score. This map details areas of high vulnerability based on several different factors, such as Regulatory Floodplain, Combined Sewer Flood-prone Areas, Repetitive Loss Properties, Severe Repetitive Loss, and Historical Claims data. These variables provide a detailed Risk Score that displays areas at risk based on mapped floodplains and mapped occurrence hotspots. These two factors provide Louisville Metro with a comprehensive understanding of where flooding is occurring, and potentially causing damage. In addition, Figure 10 displays critical facilities and the natural and beneficial functions for open space and wetlands locations.

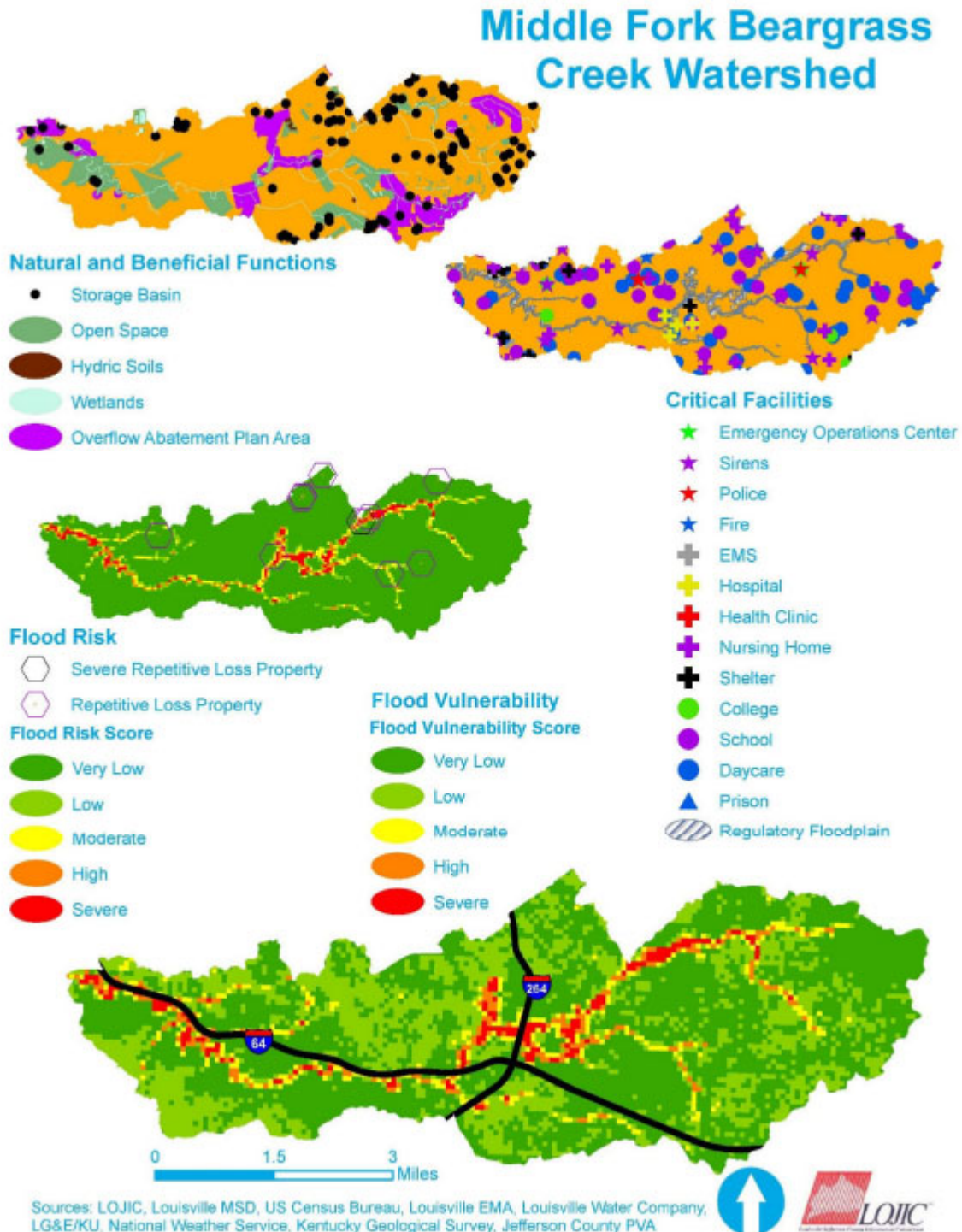


Figure 10. Middle Fork Beargrass Creek Watershed (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.14.3 Muddy Fork of the Beargrass Creek Watershed

The 8-square-mile Muddy Fork Beargrass Creek Watershed is in the north-central portion of Louisville Metro, including Indian Hills and a small part of St. Matthews. Its headwaters originate in the Graymoor/Devondale area. After descending from Indian Hills, Muddy Fork runs parallel to I-71 in the Ohio River floodplain, converging with the Main Stem of Beargrass Creek before emptying into the river. Muddy Fork regularly receives backwater from the Ohio River.

Communities lying in this watershed include Graymoor, Devondale, Crescent Hill, Rolling Fields, Mockingbird Valley, Indian Hills, and Windy Hills. Regionally notable landmarks in the watershed include the Veterans Administration (VA) Hospital, Crescent Hill Park, and the Louisville County Club. No regional basins or major channel improvement projects are in the Muddy Fork Watershed.

Figure 11 depicts the Muddy Fork Beargrass Creek Watershed Vulnerability Score. This map details areas of high vulnerability based on several different factors, such as Regulatory Floodplain, Combined Sewer Flood-prone Areas, Repetitive Loss Properties, Severe Repetitive Loss, and Historical Claims data. These variables provide a detailed Risk Score that displays areas at risk based on mapped floodplains and mapped occurrence hotspots. These two factors provide Louisville Metro with a comprehensive understanding of where flooding is occurring, and potentially causing damage. In addition, Figure 11 also displays critical facilities and the natural and beneficial functions for open space and wetland locations.

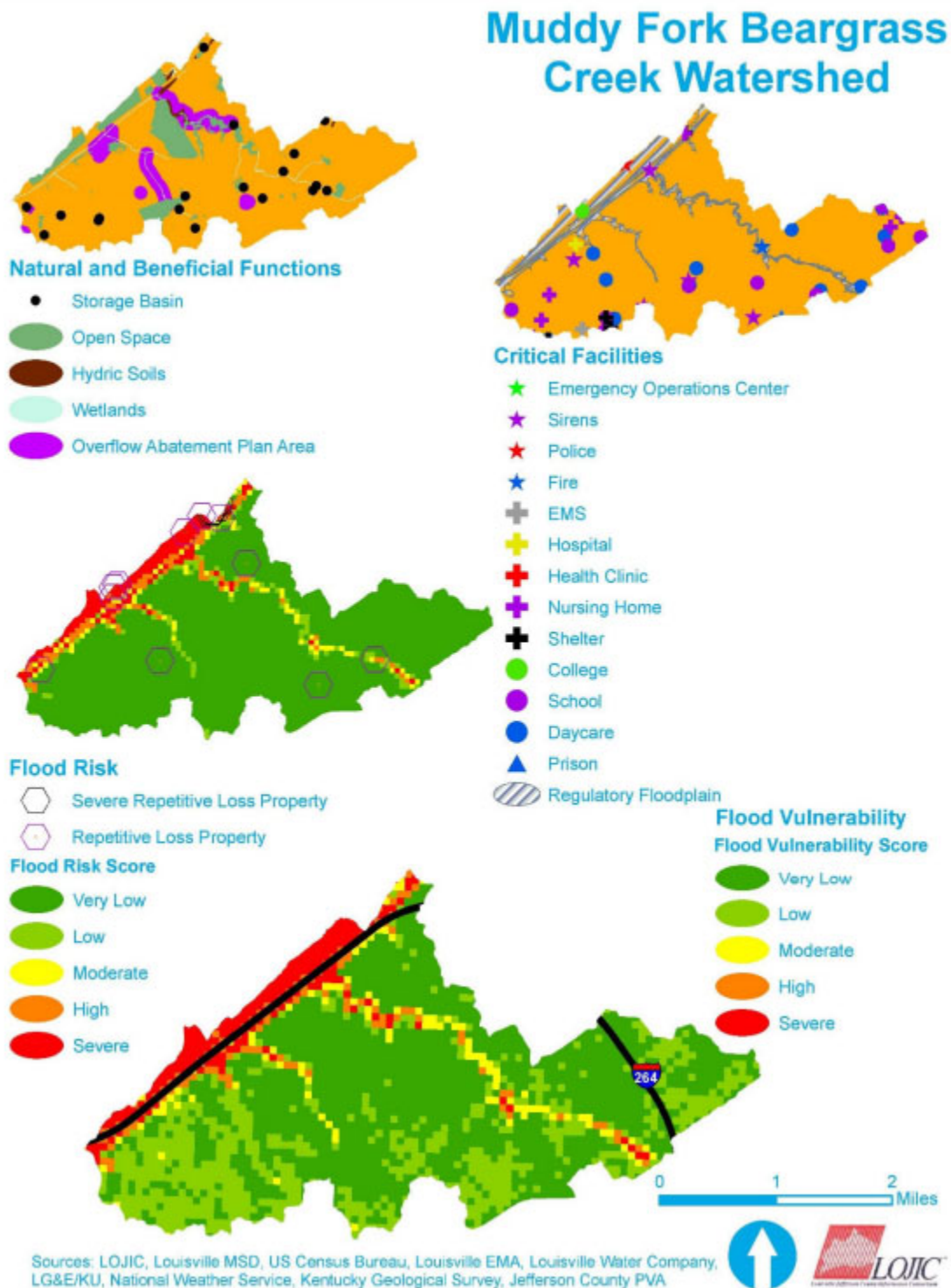


Figure 11. Muddy Fork Beargrass Creek Watershed (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.14.4 South Fork of the Beargrass Creek Watershed

The 27-square-mile South Fork Beargrass Creek Watershed is in the north-central portion of Louisville Metro. Headwaters originate in Jeffersontown 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. The Beargrass Pumping Station is located at this point.

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.

The South Fork drains a significant area of residential and institutional properties, parklands, and cemeteries where it flows in a straightened canal between Newburg Road and Poplar Level Road. At Eastern Parkway, South Fork enters the concrete “improved channel” and flows toward downtown Louisville, where it joins Middle Fork and becomes the Main Stem.

Some tributaries in older portions of town such as Snead’s Branch and the tributary along and under Trevilian Way were enclosed in pipes and converted into sewers during the booming suburban development of the 1890s-1920s. A cave along the creek bank is the only known home of the Louisville Cave Beetle, an endemic species that is listed as a Candidate for endangered species status.

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. Regionally notable landmarks in the watershed include the Beargrass Creek Pumping Station, Calvary Cemetery, the Louisville Zoo, Tyler Park, and Rest Haven Memorial Cemetery. Several parks are in the floodplain of South Fork Beargrass Creek, including Joe Creason Park and the Beargrass Creek State Nature Preserve. Buechel Park is situated 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.

The South Fork Beargrass Creek Flood Protection project was initiated in 2001 and completed in 2010. This was a joint project between the Army Corps of Engineers 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 2,000 feet of channel improvement, 1,900 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, protecting neighborhoods such as Bon Air, West Buechel, and Watterson Park. The basins are near Bashford Manor, Breckenridge Lane, Downing Way, Fountain Square, Hikes Lane, Gerald Court, Richlawn Avenue, and Old Shepherdsville Road. Another regional basin, the Dry Bed Reservoir, also in the South Fork Beargrass Creek Watershed, was constructed in the 1970s to relieve flooding along South Fork to protect assets such as homes, businesses, and infrastructure.

Due to repetitive flooding, some residents living in this watershed have participated in flood acquisition programs. These homes were demolished and the properties have been deed restricted to remain as open space to mitigate the flooding.

Figure 12 depicts the South Fork Beargrass Creek Watershed Vulnerability Score. This map details areas of high vulnerability based on several different factors, such as Regulatory Floodplain, Combined Sewer Flood-prone Areas, Repetitive Loss Properties, Severe Repetitive Loss, and Historical Claims data. These variables provide a detailed Risk Score that displays areas at risk based on mapped floodplains and mapped occurrence hotspots. These two factors provide Louisville Metro with a comprehensive understanding of where flooding is occurring, and potentially causing damage. In addition, Figure 12 also displays critical facilities and the natural and beneficial functions for open space and wetlands locations.

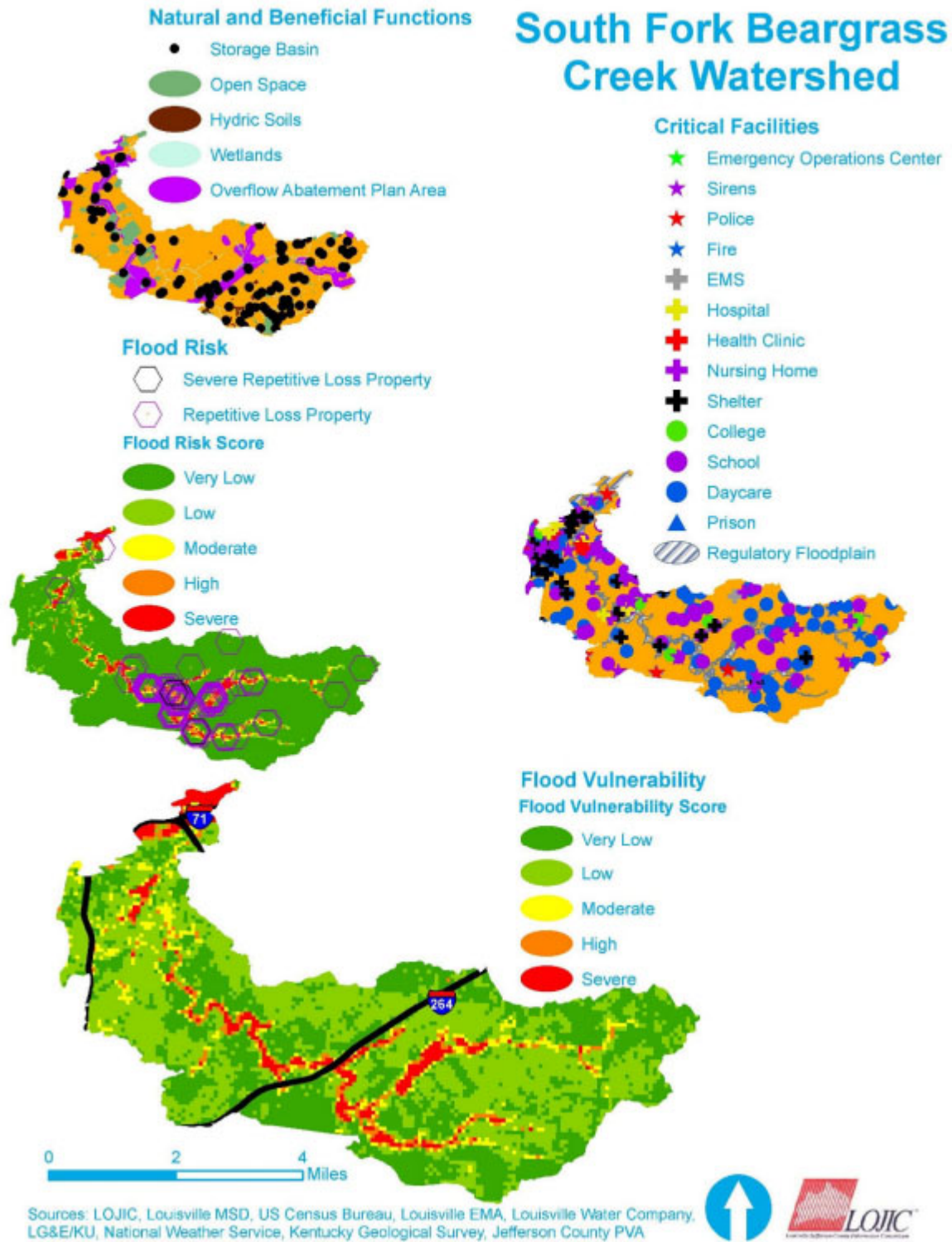


Figure 12. South Fork Beargrass Creek Watershed (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.14.5 Cedar Creek Watershed

The 11-square-mile Cedar Creek Watershed is in south-central Louisville Metro, and contains 57.9 miles of streams. 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. Cedar Creek is the only major stream in this watershed.

Communities lying in this watershed include Fern Creek and Highview. Regionally notable landmarks in the watershed include Beulah Church and Fern Creek High School. Also in this watershed is the Cedar Creek Regional Wastewater Treatment Plant.

The Cedar Creek Watershed has no regional basins or major channel improvement projects. Due to repetitive flooding, one resident living in this watershed participated in a flood acquisition program. This home was demolished and the property was deed restricted to remain as open space to mitigate the flooding.

Figure 13 depicts the Cedar Creek Watershed Vulnerability Score. This map details areas of high vulnerability based on several different factors, such as Regulatory Floodplain, Combined Sewer Flood-prone Areas, Repetitive Loss Properties, Severe Repetitive Loss, and Historical Claims data. These variables provide a detailed Risk Score that displays areas at risk based on mapped floodplains and mapped occurrence hotspots. These two factors provide Louisville Metro with a comprehensive understanding of where flooding is occurring, and potentially causing damage. In addition, Figure 13 also displays critical facilities and the natural and beneficial functions for open space and wetland locations.

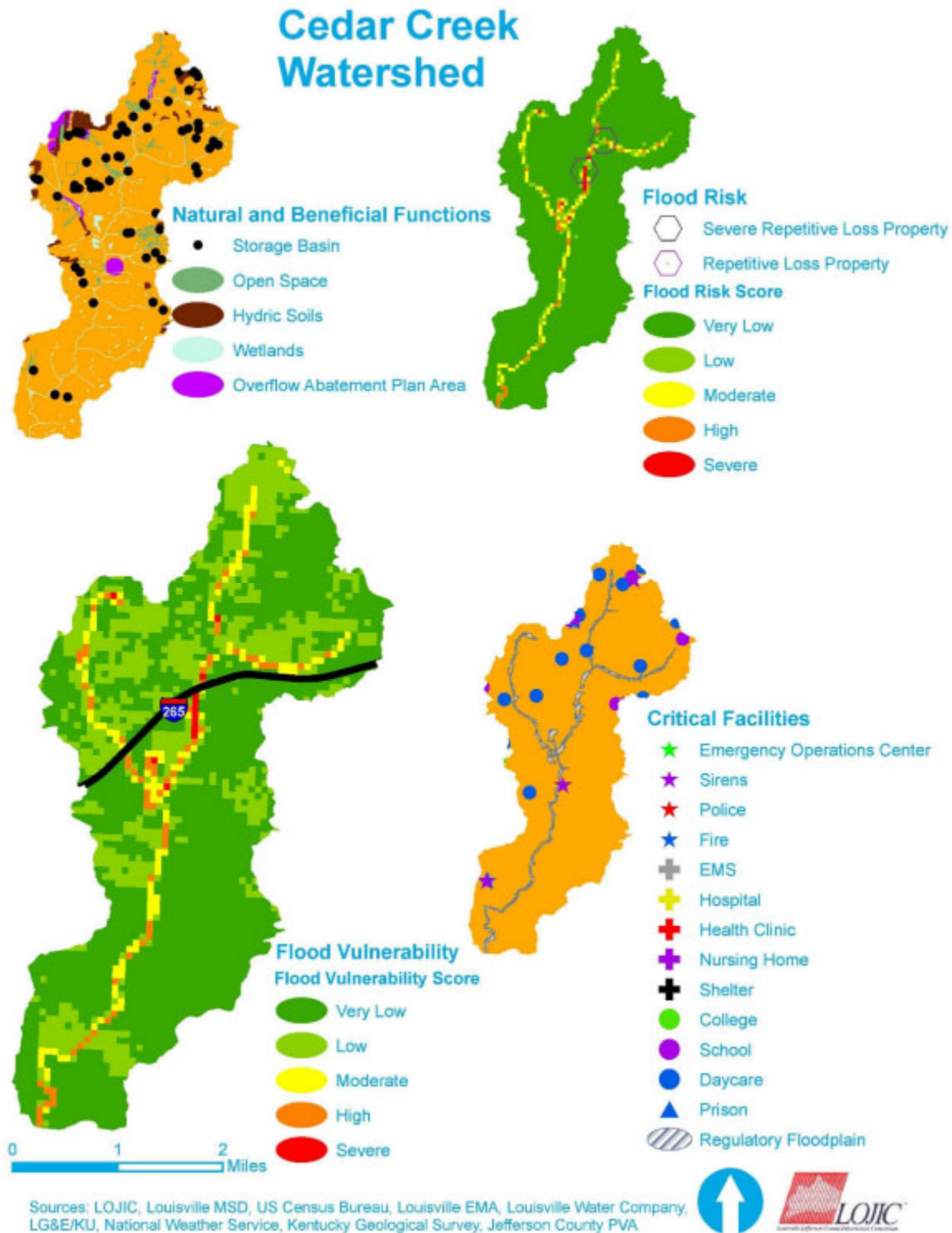


Figure 13. Cedar Creek Watershed (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.14.6 Floyd's Fork Watershed

The Floyds Fork Watershed is in eastern Jefferson County, Henry, Oldham, Shelby, Spencer, and Bullitt Counties. Its headwaters originate in southwest Henry County, approximately 13 miles beyond the Louisville Metro boundary line. Flow is generally southwest through Oldham, Shelby, and Jefferson Counties, and then into Bullitt County, where its outlets into the Salt River. The major streams in this watershed are Floyds Fork, Pope Lick, and Chenoweth Run.

Floyds Fork is the largest watershed in Louisville Metro, covering approximately 103.9 square miles and containing 673.2 stream miles. Floyds Fork, which has a total watershed area of 460 square miles, originates in Trimble County (East Fork), and flows west through Oldham County and enters Louisville Metro at Ash Avenue.

Chenoweth Run is a tributary of Floyds Fork, which originates in the Middletown area and flows south, merging into Floyds Fork. The headwater portion of Chenoweth Run watershed is heavily developed.

Communities in the area include parts of Jeffersontown, Middletown, Anchorage, Berrytown, Woodland Hills, Tucker Station, and Hopewell. Regionally notable landmarks in the watershed include the Parklands of Floyds Fork, Chenoweth Park, Valhalla Golf Course, Midland Trail Golf Course, parts of Bluegrass Industrial Park, Eastern High School, and Jeffersontown High School. Existing parks along Floyds Fork include the Parklands of Floyds Fork, which provides open space that will be preserved along Floyds Fork. The nonprofit organizations City of Parks, Future Fund, and 21st Century Parks have purchased and preserved nearly 4,000 acres in the Floyds Fork watershed, including nearly 2,000 acres of the floodplain along the creeks. For more information on this effort, please refer to The Parklands of Floyds Fork.

There are no regional basins or major channel improvement projects in the Floyds Fork Watershed. Due to repetitive flooding, some residents living in this watershed have participated in flood acquisition programs. These homes were demolished and the properties have been deed restricted to remain as open space to mitigate the flooding.

Figure 14 depicts the Floyd's Fork Watershed Vulnerability Score. This map details areas of high vulnerability based on several different factors, such as Regulatory Floodplain, Combined Sewer Flood-prone Areas, Repetitive Loss Properties, Severe Repetitive Loss, and Historical Claims data. These variables provide a detailed Risk Score that displays areas at risk based on mapped floodplains and mapped occurrence hotspots. These two factors provide Louisville Metro with a comprehensive understanding of where flooding is occurring, and potentially causing damage. In addition, Figure 14 also displays critical facilities and the natural and beneficial functions for open space and wetland locations.

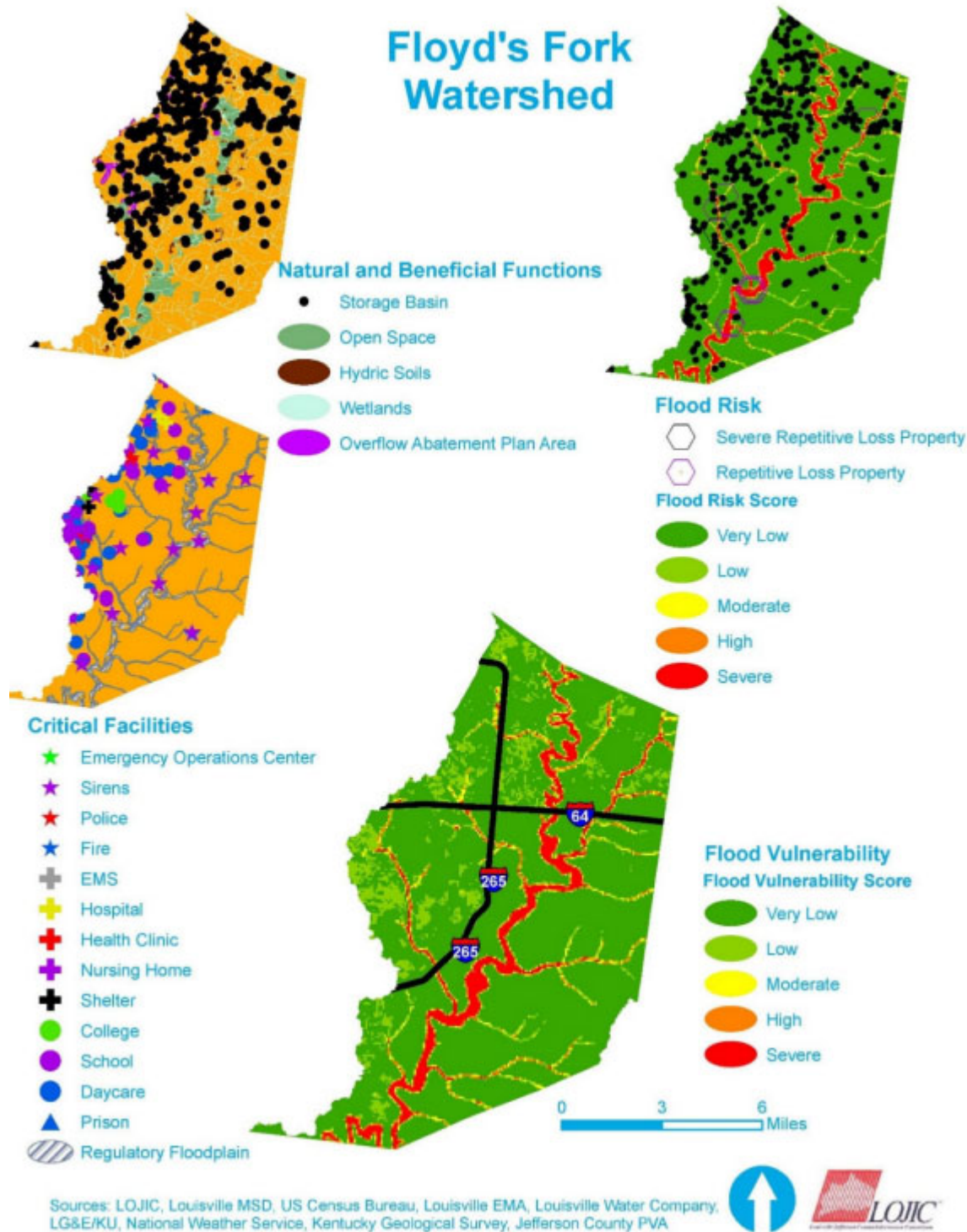


Figure 14. Floyd's Fork Watershed (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.14.7 Goose Creek Watershed

The Goose Creek of the Ohio River Watershed has an area of approximately 18.5 square miles, and contains Goose Creek of the Ohio River and Little Goose Creek of Goose Creek. This watershed is in northeastern Louisville Metro 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, flows northwesterly, and eventually discharge into Goose Creek about one-half mile from its outlet on 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. Regionally notable landmarks in the watershed 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 along Goose Creek and provides open space and wetland areas that will be preserved. E.P. "Tom" Sawyer State Park is another park along Goose Creek that provides open space that will be preserved.

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

Figure 15 depicts the Goose Creek Watershed Vulnerability Score. This map details areas of high vulnerability based on several different factors, such as Regulatory Floodplain, Combined Sewer Flood-prone Areas, Repetitive Loss Properties, Severe Repetitive Loss, and Historical Claims data. These variables provide a detailed Risk Score that displays areas at risk based on mapped floodplains and mapped occurrence hotspots. These two factors provide Louisville Metro with a comprehensive understanding of where flooding is occurring, and potentially causing damage. In addition, Figure 15 also displays critical facilities and the natural and beneficial functions for open space and wetland locations.

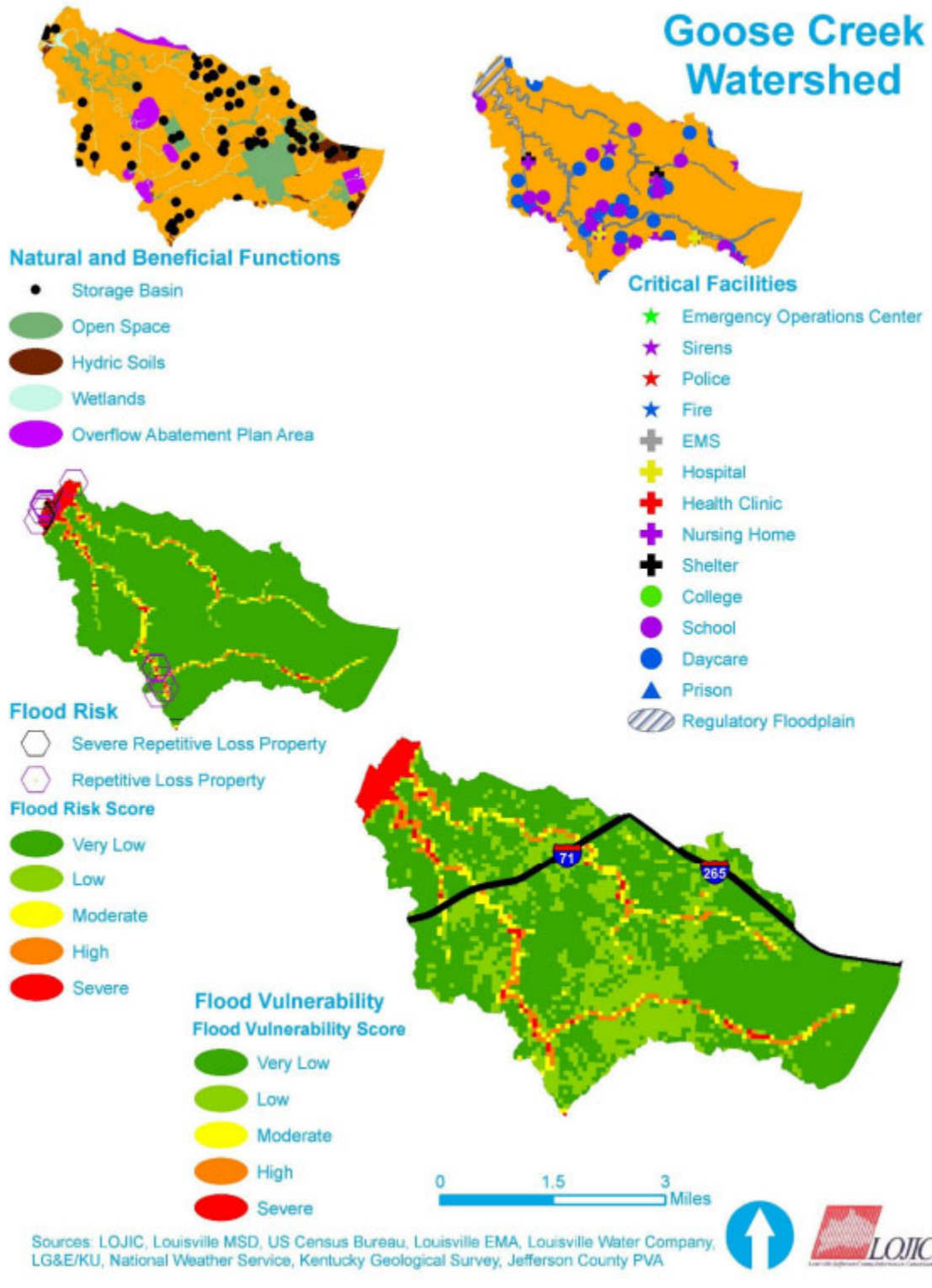


Figure 15. Goose Creek Watershed (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.14.8 Harrods Creek Watershed

The 180-square-mile Harrods Creek Watershed is in northeastern Jefferson County, Oldham, and Henry Counties. Its headwaters originate in the area east of La Grange, 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 Louisville Metro line. From this point, the flow continues southwest through Louisville Metro 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.

Only 15.3 square miles of the Harrods Creek Watershed lies within Louisville Metro. Wolf Pen Branch, a tributary of Harrods Creek, originates in the Worthington area and flows northwest, merging into Harrods Creek and eventually flowing into the Ohio River.

Communities in the study area include Fincastle, Ballardsville, Pewee Valley, Lake Louisville, Worthington, and Prospect. Regionally notable landmarks in the watershed include the Ford Motor Company Kentucky Truck Plant and Hunting Creek Country Club.

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

Figure 16 depicts the Harrods Creek Watershed Vulnerability Score. This map details areas of high vulnerability based on several different factors, such as Regulatory Floodplain, Combined Sewer Flood-prone Areas, Repetitive Loss Properties, Severe Repetitive Loss, and Historical Claims data. These variables provide a detailed Risk Score that displays areas at risk based on mapped floodplains and mapped occurrence hotspots. These two factors provide Louisville Metro with a comprehensive understanding of where flooding is occurring, and potentially causing damage. In addition, Figure 16 also displays critical facilities and the natural and beneficial functions for open space and wetland locations.

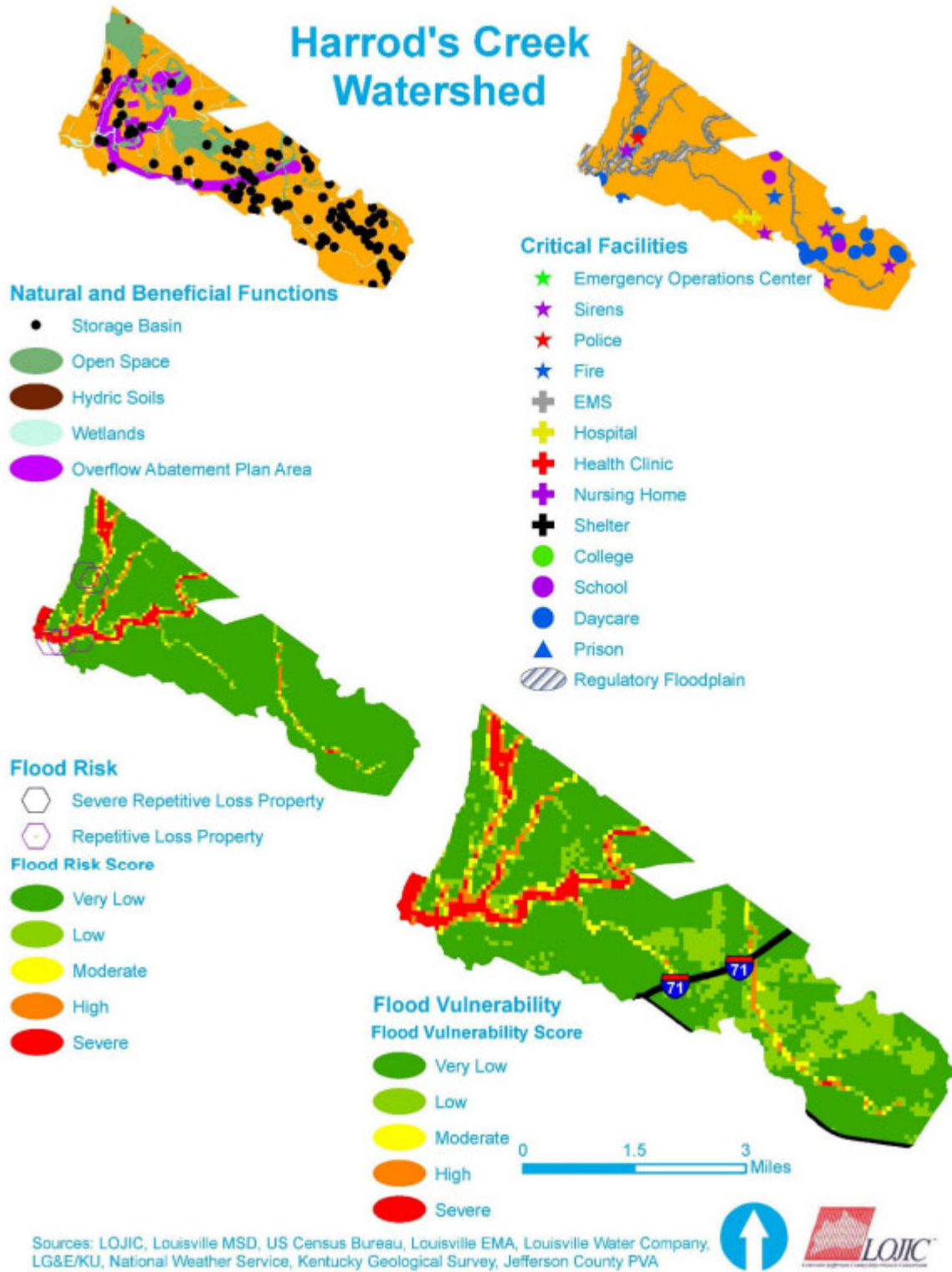


Figure 16. Harrods Creek Watershed (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.14.9 Mill Creek

The 34-square-mile Mill Creek Watershed is in the western portion of Louisville Metro, and contains 156.8 stream miles, most of it in modified drainage channels. The Mill Creek Cutoff was constructed many years ago to re-route the upper watershed directly to the Ohio River. The Mill Creek Cutoff collects stormwater from the northern end of Iroquois Park, Pleasure Ridge Park, and Shively areas.

Due to the diversion of the upstream reaches of Mill Creek into the cut-off channel, this watershed is divided into two entirely separate sections: 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.

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, Lynnvew 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 in the Riverside Gardens area near the stream outlet. This flood pumping station is part of the flood levee system that protects Louisville Metro from Ohio River flooding.

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 mile upstream of the mouth of Lower Mill Creek. This flood pumping station is part of the flood levee system that protects Louisville Metro from Ohio River flooding.

Communities lying in the Upper Mill Creek section include Shively, Heatherfield, Hunters Trace, Parkwood, St. Denis, and Riverside Gardens. Regionally notable landmarks in the watershed 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 on Mill Creek near Lower River Road. This park provides preserved open space along Mill Creek.

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. Regionally notable landmarks in the watershed include Sun Valley Community Park, Valley High School, Waverly Park, and the Louisville and Jefferson County Riverport Authority.

The Wheeler Basin is a regional basin in the Mill Creek Watershed. The basin was constructed to relieve flooding from the combined sewer system. Two other regional basins, Gagel Ave and Stallings Ave, are currently under study to determine if basin outlet modifications or the installation of water quality best management practices can reduce downstream flooding for smaller storms. Several MSD funded property acquisitions have occurred in this area to address localized repetitive flooding issues.

MSD and the USACE have also completed a flood 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.

Figure 17 depicts the Mill Creek Watershed Vulnerability Score. This map details areas of high vulnerability based on several different factors, such as Regulatory Floodplain, Combined Sewer Flood-prone Areas, Repetitive Loss Properties, Severe Repetitive Loss, and Historical Claims data. These variables provide a detailed Risk Score that displays areas at risk based on mapped floodplains and mapped occurrence hotspots. These two factors provide Louisville Metro with a comprehensive understanding of where flooding is occurring, and potentially causing damage. In addition, Figure 17 also displays critical facilities and the natural and beneficial functions for open space and wetland locations.

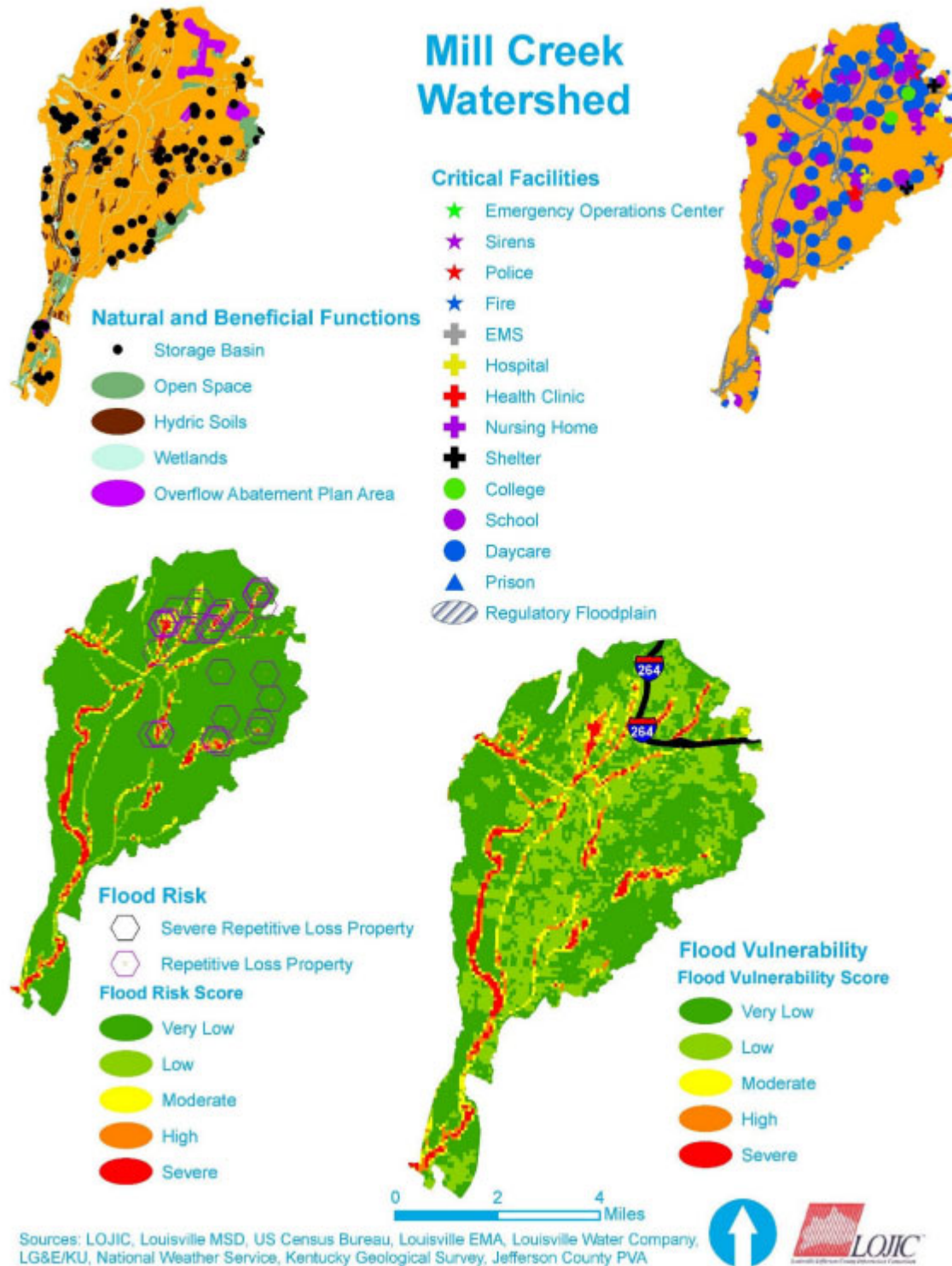


Figure 17. Mill Creek Watershed (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.14.10 Pennsylvania Run Watershed

The 7-square-mile Pennsylvania Run Watershed is in south-central Louisville Metro, and contains 33.4 stream miles, most of which are intermittent and ephemeral streams, with the exception of McNeeley Lake, a small recreational reservoir. 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. Pennsylvania Run is the only major stream in this watershed.

Regionally notable landmarks in the watershed include McNeely Lake and McNeely Lake Park. McNeely Lake Park is along Pennsylvania Run and provides preserved open space. No regional basins or major channel improvement projects are in the Pennsylvania Run Watershed.

Figure 18 depicts the Pennsylvania Run Watershed Vulnerability Score. This map details areas of high vulnerability based on several different factors, such as Regulatory Floodplain, Combined Sewer Flood-prone Areas, Repetitive Loss Properties, Severe Repetitive Loss, and Historical Claims data. These variables provide a detailed Risk Score that displays areas at risk based on mapped floodplains and mapped occurrence hotspots. These two factors provide Louisville Metro with a comprehensive understanding of where flooding is occurring, and potentially causing damage. In addition, Figure 18 also displays critical facilities and the natural and beneficial functions for open space and wetland locations.

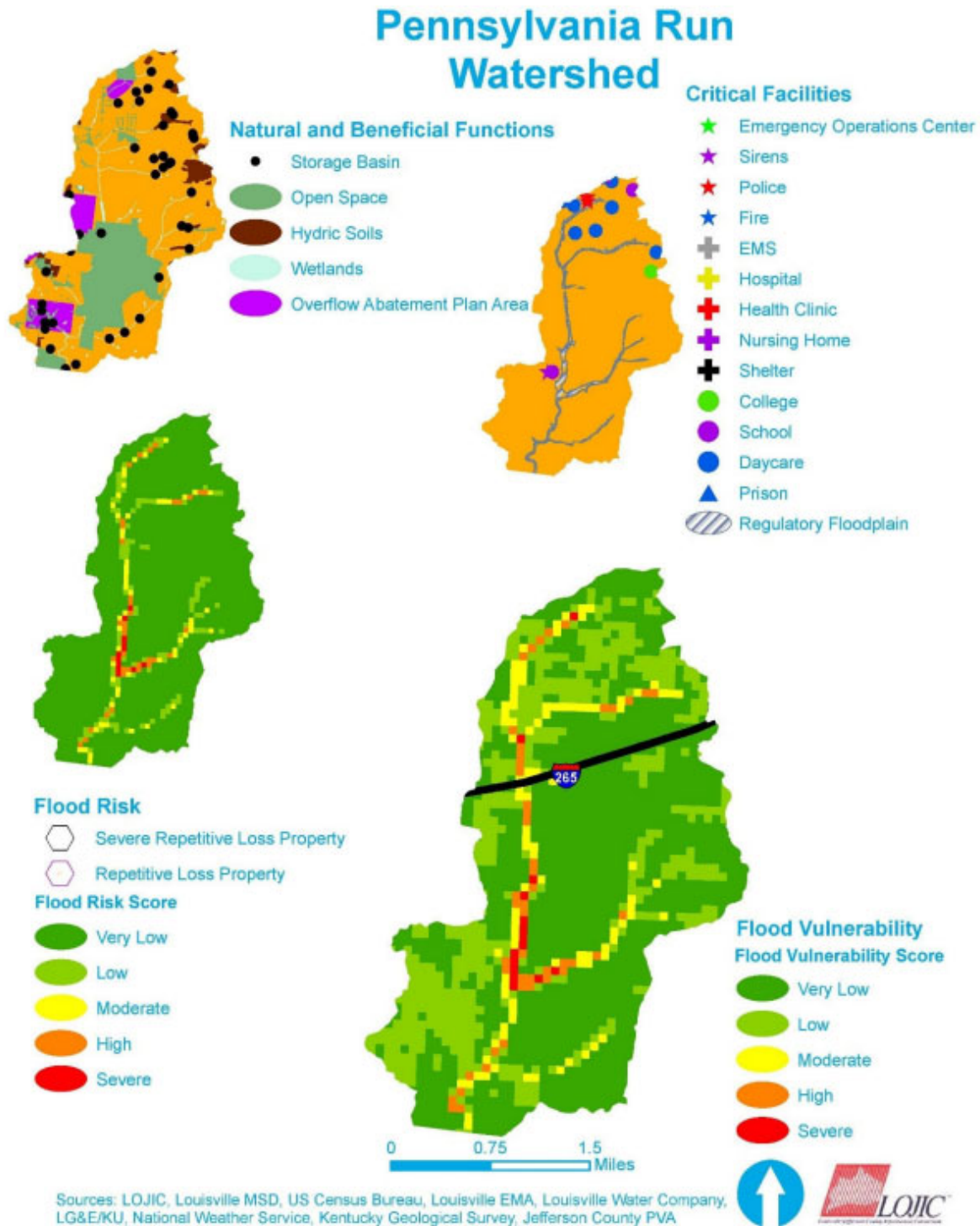


Figure 18. Pennsylvania Run Watershed (Source: Louisville Metro 2023 Hazard Mitigation Plan)

3.14.11 Pond Creek Watershed

The 94-square-mile Pond Creek Watershed is in south-central and southwest Louisville Metro, and contains 649.6 stream miles in Louisville Metro. 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 western 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, Guardian Creek, Duck Spring Branch, Salt Block Creek, Slate Run, Bearcamp Run, Crane Run, Brier Run, and Weaver Run.

Once a backwater slough for the Ohio River floodplain, with shallow lakes and swampy forests called "wetwoods," the hydrology of the central and lower reaches of this watershed have been completely modified over the past two centuries, which resulted in draining the wet areas to make the land developable; however the flood risk still remains. Upstream subwatersheds in the Pond Creek watershed include Fern Creek, Fishpool Creek, Mud Creek and Wilsons Creek. Bee Lick, Manslick, Wetwoods Creek, Guardian Creek, Blue Spring Ditch, Duck Spring Branch, and other channelized drainage ditches also feed into the central drainage canals, called Northern Ditch and Southern Ditch.

Brier Creek along the southern border of the county is in a rural valley in the Knobs, below Jefferson County Memorial Forest. Brier Creek originates in Metz Gap and Jefferson Hill, close to the Jefferson County Memorial Forest, and flows west before merging into Pond Creek.

Communities situated in this watershed include parts of Jeffersontown, Fern Creek, Highview, Newburg, Smyrna, Okolona, Lynnvew, Auburndale, Fairdale, Prairie Village, Medora, Orell, and part of Valley Station. Regionally notable landmarks in the watershed include the Louisville International Airport, General Electric's Appliance Park, Ford Louisville Assembly Plant, Jefferson Mall, part of Iroquois Park, Komosdale Cement Plant, and much of the Jefferson County Memorial Forest.

The first regional basin built by MSD was the Roberson Run Basin, a small basin constructed in the early 1990s. The basin protects the Louisville Airport, neighborhoods, schools, medical clinics, and other critical facilities. Although the impacts on flooding are minimal by today's standards, the basin is a multi-use facility with the incorporation of walking paths around the basin that link adjoining residential areas.

In 1998, MSD, Jefferson County Government, and the U.S. Army Corps of Engineers 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 incorporates greenway principles that provide pedestrian access to Pond Creek. Walking and biking paths help connect neighborhoods. The project also improves water quality along Pond Creek. A description of each phase of the project is listed below.

- Phase I: The Okolona Wetlands Restoration Site is an environmental restoration of 15 acres of wetlands in a former sludge lagoon at the former Okolona Wastewater Treatment Plant. The restoration process includes 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, a former limestone quarry. The basin was designed to fill during a 24-hour storm event, and drain over a period of approximately 8 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-inch pipe was placed through the dam to maintain base flows.

- Phase III: The Melco Detention Basin behind the Ford Louisville Assembly 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 were also completed. This phase includes 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.

In addition to the Army Corps of Engineers project, MSD has also worked with a private company to create a floodplain and runoff compensation bank in the Pond Creek Watershed. This compensation bank is funded through private development. It consists of three basins which have been completed. Pond 1 is near I-65 and the Outer Loop, and is 80 acre-feet. Pond 2 is near Wilson Creek and the Gene Snyder Freeway, and is 26.5 acre-feet. Pond 3 is at National Turnpike and is 234 acre-feet. These ponds also function as wetland mitigation banks.

MSD also 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.

Due to repetitive flooding, some residents living in this watershed have participated in flood acquisition programs. These homes were demolished and the properties have been deed restricted to remain as open space to mitigate the flooding.

Figure 19 depicts the Pond Creek Watershed Vulnerability Score. This map details areas of high vulnerability based on several different factors, such as Regulatory Floodplain, Combined Sewer Flood-prone Areas, Repetitive Loss Properties, Severe Repetitive Loss, and Historical Claims data. These variables provide a detailed Risk Score that displays areas at risk based on mapped floodplains and mapped occurrence hotspots. These two factors provide Louisville Metro with a comprehensive understanding of where flooding is occurring, and potentially causing damage. In addition, Figure 19 also displays critical facilities and the natural and beneficial functions for open space and wetland locations.

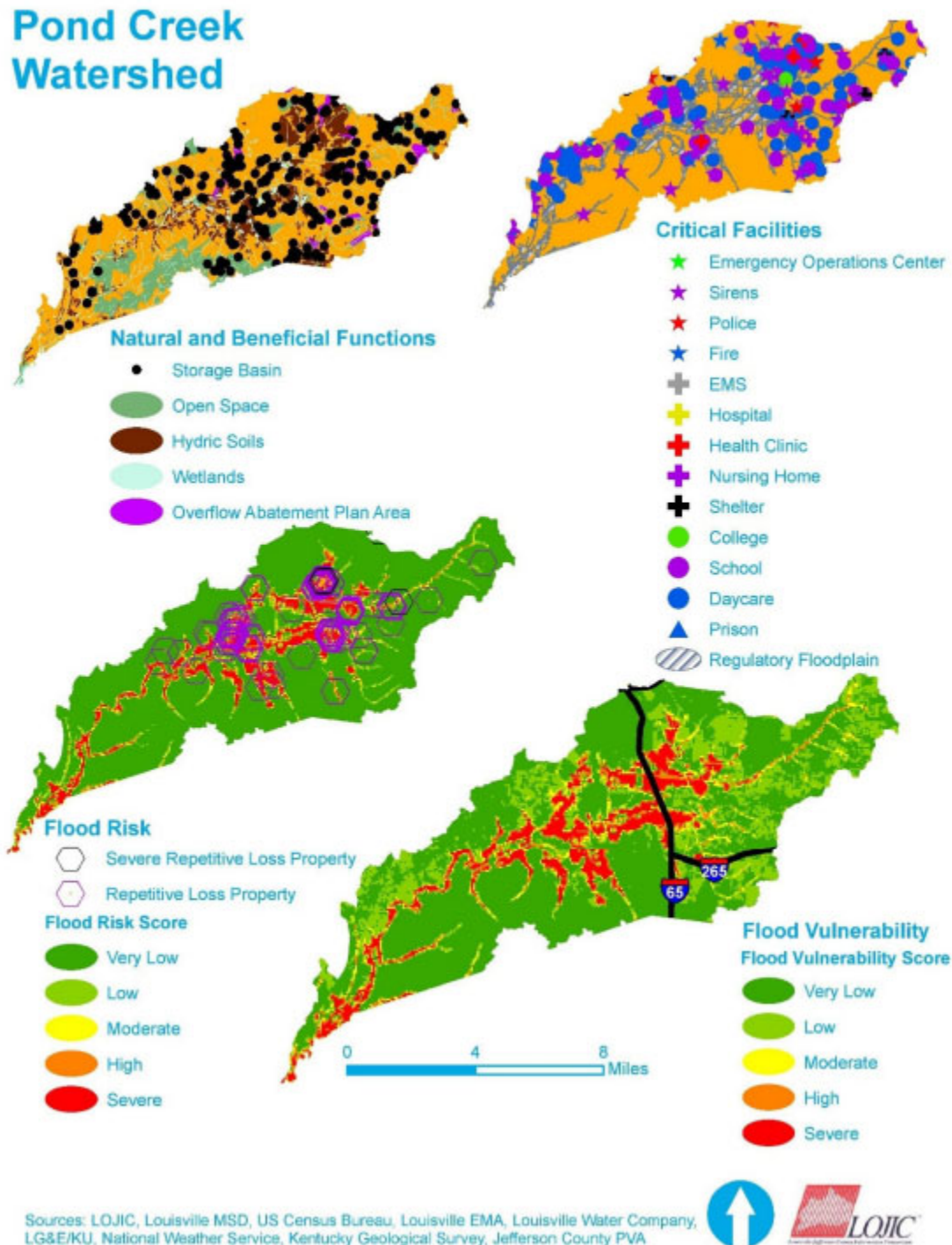


Figure 19. Pond Creek Watershed (Source: Louisville Metro 2023 Hazard Mitigation Plan)

4.0 GOALS AND OBJECTIVES

4.1 Goals

The basis of this plan is the Louisville Metro 2023 Hazard Mitigation Plan. Goals of the Hazard Mitigation Plan are shown in Table 12.

Table 12. 2023 Louisville Metro Hazard Mitigation Plan Goals

- | | |
|----|--|
| 1. | Minimize the loss of life and injuries that could be caused by multi-hazards. |
| 2. | Facilitate a sustainable economy by protecting agriculture, business, and other economic activities from multi-hazards. |
| 3. | Facilitate the strengthening of public emergency services, its infrastructure, facilities, equipment, and personnel to multi-hazards. |
| 4. | Develop a community-wide mitigation effort by building stronger partnerships between government, businesses, and the general public. |
| 5. | Increase public and private understanding of multi-hazard mitigation through the promotion of mitigation education and awareness of multi-hazards. |
| 6. | Enhance existing or design new policies and technical capabilities that will reduce the effects of multi-hazards. |
| 7. | Enhance existing technical and GIS data and capabilities that will reduce the effects of multi-hazards. |
| 8. | Promote the development of policies, programs, initiatives, and projects that prioritize diversity, equity, and environmental justice. |

The Floodplain Management Plan planning group reviewed the goals developed for the Hazard Mitigation Plan and decided to write specific goals for the Floodplain Management Plan. The goals for the Floodplain Management Plan are shown in Table 13 below. These goals were used to help guide proposed mitigation projects listed in Section 5.0 Preventative Measures.

Table 13. Floodplain Management Plan Goals

- | | |
|----|--|
| 1. | Reduce the loss of life and injuries that could be caused by flooding. |
| 2. | Reduce the impacts to property that could be caused by flooding. |
| 3. | Promote flood safety and awareness of flood impacts. |
| 4. | Protect and improve natural floodplain functions. |

5.0 PREVENTATIVE MEASURES

5.1 Preventative Activities

Through the Watershed Master Plan, 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. The existing regulations ensure that new development does not adversely impact existing development and new development is reasonably safe from flooding. Below is an overview of regulations that impact stormwater and floodplain management.

New construction and additions in the floodplain are required to be elevated or floodproofed (non-residential only) to the freeboard elevation. Freeboard is defined as one foot above the local regulatory floodplain for non-residential structures and two feet for residential structures. All mechanical and electrical equipment must be at least two feet above the local regulatory flood elevation. All substantially improved or damaged buildings must also meet the new construction requirements.

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.

For new development in the combined sewer area, the post-developed 100-yr flows are restricted to the pre-developed 10-yr flows to help reduce the flows in the system during rain events. Engineers must design the new development's onsite stormwater system to meet this MSD Design Manual requirement. 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 throughout Jefferson County for any fill placed in the fully developed local regulatory floodplain as stated in the Louisville Metro Floodplain Management Ordinance. Floodplain compensation of 1.5 times the displaced storage capacity is required. 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 perennial and intermittent streams as defined by the USGS 7.5 minute topographic maps. In addition, perennial and intermittent 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).

Chapter 4 Part 8 of the Louisville Metro Land Development code establishes minimum buffer areas along protected waterways, including: perennial and intermittent streams or rivers, wetlands, and other water bodies. The "Jefferson Protected Waterways" and "Jefferson Potential Wetlands (Hydric Soil)" LOJIC GIS mapping layers are used to identify these sensitive features during preliminary development planning. The delineation of wetland boundaries is established using Hydric Soils as a preliminary indicator of potential wetland areas and the need for further investigation. Development standards encourage areas of sensitive features to be preserved and dedicated as open space. Many residential subdivision projects within Jefferson County include the reservation of open space and/or woodland protection areas to further protect sensitive features such as wetlands, steep slopes, and floodplain and stream buffers.

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 perennial streams should use natural or “soft” approaches where possible. MSD’s Design Manual outlines natural channel design requirements in Section 10.3.6.

Water quality and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Water quality practices 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 2,000 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.

Current floodplain and stormwater regulations are generally considered sufficient to meet current needs; however, future changes to development standards will likely include updates to the rainfall data used for design purposes. The MSD Design Manual currently uses Division of Water Resources Department for Natural Resources and Environmental Protection Engineering Memorandum No. 2 (4-30-71, rev 6-1-79) data; however, this is planned to be updated to the NOAA Atlas-14 Precipitation-Frequency Atlas of the United States data with the MSD Design Manual updates that are currently underway. Based on feedback from the Floodplain Management Plan Committee, expanded stream buffers may also be considered in the future.

5.2 Property Protection Activities

Where flooding occurs along the Ohio River, residents typically have 2 to 3 days of notice to evacuate. However, elsewhere in Jefferson County, flash flooding is a greater risk because of the suddenness and unpredictability of localized flooding events. This leaves residents with little or no time to evacuate since roadways in these areas are also at risk of flooding. It also creates risk to emergency personnel because boat rescues may be required. For these reasons, there are limited opportunities to reduce flood risk by elevating or floodproofing structures and floodplain buyouts are the preferred method of flood mitigation in most cases. MSD has purchased over 300 floodprone properties through Louisville Metro. These properties are deed restricted from future development to ensure additional risk is not created on the properties.

MSD routinely reaches out to homeowners who have suffered repetitive flooding to survey interest in participating in a buyout program. Buyouts are funded by both MSD and FEMA Hazard Mitigation Assistance Buyout Programs as funds become available. Floodplain grant buyouts are voluntary. Completed interest surveys from property owners are kept on file and referenced when determining which properties to include in grant applications. Funding is limited. Projects that are not approved because of limited funding are kept on file should funding become available in the future. Once submitted, grant approval by FEMA can take 12 months or longer. Following the purchase of a grant property, the structures are demolished and the property deed restricted. Future uses are limited to those which would provide open space.

Recently, MSD carried out a planning study to prioritize properties for future buyout programs that analyzed the Special Flood Hazard Area, Local Regulatory Floodplain, and First Street Foundation Flood Factor data. Flood Factor data was included because it provides flood information at the property level for future climate scenarios as well as risks associated with pluvial flooding that would not be included in riverine flood zone mapping. Based on this study, homes anticipated to experience 2 feet or more of flooding during a 100-year flood event will be prioritized for future buyout grant applications. In addition to

the floodplain buyouts, MSD has completed one project to elevate a floodprone home and also completed one project to relocate a historic structure that was prone to flooding to a location above the floodplain.

MSD also offers a plumbing modification program to mitigate the impacts of sewer backups. Under MSD's Plumbing Modification Program, over 18,000 backflow prevention devices have been installed throughout the county. Of those devices, over 500 were located in the regulatory floodplain.

MSD also promotes the purchase of flood insurance to help the community prepare for future floods. Through the Program for Public Information Plan, MSD has created a Coverage Improvement Plan (CIP) to encourage the purchase of flood insurance. Projects included in the CIP are shown in Table 14. These projects are conducted annually.

Table 14. Coverage Improvement Plan				
Project Name	Description	Outcome	Assigned	Schedule
Target Audience 1. General Public				
CIP#1. Council Person Newsletters	Include article in council person newsletters or email blasts related to flood insurance.	Increase in flood insurance policies throughout the county	Floodplain Manager	Sent by Dec 31 st
CIP#2. MSD Streamline eNewsletter	Article in newsletter about flood insurance	Increase in flood insurance policies throughout the county	Floodplain Manager	Sent by Dec 31 st
CIP#3. MSD Website	Maintain flood insurance web page on MSD website.	Increase in flood insurance policies throughout the county	Floodplain Manager	Ongoing
CIP#4. Flood Insurance Information @ MSD Office	Brochures and handouts related to flood insurance in kiosk in lobby.	Increase in flood insurance policies throughout the county	Floodplain Manager	Brochures replaced as needed
CIP#5. Flood Insurance Information @ Kentucky State Fair	Brochure related to flood insurance available at Kentucky State Fair	Increase in flood insurance policies throughout the county	Floodplain Manager	Summer
CIP#6. Flood Insurance Social Media	Use Twitter, Facebook or other social media to engage public about flood insurance	Increase in flood insurance policies throughout the county	Public Relations Specialist	At least 2 posts by Dec 31 st
Target Audience 2. Floodplain Residents and Repetitive Loss Properties				
CIP#7. Flood insurance flyer to floodplain/ repetitive loss properties	Include flood insurance flyer in annual letter to floodplain residents and repetitive loss properties	Increase in flood insurance policies in the floodplain	Floodplain Manager	Sent by Dec 31 st
Target Audience 3. Builders and Remodelers				
CIP#8. Building Industry Association/Land Development Committee	Include at least one presentation or newsletter annually related to flood insurance.	Increase knowledge about flood insurance	Floodplain Manager	Meeting by Dec 31 st
Target Audience 4. Real Estate, Lending, and Insurance Companies				
CIP#9. Presentations	Presentations related to flood insurance and floodplain issues	Increase knowledge about flood insurance	Floodplain Manager	2 meetings by Dec 31 st

5.3 Natural Resource Protection Activities

In order to protect natural areas and natural functions of floodplains, several regulatory requirements have been adopted to reduce impacts from development. Examples of these regulatory requirements are listed below:

- 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 perennial and intermittent streams as defined by the USGS 7.5 minute topographic maps. In addition, perennial and intermittent 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.
- 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 perennial streams should use natural or “soft” approaches where possible. MSD’s Design Manual outlines this requirement in Section 10.3.6.
- The Louisville/Jefferson County Erosion Prevention and Sediment Control Ordinance requires developments with 2,000 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.
- Water quality and post-construction requirements are listed in Article 6 of the Wastewater Discharge Regulations. Water quality practices 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.

Many projects have also been constructed to improve and protect natural areas and the natural floodplain functions throughout Louisville Metro. Examples of these projects are listed below.

- MSD partnered with the Louisville Jefferson County Environmental Trust to complete a restoration project along the banks of a tributary to Middle Fork Beargrass Creek in a conservation easement along Grinstead Drive. The project installed native plants, trees and shrubs in an effort to reduce erosion and improve water quality of roadway drainage before it enters the stream.
- Metro Parks and the U.S. Army Corps of Engineers partnered in a planning effort entitled: “Beargrass Creek Trail Conceptual Shared Use Path and Ecological Restoration Plan.” The plan area extended along Beargrass Creek from its confluence with the Ohio River to the area of the Grinstead Drive/Lexington Road intersection.
- MSD and the U.S. Army Corp of Engineers worked together on the Three Forks of Beargrass Creek Ecosystem Restoration Feasibility Study that includes South, Middle, and Muddy forks of Beargrass Creek. The project investigated options to restore ecosystem structure, function and processes lost over time in the watershed. The study recommendations were completed in May 2022 with a signed Chief’s Report.
- A stream restoration in Cherokee park realigned the stream channel through a bridge and implemented methods to reduce erosion including: vane structures, pools, and toe wood and soil bioengineering techniques.

- Stream restoration at Brown Park - Realignment of Beargrass Creek in the City of St Matthews Brown Park. This work stabilized 1,050 linear feet of the flow line and banks of the creek by installing bank protection, j hooks, riffles, brush layering and log vane structures.
- Stream restoration at the City of St Matthews Community Center Park restored sections of two intermittent stream channels totaling 2,600 linear feet by planting vegetation to prevent additional erosion of the stream bank.
- MSD completed several green infrastructure projects in this watershed to improve water quality and reduce runoff including tree boxes and pervious pavers near CSO 130, which is in the Butchertown neighborhood.
- The South Fork Beargrass Creek Flood Protection project 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 2,000 feet of channel improvement, 1,900 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.
- In 2016, MSD initiated the Bartley Stream Restoration Project. The project purchased and removed one home located in the floodplain. This riparian area was then restored to a natural stream buffer. Trees, shrubs and grasses were planted along the stream buffer to improve the stream health by adding shade and habitat along Cedar Creek.
- 21st Century Parks, along with the City of Louisville and Future Fund, acquired nearly 4,000 acres of land to create the Parklands of Floyds Fork. This public park system 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 the natural habitat of several endangered species.
- CSO190 Green Infrastructure – Water quality practices in CSO190 with an investment of nearly 6.5 million dollars, treating 96 acres of impervious surface. Green infrastructure implemented through this project reduced overflows to 8 overflows per Typical Year.
- Churchill Downs Parking Lot Improvements – Churchill Downs is located in close proximity to two of MSD's largest combined trunk sewers each having a large combined sewer overflow. Churchill Downs and MSD partnered to design and construct three oversized underground infiltration basins on the Churchill Downs property. These basins mitigate the impact of the existing impervious parking lot area. The basins have a combined 4-million-gallon storage capacity, capture more than 73 million gallons of water annually and will prevent about 15 million gallons of sewer overflow each year.



Bartley Drive Stream Buffer Restoration

- University of Louisville Green Infrastructure – The University of Louisville worked with Louisville MSD to install various green infrastructure projects to keep stormwater runoff out of the combined sewer system. Projects include pervious pavement, a green roof, and infiltration basins. These projects divert about 72 million gallons of stormwater from the combined sewer system annually.
- 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 to Pond Creek.

5.4 Emergency Services Measures

Emergency Warning

The Louisville Metro Emergency Services department consists of four divisions. Emergency Medical Services operates Louisville Metro's rescue vehicles and is the primary medical care provider during emergencies. MetroSafe 911 takes emergency calls and connects residents to the police, fire department, emergency medical assistance, and other first responders. It acts as Louisville Metro's primary emergency help line. Metro311 takes non-emergency calls and provides general government customer service. It serves as the main voice connection to city government. Finally, the Emergency Management Agency coordinates the work of 95+ agencies during disasters. It supports first responders with disaster preparation, response, recovery, and mitigation efforts. It is the main emergency response team for the entire community. Under the Emergency Management Agency, the following programs are managed:

Warning Systems

Louisville Metro EMA manages and coordinates the Outdoor Warning System, which consists of over 120 sirens in various locations around the Metro area. These devices are activated from the 24-hour 911 (MetroSafe) communication center with back-up activation capability at two communication centers. The system is tested monthly with weekly diagnostic tests performed silently, and SOPs for the siren operation are developed and reviewed annually. Other warning systems located at the 24-hour warning point include Emergency Alert System (EAS), MetroCall, 1610 AM radio, TRIMARC Transportation System, and the Cable Interrupt system. Warning systems that are monitored include the NOAA weather radio and several computer-generated weather programs to keep a watchful eye on possible weather conditions that would affect Louisville Metro.

Emergency Operations Center

In the event of a large-scale emergency, the Emergency Operations Center is activated to coordinate activities such as public official alerts, care and shelter, evacuation, search and rescue, resource mobilization, and recovery. When activated, it is staffed by representatives from various city, regional, and federal agencies, and non-profit and private-sector partners. EOC staff have access to weather information, the status of healthcare facilities, and streams of information from regional, state, and media partners. They use electronic incident management tools and integrated audio and visual technologies. The EOC serves primarily as a base of operations for city officials to coordinate activities, while leaving the direct command of resources to emergency services and first responders on the scene. The EOC also functions as a critical link with state and federal agencies during a catastrophic event. The mobile EOC (MEOC) is used in the absence of a staging area for first responders during emergencies and special events. The WebEOC system is used for information sharing.

LENSAlert Emergency Notifications

In 2016, Louisville Metro Emergency Services teamed up with Bullitt, Oldham, Nelson, and Washington Counties to create a regional emergency notification system—Louisville Emergency Notification System (LENSAlert). Its enhanced capabilities include using all communications modes to send alerts: mobile phones, landlines, email, text, social media, and IPAWS-OPEN. In addition to receiving notifications, individuals can create a Safety Profile for themselves and their household that can include any information they want 9-1-1 and first responders to have in the event of an emergency. When individuals make an emergency call, their Safety Profile is automatically displayed to the 9-1-1 call taker, allowing them to send the right responders to the right location with the right information. Information about medical history, allergies to medication, number of residents in a home, and even a picture of the family dog can all be added to a Safety Profile.

Flood Actions

Louisville/Jefferson County Metro Government Emergency Operations Plan

The Louisville/Jefferson County Metro Emergency Operations Plan (EOP) establishes the organizational and procedural framework to ensure that Louisville/Jefferson County Metro will be adequately prepared for all hazards threatening the lives and property of citizens and visitors. The EOP outlines the responsibilities and coordination mechanisms of Louisville/Jefferson County Metro agencies in a disaster. The EOP also coordinates response and recovery activities with voluntary organizations active in disasters and the business community. The plan unifies the efforts of these groups for a comprehensive approach to reducing the effects of a disaster.

MSD Ohio River Flood Protection System Emergency Preparedness Plan

As the local sponsor of the Louisville and Jefferson County Flood Protection System, the Louisville and Jefferson County Metropolitan Sewer District (MSD) has developed this Emergency Response Plan (ERP) to be implemented in the event of an emergency related to the Ohio River flood protection system. The purpose of this Plan is to identify MSD's response to flood protection system emergency situations, or system failures, and to define communication protocol with regard to adverse conditions that may occur during flood events. The protocol is intended to enhance the communication between various departments and divisions within MSD and appropriate outside agencies.

MSD maintains Louisville Metro's Ohio River Flood Protection System, keeping the river at bay and out of the city. The system protects more than 200,000 people, 137,000 structures, and \$34 billion in property throughout 110 square miles of Louisville Metro. It includes 26.1 miles of floodwall and earthen levee, 16 flood pumping stations, nearly 150 floodgates and 79 floodwall closures. Where creeks and storm drains pass through the floodwall, gates are closed to keep the river from flowing up the streams, and large pumps at the flood pumping stations lift the water from the creeks and pump it into the river. Additional gates and pumping stations keep the river from backing up through storm drains and pipes, pumping the stormwater into the river.

5.5 Structural Projects

Due to significant flooding issues in Louisville Metro, many structural projects have been constructed to reduce flooding impacts to the community, including floodwalls, levees, flood control basins and channel improvements.

The U.S. Army Corps of Engineers constructed a flood protection system to help protect Louisville from Ohio River flooding. The system protects more than 200,000 people, 137,000 structures, and \$34 billion in property throughout 110 square miles of Louisville Metro. It includes 26.1 miles of floodwall and earthen levee, 16 flood pumping stations, nearly 150 floodgates and 79 floodwall closures.

In addition to the Ohio River flood protection system, the U.S. Army Corps of Engineers constructed the Willowbrook floodwall, which consists of 1,900 feet of floodwall around an apartment complex along Buechel Branch, which is a tributary to the South Fork Beargrass Creek.

Many other flood control projects have also been constructed in Louisville Metro to help mitigate flooding.



- The South Fork Beargrass Creek Flood Protection project 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 2,000 feet of channel improvement, the Willowbrook floodwall, 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.
- The Whipps Mill Basin, which is a regional flood storage basin that is situated in the upper portion of the Middle Fork Watershed, was built in 2000. The basin 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.
- 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. Two other regional basins, Gagel Ave and Stallings Ave, are also located in the Mill Creek Watershed and were constructed to help relieve flooding from tributaries of Upper Mill Creek.
- The first regional basin built by MSD was the Roberson Run Basin in the Pond Creek Watershed. 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.

- 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 was funded through private development. It consists of three basins. 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 located at National Turnpike and Southern Ditch and is 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.

5.6 Public Information Activities

Louisville MSD created a Program for Public Information Plan in 2014 to plan outreach and education programs for floodplain and water quality topics. This plan includes priority topics, messages and an overview of outreach efforts being made in Louisville Metro, as well as a flood insurance coverage improvement plan and flood response plan. The Program for Public Information Plan is updated annually with the help of a committee that includes a realtor, insurance agent, public information officer, the floodplain manager, and several others. The committee determined the priority topics should include eight priority topics, which are shown in Table 15.



Ohio River Sweep

Table 15. CRS Priority Topics

1. Know your flood hazard
2. Insure your property from the flood hazard
3. Protect people from the hazard
4. Protect your property from the hazard
5. Build responsibly
6. Protect natural floodplain functions
7. General preparedness
8. Basement flooding

Outreach projects are directed at several audiences, such as the general public, residents in the floodplain, repetitive loss properties, builders and remodelers. For example, messages developed for the general public are shown in Table 16.

Table 16. Messages for General Public

Messages	Outcome
Flood determinations are available online at www.louisvillemsd.org . (1)	Increase in the number of flood determinations requested on MSD's website.
Know the flood hazard. (1)	Increase in the number of flood determinations requested on MSD's website.
You should buy flood insurance. Flood insurance is available anywhere in Jefferson County. (2)	Increase in number of flood insurance policies.
Avoid contact with streams after it rains. (3)	No health impacts related to stream contact.
General flood safety, such as turn around, don't drown, stay out of flooded waters, do not enter a flood basement, turn off main electric switch, water valve, and gas valve before flooding starts. (3)	No injuries or fatalities related to flooding.
Keep debris and trash out of streams and ditches. Keep catch basins clear of debris and leaves. (4)	Reduced number of calls related to stream obstructions.
Store irreplaceable items and valuables in an area safe from flooding. Move vehicles to higher ground. (4)	Less damage to contents and vehicles due to flooding.
Keep water clean: Don't dump in storm drains, they drain to the stream. Do not drain pools directly to streams. Limit use of fertilizers and pesticides. Scoop the poop – keep pet waste from entering waterways. Use a car wash. Do not flush prescription drugs or put down drains (6)	Improved water quality.
How streams function, keep streams clean. Maintain stream buffers. Benefits of planting more trees. (6)	Improved water quality.
Improve water quality with green infrastructure. (6)	Increase in green infrastructure construction.
Report broken silt fences, they help keep our streams clean. (6)	Fewer notices of violation issued for Erosion Prevention & Sediment Control Ordinance.

Table 16. Messages for General Public (continued)

Messages	Outcome
General preparedness: Develop a safety plan in case of evacuation. Assemble supplies in advance, such as first-aid kit, bottled water, battery-powered radio, flashlight, etc. (7)	More families have prepared evacuation plans.
Avoid basement backups: Know where it goes! Some things are not meant to be flushed. Conserve water during heavy rains to avoid overloading sewers. Avoid putting fats, oils, and grease down the drain. MSD's plumbing modification program is available to reduce basement backups. (8)	Reduced number of calls related to sewer backups.

Outreach projects include letters, signage, brochures, presentations, stream cleanups, and other outreach activities. These outreach projects all address one or more of the priority topics. The outreach project schedule is included in Appendix A.

5.7 Action Plan

In order to meet the goals of the Floodplain Management Plan, an action plan was developed. The action plan was created in two parts, floodplain and dam/levee projects were initially developed for the Hazard Mitigation Plan. The Floodplain Management Plan Committee decided to adopt the Hazard Mitigation Plan projects related to flooding and dam and levee failure, but also added additional projects to supplement the projects listed in the Hazard Mitigation Plan. The action plan projects are shown in Appendix B. Projects are organized into six categories, Preventative Actions, Property Protection, Natural Resource Protection, Emergency Services, Structural Projects, and Public Information. Projects added by the Floodplain Management Plan committee are shown below.

1. Reduce the loss of life and injuries that could be caused by flooding.

Activities:

- Provide more education about turn around, don't drown and emergency planning.
- Promote the use of available emergency notification methods.

2. Reduce the impacts to property that could be caused by flooding.

Activities:

- FMP1 - Increase outreach for flood insurance and CRS knowledge.
- FMP2 - Compare current flood mapping with available flood mapping that considers climate change to identify those areas most impacted by future increased rainfall events.

3. Promote flood safety and awareness of flood impacts.

Activities:

- FMP3 - Expand audience of flood messaging by sharing outreach materials with partners.
- FMP4 - Expand methods of education outreach to include YouTube videos, etc.
- FMP5 - Create an online reporting system or app for neighborhood flooding to collect public-reported information about incidents of flooding to aid in future planning and flood modeling.
- FMP6 - Work with Metro TV or similar outlets to present educational information on exploring watersheds and the Ohio River.
- FMP7 - Expand outreach education to include flood pump station function and the flood protection infrastructure required to keep the city safe.

4. Protect and improve natural floodplain functions.

Activities:

- FMP8 - Promote the use of green infrastructure through social media, workshops, etc.

- FMP9 - Promote the retention of riparian buffer zones and improvement of existing buffer zones.
- FMP10 - Promote existing MSD program that provides stormwater bill reduction for non-residential properties that infiltrate stormwater and investigate how this program could be expanded to create incentives for homeowners to install rain gardens or other green infrastructure.

6.0 Adoption and Implementation

The Floodplain Management Plan will be adopted by Louisville Metro to demonstrate a commitment to fulfilling the floodplain management goals and actions outlined in the Plan. As the agency responsible for floodplain management in Louisville Metro, MSD will monitor, evaluate, and revise the plan as needed. Proposed projects within the Action Plan will be updated to reflect updates on progress. Any necessary revisions to the plan will be addressed in the annual evaluation report. The Floodplain Management Plan Committee will meet at least annually and an annual evaluation report will be completed to report on progress towards plan implementation. The overall plan will be updated at least every five years.

Appendix A

Outreach Project Schedule

Appendix A

Louisville-Jefferson County Outreach Projects

Target Audience	Messages	Outcome	Projects	Assignment	Schedule	Stakeholder
Target Audience 1. General Public	Flood determinations are available online at www.msdlouky.org . (1)	Increase in the number of flood determinations requested on MSD's website.	Public Presentations	Floodplain Manager	Scheduled as requested	Neighborhood groups, Councilman
			Maintain Flood Determination Page on MSD website	Floodplain Manager/ MSD IT Dept	Maintain as needed	-
	Know the flood hazard. (1)	Increase in the number of flood determinations requested on MSD's website.	Flood Hazard Area Signs	Public Works	Maintain as needed	-
			Great Flood of 1937 High Water Mark Signs	Public Works	Maintain as needed	-
			Army Corps of Engineers High Water Mark Obelisk and Sign	Army Corps of Engineers	Maintain as needed	Army Corps of Engineers
			Streamline Newsletter	Floodplain Manager	At least one article annually	-
			Floodplain/Repetitive Loss Newsletter	Floodplain Manager	Newsletters sent by December 1	
			MSD Field Day	Floodplain Manger	May	-
			MSD Social Media	Communications Dept	At least one post annually	-
	You should buy flood insurance, Flood insurance is available anywhere in Jefferson County. (2)	Increase in number of flood insurance policies.	Streamline Newsletter	Floodplain Manager	At least one article annually	-
			Public Presentations	Floodplain Manager	Scheduled as requested	Neighborhood groups, Councilman
			Maintain Flood Determination Page on MSD website	Floodplain Manager/ MSD IT Dept	Maintain as needed	-
			FEMA Brochures	Floodplain Manger	Brochures replaced as needed	FEMA
			MSD Social Media	Communications Dept	At least one post annually	-
	General flood safety, such as turn around, don't down, stay out of flooded waters, Do not enter a flooded basement, turn off main electrical switch, water valve, and gas valve before flooding starts. (3)	No injuries or fatalities related to flooding.	Bill stuffer	MSD Customer Relations	Bill stuffer sent Aug/Sept	-
			Public Presentations	Floodplain Manager	Scheduled as requested	Neighborhood groups, Councilman
			Brochure at MSD Main Office	Floodplain Manager	Brochures replaced as needed	-
			"Caution Do Not Enter When Flooded" signs at low areas on roadways	Public Works	Signs maintained as needed	-
			Maintain flood safety information on MSD website	Floodplain Manager/ MSD IT Dept	Maintain as needed	-

Appendix A

Louisville-Jefferson County Outreach Projects

Target Audience	Messages	Outcome	Projects	Assignment	Schedule	Stakeholder
Target Audience 1. General Public	General flood safety, such as turn around, don't down, stay out of flooded waters, Do not enter a flooded basement, turn off main electrical switch, water valve, and gas valve before flooding starts. (3)	No injuries or fatalities related to flooding.	Presentations to school age children	Floodplain Manager	As requested	Jefferson County Public Schools
			MSD Social Media	Communications Dept	At least one post annually	-
	Avoid contact with streams after it rains. (3)	No health impacts related to stream contact.	Magazine/Newspaper Ads	MSD Regulatory Services	Quarterly	-
			Brochure at MSD Main Office	MSD Customer Relations	Brochures replaced as needed	-
			Overflow Advisory signs	MSD Regulatory Services	Signs maintained as needed	-
			Maintain MSD and Project WIN websites	MSD Regulatory Services	Maintain/Update as needed	-
			MSD Social Media	Communications Dept	At least one post annually	-
	Keep debris and trash out of streams and ditches, Keep catch basins clear of debris and leaves. (4)	Reduced number of calls related to stream obstructions.	Magazine/Newspaper Ads	MSD Regulatory Services	Quarterly	-
			Brochure at MSD Main Office	MSD Customer Relations	Brochures replaced as needed	-
			No Dumping signs located at streams	Public Works	Signs maintained as needed	-
			Streamline Newsletter	Floodplain Manager	Quarterly	-
			Public Presentations	Floodplain Manager	Scheduled as requested	Neighborhood groups, Councilman
			Bill Stuffer	MSD Customer Relations	Bill stuffer sent Aug/Sept	-
			Plumbing Modifications Program Packets	MSD Customer Relations	Upon Request	-
			Maintain MSD and Project WIN websites	MSD Regulatory Services	Maintain/Update as needed	-
			MSD Social Media	Communications Dept	At least one post annually	-
	Store irreplaceable items and valuables in an area safe from flooding, Move vehicles to higher ground. (4)	Less damage to contents and vehicles due to flooding.	Streamline Newsletter	MSD Customer Relations	Bill stuffer sent Aug/Sept	-
			Bill Stuffer	Floodplain Manager	Newsletter sent monthly	-
			Update MSD Website	Floodplain Manager/ MSD IT Dept	Website updated by Sept 1	-

Appendix A

Louisville-Jefferson County Outreach Projects

Target Audience	Messages	Outcome	Projects	Assignment	Schedule	Stakeholder
Target Audience 1. General Public	Get a floodplain permit before you build. (5)	Fewer notices of violation issued for Floodplain Ordinance.	Floodplain/Repetitive Loss Newsletter	Floodplain Manager	Newsletters sent by December 1	-
	Keep water clean: Don't dump in storm drains, they drain to the stream. Do not drain pools directly to streams. Limit use of fertilizers and pesticides. Scoop the poop – keep pet waste from entering waterways. Use a car wash. Do not flush prescription drugs or put down the drain. (6),	Improved water quality.	"Dump no waste - drains to stream" stenciled on catch basins	MSD Drainage Supervisors	Maintenance as needed	-
			Streamline newsletter	MSD Customer Relations	Newsletter sent quarterly	-
			Brochure at MSD Main Office	MSD Customer Relations	Brochures replaced as needed	-
			Brochure in Plumbing Modification Packets	MSD Customer Relations	As requested	-
			Maintain MSD and Project WIN websites	MSD Regulatory Services	Maintain/Update as needed	-
			Public Presentations	MS4 Team/Floodplain Manager	As requested	Neighborhood groups, Councilman
			Presentations to school age children	MS4 Team/Floodplain Manager	As requested	Jefferson County Public & Private Schools
			MSD Social Media	Communications Dept	At least one post annually	-
	How streams function, keep streams clean. Maintain stream buffers. Benefits of planting more trees. (6)	Improved water quality.	Louisville Nature Center offers summer camps, education programs, including scouting programs, a Beargrass Creek watershed exhibit, and a library	Louisville Nature Center	Nature Center is open year-round, classes held periodically	Louisville Nature Center
			Parklands of Floyds Park offers science camps, field trips, family programs, interpretive hikes, scout programs, stream cleanups, an outdoor classroom, and a large mural related to Floyds Fork.	Parklands of Floyds Fork	Parklands of Floyds Fork is open year-round, classes held periodically	Parklands of Floyds Fork
			Stream Cleanups	MSD, ORANSO, Parklands of Floyds Fork, Beargrass Creek Alliance, Floyds Fork Env. Association	Cleanups are held periodically	ORANSO, Parklands of Floyds Fork, Beargrass Creek Alliance, Floyds Fork Environmental Association
			MSD Social Media	Communications Dept	At least one post annually	-

Appendix A

Louisville-Jefferson County Outreach Projects

Target Audience	Messages	Outcome	Projects	Assignment	Schedule	Stakeholder
Target Audience 1. General Public	Improve water quality with green infrastructure. (6)	Increase in green infrastructure construction.	Green infrastructure signage	MS4 Coordinator	Signs maintained as needed	-
			Public Presentations	MS4 Coordinator	As requested	Neighborhood groups, Councilman
			Streamline Newsletter	MSD Customer Relations	Newsletter sent quarterly	-
			MSD website	MS4 Coordinator	Maintain/Update as needed	-
			Home Garden & Remodeling Show	MS4 Coordinator	February 27th - March 1st	-
			MSD Social Media	Communications Dept	At least one post annually	-
	General preparedness: Develop a safety plan in case of evacuation. Assemble supplies in advance, such as first-aid kit, bottled water, battery-powered radio, etc. (7)	More families have prepared evacuation plans.	Streamline Newsletter	Floodplain Manager	Newsletter sent quarterly	-
			Public Presentations	Floodplain Manager	As requested	Neighborhood groups, Councilman
			Brochure at MSD Main Office	Floodplain Manager	Brochures replaced as needed	-
			MSD website	Floodplain Manager	Maintain as needed	-
			MSD Social Media	Communications Dept	At least one post annually	-
	Avoid basement backups: Know where it goes! Some things are not meant to be flushed. Conserve water during heavy rains to avoid overloading sewers. Avoid putting fats, oils, and grease down the drain. MSD's plumbing modification program is available to reduce basement backups. (8)	Reduced number of calls related to sewer backups.	Magazine/Newspaper Ads	MSD Customer Relations	At least 6 ads annually	-
			Brochure at MSD Main Office	MSD Customer Relations	Brochures replaced as needed	-
			Streamline Newsletter	Floodplain Manager	Newsletter sent monthly	-
			Brochure in Plumbing Modification Packets	MSD Customer Relations	As requested	-
			MSD website	Floodplain Manager	Maintain/Update as needed	-
			MSD Social Media	Communications Dept	At least one post annually	-

Appendix A

Louisville-Jefferson County Outreach Projects

Target Audience	Messages	Outcome	Projects	Assignment	Schedule	Stakeholder
Target Audience 2. Floodplain Residents and Repetitive Loss Properties	Your property is at risk for flooding. (1)	Increased number of flood insurance policies.	Letter to floodplain/rep loss residents	Floodplain Manager	Letters sent by December 1	-
	You need flood insurance. (2)	Increased number of flood insurance policies.	Letter to floodplain/rep loss residents	Floodplain Manager	Letters sent by December 1	-
	Renters can buy flood insurance for contents. (2)	Increased number of flood insurance policies for contents.	Metro Council eNewsletters or social media posts	Floodplain Manager	At least one post annually	Louisville Metro Council
	When a flood threatens, know when to evacuate. (3)	Fewer water rescues.	Letter to floodplain/rep loss residents	Floodplain Manager	Letters sent by December 1	-
	Replace flooded furnaces, water heaters and air conditioners with elevated ones. (4)	Fewer flood insurance claims.	Letter to floodplain/rep loss residents	Floodplain Manager	Letters sent by December 1	-
	Get a floodplain permit before you build. (5)	Fewer notices of violation issued for Floodplain Ordinance.	Letter to floodplain/rep loss residents	Floodplain Manager	Letters sent by December 1	-
	Know the substantial damage/improvement rules. (5)	Fewer notices of violation issued for Floodplain Ordinance.	Letter to floodplain/rep loss residents	Floodplain Manager	Letters sent by December 1	-
	Inventory and photograph your home's contents and put important papers and insurance policies in a safe place. (7)	Better preparedness.	Letter to floodplain/rep loss residents	Floodplain Manager	Letters sent by December 1	-
Target Audience 3. Builders and Remodelers	Check for floodplain issues prior to beginning construction or remodeling. (1)	Increase in the number of flood determinations requested on MSD's website.	BIA Meeting or Newsletter	Floodplain Manager	Summer	Building Industry Association (BIA)
			Construction Field Day	Floodplain Manager	February	-
	Follow Floodplain Ordinance requirements. (5)	Fewer notices of violation issued for Floodplain Ordinance.	BIA Meeting or Newsletter	Floodplain Manager	Summer	Building Industry Association (BIA)
			Construction Field Day	Floodplain Manager	February	-
	Use appropriate erosion prevention and sediment control (EPSC) measures during construction. (6)	Fewer notices of violation issued for Erosion Prevention & Sediment Control ordinance.	MSD EPSC Certification Classes	Enforcement Supervisor	Classes offered online	Jefferson County Public & Private Schools
			Construction Field Day	Enforcement Supervisor	February	-
	EPSC certification classes are available for homebuilders and contractors. (6)	Larger attendance at EPSC certification classes.	Jefferson County Continuing Education Classes Website	Enforcement Supervisor	Maintain as needed	Jefferson County Public & Private Schools
			Construction Field Day	Enforcement Supervisor	February	-

Appendix A

Louisville-Jefferson County Outreach Projects

Target Audience	Messages	Outcome	Projects	Assignment	Schedule	Stakeholder
Target Audience 4. Real Estate, Lending, and Insurance Companies	Online flood determinations can be done for the MLS form when listing a home (directed at Realtors) (1)	Increase in the number of flood determinations requested on MSD's website.	Electronic newsletter	Floodplain Manager	Newsletter sent by December 1	Greater Louisville Association of Realtors (GLAR)
			Realtor presentations	Floodplain Manager	As requested	Local realtors, such as Semonin and REMAX
	Online flood determinations can be done for the Standard Flood Hazard Determination Form (directed at Lenders) (1)	Increase in the number of flood determinations requested on MSD's website.	Electronic newsletter/Letter	Floodplain Manager	Newsletter or Letter sent by December 1	Mortgage brokers listed in the Kentucky Department of Financial Institutions Web Database
	Online flood determinations can be done for information for insurance policies (directed at Insurers) (1)	Increase in the number of flood determinations requested on MSD's website.	Electronic newsletter	Floodplain Manager	Newsletter sent by December 1	Big I Kentucky
	Elevation Certificates are available from MSD, map information and base flood elevations can be determined by MSD. (1)	Increase in number of elevation certificate requests.	Electronic newsletter	Floodplain Manager	Newsletter sent by October 1	Greater Louisville Association of Realtors (GLAR)
			Presentations	Floodplain Manager	As requested	Local realtors, such as Semonin and REMAX
	Flood insurance is available anywhere in Jefferson County. (2)	Increased number of flood insurance policies.	Electronic newsletter	Floodplain Manager	Newsletter sent by December 1	Greater Louisville Association of Realtors (GLAR)
			Presentations	Floodplain Manager	As requested	Local realtors, such as Semonin and REMAX
	Flood insurance is required if the structure is in the floodplain and there is a federally backed mortgage. (2)	Increased number of flood insurance policies.	Electronic newsletter	Floodplain Manager	Newsletter sent by December 1	Greater Louisville Association of Realtors (GLAR)
			Presentations	Floodplain Manager	As requested	Local realtors, such as Semonin and REMAX

Appendix B

Action Plan

2023 FLOODPLAIN MANAGEMENT PLAN ACTIONS										
CRS Topic	Action No.	Type of Activity or Project	New Building and Infrastructure	Proposed Schedule	Lead Agency	Alignment with Haz Mit Plan Goals	Funding	Cost (L-M-H)	Benefit (L-M-H)	Priority (L-M-H)
Preventative Activities	2.1	Review/Update Floodplain Ordinance: 1. Review existing Floodplain Ordinance and propose changes to improve safety and resiliency, as well as improve ordinance administration as needed/required.	No	Ongoing	MSD	Goal 1 Goal 3 Goal 4 Goal 6	Normal Operating Budget	L	H	H
	2.2	Flood studies for mitigation: 2. Continue to update flood models in areas with known flooding issues and problematic modeling, including the 10-year flood intervals.	No	Ongoing	MSD	Goal 5 Goal 7	Normal Operating Budget, Grants	L	H	H
	2.4	Review feasibility and construct regional stormwater/flood control basins: 5. Review feasibility and construct new regional stormwater/flood control basins 6. Prepare grant applications as funds become available	Yes	Ongoing	MSD	Goal 1 Goal 2	Grants	H	H	H
	2.18	Conduct a Big Run Flood Mitigation Study: 29. A grant application has been submitted to FEMA for review for conducting a flood mitigation study to determine potential projects needed to reduce flooding impacts from Big Run.	No	1-5 Years	MSD	Goal 3	Grants	H	H	H
	2.19	Continue Drive In Branch Flood Basin Project: 30. Drive In Branch, a tributary of Big Run, is currently being studied to investigate potential benefits of improvements to existing storage basins and channels in mitigating localized flooding. Alternatives being evaluated in the study are expansion of storage basin volumes, incorporation of green management practices and channel restoration.	No	Ongoing	MSD	Goal 3	Normal Operating Budget	L	H	H
	2.23	Northern Ditch Watershed Mitigation Project: 34. Preliminary approval has been given for a grant to evaluate the Northern Ditch watershed for mitigation opportunities. A location near West Indian Trail has been identified for a potential regional detention basin and would be included in this study. This basin would create additional storage volume for the Pond Creek Watershed during major flooding events.	Yes	1-3 Years	MSD	Goal 3	Normal Operating Budget	H	H	H

2023 FLOODPLAIN MANAGEMENT PLAN ACTIONS										
CRS Topic	Action No.	Type of Activity or Project	New Building and Infrastructure	Proposed Schedule	Lead Agency	Alignment with Haz Mit Plan Goals	Funding	Cost (L-M-H)	Benefit (L-M-H)	Priority (L-M-H)
Preventative Activities	3.1	Risk assessment: develop a Dam and Levee Risk Assessment with best available data. Phase 1: Verify locations for existing dams. Develop data inventory of all dams within Louisville Metro area. Steps include: 1. Collect data from KDOW for locations and assessment of the State-Owned dams. 2. Perform research in the State Dam Safety Program records, which requires an Open Records request to the KDOW. 3. Research records and locations of dams within metro boundaries. 4. From research, collect other important data, e.g. current EOPs, dam materials, past inspections, violations, etc 5. Collect inventory of dam locations and geo-code. 6. Verify which Class C dams have an EOP.	Yes	Ongoing	MSD LOJIC KDOW	Goal 1 Goal 5 Goal 7	Normal Operating Budget	L	H	H
	3.2	Risk assessment: develop a Dam and Levee Risk Assessment with best available data. Phase 2: Perform Risk Assessments on Class B and C Dams, High-Hazard Dams 7. Verify all Class C dams have and maintain an EOP (using a newly developed template and tied to above action item results). 8. Verify downstream warning system, public notice, etc. are included in EOP. Class B, Moderate/Significant Risk Dams 9. Assess Class B dams for any downstream construction that might raise dam classification	No	Ongoing	MSD	Goal 1 Goal 5	Normal Operating Budget	L	H	H
	3.3	Inspect dams for failure and removal or replace unsafe dams: 10. After inspections, unsafe dams will be addressed to determine next steps for repair and/or removal of dams. An unsafe dam would move to a Priority A project for immediate action. * Project dependent upon dam inventory and assessment (Phases 1 & 2)	Yes	Ongoing	KDOW	Goal 1 Goal 2 Goal 3 Goal 5	Others	H	H	H

2023 FLOODPLAIN MANAGEMENT PLAN ACTIONS										
CRS Topic	Action No.	Type of Activity or Project	New Building and Infrastructure	Proposed Schedule	Lead Agency	Alignment with Haz Mit Plan Goals	Funding	Cost (L-M-H)	Benefit (L-M-H)	Priority (L-M-H)
Preventative Activities	3.4	Continue evaluation to levee and flood protection systems: 11. Continue to evaluate Ohio River Flood Protection Systems and large pump stations (i.e. Beargrass Creek). Partner with USACE on both regulatory driven annual and five-year inspections	No	Ongoing	MSD USACE	Goal 1 Goal 2 Goal 3	Normal Operating Budget	H	M	H
	FMP4	Climate Change Flood Risk Assessment: Compare current flood mapping with available flood mapping that considers climate change to identify those areas most impacted by future increased rainfall events.	No	FY24	MSD	Goal 2	Normal Operating Budget	M	M	M
Property Protection	2.3	Continue floodplain buyouts throughout the county: 3. Identify repetitive loss, severe repetitive loss candidates, and other floodprone properties. 4. Prepare grant applications as funds become available.	No	Ongoing	MSD	Goal 1 Goal 4 Goal 8	Grants	H	H	H
	2.12	Elevation of floodprone properties: 20. Determine if elevation is feasible and cost effective for existing floodprone homes. 21. If feasible, elevate homes to at least one foot above the local regulatory floodplain elevation.	No	Ongoing	MSD	Goal 1 Goal 3 Goal 8	Grants	H	H	L
	2.16	Protect existing buildings and infrastructure: 27. Target at-risk public and private buildings from flood for mitigation/retrofit.	No	Ongoing	MSD LOJIC Jeffersontown	Goal 2 Goal 3	Normal Operating Budget, Grants	L	M	M

2023 FLOODPLAIN MANAGEMENT PLAN ACTIONS										
CRS Topic	Action No.	Type of Activity or Project	New Building and Infrastructure	Proposed Schedule	Lead Agency	Alignment with Haz Mit Plan Goals	Funding	Cost (L-M-H)	Benefit (L-M-H)	Priority (L-M-H)
Property Protection	2.28	Wastewater facility flood protection and customer backup prevention through Plumbing Modification and Rehabilitation Programs: Increased occurrences of extreme storms put strain on the existing collection system due to higher volume of rainfall occurring during short periods of time. These storms can increase the risk of backups in basements of customers. 39. Secure additional resources for the sewer rehabilitation program and the Plumbing Management Program (PMP) to allow for a proactive response to this risk. The PMP mitigates backups through plumbing improvements including the installation of backflow preventers, sump pump disconnections, and lateral service line renewal. The sewer rehabilitation program mitigates the stress of intense storms, improves system resilience by extending the life of existing infrastructure, reduces backups into homes and wastewater overflows to waterways, and protects residents from sewer collapse and pump station emergencies.	No	1-3 Years	MSD	Goal 1 Goal 2 Goal 3 Goal 6	Grants	M	H	H
Natural Resource Protection	2.8	Establish and coordinate tree programs and partnerships to increase tree canopy, parkway areas: 14. Continue program with Metro Parks to expand the tree canopy in the metropolitan area. 15. Metro Parks will continue over the next five years to replace trees along parkways and in landscaped park areas as needed to retain tree canopy cover in the metropolitan area. MSD will contribute 1,000 trees per year.	No	Ongoing	Metro Parks MSD Metro Community Forestry	Goal 2 Goal 4	Normal Operating Budget	L	H	H
	FMP10	Stormwater Credit Program: Promote existing MSD program that provides stormwater bill reduction for non-residential properties that infiltrate stormwater and investigate how the program could be expanded to create incentives for homeowners to install rain gardens or other green infrastructure	No	FY25	MSD	Goal 4	Normal Operating Budget	M	M	M
Emergency Services	2.6	Review and update flood related emergency preparedness and response plans: 11. Continue to review and update plans including evacuation of at-risk populations to include seniors and disabled.	No	Ongoing	Metro EMA MSD	Goal 1 Goal 5 Goal 8	Normal Operating Budget	L	H	H

2023 FLOODPLAIN MANAGEMENT PLAN ACTIONS										
CRS Topic	Action No.	Type of Activity or Project	New Building and Infrastructure	Proposed Schedule	Lead Agency	Alignment with Haz Mit Plan Goals	Funding	Cost (L-M-H)	Benefit (L-M-H)	Priority (L-M-H)
Emergency Services	2.14	Increase the use of information technology: 24. Continue to explore new technologies to replace aging infrastructure. Research and secure improvements related to level sensors on streams, flood prone areas and viaducts to provide flood information. 25. Continue to explore new technologies to ensure systems are	Yes	Ongoing	MSD	Goal 6 Goal 7	Grants	M	H	H
	2.15	Increase notification capabilities: 26. Incorporate best-practice information technology related to flooding and dams/levee failures.	No	Ongoing	MSD Metro EMA	Goal 1 Goal 6 Goal 7	Normal Operating Budget, Grants	M	H	H
	2.25	Construct additional rain gages and stream gages: 36. Construct additional gages on ungaged streams to be used for flood forecast and warning. 37. Construct additional flow/level sensor throughout the CSSA.	No	1-3 Years	MSD	Goal 1 Goal 2 Goal 3 Goal 6	Grants	M	H	H
	2.26	Development of real-time flood mapping application, predictive flood modeling, flood alert and notification system, and flood safety barricade infrastructure to improve flood safety.	Yes	1-5 Years	MSD	Goal 1 Goal 2 Goal 3 Goal 6	Normal Operating Budget, Grants	H	H	H
	3.7	Initiate 24-hour high hazard dam monitoring and warning system for those in inundation areas: 14. Moving forward with design and construction of level sensors/monitoring equipment on High Hazard dams maintained by MSD.	No	Ongoing	MSD	Goal 1 Goal 2 Goal 3 Goal 5	Others	H	H	H
	3.8	Catastrophic Flood/Levee Failure Planning Study 15. Support FEMA evacuation consultant in the development of a concept of operations plan (Phase II). Once this plan has been reviewed and approved the actual evacuation plan will be developed. Funded through grants and Silver Jackets.	No	Ongoing	MSD	Goal 1 Goal 2 Goal 3 Goal 5	Grants, Others	H	H	H
	3.13	Reduce Whipps Mill flooding potential: 19. Place flood level sensors and remote monitoring equipment on the high hazard dam located at Whipps Mill.	No	1-3 Years	MSD					

2023 FLOODPLAIN MANAGEMENT PLAN ACTIONS										
CRS Topic	Action No.	Type of Activity or Project	New Building and Infrastructure	Proposed Schedule	Lead Agency	Alignment with Haz Mit Plan Goals	Funding	Cost (L-M-H)	Benefit (L-M-H)	Priority (L-M-H)
Emergency Services	3.14	Roberson Run Flood Monitoring 20. In an effort to reduce risks associated with flooding, flood level sensors and remote monitoring equipment will be placed on the high hazard dam located at Roberson Run.	No	1-2 Years	MSD	Goal 3	Normal Operating Budget	H	H	H
Structural Projects	2.7	Repair and replace flood pump stations as required: 12. Continue to rehab, replace and update flood pump stations as needed. 13. Inventory and verify emergency generators and backup. Apply	Yes	Ongoing	MSD	Goal 1 Goal 3 Goal 6	Normal Operating Budget, Grants		H	H
	2.13	Continue drainage improvement projects: 22. Conduct new studies on subbasin basis to determine future drainage improvement projects based on the newly developed risk-based prioritization tool. 23. Construct drainage improvement projects, such as increasing culvert capacity, widening channels, and increasing flood storage.	Yes	Ongoing	MSD	Goal 3	Grants	M	H	H
	2.20	Paddy's Run Flood Pumping Station Project: 31. The Paddy's Run Flood Pumping Station will be replaced with a new facility to increase the pumping capacity of this location. Built in 1953, it is beyond its useful life and in need of full replacement to prevent catastrophic risks to disadvantaged communities within the inundation area.	Yes	3-5 Years	MSD	Goal 1 Goal 3 Goal 8	Normal Operating Budget	H	H	H
	2.21	River Road Reconstruction Project: 32. This project will elevate River Road above the 10 year floodplain to increase access to properties along River Road during smaller, more frequent floods.	Yes	1-3 Years	MSD	Goal 3 Goal 8	Normal Operating Budget	H	H	H
	2.22	Western Flood Pump Station Project: 33. The Western Flood Pump Station project proposes to increase capacity of the pump station and increase the volume of the surge basin to reduce roadway and structure flooding in this area.	Yes	1-3 Years	MSD	Goal 3	Normal Operating Budget	H	H	H

2023 FLOODPLAIN MANAGEMENT PLAN ACTIONS										
CRS Topic	Action No.	Type of Activity or Project	New Building and Infrastructure	Proposed Schedule	Lead Agency	Alignment with Haz Mit Plan Goals	Funding	Cost (L-M-H)	Benefit (L-M-H)	Priority (L-M-H)
Structural Projects	2.27	Increase Flood Risk Mitigation for Wastewater Facilities: 38. Treatment facilities within the flood plain are at risk of failing during flood events, resulting in discharge of untreated wastewater. Sanitary sewer overflows are possible when flood water infiltrates pump stations and manholes during flood events. Assets at risk of flooding may require relocation, upgrades, and or/ protections to improve resiliency during flood events, especially as frequency of extreme storms increases with climate change.	No	1-3 Years	MSD	Goal 1 Goal 2 Goal 3 Goal 6	Grants	M	H	H
	2.29	Maintain backup power generators and the connections at applicable facilities: 40. Continue to implement measures for preventing sanitary sewer overflows during storm events or other power outages Increased frequency and intensity of storm events presents additional risk to maintaining power at wastewater facilities.	No	1-3 Years	MSD	Goal 1 Goal 2 Goal 3 Goal 6	Grants	L	H	H
	3.5	Continue Metro Parks remedial work on agency operated dams: 12. Continue remedial work as needed based on inspections	No	Ongoing	Metro Parks	Goal 3	Normal Operating Budget	L	M	H
	3.9	Monitor and comment on state dam construction and inspection criteria. 16. Continue to review proposed high hazard dams and follow MSD Design Manual.	Yes	Ongoing	MSD Metro Parks	Goal 5	Normal Operating Budget	L	M	L
	3.11	Develop EOPs for Class C Dams 17. Continue with existing strategy to include: 1) Develop EOPs for dams without plans; 2) Update existing EOPs, and 3) add NWS notification for alerts via weather radios. EOPs have been completed for all Class C dams. Remaining items are on hold.	No	Ongoing	MSD Metro Parks KDOW	Goal 5	Normal Operating Budget	L	M	M

2023 FLOODPLAIN MANAGEMENT PLAN ACTIONS										
CRS Topic	Action No.	Type of Activity or Project	New Building and Infrastructure	Proposed Schedule	Lead Agency	Alignment with Haz Mit Plan Goals	Funding	Cost (L-M-H)	Benefit (L-M-H)	Priority (L-M-H)
Public Information	2.5	Place flood elevation markers, other signage and safety measures along floodprone roads and parking areas: 7. Continue program to focus on roads that are frequently overtopped to demonstrate to drivers/pedestrians how deep the water can be. 8. Complete an inventory of current sign locations, develop a strategy for posting warning signs and post as funding allows. 9. Install level sensors, automated gate-arm barricades, flashing lights, and other public notifications at selected areas throughout the city. 10. Incorporate flood notification information into emergency response route changes.	No	Ongoing	MSD Metro Public Works Metro Parks	Goal 1 Goal 5	Normal Operating Budget	L M	M	M
	2.9	Continue public outreach regarding basement flooding: 16. Continue to send annual letters to everyone in floodplain and repetitive loss properties. 17. Educate the public on keeping critical items out of basements computers, books, important files etc.	No	Ongoing	MSD Media	Goal 4 Goal 5	Normal Operating Budget	L	H	H
	2.10	Continue Public Outreach related to NFIP and Plumbing Modification Programs: 18. Continue to deliver annual letters to everyone in floodplain and repetitive loss properties discussing the merits of both	No	Ongoing	MSD	Goal 4 Goal 5	Normal Operating Budget	L	H	H
	2.11	Increase Coordination of Flood Warning using NWS Chat Rooms: 19. NWS Chat Rooms are set up to coordinate with staff in an official capacity. Several chat rooms exist, and NWS can set up additional ones if needed. Chat Rooms already include USGS, Corp, media, & EMS and can be made available to other agencies.	No	Ongoing	NWS	Goal 4 Goal 5 Goal 6 Goal 7	Normal Operating Budget	L	H	H
	2.17	Install a rain garden and creek access at the MSD Floyds Fork Water Quality Treatment Center: 28. Follow concept design to include educational outreach signage.	No	1-3 Years	MSD	Goal 4 Goal 5	Normal Operating Budget	M	H	H
	2.24	Evaluate new platforms to better facilitate communications related to flooding concerns: 35. National Weather Service personnel are currently assessing various notification platforms to increase capabilities to inform people of potential flooding events.	No	1-2 Years	NWS	Goal 1 Goal 5 Goal 7	Normal Operating Budget	L	H	H

2023 FLOODPLAIN MANAGEMENT PLAN ACTIONS										
CRS Topic	Action No.	Type of Activity or Project	New Building and Infrastructure	Proposed Schedule	Lead Agency	Alignment with Haz Mit Plan Goals	Funding	Cost (L-M-H)	Benefit (L-M-H)	Priority (L-M-H)
Public Information	3.6	Continue public awareness efforts: 13. Installation of signage related to flood protection system history and assets to indicate allowed/prohibited activities on the levee system is complete.	No	Ongoing	MSD	Goal 5 Goal 7	Normal Operating Budget	L	M	M
	3.12	Post Signs/Landmark on dams with classification type (A, B, or C): 18. Procure and place signage on nonprivately owned dams to assist the public in identifying dam types.	No	Ongoing	MSD Metro Parks KDOW	Goal 5	Normal Operating Budget	L	M	M
	FMP1	Turn Around, Don't Drown Education: Provide more education about turn around, don't drown and emergency planning	No	Ongoing	MSD	Goal 1	Normal Operating Budget	L	M	H
	FMP2	Emergency Notification Methods: Promote the use of available emergency notification methods	No	Ongoing	MSD	Goal 1	Normal Operating Budget	L	M	M
	FMP3	CRS and Flood Insurance Education: Increase outreach for flood insurance and CRS knowledge	No	Ongoing	MSD	Goal 2	Normal Operating Budget	L	M	M
	FMP5	Expand audience of flood messaging: Expand audience of flood messaging by sharing outreach materials with partners	No	Ongoing	MSD	Goal 1 Goal 2 Goal 3	Normal Operating Budget	L	M	M
	FMP6	Watershed and Ohio River Education : Work with Metro TV or similar outlets to present education information on exploring watersheds and the Ohio River	No	FY25	MSD	Goal 3 Goal 4	Normal Operating Budget	M	M	L
	FMP7	Flood Protection System Education : Expand outreach education to include flood pump station and the flood protection infrastructure required to keep the city safe	No	FY25	MSD	Goal 3	Normal Operating Budget	M	M	L
	FMP8	Green Infrastructure Education : Promote the use of green infrastructure through social media, workshops, etc.	No	Ongoing	MSD	Goal 4	Normal Operating Budget	M	M	M
	FMP9	Riparian Zone Education : Promote the retention of riparian buffer zones and improvement of existing buffer zones	No	FY24	MSD	Goal 4	Normal Operating Budget	M	M	M