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1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

West Hickman Creek watershed is located in south central Lexington, Fayette County, and northeastern Jessamine County, Kentucky. Its watershed area is almost entirely urban within Fayette County, with more rural land uses in Jessamine County. Lexington hosts approximately 6 miles of stream length and 20 square miles of watershed while Jessamine County contains approximately 2 miles of stream and 2 square miles of watershed. The headwaters of West Hickman Creek begin in Lexington and the stream flows south into Jessamine County until its confluence with East Hickman Creek to Hickman Creek. The West Hickman Creek watershed encompasses Lexington Reservoirs 1, 2, and 3, which are predominately used for recreational purposes.

West Hickman Creek was first listed as impaired for aquatic life in the 1998 303(d) list of Kentucky impaired waters. In subsequent years, additional segments and causes were listed including impairment to recreational use due to pathogens in 2004. The US Environmental Protection Agency (EPA) and the Kentucky Environmental and Public Protection Cabinet (KY EPPC) also filed a lawsuit (United States 2006) against LFUCG over violations of the Clean Water Act in 2006. The lawsuit was due to failure of the city to maintain the sanitary and storm sewer systems causing raw sewer discharges into streams. On March 14, 2008, LFUCG lodged a Consent Decree to resolve this lawsuit (United States 2008), which was officially entered into effect on January 3, 2011 (United States 2011). The stormwater portion of the Consent Decree was fulfilled and removed in 2021.

The West Hickman Watershed Management Plan (WHWMP) was developed by The Lexington-Fayette Urban County Government (LFUCG), through the Division of Environmental Services (DES), and Palmer Engineering. Development of this plan began in response to citizens' interest in the watershed and water quality. The WHWMP presents the collaborative culmination of an extensive data collection and analysis effort, recruitment of partners and stakeholders in watershed interests, and remediation strategy development. This document is intended to address the nine minimum elements required in the EPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (USEPA 2008). Much of the watershed assessment information included in Sections 2 and 3 of this report was obtained from the *West Hickman Creek Watershed Assessment*, prepared by Third Rock Consultants, LLC for LFUCG and dated September 2012. This information, and additional results are provided in this plan without significant alteration to limit duplication efforts and with the permission of LFUCG.

A vital part of the development of the WHWMP was the involvement of the partners and stakeholders in the project area. The West Hickman Watershed Council was formed with the assistance of LFUCG DES in 2017. In November 2017, the West Hickman Watershed Council established its main goal as to gather local residents and businesses together to learn about and improve the West Hickman Creek Watershed. Through meetings held by the West Hickman Watershed Council, enough interest and leadership emerged to incorporate a non-profit focused on the West Hickman Watershed called the Hickman Creek Conservancy. The Hickman Creek Conservancy was incorporated on January 1, 2019, and the 501c3 was filed on February 14, 2019. The Hickman Creek Conservancy is currently focusing most of its efforts on the West Hickman Watershed and was a vibrant part of the development of the WHWMP.

1.2 THE WEST HICKMAN CREEK WATERSHED (WHW)

The West Hickman Creek Watershed, Hydrologic Unit Code (HUC) number 05100205-120-040, is a 22.35 square-mile (14,305-acre) watershed located in Fayette and Jessamine Counties, Kentucky. The confluence of West Hickman and East Hickman Creeks marks the beginning of Hickman Creek, which flows into the Kentucky River near Camp Nelson (approximate River Mile No. 135). West Hickman Creek and Tates Creek are the two main tributaries of the West Hickman watershed. The boundary of the watershed is shown in Figure 1-1.

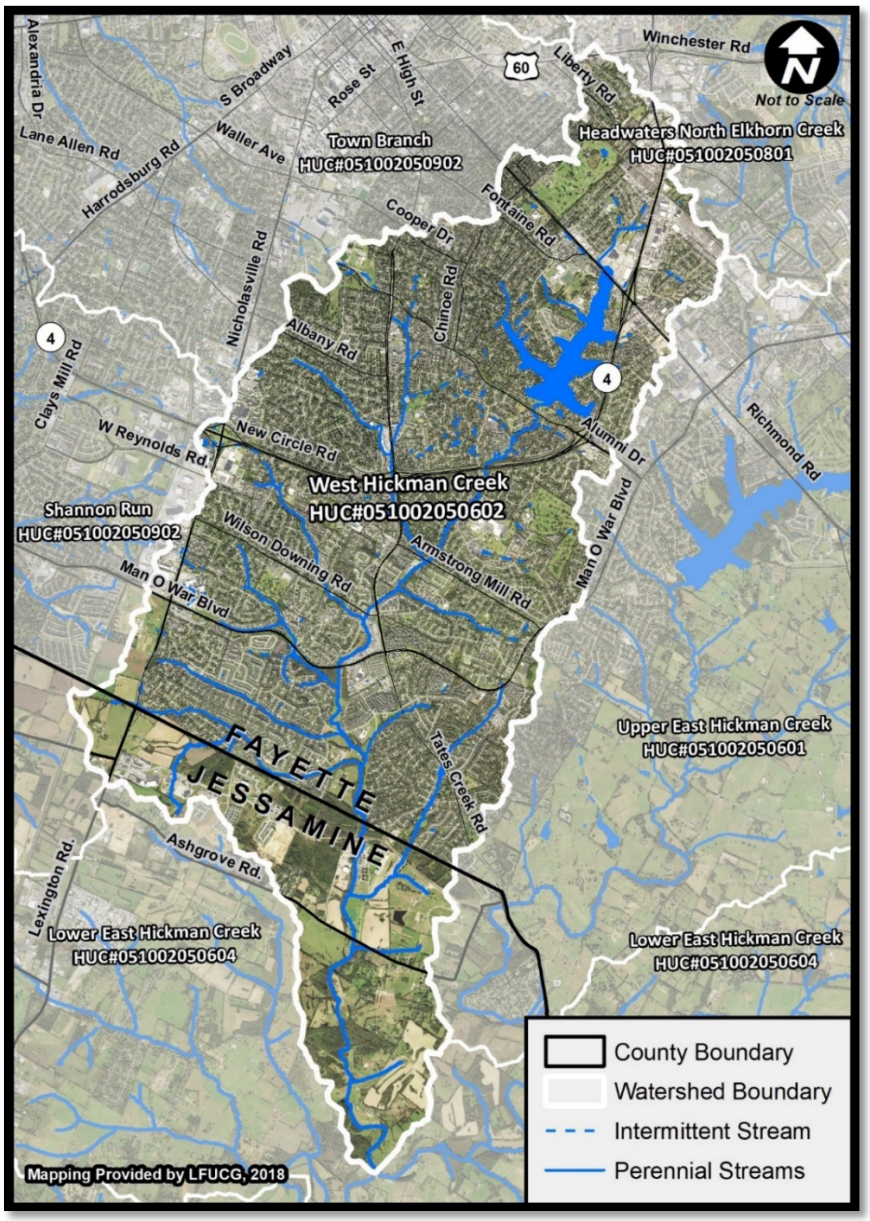


Figure 1-1: West Hickman Watershed Boundary

WHW has a rich history which is intertwined with the development of the City of Lexington. LFUCG Division of Water Quality has had a long term commitment to Watershed-Focused Monitoring which is supported by Kentucky Division of Water. The watershed includes citizen and government forces such as the Hickman Creek Conservancy, Kentucky River Basin Management Plan and LFUCG Greenway Master Plan. City urban development has always had a great impact on the characteristics of the watershed, primarily through changing land use from grassland to residential and commercial impervious areas. This plan proposes to optimize the beauty and environmental benefits provided by the WHW with consideration for its relationship with urban development.

1.3 MONITORING

As part of the development of this plan, LFUCG and Kentucky Division of Water (KDOW) gathered samples in two phases. Phase 1 was a screening effort during which dry weather sampling (at least 72 hours of consecutive dry weather prior to sampling) was conducted at 18 in-stream sites and 105 major outfalls in summer 2019. Phase 2 further studied all stream sites and 68 of the major outfalls where water was found to be routinely flowing in Phase 1. Samples were taken to analyze levels of the following pollutants: bacteria, nitrogen, phosphorus and total suspended solids. Phase 2 sampling was completed by LFUCG from May 2019 through September 2019. KDOW completed the Phase 2 sampling at only the 18 in-stream sites from October 2019 through April 2020.

In addition to water quality metrics, stream biology was also assessed by LFUCG in May 2019, including measurements for macroinvertebrates, physical water quality, water chemistry, and warm water aquatic habitat. KDOW performed macroinvertebrate benchmark assessments in March 2020.

Microbial Source Tracking (MST) was performed in 2012 and 2019 by LFUCG in an effort to narrow down the potential sources of certain pollutants, specifically human fecal material. The study from 2012 utilized a comparison between stream samples and raw domestic sewage to determine the likelihood of sewage levels in the stream. The 2019 study identified separate DNA markers to human, dog, and bird hosts to determine if E. coli levels were contributable to a human source.

1.4 ANALYSIS

To evaluate the potential impact and level of the impairments within WHC, it was necessary to compare the monitoring results with a set of water quality benchmarks. The water quality benchmarks used for WHC are a combination of documented legal limits and standard benchmarks established by LFUCG for their watershed focused monitoring efforts. These benchmarks are utilized across Fayette County by LFUCG for baseline comparisons. The critical parameters were collected and then compared with these water quality benchmarks to determine exceedances. Pollutant loads and target loads based on water quality benchmarks were calculated. When pollutant loads exceeded target loads, target reductions were calculated and compared.

All sites had at least one E. coli sample exceeding benchmark levels with some sites having over 80% of samples exceeding benchmark levels. Thirteen of the eighteen sites require some level of E. coli reduction to reach benchmark levels. Eight of these sites require reductions of up to 50% to reach benchmark. Fifteen sites had at least one nitrogen sample exceeding benchmark levels with some sites having over 90% of samples exceeding. Five sites require reductions to reach benchmark levels, two of these sites require reductions of around 50%. Phosphorus had only one sample exceedance and required a 15%

reduction at one site to reach benchmark levels. TSS had six total sample exceedances, one at six different sites. No sites required reduction in TSS levels to meet benchmarks. E. coli and nitrogen are chosen as critical parameters for the WHW. Phosphorus, TSS and other parameters will not be heavily considered.

Macroinvertebrate and habitat sampling produced a majority of poor ratings with some fair indicating that West Hickman could use improvement to build a healthier ecosystem for wildlife. Priority upland assessment indicated four potential hotspots which are recommended to be revisited for permitting assessment. Volume and velocity study indicated a level of flashiness, likely caused by high concentrations of impervious surfaces. These high velocities contribute to stream bank erosion and habitat degradation.

Optical brightener results show pollution at two locations which indicate potential sanitary sewer contamination. Microbial source tracking showed low levels of human and dog waste and high levels of bird waste. This indicates a wide range of fecal pollution which will need to be separately addressed through BMPs.

1.5 BEST MANAGEMENT PRACTICES

To direct BMP selection, the project team, with the assistance of stakeholders, established goals and objectives for the WHW. Based on the existing watershed data, sampling results, stakeholder input, and engineering judgment, the following four goals were prioritized as most important for WHW:

1. Improve water quality for aquatic life and recreational uses.
2. Improve stream and riparian zone habitat to support a healthy aquatic and terrestrial ecosystem.
3. Increase environmental awareness in the community, and provide educational resources about improving the watershed to area residents.
4. Improve aesthetic appeal of the stream corridors and waterways to encourage engagement with nature.

Goal selection provided a broad plan of action, but identified priorities that were not strictly measurable or tangible. Objectives were selected to assist in achieving the above identified goals. The project objectives were identified as:

1. Reduce nutrient impacts to benchmark concentration or by 50% to improve water quality and aesthetic appeal within 10 years.
2. Reduce total suspended solids (TSS) to benchmark concentrations through stormwater treatment, storage, redirection, and green infrastructure within 10 years.
3. Promote infiltration of stormwater flows to decrease velocity, reduce erosion, and remove pollutants through the installation of a minimum of one new structural or retrofitted measure per year.
4. Expand, maintain, and/or preserve stream riparian zone to a minimum of 25 feet on 1000 linear feet of the stream banks and waterbodies to filter runoff, reduce erosion, increase habitat, and promote citizen engagement per year.
5. Stabilize stream banks to reduce erosion and sediment inputs through a minimum of one project or a combination of projects totaling at least 1000 feet every three years.
6. Restore stream channel dimensions, pattern, and profile for improved habitat and recreational use through a minimum of one project per every five years.

7. Increase native plants throughout the watershed through a minimum of one acre of additional area per year.
8. Reduce human fecal inputs throughout the watershed to benchmark concentrations to allow for safe recreational use by 2026.
9. Reduce non-human fecal inputs throughout the watershed by 50% to allow for safe recreational use by 2030.
10. Inform the public of the water quality status and water quality impairments in West Hickman Watershed at least once per year.
11. Develop a minimum of two targeted educational materials for problem areas or water quality concerns per year.
12. Remove a minimum of 1 ton of trash and debris clogging waterways and enhance attraction to the area per year.
13. Engage the community and encourage recreation within the waterways through a minimum of two events per year.

A large number of the considered BMPs were recommended for implementation. The following list the classifications of the BMPs that were recommended for implementation:

A. Basin Retrofit
B. Tree Planting
C. Wetland Development
D. Stream Restoration
E. Sanitary Sewer Investigation
F. Sanitary Sewer Replacement
G. Riparian Vegetation
H. Green BMPs
I. Fecal Matter Control
J. Bank Stabilization
K. Dam Removal
L. Trash Removal
M. Public Education and Outreach

A total of 152 BMPs are proposed across the 18 sub-watersheds. Watersheds have varied responses to BMP application so it is difficult to predict with certainty the level of success and load reductions that will be achieved. The level of success is often determined by the level of community cooperation and involvement in implementation.

1.6 IMPLEMENTATION

The WHWMP is a dynamic, public document that is intended to assist in protection and enhancement of water quality within the WHC in Lexington, Fayette Kentucky and Nicholasville, Jessamine County Kentucky. Upon approval of this plan, the focus in West Hickman will transition to strictly implementation. Since the goals of the WHWMP align with those of the HCC, HCC will work with LFUCG to develop a central WHWMP Implementation Coordinator. Ideally a full time watershed coordinator position would be developed and filled to support this plan due to the significant amount of time and resources that will be required. The WHWMP Implementation Coordinator will pursue BMP installation and construction; assist

in securing funding through grants and other sources; ensure the WHWMP is implemented in a manner consistent with its intent; provide targeted outreach and education; and provide a main point of contact for volunteers and those interested in specific projects.

LFUCG, the West Hickman Watershed Council, and HCC will present the objectives and recommendations of this plan to the general public through a series of events planned for 2022. HCC has committed through a contract with LFUCG to maintain the HCC website to host the WHWMP and announce participation events to the general public. HCC will be maintain the official digital copy of the WHWMP and any updates to the plan will be provided to them. It is the intent of the HCC to also maintain the interactive map showing the proposed BMPs and extend the map to track progress of project completion. HCC will hold a minimum of two events in conjunction with the project team to inform the public of the completion of the planning efforts and promote implementation. No physical hard copies of the WHWMP are anticipated due to the difficulty in ensuring updates.

Proposed BMP projects in WHW will demand substantial financial resources. Expected funding sources included local agency budgets, sanitary sewer user fees and grant programs. A summary of these sources are provided below. Effective implementation of this plan will require a diverse selection of funding sources beyond what is proposed in this plan.

Results of the WHWMP can be measured in terms of not only water quality sampling results and load reductions, but also in terms of implementation progress, education efforts, and behavior modifications. HCC plans to track BMP implementation progress overtime utilizing an online mapping tool that is GIS based. With the anticipated completion of all the sanitary sewer consent decree projects in WHW by the end of 2026, no additional water quality monitoring is expected until after that date. To allow stabilization of the watershed following the completion of the projects, repeat water quality monitoring of subwatersheds where BMP projects were completed and sites downstream is recommended in 2028-2030.

Following future monitoring efforts, the WHWMP Implementation Coordinator should organize a meeting with watershed stakeholders to discuss the collected results. The effectiveness of the BMPs should be discussed. Alternative approaches should be considered in areas where BMPs are shown to not be feasible and/or effective. Discussion should include if the proposed Action Items are achieving the desired objective, if it should be continued to be pursued, and if the designated outcome indicator is the most effective measure. The effectiveness of public outreach activities should be evaluated based on the number of persons in attendance and the implementation of BMPs discussed at the activity (such as the number of rain barrels installed). As implementation progresses, the prioritization of Action Items may be altered based on a change in stakeholder involvement, project goals, or a variety of other factors. The WHWMP is intended to be a living document, so modifications should be made based on changing conditions. Changes in water quality are influenced by many factors and implementation efforts may take considerable time before changes can be observed in monitoring data.

2 INTRODUCTION

2.1 PROJECT OVERVIEW

Lexington -Fayette Urban County Government (LFUCG), through the Division of Environmental Services (DES), contracted Palmer Engineering (Palmer) to provide consulting services for the development of a Watershed Management Plan (WMP) in the West Hickman Creek Watershed in Lexington, Fayette County, Kentucky and extending into the northern portions of Jessamine County, Kentucky. The request for development of the WMP was in response to citizens' interest in the watershed and water quality. Preparation of the West Hickman Watershed Management Plan (WHWMP) has been based on EPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* and the State of Kentucky's *Watershed Planning Guidebook for Kentucky Communities.* The project team proposed to meet the requirements for §319(h) grant funded projects, as outlined in the *Watershed Planning Guidebook for Kentucky Communities*, to allow for the funding of future projects through the §319(h) grant program as administered by the Kentucky Division of Water (KDOW).

The Clean Water Act (CWA) of 1972 is the primary federal law in the United States governing water pollution. The CWA established the basic structure for regulating discharges of pollutants into the waters of the United States and regulating water quality standards. Despite these regulations, many waterways across the United States remain polluted. Since the late 1980s, waterway improvements have trended toward a watershed approach. A watershed approach allows for a more widespread tactic to address nonpoint source pollutants, provide protection, and plan improvements in coordination with one another. A watershed approach is a flexible framework for managing water resource quality and quantity (KDOW 2010).

This WMP presents the collaborative culmination of an extensive data collection and analysis effort, recruitment of partners and stakeholders in watershed interests, and remediation strategy development. This document is intended to address the nine minimum elements required in the EPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (USEPA 2008). These nine elements are as follows:

1) An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this WMP (and to achieve any other watershed goals identified in the WMP), as discussed in item 2) immediately below; Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed.
2) An estimate of the load reductions expected for the management measures described under item 3) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time); Estimates should be provided at the same level as in item 1) above.
3) A description of the nonpoint source management measures that will need to be implemented to achieve the load reductions estimated under item 2) above (as well as to achieve other watershed goals identified in this WMP), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.
4) An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan; Potential funding sources may include Section 319 programs, State Revolving Funds, US Department of Agriculture's (USDA) EQIP and Conservation Reserve Program, and other relevant federal, state, local, and private funds

that may be available to assist in implementing this plan.

5) An information/education component that will be used to enhance public understanding of the project and encourage early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.
6) A schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.
7) A description of interim, measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.
8) A set of criteria that can be used to determine whether loading reductions are being achieved over time and whether substantial progress is being made towards attaining water quality standards; if not, the criteria for determining whether this watershed-based plan needs to be revised; or, if a nonpoint source Total Maximum Daily Load (TMDL) has been established, whether the nonpoint source TMDL needs to be revised.
9) A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item 8) immediately above.

To aid in completion of these nine minimum elements, water quality sampling was completed by LFUCG Division of Water Quality's Watershed-Focused Monitoring Program and KDOW Watershed Management Branch. The following tasks were requested by LFUCG in the original scope of work to achieve these nine minimum elements and compiled into this document:

- Task 1: Development of a Stakeholder Process
- Task 2: Characterize the Watershed
- Task 3: Set Goals and Identify Solutions
- Task 4: Design Implementation Program
- Task 5: Final Approved Plan

Much of the watershed assessment information included in Sections 2 and 3 of this report was obtained from the *West Hickman Creek Watershed Assessment*, prepared by Third Rock Consultants, LLC for LFUCG and dated September 2012 and included in APPENDIX A. At the time of writing, this information was verified, and if updates were not required, some sections of the report are included in this WMP without significant alteration to limit duplication efforts and with the permission of LFUCG.

2.2 WATERSHED BACKGROUND

West Hickman Creek watershed is located in south central Lexington, Fayette County, and northeastern Jessamine County, Kentucky. Its watershed area is almost entirely urban within Fayette County, with more rural land uses in Jessamine County. Lexington hosts approximately 6 miles of stream length and 20 square miles of watershed while Jessamine County contains approximately 2 miles of stream and 2 square miles of watershed. The headwaters of West Hickman Creek begin in Lexington and the stream flows south into Jessamine County until its confluence with East Hickman Creek to Hickman Creek. The West Hickman Creek watershed encompasses Lexington Reservoirs 1, 2, and 3, which are predominately used for recreational purposes. These reservoirs, in particular Reservoir 1 are popular spots for fishing and boating.

West Hickman Creek was first listed as impaired for aquatic life in the 1998 303(d) list of Kentucky impaired waters. In subsequent years, additional segments and causes were listed including impairment

to recreational use due to pathogens in 2004. The US Environmental Protection Agency (EPA) and the Kentucky Environmental and Public Protection Cabinet (KY EPPC) also filed a lawsuit (United States 2006) against LFUCG over violations of the Clean Water Act in 2006. The lawsuit was due to failure of the city to maintain the sanitary and storm sewer systems causing raw sewer discharges into streams. On March 14, 2008, LFUCG lodged a Consent Decree to resolve this lawsuit (United States 2008), which was officially entered into on January 3, 2011 (United States 2011). Within the Consent Decree, LFUCG agreed to make extensive improvements to it storm and sanitary sewer systems, address sanitary sewer overflows and associated Municipal Separate Storm Sewer System (MS4) Permit violations, as well as to reduce the discharge of pollutants via stormwater. With the Consent Decree in place, LFUCG is furthering its efforts to improve water quality in West Hickman Creek. The stormwater portion of the Consent Decree was fulfilled and removed in 2021.

This WMP is being developed to provide a comprehensive assessment of the health of the watershed, citizen and stakeholder concerns, watershed remediation strategies, and implementation plans for the future.

2.3 PARTNERS AND STAKEHOLDERS

A vital part of the development of the WHWMP was the involvement of the partners and stakeholders in the project area. The West Hickman Watershed Council was formed with the assistance of LFUCG DES in 2017. In November 2017, the West Hickman Watershed Council established its main goal as to gather local residents and businesses together to learn about and improve the West Hickman Creek Watershed. The following objectives were also established at that time:

- Objective 1: Recruit volunteers for additional water quality monitoring
- Objective 2: Develop a West Hickman Watershed Plan
- Objective 3: Gather contact information for interested stakeholders, volunteers, and residents
- Objective 4: Strengthen grass roots effort for future ‘Friends of’ non-profit
- Objective 5: Increase community awareness through various activities
- Objective 6: Implement BMPs identified in the Watershed Plan
- Objective 7: Create synergy for an overall ecological plan/small area plan

Through meetings held by the West Hickman Watershed Council, enough interest and leadership emerged to incorporate a non-profit focused on the West Hickman Watershed called the Hickman Creek Conservancy. The Hickman Creek Conservancy was incorporated on January 1, 2019, and the 501c3 was filed on February 14, 2019. The Hickman Creek Conservancy aims to help residents of the watersheds be good stewards, plant trees to restore vegetative habitat, and advocate for green infrastructure and effective watershed management in both the East Hickman and West Hickman Watersheds. The Hickman Creek Conservancy is currently focusing most of its efforts on the West Hickman Watershed and was a vibrant part of the development of the WHWMP.

The following organizations, listed in alphabetical order, took an active role in participation of the development of the WHWMP:

- EarthCycle Design
- EcoGro/Ridgewater
- Element Design, PLLC
- Friends of Wolf Run
- Hickman Creek Conservancy
- Jackson Group
- Kentucky American Water Company
- Kentucky Division of Water
- Kentucky River Basin Coordinator
- Kentucky River Watershed Watch
- Kentucky Water Resources Research Institute
- LFUCG Division of Environmental Services
- LFUCG Division of Water Quality
- Palmer Engineering
- Third Rock Consultants

3 THE WEST HICKMAN CREEK WATERSHED

3.1 WATERSHED OVERVIEW

3.1.1 WATERSHED BASICS

The West Hickman Creek Watershed, Hydrologic Unit Code (HUC) number 05100205-120-040, is a 22.35 square-mile (14,305-acre) watershed located in Fayette and Jessamine Counties, Kentucky. The confluence of West Hickman and East Hickman Creeks marks the beginning of Hickman Creek, which flows into the Kentucky River near Camp Nelson (approximate River Mile No. 135). West Hickman Creek and Tates Creek are the two main tributaries of the West Hickman watershed.

The West Hickman Watershed boundary is shown in Figure 3-1. The main channel of West Hickman Creek begins at the outlet of Lexington Reservoirs Nos. 1, 2, and 3. The western boundary extends north along Nicholasville Road (US 27), crosses east through the Southern Heights Neighborhood and University of Kentucky Arboretum, Woodlake, Chevy Chase, Chenault Road, Shriners, Kenwick, and Fairway Neighborhoods. The northern watershed boundary is approximately Lexington Road (US 60).

The eastern boundary extends south generally following East New Circle Road through the neighborhoods of Locust Hills, Chippen Dale Square, Lakeview Islands (adjacent to Reservoirs Nos. 1, 2, and 3), and then south along Man O War Boulevard. The neighborhoods of Carriage Lane, Southern Hills, Park Place, and Hartland Home Owners are crossed by the watershed boundary before it exits Fayette County at Ashgrove Road (KY 1980).

Karst formations are common in the Inner Bluegrass, but significant karst features are absent from the West Hickman Watershed. As shown in Figure 3-2, page 13, a few small sinkholes and springs are distributed throughout the watershed but are mostly located within or adjacent to the tributaries to West Hickman Creek.

3.1.2 BASIS OF SELECTION OF WATERSHED

The *Watershed Planning Guidebook for Kentucky Communities* recommends reviewing the scale, regulatory status, and public interest in the selection of a watershed for planning efforts. West Hickman Creek Watershed was selected for preparation of a WMP by LFUCG based on the following key factors:

- LFUCG's continuing desire to improve water quality;
- Size and location of the watershed within Fayette County;
- Impaired regulatory status of West Hickman Creek;
- Availability of data from LFUCG Division of Water Quality's Watershed-Focused Monitoring in the watershed;
- Commitment of Kentucky Division of Water to continue monitoring efforts within the watershed following the completion of the LFUCG's monitoring;
- Citizen involvement and interest through the West Hickman Watershed Council and Hickman Creek Conservancy; and
- Potential positive impact to water quality improvements due to the size and number of residents within the watershed.

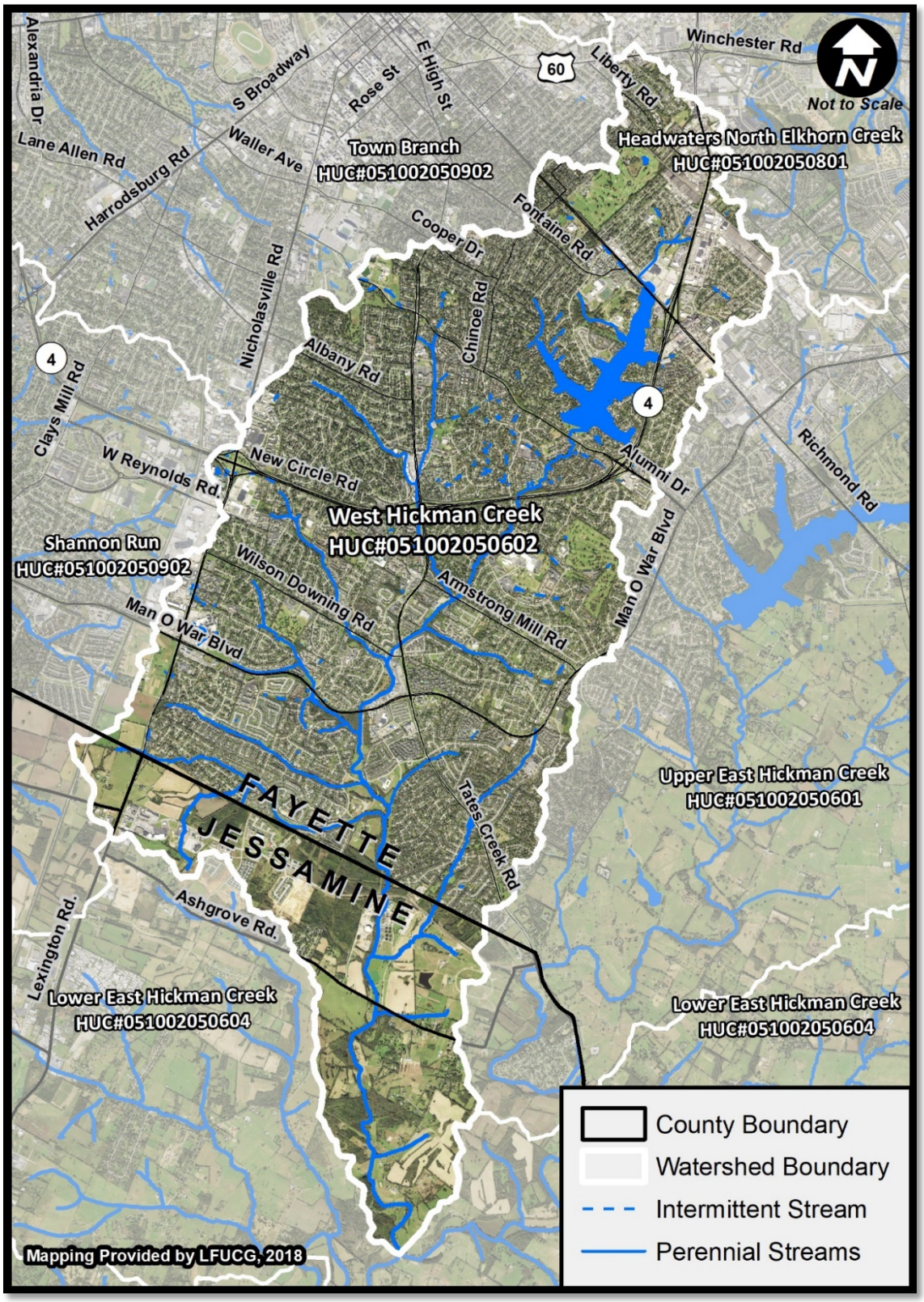


Figure 3-1: West Hickman Creek Watershed

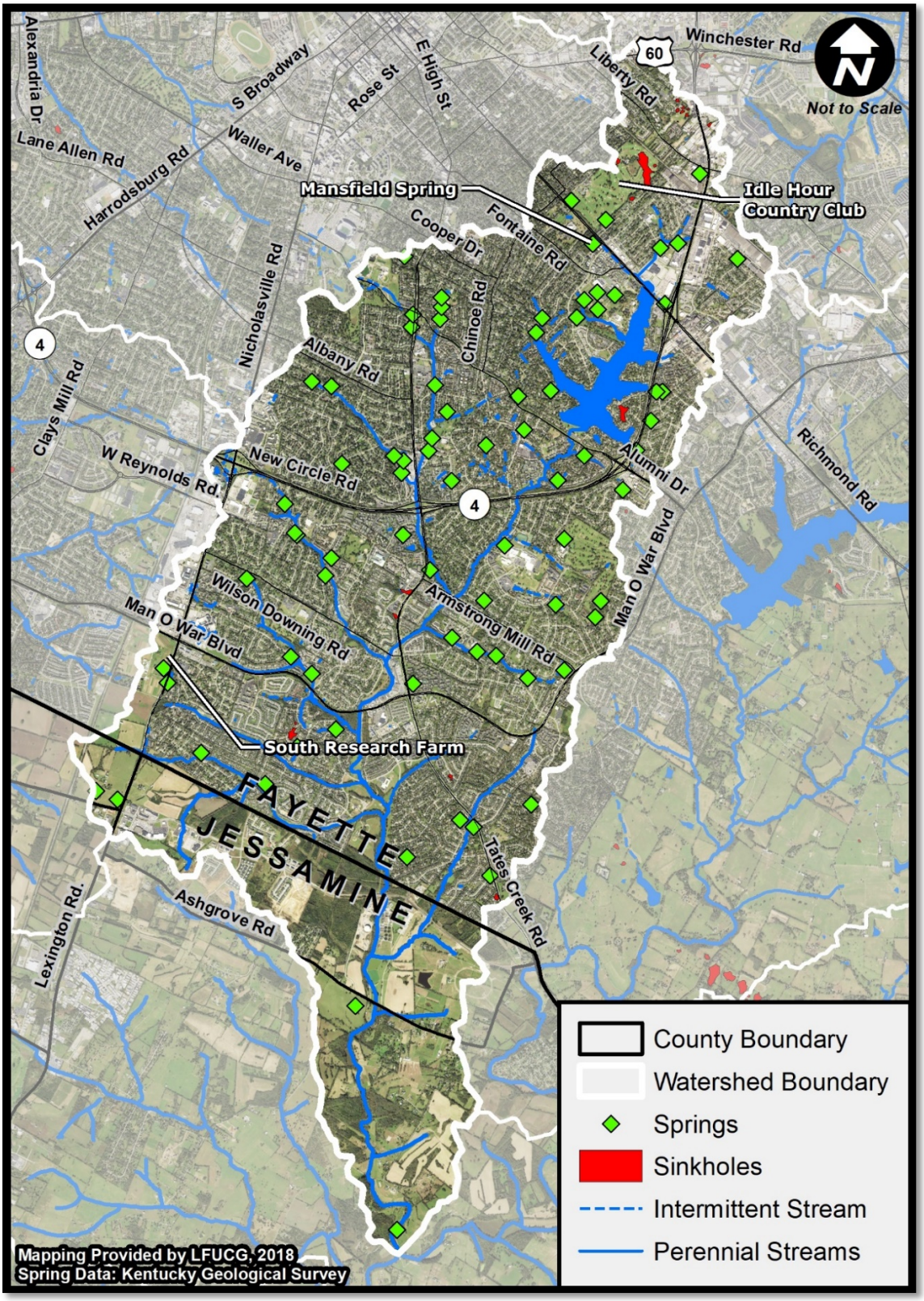


Figure 3-2: Fayette County Karst Map

3.1.3 WATERSHED MANAGEMENT ACTIVITIES

Many ongoing watershed management activities are already occurring within the West Hickman Creek Watershed, especially the portions within Fayette County. The currently known activities and previous plans are discussed in the sections below.

3.1.3.1 KENTUCKY RIVER BASIN MANAGEMENT PLAN

In 2002, the Kentucky Watershed Management Framework completed the *Kentucky River Basin Management* Plan (KWRRI 2002). This plan included summaries of each of the 97 watersheds in the Kentucky River basin. West Hickman Creek was analyzed as part of the Hickman Creek Watershed.

The summary indicates that the Hickman Watershed was ranked in the group of the highest need for protection and restoration in the Kentucky River Watershed. Pathogens and nutrients were the greatest concerns from the watershed. Because the watershed was identified as one of the top ten contributing watersheds of the Kentucky River, a citizen action plan was developed in 2003 to identify watershed resources, identify pollutants, conduct monitoring, and develop a plan for improvement (Hahn 2003). The citizen action plan identified four action items as follows:

1. Conduct focus testing at KRWW site #K133 (867) (tributary parallel to Zandale Drive beginning at Lansdowne Estates);
2. Use GIS to assist in identification of pollution sources;
3. Initiate an environmental restoration stream/wetland project along one of the smaller tributaries of the creek; and
4. Educate users of Veterans Park of potential dangers posed by sanitary sewer overflows along the edge of creek and soccer field.

A potential stream restoration site was identified behind Veterans Park, and the group indicated interest in supporting elementary schools in the wetland and stream restoration efforts as a living laboratory.

3.1.3.2 WEST HICKMAN WATERSHED COUNCIL

The West Hickman Watershed Council was formed with the assistance of LFUCG DES in 2017. In November 2017, the West Hickman Watershed Council established its main goal as to gather local residents and businesses together to learn about and improve the West Hickman Creek Watershed. The objectives identified by the Council at that time are identified in Section 2.3. Currently, West Hickman Watershed Council meetings are not regularly scheduled, but the Council was a vital part of this plan development through periodically scheduled meetings during the process of development of WHWMP. Some meetings had to be held virtually due to the ongoing global pandemic due to the novel coronavirus during 2020 and 2021.

3.1.3.3 HICKMAN CREEK CONSERVANCY

Through meetings held by the West Hickman Watershed Council, enough interest and leadership emerged to incorporate a non-profit focused on West Hickman Watershed called the Hickman Creek Conservancy. The Hickman Creek Conservancy was incorporated on January 1, 2019, and the 501c3 was filed on February 14, 2019. The Hickman Creek Conservancy aims to help residents of the watersheds be good stewards, plant trees and restore vegetative habitat, and advocate for green infrastructure and effective watershed management in both the East Hickman and West Hickman Watersheds. In 2019, the Hickman Creek Conservancy completed stream walks, stream cleanups and assisted with volunteer coordination. One specific effort involved assisting a Homeowners Association to solicit volunteers to conduct stream

walks as part of a data collection effort to study sedimentation and erosion. The group was also involved in tree and native planting events in the watershed and conducted a stream walk in Belleau Wood Creek in Fall 2019. The Hickman Creek Conservancy further assisted with the development of the WHWMP through promoting West Hickman Watershed Council meetings, hosting meetings with local Homeowners Associations and other local groups, and conducting outreach events.

During 2020 Hickman Creek Conservancy continued to take an active role in public outreach and further development the infrastructure necessary for continued progress within the watershed. Several creek walks and planting events were held despite the global pandemic while observing social distancing. Their website is a tool that works, in tandem and through coordination with LFUCG's own public information and engagement efforts to amplify messaging for public involvement. The organization is proving to be rooted in the community and a dependable partner.

3.1.3.4 SMALL AREA PLANS

Kentucky state law requires that the Division of Planning to maintain the community's Comprehensive Plan. The Comprehensive Plan for LFUCG is discussed in detail in Section 3.6.3.1 on page 48. Implementation of the Comprehensive Plan often indicates a need for additional small area plans. Two small area plans have been developed by LFUCG within the West Hickman Creek watershed, Armstrong Mill West and South Nicholasville Road. Both small area plans were developed under previous versions of LFUCG Comprehensive Plans and have not been updated to reflect the changes in the latest plan, but are available at https://www.Lexington ky.gov/plans-studies-and-surveys.

3.1.3.5 ARMSTRONG MILL WEST SMALL AREA PLAN

The area of this small area plan is bounded by New Circle Road to the north, Tates Creek to the west, Man O'War Boulevard along the southern and eastern boundary, and Alumni Drive to the northeast. The area is dominated by residential development. Most of the neighborhoods were developed from the late 1950s through the late 1970s. This plan suggested incorporating best management practices for stormwater management on the Tates Creek School campus that could incorporate water quality and educational components. Additional tree cover throughout the study are was also suggested, especially native species.

3.1.3.6 SOUTH NICHOLASVILLE ROAD SMALL AREA PLAN

The area of this small area plan examines nearly 400 acres of highly visible urban land, most of which has been in active agricultural use for many decades. Included in the agricultural land is the University of Kentucky Horticulture Research Farm, as well as general agriculture family farms. One of these family farms has been developed into a multi-use commercial and residential area since the writing of this plan, called the Summit at Fritz Farm. Several stormwater and flooding concerns were expressed in this report.

3.1.3.7 GREENWAY MASTER PLAN

Greenways are linear corridors that can provide critical linkage and protection of natural and cultural resources. Issues, such as flooding, transportation, water quality, habitat loss, historic preservation, economic stimulation, recreation, and fitness can be addressed and resolved by a multi-objective greenway system. As part of the Comprehensive Plan in 2001, LFUCG developed the Lexington -Fayette County Greenway Master Plan (LFUCG 2001) to communicate the importance and need for greenways, and recommended a countywide system of interconnected greenways. An update to the Greenway Master Plan is currently ongoing.

The plan noted numerous trails and greenways within the West Hickman Watershed, as shown in Figure

3-3. The plan discusses the West Hickman Creek Conservation Greenway Corridor, Veterans Greenway Trail, South Elkhorn Greenway Trail, Man O' War Greenway Trail, Henry Clay Greenway Trail, and the Big Sandy Greenway Trail. The West Hickman Creek Greenway Corridor is described as beginning at Lexington Reservoir Nos. 2 and 3, and extending along West Hickman Creek and its tributaries to Veterans Park. The objectives for this corridor include floodplain/riparian preservation and restoration, flood reduction, water quality improvements, drinking water protection, open space preservation, and habitat mitigation. The Greenway Master Plan recommends focusing on floodplain preservation along West Hickman Creek downstream of Wilson Downing Road, particularly the undeveloped section between Man O' War Boulevard and Veterans Park. Upstream of Wilson Downing Road, the Greenway Master Plan suggests purchasing flood-prone properties and incorporating them into the greenway. Several properties along Olympic Drive, Armstrong Mill, and Greentree Road have already been purchased for this purpose.

Creation of riparian buffers around the reservoirs at the head of West Hickman Creek and a greenway buffer around the former Lexington Mall shopping center (current Southland Christian Church campus) were also recommended for water quality improvements. Public parks and schools adjacent to the greenway include Lakeview Park, Belleau Woods Park, Veterans Park Elementary School, and Veterans Park. With trails that follow the West Hickman Conservation Greenway, opportunities may exist for stream enhancements in conjunction with trail construction.

3.1.3.8 ADDITION OF GREENWAYS TO *2016 PROCEDURES MANUAL FOR INFRASTRUCTURE DEVELOPMENT*

In 2020, LFUCG revised the *2016 Procedures Manual for Infrastructure Development* to classify Greenways as Public Infrastructure (similar to roadways and storm sewer) and describe the role of the Developer and LFUCG in the development, construction, final inspection, and long-term maintenance of Greenways. The key components of this addition include:

- Greenway Plan Development – The plan would be developed cooperatively among the Developer, Division of Planning, and Division of Environmental Services and would include the following:
    - Existing conditions, including vegetation, trails, streams, structures, roads, stormwater controls, wetlands, sinkholes, existing bank erosion, etc.
    - Proposed conditions, including vegetation, trails, signage, and proposed construction
    - Name of legal entity who would become the owner of the greenway
    - A post-construction operation and maintenance plan for the greenway
    - Proposed deed and/or conservation easement for greenway owner/manager

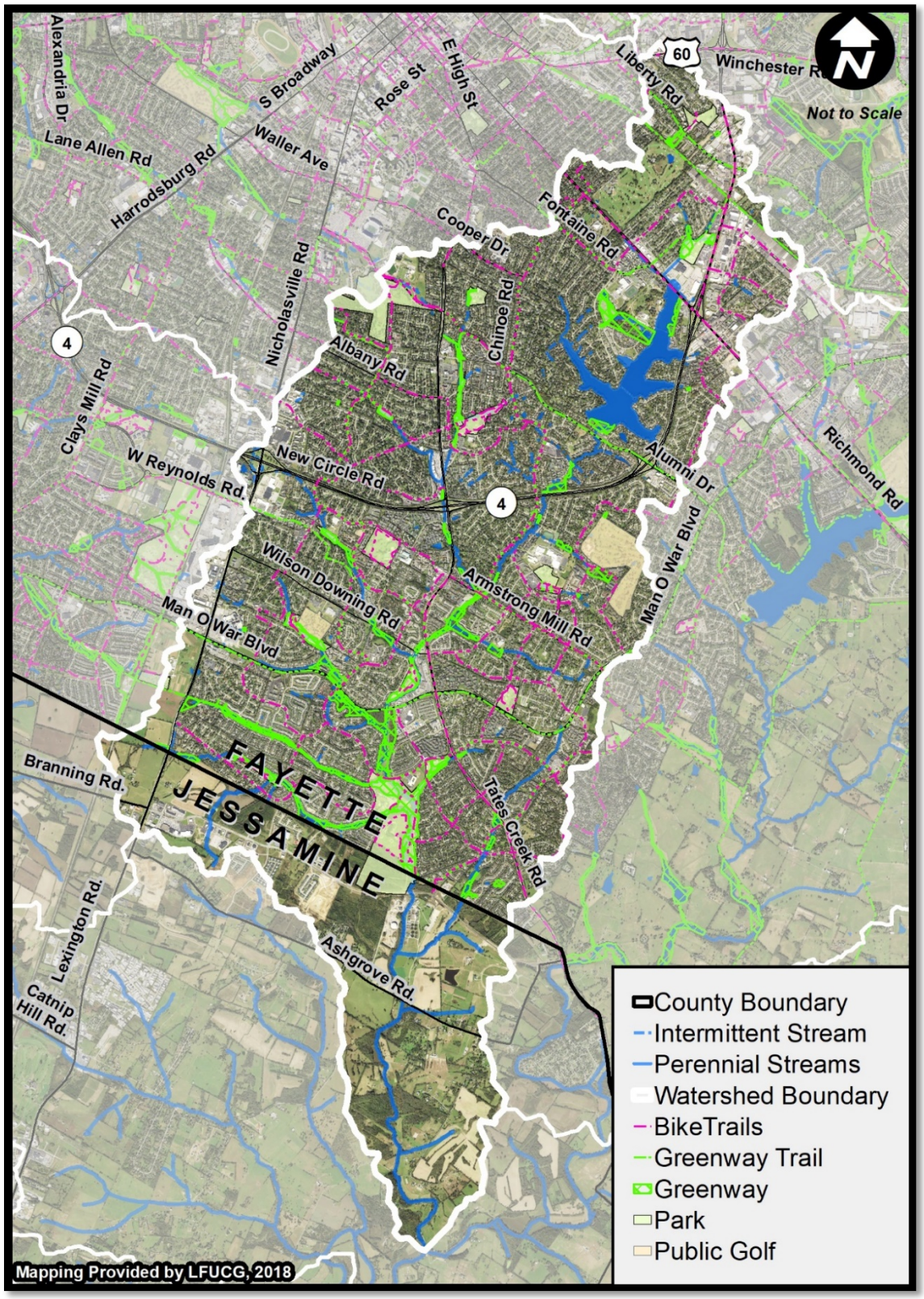


Figure 3-3: Greenway and Trail Map

- Construction – The Developer would implement the Greenway Plan. The Division of Engineering would inspect the engineered infrastructure in the same manner as other public infrastructure. The Division of Environmental Services would inspect the greenway components.
- Final Inspection – The Developer, Division of Environmental Services, and Division of Engineering would coordinate on the final inspection and punch list. The Developer would prepare the applicable plat or easement documents.
- Management – The Developer would execute a management agreement with the ultimate greenway owner/operator, who would typically be LFUCG or the Homeowners' Association. The agreement would be reviewed by the Division of Environmental Services and the Department of Law.

The primary goal of the addition of this information to the *Procedures Manual for Infrastructure Development* was so that LFUCG could have more input into the development of greenways and ensure protection of these areas.

3.1.3.9 PREVIOUS STREAM RESTORATION, CONSERVATION EFFORTS, AND GRANTS

Stream restoration, conservation efforts, and water quality grants are ongoing in the West Hickman Watershed. Some of the more prominent projects and programs in the watershed include the Gainesway Pond Water Quality and Environmental Education Project, Mill Creek Wetland and Stream Restoration Project, Reforest the Bluegrass, the Bluegrass Rain Garden Alliance (although now inactive), and grants through LFUCG's Stormwater Quality Projects Incentive Grant Program.

Gainesway Pond Water Quality and Environmental Education Project was an $830,000 project funded in part by US EPA Section 319(h) grant funds with matching funds from LFUCG. The project was completed in 2009, included the renovation of the existing pond, and created adjacent wetlands. The pond and wetlands would help control the impact of stormwater to West Hickman Creek, prevent sedimentation of the pond, improve wildlife habitat, and provide educational opportunities for adjacent schools and the public.

Mill Creek Wetland and Stream Restoration Project was a $200,000 project funded by the Kentucky Department of Fish and Wildlife Resources Wetland and Stream Mitigation Program and the Five Star Restoration Challenge Grant. The project involved the restoration of 700 feet of stream length with creation of adjacent wetlands. The goals of the project were to improve water quality, create and improve wildlife and aquatic life habitat, and provide educational opportunities.

The Reforest the Bluegrass program was started in March 1999 as a cooperative effort between LFUCG's Water Quality, Urban Forestry, and Parks and Recreation management programs. Its purpose is to recreate pre-settlement streamside forests that were once native to the Inner Bluegrass Region of Kentucky. Today, through the efforts of thousands of volunteers, Lexington is progressively restoring those long-lost benefits of streamside forests (riparian buffers) for generations to come. This step is crucial to protecting our valuable water resources and enhancing our living standards. Reforest the Bluegrass (RTB) uses beneficial qualities of native species of trees to bring natural balance to our ecosystems. Approximately 7,000 trees, comprising 25 different species, were planted in Veterans Park in April 2009. Trees were planted along an unnamed tributary of West Hickman Creek and behind Lexington Fire Station #22. The event's 19th year was also in Veteran's Park in 2018. More recently, two planting events took place in Meadowbrook Park, one as part of Plant for the Planet and the other as part of "Maya Meena's Last Straw." Maya is a five year old in Lexington who was moved to action after learning about marine

life dying from plastic waste. Her efforts were supported by LFUCG Urban Forestry, the Living Arts and Science Center, and the Bluegrass Youth Sustainability Council. These efforts added nearly 200 trees along the Tiverton Way Tributary.

3.1.3.10 LFUCG STORMWATER QUALITY INCENTIVE GRANT PROGRAM

Under the LFUCG's Stormwater Quality Projects Incentive Grant Program, multiple projects within the West Hickman Watershed have been funded. Since 2010, with some projects detailed on the map located at https://www.Lexington ky.gov/stormwater-incentive-grant-program, the following projects were funded within the West Hickman Watershed:

- **Ashwood Townhomes of Laredo, Inc. (FY2017 Class A Neighborhood)**: $16,760 awarded to improve water quality in the Ashwood and Orchard Hill Townhomes Community by mitigating issues of erosion. The project elements included design and installation of two raingardens; and two community events involving a litter clean-up, invasive species and plant removal, and a rain barrel Give-A-Way. The project also included educational signage, an updated website with a community events calendar, and a community education tab with information about stormwater management.
- **Ashwood Townhomes of Laredo, Inc. (FY2019 Class B Infrastructure)**: $22,458.06 for retrofit a portion of the existing parking area with permeable pavers (approximately 15,000 SF) and design of a vegetated roof atop existing carports for bioretention.
- **Gainesway Neighborhood Association, Inc. (FY2011 Class A Neighborhood)**: $10,255 for stream bank restoration and riparian buffer enhancement of a tributary of West Hickman Creek. The project also incorporated a Clean-up Event, removal of invasive species, new native plantings, and three community educational workshops on water quality and stormwater.
- **Gardens of Hartland Homeowners Association, Inc. (FY2011 Class A Neighborhood)**: $36,565 to design and construct a multi-cell rain garden at 5095 Ivybridge Road. Other project elements included plantings along a portion of the West Hickman stream, and stormwater education in the form of a workshop focused around the newly constructed rain garden.
- **Hartland Homeowners Association, Inc. – Stormwater Basin Retrofit Grant (FY2012 Class A Neighborhood):** $50,000 for design and construction improvements to an existing stormwater basin that enhanced detention volume, reduced runoff from stormwater events, and stabilized the eroded stream. Stormwater education was also provided in the form of an updated website to include project information and a rain barrel seminar.
- **The Board of Education of Fayette County, Kentucky – Henry Clay High School (FY2011 Class B Education)**: $2,500 for the development and implementation of an environmental / stormwater curriculum, educational seminars, signage identifying the rain garden plantings, as well as enhancement of an existing rain garden at Henry Clay High School.
- **Idle Hour Neighbors Alliance, Inc. (FY2016 Class A Neighborhood)**: $6,910 to create a stream buffer (*i.e.*, plantings) along the unnamed creek that borders the Idle Hour Greenspace at 209 St. Ann Drive. The project's goal was to improve water quality and reduce water quantity in the Idle Hour Community. All plant species were native to Kentucky. An instructional sign explaining the purpose of the buffer and its ecological benefits was also installed.
- **Kentucky American Water Company (FY2018 Class B Infrastructure)**: $261,208.40 to improve water quality in the stream draining to Reservoir #1 (located at 2300 Richmond Road) through stream restoration. Project elements included constructing a riparian buffer, riffles, and pools; widening the channel and flattening the slopes of the streambank; and constructing bioswales.

The project also had an educational element that included outreach activities as part of KAWC's routine tours and signage.

- **Lakeshore Village, Inc. (FY2020 Class B Infrastructure)**: $4,800 for a feasibility study to evaluate and recommend potential water quality and quantity BMPs in an effort to mitigate issues of flooding and erosion surrounding Lake Fontaine. The project also provided stormwater education to citizens through an annual article about water quality on the Lakeshore Village website, as well as one or two signs indicating the water quality concerns, as determined by the study.
- **Lansdowne Elementary (FY2013 Class B Education)**: $3,500 for design and construction of a rain garden at Lansdowne Elementary School. Stormwater education was also provided through community outreach and incorporating the newly-constructed rain garden into the environmental education curriculum for K-5 students.
- **Lansdowne-Merrick Neighborhood Association Corporation (FY2018 Class A Neighborhood)**: $8,985 to improve water quality by initiating ecological restoration in Lansdowne-Merrick Park (*i.e.*, improving the balance between exotic and native plantings). Project elements included the creation of two riparian zones (Phases 1 & 2), a wetland zone, and community education.
- **Lansdowne Neighborhood Association, Inc. (FY2012 Class A Neighborhood)**: $10,000 for a conceptual plan that addressed stormwater runoff and erosion (*i.e.*, stream improvements) in the Zandale Tributary to West Hickman Creek. The project also provided stormwater education through seminars for the Lansdowne neighborhood residents.
- **Lansdowne Neighborhood Association, Inc. (FY2013 Class A Neighborhood)**: $47,714 for the streambank stabilization that included design and construction of a log vane armoring system to mitigate streambank erosion on a portion of the Lansdowne Drive Tributary of West Hickman Creek.
- **Tanbark Association of Neighbors (FY2017 Class A Neighborhood)**: $31,650 to improve water quality by mitigating issues of erosion and ponding from stormwater runoff in an existing swale located west of Crosby Drive, between Hartland Parkway and Tanbark Road. The project elements included a newly-graded drainage swale with plantings, an underdrain system, and installation of an Erosion Control Mat along the full length of the swale. The project also educated local residents on the many methods used to stabilize swales through meetings, mail, flyers, door-to-door communications, and a scheduled seminar.
- **University of Kentucky Research Foundation (FY2018 Class B Infrastructure)**: $299,400 to restore an unnamed tributary to West Hickman Creek (stream and valley) in a similar manner to the previously restored section of Vaughn's Branch on UK's property. The project elements incorporated a riparian buffer restoration; construction of a bio-infiltration swale and an enhanced hyporheic zone (designed to reduce nitrates through denitrification); and the creation of an outdoor classroom for stormwater education research and to demonstrate water quality protection and water quantity reduction BMPs.
- **Waterford II Homes Association, Inc. (FY2019 Class A Neighborhood)**: $16,132 for a feasibility study to evaluate options for future management of Waterford Pond. Project elements included an assessment of upstream sediment and nutrient sources, as well as upstream mitigation measures (*i.e.*, streambank stabilization). The project also provided stormwater education through newsletters, social media, board meetings, and two workshops.
- **Woodfield Homes Association (FY2017 Class A Neighborhood)**: $100,000 funded design and construction solutions to address the protection of the Woodfield Stormwater Retention Pond. The project elements included stabilization of an eroding channel bank downstream of the Tates

Creek culvert outflow, stabilization of a portion of the eroded pond bank with rock toe, slope reduction of the pond bank, and installation of a vegetated littoral shelf. The project also re-established the *no-mow* riparian zone along the pond's edge near Tates Creek Road. Woodfield Homes Association also hosted a public involvement Field Day Event and installed educational signage at the pond.

- **Woodfield Homes Association, Inc. (FY2019 Class A Neighborhood)**: $48,000 funded water quality and quantity control by restoring the stormwater pond. The project elements included design and construction of a new outlet valve structure, stabilization of a portion of the eroded pond banks with rock toe, and installation of a vegetated littoral shelf.

3.2 WATERSHED RESOURCES

3.2.1 HYDROLOGY

West Hickman Creek lies within the Inner Bluegrass Ecoregion, which contains undulating terrain with moderate rates of both surface runoff and subsurface drainage. West Hickman Creek flows for approximately 10.1 miles from its headwaters to its confluence with Hickman Creek. Approximately 27.8 miles of perennial streams and tributaries are within the watershed. Excluding the headwaters, West Hickman Creek is predominately a high gradient perennial stream of mixed substrates flowing through a gently rolling topography with slight relief, and general elevations varying from 800 to 1000 feet above sea level. Named waterbodies include Mill Creek, Tates Creek, and Reservoirs No. 1, No. 2, and No. 3. These reservoirs are in sequence with a combined watershed area of approximately 4.28 square miles and length of 1.3 miles. The reservoirs are located within the headwaters of West Hickman Creek. Tates Creek is the next largest tributary with a watershed area of 3.43 square miles and flows approximately 2.9 miles from its headwaters to confluence with West Hickman Creek at Armstrong Mill Road. Other tributaries include Mill Creek, Tiverton Way Tributary, South Point Tributary, and other unnamed tributaries. The majority of the watershed within Fayette County is developed (89%) with impervious surfaces (streets, roofs, etc.) that contribute to flashy storm flows due to quick runoff from the impervious surfaces. Approximately 4.3 square miles are located within a more rural portion of Jessamine County, flowing approximately 3.6 miles from the county line to the confluence.

A United States Geological Survey gaging station was established on West Hickman Creek near Ash Grove Pike in October 1997. However, this gaging station was located downstream of the discharge from the wastewater treatment plant and, therefore, had artificially elevated flows. The gaging station was moved upstream to Veterans Park near the Urban Service Area boundary in June 2012. Basic statistics on the discharge at this station once relocated to Veterans Park are provided in Figure 3-4 based on available information for a one-year time period from December 1, 2018 through December 1, 2019. These statistics indicate that West Hickman Creek discharged approximately a minimum of 0.64 cubic feet per second (cfs) and a maximum of 404 cfs during the time period analyzed. The average flow rate was approximately 34 cfs with a median flow rate of approximately 18 cfs.

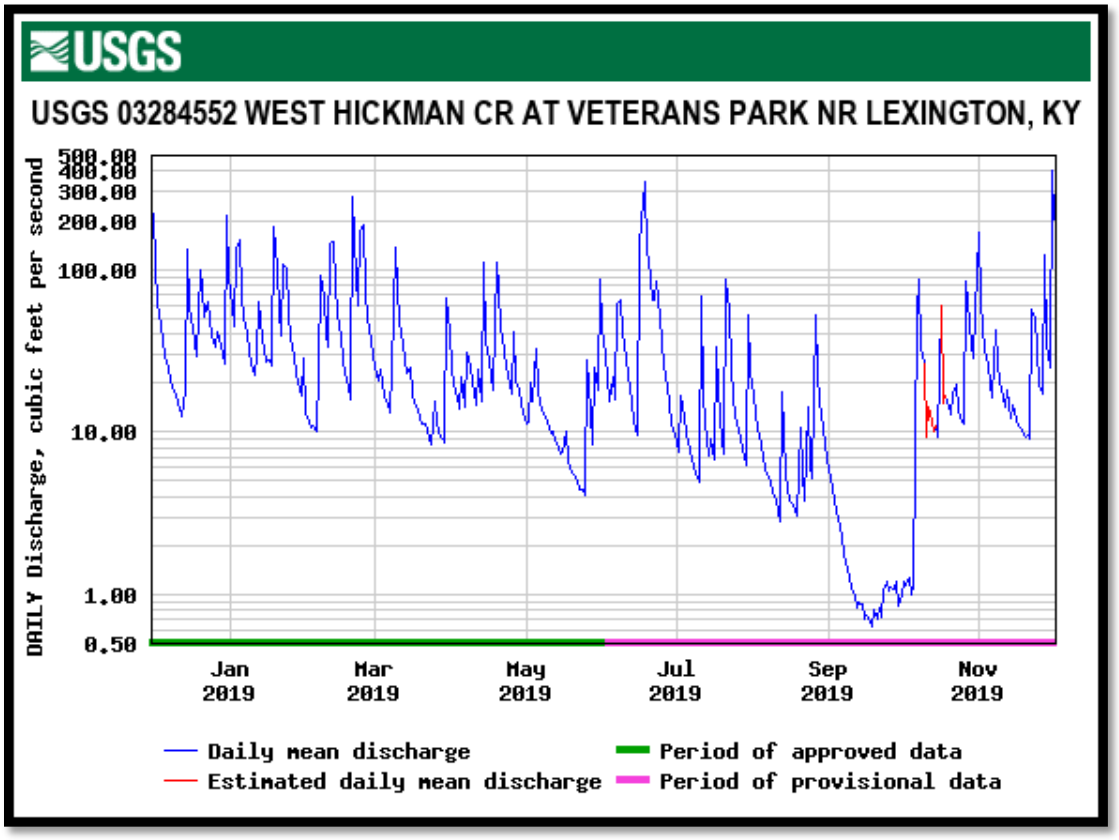


Figure 3-4: USGS Gaging Station 03284552 Discharge Data

Table 3-1: Climatology Data from 1999 - 2018

Month	Max Temp (°F)	Min Temp (°F)	Avg Temp (°F)	Precip (in)	Snow (in)
January	41.4	24.8	33.1	3.21	4.9
February	45.7	27.7	36.7	3.59	4.2
March	55.8	35.9	45.8	4.01	2.8
April	67.3	45.9	56.6	4.65	0.1
May	75.7	55.4	65.5	5.23	0.0
June	83.7	63.2	73.4	4.24	0.0
July	86.1	66.6	76.4	5.44	0.0
August	85.8	65.5	75.6	3.97	0.0
September	79.8	58.5	69.1	3.94	0.0
October	68.0	47.3	57.6	3.87	0.0
November	56.1	37.0	46.5	3.29	0.3
December	45.0	29.4	37.2	4.37	2.0
Annual	65.8	46.4	56.1	49.82	14.2

National Weather Service, 2019

3.2.2 CLIMATE AND PRECIPITATION

Table 3-1 shows the monthly climatological norms for temperature and precipitation based on records from 1999 to 2018 compiled by the National Weather Service (NWS, 2019). The temperature in this area ranges from an average monthly minimum of 24.8° Fahrenheit (F) in January to an average monthly maximum of 86.1°F in July. The average total precipitation is 49.82 inches annually with 14.2 inches of snowfall on average. The driest month over this period is January with an average of 3.21 inches of precipitation and July was the wettest with an average of 5.44 inches.

3.2.3 GROUNDWATER-SURFACE WATER INTERACTION

When limestone bedrock is near the surface, surface water and precipitation often pass through the soil into the limestone, where it is called groundwater. Over time, horizontal and vertical cracks in the rock can become enlarged by the acids in the water to form a landscape characterized by sinkholes, springs and caves, called karst topography.

The West Hickman Creek Watershed has some karst features throughout the watershed area, however significant karst features are absent. As shown in Figure 3-2, page 13, numerous springs and a few small sinkholes are located within the watershed.

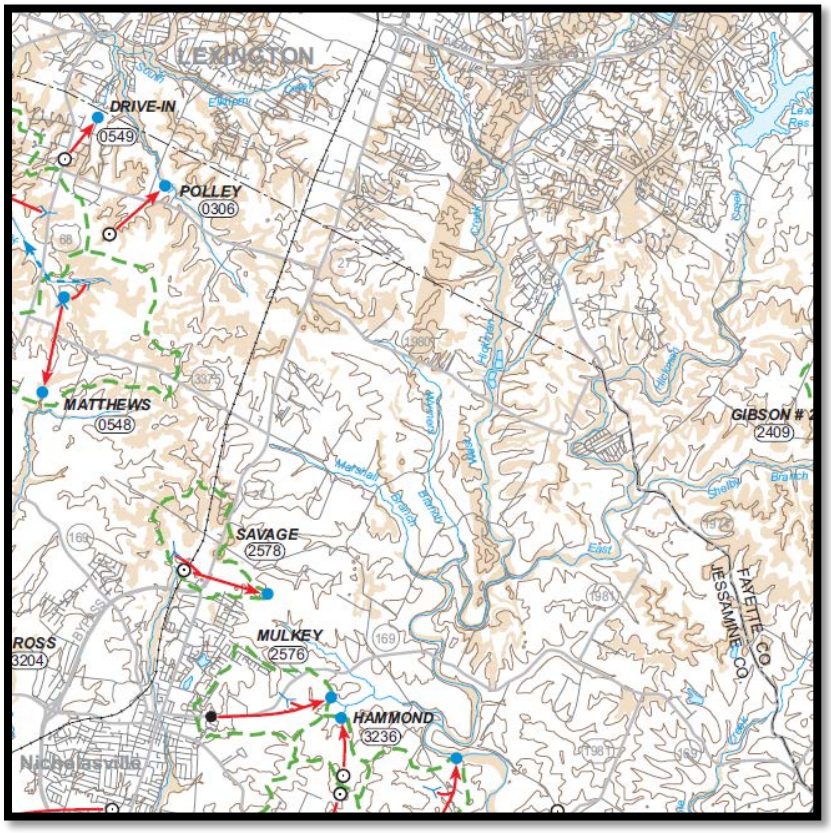
The largest sink is located in the northern portion of the watershed at the Idle Hour Country Club. Another sink is located adjacent to Reservoirs No. 2 and No. 3 near Island Drive. Another very small sink is located in the southern portion of the watershed within Fayette County near Ridgewater Drive.

Three named springs occur within the West Hickman Watershed (Figure 3-2, page 13). Idle Hour Country Club Spring and Mansfield Spring are located in the northern part of the watershed near Richmond Road. South Research Farm Spring is located adjacent to Nicholasville Road in the southern part of the watershed.

In addition to these named springs, numerous unnamed springs are located throughout the watershed area, especially adjacent to Tates Creek and the Reservoirs No. 1, No. 2, and No. 3. Some of these springs have perennial flow while others are seasonal. The abundance of springs in the watershed may sustain surface flows during dry conditions.

The Kentucky Geological Survey has developed Karst Atlas maps of Kentucky that depict groundwater basins, sinkholes prone to flooding, and the potential for the development of cover-collapse sinkholes. These maps were reviewed for the portions of the watershed within Jessamine County. West Hickman Creek Watershed is located on both the Harrodsburg and Lexington Quadrangles, with the Jessamine County portion shown on the Harrodsburg Quadrangle. An excerpt of the region is shown in Figure 3-5, on page 24, and no notable features were observed.

To evaluate the sensitivity of groundwater resources to water pollution, KDOW developed a hydrologic sensitivity index to quantify the regions of Kentucky (Ray et al. 1994). Based on groundwater recharge, flow, and dispersion rates, the index ranges from 1 (low-shaded gray) to 5 (high-shaded purple). With the amount of karst in the West Hickman Watershed, the hydrologic sensitivity index is high (5) as shown in Figure 3-6, on page 25, with the purple shading in most of the watershed, indicating that the area is highly susceptible to groundwater pollution.



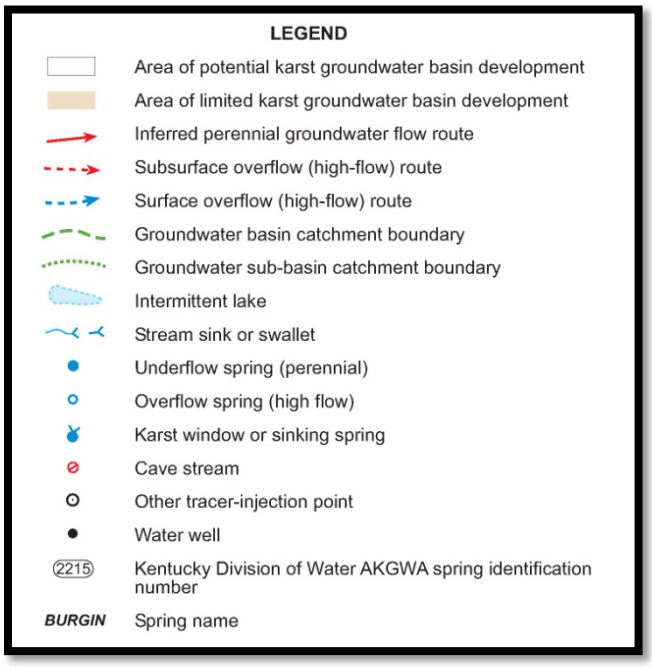


Figure 3-5: Excerpt from Karst Atlas of Kentucky and Legend

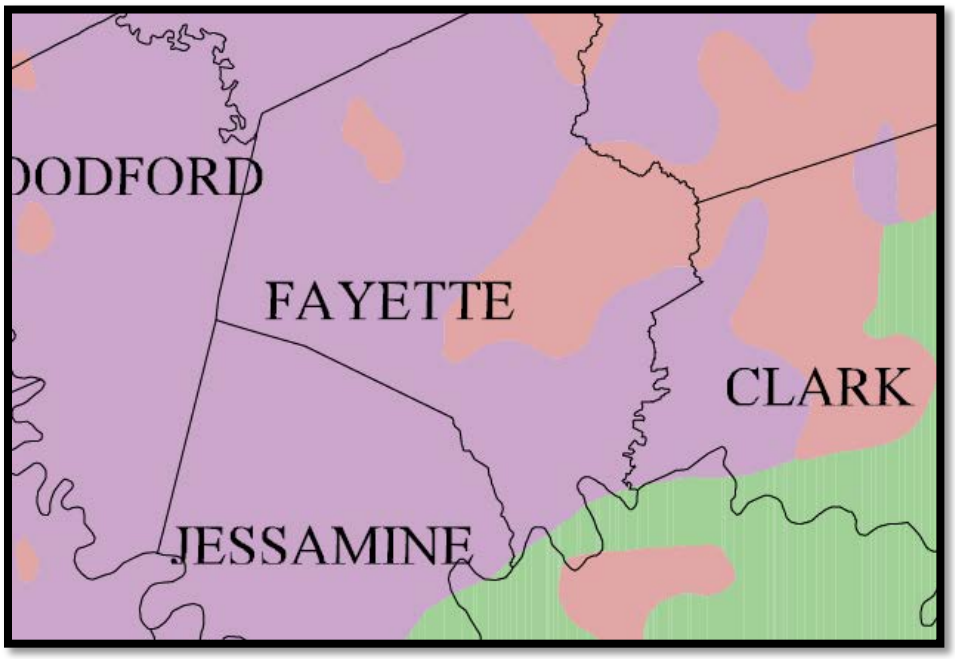


Figure 3-6: Hydrologic Sensitivity Map

3.2.4 FLOODING

Floodplains are lands adjacent to streams that flood during intense wet weather events. The ability of a stream to access the floodplain is a critical component of a stream's health. When streams have access to natural floodplains, the number and severity of floods is reduced, nonpoint source pollutants are reduced, water slows down and sediments settle out over the large floodplain area, and groundwater can be recharged. A stream that cannot access its floodplain (e.g., by channelization, channel incision, or construction of a flood wall) will carry more energy causing bank erosion and channel downcutting. It will also carry a higher pollutant load downstream during storm events and may have reduced baseflow.

Much of the 100-year floodplain along West Hickman Creek has been encroached upon by urban development, particularly in the headwaters (Figure 3-7, page 26). However, LFUCG has established greenways along much of the remaining floodplain area. In the past, LFUCG purchased and demolished numerous flood-prone homes in the watershed in an effort to reclaim a portion of this floodplain. These purchased properties then typically become LFUCG-maintained Green Spaces. Additionally, LFUCG owns properties, mostly as greenways, within the floodplain of West Hickman Creek, which should prevent development of these areas that potentially flood. A long section of Tates Creek's floodplain is located within greenways from approximately Alumni Drive to Tate Creek Road. From Wilson Downing Road to the Fayette/Jessamine county line, almost the entire floodplain of West Hickman Creek and its tributaries are located within greenways. These greenways include Belleau Woods Park and Veterans Park.

The frequency and magnitude of flooding is affected by the percent of impervious surface in a watershed. Under natural conditions, most rainwater is absorbed into soil or evapo-transpired by trees. With increased impervious surfaces such as rooftops or pavement, water cannot infiltrate into the soil, and, therefore quickly flows into the stream leading to frequent and/or flooding events of higher magnitudes. Much of the West Hickman Creek Watershed in Fayette County is developed and has a high percentage of impervious surfaces.

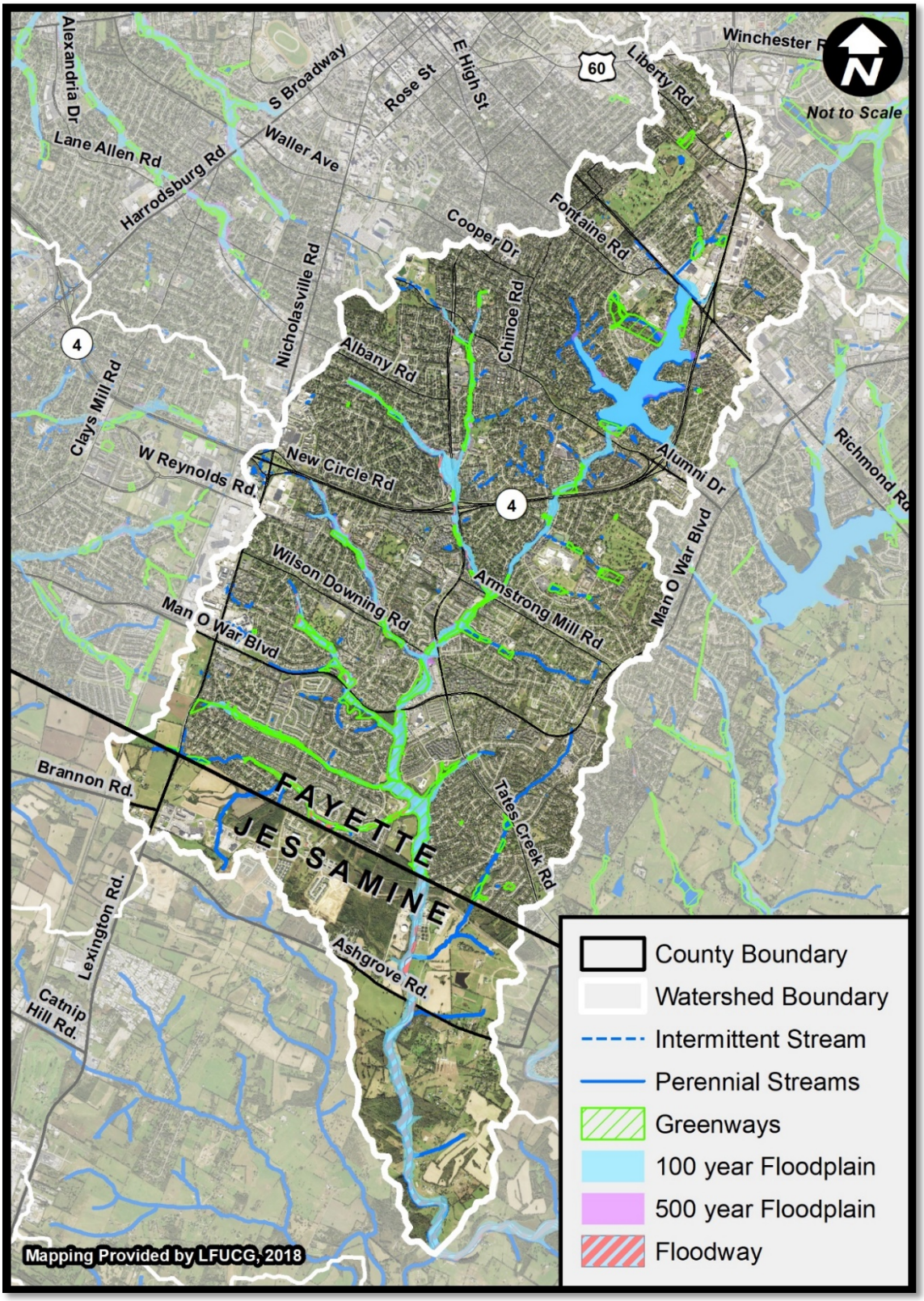


Figure 3-7: Floodplain Map

Sections of the watershed in Jessamine County are much more rural, and flooding impacts along the main channel impact far fewer structures. Within Jessamine County, the floodplain is much more accessible and not nearly as limited by development when compared to the Fayette County sections. However, the upstream development in the watershed still can lead to frequent and/or severe flooding within the sections in Jessamine County.

LFUCG maintains a Stormwater Priority Projects Master List with each project being assessed a Severity Score and ranked among other projects based on the efficiency value. The January 2019 version was available for review at the time of writing. As of December 2019, LFUCG was in the Right-of-Way acquisition phase for the Woodhill/Peachtree project located within the watershed. This project combines prioritized project numbers 71.5 and 72 from the Master List and is centered around the intersection of Woodhill Drive and Peachtree Road to mitigate roadway flooding. Construction is anticipated to begin in late 2020. In 2018, LFUCG completed replacement of the culvert under Wilson Downing Road between Ridgepoint Run and Allante Brook. The project reduced the base flood elevations on the Landsdowne Tributary, and the formal LOMR was received on December 10, 2019. Prioritized project number 83 (Idle Hour Drive) and project number 85 (Gainesway Drive) are expected to enter into the design phase in 2022.

3.2.5 REGULATORY STATUS OF THE WATERWAY

The EPA water quality standards regulation necessitates that Kentucky must specify appropriate water uses to be achieved and protected for each of the water bodies. Kentucky assigns designated uses to each of its waterways, such as recreation, aquatic habitat, and drinking water. For each use, certain chemical, biological, or descriptive (*narrative*) criteria apply to protect the stream so that its uses can safely continue. The criteria are used to determine whether a stream is listed as *impaired* in the 303(d) list (KDOW 2010) and, therefore, needs a watershed based plan or TMDL computations and load allocations. Figure 3-8, page 28 shows the impaired sections of waterways in the watershed.

3.2.5.1 DESIGNATED USES

The designated uses of West Hickman Creek and its tributaries include warm water aquatic habitat (WAH), fish consumption, primary contact recreation (PCR), and secondary contact recreation (SCR). The WAH criteria are in place to protect aquatic life that inhabits streams. PCR criteria are in place to protect people recreating in a way that likely will result in full-body immersion in the water body, such as swimming. Lake Ellerslie has been assessed for drinking water use, but according to Kentucky American Water in conversations held in October 2019, it is unlikely it will ever be utilized as a source.

SCR designated-use criteria are in place to protect those recreational activities that are likely to result in incidental contact with water, such as boating, fishing, and wading. Fish consumption is not a designated use in Kentucky water quality standards, but the use is implied in 401 KAR 10:031 Section 2 and through human health criteria in Section 6. The fish consumption use is based on water body specific monitoring and comparing the fish tissue body burden results for specific pollutants (e.g., mercury, PCB, chlordane) in applicable water quality standards.

3.2.5.2 DESIGNATED-USE IMPAIRMENT STATUS

Streams are assessed to determine whether they support their designated uses. Each stream receives one of three classifications to denote relative level of designated-use support: fully supporting (good to excellent water quality); partially supporting (fair water quality, does not fully meet designated use); and nonsupporting (poor water quality). Streams that fail to support their designated uses are listed on the 303(d) list of impaired surface waters of Kentucky.

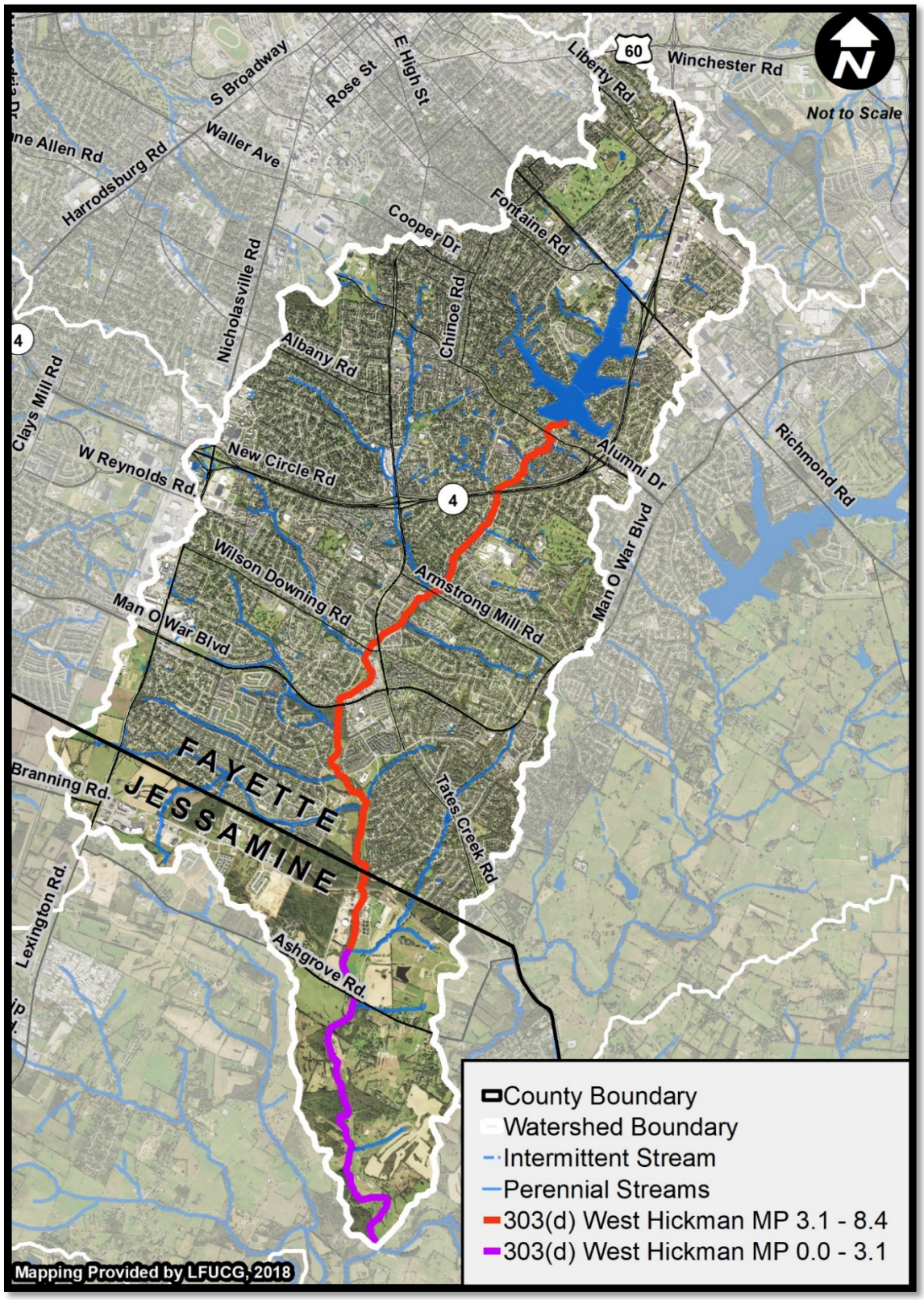


Figure 3-8: Impaired Sections of Streams in West Hickman Watershed

According to the 2016 303(d) list (KDOW 2018), West Hickman Creek is impaired from mile 0.0 to 8.1 for WAH (partially supporting) and PCR (partially supporting) as shown in Figure 3-8 and Table 3-2. The primary contact recreation impairment was first listed from mile 3.1 to 8.4 during the 2016 cycle. A newer published 303(d) list was not available for review as of December 2019. From mile 0.0 to 3.1, three pollutants are listed as impairing the waterway: fecal coliform, nutrient/eutrophication biological indicators, and organic enrichment (sewage) biological indicators. Suspected sources are listed as municipal point source discharges and unspecified urban stormwater. From mile 3.1 to 8.4, five pollutants are listed as impairing the waterway: fecal coliform, nutrient/eutrophication biological indicators, organic enrichment (sewage) biological indicators, sedimentation/siltation, and specific conductance. Suspected sources are residential districts, urban runoff/storm sewers, and unspecified urban stormwater. Lake Ellerslie (Reservoir No. 1) was found to fully support drinking water use.

Table 3-2: Regulatory Status of West Hickman Creek

Stream Section	Impaired	Impaired Uses (Partially Supporting)	Pollutants of Impairment	Suspected Sources of Impairment
MP 0.0 - 3.1	Yes	1. Primary Contact Recreation 2. Warm Aquatic Habitat	1. Fecal coliform 2. Nutrient/eutrophication biological indicators 3. Organic enrichment (sewage) biological indicators	1. Municipal point source discharges 2. Unspecified urban stormwater
MP 3.1 - 8.4	Yes	1. Primary Contact Recreation 2. Warm Aquatic Habitat	1. Fecal coliform 2. Nutrient/eutrophication biological indicators 3. Organic enrichment (sewage) biological indicators 4. Sedimentation/siltation 5. Specific conductance	1. Residential districts 2. Urban runoff/storm sewers 3. Unspecified urban stormwater

3.2.6 EXISTING WATER CHEMISTRY AND BIOLOGY DATA

3.2.6.1 KENTUCKY RIVER WATERSHED WATCH SAMPLING

Kentucky River Watershed Watch (KRWW) is a non-profit organization that was formed in 1997 to support a citizen-led water quality monitoring effort. The mission of the KRWW is to improve and protect water quality by raising community awareness and supporting implementation of the goals of the Clean Water Act and other water quality initiatives in the Kentucky River Basin. Annual Sampling Results Reports from 2016 to 2019 were reviewed from the KRWW website.

Review of the 2016 KRWW Annual Sampling Report was performed, and the following results were noted:

- The highest chloride value of 398 mg/L was observed at Site #792 on West Hickman Creek. The site is located behind Tates Creek Shopping Center.
- Site #792 was listed as a site of concern for dissolved oxygen, conductivity, and chlorides.
- Site #3471, located behind the residence at 4501 Mandeville Way on an unnamed tributary to West Hickman Creek, had an E. coli result of 8,664 CFU/100 mL in July 2016.

Review of the 2017 KRWW Annual Sampling Report was performed, and the following results were noted:

- Five sites in West Hickman were included in the sampling events, and all received a “D” grade

for bacteria; but none were listed as primary sites of concern for KRWW.

- Habitat assessment of fair was rated at Site #3216 (an unnamed tributary to West Hickman at the Waterford subdivision near the pond). This site was one of only four sites where habitat assessments were conducted in 2017.

The 2018 and 2019 KRWW Annual Sampling Reports did not note any sites in West Hickman as those of concern, but they did indicate that volunteers through KRWW assisted LFUCG with the Watershed-Focused Monitoring in West Hickman Watershed.

3.2.6.2 WEST HICKMAN MICROBIAL SOURCE TRACKING DRY WEATHER ASSESSMENT OF PATHOGEN SOURCES FOR SANITARY SEWER PRIORITY AREAS

The goal of the *West Hickman Microbial Source Tracking Dry Weather Assessment of Pathogen Sources for Sanitary Sewer Priority Areas* prepared by Third Rock Consultants, LLC, in March 2012 was to identify dry-weather sources of exflow and exfiltration from the sanitary sewer system to direct investigation and point repairs. The study also was to provide background conditions to evaluate the reduction of fecal loading as a result of the remedial measures plan.

Dry-weather samples were collected at 18 sampling sites and from the raw influent to the West Hickman Wastewater Treatment Plant. The samples were analyzed for E. coli concentration, fecal age, and human-specific genetic markers. The results were compared to regulatory criteria for recreational use and in the scoring process termed Sanitary Category Value (SCV) to analyze the relative similarity of a site to sewage. Because only four samples were analyzed from each site and due to laboratory variability with the E. coli testing, the data set is considered highly variable.

Regarding E. coli concentrations, 53 of the 72 results (74%) were at or above the regulatory limit for recreational contact (130 CFU/100 mL). These concentrations were also used to calculate pollutant load, incremental load, and the pollutant yield of contributing area. The fecal age determination was based on the ratio of atypical coliform to typical coliform. Prior studies were used to set thresholds for ranking the age of fecal coliforms such that values above 20 were the most aged sources such as those found in standing water, and those below 15 were associated with fresh fecal age. Below 10 was associated with significant, raw sewage inputs. Three sample sites had ratios below 10, and another 3 with ratios between 10 and 15, indicating concern about a fresh source for the bacteria.

Human DNA markers (Bacteroides, HuBac and qHF183) were also utilized to determine if human sewage was a source of contamination in the watershed. HuBac was recovered during dry weather at all sampling locations indicating that human sewage was present to some degree in all areas of sampling in the West Hickman Creek Watershed. The qHF183 marker is considered more conservative and was only detected at three sites.

Looking at all of the factors compiled together, four high priority sites were identified for investigation and potential remediation:

1. Site WH-11: West Hickman Creek at Wilson Downing Road
2. Site WH-08: Landsdowne Drive Tributary at Landsdowne Shopping Center
3. Site WH-06: West Hickman Creek at Armstrong Mill Drive
4. Site WH-01: Unnamed Tributary to Idle Hour Tributary at St. Ann Drive

3.2.7 GEOMORPHOLOGY

Geomorphology is defined as the study of landforms, starting with their origin through the processes that continue to shape them. Landforms are modified by a combination of surface processes and geologic processes. Surface processes are comprised of the actions of water, wind, ice, fire, and living organisms, which are strongly mediated by climate. Geologic processes include processes such as the uplift of mountain ranges and the growth of volcanoes. Landforms transform in response to the balance of additive processes, such as uplift and deposition, and subtractive processes, such as subsidence and erosion.

West Hickman Creek is located in a region of the Kentucky River Valley known as the Palisades, stretching from eastern Fayette and Madison Counties along the Kentucky River to Frankfort in Franklin County. In this region, the Kentucky River cuts a deep gorge with walls rising as high as 400 feet. The Palisades are categorized by a series of steep, scenic gorges and limestone outcroppings. Although designated as a part of this region, these characteristics are not seen in the West Hickman Creek Watershed. Hickman Creek, once East Hickman Creek and West Hickman Creek come together, displays more of the classic characteristics of the Palisades region. The region is part of the Interior Low Plateaus geomorphic province. In *Ecological Subregions of the United States*, McNab and Avers explain, "Platform deposition of continental sediments into a shallow inland seas was followed by uplifting to form a level-bedded plateau, which has been shaped by differential erosion to form a moderately dissected surface." Equal amounts of irregular plains and open hills comprise 90% of the landforms in the Interior Low Plateaus region, with a small area of smooth plains.

3.3 NATURAL FEATURES

3.3.1 GEOLOGY

The West Hickman Creek Watershed lies in the Lexington West (Miller 1967), Lexington East (MacQuown and Dobrovolny 1968), Coletown (Black 1967), and Nicholasville (MacQuown 1968) geologic quadrangles. As shown in Figure 3-10, page 35, Ordovician Lexington Limestone, Upper Ordovician Garrard Siltstone, Clays Ferry Formation, and Quaternary Alluvium runs throughout the watershed. Quaternary Alluvium is deposited along the stream channels, while Garrard Siltstone is restricted to the Bryan Station Fault, which runs throughout the watershed just west of West Hickman Creek. The Bryan Station Fault cuts across Fayette County and the watershed in a northeast to southwest trend (Figure 3-10, page 35). The fault has not moved in recorded human history. Clays Ferry Formation is present within portions of the Bryan Station Fault and the northeastern portion of the watershed, then south along the eastern watershed boundary. The Millersburg Member overlays the Tanglewood Limestone Member, and this layer is predominant in the east-central portion of the watershed. The Tanglewood Limestone Member, which overlays the Brannon Limestone Member, is the dominant layer within the watershed. This layer is predominant west of the Bryan Station Fault, and within the southeastern portion of the watershed in Fayette County. Grier Limestone Member is mostly confined to the southwestern portion of the watershed within Fayette County west of the Bryan Station Fault.

According to the Lexington West geologic quadrangle (Miller 1967), the alluvium formation is clay, silt, and gravel, which locally contains abundant chert and dense argillaceous limestone fragments. Generally the alluvium is 10 feet thick along larger streams but less than 5 feet thick along smaller tributaries. Alluvium in the Lexington East and Nicholasville geologic quadrangles is comprised of clay, sand, silt, and gravel, which is generally less than 10 feet in thickness. Within the Coletown geologic quadrangle, alluvium is comprised of silty clay, silt, sand, and gravel. Silty clay and silt is especially abundant in highland

streambeds, while pebble to boulder-sized gravel is common in steep drainage tributaries to the Kentucky River.

The Garrard Siltstone formation of the Bryan Station Fault is approximately 80 feet or greater in thickness and is comprised of siltstone and minor limestone in the Lexington East geologic quadrangle. Garrard Siltstone is similar to, and partly the lateral equivalent to, the silty upper part of the adjacent Clays Ferry Formation. The Garrard Siltstone formation ranges in thickness from 50 to 80 feet or greater and is comprised of siltstone with limestone and shale and siltstone interbedded throughout. In some areas, the upper portion of the formation can be mostly siltstone with minor amounts of limestone, while the lower portion is dominated by shale, then limestone, and then siltstone (Miller 1967).

3.3.2 TOPOGRAPHY

As shown in Figure 3-11, page 36, the topography of the West Hickman Creek Watershed is gently rolling with local relief generally varying by 50 to 150 feet (Woods et al. 2002). Most of the variation is found just west of West Hickman Creek along the Bryan Station Fault. The watershed is located on the Nicholasville (K41), Coletown (K42), Lexington East (J42), and Lexington West (J41) 7.5-minute topographic quadrangle maps.

3.3.3 SOILS

The type of soil is of importance for watershed planning because of the ways different soil types absorb and hold water. Rain Bird presents the graphic in Figure 3-9 and the chart in Table 3-3 that explain the difference in sand, silt, and clay. The more clay mixed in the soil, the higher the water retention and the less the intake rate. According to the soil survey of Fayette County (McDonald et al. 1983), there are two primary soil associations are within the West Hickman Creek Watershed within the Urban Services Area and include the Maury-McAfee and the Lowell-Lordale-Mercer association. A soils map is shown in Figure 3-12 on page 37. The Maury-McAfee soil association is described as undulating, deep and moderately deep soils that are high in phosphates, well drained, and occur on uplands. The Lowell-Lordale-Mercer association is described as gently sloping, well drained to moderately well drained soils that are deep and moderately deep that also occur on uplands. The Maury-McAfee association is located primarily in the western part of the watershed, while the eastern portion is mostly located in the Lowell-Lordale-Mercer association.

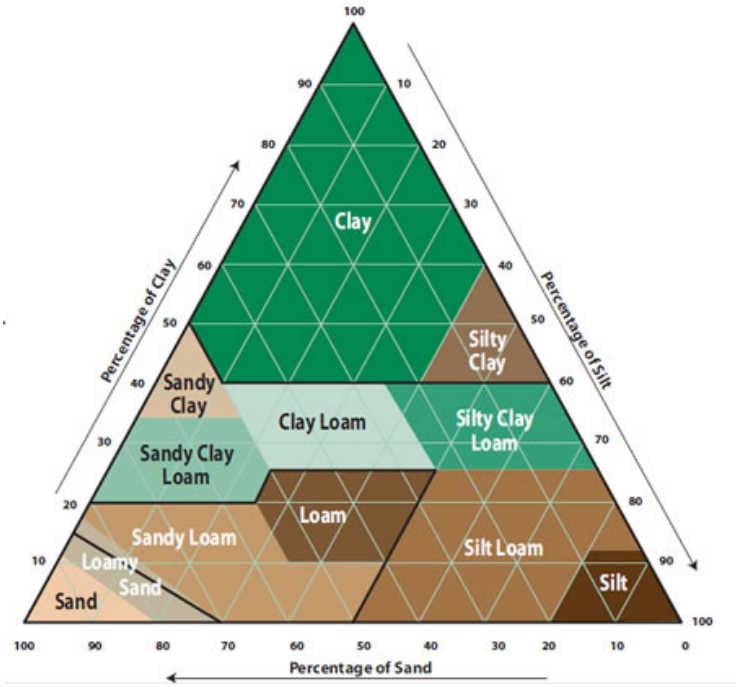


Figure 3-9: Sand, Silt, and Clay Percentages

Table 3-3: Soil Type Characteristics

SOIL TYPE	SOIL TEXTURE	SOIL COMPONENTS	INTAKE RATE	WATER RETENTION	DRAINAGE EROSION
Sandy soil	Coarse texture	Sand	Very high	Very low	Low erosion Good drainage
		Loamy sand	High	Low	
Loamy soil	Moderately coarse	Sandy loam	Moderately high	Moderately low	Low erosion Good drainage
		Fine loam	Moderately high	Moderately low	
	Medium texture	Very fine loam	Medium	Moderately high	Moderate drainage
		Loam	Medium	Moderately high	Moderate drainage
		Silty loam	Medium	Moderately high	Moderate drainage
		Silt	Medium	Moderately high	Moderate drainage
	Moderately fine	Clay loam	Moderately low	High	
		Sandy clay loam	Moderately low	High	
		Silty clay loam	Moderately low	High	
Clay soil	Fine texture	Sandy clay	Low	High	Drainage
		Silty clay	Low	High	Severe erosion
		Clay			

According to the soil survey of Jessamine and Woodford Counties (Sim et al. 1987), the three primary soil associations within the West Hickman Creek Watershed within Jessamine County are McAfee silt loam, Bluegrass-Maury silt loam, and Huntington silt loam.

Maury series soils are the most dominant soil type comprising over one-third of the watershed. These soils are formed mostly from weathered material from phosphatic limestone. Therefore, high phosphorus in the water samples does not necessarily indicate water pollution but could simply indicate background geological conditions. Maury soils are silt loam soils described as fertile, deep, and well drained.

McAfee series soils comprise approximately one-tenth of the watershed and are mostly silt loam and silty clay. McAfee soils are described as well drained to somewhat excessively well-drained soils on uplands. Like Maury soils they have formed over phosphatic limestone and are moderately deep or shallow over bedrock. These soils are noted for their utility in raising thoroughbred racehorses, although hay, silage, beef cattle, and tobacco are also farm uses of the soil. These soils are commonly underlain by sinkholes and karst drain-ways.

Lowell silt loam is the second most dominant soil comprising one-fourth of the watershed. Lowell silt loams are deep, well-drained and moderately, well-drained soils in uplands that are suited to growing all common crops. This soil formed in material from weathered interbedded limestone and calcareous shale.

Salvisa series soils are the third most dominant soil comprising one-tenth percent of the watershed. Salvisa series soils consist of well drained to somewhat excessively drained, deep or shallow soils that occur in uplands. Salvisa soils are silty clay loam soils that are suitable for raising forage crops. Depth to bedrock ranges from 15 to 36 inches with rock outcrops in places.

Overall, the soil in the watershed is predominantly loamy, ranging from silty loam with medium intake rates and moderately high water retention to silty clay loam with moderately low intake rates and high water retention.

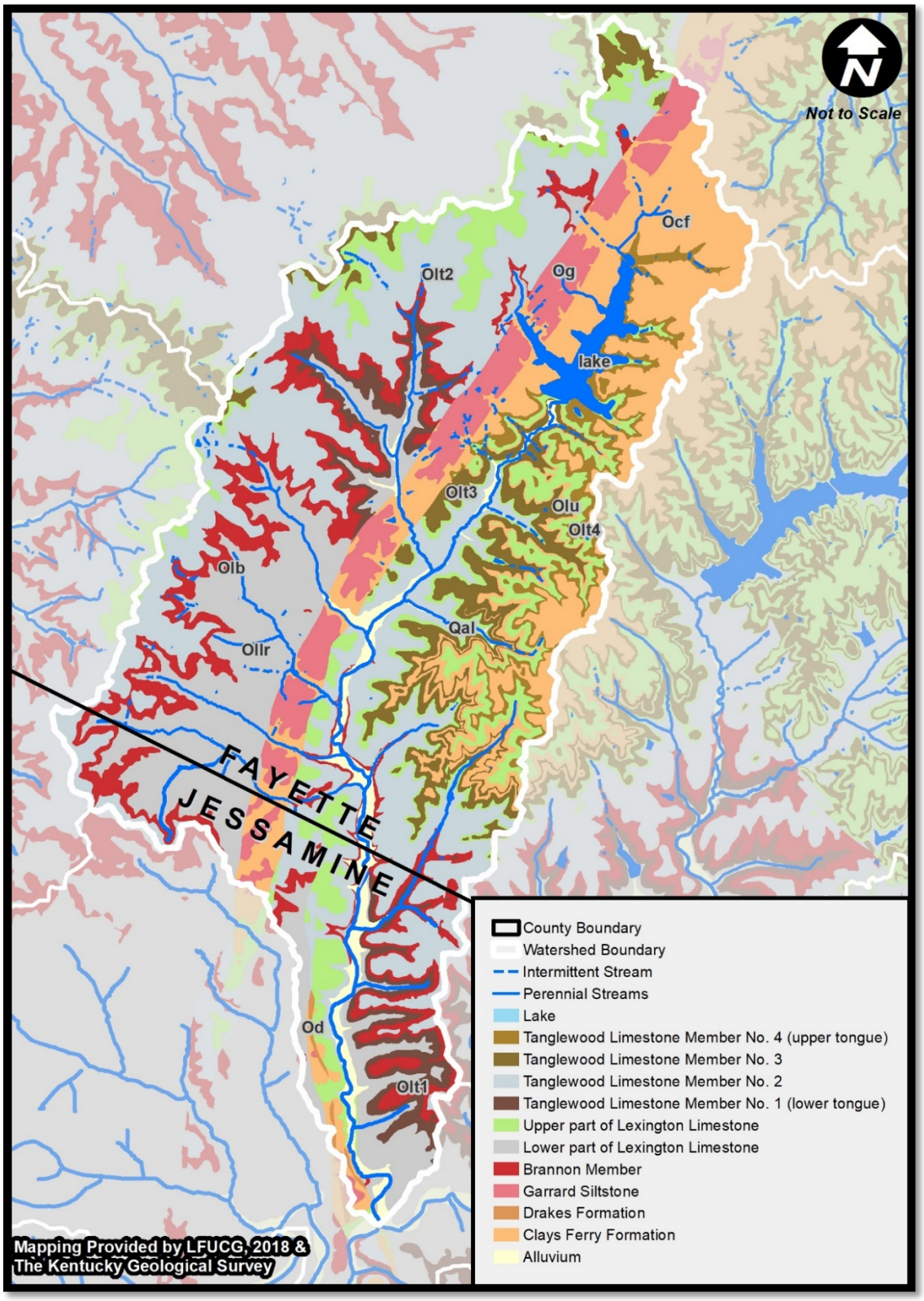


Figure 3-10: Geology Map

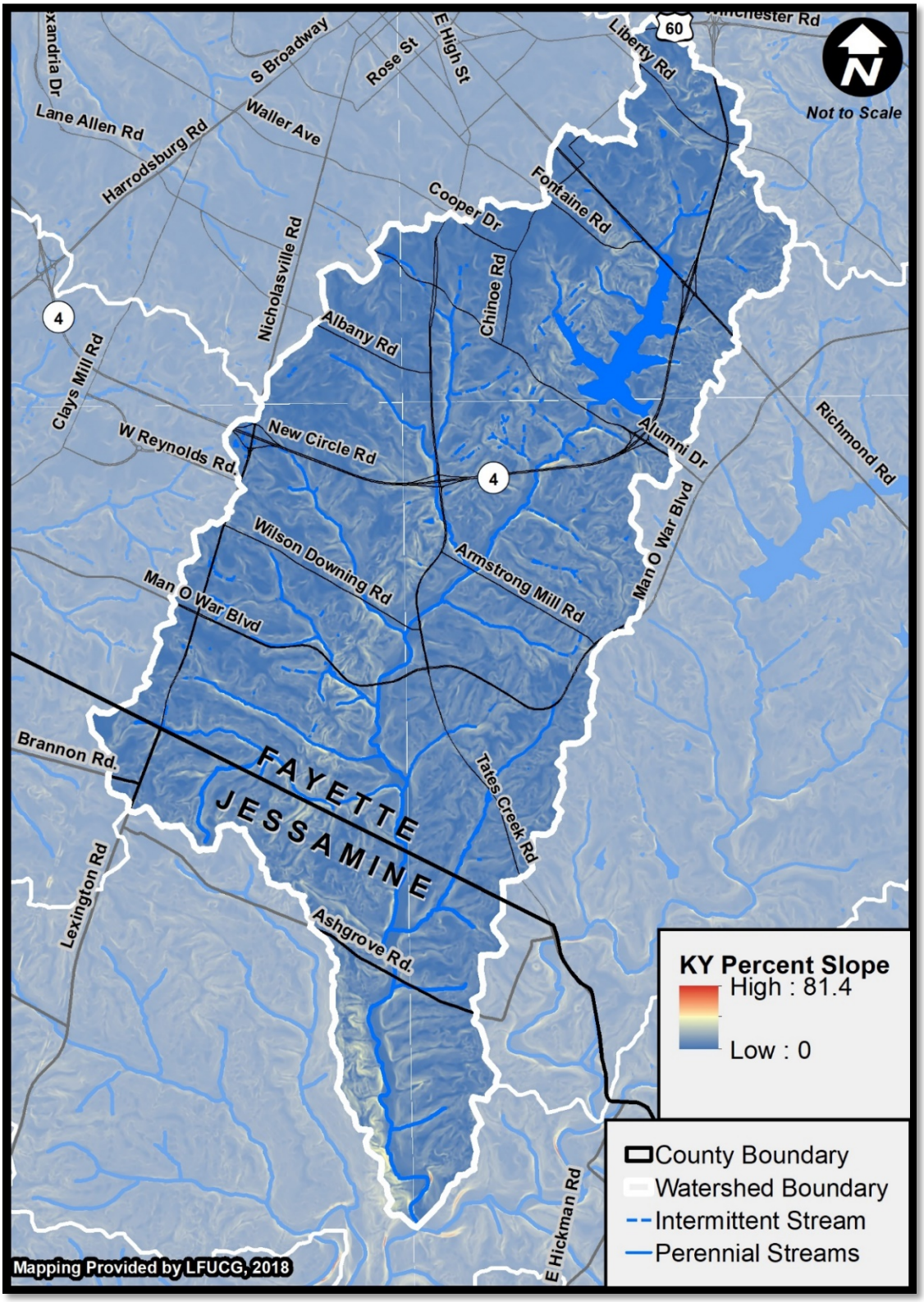


Figure 3-11: Topography Map

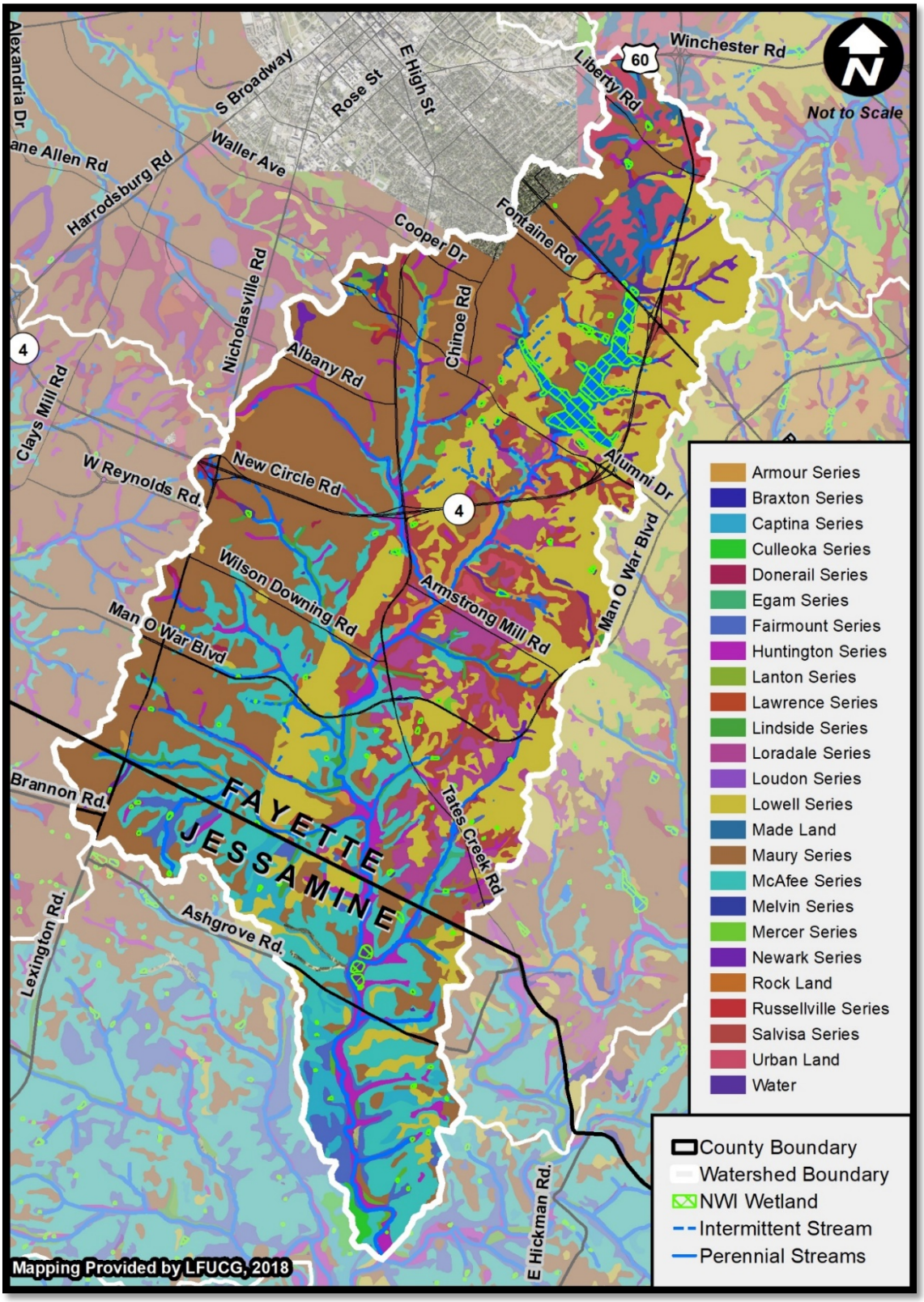


Figure 3-12: Soils Map

Lanton silty clay loam and Melvin silt loam are listed as hydric within Fayette and Jessamine Counties. Lawrence silt loam, Loudon silt loam, and Newark silt loam are listed as possibly having inclusions of hydric soils. With the exception of Loudon silt loam, each of these soils is located within the watershed (see Figure 3-12, page 37), but only comprises a small percentage of the land area. Areas of hydric soil are important since wetland restoration or expansion is more likely to be successful in these areas. Headwaters of Tates Creek and upstream of the reservoirs on West Hickman Creek have adjacent hydric soils where wetland restoration or creation may be an option, dependent on current land use. Wetland creation could help improve water quality in West Hickman Creek through water filtration and flood water retention.

3.3.4 ECOREGIONS

The West Hickman Creek Watershed is located in the Inner Bluegrass (71l) Level 4 Ecoregion (Woods et al. 2002). This region is described as unglaciated, weakly dissected upland plan that is level to gently rolling, with extensive karst. Upland streams have low-to-moderate gradients, with cobble and bedrock substrates. Many of these upland streams are intermittent, but some are fed by major springs and have plentiful year round flow conditions. Sinking streams, underground drainage, springs, numerous sinkholes, and ponds occur throughout the region (Woods et al. 2002).

The natural vegetation of upland areas is described as remnants of an open oak-hickory forest with dominants of blue ash, white oak, shumard oak, walnut, chinquapin oak, bur oak, shellbark hickory, and Kentucky coffeetree. Dominant vegetation surrounding sinkholes is described as sycamore, black locust, hackberry, and mulberry while abandoned agricultural land often has broomsedge and sumac dominants. Poorly drained floodplain forests of the region are dominated by sweet gum, pin oak, box elder, yellow poplar, and hackberry, while along rivers and gorges, oak-maple forests dominate. This oak-maple forest is usually comprised of white oak, northern red oak, scarlet oak, black oak, chinquapin oak, white ash, sugar maple, red maple, and eastern red cedar. Cane is a common understory species throughout the inner bluegrass (Woods et al. 2002).

Current land use of the ecoregion includes pastureland (horse, cattle), cropland (burley tobacco, corn, and hay), and urban-suburban development. Urban-suburban areas are expanding within the ecoregion. The region is very fertile with Alfisols and Mollisols soils developed from the underlying phosphatic limestone (Woods et al. 2002).

Agricultural activities contribute sediment, nutrients, pesticides, and pathogens to surface water within the ecoregion. High nutrient levels in the streams contribute to algal blooms and low dissolved oxygen levels, especially in areas with no tree canopy. Impervious surfaces runoff of urban areas and wastewater discharge release trace metals into surface waters. The Kentucky River has very high concentrations of nutrients (nitrite+nitrate and phosphate) in the state (Woods et al. 2002).

3.4 RIPARIAN/STREAMSIDE VEGETATION

Although riparian zones produce many water quality benefits, these benefits are dependent on the width of the riparian area, the size of the stream that it borders, vegetative composition, and density. Stream order is a system applied to designate the size and location of stream systems. One method of stream ordination, as shown in Figure 3-13, assigns all headwater perennial streams with an order of one and increases the order at the confluence of streams of equal order. Thus, when two third-order streams combine, a fourth-order stream is produced. The water quality functions provided by the riparian zone

vary by stream order. Riparian corridors on first- and second-order streams provide the maximum nutrient removal, shading, and bank stabilization benefits (Palone et al. 1997). Fish habitat and aquatic ecosystem benefits are typically greatest for third- and fourth-order streams, while flood mitigation benefits of riparian corridors increase as the stream order increases. Sediment control benefits remain relatively constant for all stream orders.

The width of the riparian zone necessary to achieve these benefits varies, depending on the function. The US Army Corps of Engineers (USACE) (Fischer and Fischenich 2000), recommends the following riparian buffer widths for various functions: 5 to 30 meters (16 to 100 feet) for water quality protection, 30 to over 500 meters (100 to over 1,600 feet) for riparian habitat, 10 to 20 meters (30 to 65 feet) for stream stabilization, 20 to 150 meters (65 to 500 feet) for flood attenuation, and 3 to 10 meters (10 to 30 feet) for detrital input.

An analysis of the actual riparian widths in the West Hickman Creek Watershed was compared against the minimum recommended buffer width for each function. Thirty (30) feet was used instead of 16 feet as the minimum width for water quality protection since most filtering occurs within 30 feet for low-to-moderate slopes found throughout the watershed. The riparian width and edge of water for each bank were delineated from aerial photographs. Areas with forested canopy or overgrown vegetation were included in the riparian buffer zone. Each bank was then divided into segments based on the maximum width of the riparian corridor and stream order. Figure 3-14 and Figure 3-15, pages 40 and 41, show the locations of riparian zones.

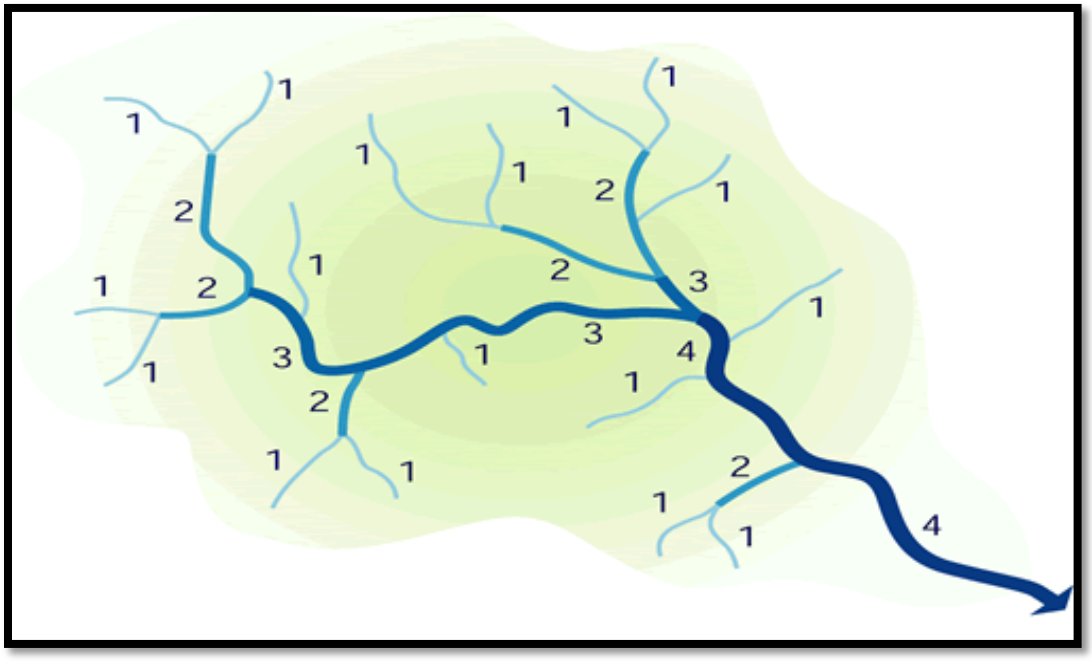


Figure 3-13: Stream Order Diagram
Source: FISRWG 1998

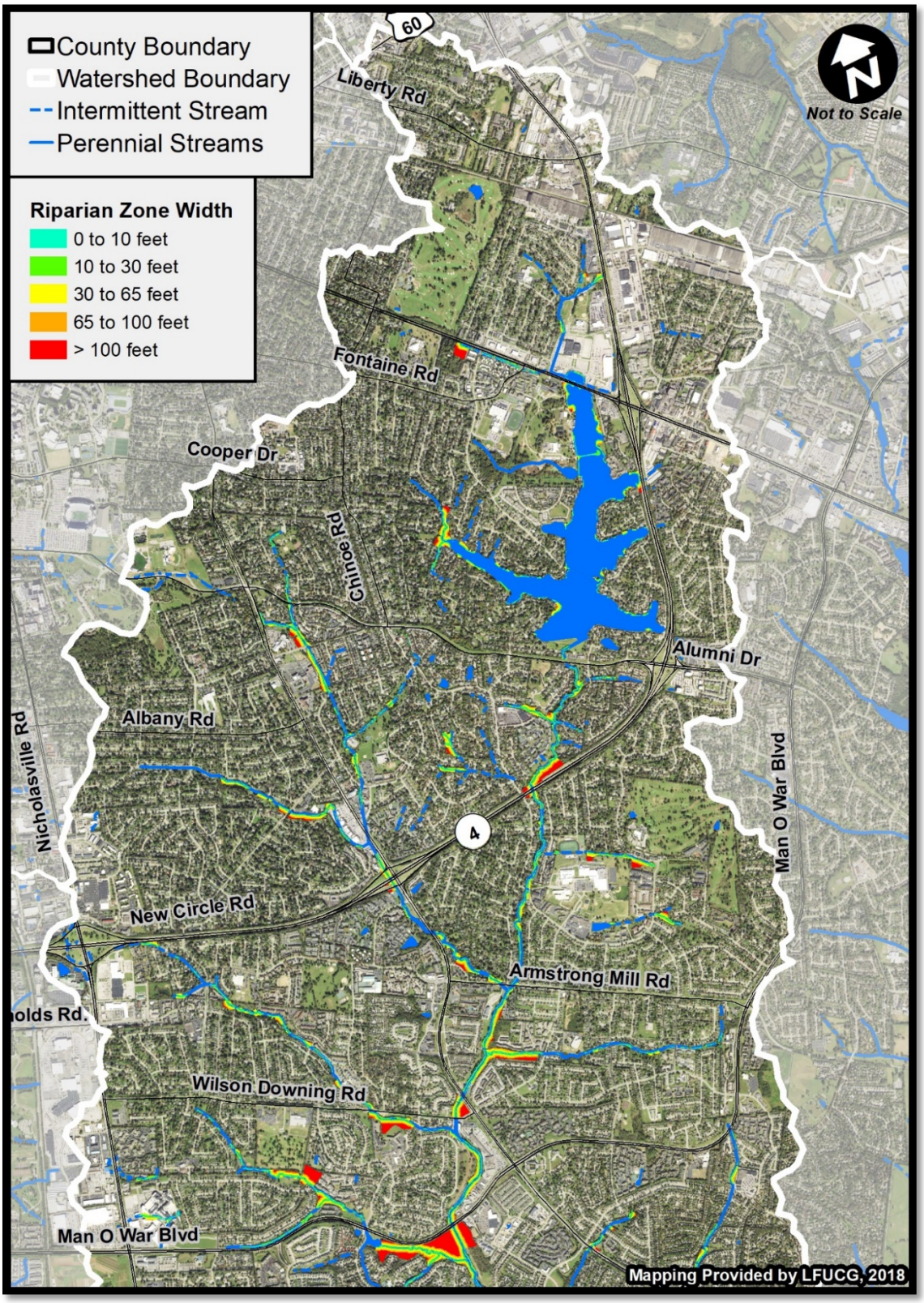


Figure 3-14: Riparian Area – North

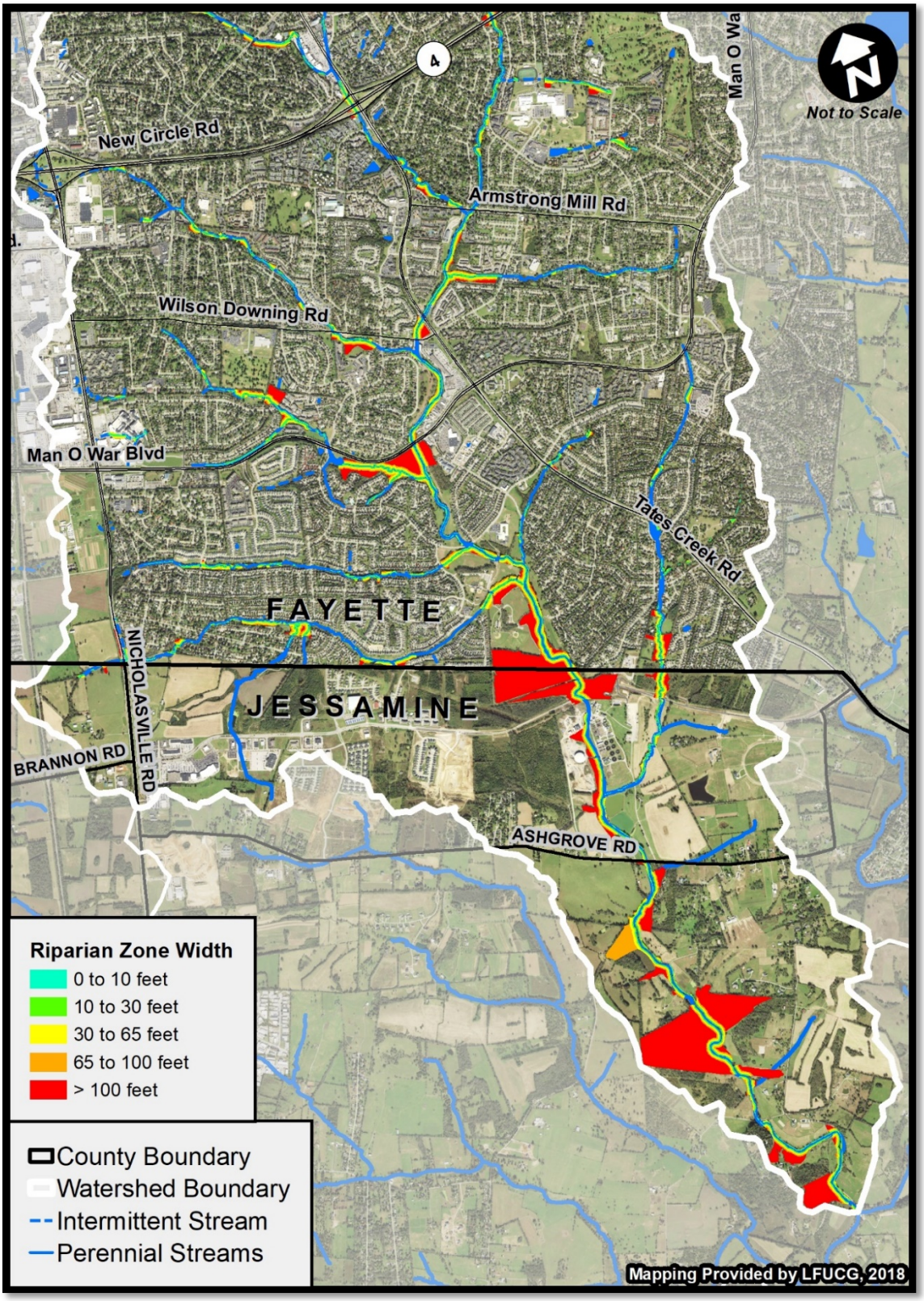


Figure 3-15: Riparian Area – South

A riparian width analysis was conducted by Third Rock Consultants and is summarized in Table 3-4. The riparian width analysis consisted of estimating the width of riparian buffers based on aerial photography. The analysis revealed similar trends among all stream orders. Riparian zones for each stream order were most abundant in the first 10 feet but decreased dramatically at each successive threshold.

Table 3-4: Percentages of Stream Banks with Riparian Areas Providing Functional Benefits in the West Hickman Creek Watershed

Stream Order	Organic Input (>10 Ft)	Stream Stabilization & Water Quality (>30 Ft)	Flood Attenuation (>65 Ft)	Riparian Habitat (>100 Ft)
First Order	40%	18%	7%	3%
Second Order	51%	27%	14%	8%
Third Order	84%	46%	29%	21%
Fourth Order	78%	55%	43%	29%

Based on the aerial delineations, the impacts to the riparian zone in this highly urbanized watershed are obvious. While the quality of the riparian zone cannot be accurately determined via aerial analysis (*i.e.* mature trees, small shrubs, mowed grass, etc.), such an analysis is useful for identifying areas with sufficient buffer zones for riparian enhancements. Unfortunately, encroachments on the riparian zones of many streams in the watershed significantly restrict the potential for enhancement. Roughly 40% of first-order streams and just over 50% of second-order streams have riparian cover within the first 10 feet of the stream bank.

3.5 RARE AND EXOCTIC/INVASIVE PLANTS AND ANIMALS

Fauna in the West Hickman Watershed in Fayette County is primarily domestic pets (dogs, cats). Livestock (horses, cattle) is mostly absent from the watershed within Fayette County due to the residential nature of the watershed. Therefore, these animals are scarce within the West Hickman Creek Watershed compared to other watersheds within Fayette County. Within Jessamine County, few properties with horses and cattle lie within the watershed based on review of aerial photography and limited visual observation. Other animals inhabiting the watershed are those that are highly adaptable and/or tolerant of disturbance (e.g., raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), squirrel (*Sciurus carolinensis*), northern cardinal (*Cardinalis cardinalis*), blue jay (*Cyanocitta cristata*), robin (*Turdus migratorius*), house sparrow (*Passer domesticus*), starling (*Sturnus vulgaris*), etc). Domestic animals and a select few waterfowl, such as Canada goose (*Branta canadensis*) and mallard (*Anas platyrhynchos*) (especially around Reservoirs No. 1, No. 2, and No. 3), are likely species that may contribute to fecal inputs into West Hickman Creek.

According to the Kentucky State Nature Preserve Commission (KSNPC), United States Fish and Wildlife Services (USFWS), and the Kentucky Department of Fish and Wildlife Resources (KDFWR), Fayette County contains several state and federally listed threatened, endangered, or special-concern species. Table 3-5 lists these species and communities. Habitat for some of these species is present within the watershed; management activities that create or enhance habitat for these species (i.e., tree plantings, wetland creation) and also improve water quality (both within the watershed and in the receiving streams) would have opportunity for additional funding.

Table 3-5: Threatened, Endangered, and Special-Concern Species of West Hickman Watershed

Common Name	Scientific Name	Agency	US Status*	KY Status*
Amphibians				
Eastern hellbender	*Cryptobranchus alleganiensis alleganiensis*	KSNPC, KDFWR	-	S
Northern leopard frog	*Rana pipiens*	KSNPC, KDFWR	-	S
Birds				
American coot	*Fulica americana*	KSNPC, KDFWR	-	E
Bank swallow	*Riparia riparia*	KSNPC, KDFWR	-	S
Barn owl	*Tyto alba*	KSNPC, KDFWR	-	S
Black-crowned Night-heron	*Nycticorax nycticorax*	KSNPC, KDFWR	-	T
Blue-winged Teal	*Anas discors*	KSNPC, KDFWR	-	T
Bobolink	*Dolichonyx oryzivorus*	KSNPC, KDFWR	-	S
Dark-eyed Junco	*Junco hyemalis*	KSNPC, KDFWR	-	S
Double-crested Cormorant	*Phalacrocorax auritus*	KSNPC, KDFWR	-	E
Henslow's sparrow	*Ammodramus henslowii*	KSNPC, KDFWR	-	S
Northern shoveler	*Anas clypeata*	KSNPC, KDFWR	-	E
Lark sparrow	*Chondestes grammacus*	KSNPC, KDFWR	-	T
Little blue heron	*Egretta caerulea*	KSNPC	-	E
Osprey	*Pandion haliaetus*	KDFWR	-	T
Peregrine falcon	*Falco peregrinus*	KSNPC, KDFWR	PS-LE	E
Savannah sparrow	*Passerculus sandwichensis*	KSNPC, KDFWR	-	S
Sedge wren	*Cistothorus platensis*	KSNPC, KDFWR	-	S
Yellow-crowned Night-heron	*Nyctanassa violacea*	KSNPC, KDFWR	-	T
Insects				
Garman's cave beetle	*Pseudanophthalmus horni*	KSNPC, KDFWR	-	S
Northern hairstreak	*Satyrium favonius ontario*	KSNPC, KDFWR	-	S
Sedge sprite	*Nehalennia irene*	KSNPC, KDFWR	-	E
American burying beetle	*Nicrophorus americanus*	USFWS	LE-X	X
Mammals				
Gray myotis	*Myotis grisescens*	KSNPC, USFWS	LE	T
Indiana bat	*Myotis sodalis*	KSNPC, USFWS, KDFWR	LE	E
Least weasel	*Mustela nivalis*	KSNPC, KDFWR	-	S
Plants				
Globe bladderpod	*Lesquerella globosa*	USFWS	C	T
Running buffalo clover	*Trifolium stoloniferum*	USFWS	LE	E

**Abbreviations are as follows: LE = Listed Endangered. PS = Partial Status (status only applies to a portion of the species range), E = Endangered, T = Threatened, S = Special Concern, X = Extirpated*

Of the six federally listed species, only two have suitable habitat in the watershed or are known to occur in the area. Globe bladderpod is a federal candidate species for listing that is found in dry to mesic limestone woods (Jones 2005). While this habitat type is uncommon within the West Hickman Creek Watershed within Fayette County, the Lexington -Fayette County Greenway Master Plan (LFUCG 2001) lists globe bladderpod as occurring near Troy Road (close to Belleau Woods Park) within the watershed. Indiana bats (*Myotis sodalis*) utilize floodplain and riparian forests for foraging and roosting habitat in the summer. This habitat does exist in the most southern portion of the watershed within Fayette County in Veterans Park and in the undeveloped, rural areas of Jessamine County. Riparian trees adjacent to West Hickman Creek in Veterans Park could provide potential summer roosting habitat for Indiana bats. Open fields in the above-mentioned parks and the riparian area of West Hickman Creek in Veterans Park could provide foraging, nesting, or other types of habitat to a few of the state-listed species (i.e., barn owl).

Of the other federally listed species, habitat does not occur in the watershed. American burying beetle (*Nicrophorus americanus*) is considered extirpated, and the peregrine falcon (*Falco peregrinus*) is not listed for this part of its range. Running buffalo clover (*Trifolium stoloniferum*) is known to occur within Fayette County (Ashland – historic home of Henry Clay), and its habitat varies from stream banks and low moist forests to open woods and cemeteries (Slone and Wethington 2001). It also requires moderate periodic disturbance such as grazing, and habitat with this type of disturbance does not occur within the West Hickman Watershed located within Fayette County. No documented evidence of running buffalo clover was found for the portion of the watershed in Jessamine County, but the true presence is not known since most of this land is undeveloped and unstudied private property. Both Indiana bats and gray bats (*Myotis grisescens*) utilize caves for winter roosting, which are not present within the watershed.

While consideration of threatened and endangered species is important, consideration of exotic and invasive species in the watershed is also important. Exotic invasive species of plants can wreak havoc with ecological balance, creating trouble for rare and common species alike, and also degrade waterways and interfere with water uses. The Kentucky Department of Fish and Wildlife Resources and the Kentucky Exotic Plant Council list the following species as *severe threats* in Kentucky:

- *Ailanthus altissima* – Tree-of-heaven
- *Alliaria petiolate* – Garlic mustard
- *Carduus nutans* – Musk thistle
- *Celastrus orbiculata* – Oriental bittersweet
- *Conium maculatum* – Poison hemlock
- *Coronilla varia* – Crown vetch
- *Dioscorea oppositifolia* – Chinese yam
- *Elaeagnus umbellata* – Autumn olive
- *Euonymus alatus* – Winged euonymus, burningbush
- *Euonymus fortunei* – Winter creeper
- *Festuca arundinacea (Lolium arundinaceum)* – Kentucky 31 fescue
- *Lespedeza cuneata* – Sericea lespedeza
- *Ligustrum sinense, L. vulgare* – Privet
- *Lonicera japonica* – Japanese honeysuckle
- *Lonicera maackii, L. morrowi, L. tatarica* – Bush honeysuckle
- *Lythrum salicaria* – Purple loosestrife
- *Melilotus alba* – White sweet clover

- *Melilotus officinalis* – Yellow sweet clover
- *Microstegium vimineum* – Japanese grass
- *Miscanthus sinensis* – Chinese silver grass
- *Phragmites australis* – Common reed
- *Polygonum cuspidatum* – Japanese knotweed
- *Pueraria lobata* – Kudzu
- *Rosa multiflora* – Multiflora rose
- *Sorghum halapense* – Johnson grass
- *Stellaria media* – Chickweed

3.6 HUMAN IMPACTS

Human influences on the West Hickman Creek Watershed are a mix of urban, suburban, commercial and small farm/agricultural. Demographics of the watershed, point source permitted dischargers, stormwater system, sanitary sewer system, water supply, and watershed management activities are each discussed in their respective sections.

3.6.1 HISTORICAL CONTEXT AND CULTURAL RESOURCES

Fayette County is one of the three original counties formed by Virginia on June 30, 1780. The county was named after General Lafayette from the Revolutionary War. Jessamine County and Fayette County were originally part of the same county jurisdiction. Jessamine County was established as its own county in 1798 by the Kentucky State Legislature and is one of the smallest counties in the Commonwealth.

The West Hickman watershed is the site of much of Lexington's foundational history. According to information published by Kentucky American Water Company, Levi Todd, one of the founders of Lexington , built the first brick house in Fayette County, at what is now the site of Southland Christian Church on Richmond Road in 1787 and named it after the village in Scotland where his family originated, Ellerslie. Lake Ellerslie was the name given to the first water supply reservoir, built as a response to successive droughts, cholera deaths due to polluted cisterns, and the need for fire protection. In 1879, the Phoenix Hotel burned; 17 stores burned in 1881; and in 1883, the Street Railway's barn and stables caught fire, killing the mules and destroying street cars. Amid these substantial losses, the Lexington Hydraulic and Manufacturing Company was chartered in 1882. The controversial 40-acre reservoir was dug by convicts in 1884 and had the capacity to impound 122 million gallons of the headwaters of West Hickman Creek.

Kentucky American Water Company also reports that by 1903, two additional reservoirs were constructed, but these were sold to private developers in the 1960's after water supply was routed from the river. The neighborhoods that now surround the lakes have their own decades of history related to recreational activities. Reservoirs Nos. 2 and 3 hold approximately 325 million gallons and 426 million gallons, respectively, remaining connected by a system of 36-inch pipes.

The Summit development in the upper reaches of the southern portion of the watershed opened in 2015 and honors the Fritz family farm that operated there until the land was sold for the development project. The context sensitive design honors the history of the area's barns and tobacco farming. The Signature Club, located on Lansdowne Drive, is Lexington's oldest membership club, originally built in 1958 as a draw for potential homeowners in the subdivision. Locals express memories of the Lansdowne tributary behind The Signature Club being a showcase of wildflowers, but currently aggressive non-native plants dominate.

3.6.2 POPULATION INFORMATION

A summary of the United States Census Bureau's 2010 Census statistics with 2018 amendments (US Census Bureau 2019) for Fayette and Jessamine Counties is shown in Table 3-6 to provide an overview of the area demographics. The human population of the counties grew significantly faster than the state as a whole from April 2010 to July 2018 for an estimated total of 323,780 in Fayette County and 53,920 in Jessamine County.

Table 3-6: Census Data Summary

Census Statistic	Kentucky	Fayette County	Jessamine County
Population (2010 Census)	4,339,367	295,803	48,586
Percent Growth (April 1, 2010 to July 1, 2018)	3.0%	9.4%	11.0%
Estimated 2018 Population	4,469,548	323,780	53,920
Persons per household, 2017	2.49	2.37	2.69
Persons under 18 years old, percent, 2018	22.6	20.9	24.1
Persons 65 years old and over, percent, 2018	16.4	13.3	15.0
Education			
% High School Graduate or higher, 2017	85.2%	90.5%	86.4%
% Bachelor's degree or higher, 2017	23.2%	41.8%	30.0%
Income			
Median Household Income, 2017	$46,535	$53,013	$55,450
Housing			
Total Housing Units, 2018	1,995,182	142,680	20,698
Homeownership rate, 2017	67.0%	54.0%	62.1%
Median value of specified owner-occupied units, 2017	$130,000	$175,000	$164,300

Based on U.S. Census Bureau State and County QuickFacts (US Census Bureau 2019)

Fayette County and Jessamine County residents have a higher median income and home value, but lower homeownership rate than the state as a whole. Educationally, Fayette and Jessamine County residents have also achieved higher graduation rates.

Within the West Hickman Creek Watershed, numerous Neighborhood Associations represent many of the residents in the area. The locations of these Neighborhood Associations are depicted in Figure 3-16 on page 47. Review of aerial photography was also conducted to identify other residential areas in the watershed within Fayette County that are not a part of a recognized Neighborhood Association. These areas are designated in gray in Figure 3-16 on page 47. The watershed is within Fayette County School Board Districts 3, 4, and 5 and Urban County Council Districts 3, 4, 5, 8, and 9.

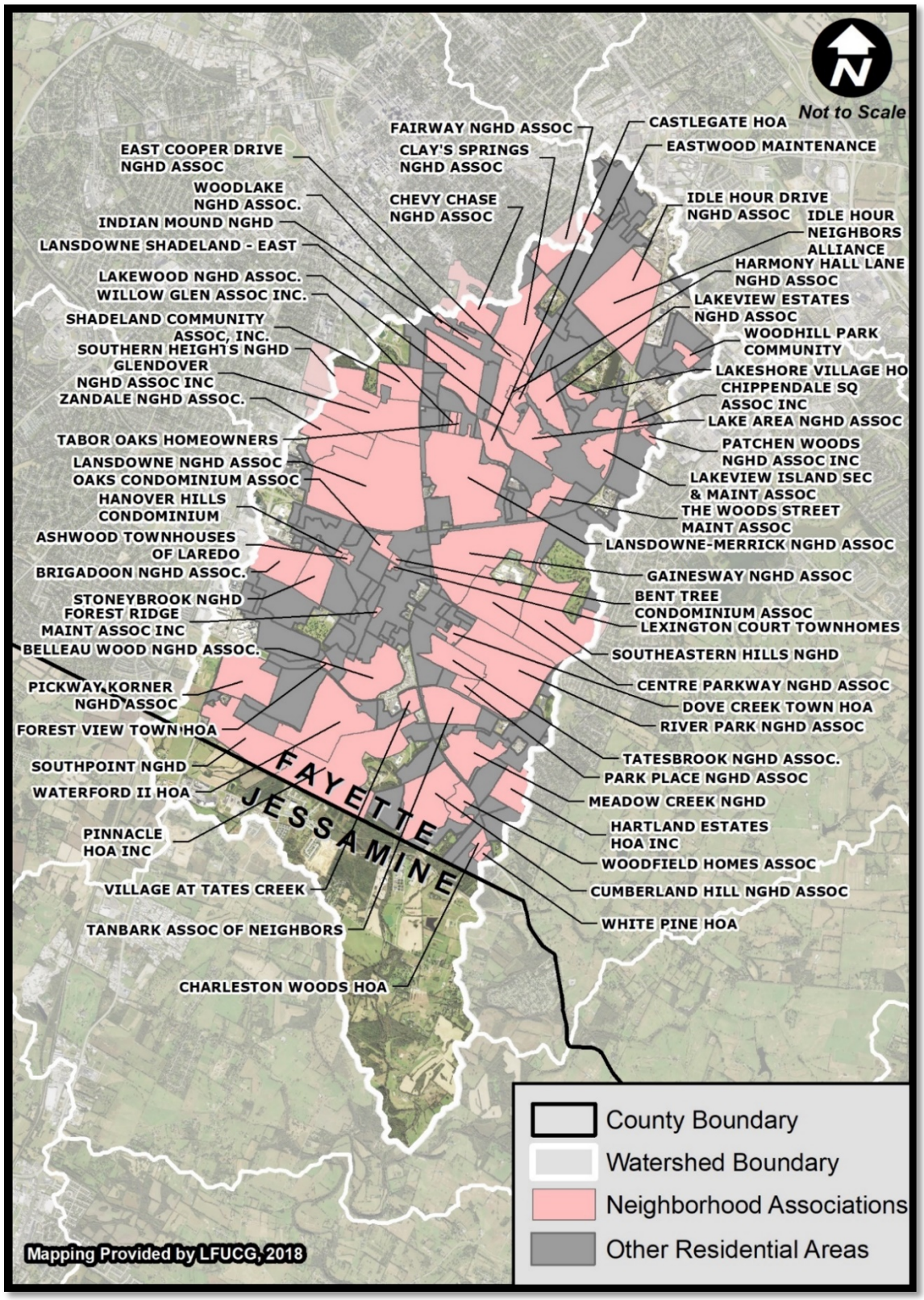


Figure 3-16: Neighborhood Associations and Developed Residential Areas in Fayette County

3.6.3 LAND USE AND NONPOINT SOURCE POLLUTANTS

3.6.3.1 LAND USE AND PLACEMAKING

Because different types of land use contribute different types of pollution and stresses to the creek, identifying these land uses within the West Hickman Creek Watershed is important for watershed planning. The 2007 Comprehensive Plan for Lexington -Fayette County (LFUCG 2007) divided the Lexington -Fayette County area into 20 land-use categories. In 2018, LFUCG overhauled the Comprehensive Plan and developed the Placebuilder (LFUCG 2018) as a response to the 2013 decision by the Planning Commission to move away from predetermining the future land uses of all the properties in Lexington on a map in favor of a more robust and flexible approach to land use. The 2018 Comprehensive Plan further refines this tactic, realizing that placemaking, context, and site layout are much more important in modern times than individual land uses. The Placebuilder is a compilation of the urban planning best practices found in polices throughout the Comprehensive Plan. It sorts these best practices into development criteria that are applicable to proposed developments seeking a zone change. In addressing the development criteria, applicants demonstrate that they are in agreement with the Comprehensive Plan and that their individual developments work toward implementing the broader Goals and Objectives developed by the community. The Placebuilder defines several place-types as listed in Table 3-7. While placemaking versus land-use making may be beneficial for land development, it is difficult to analyze in terms of watershed planning. For the purpose of this discussion, the previous land-use maps from the 2007 Comprehensive Plan for LFUCG are referenced.

Land use in the West Hickman Creek Watershed is dominated by residential, which accounts for approximately 72% of the West Hickman Creek Watershed area as shown in Table 3-8 on page 50. Low-density residential is the dominant type of residential area comprising 53% of the land use in the watershed, followed by medium density (10%), high density (9%), and very high density residential (1%) land use. Public recreation (5%), retail, trade and personal services (4%), greenspace / open space (4%), and semi-public facilities (3%) are the only other type of land uses that comprise more than 2% of the land use within the watershed. All buildings within the watershed are on the Lexington sanitary sewer network. All of the above discussion specifically relates to the portions of the watershed within Fayette County only.

As low-density residential accounts for such a large proportion of land use in the watershed within Fayette County, nonpoint sources (NPS) of pollution commonly associated with such land use may play a large role in the health of West Hickman Creek and its tributaries. Lawn fertilizers (typically high in nitrogen and phosphorus), herbicides, and pesticides are commonly applied in these zones to keep grass green. However, fertilizer that is not absorbed into the soil may be carried into streams in runoff resulting in nutrient pollution problems and algal blooms in West Hickman Creek and its tributaries. Often, household pets are associated with low-density residential areas and can contribute to fecal and nutrient pollution.

Businesses are grouped together in shopping centers such as Tates Creek Shopping Center, Lansdowne Shopping Center, the Summit at Fritz Farm, Brannon Crossing, and South Park Shopping Center. Many businesses are adjacent to the major thoroughfares in the watershed including Tates Creek Road, Lexington Road, Richmond Road, and Nicholasville Road. Several large churches are also within the watershed, namely Tates Creek Christian Church, Immanuel Baptist Church, and Centenary United Methodist Church along Tates Creek Road and Southland Christian Church Lexington Campus at the former site of Lexington Mall on Richmond Road. Part of the University of Kentucky campus, including some athletic fields and parts of the Arboretum, is located in the headwaters. The watershed tends to

become more residential and less commercial from the headwaters as it flows into Jessamine County.

Within the West Hickman Watershed, other threats to stream health and water quality exist, including roadway crossings, streamside businesses, suspected sanitary sewer overflows or losses from the sanitary sewer collection system, and a high level of imperviousness. With the undeveloped portions of the land in Jessamine County, NPS pollution associated with this land use (i.e., fecal input from cattle, nutrient input from cropland) are likely separate issues than those in Fayette County.

Table 3-7: Place-Type Descriptions from 2018 Placebuilder for LFUCG

Place-Type	Description
Downtown	The urban epicenter of commerce and entertainment; The core should be anchored by high-rise structures with activated ground-levels. They are surrounded by mid-rise buildings that increasingly offer dense residential uses. A mix of uses and variety of transportation options should be prioritized, and parking should be addressed as a shared urban core asset.
2nd Tier Urban	Where significant infill and redevelopment opportunities exist to complement the urban core; While not expected to be as intensely developed as the downtown core, high-rise opportunities are not precluded provided that they are context sensitive. The forward trend for development in the 2nd tier urban areas should be toward increased walkability and intensity.
Regional Center	A vibrant hub of commerce, employment, diverse housing opportunities, and entertainment; It includes larger buildings with active ground levels, intentional open spaces, and walkable transportation networks, all to provide the user/resident with a unique experience. It's often located at major intersections and along primary corridors.
Corridor	Lexington's major roadways focused on commerce and transportation; The overriding emphasis of Imagine Lexington is significantly overhauling the intensity of the major corridors. The future of Lexington's corridors lies in accommodating the shifting retail economic model by incorporating high-density residential and offering substantial flexibility to available land uses.
New Complete Neighborhood	Undeveloped areas designed to provide housing in a sustainable format; These areas should include neighborhood-serving retail, services, and employment options, as well as town centers. Accessible greenspace, neighborhood focal points, and a multimodal transportation network should be provided to add a sense of place and connectivity.
Enhanced Neighborhood	An existing residential area to be enhanced with additional amenities, housing types, and neighborhood serving retail, services, and employment options; Development should be context sensitive to surrounding areas and should add to the sense of place. Incorporating multi-modal connections is crucial to neighborhood success and viability.
Industry and Production Center	Where Lexington's most intense types of economic development and job creation occur; These places should be located near major corridors to facilitate efficient and affordable shipping and transportation of goods throughout the region. Developments should minimize negative impacts on adjoining lower-intensity uses.

Table 3-8: Fayette County Land Use from 2007 Comprehensive Plan

Land Use Type	Total (Acres)	Relative Abundance (%)
Low-Density Residential	6022.5	52.6
Medium-Density Residential	1144.7	10.0
High-Density Residential	1021.1	8.9
Public Recreation	613.9	5.4
Retail, Trade, and Personal Services	487.0	4.3
Greenspace / Open Space	421.8	3.7
Semi-Public Facilities	380.6	3.3
Public Education	195.7	1.7
Warehouse and Wholesale	193.8	1.7
Circulation	182.6	1.6
Water	174.9	1.5
Professional Services	166.1	1.5
Very High-Density Residential	154.3	1.4
Highway Commercial	114.6	1.0
Other Public Uses	66.6	0.6
Office, Industry, Research Park	53.0	0.5
Light Industrial	41.8	0.4
Utilities	13.5	0.1
Grand Total	**11,448.5**	**100.00**

Land use in Jessamine County is presented as unclassified in the information available for review except for the most northern portion of the watershed located in the vicinity of Jessamine County. Portions of this area are designated for future low-density residential, medium-density residential, and future professional office as shown on the *2017 Joint Comprehensive Plan Future Land Use Map for Wilmore, Nicholasville, and Jessamine County*. A portion of this map is shown in Figure 3-17 on page 51.

3.6.3.2 LAND USE WITHIN 100 FEET OF WEST HICKMAN CREEK

Land use within 100 feet of West Hickman Creek and its tributaries is still predominately low-density residential (36.3%), followed by rural land use (14.1%), greenspace/open space (13.9%), and public recreation (10.8%), high density residential (6.7%) and medium-density residential (6.4%) as shown in Table 3-9 on page 51. Thus, residential land use accounts for nearly 50% of the land within 100 feet of the streams and tributaries in the West Hickman Watershed. Because opportunities for improving habitat, filtration, and other beneficial water quality functions increase with proximity to the streams, the land-use types in this area are important to identify for development and implementation of BMPs to address stormwater runoff NPS pollution. The abundance of land within this zone that is residential (49%) and rural and greenspace/open space (28%) may provide good targets for riparian zone improvements.

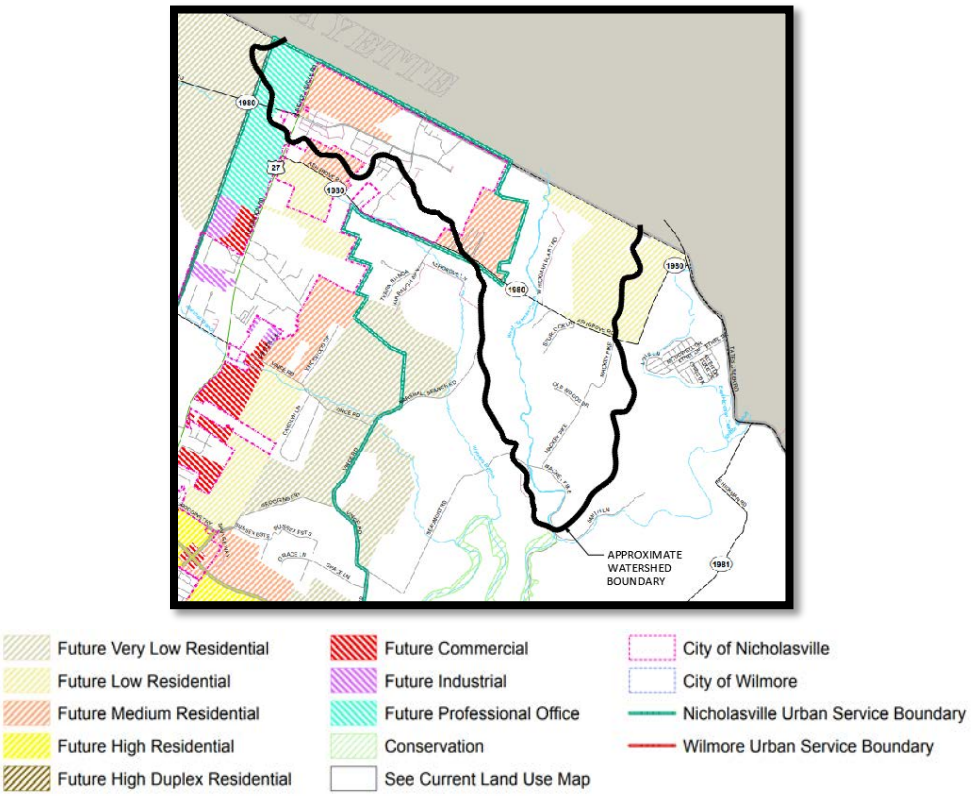


Figure 3-17: Excerpt from Jessamine County Future Land Use Map

Table 3-9: Land Use within 100 Feet of West Hickman and Tributaries

Land Use Type	Total (Acres)	Relative Abundance
Low-Density Residential	295.2	36.2
Rural (Jessamine County)	115.2	14.1
Greenspace/Open Space	112.9	13.9
Public Recreation	87.6	10.8
High-Density Residential	54.6	6.7
Medium-Density Residential	52.1	6.4
Retail, Trade, and Personal Services	22.9	2.8
Circulation	17.0	2.1
Semi-Public Facilities	16.8	2.1
Office/Warehouse	10.2	1.3
Public Education	9.3	1.1
Professional Service/Office	7.9	1.0
Very High-Density Residential	6.8	0.8
Utilities	4.0	0.5
Warehouse and Wholesale	1.4	0.2
Other Public Uses	0.7	0.1
Highway Commercial	0.05	0.01
Total	**814.65**	**100.00**

3.6.3.3 ZONING

Zoning in Lexington -Fayette County is established and presented in a Zoning Ordinance document (LFUCG, 2018) and in Chapter 20 of the Charter and Code of Ordinances (LFUCG 2019). Zoning in Jessamine County is established by the Zoning Ordinance for the City of Nicholasville, Kentucky (2018) and Jessamine County/City of Wilmore Zoning Ordinance & Subdivision Regulations (2017). Most of the portions of the watershed in Jessamine County are not zoned as they lie outside of the City of Nicholasville. A portion of the development known as Brannon Crossing is located in the City of Nicholasville and located in north Jessamine County. This area has been annexed to the City of Nicholasville and is zoned as discussed below. As shown in Figure 3-19, page 54, the West Hickman Creek Watershed contains 17 different zoned areas within its boundaries. In Figure 3-19, all R-1 zones (A, B, C, D, and E) have been combined. A summary of the total acreage of each type of zoning and the relative percentage in the watershed is found in Table 3-10 on page 55.

Of the 11,445 acres of zoned land in the West Hickman Creek Watershed, over 9,300 acres (82%) are zoned for residential use. Zones R-1C, R-1D, R-3 and R-1B account for the majority of residential land use in the watershed at over 7,700 acres. These zones permit for single-family detached residences, in addition to parks and playgrounds operated by government, with the exception of zone R-3. Zone R-3 is for planned neighborhood residential with a max floor to area ratio of 0.5. The remaining residential land-use zoning (R-1E, R-2, R-4, R-5) is for multi-family use, patio homes or apartments, with the exception of R-1A, which is a single family residential with a minimum lot size of 1 acre. Zone R-1A only comprises approximately 73 acres within the West Hickman Watershed.

In general, zones R-1A through R-1D have more green/open space associated with them and proportionately more pervious surface than higher-density, multi-family housing. Land zoned for R-1A through R-1D accounts for 56% of zoned land in the West Hickman Creek Watershed, and these zones are the location of only 52% of impervious surfaces. Whereas the higher-density residential land uses (R-1T, R-1E, R-2 through R-5) comprise 26% of the zoned land but make up 28% of the impervious surface area in the watershed.

Land zoned for urban agricultural use (A-U) accounts for the next most abundant zoning type with over 950 acres set aside in the West Hickman Creek Watershed for agricultural uses. These lands are used solely for agricultural purposes, including small farm wineries, as outlined in KRS 100, and also allow for single-family detached dwellings. The A-U zones are scattered throughout the watershed within the urban service area. The A-U zones are designed to help control and slow the development of agricultural land within the urban service area. Agricultural lands currently make up approximately 8% of the watershed in Fayette County but contain only 4% of the impervious surface. Continued use as agricultural lands coupled with proper nutrient management and riparian buffer zones would be beneficial to West Hickman Creek and its tributaries. Poorly managed development of these lands would almost certainly lead to an increase of impervious surface in the watershed. Should these lands be developed, the Watershed Management Plan should play a critical role in ensuring the developments do not negatively impact the health of the watershed.

Business zones (B-3, B-6P, B-4, and B-1) comprise 808 acres in the watershed, totaling 7 percent of the land use but are responsible for 12 percent of the total impervious area within the West Hickman Creek Watershed. Highway service business (3%) and planned shopping centers (2%) are the most common business types within the watershed. Light industrial (I-1) and professional office space account for 326 acres for 3% of the land use but account for 5% of the impervious area.

Table 3-10, page 55, indicates a listing of the breakdown on the zones by area and approximate percent impervious by zone. Particularly high percentages of imperviousness are found in areas zoned for neighborhood business (B-1), planned shopping centers (B-6P), highway service business (B-3), very high-density apartments (R-5), and light industrial (I-1). Green roofs, rain gardens, tree wells, and other best management practices that decrease the amount of impervious surface should be targeted towards these zones.

Only a small portion of the land located in Jessamine County has a zone assigned to it as previously discussed from the Zoning Ordinance for the City of Nicholasville, Kentucky. This area lies in the Brannon Crossing development and surrounding area as shown in Figure 3-18. An approximate watershed boundary line is shown on Figure 3-18. Areas above (north) this line are in the West Hickman Creek Watershed. This area is currently zoned approximately 25% agricultural. Development of this area began in the early 2000s and has continued over the past two decades. It is expected that development will continue to increase and expand in this area now that the extension of Brannon Road from Nicholasville Road (US 27) to Tates Creek Road (KY 1974) is completed. The prominent zones are listed below:

- A-1: Agricultural District
- B-2: Highway Business District
- P-1: Professional District
- R1-D, R1-E, and R1-F: Single Family Residential Districts
- R1-T: Townhouse Residential District
- R-3: Multi-Family Residential District.

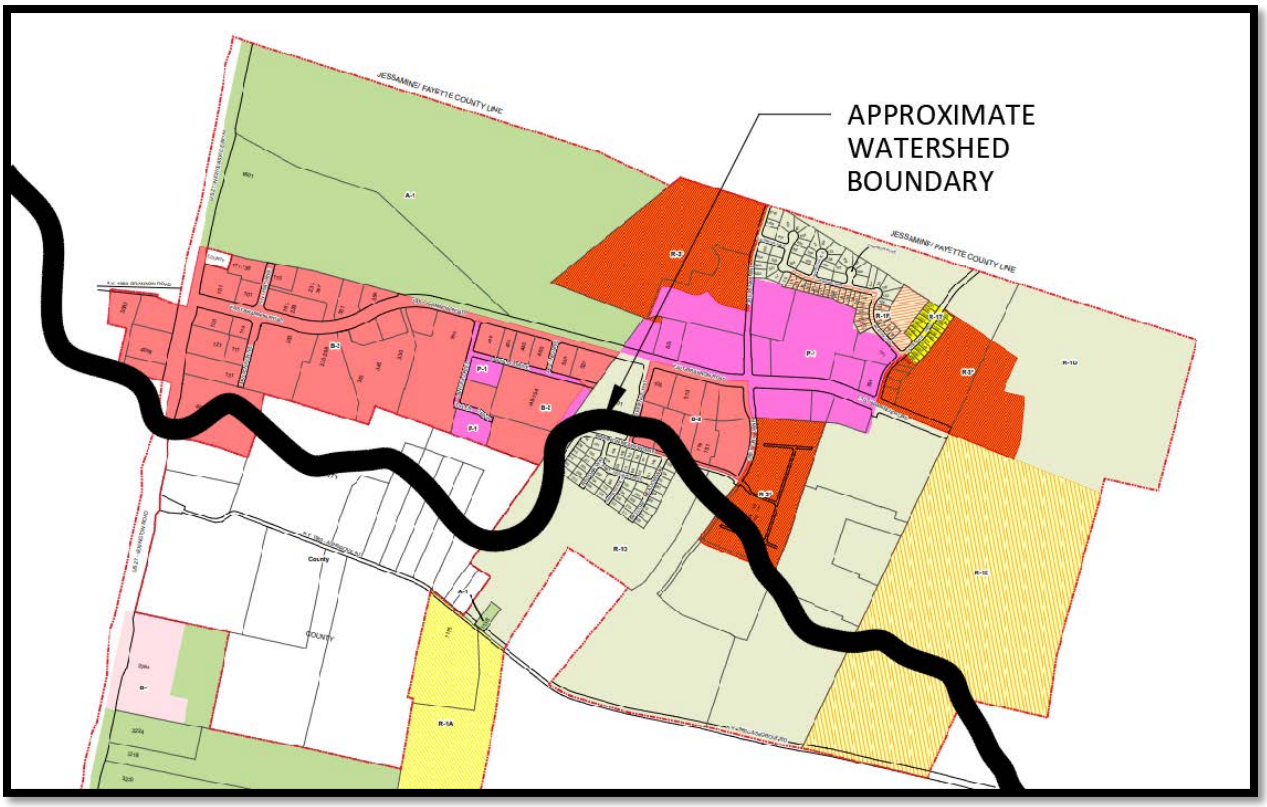


Figure 3-18: City of Nicholasville Zoning Map

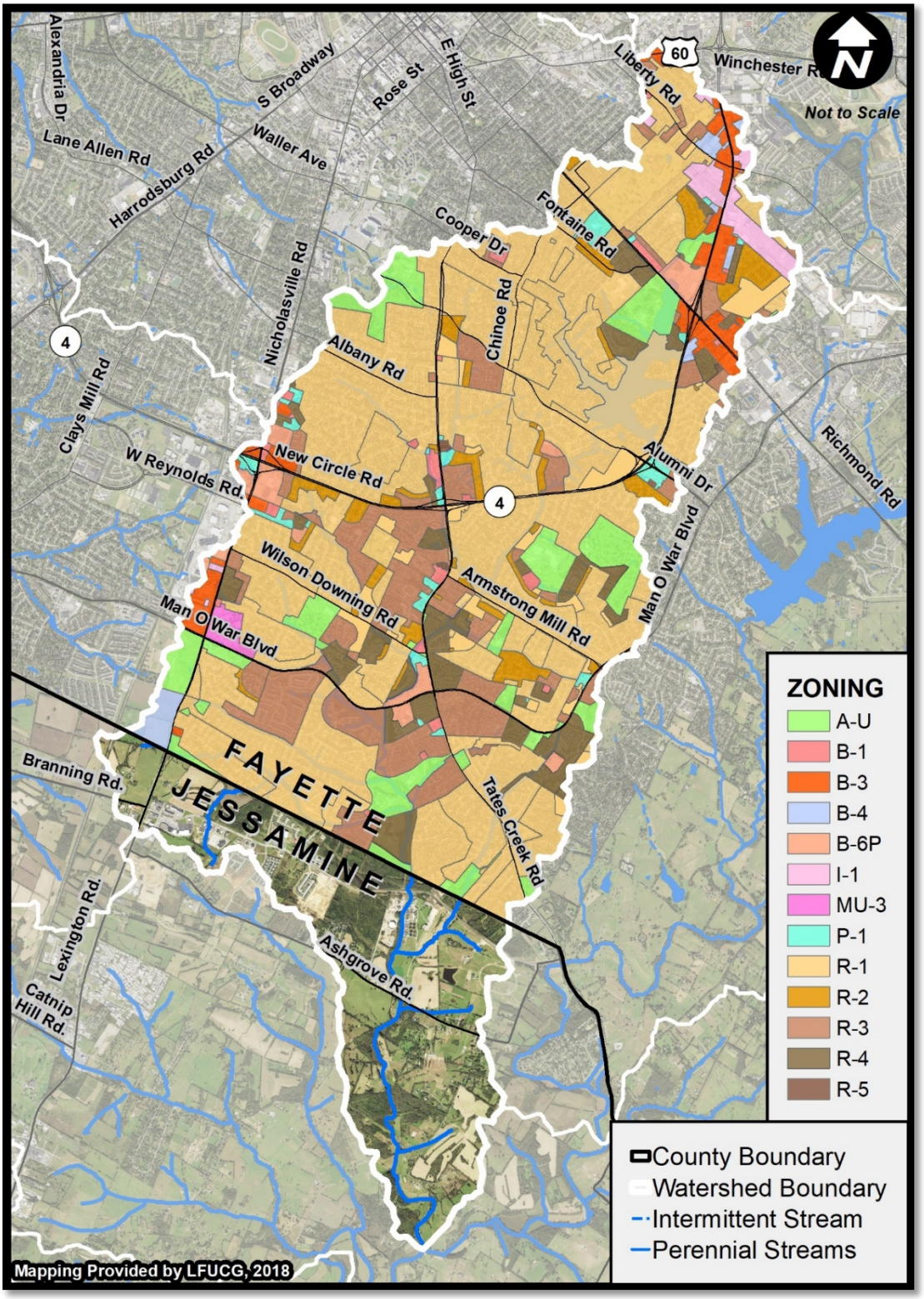


Figure 3-19: LFUCG Zoning Map

3.6.4 IMPERVIOUS SURFACE

Impervious surfaces, delineated from the National Land Cover Database (USGS 2016), in the watershed account for 25% of the watershed area but up to 40% of the watershed for portions within Fayette County, as shown in Table 3-10, page 55 and Figure 3-20, page 56. Impervious surfaces, such as roadways and rooftops, are surfaces that water cannot penetrate. Because these surfaces are unable to infiltrate water, they subject streams to extraordinarily high flows during storm events leading to erosion and further pollution. Impervious surfaces have been found to multiply discharge rates by 2 to 5 times for a given event. Other impacts of impervious surfaces to water quality include:

- On impervious roadways, vehicles introduce numerous pollutants including oils, grease, rubber, and heavy metals (lead, zinc, copper). Some of these pollutants also accumulate when the vehicles are idle on parking lots, driveways, and other parking areas. Most heavy metals tend to gather and remain within vegetated ditches adjacent to the surface. Other roadway pollutants tend to be more mobile. Research indicates that the amount of pollutants in surface waters is proportional to the amount of average daily traffic.
- In winter months, deicing salt transported through runoff can be a significant pollutant to surface waters.
- Roof runoff can be high in certain metals and solids.
- In residential areas, lawn fertilization and pesticide applications--even those just carried to streams--through the storm sewer system, can also contribute to nonpoint source (NPS) pollution.
- Runoff from impervious surfaces often has a much higher temperature than receiving streams.

Table 3-10: Land Use Types and Impervious Surfaces in Fayette County

Zone Title	Zone Code	Total Acreage	% Zoned of Watershed	% Impervious by Zone
Single Family Residential	R-1A R-1B R-1C R-1D R-1E	6477.5	56.6	38%
Planned Neighborhood Residential	R-3	1423.6	12.4	42%
Agricultural Urban	A-U	891.3	7.8	18%
High Density Apartment	R-4 R-5	714.5	6.2	43%
Two-Family Residential	R-2	440.2	3.8	42%
Business (Highway Service, Neighborhood, Wholesale and Warehouse Business, and Planned Shopping Center)	B-1 B-3 B-4 B6-P	808	7.1	68%
Townhouse Residential*	R-1T	303.4	2.7	47%
Light Industrial	I-1	168.9	1.5	79%
Professional Office	P-1	162.7	1.4	51%
Mixed Use	MU-3	55.5	0.5	51%
Total		**11445**	**100.0**	**40%**
***Newer townhouse zone layouts have increased impervious % up to 68%				

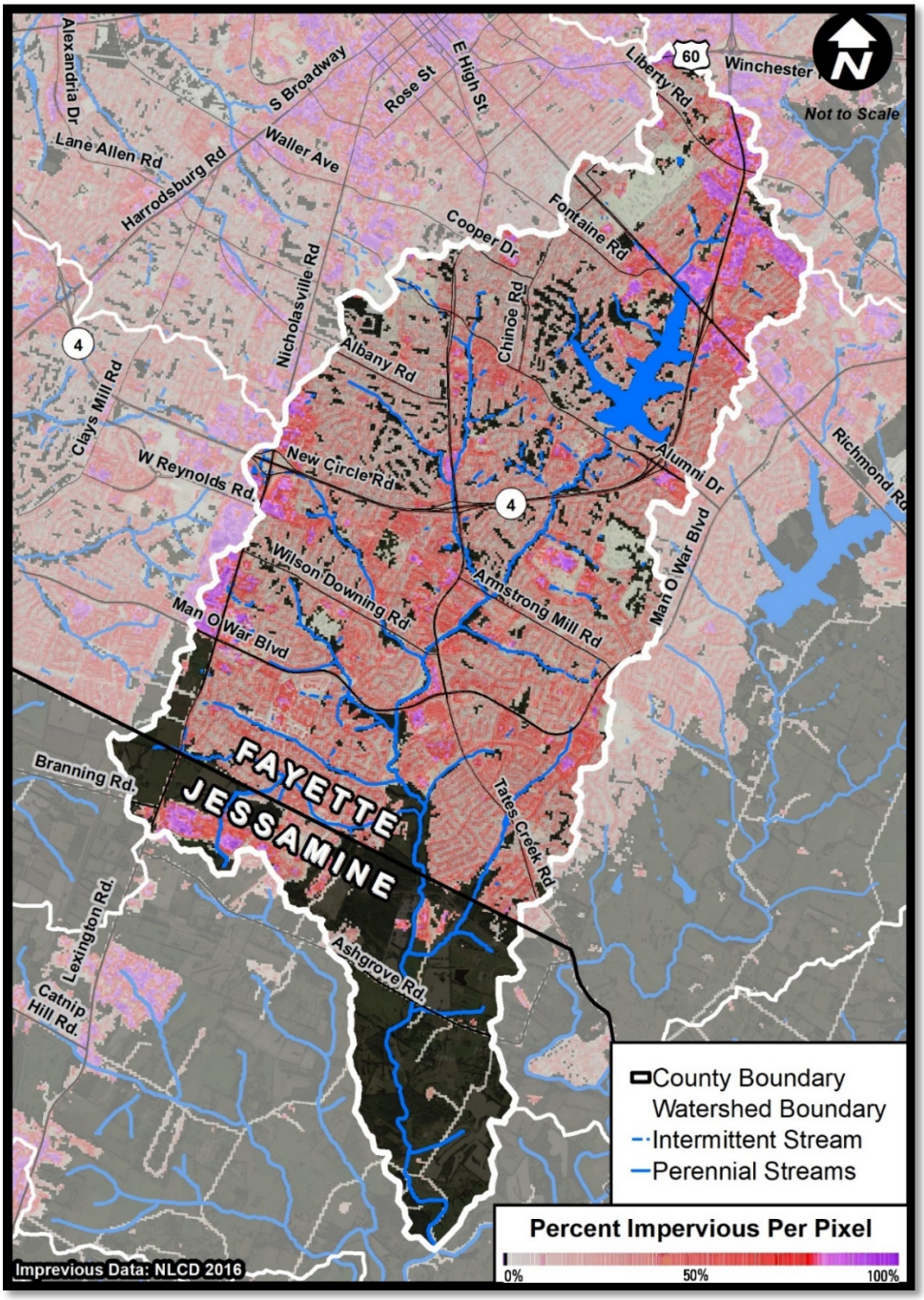


Figure 3-20: Impervious Areas

Land uses and zoning in the watershed contribute varying proportions of impervious surfaces when compared to their relative abundance in the watershed. Since data for zoning in Jessamine County is not available, the following discussion concerns portions of the watershed within Fayette County only. While single-family residential, for example, contributes the most of any other land use at 55% in R-1B, R-1C and R-1D, its overall imperviousness in the watershed is less than its relative abundance in the watershed. Business and professional office, on the other hand, contribute over 11% imperviousness while only

accounting for approximately 7% percent of the zones in the watershed. Retail, trade, personal services, circulation, highway commercial, and light industrial land uses have the highest percentage of impervious surface by land-use type. BMPs for improving infiltration should be targeted for those land uses and zones that contribute the most to impervious surfaces in the watershed. Within 100 feet of West Hickman Creek and its tributaries, impervious surfaces account for only 12% of the land surface. This degree of impervious surface may be a good indicator of the amount of land readily available for riparian zone enhancements and protection. This data is shown in Table 3-9 on page 51.

3.6.4.1 AGRICULTURAL ZONING AND UNZONED LAND USE

Agricultural land accounts for approximately 8% of land use in the watershed in Fayette County, according to zoning maps, and these areas are scattered throughout the watershed. However, a majority of these agricultural-zoned areas in Fayette County (A-U) are, in actuality, golf courses (Idle Hour Country Club, Tates Creek Country Club), local parks (Gainesway Park, Idle Hour Park), or large public school grounds (Henry Clay High School). Some of the agricultural-zoned areas are being utilized for agriculture and include the University of Kentucky Arboretum, located in the northwest section of the watershed, and an area located in the southwest portion of the watershed adjacent to the intersection of Man O' War Boulevard and Nicholasville Road. This southwestern area contains a research farm operated by the University of Kentucky. Recently, the northeast corner of the intersection was rezoned from A-U to accommodate a large-scale mixed-use development called the Summit at Fritz Farm. None of these areas are involved in large-scale agricultural production; therefore, pollution produced from these areas is probably much smaller compared to typical agricultural areas. Livestock are not present within any of these urban agricultural areas within the watershed within Fayette County.

Much of the land in the Jessamine County portions of the watershed is agricultural and undeveloped. Even within the portion of the watershed in Jessamine County with zoning within the City of Nicholasville limits, approximately 25% of it is currently zoned agricultural. It appears that some residential development is near the intersection of Mackey Pike and Ash Grove Road (KY 1980) on both roads. The residential lots appear to be one to two acres in size, with much less density and imperviousness than the residential development within Fayette County. The remaining portions of the watershed in Jessamine County appear to be agricultural and undeveloped lands. Evidence of cattle and horses can be seen from review of aerial photography and limited on the ground visual observations.

3.6.5 LAND DISTURBANCES

No history of mining or quarries is noted in the area; given current land use, future land disturbances will be limited to redevelopment and infill efforts within Fayette County. Some undeveloped parcels do remain and will likely be developed as the population continues to grow. For example, the former Shriners Hospital property on Richmond Road is 28.34 acres and is for sale, marketed as having about half of that acreage as developable land. Within Jessamine County, the extension of East Brannon Road added 2 miles of roadway through undeveloped land in 2018, most of which is in the watershed. Section 3.6.8.1 on page 60 provides a detailed review of the current active KPDES Permits, including those that are associated with construction activity. Currently, 39 active KPDES permits are associated with construction activity in the West Hickman Creek Watershed. Construction and development are the largest current and projected land disturbances.

3.6.6 OTHER WATER DISTURBANCES

LFUCG Division of Environmental Services retained services for a study of problems with the dam and to determine a conceptual plan for its removal and for stream restoration. This study was completed by EcoGro/Ridgewater and Stantec in 2019 and finalized in 2020. The study concluded that the Veterans Park Dam is a clear problem, posing a threat to both human and aquatic life. The most notable observations of the dam as reported in the study include:

- The creek has eroded around the dam, such that water no longer flows over the dam;
- The concrete of the dam has been eroded/undercut by the creek;
- The creek banks around the dam are eroded, resulting in steep, unstable banks which pose a safety risk and could lead to the erosion of hiking trails in the park;
- Significant sediment has accumulated upstream of the dam; and
- The creek upstream of the dam for approximately 1,000 linear feet has low flow velocity due to the increased depth of water caused by the dam.

The study concluded that removal of the dam and restoration of the West Hickman Creek by replacing the eroding dam with a rock riffle would reduce upstream sediment deposition and flatten and armor the steep, eroded banks. The improvements include habitat, oxygenation, safety, and prevention of further erosion.

In addition to the Veterans Park Dam, other water disturbances of note include:

- A dam in the Tates Creek tributary between Willowood Drive and Armstrong Mill Road has erosion problems, and the residents along the creek are concerned about erosion; but, nostalgia exists about the history of the dam having been a neighborhood amenity in the past.
- In several areas of the watershed, development has occurred by constructing storm networks to channel intermittent streams as in the Woodhill area and in the Gainesway neighborhood where Gainesway pond drains through storm pipe to West Hickman Creek. In other areas, development occurs over tributaries diverted into culverts, as in the Idle Hour and Lansdowne areas.
- In the Gainesway Park, the pond outlets into roughly 2000 linear feet of storm pipe and daylights at West Hickman Creek behind the residence at 3505 Olympia.
- The Idle Hour tributary is diverted underground at the park and daylights beside the intersection of Life Lane and Richmond Road in front of Central Bank.
- The Lansdowne Drive tributary is diverted into successive culverts (approximately 160 linear feet and then another 180 linear feet of box culverts) over which a parking lot and restaurant are built.
- The Tates Creek tributary is diverted into 830 linear feet of culvert above Dove Run Road, crosses under Tates Creek Road, and then is parallel to the road over which a parking lot is built. The two tributaries daylight and converge in front of the Arby's restaurant at 3391 Tates Creek Road in the Lansdowne Shoppes development.
- Multiple developments throughout the watershed divert and alter channels, and disconnect them from the floodplain, while also filling in the floodplain in many areas.
- In residential areas throughout the watershed, channel straightening is evident.

3.6.7 WATER USE

3.6.7.1 WITHDRAWAL AND SUPPLY

The federal Safe Drinking Water Act Amendments of 1996 require states to analyze existing and potential threats to each of its public drinking water systems. Source Water Protection Plans assess the quantity of water used in a public water system and to formulate protection plans for the source waters used by these systems. The drinking water supply for the West Hickman Watershed is provided by Kentucky American Water and is withdrawn from Kentucky River at Pools 3 and 9 as well as the reservoir near Jacobson Park. According to KDOW, no permitted water withdrawal sites are within the West Hickman Watershed. Lake Ellerslie (Reservoir #1), Lexington 's original water supply reservoir and owned by Kentucky American Water Company, was once considered for use for drinking water withdrawals in times of extreme emergency; but Kentucky American Water Company, during an October 2019 meeting, has indicated that this scenario is extremely unlikely.

3.6.7.2 PROTECTION PLANS

Wellhead Protection Plans are used to assist communities that rely on groundwater as their public water source. According to the Wellhead Protection Program of KDOW via correspondence in February 2020, no Wellhead Protection Plans exist in the West Hickman Watershed.

Groundwater Protection Plans (GPPs) are required for anyone engaged in activities that have the potential to pollute groundwater. These activities include anything that could leach into the ground, including septic systems and pesticide storage. Section 1(1) of 401 KAR 5:037 requires that these facilities have a GPP, but this requirement is not monitored. GPPs are required to be recertified every three years and must be updated if activities are changed. KDOW retains the plans indefinitely. According to the LFUCG Division of Water Quality, three GPPs were on file for facilities in the West Hickman Watershed. These facilities include:

- Meadowbrook Golf Course, 370 Wilson Downing Road
- Tates Creek Golf Course, 1400 Gainesway Drive
- West Hickman Wastewater Treatment Plant, 645 West Hickman Plant Road

These GPPs implement BMPs to protect groundwater from pollution from the application of pesticides, herbicides, and fungicides, application of fertilizers, storage and handling of petroleum products, storage and handling of substances held for recycling, and use of sewage holding tanks.

401 KAR 5:037 does not require Groundwater Protection Plans (GPPs) to be submitted to the Kentucky Energy and Environment Cabinet for review and approval unless called in by Department for Environmental Protection inspectors, the Groundwater Section of the Watershed Management Branch, or Division of Enforcement. To ascertain whether a facility has a GPP, the Groundwater Section highly recommends that a door-to-door survey be conducted within the watershed. A Stormwater BMP Plan or SPCC Plan is not a substitute for a GPP. Any facilities conducting activities subject to 401 KAR 5:037 that do not have a GPP should contact KDOW Groundwater Section. Additional GPPs may be within the watershed that have not been submitted to LFUCG or the Kentucky Energy and Environment Cabinet.

3.6.8 POINT SOURCE DISCHARGES

3.6.8.1 KPDES DISCHARGES

An open records request from KDOW, completed in January 2020, indicated 43 active Kentucky Pollutant Discharge Elimination System (KPDES) permits in West Hickman Creek Watershed as shown in Figure 3-21. Of these active permits, 39 of them were General Permits for Stormwater Discharge Associated with Construction Activities (KYR10). A Stormwater Discharge Associated with Construction Activities permit is required by KDOW for all construction activities disturbing over one acre of land, or if part a larger plan of development that disturbs over one acre of land unless the site had coverage under a previous KPDES permit. Stormwater Discharge Associated with Construction Activities permits can be General (KYR10) or Individual permits. Currently, no Individual Stormwater Discharge Associated with Construction Activities Permits are active in West Hickman Watershed. 22 active KYR10 KPDES permits in Fayette County and 17 active KYR10 KPDES permits in Jessamine County were in the watershed. Although the majority of the watershed is in Fayette County, 44% of the active construction projects disturbing over one acre are in Jessamine County, indicating that development is spreading in the currently undeveloped sections of the watershed. This development includes recent annexation of 123 acres at 3090 Ashgrove Road in Jessamine County. This will convert a portion of existing agricultural land to residential, increasing impervious surfaces.

The four remaining KPDES permits are not related to construction activities. Two of the KPDES Permits are General Permits for Stormwater Associated with Industrial Activities (KYR00). These two permits are held by Parker Hannifin and Ruskin Company, located as shown on Figure 3-21. Parker Hannifin lists a Standard Identification Code (SIC) of fabricated rubber products. Ruskin Company lists a SIC of sheet metal work. The remaining two active KPDES Permits are a Minor Drinking Water Backwash Permit held by Kentucky American Water at Resevior No. 1 and a Sanitary Sewer System Major Municipal held by LFUCG for the West Hickman Wastewater Treatment Plant. Routine water sampling is conducted and submitted to KDOW as a part of these permits.

KDOW also provided the KDPES permitted outfalls in the watershed through the open records request. Seven permitted outfalls are all associated with the four non-construction related KDPES permits except one for Jessamine South Elkhorn Water District near the Jessamine/Fayette County line. The KPDES permitted outfalls are identified on Figure 3-21. Kentucky American Water Company has two permitted outfalls, one for filter backwash water and one for noncontact cooling water. Parker Hannifin also has two permitted outfall from its operations. Current KPDES permits can be viewed on the KDOW website at http://dep.gateway.ky.gov/eSearch/Search_AI.aspx.

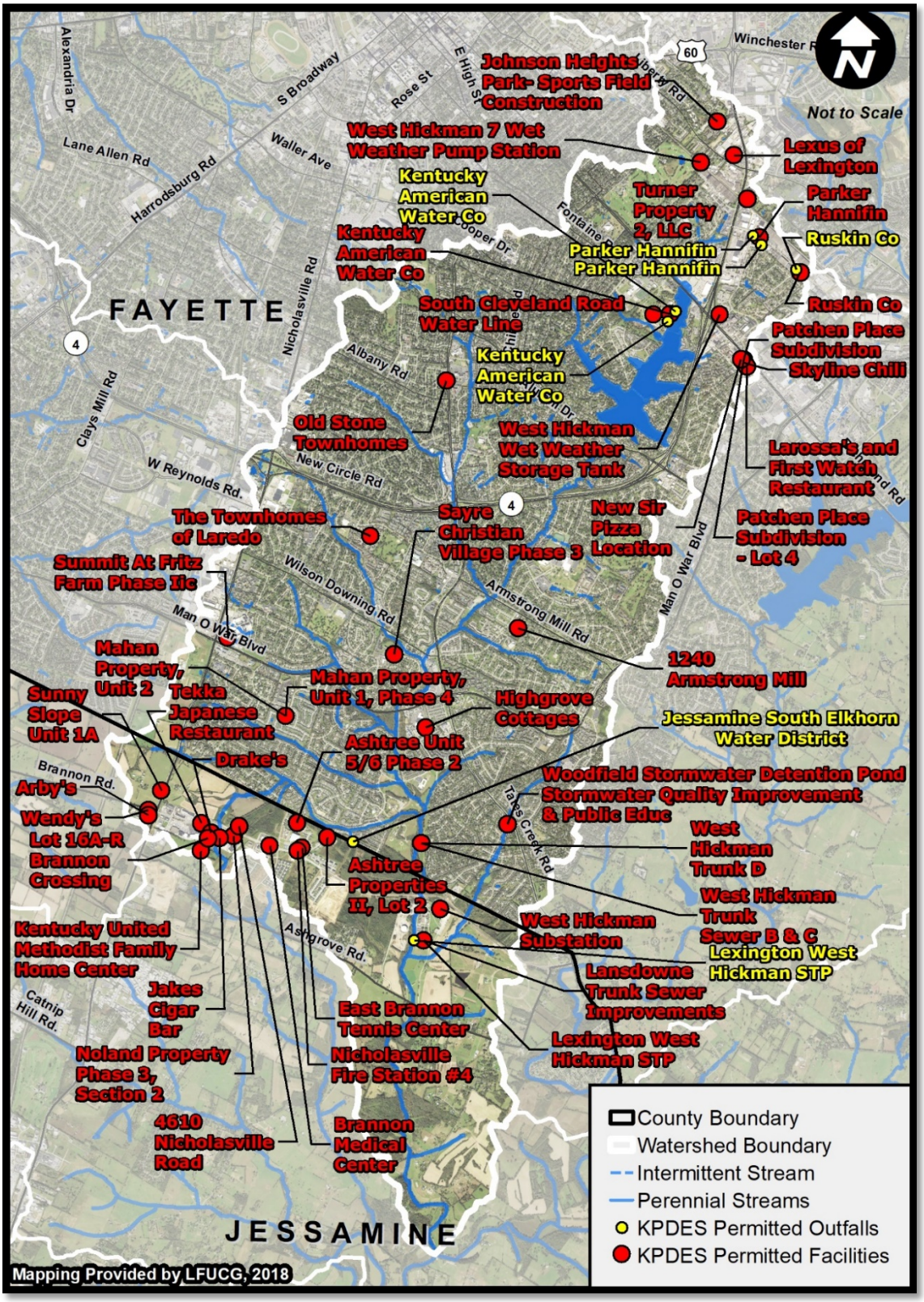


Figure 3-21: KPDES Permit and Outfall Locations

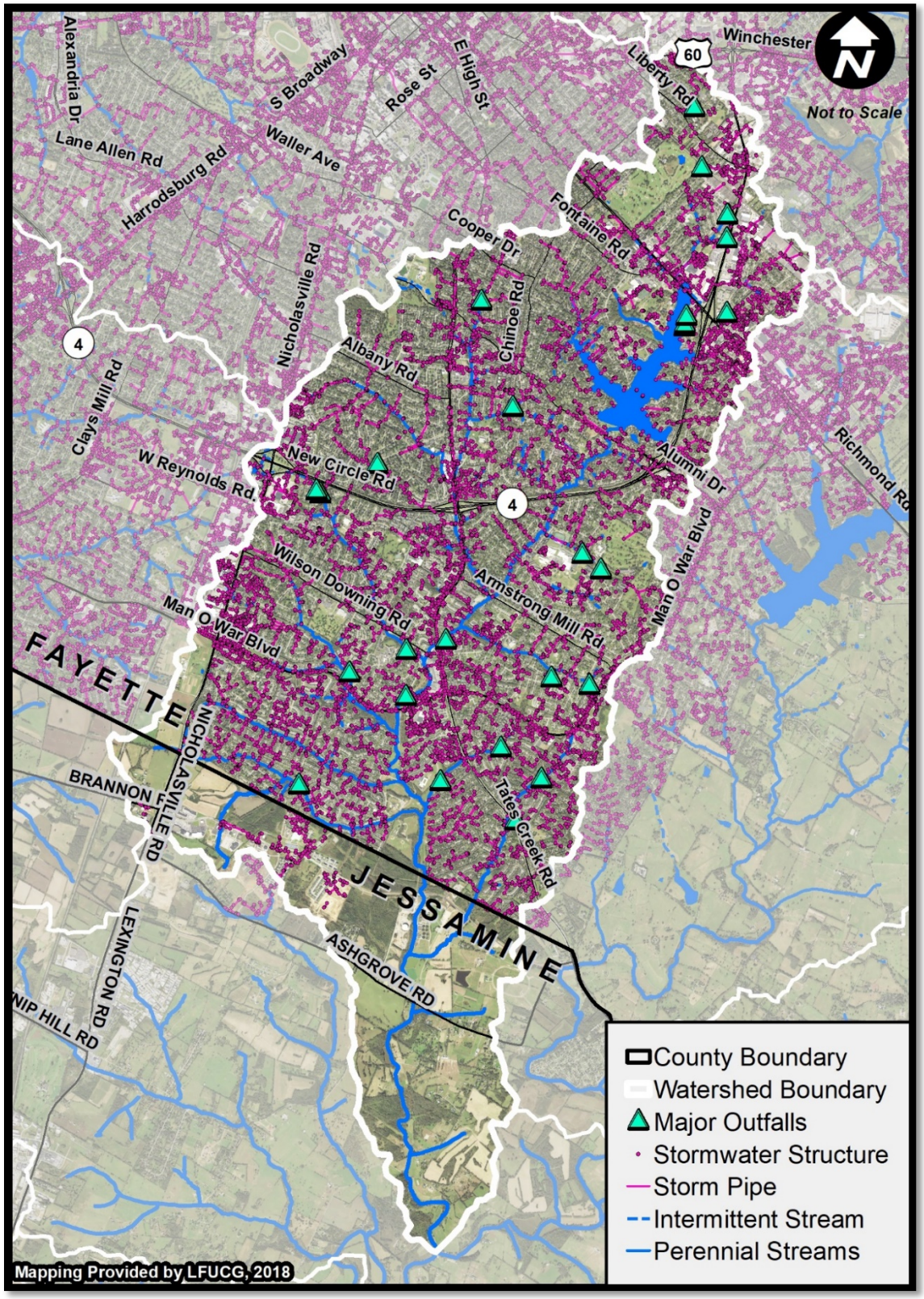


Figure 3-22: Storm Pipes and Major Outfalls

3.6.8.2 STORM SEWER SYSTEM

Stormwater management has grown and developed with the passage of the Clean Water Act by Congress in 1972. The EPA is the enforcement arm of the federal government for the Clean Water Act. In Kentucky, the enforcement has been delegated to the KDOW. The EPA has categorized MS4s into the three categories of small, medium, and large, based on population served. The MS4 is defined as follows:

- A conveyance, or series of conveyances, that includes roadways with drainage systems, streets, catch basins, curbs, gutters, ditches, man-made channels or storm drains that are owned and/or operated by the government, state, city, town, county, district, or other association or public body or utility having jurisdiction over disposal of stormwater that discharges into the waterways of the Commonwealth of Kentucky;
- Is designed or utilized for collecting or conveying stormwater; or
- Is not a combined sewer and is not part of a publicly owned treatment facility.

Lexington is a Phase I MS4 community and is governed under three documents: the Consent Decree, the MS4 permit, and the Stormwater Quality Management Plan (SWQMP). In addition to these governing documents, individual institutions may have Stormwater Pollution Protection Plans (SWPPPs) that govern site-specific practices. Locations of major stormwater outfalls are provided in Figure 3-22, page 62, along with the currently mapped (Fall 2019) stormwater pipes and outfalls in the West Hickman Watershed.

Three other MS4 permit holders are located in the West Hickman Watershed. The University of Kentucky is a small MS4 permittee located in the headwaters of the West Hickman Watershed. The University of Kentucky permit coverage only applies to portions of campus within the watershed. The Kentucky Transportation Cabinet (KYTC) is also an individual stormwater MS4 permit holder. The City of Nicholasville is also a Phase II MS4 Community. A portion of the northern section of Jessamine County where Brannon Crossing is located is included within the MS4 boundary for the City of Nicholasville.

3.6.8.3 LFUCG CONSENT DECREE

The March 14, 2008 Consent Decree (United States 2008) was filed by LFUCG in order to resolve the lawsuit led by the EPA and Commonwealth of Kentucky against violations of the Clean Water Act by LFUCG. The stated objective of the Consent Decree is:

> "It is the express purpose of the Parties in entering this Consent Decree to further the objectives of the CWA [Clean Water Act]…and to eliminate SSOs, Unpermitted Discharges, Unpermitted Bypasses and Exceedances, to eliminate and prevent CWA permit violations, and, specifically with respect to LFUCG's Stormwater Quality Management Program ("SWQMP"), ensure implementation of a SWQMP that reduces the discharge of pollutants to the maximum extent practicable, and require implementation of measures to ensure compliance with LFUCG's MS4 Permit."

The Consent Decree contains compliance measures that relate to the storm sewer system as well as the sanitary sewer system and additional environmental projects. For the Storm Sewer System, the Consent Decree implements the following compliance measures:

- SWQMP (Section 11) - Implementation of the SWQMP (LFUCG 2008a) and enforcement of the "Performance Standards" stated therein.
- Legal Authority (Section 12) - Numerous measures that confer legal authority to LFUCG to adopt

and/or maintain ordinances that enforce the stormwater program

- Funding (Section 13) - Establishment of a stormwater management fee to fund stormwater management services
- Personnel, Training, and Equipment (Section 14) - Provision for annual education on and acquisition of equipment necessary for Consent Decree compliance

All Consent Decree related materials may be accessed from the LFUCG Division of Water Quality Web Page at https://www.Lexington ky.gov/epa-consent-degree.

3.6.8.4 MS4 PERMIT

The Phase I MS4 Permit for LFUCG (KPDES No. KYS00002 AI No. 74551) was issued on May 1, 2015 with a five-year duration period. The permit requires a comprehensive wet weather plan and implementation of a program that addresses seven minimum program elements:

- Public Education and Outreach on Stormwater Impacts
- Public Participation and Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post Construction Stormwater Management in New Development and Redevelopment
- Industrial Monitoring and Control
- Good Housekeeping and Pollution Prevention for Municipal Operations

The permit is set to expire in April 2020. A revised application was submitted in November 2019. The permit applies to the entire urban-county government area, but the Illicit Discharge Detection and Elimination (IDDE) Program (except for the Industrial Facilities Program), Pollution Prevention in Residential and Commercial Areas, and Pollution Prevention for Municipal Operations only applies inside the Urban Area boundary. The SWQMP developed by LFUCG must meet the minimum requirements specified in the permit for each of these programs. The SWQMP may be modified to add requirements, replace ineffective or unfeasible Best Management Practices (BMPs), or adjust the schedule for maintenance activities during the life of the permit, provided the permit-specified procedures are followed. The content and provisions of the SWQMP are also not considered permit conditions but a tool to ensure permit compliance. LFUCG's MS4 permit may be viewed on-line at the Stormwater Web Page (https://www.Lexington ky.gov/stormwater).

The University of Kentucky (UK) and the City of Nicholasville have been issued Phase II Small MS4 permits (Permit No. KYG200000), which became effective on May 1, 2018, that is set to expire on April 20, 2023. The scope and requirements of this permit are less than that of LFUCG, addressing only six minimum elements (Industrial Monitoring and Control is excluded) and with fewer individual requirements. Detailed information on this permit may be accessed at https://eec.ky.gov/Environmental-Protection/Water/PermitCert/KPDES/Documents/KYG20PermitPage.pdf. UK and LFUCG are responsible for their respective drainage areas; other coordination efforts are ongoing.

3.6.8.5 LFUCG STORMWATER QUALITY MANAGEMENT PLAN

The LFUCG SWQMP (LFUCG 2016) is a comprehensive, detailed set of procedures and protocols for implementing the stormwater best management programs in order to manage the quality of stormwater discharged from LFUCG's storm sewer system. The content of the SWQMP is based on the terms and conditions of the MS4 permit and addresses the following specific permit elements:

- Public Education and Outreach
- Public Involvement and Participation
- Illicit Discharge Detection and Elimination
- Post-Construction Stormwater Management in New Development and Redevelopment
- Pollution Prevention for Municipal Operations
- Industrial Facility Stormwater Pollution Prevention
- Water Quality Monitoring
- Reporting and Recordkeeping
- Total Maximum Load Daily Loads and Impaired Waters

In addition to these elements, a Watershed Management element is included in the SWQMP, but it is not in the permit. This element will serve to document the activities and efforts by a major watershed, and the resulting reports will guide stormwater management activities.

The method used to evaluate the program elements of the SWQMP consists of assessing whether the *measurable goals* within each program element have been met. The *measurable goals* consist of clearly defined tasks and schedules. The SWQMP includes 186 measurable goals among the 10 program elements. The SWQMP can be found at https://www.Lexington ky.gov/stormwater for more information. The success of the SWQMP in minimizing stormwater pollution to the West Hickman Creek Watershed should result in improvements to water quality and is, therefore, important in the watershed planning process.

3.6.8.6 STORMWATER POLLUTION PREVENTION PLANS FOR INDUSTRIAL AND HIGH-RISK COMMERCIAL STORMWATER SITES

Chapter 16, Article X, Division 3 of the LFUCG Code of Ordinances (LFUCG 2010) specifically allows LFUCG to regulate industrial and high-risk commercial facilities to develop and implement SWPPPs and monitoring plans. The purpose of this program is to reduce pollutant loadings and improve the quality of stormwater runoff discharged from these areas into the local waterways. Facilities may already have a Best Management Practices (BMP) Plan, Groundwater Protection Plan (GPP), Spill Prevention Control and Countermeasure Plan, or Stormwater Pollution Prevention Plan (SWPPP). Although the State requires a BMP or GPP plan, LFUCG is in the process of requesting a SWPPP be created for regulated facilities. A SWPPP is more detailed than a BMP, GPP, or SPCC plan, although all of these plans may be compiled into an Integrated Contingency Plan, if desired. The four main objectives of a SWPPP are:

1. Identify Pollutant Sources – The plan shows actual and potential sources of pollution that could affect stormwater discharges and how they were identified.
2. Control the Sources – The plan establishes practices and controls to prevent or effectively reduce pollution in stormwater discharges, ensuring compliance with the general permit.
3. Document the Control Methods – The plan describes how the selected practices and controls are appropriate for the facility and how they effectively prevent or reduce pollution.
4. Integrate Pollution Prevention – The plan discusses how controls and practices relate to each other in an integrated, facility-wide approach to pollution prevention.

In addition to inspecting facilities, division staff will also be evaluating SWPPPs to ensure all required information is included. Two industrial/high risk commercial sites (Kentucky American Water Company and Ruskin Company) are in the watershed as shown on Figure 3-23 on page 67. For the most part, these

SWPPPs indicate that the largest potential stormwater contaminants from these sites are due to vehicle maintenance fluids, parking lot runoff, and soil erosion. Chemical parameters that would reflect pollution from these sites in the watershed include oil and grease, chemical oxygen demand, total residual chlorine, and total suspended solids.

3.6.8.7 STORMWATER CONTROLS

Stormwater controls describe a wide variety of BMPs used to treat, store, or otherwise manage the quality or quantity of stormwater. Four types of stormwater controls have been identified within the West Hickman Watershed: detention basins, retention basins, underground basins, and other BMPs. The locations of these structures are shown in Figure 3-23.

A detention basin is a stormwater control basin designed to hold water when it rains and completely drain afterward. During a rainstorm, a detention basin can store a large quantity of water that will be allowed to discharge slowly. According to 2019 GIS data provided by LFUCG, 72.5 acres of detention basins are in the West Hickman Creek Watershed in Fayette County. The average basin is 0.3 acre in size, with the majority located on commercial lands.

Traditional detention basins are designed to reduce peak flows from large storms in developed areas. However, the smaller and more frequent storm events cause streambank erosion and transport of pollution to streams. Traditional stormwater basins do little or nothing to filter out pollutants or slow the runoff velocity for these smaller storms. Detention basins can be retrofitted to manage runoff from smaller storms. In this way, stormwater is retained for longer periods than originally designed, and the velocity of the water discharged from small storms is slowed, reducing erosion and filtering pollutants such as sediments, oils, grease, nutrients, and pesticides. Use of native plants can also reduce the maintenance required for the detention basin.

A retention pond maintains a permanent pool of water and can provide greater improvements in water quality when used to capture and treat stormwater runoff. A retention pond slows incoming runoff and facilitates greater settling of sediment and can filter pollution from runoff through natural bio-chemical activity in the pond. Unlike a detention basin, a retention pond permanently holds water instead of draining within a few days of a rainstorm. 29.8 acres of retention ponds are in the West Hickman Creek Watershed. The average pond is 1.2 acres in size. The location of these ponds is shown in Figure 3-23. Retention ponds can be retrofitted to add enhanced removal capacities for suspended solids, nutrient, metals, and fecal coliforms. Typically, the retrofit involves the enhancement of the littoral shelf, or area in which wetland vegetation can grow.

Because most of these stormwater controls are located on commercial areas, the landowners will have full responsibility for maintenance. On residential areas, the landowners or homeowners associations are responsible for mowing; removal of algae, litter, small dead trees and branches; maintenance of landscaping, and replanting small bare areas. LFUCG will be responsible for severe erosion, excess silt removal, removal of large debris, and maintenance of structural repairs to pipes and spillways.

Each retention pond and detention basin larger than 0.4 acres in the West Hickman watershed was inspected and evaluated for its retrofit potential to improve water quality in 2012 by Third Rock Consultants. 75 ponds and basins in the West Hickman watershed were evaluated for retrofit potential. The opportunities for retrofit were evaluated at the 75 ponds and basins included extending detention to increase settling of pollutants, improving the channel condition to lengthen the travel time through the

basin, promoting infiltration through various practices, and other opportunities such as education of residents and businesses in the vicinity of the basin, litter control, and stabilization of eroded areas.

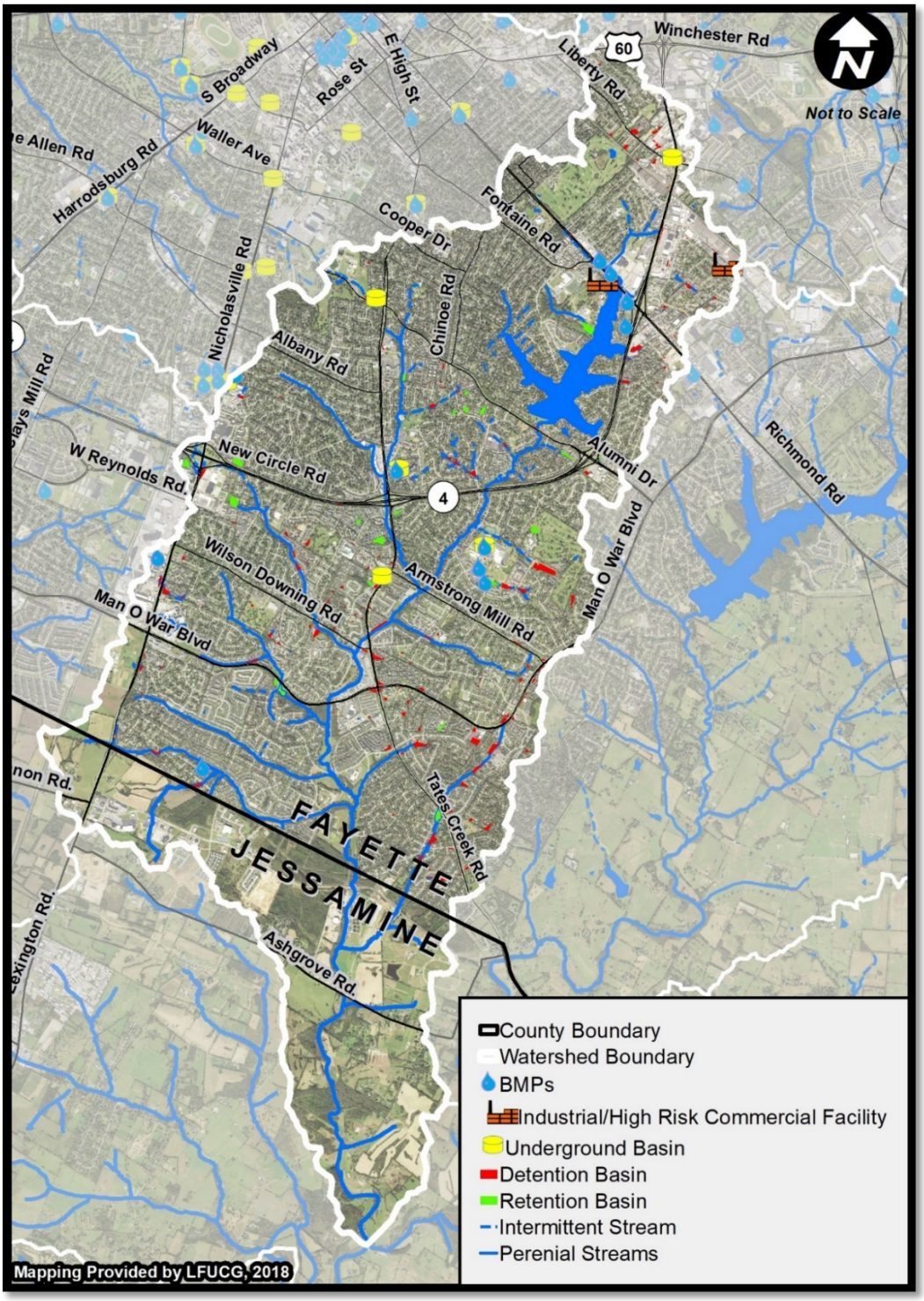


Figure 3-23: Stormwater Controls in Fayette County

Underground basins include underground pipe systems and vaults used to store stormwater. Three underground basins are located in the West Hickman Creek Watershed as shown on Figure 3-23. For these facilities, the private property owners are required to conduct all necessary maintenance including annual inspections of the facilities.

Other stormwater BMPs are located within the West Hickman Creek Watershed. These BMPs include the Gainesway Pond Water Quality Facility and Park Community Center, several water quality units, oil-water-debris separators, and a basin filter. For these facilities, the private property owners, or their designated manager, are required to conduct all necessary maintenance including annual inspections of the facilities. LFUCG also conducts inspection of all above-ground devices every five years to ensure the property owners or manager is maintaining the structures.

3.6.9 REGULATIONS AND ORDINANCES – FAYETTE COUNTY

The LFUCG Code of Ordinances was reviewed to determine the regulations for potential impacts to the watershed (LFUCG 2019). While numerous ordinances apply to watershed management and affect water quality in various manners, some ordinances are particularly applicable to watershed management. These ordinances include:

- Chapter 12: Housing
    - Article 3: Riparian Areas
- Chapter 16: Sewage, Garbage, Refuse, and Weeds
    - Article 10: Stormwater Discharges
    - Article 14: Water Quality Management Fee
- Chapter 20: Zoning
    - Article 19: Floodplain Conservation and Protection
    - Article 26: Tree Protection Standards

A brief summary of each of these ordinances follows. While some areas are addressed with specific ordinances, sinkholes and karst areas, other special environmental areas are addressed through BMPs and site plans associated with other ordinances. Additionally, neighborhood-specific ordinances, deed restrictions, and design standards not addressed herein may have applicability to watershed management in specific areas.

3.6.9.1 RIPARIAN AREAS

This ordinance (Chapter 12, Article 3) allows “any person whose property contains a riparian area…[to] create a buffer area bordering the riparian area upon obtaining a permit from the urban forester or his designee. Such a buffer area shall be exempt from the nuisance provisions of Chapter 12 provided that the area is properly maintained as defined herein, and acceptable species of vegetation are utilized.” In this way, natural riparian areas may be maintained without being cited for a penalty nuisance provisions. The maximum area for such a riparian zone is “twenty-five (25) feet from the edge of the wetland, river, stream or lake, unless a larger area is approved by the urban forester and so designated on the permit.”

3.6.9.2 PRIVATELY-OWNED DETENTION AND RETENTION BASINS

The purpose of Division 2 of Article 10, Chapter 16 is to set forth ordinances that will ensure compliance with LFUCG’s MS4 permit regulations by clarifying the roles of the private property owner and LFUCG in managing stormwater control devices including detention basins and retention ponds. The ordinance requires that these control structures be properly maintained, both through structural repairs and non-

structural maintenance. The ordinance also prohibits structures such as fences, gazebos, swimming pools, and sheds from being located in a detention basin or retention pond.

In an area where a public easement exists, the property owner and LFUCG share responsibility for the basin or pond. The property owner is responsible for non-structural maintenance such as mowing, litter removal, algae removal, tree limb removal, and landscaping. LFUCG is responsible for structural maintenance such as repairing severe erosion, removing excess silt, and removing large debris. LFUCG also repairs any structures that are failing, such as concrete flumes or pipes. In an area without a public easement, the property owner is responsible for all non-structural and structural maintenance of the basin or pond. All structural and non-structural maintenance of stormwater control devices on commercial or industrial property is the responsibility of the property owner and manager.

3.6.9.3 INDUSTRIAL AND HIGH-RISK COMMERCIAL STORMWATER RUNOFF

Chapter 16, Article 10, Division 3 specifically allows LFUCG to regulate industrial and high-risk commercial facilities to develop and implement SWPPPs and monitoring plans, even if they are not otherwise required to have this information. The purpose of this program is to reduce pollutant loadings and improve the quality of stormwater runoff discharged from these areas into the local waterways. (See previous discussion, in Section 3.6.8.6).

3.6.9.4 EROSION AND SEDIMENT CONTROL

Soil erosion from construction sites contributes to the impairment of the floodplain, increased road maintenance costs, clogging of storm sewers, degradation of land surfaces and streams, flooding, and dusty conditions when eroded material dries on streets. Significant erosion results from rainfall and runoff over unprotected soil. Erosion is increased by intense rainfalls, long slopes, steep slopes, and lack of adequate vegetative cover. These conditions are in part caused by or aggravated by improper construction, grading, or excavation, which results in removal of natural ground cover without taking appropriate steps to control erosion problems. The intent of Chapter 16, Article 10, Division 5 is to reduce soil erosion in Fayette County and to provide procedures for submission, review, and acceptance of erosion and sediment control plans and applications for land disturbance permits prior to soil disturbance.

The ordinance covers control measures such as installation of silt fences, construction entrances, seeding and mulching, proper disposal of trash, curb and surface inlet protection, inspection of controls, street cleaning, drainage alteration, and snow fences for construction sites of various sizes and disturbance limits. The ordinance also includes enforcement measures and penalties for violations.

3.6.9.5 WATER QUALITY MANAGEMENT FEE

Under Chapter 16, Article 14, a water quality management fee is imposed on every parcel of land within the water quality management area except undeveloped parcels, railroad tracks, and federal, state, or urban county streets and roads. Single-family homes and duplexes will pay $5.00 per month, while apartment complexes and non-residential properties will pay the fee based on the total amount of impervious surface on their properties. Impervious surfaces are areas such as roofs, parking lots and driveways that do not infiltrate water when it rains. The ordinance establishes a Water Quality Fees Board and a stormwater projects incentive program.

The Stormwater Quality Projects Incentive Grant Program provides financial assistance for projects in the community that improve water quality, address stormwater runoff, and educate the public about these issues. LFUCG's Division of Water Quality will receive the applications and make recommendations for

project selection. Projects will be ranked based upon project impact, project team, and other factors. The Water Quality Fees Board reviews all recommendations and makes the final selection on all grant awards. Because neighborhoods and institutions have different needs, two types of grants are available.

3.6.9.6 FLOODPLAIN CONSERVATION AND PROTECTION

Under Chapter 20, Article 19, the designation of flood hazard areas and the regulations imposed on these zones are intended to provide for public awareness of the flooding potential, protect human life and health, minimize public and private property damage, protect individuals from buying lands and structures that are unsuited for intended purposes because of flood hazards, and minimize surface and ground water pollution and erosion of the floodplain soils, which will adversely affect human, animal, or plant life.

3.6.9.7 TREE PROTECTION STANDARDS

LFUCG recognizes the importance of trees as a vital component in counterbalancing the effects of an urban setting by providing cooling shade, reducing noise and glare, significant contribution to urban aesthetics, improving air quality through carbon dioxide reduction and replenishing oxygen to the atmosphere, improving surface drainage and reducing the effects of storm drainage flooding, filtering non-point source pollution from area streams, stabilizing soil thereby minimizing erosion, and providing habitat for wildlife. The purpose of Chapter 20, Article 26, is to establish standards and procedures for countywide tree protection and planting in new developments.

3.6.9.8 SANITARY SEWER SYSTEM AND WASTE MANAGEMENT

As explained in the Stormwater System section on page 24, the Consent Decree (United States 2008) contains compliance measures that relate to the storm sewer system, sanitary sewer system, and additional environmental projects. With regard to the sanitary sewer system, the Consent Decree is divided into two sections (15 and 16). Section 15 requires:

A: Capital Improvement Projects and Short-Term Measures
B: Sewer System Assessment (SSA)
C: Pumping Station Design, Capacity and Equipment Condition Adequacy Analysis Evaluation
D: Capacity Assessment
E: Hydraulic Model
F: Reporting (SSA Reports)
G: Sanitary Sewer System and WWTP Remedial Measures Plan

Section 16, Capacity, Management, Operation, and Maintenance (CMOM) Program requires the development of a CMOM Self-Assessment with the following activities:

A: Sewer Overflow Response Plan
B: System Capacity Assurance Program
C: Fats, Oils, and Grease (FOG) Program
D: Gravity Line Preventative Maintenance Program
E: Pump Station Operation Plan for Power Outages
F: Backup Power for WWTPs

According to the Sanitary Sewer Assessment Work Plan (LFUCG 2008b), the West Hickman Creek Watershed contains 148,170 linear feet of trunk sewer; 1,547,520 linear feet of collection sewer; 12,440 linear feet of force main; 8 pump stations; and 9,150 manholes. The West Hickman Creek Watershed

contains the most linear feet of trunk and collection sewer lines but the least amount of linear feet of force mains for Fayette County. 40 SSOs were located in the watershed according to the assessment, which was the highest for any watershed in Fayette County at the time of the assessment. The sanitary sewer lines in the West Hickman Creek Watershed flow to the West Hickman Wastewater Treatment Plant (WWTP), which discharges into the West Hickman Creek in Jessamine County. The West Hickman WWTP is a two-stage activated sludge nitrification system, which treats billions of gallons of wastewater annually. The peak flow at the West Hickman WWTP is 64 million gallons a day.

A Sanitary Sewer Remedial Measures Plan (LFUCG 2016) has been completed and was given final approval on March 19, 2016. The approved plan is located at https://www.Lexington ky.gov/atyourservice. The Sanitary Sewer Remedial Measures Plan contained 20 projects in the West Hickman Watershed as detailed in Figure 3-24, page 72. As indicated in the *2019 Annual Report* to the EPA, eight of the projects (highlighted in yellow in Figure 3-24) have been constructed, one project (highlighted in blue in Figure 3-24) is currently under construction, and one project (highlighted in green in Figure 3-24) is currently under construction. The schedule outlined in the Sanitary Sewer Remedial Measures Plan indicates that all projects are expected to be designed and constructed prior to January 2027. The *2019 Annual Report* also states that 137,461 linear feet of sewer lines were cleaned in West Hickman from January 1, 2019 through December 31, 2019 as a part of the CMOM Program.

Projects identified in the Sanitary Sewer Remedial Measures Plan are expected to have a combined measurable difference in the water quality of West Hickman Creek watershed due to removal of sanitary sewer overflows and reduction of leaking/damaged pipes. LFUCG reported in the 2019 Report to the EPA that 24 of the recurring SSOs have been abated or relocated since 2013. Those SSOs that were relocated are planned to but be abated by a future Remedial Measures Plan Project. Ten of the SSOs were abated in 2019 when the WH7 Equalization Tank was added to the system.

Inflow and infiltration rates from rainfall and groundwater, both of which have important relationship to watershed planning, are also a concern within the West Hickman Creek Watershed. When high levels of rainfall enter into the sanitary sewer system, it causes SSOs to occur, which contribute to fecal pollution and nutrient loading in the watershed. Where groundwater inflow/infiltration rates are high, fecal pollution and nutrient loading may pass from the sanitary sewer to the groundwater via diffusion or exfiltrate from the sanitary sewer to the groundwater when groundwater levels are low. Groundwater infiltration would also contribute to SSOs.

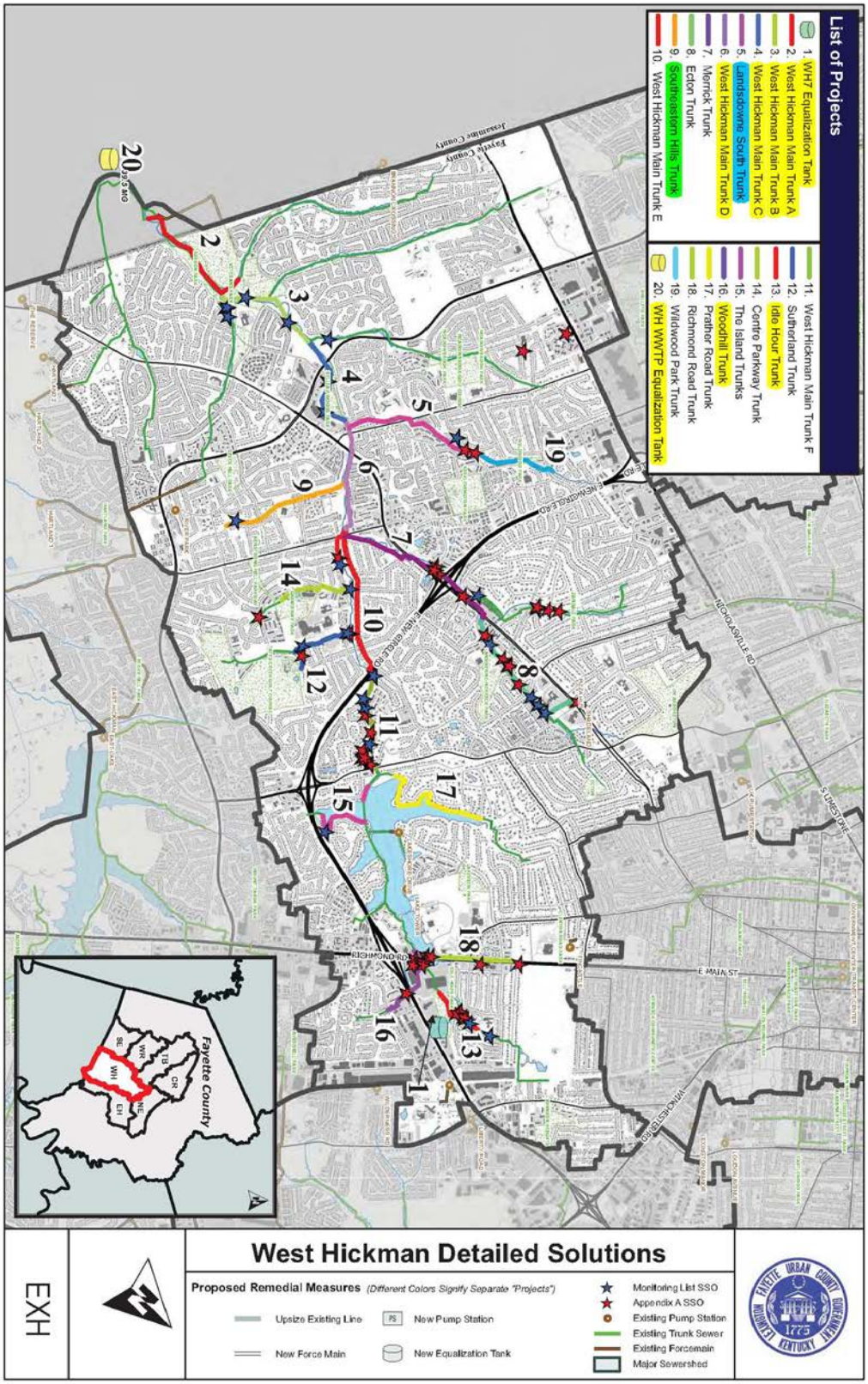


Figure 3-24: West Hickman Watershed Consent Decree Projects

3.6.10 REGULATIONS AND ORDINANCES – JESSAMINE COUNTY

The Jessamine County Code of Ordinances was reviewed to determine the regulations for potential impacts to the watershed (Jessamine County, Kentucky, 2019). While numerous ordinances apply to watershed management and affect water quality in various manners, some ordinances are particularly applicable to watershed management. These ordinances include:

- Chapter 152: Stormwater: Illicit Discharges and Connections
  - Section 2: Discharges
- Chapter 153: Subdivision Regulations
  - Section 4: General Requirements; Minimum Design Standards
- Chapter 155: Flood Damage Prevention
  - Section 4: Provisions for Flood Hazard Reduction
- Chapter 156: Stormwater: Post-Construction Management
  - Section 5: Basic Stormwater Management Design Criteria
  - Section 6: Requirements for Stormwater Management Plan Approval
  - Section 7: Construction Inspection
  - Section 8: Maintenance and Repair of Stormwater Facilities

3.6.10.1 DISCHARGES

Chapter 152, Articles 15 through 18, state the types of discharges that are and are not acceptable to the municipal storm drain system, as well as connections to the drain system that are permissible. This set of ordinances also gives permission to the County Fiscal Court to enforce the Stormwater Pollution Prevention Plan, as necessary, for compliance with requirements of the NPDES permit.

3.6.10.2 WATERCOURSE PROTECTION

This ordinance (Chapter 152, Article 19) requires that any person who owns property through which a watercourse passes shall keep that area clean of trash, debris, and other obstacles that would pollute, contaminate, or significantly retard the flow of water through the watercourse. Property owners shall also maintain any private drainage structures in or near the watercourse.

3.6.10.3 MINIMUM DESIGN STANDARDS

Chapter 153, Article 61, contains ordinances related to land proposed for subdivision and lays out specific cases where the land shall be considered unsuitable. Land subject to flooding shall not be platted for residential or any use that may increase danger to or aggravate erosion or flood hazards. Land of unsuitable topography soil and other describe cases where land may be found to be unsuitable for subdivision based on bad drainage, poor percolation and other factors that may increase erosion or flood hazards with clarification that adequate methods for meeting the problems may be proposed by subdivider.

3.6.10.4 PROVISIONS FOR FLOOD HAZARD REDUCTION

Chapter 155, Articles 40 through 46, set forth construction standards for residential, non-residential, and manufactured homes as well as the storage of recreational vehicles, specifically sites located within flood hazard areas on the community's FEMA Flood Insurance Rate Map (FIRM).

3.6.10.5 STORMWATER: POST-CONSTRUCTION MANAGEMENT

Chapter 156 contains the establishment of water quality and quantity policies applicable to surface waters

in order to provide guidance for the regulation of stormwater runoff from land development projects and construction activities. The chapter lays out the purpose and applicability of standards; it tasks the Planning Commission staff with review of plans in order to ensure standards are maintained.

Chapter 156, Article 5, requires that the latest edition of the manual produced by the University of Kentucky Transportation Center titled "Best Management Practices (BMPs) for Controlling Erosion, Sediment, and Pollutant Runoff from Construction Sites" be used in the absence of a BMP manual adopted by the Jessamine County Fiscal Court.

Chapter 156, Articles 50 through 65, lay out general performance and basic management criteria for stormwater. The articles address site feasibility, conveyance issues, landscaping plans, maintenance agreements, and non-structural practices.

3.7 DEMOGRAPHIC AND SOCIAL ISSUES

The demographics of the West Hickman Creek Watershed help to provide an indication of how the watershed will continue to develop and where the most impact can be made. As previously discussed in Section 3.6.2, the populations in Fayette and Jessamine Counties are growing faster than the state of Kentucky as a whole. Development continues to sprawl, and especially the Jessamine County portions of the watershed may see increased and denser development over time. Both counties have a greater High School graduation rate and higher number of individuals with a Bachelor's degree when compared with the State of Kentucky. These criteria are important to consider with the type and methods of public education and outreach.

As technology becomes more and more prominent and citizens are bombarded with information, it is vital to consider effective and visible methods for communicating. Fayette and Jessamine Counties are younger than the average for the State of Kentucky with 15% less population over 65 years old. Innovative and unconventional methods of communication could be beneficial.

LFUCG has recently implemented various projects to promote and inform the public of water quality issues through the Live Green Lexington campaign. Some of these programs include:

- Household Hazardous Waste Collections – event to safely dispose of unwanted hazardous waste
- Adopt a Storm Drain – inviting citizens to pledge to remove debris from the drain, report maintenance issues, and stencil a message on the concrete
- Plant by Numbers – a do-it-yourself guide for beautiful, pollinator-friendly landscaping
- Right Place, Right Tree – providing information on appropriate trees to plant in locations
- Paint by Nature – local artists were invited to depict native plants based on a yearly theme
- Nature Hop – a way for citizens to enjoy natural areas of Fayette County
- Go See Trees – a way to introduce Lexington residents to various tree species in the community

Despite increased efforts by many groups, especially LFUCG, many people in Fayette and Jessamine Counties seem to be unaware or uninformed about water quality issues. Due to the highly residential nature of the West Hickman Creek watershed, continued targeted meetings and communication can increase the knowledge base and lead to adaptations in behavior ultimately improving water quality in the watershed.

3.8 FIELD OBSERVATIONS

Extensive visual inspection and habitat assessments in Fayette County portions of the West Hickman Creek watershed were completed by LFUCG through a previous contract that will be discussed in detail in the following chapters. In addition to the previous work completed by LFUCG and provided to the project team, a partial visual assessment was completed by members of the project team from Jackson Group in March 2020. A certified biologist visited 12 stream sites in addition to the previous 23 stream site studies by LFUCG and their consultants on previous contracts. Four of these sites were located in Jessamine County in the more rural portions of the watershed that was not previously investigated. Rapid Bio assessment Protocols were evaluated and the four stream sites classified as "fair" and "poor" habitat for wadeable reaches. The results of the field collected data are shown below in Table 3-11. Blank forms are included in APPENDIX D. No notable differences were observed in the stream site located in Fayette County than work previously performed.

Table 3-11: Jessamine County Additional Observation Locations

Site	Stream	County	Latitude	Longitude	Total RBP Score	Classification	Dissolved Oxygen (mg/L)	Conductivity (µs/cm)
WH-24	West Hickman	Jessamine	37.90676	-84.49964	110	Poor	8.7	383
WH-25	UT of West Hickman	Jessamine	37.91235	-84.4985	112	Poor	11.1	285
WH-26	West Hickman	Jessamine	37.91451	-84.50341	125	Fair	9.5	386
WH-27	West Hickman	Jessamine	37.92727	-84.50482	125	Fair	9.1	382

Predominately West Hickman Creek is a very urban watershed, especially through the portions of Fayette County. The development is extending into the northern portions of Jessamine County, but overall the Jessamine County portions are far less developed. Photographs taken during the site visits in Jessamine County are shown in Figure 3-25 through Figure 3-28. Lack of riparian corridor appears to be a large problem through the watershed.

Figure 3-25: WH-24 Looking Up Stream

Figure 3-26: WH-25 Looking Downstream

Figure 3-27: WH-26 Looking Downstream

Figure 3-28: WH-27 Looing Downstream

3.8.1 HICKMAN CREEK CONSERVANCY STREAM WALK OBSERVATIONS

The Hickman Creek Conservancy hosted creek walks through out the watershed since their inception in January 2019. The purpose of the stream walks include meeting on site with concerned citizens, discovery walks to gain familiarity with BMPs, cleanups, plantings, and citizen engagement efforts. In more than 15 stream walk events, the group has observed that multi-family dwelling areas relying on dumpsters are a significant source of windblown trash. They have noted that in areas with pet waste programs, users often do not make it to a trash receptacle after bagging feces. Finally, the group has expressed that maintenance approaches to BMPs vary widely throughout the watershed.

3.9 INTERIM CONCLUSIONS

Based on review of the background information from the sources presented, the West Hickman Creek watershed is a predominately urban watershed that flows from Fayette County into Jessamine County totally just over 14,000 acres. Associated with this development is a large amount of impervious area, especially within the portion of the watershed within Fayette County. Development is extending into Jessamine County. Fayette and Jessamine Counties are maintaining ordinances and requirements to facilitate protection of West Hickman Creek and its tributaries as development and re-development occurs in the watershed. Currently less than 50% of the streams in the watershed have riparian areas of greater than 30 feet, which significantly smaller areas of riparian corridor as the stream decrease in order.

Land use in West Hickman Creek Watershed is dominated by residential, which accounts for approximately 72% of the area in Fayette County. As low density residential accounts for such a large proportion of land use in the watershed within Fayette County, NPS of pollution commonly associated with such land use may play a large role in the health of West Hickman Creek and its tributaries. Lawn fertilizers, herbicides and pesticides are commonly applied in these zones to keep grass green. Household pets are also often associated with low-density residential areas and can contribute to fecal and nutrient pollution.

Citizens in West Hickman Creek watershed are interested in water quality and willing to become involved in improvements. This has been evidenced through the creation of the Hickman Creek Conservancy, attendance at the West Hickman Watershed Council meetings, and the numerous LFUCG Incentive Grant Program projects that have been implemented by Homeowner Associations, area businesses, and educational institutions. Citizen interest and involvement is vital to the success of the implementation of the watershed management plan.

As a part of the LFUCG Watershed-Focused Monitoring Program, the portions of the watershed located in Fayette County have been studied and visited in detail with a total of 23 stream sites and all the major outfall (105 total). Following the conclusion of the LFUCG Watershed-Focused Monitoring sampling, KDOW took over sampling the stream sites from October 2019 through April 2020. The remainder of this plan will aim to incorporate the background information presented in this chapter with the analysis of the sampling data collected by LFUCG and KDOW to meet the identified goals and objectives of the WHWMP.

4 MONITORING

4.1 MONITORING OVERVIEW

As part of the development of this plan, KDOW and LFUCG gathered samples from 18 stream sites and LFUCG collected supplemental sample data from more than 100 headwall outfalls throughout the watershed. LFUCG collected samples from October 2018 to September 2019 and KDOW collected samples from October 2019 to March 2020. Agencies gathered data points for the following parameters for each sample:

- Site ID
- Date
- Estimated Flow (cfs)
- Dissolved Oxygen Saturation (%)
- Dissolved Oxygen (mg/L)
- pH (SU)
- Conductivity (µS/cm)
- Temp (C)
- Chlorine (mg/L)
- Fluoride (mg/L)
- Nitrogen (mg/L)
- Phosphorous (mg/L)
- Total Suspended Solids (mg/L)
- E. Coli (MPN/100mL)
- Various qualitative measurements (weather, canopy cover, odor, etc.)
- Various metal concentrations (antimony, aluminum, copper, lead, etc.)

In addition to water quality metrics, stream biology was also assessed by LFUCG in May 2019, including measurements for macroinvertebrates, physical water quality, water chemistry, and warm water aquatic habitat. KDOW performed macroinvertebrates benchmark assessments in March 2020.

Microbial Source Tracking (MST) was performed in 2012 and 2019 by LFUCG in an effort to narrow down the potential sources of certain pollutants, specifically human fecal material. The study from 2012 utilized a comparison between stream samples and raw domestic sewage to determine the likelihood of sewage levels in the stream. The 2019 study identified separate DNA markers to human, dog, and bird hosts to determine if E. coli levels were contributable to a human source.

Each set of monitoring data is described in more detail later in this section and analyzed in Section 5. Original reports and data are provided in various appendices for reference.

4.2 MONITORING PARAMETERS

The *Watershed Planning Guidebook for Kentucky Communities* specifies parameters that must be collected for WMP development to be in compliance with 319(h) grant funded projects. These parameters were also identified as critical parameters because they are directly related to the objectives of this study. The critical parameters and related standard operating procedures are listed in Table 4-1. The critical

parameters can be broken down into seven main groups -- bacteria, nutrients, sediment, flow, field data, habitat, and biology. To assist in monitoring evaluation, photographs were taken at each site location during various sampling events. LFUCG sampled 18 stream sites and over 100 outfall locations. KDOW sampled only 18 stream sites.

Table 4-1: Parameter Testing Frequencies

Group	Parameter	Monthly LFUCG	Monthly KDOW	Standard Operating Procedure (SOP)
Bacteria	E. coli (*Escherichia coli*)	X	X	DOWSOP03015
Nutrient	NO3 (Nitrate)	X	X	DOWSOP03015
	NH3-N (Ammonia – Nitrogen)	X	X	DOWSOP03015
	TP (Total Phosphorus)	X	X	DOWSOP03015
Sediment	TSS (Total Suspended Solids)	X	X	DOWSOP03015
Flow	Stream Discharge	X	X	DOWSOP03019
FieldData	pH	X	X	DOWSOP03014
	DO (Dissolved Oxygen)	X	X	DOWSOP03014
	Specific Conductivity	X	X	DOWSOP03014
	% Saturation (Percent of DO)	X	X	DOWSOP03014
	Temperature	X	X	DOWSOP03014
Habitat	Habitat Assessment (KDOW Method)		X	DOWSOP03024
Biology	Biological Assessment (KDOW Method)			DOWSOP0300/ DOWSOP03005

Critical parameters were tested in accordance with LFUCG Watershed-Focused Monitoring Plan. This plan includes the following five elements: water quality monitoring at in-stream sites and major outfalls; stream corridor habitat, substrate, and macroinvertebrate presence; stream biology (macroinvertebrates); neighborhood sources and potential generators in priority upland areas; and microbial sources and optical brighteners to trace illicit discharges. Samples and field data at the time of sampling were collected by Third Rock Consultants, LLC, LFUCG staff, and trained volunteers. The monitoring process consists of two phases, screening and monitoring. The screening phase requires sampling of a wide range of in stream and outfall locations. The goal is to identify areas of concern for more critical study. Phase 2 monitoring involves further study at the in-stream sites and outfalls noted to have flow during 50% of phase 1 visits. This process is discussed in section 4.3.2.

MST was incorporated as a part of the development of the WHWMP to establish a systematic approach to water quality and data analysis that identifies hot spots of human fecal wastes within WHC. The procedures were used to identify samples that were indicative of contamination with human fecal waste, using fecal load, age, and source in the 2012 analysis. Separate DNA markers to human, dog, and bird hosts were utilized in the 2019 analysis. This process is further discussed in section 4.2.1.

4.2.1 BACTERIA

Bacteria are microscopic organisms that cannot be seen with the naked eye. Bacteria are found everywhere and most are harmless to humans; some even assist in keeping human's bodies functioning properly. The critical parameter E. coli is a type of bacteria in the fecal coliform group. Fecal coliform are only found in fecal waste of humans and other warm-blooded animals. E. coli is a gram-negative rod-shaped bacterium that is commonly found in the lower intestine of warm-blooded organisms. Most strains are harmless to humans. Determining the number of E. coli colony forming units (cfu) found in a water sample of a given size serves as an indicator to whether pathogens are possibly present. Pathogens are defined as bacteria, viruses, and parasites that cause disease and illness. The pathogens of primary concern in water with temperatures of less than 30 degrees Celsius include Bacteroides species; salmonella; shigella; aeromonas; enamoeba histolytica; and the O157:H7 strain of E. coli. The higher the level of E. coli, the more likely the water contains pathogens.

To assist in developing best management practices for pollutant load reductions, MST sampling and analysis was incorporated into the project in addition to determining the amount of E. coli at select sampling sites. In areas where high levels of E. coli were found, additional testing was used to determine whether the bacteria was being introduced into the stream through human or animal sources. Human, bird, and dog specific biomarkers were used. *Bacteroides* ID™ Species: B. dorei was chosen as the human source marker. Potential human sources of fecal material include sanitary sewer overflows, leaking or failed sanitary sewer lines or laterals, failing sewer lines or septic systems, and straight pipes. Bacteroides dorei is an anaerobe frequently shed from the gastrointestinal tract and isolated from human feces worldwide.

Fecal material from animal sources can pollute streams through overland flow, when animals defecate in the stream or when a concentrated animal feed operation is in proximity to the stream. In more urban watersheds such as this one, house pets and common urban wild animals are often the source. Dog Bacteroidetes ID™ was used as the biomarker for dog waste. Bird Fecal Quantification ID™ was used as the biomarker for bird associated waste. This biomarker is present in birds including but not limited to gull, goose, chicken, pigeon, and duck. This bird marker is generally not quantifiable due to the limitations

of the method, but when quantifiable the results suggest significant bird waste. The "general" Bird Fecal biomarker was chosen over the goose specific marker due to limitations of the goose specific marker in flowing water conditions. According to Source Molecular, the goose specific method is more reliable in lentic environments such as lakes and ponds. Source Molecular is a commercial microbiology lab specializing in microbial source tracking. Third Rock took possession of the samples from the volunteers and shipped the samples directly to Source Molecular for analysis.

4.2.2 NUTRIENTS

Nutrients are natural elements in soil, water, and organisms that are essential for plant and animal growth, maintenance, and reproduction. Excess nutrients are usually the result of pollution from land use activities and can be detrimental to streams. Stormwater runoff, decomposition of organic matter, discharges from wastewater systems, failing septic systems, excess use of fertilizers, and waste products from farm animals and domestic pets are common sources of nutrients. High concentrations of nutrients within a water body promote excessive growth of algae in an event called a harmful algal bloom. These blooms will eventually die and bacteria will breakdown the decomposing algae which depletes the water of available oxygen. The depletion of oxygen can lead to the death of other organisms such as fish. This process is called eutrophication. Some types of algae, such as blue-green algae produce toxins which are poisonous to people and animals. Excess algae can cause unpleasant conditions, odors, and poor habitat.

Nitrogen and phosphorus are the two primary nutrients discussed in this plan. Nitrogen and phosphorus are found in fertilizers applied to farm land and residential lawns and gardens and are essential for plant growth. Nitrogen and phosphorus can be measured in several forms. The critical parameters for nitrogen are nitrate-nitrogen (NO3-N) and ammonia nitrogen (NH3-N). Elevated nitrogen and phosphorus levels may indicate the presence of a pollution source. Ammonia-nitrogen was measured using field Hanna Checkers (handheld colorimeter units). Total nitrogen as nitrate was also measured via grab sample lab analysis and reported in milligrams per liter. The critical parameter for phosphorus is total phosphorus (TP). Total phosphorus was measured by collecting grab samples and sending them to Town Branch WWTP Laboratory for analysis. The results are reported in milligrams (mg) per liter (L).

Figure 4-1: Algae and Other Plant Life on Water Surface at WH - 20

4.2.3 FLOW

Flow is determined by measuring stream discharge. Stream discharge is the volume of water that passes through a stream in one second. Stream discharge is calculated using measurements of stream width, depth, and velocity. Prior to sampling, physical characteristics (i.e. cross-section, slope, roughness) of each in-stream site and outfall location were measured such that stream or pipe flow could be calculated using water depth values measured during sampling events. The USGS gage at West Hickman Creek at Veteran's Park (Station 03284552) was used to validate flow estimates when needed.

Figure 4-2: Staff Gauge for Water Depth at WH 08 Site

4.2.4 SEDIMENTS

Total suspended solids concentrations and turbidity are critical parameters used to measure the amount of solid material suspended in the water. High levels of total suspended solids and turbidity will often cause the water to appear muddy. In a water body, suspended materials block light from reaching plants on the streambed, limiting photosynthesis. These materials can harm fish spawning beds and impair fish gill function. These impacts combine to reduce plant and animal life in the stream. Suspended materials often carry other pollutants such as metals and bacteria. Turbidity is the cloudiness of a fluid caused by suspended solids and measures the amount of light scattered. The total suspended solids test measures the actual weight of material in a given volume of water. High total suspended solids concentrations and turbidity values can be an indicator of a source of sediment. Total suspended solids were measured via grab samples analyzed in the Town Branch WWTP Laboratory and were reported in milligrams per liter.

Figure 4-3: Turbid Water at WH-17 on October 30th 2019

4.2.5 FIELD DATA

Field data was collected at each sample site in conjunction with the water sample collection and flow measurements. Field data was collected using a multimeter water quality probe and included measuring water temperature, dissolved oxygen (DO), potential Hydrogen (pH), and conductivity. Chlorine and ammonia-nitrogen were measured in the field using Hannah Checkers (handheld colorimeter units).

Water temperature quantitatively assigns a value to the notion of hot and cold. Aquatic organisms can be greatly affected by the water temperature. The optimal water temperature can vary greatly by the species, but variations above or below a normal range can impact organisms' processes. Temperatures will vary during the day, especially near the water surface or in shallow waters. Aquatic organisms adjust to temperature changes by moving to other areas in the water body according to their desired temperature. Extended periods of temperature variation can cause stress and death of organisms. Water temperature can be changed by the removal of trees and other vegetation that normally provides shade; dam construction or other impoundments; industrial or urban stormwater discharges; and groundwater flows. Water temperature was measured in degrees Celsius.

Dissolved oxygen (DO) is the amount of oxygen that is present in the water. Most aquatic organisms get the oxygen they need to survive from the DO in the water. Water is oxygenated by diffusion from the surrounding air, aeration through rapid movement, and as a waste product of photosynthesis. Colder water typically has higher levels of DO. Dissolved oxygen can be affected by high levels of bacteria which consume oxygen as organic matter decays. Percent saturation of DO was the amount of oxygen dissolved in the water sample compared to the maximum amount possible at the same temperature. If the percent saturation of DO is equal to 100%, the water is said to be saturated. Water can become supersaturated with oxygen when percent saturation of DO exceeds 100%.

Potential Hydrogen (pH) is a measure of the concentration of hydrogen ions in a water sample and indicates whether a sample is acidic or basic. Potential Hydrogen values are unitless and range from zero to 14, with pure water measuring seven. Water samples with a pH below seven are considered acidic. Water samples with a pH above seven are considered basic. Most organisms are more successful in a pH range of 6.5 to 8. Potential hydrogen values outside of this range can lessen diversity due to reductions in reproduction and stress on organisms. Very acidic solutions can change the solubility of material, causing harmful metals or other compounds to be leached into water in previously insoluble compounds. Water in the central Kentucky region tends to be slightly basic due to the underlying limestone. As the limestone dissolves, hydroxide ions are released into the water increasing the pH. The pH can also be affected by the pH of rainfall. Acid rain can lower the pH of a stream.

The measure of a material's ability to conduct electricity is known as conductivity. According to the EPA, conductivity can indicate the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions or sodium, magnesium, calcium, iron, and aluminum cations. Pure water has a very low conductivity. Water temperature also effects conductivity; typically the warmer the water, the higher the conductivity. Conductivity can also be affected by the geology of the region in which stream is located. Areas where the stream flows through limestone and clay soils tend to have high conductivity. Discharges into streams may also change the conductivity. Discharge from a sanitary sewer overflow would raise the conductivity due to the presence of chloride, phosphate, and nitrate. Specific conductivity was measured because it normalizes the reading to 25 degrees Celsius. Specific conductivity was measured in microsiemens per centimeter (µS/cm).

Figure 4-4: Field Data Collection at WH - 22

4.2.6 HABITAT

Stream habitat is vital for successful plant and animal communities within waterways. Stream habitat is the areas where plants and animals live, including on, under, and between rocks; in or on plant and woody debris; and in mud or sand. Stream habitat is not limited to the area within the channel banks, but also includes the riparian zone. If a variety of habitats are available within the stream corridor, there is more opportunity for multiple plant and animal species to thrive. Assessing the habitat can help in determining the health of the stream. Stream habitat assessment looks at particular features within a section of stream and analyzes how those features function. Habitat assessments were performed using the Rapid Bioassessment Protocols (RBPs) developed by KDOW. Two sets of RBPs have been established, one for high gradient stream and one for low gradient streams. High-gradient streams are defined as streams with velocities greater than 0.5 feet per second (ft/s) that exhibit rapid changes in stream gradient and a high frequency of riffle habitat. Low-gradient streams are defined as streams with velocities less than 0.5 ft/s and often lacking rifle habitat. All the sample site locations for the WHWMP were classified as high-gradient. The RBPs for high-gradient streams include the assessment of ten major parameters: epifaunal substrate and available cover; embeddedness; velocity and depth regime; sediment deposition; channel flow status; channel alteration; frequency of riffles; bank stability; vegetation protection; and riparian vegetative zone width. KDOW has established specific criteria for the time of year habitat assessment should be completed based on stream size and drainage area. Streams are classified as headwater or wadeable. Headwater streams have a surface drainage area less than five square miles and wadeable streams have a surface drainage area of more than five square miles. The Standard Operating Procedure (SOP) developed by KDOW, DOWSOP03024, specifies that habitat assessment for wadeable streams should be conducted from June 1st until September 30th and headwater streams from March 1st until May 31st. The habitat assessments for the headwater and wadeable streams sampled for WHWMP were

assessed in May 2019. Assessments were completed as a part of the LFUCG watershed focused monitoring process.

4.2.7 BIOLOGY

Biological assessments can also help determine the health of a watershed. Different organisms can tolerate varying levels of pollution in the water. If organisms with a very low pollution tolerance are found it is an indicator of good water quality. A large portion of the organisms living in streams are benthic macroinvertebrates. These organisms live close to or on the bottom of the stream, do not have backbones, and can be seen with the naked eye. Benthic macroinvertebrates may be immature forms of organism that live on land once full grown. Benthic macroinvertebrates serve important roles in the stream system, providing food for larger organisms, eating algae and bacteria, and breaking down decaying material and debris. *Watershed Planning Guidebook for Kentucky Communities* indicates that benthic macroinvertebrates are good indicators of the health of a watershed "because they:

- live in the water for all or most of their lives
- stay in areas suitable for their survival
- are easy to collect
- tolerate different amounts and types of pollution
- are easy to identify in a laboratory
- often live for more than one year
- do not move very far in the stream
- are exposed to all conditions and pollution in the stream."

The Macroinvertebrate Biotic Index (MBI) is used to classify the water based on benthic macroinvertebrates that are found within a stream reach. KDOW uses seven core metrics in the MBI computation: Taxa Richness (G-TR); Ephemeroptera, Plecoptera, Trichoptera Richness (EPT); Modified Hilsenhoff Biotic Index (mHBI); Modified Percent EPT Abundance (m%EPT); Percent Ephemeroptera (%EPHEM); Percent Chironomidae + Oligochaeta (%Chir+%Olig); and Percent Primary Clingers (%Clingers). Table 4-2 lists these metrics and defines their function and response to disturbance.

Table 4-2: Metrics to Develop an MBI for Water Quality Analysis and Responses to Disturbances

Metric	Function	Response to Disturbance
G-TR	Refers to total number of taxa present	Negative
EPT	Number of taxa within these pollution-sensitive insect orders	Negative
mHBI	Assesses impacts other than organic enrichment	Positive
m%EPT	Measures relative abundance of pollution-sensitive organisms	Negative
%EPHEM	Measures impacts in response to metals and high conductivity	Negative
%Chir+%Olig	Measures relative abundance of pollution tolerant organisms	Positive
%Clingers	Habitat metric for organisms that need hard silt-free substrate	Negative

Similar to the habitat assessment, KDOW stipulates specific times of the year when benthic macroinvertebrate should be collected to obtain accurate, comparable results for wadeable and headwater streams. Benthic macroinvertebrate collection for wadeable streams should be conducted from June 1st until September 30th and headwater streams from March 1st until May 31st. For this study, semi-quantitative and qualitative macroinvertebrate samples were collected on May 21, 22, and 23, 2019.

4.3 STUDY WATERSHED MONITORING

4.3.1 MONITORING LOCATIONS

A total of 18 stream sites were chosen throughout the watershed for monitoring and analysis as shown in Figure 4-5 on page 89. Monitoring proceeded in two phases. Phase 1 was a screening effort during which dry weather sampling (at least 72 hours of consecutive dry weather prior to sampling) was conducted at 18 in-stream sites and 105 major outfalls. Phase 2 further studied all stream sites and 68 of the major outfalls where water was found to be routinely flowing in phase 1. A short overview of each stream monitoring location is provided below. Note that there are 23 sites shown. Only 18 of these sites were chosen for analysis in this study, they will retain their original numbering. Geographic locations for each site are shown in Table 4-3.

Table 4-3: Geographic Location of Stream Sites

Site ID	Location	Latitude	Longitude	County
WH-1	Forest Lake Tributary at Ivy Bridge Road	37.94463	-84.49429	Jessamine
WH-2	Southpoint Tributary at Veterans Park	37.95520	-84.50614	Fayette
WH-3	West Hickman Creek at Veterans Park	37.95812	-84.50219	Fayette
WH-4	Emmett Creek at Southpoint Drive	37.95932	-84.50723	Fayette
WH-7	Belleau Wood Drive Tributary at Man-O-War	37.97182	-84.51123	Fayette
WH-8	Wilson Downing Tributary at Belleau Woods Park	37.97356	-84.50037	Fayette
WH-9	West Hickman Creek at Wilson Downing Road	37.97433	-84.49951	Fayette
WH-10	Lansdowne Tributary at Camelot Drive	37.98273	-84.50773	Fayette
WH-11	Mill Creek at Appian Crossing Way	37.97718	-84.49425	Fayette
WH-13	West Hickman Creek at Armstrong Mill Road	37.98055	-84.49016	Fayette
WH-14	Tates Creek at Armstrong Mill Road	37.98086	-84.49079	Fayette
WH-16	Lansdowne Tributary at Lansdowne Shopping Center	37.99379	-84.49623	Fayette
WH-17	Tates Creek at Montavesta Road	37.99749	-84.49398	Fayette
WH-19	West Hickman Creek at New Circle Road	37.99129	-84.48096	Fayette
WH-20	West Hickman Creek at Reservoir Spillway	37.99909	-84.47321	Fayette
WH-21	UNT to Reservoir at Lakewood Court*	38.01216	-84.47719	Fayette
WH-22	UNT to Idle Hour Tributary at St Ann Drive	38.02136	-84.45943	Fayette
WH-23	West Hickman at Ashgrove Road	37.93444	-84.50216	Jessamine

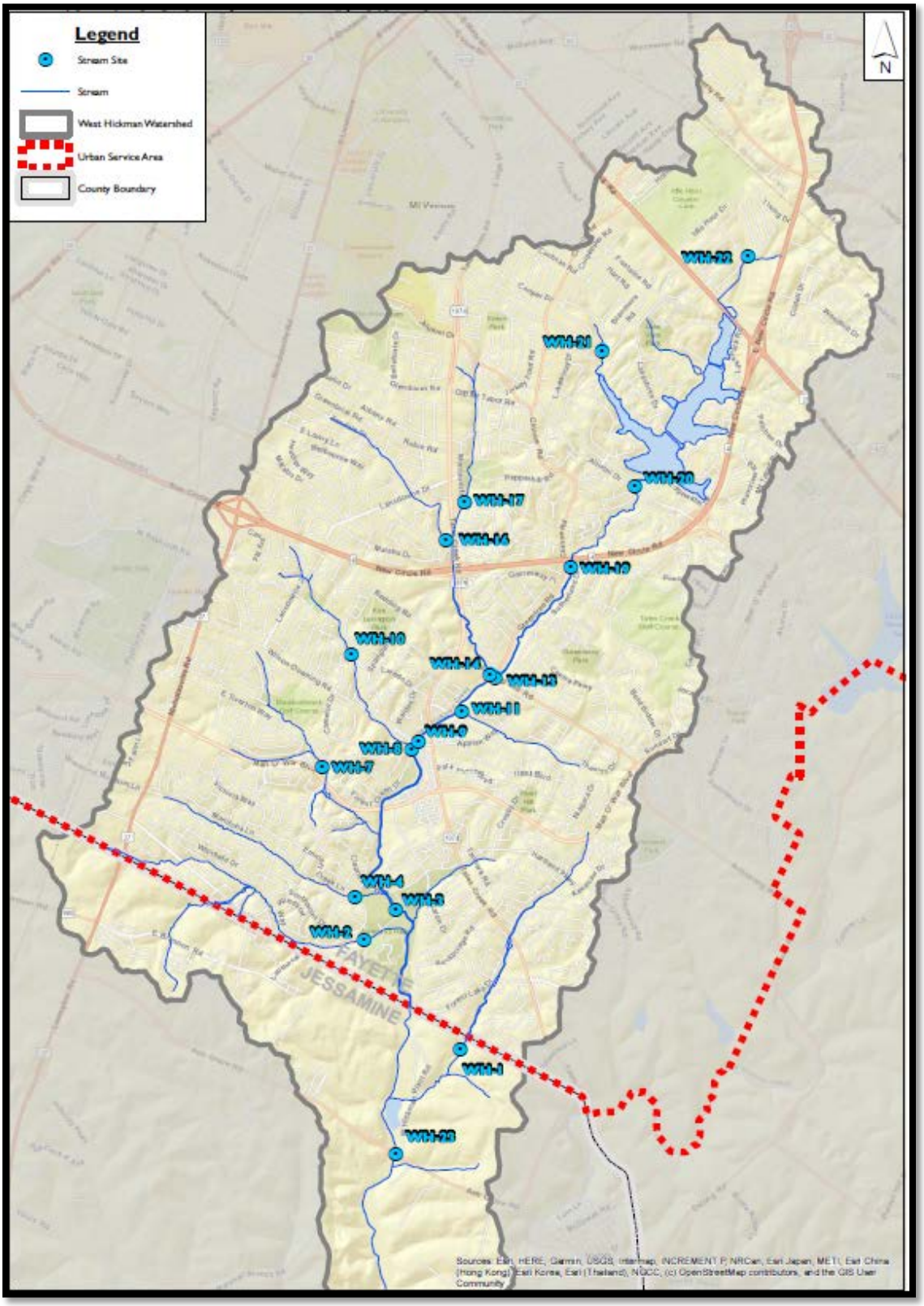


Figure 4-5: Stream Monitoring Locations

Site WH-1 is located within an unnamed tributary in the southern portion of the watershed just outside Fayette County. The site is located approximately 3,000 linear feet upstream of the confluence with West Hickman Creek. Site WH-1 is accessible via the bridge along East Brannon Road or from Ivybridge Drive. The unnamed tributary discharges to impaired waters per the 2016 303(d) list published by KDOW. Site WH-1 is characterized by low density residential land use. Notable features upstream of this site include the Cumberland Hill Neighborhood Association, Hartland Estates Homeowner Association, the Woodfield Homes Association, the Charleston Woods Homeowners' Association, and the White Pine Homeowners' Association. This site represents an unnamed tributary to West Hickman Creek which joins downstream of the wastewater treatment plant. The Site location and photo can be seen below in Figure 4-6.

Figure 4-6: Monitoring Location WH-1

Site WH-2 is located within the Southpoint Tributary in the southern portion of the watershed at Veterans Park. The site is located approximately 1,800 linear feet upstream of the confluence with West Hickman Creek. Site WH-2 is accessible via Henderson Drive near Lexington Clinic. The unnamed tributary discharges to impaired waters per the 2016 303(d) list published by KDOW. Site WH-2 is characterized by low density residential land use and at the box culvert for Henderson Drive. Notable features upstream of this site include Southpoint Park, Southpoint Neighborhood Association and the Pinnacle Homeowners Association. This site represents the Southpoint Tributary to West Hickman Creek. Site location and photo can be seen below in Figure 4-7.

Figure 4-7: Monitoring Location WH-2

Figure 4-8: Monitoring Location WH-3

Site WH-3 is located along West Hickman Creek in the southern portion of the watershed at Veterans Park. Site WH-3 is accessible by utilizing a concrete path within Veterans Park. The site is within the limits of impaired waters per the 2016 303(d) list published by KDOW. Site WH-3 is characterized by low density residential land use. Notable features upstream of this site include the north tip of Veterans Park and Veterans Park Elementary. Immediately downstream of this site is one of the LFUCG MS4 sites (WH-S0). Site location and photo can be seen in Figure 4-8 on page 91.

Site WH-4 is located along the Higbee Mill Road Tributary in the southern portion of the watershed at Southpoint Drive. The site is located approximately 1,000 linear feet upstream of the confluence with West Hickman Creek inside Veterans Park. Site WH-4 is accessible via Southpoint Drive. The Higbee Mill Road Tributary discharges to impaired waters per the 2016 303(d) list published by KDOW. Site WH-4 is characterized by low density residential land use. Notable features upstream of this site include the Pickway Korner Neighborhood Association, the Waterford II Home Owners' Association and the Pinnacle Homeowners Association. This site represents the Higbee Mill Road Tributary to West Hickman Creek. Site location and photo can be seen below in Figure 4-9.

Figure 4-9: Monitoring Location WH-4

Site WH-7 is located along the Belleau Wood Drive Tributary in the central portion of the watershed just inside of Man-O-War Boulevard. The site is located approximately 3,800 linear feet upstream of the confluence with West Hickman Creek. Site WH-7 is accessible via Belleau Wood Drive. The Belleau Wood Drive Tributary discharges to impaired waters per the 2016 303(d) list published by KDOW. Site WH-7 is characterized by low density residential land use. The site is downstream of the Meadowbrook Golf Course and the Summit Shopping District. More notable features upstream of this site include Southern Middle School, Southern Elementary School and the Forest View Town Home Association. This site represents the Tiverton Way Tributary to West Hickman Creek. Site location and photo can be seen in Figure 4-10 on page 93.

Figure 4-10: Monitoring Location WH-7

Figure 4-11: Monitoring Location WH-8

Site WH-8 is located along the Wilson Downing Tributary just upstream of the confluence with West Hickman Creek. Site WH-8 is accessible via Tates Creek Center Drive. The Wilson Downing Tributary discharges to impaired waters per the 2016 303(d) list published by KDOW. Site WH-8 is characterized by low density residential land use. This site captures West Hickman Creek after the joining with the tributary sampled at WH-10. Site location and photo can be seen in Figure 4-11 on page 93.

Site WH-9 is located along West Hickman Creek just upstream of the confluence with Wilson Downing Tributary. Site WH-9 is accessible via Wilson Downing Road. The site is within the limits of impaired waters per the 2016 303(d) list published by KDOW. Site WH-9 is characterized low density residential land use and is under a bridge. Notable features upstream of this site include the Tatesbrook Neighborhood Association. Site location and photo can be seen below in Figure 4-12.

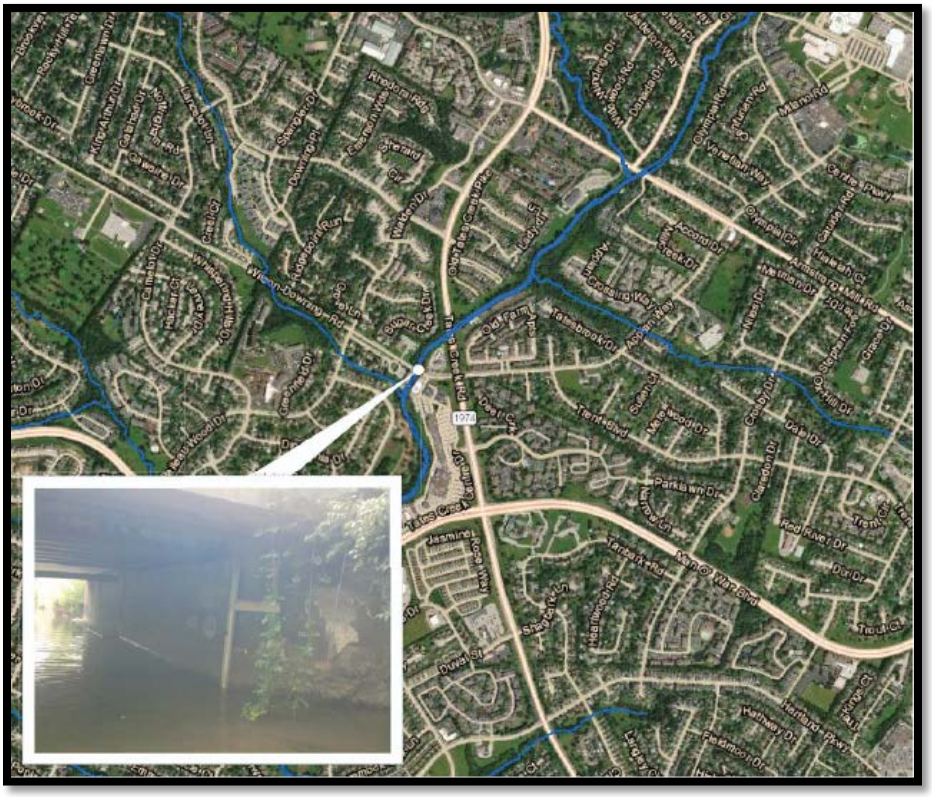


Figure 4-12: Monitoring Location WH-9

Site WH-10 is located within the Lansdowne Tributary in the central portion of the watershed. The site is located approximately 4,000 linear feet upstream of site WH-10 and the confluence with West Hickman Creek. Site WH-10 is accessible via Lancelot Lane. The Lansdowne Tributary discharges to impaired waters per the 2016 303(d) list published by KDOW. Site WH-10 is characterized by low density residential land use. The site is downstream of Kirklevington Park. Notable features upstream of this site include Landsdowne Elementary, Stonybrook Neighborhood Association and Brigadoon Neighborhood Association. Site location and photo can be seen below in Figure 4-13 on page 95.

Figure 4-13: Monitoring Location WH-10

Site WH-11 is located along Mill Creek in the central portion of the watershed just upstream of the confluence with West Hickman Creek. Site WH-11 is accessible via Lady Di Lane and following a small trail to the stream. Mill Creek discharges to impaired waters per the 2016 303(d) list published by KDOW. Site WH-11 is characterized by low density residential land use. Notable features upstream of this site include Mill Creek Elementary, Armstrong Mill Parkway, Southeastern Hills Neighborhood Association and River Park Neighborhood Association. This site represents the Mill Creek tributary to West Hickman Creek. Site location and photo can be seen in Figure 4-14 on page 96.

Site WH-13 is located along West Hickman Creek in the central portion of the watershed. Site WH-13 is accessible via Armstrong Mill Road. The site is within the limits of impaired waters per the 2016 303(d) list published by KDOW. Site WH-13 is characterized by low density residential land use and the Tates Creek School complex. The site is downstream of Gainesway Park and the Tates Creek Golf Course. Upstream neighborhood associations include Center Parkway and Southeastern Hills. Site location and photo can be seen in Figure 4-15 on page 96.

Figure 4-14: Monitoring Location WH-11

Figure 4-15: Monitoring Location WH-13

Site WH-14 is along Tates Creek in the central portion of the watershed. The site is located just upstream of the confluence with West Hickman Creek. Site WH-14 is accessible via Armstrong Mill Road. Tates Creek discharges to impaired waters per the 2016 303(d) list published by KDOW. Site WH-14 is characterized by low density residential land use and is next to a bridge. Notable features upstream of this site include the Oaks Condominium Association and the Gainesway Neighborhood Association. This site represents the Landsdowne Drive Tributary just before joining with West Hickman Creek. Site location and photo can be seen below in Figure 4-16.

Figure 4-16: Monitoring Location WH-14

Site WH-16 is located within The Lansdowne Tributary in the central portion of the watershed. The site is located just upstream of the confluence with Tates Creek, approximately one mile upstream of the confluence with West Hickman Creek. Site WH-16 is accessible via Tates Creek Road. The Lansdowne Tributary discharges to impaired waters per the 2016 303(d) list published by KDOW. Site WH-16 is characterized by low density residential land use. The site is immediately downstream of the Lansdowne Shopping District. Notable features upstream of this site include St Michaels School and Zandale Park. Upstream neighborhood associations include Landsdowne, Zandale, Glendover, and Southern Heights. This site represents one of the two tributaries to the Landsdown Drive Tributary. Site location and photo can be seen in Figure 4-17 on page 98.

Figure 4-17: Monitoring Location WH-16

Site WH-17 is located along Tates Creek in the central portion of the watershed. The site is located approximately 1,400 linear feet upstream of the confluence with the Lansdowne Tributary and 6,600 linear feet upstream of the confluence with West Hickman Creek. Site WH-17 is accessible via Dove Run Road. Tates Creek discharges to impaired waters per the 2016 303(d) list published by KDOW. Site WH-17 is characterized by low density residential land use. The site is downstream of Landsdowne Merrick Park and the southeastern portion of the Lexington Arboretum. The site is also downstream of a large complex of three churches including Immanual Baptist, Tates Creek Christian, and Centenary United Methodist Church, all with significant impervious surfaces. Notable features upstream of this site include Julius Marks Elementary, Glendover Elementary, Lexington Christian Academy, Ecton Park, Castlegate HOA and Shadeland Community Association. This site represents one of the two tributaries to Landsdowne Drive Tributary. Site location and photo can be seen in Figure 4-18 on page 99.

Site WH-19 is located along West Hickman Creek in the central portion of the watershed just south of New Circle Road. The site is located approximately one mile upstream of the confluence with Tates Creek and approximately one mile downstream of the reservoir. Site WH-19 is accessible via Greentree Circle. The site is within the limits of impaired waters per the 2016 303(d) list published by KDOW. Site WH-19 is characterized by low density residential land use. Notable features upstream of this site include the Woods Street Maintenance Association and the Landsdown-Merrick Neighborhood Association. Site location and photo can be seen below in Figure 4-19 on page 99.

Figure 4-18: Monitoring Location WH-17

Figure 4-19: Monitoring Location WH-19

Site WH-20 is located at the reservoir spillway in the northern portion of the watershed. Site WH-20 is accessible via Edgewater Court. The site is within the limits of impaired waters per the 2016 303(d) list published by KDOW. Site WH-20 is characterized by low density residential land use. Notable features upstream of this site include Henry Clay High School and Lakeview Park. Upstream neighborhood associations include Patchen Woods, Lake Area, Lakeview Island, Lakeshore Village and Lakeshore Estates. The site is downstream of reservoirs 1, 2 and 3. Site location and photo can be seen below in Figure 4-20.

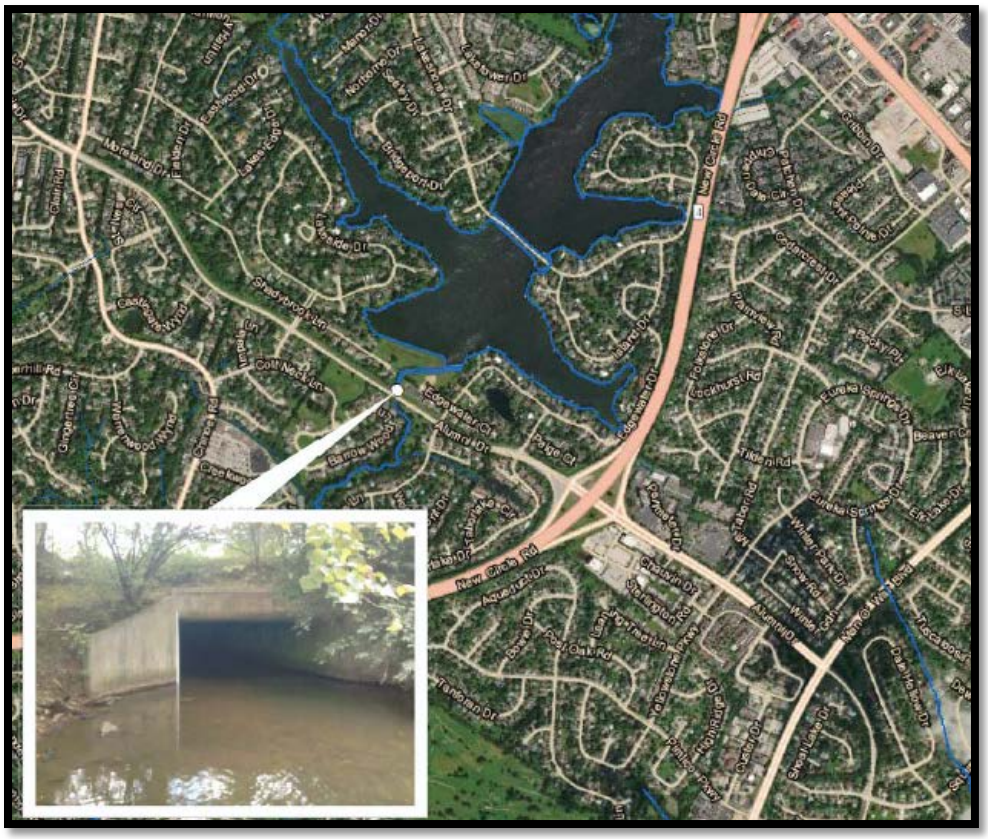


Figure 4-20: Monitoring Location WH-20

Site WH-21 is located within an unnamed tributary in the northern portion of the watershed. The site is located approximately 1,000 linear feet upstream of the reservoir. Site WH-21 is accessible via the bridge along East Brannon Road or from Ivybridge Drive. The unnamed tributary discharges to impaired waters per the 2016 303(d) list published by KDOW. Site WH-21 is characterized by low density residential land use, on which most was built prior to 1980. The site is upstream of reservoir 3. Site location and photo can be seen in Figure 4-21 on page 101.

Figure 4-21: Monitoring Location WH-21

Site WH-22 is located within an unnamed tributary in the northern portion of the watershed. The site is located approximately 3,000 linear feet upstream of the reservoir. Site WH-22 is accessible via Idle Hour Park at St Ann Drive. The unnamed tributary discharges to impaired waters per the 2016 303(d) list published by KDOW. Site WH-22 is characterized by low density residential land use. The site is downstream of the Idle Hour Country Club and upstream of reservoir 1. Mote notable features upstream of this site include Breckinridge Elementary, Johnson Heights Park, Idle Hour Park, the Idle Hour Drive Neighbors Alliance and the Pleasant Ridge subdivision. Site location and photo can be seen in Figure 4-22 on page 102.

Site WH-23 is located along Hickman Creek in the southern portion of the watershed. The site is the furthest downstream in the study and is located approximately one mile downstream of the Fayette County/Jessamine County line. Site WH-23 is accessible via Ash Grove Road. The site is within the limits of impaired waters per the 2016 303(d) list published by KDOW. Site WH-23 is characterized by low density residential and agricultural land use. The site is immediately downstream of the West Hickman Wastewater Treatment Plant. Site location and photo can be seen in Figure 4-23 on page 102. Comparison of flow data from collection events and clean water release from the WWTP indicated that nearly 50% of flow at this site could be from the WWTP.

The majority of sites are contained within bounds of Fayette County. Only two sites, WH-1 and WH-23 are located in Jessamine County south of Fayette County. This project has been funded by the LFUCG. There was limited interest and response from Jessamine County and the City of Nicholasville in working together with LFUCG on this project. Jessamine County locations were also not included in KDOW sampling sites.

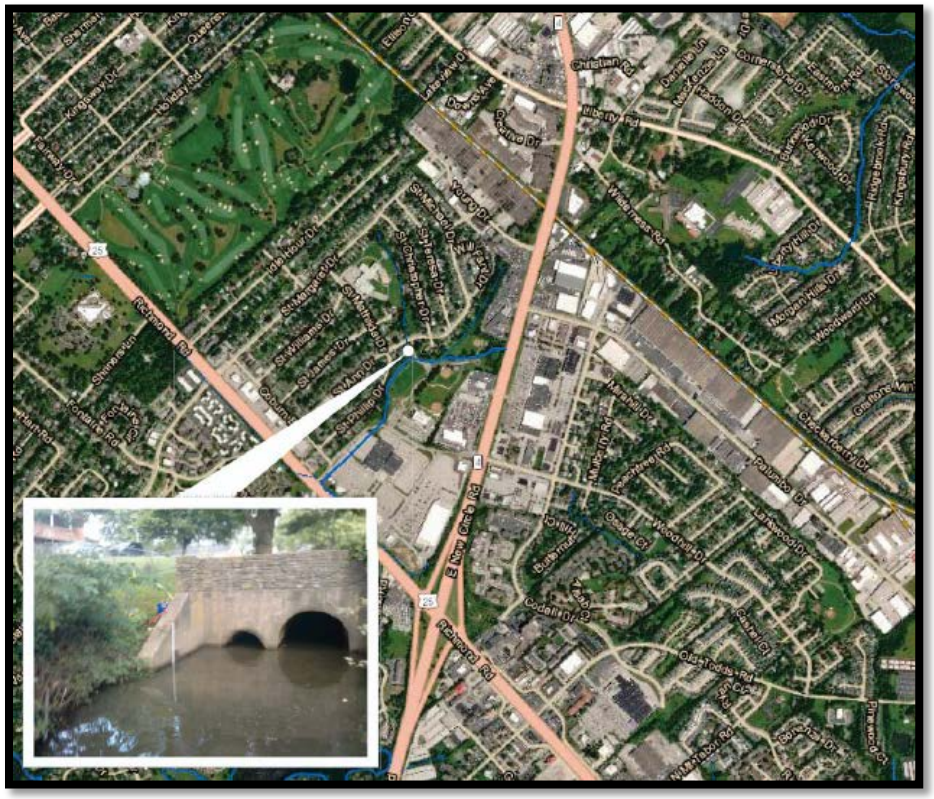


Figure 4-22: Monitoring Location WH-22

Figure 4-23: Monitoring Location WH-23

4.3.2 LEXINGTON -FAYETTE URBAN COUNTY GOVERNMENT MONITORING

As a part of the LFUCG Watershed-Focused Monitoring Program (WFMP), the West Hickman Creek watershed within Fayette County was assessed for five key monitoring elements including:

1. Stream Corridor Characterization
2. Stream Biology
3. Water Quality Monitoring
4. Discharge Prevention/Source Investigation
5. Priority Upland Visual Assessment

Third Rock Consultants, LLC was retained as a subconsultant to Tetra Tech, Inc. to assist with completing this monitoring. With permission of LFUCG, portions of results and text were utilized directly from reports prepared by Third Rock Consultants, LLC to not duplicate efforts. Most of the results will be discussed in the following sections, but the stream characterizations are summarized below. The full technical memorandum can be found in APPENDIX E. The stream corridors in the West Hickman Creek watershed were characterized at half-mile intervals by project staff and trained volunteers. This process included the identification of sixty individual reaches within the watershed for assessment, which all except for three were characterized in the field. Parameters such as sediment deposition, channel alteration, bank stability and others were visually assessed and scored using a high gradient habitat assessment field data sheet modified from US EPA 841-B-99-002 (Barbour et al., 1999). The resulting score was then compared to regional criteria for the Bluegrass Bioregion based upon stream size (headwater or wadeable) to determine a habitat rating for each reach (KDOW 2011) following the Rapid Bioassessment Protocols (RBP). Based upon the data collected, only one wadeable (>5 sq. mile drainage area) reach and two headwater (<5 sq. mile drainage area) reach were classified as “good” habitat. Two wadeable reaches and one headwater reach were classified as having “fair” habitat. All other wadeable and headwater streams had “poor” habitat. As would be expected of an urban watershed, the narrow riparian zone in most reaches contributed to low habitat scores.

4.3.2.1 STREAM BIOLOGY ASSESSMENT

Third Rock Consultants studied stream biology at the request of LFUCG under a separate contract. Semi-quanitative and qualitative benthic macroinvertebrate samples were collected at WH-6 and WH-12 on May 21, 2019, sites WH-3, WH-12 and WH-18 on May 22, 2019, and sites WH-5 and WH-23 on May 23, 2019. Location of these sites are shown in Figure 4-24 on page 105. All samples were taken using methods developed by the Kentucky Division of Water (KDOW 2015a). Semi-quantitative sampling required collection of four 0.25 square meter samples collected from at least 2 riffles at each station using a 0.25 meter squared quadrat and a kicknet (600 µm mesh).

For headwater streams the qualitative sampling required the following steps:

- collection of three leaf packs; each from a riffle, run, and pool
- three jabs (with an 800 x 900µm D-frame dip net) in sticks/wood
- three jabs into undercut banks/submerged roots, edge habitat
- three scoops from depositional areas (soft sediment) using a US #10 sieve
- hand-picking of five small boulders from pools
- visual searches of approximately 2 linear meters of large woody debris.

For wadeable streams the qualitative sampling required the following steps:

- collection of three leaf packs; each from riffle, run and pool habitats
- three scoops from depositional areas (soft sediment) using a US #10 sieve
- collection of Aufwuchs (e.g. filamentous algae) material from rocks, and sticks
- three sweeps of dip net from bedrock and slabrock habitats
- three jabs into undercut banks/submerged roots, edge habitat (emergent vegetation); each from riffle, run, and pool habitats
- hand-picking of small boulders; five from pools, five from riffles, and five from runs
- visual searches of three to six linear meters of large woody debris.

Samples were preserved in 95% ethanol and returned to Third Rock's laboratory for processing and identification. Random 300-specimen subsamples were removed from the semi-quantitative (riffle) samples using methods described by KDOW (2015b). Each riffle sample was poured into a Canton sorting tray and divided into 30 equally sized grids. Organisms were removed from the sample in randomly selected grids until the 300-specimen total was reached or all specimens had been removed. The number of grids sorted was recorded for each sample to allow estimation of total organism abundance. Representative individuals for all distinct taxa were removed from the qualitative (multi-habitat) sample for identification. All organisms were identified to the lowest possible taxonomic level and recorded on laboratory bench sheets.

Macroinvertebrate sampling results were evaluated through calculation of several community metrics specified by KDOW. Community metrics include genus taxa richness, genus EPT [ephemeroptra (mayfly), plecoptra (stonefly), and trichoptera (caddisfly)] richness, total number of individuals, modified percent EPT individuals, modified Hilsenhoff biotic index (mHBI), percent Ephemeroptera (headwater only), percent primary clingers, and percent Chironomidae plus Oligochaeta (aquatic worms).

The results of all samples were combined to calculate a Macroinvertebrate Bioassessment Index (MBI) Score from 0 (worst) to 100 (best). These results were compared against criteria developed by the KDOW for headwater and wadable streams in the Bluegrass Bioregion. The MBI score and related metrics are given in Table 5-4 on page 120. Results of the monitoring efforts are discussed in Section 5.2.1

Figure 4-24: Location of Biology Assessment Study Sites

4.3.2.2 STREAM HABITAT ASSESSMENT

In addition to the MBI score, the U.S. EPA Rapid Bioassessment Protocol (RBP) was used to assess the quality of stream habitat. Ten physical habitat parameters which describe the "microscale" habitat, the "macro-scale" features, and the riparian/bank structure features were assessed and recorded on field data sheets. Results of this analysis are discussed in section 5.2.2.

4.3.2.3 WATER QUALITY MONITORING

Water quality monitoring was studied by Third Rock Consultants through a separate contract with LFUCG. Monitoring of the West Hickman Creek watershed began in 2018 and was completed in 2019. Monitoring

was conducted in two phases. Phase 1 was a screening effort involving dry weather sampling (at least 72 hours of dry weather prior to sampling) at 18 in-stream sites and 105 major outfalls shown in Figure 4-25 (page 106) and Figure 4-26 (page 107). Phase 2 monitoring involved 18 in-stream sites and 68 of the Phase 1 major outfalls found to be routinely flowing during Phase 1, these sites are shown in Figure 4-27 (page 108) and Figure 4-28 (page 109). Physical characteristics of each in stream site and outfall location were measured so that stream or pipe flow could be calculated. Flow estimates were referenced with the USGS gage at West Hickman Creek at Veteran's Park (Station 03284552).

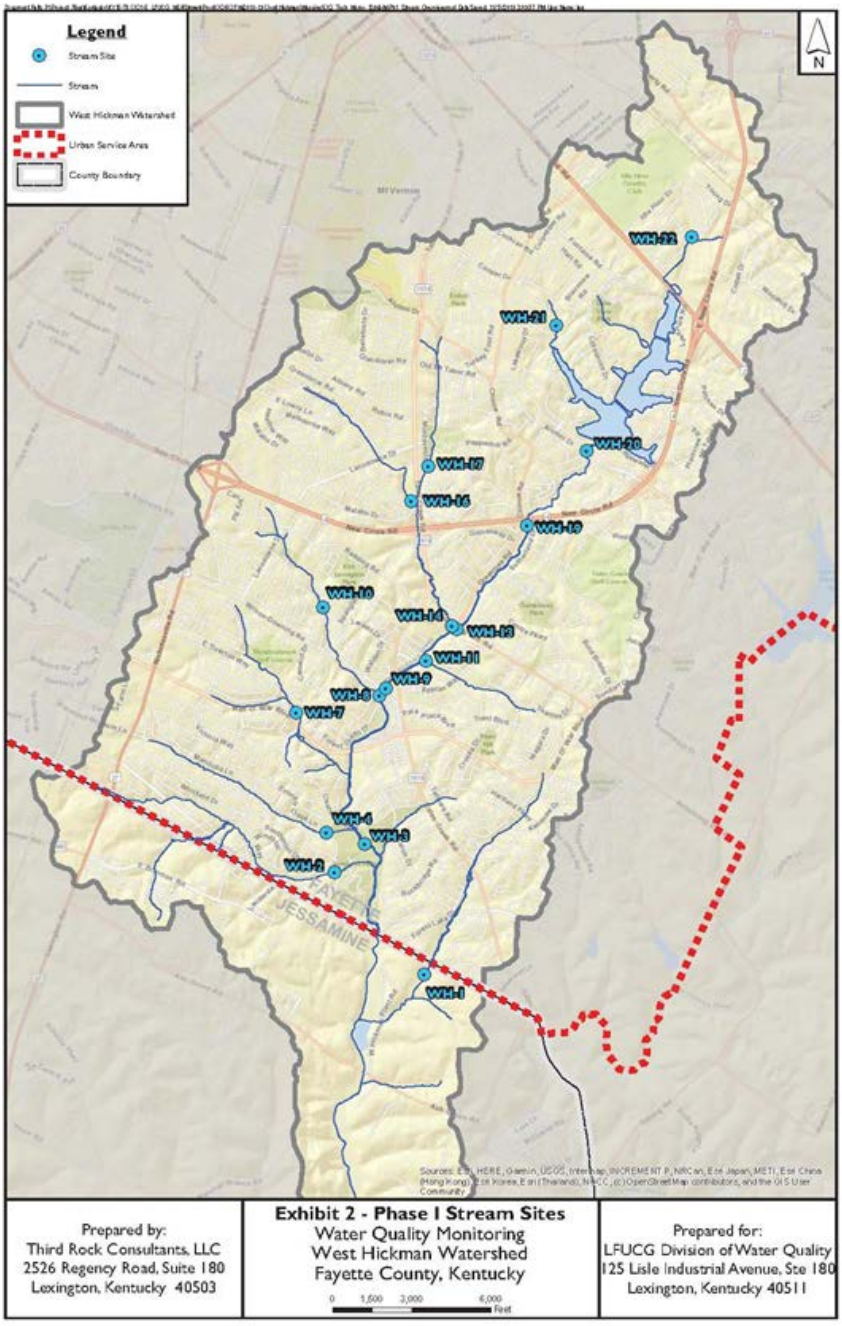


Figure 4-25: Phase 1 Water Quality Monitoring Stream Sites

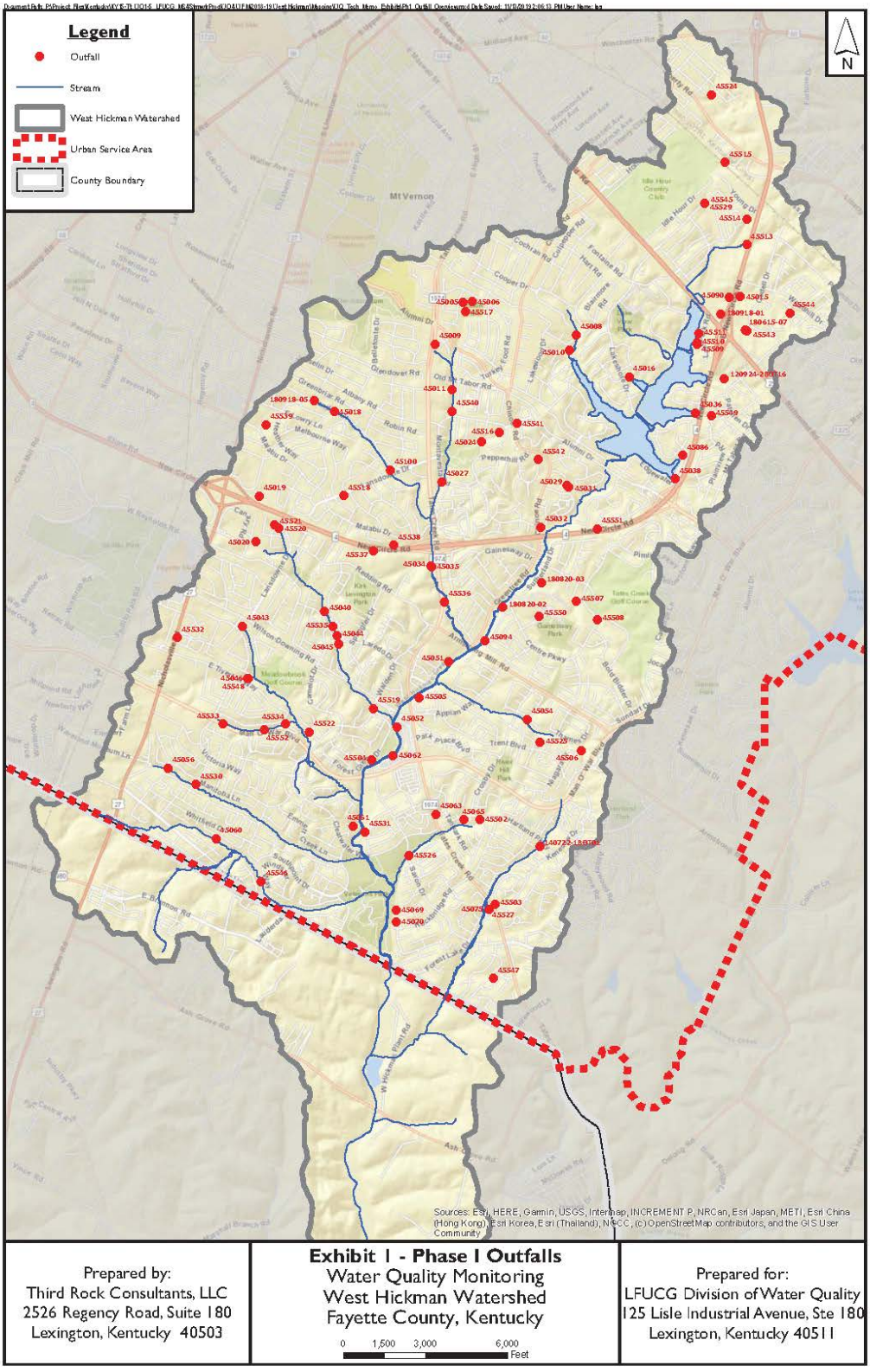


Figure 4-26: Phase 1 Water Quality Monitoring Outfalls Map

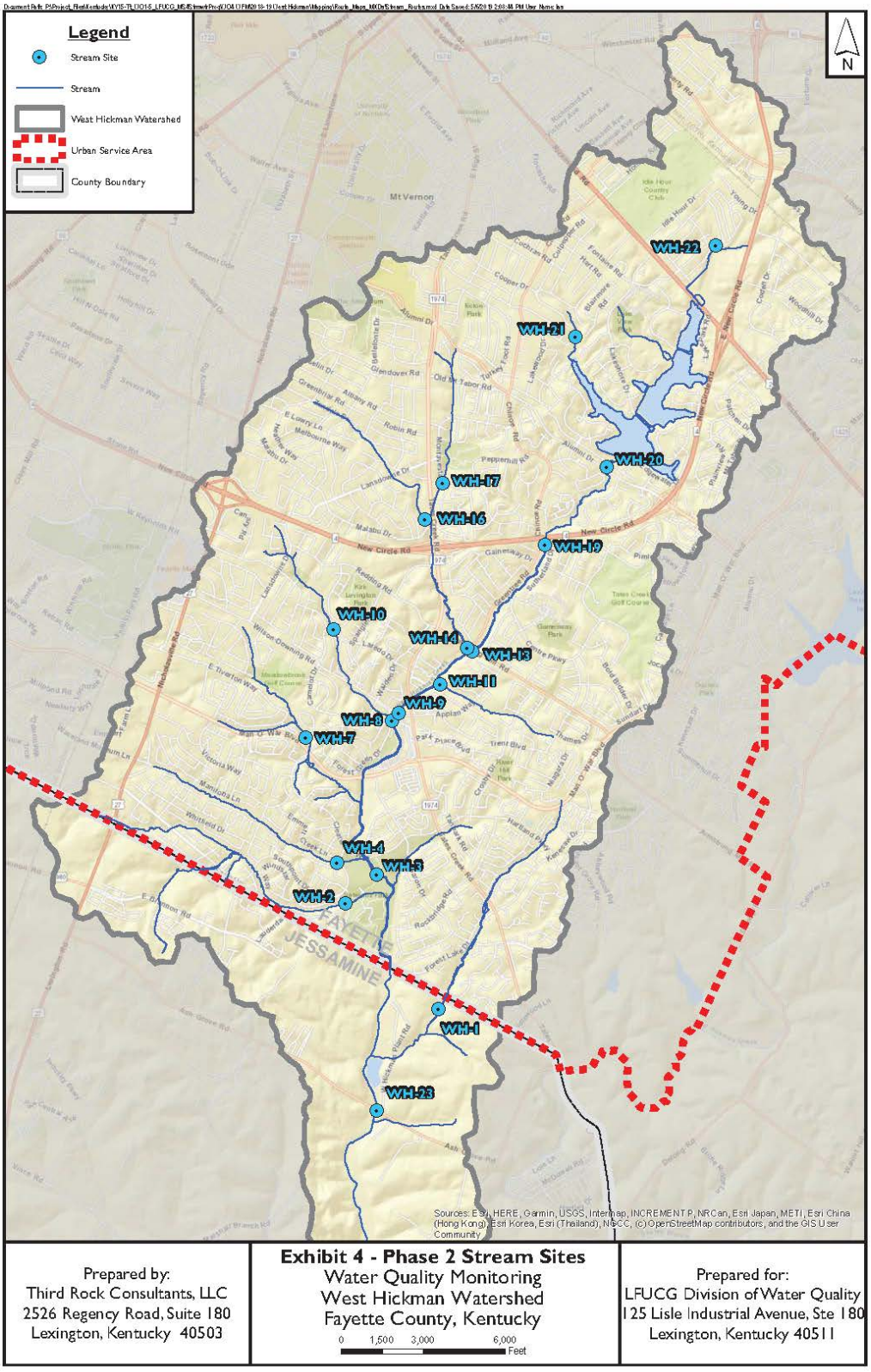


Figure 4-27: Phase 2 Water Quality Monitoring Stream Sites Map

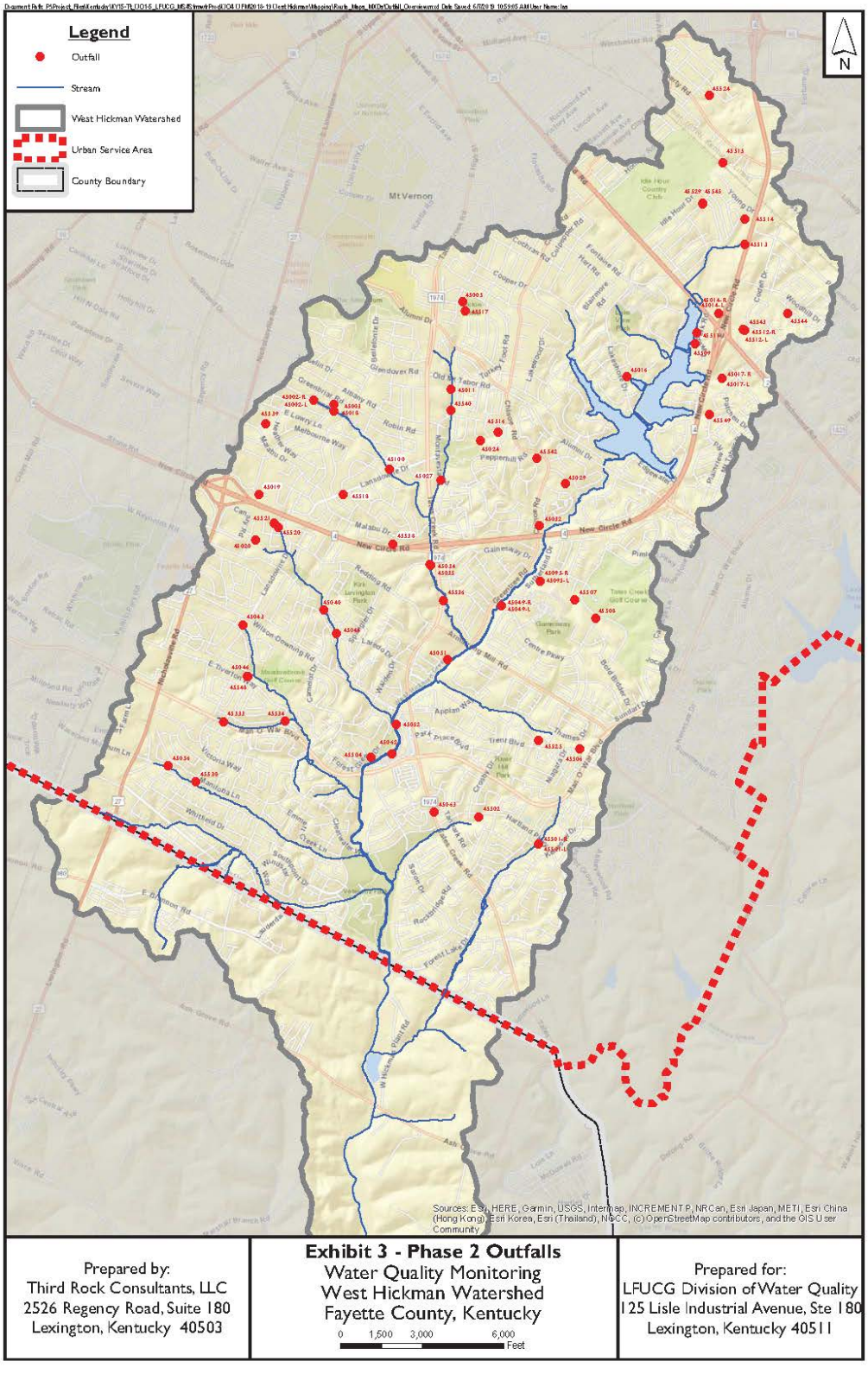


Figure 4-28: Phase 2 Water Quality Monitoring Outfalls Map

Phase 1 sampling was conducted in October of 2018 and January through March of 2019. Each site was visited four times, but samples were only collected when water was flowing. Chlorine and ammonia-nitrogen were measured using Hanna Checkers (handheld colorimeter units). Dissolved oxygen, pH, temperature, and conductivity were measured in-situ using a multimeter water quality probe. Grab samples were collected and transported to the LFUCG WWTP Laboratory for analysis of E. coli, TSS, total phosphorus, NO3-N, detergents, and fluoride. All samples were preserved according to method specifications and transported to the laboratory within method holding times and temperature requirements.

Phase 2 monitoring consisted of 10 sampling events during the Primary Contact Recreation (PCR) period (May through September 2019) on a set day of the week, regardless of weather conditions. Chlorine was measured in the field using Hanna Checkers. Dissolved oxygen, pH, temperature, and conductivity were measured in-situ using a multimeter water quality probe. Grab samples were collected and transported to the Town Branch WWTP Laboratory for analysis of E. coli, TSS, total phosphorus, NO3-N, NH3-N, detergents, and fluoride. All samples were preserved according to method specifications and transported to the laboratory within method holding times and temperature requirements.

LFUCG staff collected duplicate grab samples and associated field replicates of in situ measurements and field test kits at four (4) outfalls for each of the 10 events during Phase 2 sampling. The QAPP (Third Rock 2017) requires field duplicates and associated field replicates of in situ measurements and field test kits be collected by LFUCG staff at 5% (or 1 for every 20 sites sampled) during each of the Phase 2 monitoring events, thus the QAPP requirements were met for the effort. Internal laboratory quality control samples were analyzed to determine if the project accuracy standards listed in Table 7 of the QAPP (Third Rock 2017) were also met. The QAPP is included in APPENDIX I.

When water quality parameter benchmarks, as defined in Table 4-4, were exceeded by the water quality sample results, the LFUCG staff initiated illicit discharge prevention investigations to locate pollution sources. These benchmarks are gathered from LFUCG Division of Water Quality as discussed further in Section 5.1.2.

Table 4-4: Water Quality Parameter Benchmarks

Parameter	Limit	Parameter	Limit
E. coli	>676 MPN/100 mL	Fluoride	>0.5 mg/L
Total Suspended Solids	>80 mg/L	Ammonia-Nitrogen	>0.5 mg/L
Conductivity	>500 µS/cm	Detergents	>0.5 mg/L
Chlorine	>0.25 mg/L	pH	<6 SU or >9 SU
Temperature	>90°F or 32.2°C	Dissolved Oxygen	<4 mg/L

Acceptance criteria for accuracy, precision, and sensitivity were defined in the QAPP (Third Rock 2017). While these criteria were generally met, the reporting limit specified in the QAPP for E. coli was 100 MPN/100mL, but the laboratory reported values of <100 MPN/100mL for results below the reporting limit. In the analysis of the Phase 2 data, when values for E. coli were below the reporting limit, a value of 100 MPN/100mL was used. Likewise, for other laboratory measurements below the reporting limit, the reporting limit was used in the analysis of the data. However, this was not a frequent occurrence.

Pollutant loads are found for a parameter by multiplying the pollutant concentration by stream discharge

and unit conversion factors. Pollutant load gives an understanding of how much total pollutant is being output from a water source. Professional judgement must be used to determine a representative discharge and flow rate for annual conditions. Palmer Engineering combined results of Phase 1, Phase 2, and KDOW data to calculate pollutant concentrations for each of the stream sites. This will be discussed further in section 5.4.

Data from the Kentucky Geological Survey was used to understand the interaction between surface and groundwater in the watershed. Immature karst features are present in the watershed, but they do not cause significant changes in surface water level in the subwatersheds. Generally for Phase 2 sites, the related groundwater basins lie within the boundary of the subwatershed. Surface drainage areas were computed for outfall sites based on LFUCG stormwater network information.

4.3.2.4 USGS DATA

LFUCG worked in cooperation with the USGS to collect continuous water quality data at its stream flow gauging stations within Fayette County on a rotation basis. Conductivity, pH, water temperature, and dissolved oxygen were collected at the USGS gaging station at West Hickman Creek at Veteran's Park (Station 03284552) during the watershed-focused monitoring effort between June 28, 2018 and July 16, 2019. Thus, the USGS record ends before the last four (4) samples of the Phase 2 effort were collected.

USGS-monitored pH was within the desired water quality standard range for the entire record. Dissolved oxygen was observed to be within the desired water quality standard for most of the USGS record. In the dissolved oxygen record, there is a 14 hour period observed on May 18th, 2019 and May 19th, 2019 where the dissolved oxygen reading dropped to 0.1 mg/L for approximately six (6) hours, and fluctuated in a range between 0.2 mg/L and 5.3 mg/L for the remainder of the 14 hour period. Conductivity was below the benchmark for this study the majority of the time, but conductivity readings were commonly observed above the benchmark for this study. Conductivity readings were noted above the benchmark for this study, but these readings were observed during the winter season and is most likely a result of deicing salts. Seasonal fluctuations of water temperature were observed, but the water temperature was well below the water quality standard during the entire USGS monitoring period. Full results are available in APPENDIX E.

4.3.2.5 DISCHARGE PREVENTION/ SOURCE INVESTIGATION

Third Rock Consultants also studied Discharge Prevention/ Source Investigation at the request of LFUCG under a separate contract. Once the results of water quality monitoring discussed in Section 4.3.2.3 revealed an exceedance of action limits, LFUCG DWQ Environmental Inspectors were notified and investigated the source of the discharge. These inspectors were tasked to confirm previously measured exceedances and then trace problem values through the stream and stormwater network in accordance with LFUCG's IDDE-01: *Illicit Discharge and Elimination Protocol*. These inspectors worked bridge-to-bridge or manhole-to-manhole to isolate sources. A full list of the current progress of the LFUCG IDDE investigation was compiled and is given in APPENDIX E.

4.3.2.6 OPTICAL BRIGHTENER SURVEY

Optical brighteners are dyes added to many laundry detergents. The brighteners adhere to natural fibers and increase the "brightness" of fabrics. Laundry effluent is often combined with sanitary wastewater, thus evidence of optical brighteners in storm drains can indicate an illicit discharge or untreated wastewater entering the stormwater system from faults in the sanitary system. 12 locations were identified for investigation by LFUCG and Third Rock Consultants based on the water quality monitoring.

The cotton absorption method was utilized in accordance with *LFUCG Standard Operating Procedure for Optical Brightener* (SOP-ID: DWQ-MON-03). This method includes leaving cotton pads in the stormwater system during dry weather for at least three days. These unbleached cosmetic cotton pads were checked for negative florescence before deployment. Pads were placed in plastic mesh bags and anchored in the stormwater system at each location using bricks as can be seen in Figure 4-29.

Figure 4-29 Monitoring Device Deployed in Outfall

Pads were deployed at various intervals on the following days: September 11 2019 to September 17 2019 and September 17 2019 to September 23 2019. The sets of pads were left out of direct sunlight where they remained for a minimum of three days. Once retrieved, they were rinsed with source water and transported in brown envelopes to the Third Rock office to protect the samples from sunlight. The pads were left in a dark room and left to dry overnight before being viewed and photographed under a UV light. Optical Brightener will become visibly florescent dyed when exposed to UV light. A positive, dipped in a detergent solution, and negative control were developed to compare against the sample pad. These are displayed in Figure 4-30. A map of study sites and results is given in Figure 5-2 on page 140.

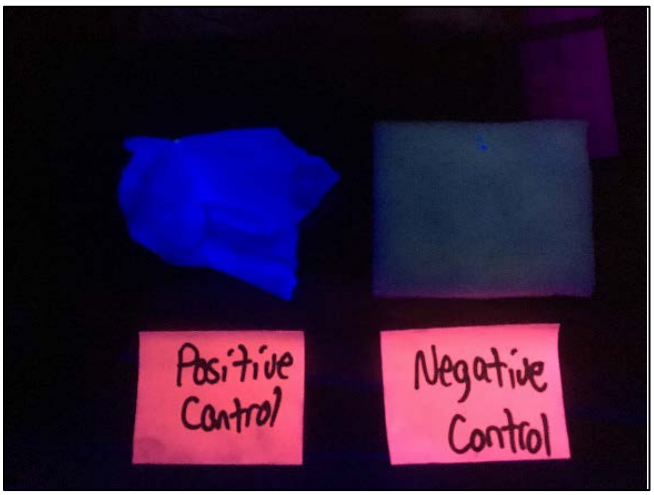


Figure 4-30: Visual Florescence of Control Cotton Pads

4.3.2.7 PRIORITY UPLAND ASSESSMENT

Priority upland assessment involved using neighborhood sources and identifying potential pollutant generators. This analysis was completed by Third Rock Consultants under a separate contract with LFUCG. Eight neighborhoods were visually assessed for indicators of nutrients, oil and grease, trash / litter, bacteria, and sediment based on their position upstream of LFUCG monitoring sites with high pollutant loads discussed in section 4.3.2.3. These eight neighborhoods include the following: Lansdowne Shadeland-East, Brigadoon, River Park, Hartland, Zandale, Lansdowne Merrick, Gribbin, and Medlock. A Map of these neighborhoods can be seen in Figure 4-31: Neighborhoods Studied for Upland Visual Assessment. Visual assessment followed methods defined by the Center for Watershed Protection's "Unified Subwatershed and Site Reconnaissance: A User's Manual" (2004). Field study was conducted between September 16, 2019 and September 19, 2019. Initially a driving survey was taken of all neighborhood streets, then three representative properties were chosen for detailed inspection. Representative properties were assessed based on neighborhood characterization; yard and lawn condition; driveway, sidewalk, and curb; rooftop; and common area as illustrated on the Neighborhood Source Assessment (NSA) forms. Following the field study, ArcView GIS was used to confirm lot size and percent ground cover. Pollution Severity Index (PSI) and Neighborhood Restoration Opportunity Index (NROI) were found for each neighborhood. PSI scores range from 0 (low severity) to 15 (high severity). NROI scores vary from 0 (least likely to improve pollution control) to 8 (most likely to improve pollution control). The full report and assessment is located in APPENDIX E.

4.3.2.8 POTENTIAL POLLUTANT GENERATORS

Eleven potential pollutant generators were visually assessed for indicators of sediment, organic material, and litter by Third Rock Consultants under a separate contract with LFUCG. These sites included unpermitted and lower risk commercial and industrial operations and were defined by their position upstream of problem water quality monitoring sites. The list of potential generator sites is as follows: Redmons Garden Center, Kings Garden Center, Glenn's Auto, Courtesy Acura, Lexel, Ultimate Lawn & Landscape, Lexington Outdoor Power Equipment, Sunbelt Rentals, Lexus, Quantrell and Parker Seal. The following assessment criteria was used: vehicle operations; outdoor materials; waste management; physical plant; turf and landscaping; and stormwater infrastructure. A Hotpot Status Index (HSI) was calculated for each site. HSI scores range from 0 (not a pollutant hot spot) to 28 (risk of severe hotspot). The full report and assessment is located in APPENDIX E.

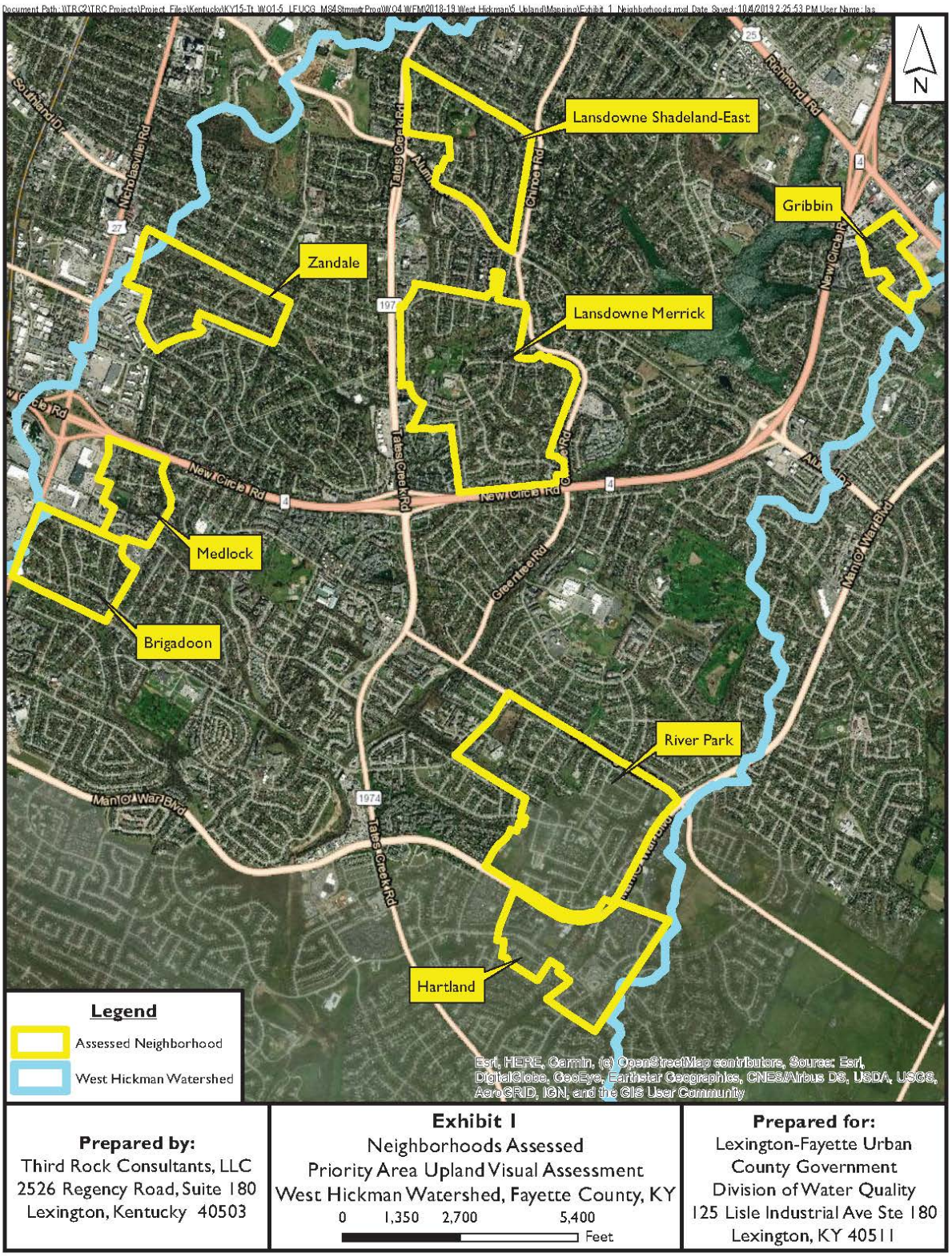


Figure 4-31: Neighborhoods Studied for Upland Visual Assessment

4.3.3 KENTUCKY DIVISION OF WATER MONITORING

The Kentucky Division of Water monitored each of the 18 stream sites identified in Phase 1 from Figure 4-5. October 2019 to March 2020, gathering approximately 75 stream sample data points in total. Each sample point reported similar data to LFUCG water monitoring listed above, but also provided qualitative measurements (weather, canopy cover, odor, etc.) as well as various metal concentrations (antimony, aluminum, copper, lead, etc.). The full results are included in APPENDIX J.

4.3.4 VOLUNTEER MONITORING EFFORTS

Much of the sampling data collected in the West Hickman watershed was result of volunteer efforts from local citizens. As previously discussed in 3.2.6.1, the Kentucky Watershed Water is a volunteer network of individuals who participate in water quality monitoring events. Many of these same volunteers assisted LFUCG with their watershed-focused monitoring efforts for Phase 1 and Phase 2 sampling of stream and outfall sites. The collection of data used for analysis in this report would not have been possible without the help of these volunteers. Volunteers that participated in the watershed-focused monitoring efforts, were trained by LFUCG and a consultant team prior to collection of data. This data collected by volunteers was utilized for analysis of pollutant loads as discussed in section 5. Yearly data reports from KWW are provided in APPENDIX F.

4.3.5 ADDITIONAL MONITORING NEEDS

Due to the combined efforts of LFUCG and KDOW, a large dataset for the West Hickman Creek watershed is available for analysis at the time of writing of this report in Fayette County. The following additional monitoring needs are suggested as funding and personnel are available in Fayette County:

- Additional Studies for Leaking Laterals and Collector Sanitary Sewer Lines – to identify potential bacteria and nutrient sources in older neighborhoods where replacement projects are not already planned and higher levels of pollutants were identified
- Repeat Water Quality Monitoring in Areas Impacted by RMP Projects – to identify pollutant reductions and removals that were associated with SSOs and aged/failing infrastructure that was replaced or repaired by RMP projects. Projects are expected to be complete by the end of 2026. To allow stabilization of the watershed following the completion of the projects, repeat water quality monitoring of subwatersheds where RMP projects were completed and sites downstream is recommended in 2028-2030.

The largest gap in data is due to the lack of sites in the Jessamine County portion of the watershed. The only site located with significant drainage within Jessamine County is immediately downstream of the West Hickman WWTP and on LFUCG property (WH-23). As previously discussed, the portion of the watershed in Jessamine County is much more rural than the portion in Fayette County. Most of the watershed in Jessamine County is not connected to a publically-treated municipal waste system, so failing septic system and/or straight pipes may be an issue. Without additional sampling sites in Jessamine County, load reductions and the effectiveness of potential projects is very difficult to evaluate. Additional stream sites in the lowest portion of the watershed would allow a more complete analysis. LFUCG did not have any sampling locations outside of their jurisdiction. Palmer contacted Jessamine County Fiscal Court and the City of Nicholasville early in the project to gather their input and engagement, but they did not have capacity to support at that time. The additional of more Best Management Practices may be needed if additional sampling efforts can be funding in the Jessamine County portion of the watershed.

5 ANALYSIS

5.1 ANALYSIS OVERVIEW

To evaluate the potential impact and level of the impairments within WHC, it was necessary to compare the monitoring results with a set of water quality benchmarks. As previously discussed in Chapter 4, data was collected by LFUCG and KDOW. For the data collected by LFUCG, Third Rock Consultants completed analysis of that data only which included macroinvertebrates and habitat, water quality, volume and velocity impact, priority upland assessment, optical brightener assessment and microbial source tracking. Analysis for the volume and velocity impact, priority upland assessment, optical brightener assessment, and microbial source tracking performed by Third Rock Consultants are summarized in this chapter. KDOW performed limited sampling for the following parameters: water chemistry, macroinvertebrates, and habitat assessment. Palmer was provided all the data and combined the results to perform the analysis presented in this chapter. Analysis performed by Palmer included pollutant loading and target reductions. Only water quality sampling data from stream sites were utilized for the pollutant loading calculations.

5.1.1 SUMMARY OF SAMPLING EVENT CONDITIONS

Sampling occurred on 23 days from October 2018 to March 2020. Thirteen of these sampling days produced a sample for 17 or 18 sites. The remaining sampling days only resulted in samples for between 2 and 14 sites. Each sampling day has been classified as dry, intermediate or wet. This classification describes the weather conditions up to and during the sampling day. To quantify this, flow in West Hickman Creek was summarized by readings from the USGS gage station 03284552 in Veterans Park. Dry sampling days were considered to be any day where the flow in West Hickman creek was up to the 75th percentile of all flows between October 2018 and March 2020. Intermediate was considered to be between the 75th and 95th percentile. Wet sampling days represented flow at a magnitude above the 95th percentile. Eighteen of the 23 sampling days are considered to be dry. There was no rainfall on these days and flow at the USGS gage station ranged from 0.97 cfs to 31.4 cfs. There were two intermediate sampling events. The 2/19/2020 event occurred during light rain. Flow during these events was 38.6 cfs and 41.3 cfs. Three sampling events are classified as wet. All three of these events occurred with active rainfall. For the 8/13/2019 event, rainfall began mid collection so some samples represent dry conditions and some represent wet conditions. Flow during these events ranged from 92 cfs to 1370 cfs. A summary of these events, their classification, USGS gauge flow during the event and rainfall preceding the event is provided in Table 5-1.

Table 5-1: Sampling Event Conditions Summary.

Event Data			Event Rainfall	USGS		Previous Rainfall		
Sample Date	# of Sites Sampled	Event Type	Amount (in)	Stream flow (cfs)	% Flows Exceeding*	Date	Amount (in)	Prior Days Dry
10/23/2018	17	Dry	0	10.9	75.93	10/20/2018	0.16	3
1/10/2019	17	Dry	0	25.9	43.08	1/5/2019	1.19	5
1/28/2019	4	Dry	0	22.7	47.20	1/24/2019	0.96	4
2/19/2019	2	Dry	0	16.2	60.59	2/13/2019	0.57	6
2/27/2019	10	Intermediate	0	38.6	26.68	2/24/2019	1.65	3
3/13/2019	14	Dry	0	26.9	41.73	3/10/2019	0.94	3
4/11/2019	3	Dry	0	14.7	64.99	4/8/2019	0.54	3
5/7/2019	18	Dry	0	15.2	63.29	5/5/2019	0.79	2
5/21/2019	18	Dry	0	5.28	89.45	5/20/2019	0.13	1
6/4/2019	18	Dry	0	15.6	62.11	6/1/2019	0.52	3
6/18/2019	18	Wet	1.25	1370	0.01	6/17/2019	1.17	1
7/1/2019	18	Dry	0	8.64	83.08	6/29/2019	0.22	2
7/16/2019	18	Dry	0.08	7.17	85.90	7/12/2019	0.24	4
7/30/2019	18	Dry	0.09	6.43	87.40	7/22/2019	0.94	8
8/13/2019	18	Wet/Dry	0.41	92	6.47	8/1/2019	0.05	12
8/27/2019	18	Wet	0.76	305	1.21	8/26/2019	0.21	1
9/10/2019	17	Dry	0	0.97	97.48	8/27/2019	0.76	14
10/29/2019	18	Dry	0	27.8	40.57	10/27/2019	0.95	2
11/21/2019	11	Dry	0	9.39	81.25	11/20/2019	0.11	1
12/5/2019	11	Dry	0	31.4	35.12	12/1/2019	1.82	4
1/23/2020	11	Dry	0	10.4	77.67	1/19/2020	0.33	4
2/19/2020	11	Intermediate	0.15	41.3	24.04	2/18/2020	0.14	1
3/11/2020	13	Dry	0.27	13.5	68.65	3/10/2020	0.03	1

*Percent Flows Exceeding calculated from 10/1/2018 to 3/31/2020 flow from USGS guage station 03284552

One particular event of note is the 6/18/2019 event. Flow during this event was in the 99.99th percentile of all flows occurring over the span of sampling. Lexington received 1.17 inches of rain on 6/17 and 1.25 inches of rain on 6/18. As detailed in the LFUCG April – June 2019 Consent Decree Quarterly Report, from 6/16 to 6/18, 34 sanitary sewer overflows occurred in the West Hickman Watershed. Additionally, there were two unpermitted bypasses from the West Hickman Wastewater Treatment Plant. This only accounts for reported overflows, so the real number may be higher. Sanitary overflows and unpermitted bypasses are planned to be eliminated in Lexington due to the requirements of the Consent Decree. This problem will not be addressed by this plan but their occurrence during a sampling event will be considered in

calculations.

5.1.2 WATER QUALITY BENCHMARKS

The water quality benchmarks used for WHC are a combination of documented legal limits and standard benchmarks established by LFUCG for their watershed focused monitoring efforts. These benchmarks are utilized across Fayette County by LFUCG for baseline comparisons. These benchmarks are provided in Table 5-2.

The legal limits for surface water standards are published in 401 KAR 10:301. As stated in 401 KAR 10:031, this "regulation establishes water quality standards that consist of designated uses of the surface waters of the Commonwealth and the associated water quality criteria necessary to protect those uses." The parameters listed for warm water aquatic habitat and secondary contact recreation waters were used as benchmarks for comparison. The regulation lists specific numeric parameters for E. coli, pH, dissolved oxygen, and temperature. These values are listed in Table 5-2. No specific values are listed in 401 KAR 10:031 for specific conductivity, flow, and total suspended solids, but it is indicated that levels "shall not be changed to the extent that the indigenous aquatic community is adversely affected." The regulation also specifies that "where eutrophication problems exist, nitrogen, phosphorous, carbon, and contributing trace element discharges shall be limited in accordance with: 1. the scope of the problem; 2. the geography of the affected area; and 3. relative contributions from existing and proposed sources."

Benchmarks without documented legal limits were standardized by LFUCG Division of Water Quality as a part of the watershed focused monitoring efforts completed for the MS4 program. These benchmarks are utilized across watersheds in Fayette County. These benchmarks are narrative water quality reference levels, opposed to numeric, due to the variable relationship between biological integrity and pollutant concentration levels in streams. LFUCG worked with KDOW to establish these reference levels based on reference reach data and previous watershed plans. It is important to note that exceedance of these reference levels does not necessarily indicate the need of impairment listing. The reference points are used in conjunction with analysis of biology scores and other impairment indicators to make decisions as stated in the Cane Run Watershed – Based Plan prepared by Third Rock Consultants. Note that some benchmarks are an upper limit, some are a lower limit, and some provide a range of acceptable values.

Table 5-2: Project Water Quality Benchmarks

Parameter	Min Limit	Max Limit	Notes	Source
E. Coli	---	676 MPN/100 ml	Shall not exceed 130 colonies/100 ml as a geometric mean based on not less than five samples taken in 30 days	LFUCG
Nitrate-Nitrite-N	---	2.0 mg/L		LFUCG
Ammonia-Nitrogen	---	0.5 mg/L		LFUCG
Total Phosphorous (TP)	---	0.5 mg/L		LFUCG
TSS	---	80 mg/L		LFUCG
Chloride	---	0.25 mg/L		LFUCG
Fluoride	---	0.5 mg/L		LFUCG
Detergents	---	0.5 mg/L		LFUCG
Stream Discharge	---	---	No overall specific stream discharge requirements; varies based on drainage area size and characteristics	
pH	6.0	9.0	Cannot vary more than 1.0 units over a 24 hour period	401 KAR 10:031
DO	4.0 mg/L*	---	Instantaneous minimum shall not be less than 4.0 mg/L	401 KAR 10:031
Conductivity	---	500 (µS/cm)		LFUCG
% Saturation	---	---	No specific legal or local standard	
Temperature	---	32.2 C (90 F)		401 KAR 10:031

*Outstanding State Resource Waters have a standard of 5.0mg/L instantaneous and 6.0 mg/L as 24-hour average

5.2 AQUATIC COMMUNITY HABITAT

The habitat assessment benchmark was specified as receiving a "good" rating as listed in *Methods for Assessing Habitat in Wadeable Waters* (DOWSOP03024), dated March 2011. The habitat parameters were assessed and cumulative score designated as "good", "fair", or "poor" according to the ratings as shown in Table 5-3. The biological assessment benchmark was specified as receiving an "excellent" or "good" rating as listed in *The Kentucky Macroinvertebrate Bioassessment Index*, dated September 2003. Similar to the habitat parameters, the biological parameters were assessed and the cumulative score designated as "excellent", "good", "fair", "poor", or "very poor" according to the ratings as shown in Table 5-4. Data was collected by both LFUCG and KDOW for various stream sites in the watershed. Data was not collected at all sites. Semi-quantitative and qualitative macroinvertebrate samples were collected at sites WH-6 and WH-12 on May 21, 2019, sites WH-3, WH-12 and WH-18 on May 22, 2019, and sites WH-5 and WH-23 on May 23, 2019. The Standard Operating Procedure (SOP) developed by KDOW, DOWSOP03024,

specifies that habitat assessment for wadeable streams should be conducted from June 1st until September 30th and headwater streams from March 1st until May 31st. It should be noted that all wadable stream sites (WH-3, WH-5, WH-18 and WH-23) were taken outside of the recommended range by KDOW.

Table 5-3. Habitat Ratings Classification

Rating	Headwater (<5.0 sq. miles)	Wadeable (>5.0 sq. miles)
Good	≥ 156	≥ 130
Fair	142-155	114-129
Poor	≤ 141	≤ 113

Table 5-4. Biological Ratings Classification

Rating	Headwater (<5.0 sq. miles)	Wadeable (>5.0 sq. miles)
Excellent	≥ 58	≥ 70
Good	51-57	61-69
Fair	39-50	41-60
Poor	19-38	21-40
Very Poor	0-18	0-20

5.2.1 MACROINVERTEBRATES

The MBI scores from all sites ranged from 21 (WH-17) to 57.4 (WH-3). The higher the score, the more the indication of better water quality. All sites in the upper section of the watershed (upstream of Man O' War Boulevard) had 'poor' MBI ratings. Most sites located in the bottom reaches of the watershed had 'fair' ratings. A single site in the lower reaches, the site downstream of the wastewater treatment plant (WH-23), had a poor rating. The results from the analysis are summarized in Table 5-5. Stream class W represents wadeable and stream class H represents headwater.

Table 5-5: Macroinvertebrate Results from Third Rock Consultants and KDOW

	SITE ID									
METRIC	**WH-3**	**WH-5**	**WH-6**	**WH-12**	**WH-15**	**WH-18**	**WH-23**	**WH-16**	**WH-17**	**WH-2**
Date Sampled	5-22-19	5-23-19	5-21-19	5-22-19	5-21-19	5-22-19	5-23-19	3-12-20	3-12-20	3-3-21
Stream Class	W	W	H	H	H	W	W	H	H	H
Taxa Richness-genus level	48	52	30	35	24	39	24	27	26	36
EPT Richness-genus level	10	9	4	3	3	1	2	1	0	8
mHBI	5.78	5.9	5.89	6.51	6.13	6.04	6.44	6.66	6.08	5.07
% modified EPT	25.2	13.1	3.0	0	1.2	0.31	1.7	0	0	4.8
% Mayflies	N/A	N/A	0	0	0.9	N/A	N/A	0	0	N/A
% Midges & Worms	22.5	24.1	19.1	3.3	26.8	49.5	12.9	13	52.3	N/A
% Clingers	48.4	52.6	74.7	3.3	54.9	44.0	27.8	0	1.4	20.4
MBI Score	57.4	55.4	42.9	30.8	35.6	38.2	37.0	26	21	35
MBI Rating	Fair	Fair	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor

Genus level taxa richness ranged from 24 (WH-15 and WH-23) to 52 (WH-5), and genus EPT richness ranged from 0 (WH-17) to 10 (WH-3). Genus taxa richness and genus EPT richness were considerably higher at sites WH-3 (52 and 9) and WH-5 (48 and 10) compared to the other sites. These sites are on the main stem of West Hickman, located downstream of Man O' War Boulevard. The lowest genus taxa richness and genus EPT richness were at sites WH-15 (24 and 3) and WH-23 (24 and 2). WH-15 is located near the mouth of the Lansdowne Tributary to West Hickman and drains mostly residential and commercial land uses. WH-23 is located downstream of the West Hickman Wastewater Treatment Plant. Increasing taxa and EPT richness is associated with improving water quality, habitat diversity, and/or habitat suitability. Both sites studied by KDOW on March 12, 2020 had low lowest genus taxa richness and genus EPT richness. Both of these sites represent areas around the Landsdowne tributary in the northeast of West Hickman. Upstream areas of these sites have high impervious surface area and concentrated residential and commercial land use.

Modified Hilsenhoff Biotic Index (mHBI) scores ranged from a low of 5.78 (WH-3) to 6.66 (WH-16). All sites rated "fairly poor" with the exception of WH-12, which rated "poor" for mHBI. A "fairly poor" rating indicates "substantial organic pollution likely", and a "poor" rating indicates "very substantial organic pollution likely" (Hilsenhoff 1988). An increasing mHBI value indicates decreasing water quality due to the degree of organic pollution.

Percent modified EPT abundance, which excludes the ubiquitous caddisfly Cheumatopsyche, was highest at sites WH-3 (25.2%) and WH-5 (13.1%), all other sites had less than 3% percent modified EPT abundance. Mayflies were essentially absent from headwater streams. Mayfly abundance, which is a metric for headwater streams only, was 0 for WH-6, WH-12, W-16, and W-17 and <1% for WH-15. Increased EPT abundance is associated with improving water quality and/or habitat conditions, whereas mayfly abundance generally decreases with the presence of brine and metal contamination.

Abundance of generally pollution tolerant midges and oligochaeta (worms) ranged from 3.3% (WH-12) to 52.3% (WH-17). Midge and worm abundance comprised greater than 20% of the macroinvertebrate community for sites WH-3 (22.5%), WH-5 (24.1%), WH-15 (26.8%), WH-18 (49.5%), and WH-17 (52.3%). An increase in midge and oligochaeta abundance suggests decreasing water quality conditions.

Primary clingers were fairly abundant (>40% of the macroinvertebrate community) at all sites except WH-12 (3.3%) and WH-23 (27.8%). Primary clingers require hard, silt free substrates on which to "cling". Both KDOW studied sites WH-16 and WH-17 had <2% clinger abundance.

The culmination of all provided macroinvertebrate biological index scores give us an understanding of the stream reaches ability to support aquatic life. Certain macroinvertebrates are only able to live and reproduce in clean, unpolluted streams while others are able to live under any conditions. The abundance or absence of certain macroinvertebrates is what illuminates stream quality. Stream sites with fair and poor ratings show that there is room for improvement for BMPs. In some cases, it is advantageous to focus resources on "fair" streams with the expectation that they will be able to maintain a higher rating for longer periods of time. In other cases is may be urgent to prioritize "poor" streams to address immediate concerns.

5.2.2 HABITAT

Habitat results are summarized in Table 5-6**.** Habitat assessment indicated "poor" habitat for all headwater sites and one wadeable site (WH-23), and "fair" habitat for all other wadeable sites when

compared to KDOW criteria for streams of the Bluegrass Bioregion. Most habitat parameters rated within the suboptimal or marginal categories. Epifaunal substrate cover, sediment deposition, and riparian zone width were the most impaired habitat parameters with median scores in the marginal range. Embeddedness was the next most impaired habitat parameter with a median score in the low sub-optimal category (10). Channel flow status and vegetative protection also had median scores within the low sub-optimal category (12). Channel alteration and frequency of riffles and bends were the highest rated parameters with high sub-optimal median scores (14). Riparian vegetation zone width was the most variable parameter evaluated during the assessment with scores ranging from 4 to 18. Embeddedness also had a wide range in habitat scores (2 to 14).

Table 5-6: Stream Habitat Assessment Results From Third Rock Consultants and KDOW

PARAMETER	SITE ID								
	WH-3	**WH-5**	**WH-6**	**WH-12**	**WH-15**	**WH-18**	**WH-23**	**WH-16**	**WH-17**
Date Sampled	5-22-19	5-23-19	5-21-19	5-22-19	5-21-19	5-22-19	5-23-19	3-12-20	3-12-20
Stream Class	W	W	H	H	H	W	W	H	H
Epifaunal Sub/Available Cover	13	10	10	8	13	11	6	10	10
Embeddedness	12	6	11	6	14	13	2	10	10
Velocity Depth Regime	15	10	15	7	13	10	16	12	14
Sediment Deposition	10	5	10	14	14	14	4	7	8
Channel Flow Status	12	12	11	7	14	11	16	13	15
Channel Alteration	15	16	16	17	14	14	14	6	9
Frequency of Riffles (or Bends)	14	15	16	16	15	11	14	13	13
Bank Stability	10	12	7	17	14	15	16	14	5
Vegetative Protection	13	14	8	18	9	12	12	10	5
Riparian Zone Width	12	15	18	12	5	6	8	5	4
RBP Score	126	115	122	122	125	117	108	100	93
RBP Zone Rating	Fair	Fair	Poor	Poor	Poor	Fair	Poor	Poor	Poor

Similarly to the results of the MBI scores, the sites in the upper portions of the watershed rated lower than those in the lower portion. Although in this case, there was more variation on this trend. Site WH-6 in the lower portion rated poorly and site WH-18 in the upper portion rated fair. Site WH-23 downstream of the wastewater treatment plant scored the lowest of all sites.

In the same way as the benefits of the macroinvertebrate biological index scores indicate stream health, habitat scores produce conclusions on a streams ability to support plant and animal life. LFUCG is interested in maintaining a diverse ecosystem so it is important to consider non-human stakeholders. All sites assessed indicate additional BMP may be beneficial to provide improvements in habitats.

5.2.3 PRIORITY UPLAND ASSESSMENT

The PSI for each neighborhood reviewed for the priority upland assessment effort ranged from 0 (no pollution severity rating) to 4 (moderate pollution severity rating). Most of the neighborhoods assessed had a majority percentage of lawn coverage per lot and evidence of high management landscaping and yard manicuring. Both of these characteristics add to the PSI, increasing the pollution severity rating. Other neighborhood characteristics noted during the assessment include the presence of swimming pools, presence of waste from pets, and dirty and/or broken driveways. This analysis was performed by Third Rock Consultants in September 2019 and is summarized in Table 5-6 and Table 5-7.

Table 5-7: Neighborhood Source Assessment Results

NSA Criteria	Neighborhood							
	Lansdowne	**Brigadoon**	**River Park**	**Hartland**	**Zandale**	**Lansdowne**	**Gribbin**	**Medlock**
Downstream Site	**WH-10**	**WH-10**	**WH-11**	**WH-1**	**WH-14**	**WH-10**	**WH-20**	**WH-10**
Neighborhood								
Housing Style	Single Family Detached	Single Family Detached	Single Family Attached, Single Family Detached, Multifamily	Single Family Attached, Single Family Detached, Multifamily	Single Family Detached	Single Family Detached	Single Family Attached, Single Family Detached, Multifamily	Single Family Attached, Single Family Detached
Acres	155	95.18	315.92	150.37	118	301.46	37.85	72.65
Garage (%)	80	10	10	85	15	90	95	80
Basement (%)	90	75	40	80	15	90	10	50
Index of Infill, Etc. (%)	<5%	<5%	<5%	<5%	<5%	<5%	<5%	<5%
Yard and Lawn Conditions								
Average % of Impervious Cover	39	28	31	42	43	41	50	30
Average % of Grass Cover	51	71	68	57	37	57	48	69
Average % of Landscaping	10	1	1	1	20	2	1	1
Average % of Bare Soil	0	0	0	0	0	0	0	0
Average % of Forest Canopy	29	14	8	22	22	22	6	36
Average % of Evidence of Non-Target Irrigation	0	0	0	0	0	0	0	0
Proportion of High Lawn Management (%)	60	50	30	90	15	90	75	60
Proportion of Medium Lawn Management (%)	35	40	50	10	75	10	15	20
Proportion of Low Lawn Management (%)	5	10	20	0	10	0	10	20
Estimated # of Swimming Pools	35	0	15	10	0	40	5	0
Junk/Trash in Yards (%)	0	1	2	0	0	0	5	5

NSA Criteria	Neighborhood							
	Lansdowne	**Brigadoon**	**River Park**	**Hartland**	**Zandale**	**Lansdowne**	**Gribbin**	**Medlock**
Downstream Site	**WH-10**	**WH-10**	**WH-11**	**WH-1**	**WH-14**	**WH-10**	**WH-20**	**WH-10**
Driveways, Sidewalks, and Curbs								
% of Driveways that Are Impervious	100	100	100	100	100	100	100	100
Driveway Conditions	Clean	Clean	Stained, Dirty	Clean	Dirty	Clean	Clean	Damaged
Distance Between Sidewalk and Streets (ft)	4	4	4	4	4	4	4	4
Curb and Gutter Conditions	Lawn Clippings	Clean and Dry, Lawn Clippings	Long-Term Car Parking	Clean and Dry, Lawn Clippings	N/A	Lawn Clippings	Clean and Dry, Long-Term Car Parking, Lawn Clippings	N/A
Pet Waste Present?	No	No	No	No	No	No	No	No
Rooftops								
Downspouts Connected Directly to Sewer (%)	0	0	0	0	0	0	0	0
Downspouts Directed to Impervious Areas (%)	20	15	15	10	30	5	25	10
Downspouts Discharge to Pervious Areas (%)	80	85	85	90	70	95	75	90
Downspouts Discharge to a Cistern/Rainbarrel (%)	0	0	0	0	0	0	0	0
Common Areas								
Storm Drain Inlets?	Yes	N/A	No	N/A	Yes	No	N/A	N/A
Storm Drains Stenciled?	No	N/A	N/A	N/A	No	N/A	N/A	N/A
Storm Drain Conditions	Clean	N/A	N/A	N/A	Clean	N/A	N/A	N/A
Open Space Conditions	Dumping	N/A	Clean	N/A	N/A	Clean	N/A	N/A
Buffers/Floodplain	Yes	N/A	No	N/A	Yes	Yes	N/A	N/A

NSA Criteria	Neighborhood							
	Lansdowne	Brigadoon	River Park	Hartland	Zandale	Lansdowne	Gribbin	Medlock
Downstream Site	WH-10	WH-10	WH-11	WH-1	WH-14	WH-10	WH-20	WH-10
NSA Pollution Severity Index (PSI)	4	2	3	3	0	3	2	2
NSA Pollution Severity Rating (PSI)	Moderate	Moderate	Moderate	Moderate	None	Moderate	Moderate	Moderate
Neighborhood Restoration Opportunity Index (NROI)	3	3	3	3	3	3	3	2
Neighborhood Restoration Opportunity Rating (NROI)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

Table 5-8: Potential Generator Investigation Results

PGI Criteria	Redmonds Garden Center	Kings Garden Center	Glenn's Auto	Courtesy Acura	Lexel	Ultimate Lawn & Landscape	Lexington Outdoor Power Equipment	Sunbelt Rentals	Lexus	Quantrell	Parker Seal
Downstream Site	**WH - 2**	**WH-2**	**WH-22**	**WH-2**	**WH-22**	**WH-22**	**WH-21**	**WH - 22**	**WH-22**	**WH-20**	**WH-20**
Site Data and Characteristics											
Date Assessed	9/11/2019	9/11/2019	9/12/2019	9/12/2019	9/12/2019	9/11/2019	9/11/2019	9/11/2019	9/11/2019	9/12/2019	9/12/2019
Category	Commercial	Commercial	Commercial	Commercial	Industrial	Commercial	Commercial	Commercial	Commercial	Commercial	Industrial
NPDES Status	-	-	-	-	-	-	-	-	-	-	-
Vehicle Operations											
Vehicle Type	-	Fleet Vehicles	New and Used	New and Used	N/A	Fleet Vehicles	Lawn Mowers	Fleet Vehicles	New and Used	New and Used	Parking
Approximate Number	-	3	>100	>100	N/A	4	>100	>100	>100	>100	-
Vehicle Activities	-	Stored	All	All	N/A	Stored	Repaired, Stored	Fueled, Washed, Stored	Stored	All	-
Stored/ Repaired Outside	Can't Tell	Can't Tell	Yes	Yes	N/A	No	Yes	Yes	No	Yes	No

PGI Criteria	Redmonds Garden Center	Kings Garden Center	Glenn's Auto	Courtesy Acura	Lexel	Ultimate Lawn & Landscape	Lexington Outdoor Power Equipment	Sunbelt Rentals	Lexus	Quantrell	Parker Seal
Downstream Site	**WH - 2**	**WH-2**	**WH-22**	**WH-2**	**WH-22**	**WH-22**	**WH-21**	**WH - 22**	**WH-22**	**WH-20**	**WH-20**
Lacking Runoff Diversion Methods?	Can't Tell	No	No	Can't Tell	N/A	No	No	-	No	No	Can't Tell
Spills or Leaks?	No	No	Yes	No	N/A	No	Yes	No	No	No	Yes
Uncovered Outdoor Fueling Areas?	Yes	Yes	No	-	N/A	Yes	No	Yes	No	No	No
Fueling Areas Connected to Storm Drains?	Can't Tell	No	-	-	N/A	No	No	No	No	No	No
Vehicles Washed Outdoors?	Can't Tell	Can't Tell	No	-	N/A	Can't Tell	No	Yes	No	No	No
Washing Area Connected to Storm Drain?	Can't Tell	-	No	-	N/A	-	-	-	-	-	-
Outdoor Materials											
Loading/ Unloading	Yes	Yes	No	N/A	Yes	No	No	No	No	No	N/A
Materials Stored	Yes	Yes	Yes	N/A	No	Yes	Yes	Yes	No	No	N/A
Storage Area Connected to Storm Drain?	No	No	-	N/A	Yes	No	Can't Tell	-	No	No	N/A
Staining or Discoloration	No	No	Yes	N/A	No	No	Yes	No	No	No	N/A
Lacking Covered Storage Area?	Yes	Yes	Yes	N/A	No	No	Yes	Yes	No	No	N/A
Lacking Secondary Liquid Containment	Yes	Yes	Yes	N/A	No	Yes	Yes	Can't Tell	No	No	N/A
Labeling in Poor Condition?	-	Can't Tell	Can't Tell	N/A	No	No	No	No	No	No	N/A

PGI Criteria	Redmonds Garden Center	Kings Garden Center	Glenn's Auto	Courtesy Acura	Lexel	Ultimate Lawn & Landscape	Lexington Outdoor Power Equipment	Sunbelt Rentals	Lexus	Quantrell	Parker Seal
Downstream Site	**WH - 2**	**WH-2**	**WH-22**	**WH-2**	**WH-22**	**WH-22**	**WH-21**	**WH - 22**	**WH-22**	**WH-20**	**WH-20**
Waste Management											
Type of Waste	Garbage	Garbage	N/A	Garbage	N/A	N/A	Garbage	N/A	N/A	Garbage	N/A
Dumpster Condition	-	-	N/A	-	N/A	N/A	-	N/A	N/A	-	N/A
Dumpster Near Storm Drain Inlet?	Can't Tell	No	N/A	No	N/A	N/A	-	N/A	N/A	No	N/A
Physical Plant											
Building Condition	Clean	Clean	Clean	Clean	Clean	N/A	Clean	N/A	N/A	Clean	Clean
Evidence of Discharge from Maintenance	-	No	No	No	No	N/A	Don't Know	N/A	N/A	-	No
Parking Lot Condition	Clean	Clean	Stained	Clean	Clean	N/A	Stained	N/A	N/A	Clean	Stained
Downspouts Directed to Impervious Surfaces?	No	No	No	None Visible	Yes	N/A	Don't Know	N/A	N/A	Don't Know	Don't Know
Turf / Landscaping											
% Forest Canopy	10	60	N/A	10	N/A	N/A	N/A	N/A	10	N/A	N/A
% Turf	5	5	N/A	10	N/A	N/A	N/A	N/A	10	N/A	N/A
% Landscaping	85	35	N/A	80	N/A	N/A	N/A	N/A	10	N/A	N/A
% Bare Soil	0	0	N/A	0	N/A	N/A	N/A	N/A	-	N/A	N/A
Turf Management Status	High	High	N/A	High	N/A	N/A	N/A	N/A	High	N/A	N/A
Evidence of Non-Target Irrigation	No	Yes	N/A	No	N/A	N/A	N/A	N/A	No	N/A	N/A
Landscaping Drain to Storm Drain Inlet?	Yes	No	N/A	Yes	N/A	N/A	N/A	N/A	Yes	N/A	N/A

PGI Criteria	Redmonds Garden Center	Kings Garden Center	Glenn's Auto	Courtesy Acura	Lexel	Ultimate Lawn & Landscape	Lexington Outdoor Power Equipment	Sunbelt Rentals	Lexus	Quantrell	Parker Seal
Downstream Site	**WH - 2**	**WH-2**	**WH-22**	**WH-2**	**WH-22**	**WH-22**	**WH-21**	**WH - 22**	**WH-22**	**WH-20**	**WH-20**
Accumulation of Organic Matter?	Can't Tell	No	N/A	No	N/A	N/A	N/A	N/A	No	N/A	N/A
Storm Water Infrastructure											
Storm Water Treatment Present?	N/A	No	N/A	No	N/A	No	No	N/A	Un-known	N/A	No
Private Stormdrains in the Area?	N/A	No	N/A	Yes	N/A	Yes	No	N/A	Yes	N/A	No
Index Rating for Gutter Accumulation											
Sediment	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Organic Material	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Litter	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hot Spot Index (HSI)	5	4	8	1	2	2	7	6	1	2	2
Hot Spot Status	Potential Hotspot	Not a Hotspot	Po-tential Hotspot	Not a Hotspot	Not a Hot-spot	Not a Hotspot	Potential Hotspot	Potential Hotspot	Not a Hotspot	Not a Hotspot	Not a Hotspot

The neighborhood restoration opportunity index (NROI) for each neighborhood assessed during this effort ranged from 2 to 3, which both are considered a moderate restoration opportunity rating. Most neighborhoods assessed had a moderate amount of landscaping present, a low amount of tree canopy coverage, and a lack of stenciling on storm drain inlets. Each of these characteristics contribute to the NROI and can be corrected to better the water quality in neighborhoods.

In addition to the neighborhood assessment, potential pollutant generators were assessed by Third Rock Consultants in September 2019. The results are summarized in Table 5-8. Of the eleven (11) potential pollutant generators assessed, four (4) were determined to be potential hotspots. It is recommended that these four (4) potential hotspots be revisited for permitting assessment. The scores ranged from 1 to 8 with no confirmed or severe hotspots identified. The hot spot status and location of each hot spot site is shown in Figure 5-1.

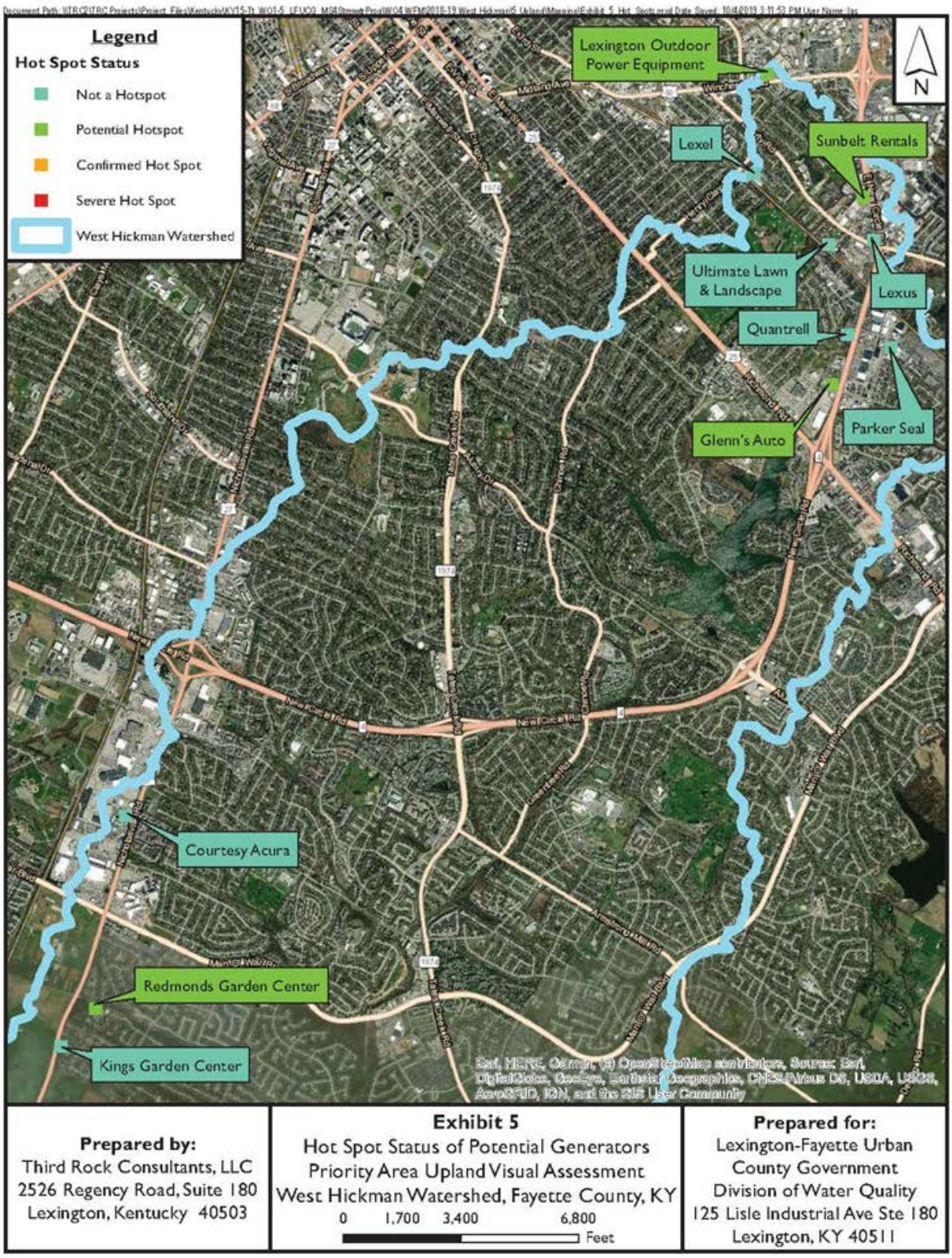


Figure 5-1: Hot Spot Status of Potential Pollutant Generators

5.3 VOLUME AND VELOCITY IMPACTS

Aquatic habitats can also be harmed by the volume and velocity of water flowing through them. High speed water can create erosion and scarring on the stream lining which will disrupt fish spawning beds and macroinvertebrate habitat. High speeds may also put stress on plant life to uproot plants, or directly erode the surface. High amounts of impervious area in urban Lexington enable large amounts of rainwater to quickly flow to the streams.

During the study by Third Rock Consultants, stream water depth was measured at each stream site for 14 monitoring events. Measurements were taken by Third Rock Consultants employees and volunteers. These occurred from October 23, 2018 to September 10, 2019. Stream depth was measured via a staff gauge. Cross section surveys were conducted at 16 West Hickman stream sites during August and September of 2018. Stream discharge was directly measured at the time of gauge installation to calibrate the calculated discharge curve. Using RiverMorph, a stage-discharge curve was calculated for each stream site with Manning's equation based on cross-section dimensions, longitudinal slope, and channel roughness. In some cases, channel roughness was adjusted so that flow output would better represent field conditions. This analysis was completed entirely by Third Rock Consultants.

Of the 14 monitoring events, 2 represented times during or shortly after a storm event. At all stream sites flow increased significantly during the storm events. The stream sites with the highest flows were WH-09, WH-03, and WH-23. During the largest storm event these sites had 391 cfs, 217 cfs, and 150 cfs respectively. All three of these sites represent locations in the main reach of West Hickman Creek, so it is expected that they would have the highest flow. During the 12 monitoring events which occurred outside of a storm event flows were low, but consistent. This suggests that all monitored locations represent a perennial location in the West Hickman Creek watershed. Stream depth was similarly consistent during the 12 low flow monitoring events.

The Kentucky Division of Water carried out similar flow measurements from October 29, 2019 to March 11, 2020. Their monitoring events captured two storm events. Similarly to the Third Rock results, the locations with the most flow were WH-23, WH-03 and WH-09 respectively. These results make a little bit more sense than the Third Rock results because while we would expect these three sites to have the highest flow, the expectation is that flow would decrease from the downstream to the upstream sites. Most downstream is WH-23 followed by WH-03 and WH-09. The time of sampling during the storm event likely led to the locations of unanticipated higher flows. Also similar to the Third Rock results, flow was maintained during all monitoring events, further suggesting that all monitored locations represent perennial streams.

Data used to create the stage discharge curve at each site was used to create a relationship between depth and velocity to estimate velocity at each site for each sampling event. The median velocities at each site are provided in below in Table 5-9. Sites such as WH-14 and WH-4 with higher velocities will be more at risk from channel degradation from erosion and habitat damage. Sites such as WH-11 and WH-8 had very low velocity even though water was always present in the stream. It should be noted that the method used to calculate velocity at these sites resulted in a negative values. The stage discharge curve will often break down at low velocities. Negative readings were rounded up to zero, but it should be noted that in reality velocity is slightly higher than zero. These sites will be more at risk from an overabundance of sediment deposition. Site 21 did not have any measurements for stream velocity.

Table 5-9: Median Stream Velocities

Site	Median Velocity (CFS)	Site	Median Velocity (CFS)
WH-1	0.84	WH-13	0.50
WH-2	1.42	WH-14	4.68
WH-3	0.51	WH-16	1.37
WH-4	3.76	WH-17	1.42
WH-7	0.83	WH-19	1.60
WH-8	0.00	WH-20	1.25
WH-9	0.66	WH-21	N/A
WH-10	1.49	WH-22	3.03
WH-11	0.00	WH-23	0.38

The USGS gage at Veterans Park (03284552) was further studied as a comparison with the measured and modeled flow estimates. Flow at this location ranges from 0.5 cfs to 1540 cfs. The median flow at this site was 18.2 cfs, and 4.9% of flows exceed 100 cfs. This further indicates that West Hickman Creek is a flashy system which is quick to reach peak flows and quick to return back to base flows. This is caused in part by a high percentage of impervious surface area and geological factors.

The flashiness in the West Hickman Creek will be addressed by BMPs. This will result in a reduction of stormflow velocities in the stream. These BMPs will come in various forms such as storm water detention basin retrofits, increase in green space, bio-swales, and other forms of green infrastructure. Storm water detention basins will hold rain water in one location and slowly release over time. Green space will increase the amount of pervious area which allows water to seep into the groundwater table instead of overland flow directly to the stream. Green space will also increase the surface resistance to flow compared to impervious areas due to plant cover. Bio-swales combine the benefits of both above measures by holding water, allowing it to seep into the groundwater, and increasing surface resistance. By increasing the amount of time it takes for water to get to the stream, water can be conveyed into the stream at times after peak, when the stream has more capacity.

WATER QUALITY

5.3.1 OVERALL PHASE I AND PHASE II SAMPLING SUMMARY

A total of 295 samples were collected in Phase I. All Phase I sampling was completed by LFUCG. A total of 18 stream sites and 69 outfalls were monitored during Phase I. The benchmarks defined in Table 4-4 were

exceeded for one or more parameter at 39 of the outfalls and 6 of the in-stream locations. The most exceedances of a benchmark occurred for E. coli and conductivity.

A total of 710 samples were collected in Phase II. As previously discussed, Phase II water quality sampling was a combined effort between KDOW and LFUCG. A total of 18 stream sites and 68 outfalls were monitored during Phase II. The benchmarks defined in Table 4-4 were exceeded for one or more parameter at 64 of the outfalls and at all 18 in-stream locations. The most exceedances of a benchmark occurred for E. coli.

The following is a bulleted summary of Phase I and Phase II sampling results for each parameter.

- pH exceeded the water quality benchmark seven times at seven sites (6 outfalls and 1 in stream). The maximum pH reading of 9.26 occurred at Outfall 45520 (Upstream of WH-10). The minimum pH reading of 4.99 occurred at Outfall 45002-L (Upstream of WH-16).
- Dissolved Oxygen (DO) was lower than the water quality benchmark 30 times at 17 outfall sites and four stream sites. DO at Outfall 45540 (Upstream of WH-17) fell below the benchmark 4 times.
- Conductivity exceeded the benchmark of 500 us/cm during most events at most sampling stations.
- Water temperature did not exceed the benchmark at any time at any site.
- Detergent measurements met or exceeded the water quality standard at 34 outfall sites and 10 stream sites. Most exceedances were barely over the benchmark, but once each at Outfall 45029 (Upstream of WH-19) and Outfall 45548 (Upstream of WH-7), detergent concentration was 1.50 mg/L.
- Chlorine measurements exceeded water quality standards at five stream sites and 18 outfall sites. Generally chlorine was below the benchmark at all stations. Outfalls 45017-L (Upstream of WH-20) and 45512-L (Upstream of WH-20) experienced repeated high chlorine observations.
- Ammonia-Nitrogen exceeded the water quality standards at 13 outfalls and 2 stream sites. Outfall 45515 (Upstream of WH-22) experienced repeated high Ammonia-Nitrogen measurements.
- Nitrate-Nitrogen exceeded water quality standards frequently at most stations. The highest concentration of 13.5 mg/L occurred at stream site WH-23. WH-23 experienced six notably high Nitrate-Nitrogen concentrations between 5.78 mg/L to 13.5 mg/L. This can be expected due to the nature of WH-23 downstream of the West Hickman Wastewater Treatment Plant.
- Total Phosphorus exceeded water quality standards at least once at 14 outfalls and 12 stream sites. Outfall 45056 (Upstream of WH-4) had the highest frequency of exceedance, during 12 of the Phase 1 and 2 sampling events. Site WH-23 phosphorus exceeded standards during 8 of the Phase 2 sampling events.
- Total Suspended Solids generally fell within benchmarks at all sites. The highest TSS concentration of 359 mg/L was measured at WH-7.
- All sites had E. coli values above the PCR benchmark. For SCR, there were fewer total exceedances, but most sites still had some values above the SCR standard. The highest E. coli concentration during the study was at Outfall 45027 (Upstream of WH-16) and exceeded the maximum limit for the laboratory method of 241,960 MPN/100mL.

Table 5-10 provides a full count of exceedances for each parameter at each sample site. The following

sections discuss these results in detail for each sample site.

Table 5-10: Number of Events Exceeding Water Quality Benchmarks at Each Site for Phase I and Phase II

Site ID	E. coli	NO3-N	TP	TSS	Conductivity	DO
WH-1	4/15	0/14	0/14	0/14	13/15	0/15
WH-2	7/15	8/20	2/20	1/19	15/20	0/20
WH-3	9/16	1/20	0/20	0/18	10/20	0/20
WH-4	8/15	10/14	1/14	0/14	12/15	0/15
WH-7	7/15	12/20	1/19	1/16	18/20	0/20
WH-8	12/15	2/15	1/15	1/15	14/15	0/15
WH-9	7/14	0/19	0/19	0/18	6/19	0/19
WH-10	13/15	3/14	1/14	1/14	13/15	0/15
WH-11	7/15	2/20	2/20	0/15	18/20	1/20
WH-13	12/15	0/20	1/20	1/18	4/20	0/20
WH-14	8/16	10/20	1/19	1/15	14/20	0/20
WH-16	12/16	19/20	1/20	0/15	15/21	0/20
WH-17	6/15	13/21	2/21	0/16	15/21	0/20
WH-19	2/15	1/14	0/14	0/14	1/15	0/15
WH-20	1/15	1/18	0/17	0/16	3/20	1/20
WH-21	3/15	13/14	0/14	0/14	3/15	0/15
WH-22	10/14	2/13	0/13	0/13	2/14	1/14
WH-23	3/12	15/15	8/15	0/13	14/16	1/16

5.3.1.1 WH-1 SITE SAMPLING SUMMARY

Site 1 experienced 17 instances of a measurement above the benchmark. E.coli measurements were high during four sampling events all occurring around storm events. The highest measurement was taken during the highest flow event captured at WH-1. This suggests that WH-1 is at risk from overland runoff contaminated by animal waste or sanitary sewer overflows. Conductivity levels were above the benchmark in 13 instances. All conductivity readings above the benchmark occurred during low flow events.

5.3.1.2 WH-2 SITE SAMPLING SUMMARY

Site 2 experienced measurements above benchmark for NO3-N, TP, TSS, E. coli and Conductivity. A total of eight exceeding nitrogen readings were around 0.5 mg/L above the 2.0 benchmark. These measurements occurred throughout every month of the year during high and low flow sampling events. The total phosphorus exceedances were higher than most readings at the site by about 0.4 mg/L, these both occurred during a heavy storm event. The isolated nature of this exceedance and its occurrence during a storm suggest that this is not a priority at the WH-2 site. The high TSS reading occurred during a storm event on 8/13/2019. Seven high E. coli reading occurred all during storm events which suggests that WH-2 is at risk from overland runoff contaminated by animal waste, sanitary sewer overflows, and/or runoff with excessive nutrient loads. Conductivity levels were above the benchmark for 15 samples. All conductivity readings above the benchmark occurred during low flow events.

5.3.1.3 WH-3 SITE SAMPLING SUMMARY

Site 3 experienced nine instances of E. coli and one instance of nitrogen measurements above the benchmark. The nine measurements all occurred during storm events. Readings from Third Rock Consultants for E. coli of 2822, 17934 and 21872 MPN/100 mL occurred when stream flow was 47, 77, and 217 cfs respectively. This reveals that WH-3 is more at risk of fecal pollution with increasing event magnitude. This suggests that WH-3 is at risk from overland runoff contaminated by animal waste or sanitary sewer overflows. Conductivity levels were above the benchmark for 10 samples. All conductivity readings above the benchmark occurred during low flow events.

5.3.1.4 WH-4 SITE SAMPLING SUMMARY

Site 4 experienced eight instances of E. coli and ten instances of nitrogen readings above the benchmark. Six high E. coli readings occurred during storm events, two occurred during low flow events. Pollution during low and high flow events suggests that WH-4 is vulnerable from overland animal runoff and direct fecal input to the stream from sanitary sewers. Site 4 had ten instances of high nitrogen readings; many readings were well above the benchmark. The maximum reading was 7.48 mg/L. GRW Engineers, Inc. completed a study of the Waterford Pond which lies between WH-4 and WH-7. The study recognized a few major contributors to nitrogen pollution in the area. GRW noted large amounts of dog waste in the apartment communities (The Mansion and Springhouse). GRW also identified the systemic issue of landlord and property owners contracting lawn fertilization companies. These companies will spray fertilizer on grasses, often much more than is needed and capable of being absorbed by the plant life. High amounts of impervious area in these neighborhoods provide quick pathways for this fertilizer to be picked up by stormwater and transferred directly to the stream. Site 4 had one instance of a total phosphorus reading above the benchmark. The total phosphorus exceedance was higher than most readings at the site by about 0.4 mg/L, this occurred during a heavy storm event. The isolated nature of this exceedance and its occurrence during a storm suggest that this is not a priority at the WH-4 site. Conductivity levels were above the benchmark for 12 samples. Conductivity readings above the benchmark occurred during high and low flow events.

5.3.1.5 WH-7 SITE SAMPLING SUMMARY

Site 7 had seven E. coli, twelve nitrogen, one total phosphorus and one total suspended solids exceedances. All E. coli exceedances occurred during storm events which suggests Site 7 is at risk from overland runoff contaminated by animal waste or sanitary sewer overflows. Site 7 is experiencing the same dog waste and fertilizer issues presented by the GRW report as site WH-4. Site 7 had one instance of a total phosphorus reading above the benchmark. The total phosphorus exceedance was higher than most readings at the site by about 1.6 mg/L, this occurred during a heavy storm event. The isolated nature of this exceedance and its occurrence during a storm suggest that this is not a priority at the WH-7 site. The one TSS exceedance occurred during a significant storm event where flow was much greater than normal, a high TSS reading under these conditions is to be expected and may indicate bank erosion due to high velocities. Most nitrogen readings were between 0.2 and 1 mg/L above the 2.0 benchmark. Based on the MST results, bird fecal contamination appears to be a high priority for WH-7. Conductivity levels were above the benchmark for 18 samples. All conductivity readings above the benchmark occurred during low flow events.

5.3.1.6 WH-8 SITE SAMPLING SUMMARY

Site 8 had twelve E. coli, two nitrogen, one total phosphorus and one total suspended solids exceedances. All besides three sampling events experienced E. coli above the benchmark. These occurred during both

high flow and low flow events. This location has relatively less flow than most other sampling locations. High E. coli concentrations at low flow suggest direct input of waste into the stream such as from a sanitary sewer leak, sanitary sewer overflow or nearby animal waste. The two nitrogen exceedances were exactly at 2 mg/L, this site is not a priority for nitrogen pollution reduction. Site 8 had one instance of a total phosphorus reading above the benchmark. The total phosphorus exceedance was higher than most readings at the site by about 1.6 mg/L, this occurred during a low flow sampling event. The isolated nature of this exceedance suggests that this is not a priority at the WH-8 site. The one TSS reading occurred during a period of low flow. Since this is an isolated event, it can possibly be explained by an abnormality of the sampling process. Conductivity levels were above the benchmark for 14 samples. All conductivity readings above the benchmark occurred during low flow events.

5.3.1.7 WH-9 SAMPLING SUMMARY

Site 9 had seven E. coli exceedances. Exceedances occurred both when the stream was at baseflow and during storm events. E. coli exceedances during low and high flow events suggests that WH-9 is vulnerable from both overland flow and potential direct inputs to the stream. Sanitary sewer leaks, sanitary sewer overflows, and animal waste are all possible contributors. Conductivity levels were above the benchmark for 6 samples. Conductivity readings above the benchmark occurred during low and high flow events.

5.3.1.8 WH-10 SITE SAMPLING SUMMARY

Site 10 had thirteen E. coli exceedances, three nitrogen, one TP and one TSS exceedances. E. coli samples exceeded the benchmark on all but two sampling events. The three nitrogen exceedances only exceeded 2.0 by around 0.2 mg/L so this is not a priority. The lone TSS exceedance occurred during a storm event which is to be expected due to higher velocity flows. E. coli readings were above the benchmark, sometimes well above the benchmark during base flow stream conditions. This suggests that the site is at risk from direct pollution from human waste through sanitary sewer leakage or animal inputs. The two highest samples of over 10x more MPN/100 mL than the 676 benchmark occurred during storm events which suggests that this site is also at an increased risk from overland runoff from animal waste or sanitary sewer overflows. The total phosphorus exceedance was higher than most readings at the site by about 1.2 mg/L, this occurred during a heavy storm event. The isolated nature of this exceedance and its occurrence during a storm suggest that this is not a priority at the WH-10 site. Conductivity levels were above the benchmark for 13 samples. Conductivity readings above the benchmark occurred during low flow events.

5.3.1.9 WH-11 SITE SAMPLING SUMMARY

Site 11 had seven E. coli exceedances, two nitrogen, two TP, one conductivity, and one DO exceedance. The two nitrogen exceedances were only about 0.1 mg/L above the benchmark, so nitrogen pollution is not a priority in this watershed. The DO reading dropped below the benchmark. This occurred during low flow and no other exceedances occurred during this sampling event. It is likely that this is not representative of normal conditions and DO is not a priority at this site. The one conductivity exceedance occurred during base flow conditions. Given that most conductivity readings are well below (-300 us/cm) the exceedance, this is not a priority at this site. The E. coli exceedances occurred during both high flow and low flow conditions but the highest reading (61,314 MPN/100 mL) occurred during the second highest flow event. The highest event did have exceedance (2,954 MPN/100 mL), but not on the magnitude as the highest reading. This suggests that E. coli pollution may be from human source through sanitary sewer leakage or a sanitary sewer overflow. The total phosphorus exceedances were higher than most readings at the site by about 0.3 mg/L, these occurred during heavy storm events. The isolated nature of these

exceedances and their occurrence during a storm suggest that this is not a priority at the WH-11 site. Conductivity levels were above the benchmark for 18 samples. Conductivity readings above the benchmark occurred during low and medium flow events.

5.3.1.10 WH-13 SITE SAMPLING SUMMARY

Site 13 had twelve E. coli exceedances, one TP and one TSS exceedance. The one TSS exceedance occurred during the second highest storm event. It is curious that the highest storm event did not have a TSS exceedance when this storm event did, but the fact that this only occurred once suggests that TSS is not a priority at this site. The reading may be as a result of a temporary land disturbance at the time of sample collection. E. coli exceedances occurred during high and low flow events. High flow events tended to produce higher E. coli readings. This site experienced one of the highest E. coli readings of 92,084 MPN/100 mL during a storm event on 8/13/2019. These results suggest that WH-13 is vulnerable from pollution from sanitary sewer damage, sanitary sewer overflows, and overflow and from animal waste runoff to the stream. As will be discussed later in this chapter, WH-13 exhibited high indications of human and bird fecal source contamination in the MST results. The total phosphorus exceedance was higher than most readings at the site by about 1.2 mg/L, this occurred during a heavy storm event. The isolated nature of this exceedance and its occurrence during a storm suggest that this is not a priority at the WH-13 site. Conductivity levels were above the benchmark for 4 samples. Conductivity readings above the benchmark occurred during low and high flow events.

5.3.1.11 WH-14 SITE SAMPLING SUMMARY

Site 14 had eight E. coli, ten nitrogen exceedances and one TP exceedance. The E. coli and nitrogen exceedances represent half of the total samples for each parameter. Nitrogen exceedances ranged from 0.1 to 1.1 mg/L above the benchmark with values generally in the higher range. These high results occurred both during high and low flow sampling events. E. coli exceedances also occurred during high and low flow events with higher values occurring during storm events. This suggests that WH-14 is vulnerable from direct pollution from sanitary sewer leaks or overflows and indirect pollution from animal waste runoff. Based on the MST results, bird fecal contamination appears to be a high priority for WH-14. The total phosphorus exceedance was higher than most readings at the site by about 0.4 mg/L, this occurred during a heavy storm event. The isolated nature of this exceedance and its occurrence during a storm suggest that this is not a priority at the WH-14 site. Conductivity levels were above the benchmark for 14 samples. Conductivity readings above the benchmark occurred during low and high flow events.

5.3.1.12 WH-16 SITE SAMPLING SUMMARY

Site 16 had twelve E. coli exceedances, nineteen nitrogen exceedances and one TP exceedance. Only three E. coli samples and one nitrogen sample fell within benchmarks. This makes Site 16 the site with the highest combined exceedances of E. coli and nitrogen. Nitrogen exceedances ranged from 2.46 to 4.0 mg/L. The one acceptable reading was 1.58 mg/L which is still near the 2.0 benchmark. Although nitrogen concentrations at WH-16 are not as high as at WH-4, continuous high nitrogen pollution is cause for concern. Sampling events covered both low flow and high flow conditions which suggests WH-16 is vulnerable to nitrogen pollution through direct and indirect factors such as animal waste directly into the stream and storm water runoff polluted by animal waste and fertilizer use. E. coli exceedances also occurred during high and low flow sampling events. One of the E. coli samples was one of the highest recorded samples at 155,312 MPN/100 mL. The total phosphorus exceedance was higher than most readings at the site by about 0.2 mg/L, this occurred during a heavy storm event. The isolated nature of this exceedance and its occurrence during a storm suggest that this is not a priority at the WH-16 site.

Conductivity levels were above the benchmark for 14 samples. Conductivity readings above the benchmark occurred during low and medium flow events.

5.3.1.13 WH-17 SITE SAMPLING SUMMARY

Site 17 had six E. coli exceedances, thirteen nitrogen exceedances and two total phosphorus exceedances. The total phosphorus exceedances were higher than most readings at the site by about 0.3 – 0.5 mg/L, these both occurred during a heavy storm event. The isolated nature of this exceedance and its occurrence during a storm suggest that this is not a priority at the WH-17 site. The thirteen nitrogen exceedances were between 0.1 and 1.1 mg/L higher than the benchmark of 2.0. These exceedances occurred during high and low flow sampling events. The high E. coli readings also occurred during high and low flow sampling events. This suggests that WH-17 is vulnerable to direct pollution from sanitary sewer and indirect from animal waste stormwater runoff during both wet and dry conditions. Conductivity levels were above the benchmark for 15 samples. Conductivity readings above the benchmark occurred during low flow events.

5.3.1.14 WH-19 SITE SAMPLING SUMMARY

Site 19 had two E. coli and one nitrogen exceedance. The one nitrogen exceedance was one of the highest concentrations of nitrogen recorded at 8.02 mg/L. Most other samples measured around 0.5 mg/L. The abnormality and isolation of this event suggests that it is not reflective of normal conditions and will not be considered a priority. The two E. coli exceedances occurred during storm events, but not all storm events resulted in high E. coli samples. This suggests that WH-19 is vulnerable to polluted storm water runoff, but it is not an often occurring problem. Conductivity levels were above the benchmark for 1 sample. The conductivity reading above the benchmark occurred during a low flow event.

5.3.1.15 WH-20 SITE SAMPLING SUMMARY

Site 20 had one E. coli, one nitrogen, and one DO exceedance. The one DO exceedance occurred on 7/16/2019 with a reading of 3.69. Most other readings are well above the benchmark some with values above 10 mg/L. The isolated nature of this exceedance and the regular high DO readings at this site suggest that DO is not a priority. Similarly to with WH-19, the one nitrogen exceedance was one of the highest concentrations of nitrogen recorded at 8.02 mg/L. Most other samples measured around 0.4 mg/L. The abnormality and isolation of this event suggests that it is not reflective of normal conditions and will not be considered a priority. It is of note that both of these samples occurred during the same sampling event and WH-20 is upstream of WH-19, so whatever caused the high reading at WH-19 also caused the high reading at WH-20. The one E. coli exceedance occurred during the lowest flow event recorded. It is possible that this reading was an anomaly considering most other readings at this site are well below the benchmark. Conductivity levels were above the benchmark for 3 samples. Conductivity readings above the benchmark occurred during low flow events.

5.3.1.16 WH-21 SITE SAMPLING SUMMARY

Site 21 had three E. coli exceedances and thirteen nitrogen exceedances. Only one sample showed nitrogen values below the benchmark. This sample occurred during an extremely high flow event and is to be expected with stormwater diluting stream concentrations. Nitrogen readings at this site were consistently well above the benchmark during high and low flows, the median reading was 3.9 mg/L. The frequency of high concentrations well above the benchmark assert that nitrogen pollution is a high priority at this site. The three E. coli exceedances occurred during high and low flow events suggesting this site is occasionally vulnerable to direct and indirect pollution from sanitary sewer and stormwater polluted by

animal waste. Due to the age of construction of homes in WH-21, this area is also relatively more at risk from sanitary cross connections and aged/damaged sanitary lines. Conductivity levels were above the benchmark for 3 samples. Conductivity readings above the benchmark occurred during low flow events.

5.3.1.17 WH-22 SITE SAMPLING SUMMARY

Site 22 had ten E. coli exceedances, two nitrogen, one conductivity, and one DO exceedance. The low dissolved oxygen reading did not occur during a high flow/storm event. It is not clear what caused these readings or why they occurred at the same time. Most other DO and conductivity readings were well within benchmark levels so they will not be considered a priority. The two nitrogen exceedances occurred during slightly higher than base flow. Due to the high number of E. coli exceedances it is likely the nitrogen pollution in this case is related to the E. coli pollution. This suggests the cause is human or animal waste directly near the stream. The ten E. coli exceedances occurred during high and low flow sampling events. Based on the MST results, bird fecal contamination appears to be a high priority for WH-22. Conductivity levels were above the benchmark for 2 samples. Conductivity readings above the benchmark occurred during low flow events.

5.3.1.18 WH-23 SITE SAMPLING SUMMARY

Site 23 had three E. coli, fifteen nitrogen. 7 total phosphorus, and one DO exceedance. The one DO exceedance was just barely below the benchmark and will not be considered a priority. This was the only site which had every nitrogen sample above the benchmark. This site had the highest nitrogen readings of any other site with a median of 5.78 mg/L with a maximum reading of 13.5 mg/L. The high levels of nitrogen are thought to be because site WH-23 is downstream of the West Hickman Wastewater Treatment Plant. The discharge limits from the Wastewater Treatment Plant are considerably higher than the benchmark concentrations. A direct correlation could not be assessed as NO3-N is not regularly sampling at the Wastewater Treatment Plant effluent. The discharge limit for Ammonia-Nitrogen from the Wastewater Treatment Plant is 4.0 mg/L. Review of data collected by LFUCG showed Ammonia-Nitrogen did not exceed 4.0 mg/L in the sampling data provided. The three E. coli readings occurred during high flow sampling events. This site also represents the most rural land use of any other site. This was the only site with more than two total phosphorus exceedances. Total phosphorus samples at this site ranged from 0.153 mg/L at the lowest and 3.21 mg/L at the highest. The high number of exceedances is also a likely result of the proximity to the Wastewater Treatment Plant. Conductivity levels were above the benchmark for 14 samples. Conductivity readings above the benchmark occurred during low flow events.

5.3.1.19 ALL SITES SUMMARY

Overall, E. coli is the highest priority issue at most sites. Every single site had at least one E. coli exceedance. Nitrogen is a high priority at many sites with all except three experiencing exceedances. Total phosphorus had multiple exceedances but was limited to 1 or 2 at all sites except for WH-23. TSS and DO both had at least one exceedance, but never more than one at a single site. The low frequency of exceedances from these parameters assert that these are not priorities to be addressed in the West Hickman Watershed. Conductivity readings were above the benchmark for most samples at most sites. Most readings occurred during low flow events which suggests West Hickman Creek has a high level of background conductivity which is diluted during storm events. Conductivity will be discussed further in section 5.4.2.

5.3.2 OPTICAL BRIGHTERNER RESULTS

Results of the Optical Brightener Survey show that optical brighteners were present in the outfalls during the sampling periods. Fluorescence was observed on the sampling devices from Outfall 45017-R (upstream of WH-20) during the 9/13/19 deployment and from Outfalls 45017-R and 45027 (Upstream of WH-14) during the 9/17/19 through 9/23/19 deployment. The fluorescence from 45017-R was weak and did not suggest significant pollution. Outfall 45027 had strong florescence which does suggest significant illicit discharge. Soap suds were observed from outfall 45027 when the monitoring device was retrieved on 9/23/19. Soap suds indicate possible contamination with sanitary sewer. Upstream of WH-14, proposed BMPs include sanitary sewer investigation for lateral leaks and repair deficiencies in the Lansdowne and Brookhaven neighborhoods. A sanitary sewer overflow removal from the Merrick Trunk Remedial Measures Project is also proposed for WH-14. Multiple sanitary trunk removal and replacements are suggested for upstream of WH-20 including the following: Plainview Trunk, Richmond Road Trunk, Prather Road Trunk, Island Trunks and a sanitary sewer investigation in the Ashland Park neighborhood. These projects will be discussed in more detail later this report.

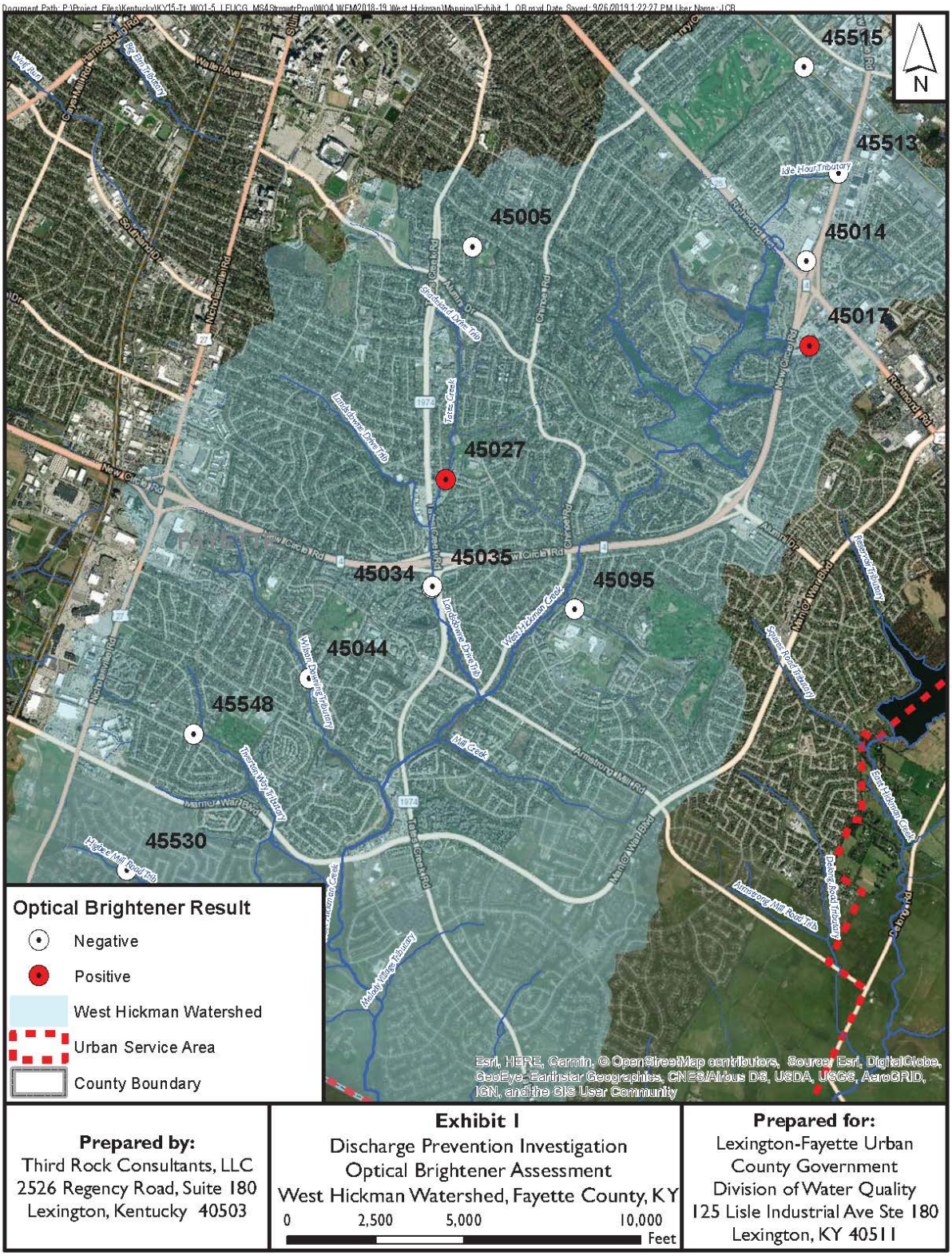


Figure 5-2: Optical Brightener Assessment

5.3.3 MICROBIAL SOURCE TRACKING RESULTS

Results from Source Molecular show that the majority of the quantifiable Human *Bacteroids* were low concentration. Low quantifiable levels were detected at outfalls 45044 (upstream of WH-10), 45034 (upstream of WH-14), 45005 (upstream of WH-17), 45017-R (upstream of WH-20) and sites WH-8, WH-9, and WH-10. Human *Bacteroids* were not detected at Outfalls 45548, 45530, 45035, 45027, 45014-L, 45515 and sites WH-17, and WH-11. WH-16 and Major Outfall 45513 (upstream of WH-22) exhibited moderate concentrations. WH-13 was the only site or outfall to exhibit high concentrations of Human *Bacteroids*. These concentrations were so high to suggest relatively fresh human waste present during the sample. Sampling locations referenced are shown in Figure 5-3 on page 142. Presence of Human *Bacteroids* suggests contamination from the sewer system. All of the affected project locations have proposed BMPs which address sanitary sewer overflows through trunk replacement and sanitary sewer leaks and repair deficiencies through investigation.

Dog Bacteroidetes ID™ was used as the biomarker for dog waste. Low concentrations of Dog Bacteroidetes were identified at the following sites: WH-10, WH-13 and WH-17. Major Outfalls 45548 and 45095-L and Stream Site WH-16 exhibited positive results, but did not quantify. The following sites were analyzed for the presence of the dog biomarker, but the marker was not detected: 45530, 45044, 45034, 45035, 45027, 45005, 45017-R, 45513 and 45014-L. Sampling locations referenced are shown in Figure 5-4 on page 143. Overall dog waste was not identified at significant concentrations at any of the sampling locations in the watershed.

Bird Fecal Quantification ID™ was used as the biomarker for bird associated waste. This biomarker is present in birds including, but not limited to gull, goose, chicken, pigeon, and duck. This bird marker is generally not quantifiable due to the limitations of the method, but when quantifiable the results suggest significant bird waste. The Bird marker was detected to some degree at each sampling location. Major Outfalls 45530 (upstream of WH-4), 45044 (upstream of WH-8), 45034 (upstream of WH-14), 45027 (upstream of WH-16), 45005 (upstream of WH-17), 45017-R (upstream of WH-02), 45014-L (upstream of WH-20), 45515 (upstream of WH-22) and Stream Sites WH-10, WH-16 and WH-17 exhibited a positive result, though not quantifiable. Quantifiable results were detected at Major Outfalls 45548 (upstream of WH-7), 45095-L (upstream of WH-13), 45035 (upstream of WH-14), 45513 (upstream of WH-22), though at low levels. However, Stream Site WH-13 exhibited Bird biomarker concentrations considered to be in the 90th percentile for this specific marker indicating a substantial bird influence. As the Bird Fecal biomarker identifies birds of various species, it is not possible to isolate these results specifically to geese. The “general” Bird Fecal biomarker was chosen over the goose specific marker due to limitations of the goose specific marker in flowing water conditions. According to Source Molecular, the goose specific method is more reliable in lentic environments such as lakes and ponds. Sampling locations referenced are shown in Figure 5-5 on page 144. Based on these results, bird associated waste appears to be a significant factor in West Hickman Creek, especially in project locations WH-7, WH-13, WH-14, and WH-22. BMPs to reduce bird waste in the stream include stream and wetland restoration and development of riparian buffers which will discourage bird activity immediately near the stream and capture pollution from upstream runoff. Coordination with USDA will also provide insight on how to control bird fecal pollution.

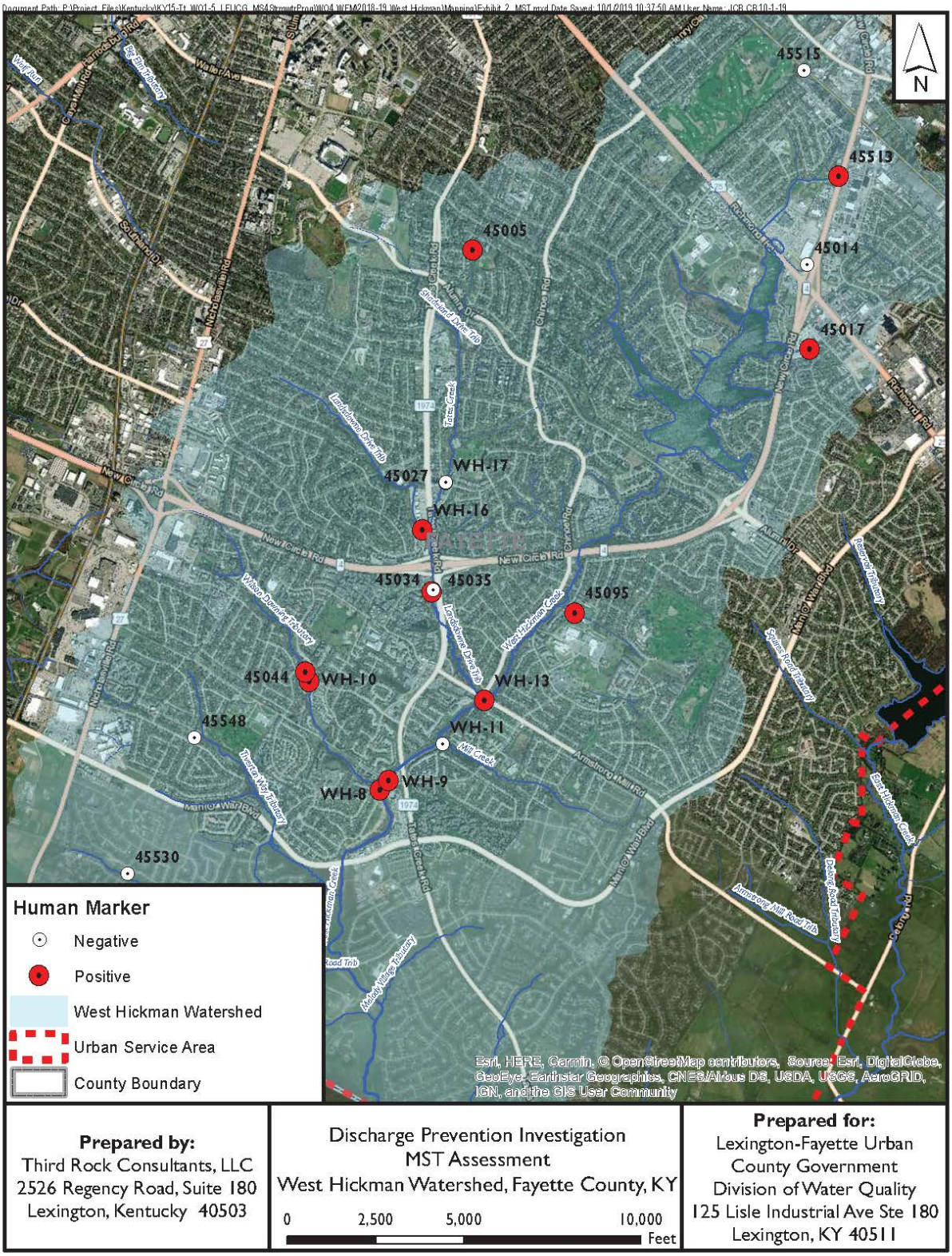


Figure 5-3: MST Assessment Human Biomarkers

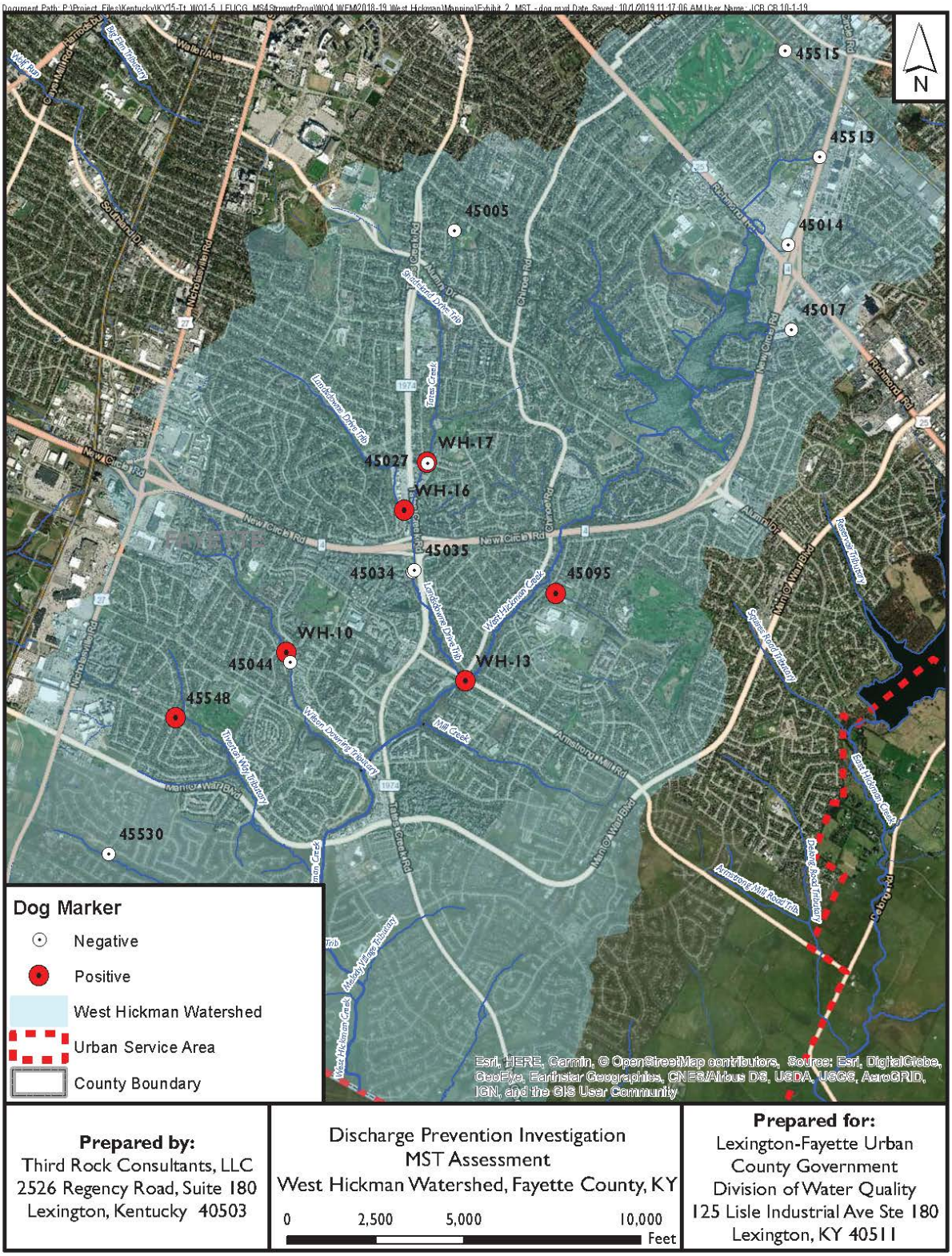


Figure 5-4: MST Assessment Dog Biomarkers

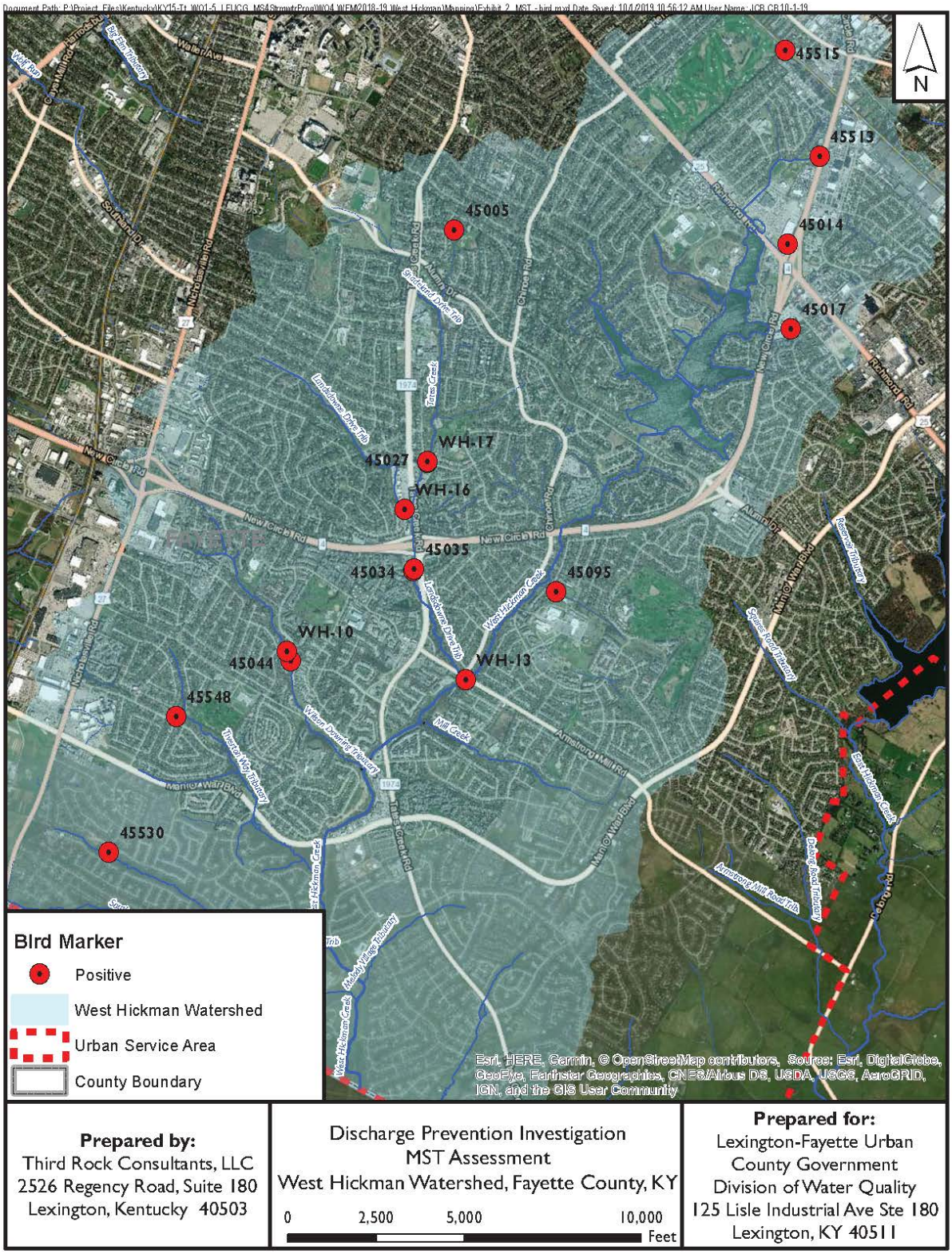


Figure 5-5: MST Assessment Bird Biomarkers

5.4 POLLUTANT LOADS AND TARGET REDUCTIONS

Pollutant load predictions in WHW were based on the concentration of the pollutant and the stream flow. The concentrations of the pollutants were utilized from the sampling results discussed in Section 4.3.2.2. Based on the requirements outlined in the Watershed Planning Guidebook for Kentucky Communities, pollutant loads were calculated for E. coli, nitrate-nitrogen, total phosphorous, and total suspended solids. Total Nitrogen was not one of the pollutants analyzed in all sampling events, so nitrate-nitrogen was utilized as the nitrogen load. Flow data was gathered as previously discussed in Section 5.3. Flow data calculations from LFUCG depth sampling was utilized at all sites. Flow data for each sampling event was also provided by LFUCG and KDOW. The discharge recorded at each sampling event is recorded in the tables in APPENDIX E.

The formula used for calculating yearly parameter loading for each site and each sampling event is provided for each parameter in the appropriate section. This formulas follow the framework below.

Parameter Loading	=	Concentration	x	Discharge	x	Variable Annual Load Conversion
(Unit/yr)		(Unit/Volume)		(cfs)		

Once parameter loading is calculated for each site during each sampling event, the yearly parameter loadings are averaged (using the arithmetic mean) to produce one calculated load per year. Using an average will capture concentrations from all of the following event types: dry, intermediate and wet. Each event type represents variable pollutant sources. Dry events are more controlled by background pollutant levels and point source inputs. Wet events are more controlled by non-point source runoff of pollutants. This is typical for most rural and suburban areas. In some urban areas, such as Lexington, sanitary sewer overflows can result in wet events also being controlled by point sources. Typical procedures call for use of the arithmetic mean to capture the influence of all event types. In the sampling events for this project, E. coli readings during the 6/18/2019 event are 3 to 4 magnitudes higher than other events due to documented SSOs and WWTP bypasses. The WWTP bypasses and SSOs that occurred within 48 hours of the sampling event are listed in Table 5-11 and Table 5-12. These SSOs are just the ones that were reported or observed. It is very likely that the watershed experienced other SSOs that are not known. This has a great impact on the average. To address this, a geometric mean will be used as opposed to an arithmetic mean for E. coli only. While an arithmetic mean uses the sum of numbers, a geometric mean uses the product of numbers to find a representative point. This difference enables the geometric mean to be more resistant to highly volatile datasets. In this case, the volatility comes from the 6/18/2019 event where so many known point source pollutants (SSOs and WWTP bypasses) influenced the data set.

Table 5-11: Reported Sanitary Sewer Overflows Preceding and During the 6/18/2019 Storm Event

Date	MH ID#	Address	Estimated Overflow Volume (Gallons)	WHWMP Subwatershed
6/16/2019	WH3 658	3422 Greentree Rd	658625	WH19
6/16/2019	WH3 658A	3431 Sutherland Dr	598750	WH19
6/16/2019	WH7 37	2300 Richmond Rd	449250	WH20
6/16/2019	WH7 982	3401 Richmond Rd	149750	WH20
6/16/2019	WH7 983	3401 Richmond Rd	149750	WH20
6/17/2019	WH1 1043	700 Southpoint Dr	103750	WH23
6/17/2019	WH1 1044	700 Southpoint Dr	103750	WH23
6/17/2019	WH1 1045'	700 Southpoint Dr	103750	WH23
6/17/2019	WH1 1046''	700 Southpoint Dr	103750	WH23
6/17/2019	WH1 1047	700 Southpoint Dr	103750	WH23
6/17/2019	WH1 1048	700 Southpoint Dr	103750	WH23
6/17/2019	WH1 455	787 Tyrus Ct	103750	WH23
6/17/2019	WH2 395A	1156 Appian Crossing Way	43500	WH11
6/17/2019	WH2181	3501 Lareedo Dr	100250	WH10
6/17/2019	WH3 56	3051 Kirklevington Dr	873000	WH14
6/17/2019	WH5 45A	3134 Montavesta Rd	153250	WH17
6/17/2019	WH6 645	2309 The Woods Ln	432000	WH20
6/17/2019	WH6 74	3538 Creekwood Dr	111750	WH19
6/18/2019	WH2 395B	1145 Appian Crossing Way	38250	WH11
6/18/2019	WH2 396A	1176 Appian Crossing Way	39750	WH11
6/18/2019	WH3 144	3051 Kirklevington Dr	74500	WH14
6/18/2019	WH3 354	3498 Greentreee Rd	29000	WH19
6/18/2019	WH3 55A	3051 Kirklevington Dr	37250	WH14
6/18/2019	WH3 67	3393 Tates Creek Rd	219750	WH16
6/18/2019	WH3 78C	3329 Tates Creek Rd	366250	WH16
6/18/2019	WH5 123	3117 Lamar Dr	35500	WH17
6/18/2019	WH5 166	260 Old Mt Tabor Rd	6250	WH17
6/18/2019	WH5 44A	3150 Montavesta Rd	390500	WH17
6/18/2019	WH5 45	3134 Montavesta Rd	7100	WH17
6/18/2019	WH6 102	3641 Barrow Wood Ln	7000	WH20
6/18/2019	WH6 104	3625 Barrow Wood Ln	7000	WH20
6/18/2019	WH6 75	3540 Creekwood Dr	14500	WH19
6/18/2019	WH6 98	3544 Creekwood Dr	79750	WH19
6/18/2019	WH7 280A	204 St Ann Dr	2500	WH20

Table 5-12: Unpermitted Bypasses During the 6/18/2019 Storm Event

Date	Facility ID	Address	Estimated Overflow Volume (Gallons)	WHWMP Subwatershed
6/16/2019	West Hickman WWTP	645 West Hickman Plant Rd	543600	WH23
6/17/2019	West Hickman WWTP	646 West Hickman Plant Rd	46500	WH23

5.4.1 E. COLI LOADING

Pollutant load predictions and target load reductions for E. coli were derived from the following formula based on the geometric mean:

E. coli Loading (CFU/yr) = Concentration (CFU/100mL) x Discharge (cfs) x 8,907,973,920 (Annual Load Conversion)

Table 5-13: E. coli Loading and Target Reductions Using Geometric Mean

Site ID	Area (Acres)	Calculated Load (CFU per year)	Benchmark Load (CFU per year)	Required Reduction (CFU per year)	% Target Reduction
WH-1	641	9.29351E+11	1.33726E+12	-4.07908E+11	0
WH-2	1213	2.89962E+13	2.02002E+13	8.79598E+12	30
WH-3	9664	3.11389E+14	1.69442E+14	1.41947E+14	46
WH-4	458	9.58784E+13	7.67797E+13	1.90987E+13	20
WH-7	779	7.08609E+12	9.15312E+12	-2.06703E+12	0
WH-8	933	3.95916E+12	1.66986E+12	2.2893E+12	58
WH-9	6464	7.89996E+14	2.4758E+14	5.42416E+14	69
WH-10	670	2.48777E+13	9.89675E+12	1.4981E+13	60
WH-11	388	5.53999E+13	2.42746E+13	3.11253E+13	56
WH-13	4225	7.08607E+13	3.05552E+13	4.03055E+13	57
WH-14	2088	3.88092E+14	1.36233E+14	2.51859E+14	65
WH-16	612	6.90841E+13	1.57573E+13	5.33268E+13	77
WH-17	918	1.6147E+13	8.15671E+12	7.9903E+12	49
WH-19	3359	1.85092E+13	5.48527E+13	-3.63434E+13	0
WH-20	2815	4.42855E+12	1.77033E+13	-1.32748E+13	0
WH-21	138	1.21024E+13	2.11462E+13	-9.0438E+12	0
WH-22	601	1.60909E+13	4.82068E+12	1.12702E+13	70
WH-23	13016	3.12813E+14	2.87336E+14	2.54773E+13	8

For E. coli loading calculations, the above formula was applied to the data from each sampling event. All sampling events were then averaged using the geometric mean to obtain an average annual load. Although a portion of WH is on the 303(d) list for impaired streams, no TMDLs have been provided by KDOW. The benchmark of 676 CFU/100 mL was used to calculate the target loads for secondary contact

recreation waters. Based on these calculations, the E. coli loading and target reductions are shown in Table 5-13. The reduction to achieve the target loading was calculated by subtracting the E. coli loading from the E. coli target loading. The percent reduction target was calculated by dividing the required value for the reduction to achieve the target loading by the E. coli loading present expressed as a percentage. E. coli loadings at Sites WH-1, WH-7, WH-19, WH-20 and WH-21 are below the E. coli target loadings. E. coli loadings at Sites WH-2, WH-3, WH-4, WH-8, WH-9, WH-10, WH-11, WH-13, WH-14, WH-16, WH-17, WH-22, and WH-23 all exceed E. coli target loading and will be targeted for reductions. Sites WH-1, WH-2, WH-3, WH-4, WH-23, WH-7, WH-9, WH-11, WH-13, WH-21 all had high E. coli concentrations which correlated with high flow estimates during storm events. This indicates that these sites are at risk for E. coli loadings during wet weather events. Site WH-8, WH-10, and WH-22 had high E. coli readings at low and high flow levels. Table 5-14 provides results for loading and target reductions if arithmetic mean was used to calculate load per year instead of geometric mean. Required reductions using this method are drastically higher than when using geometric mean. The difference between these numbers serves as a quantification of the impact SSOs during the 6/18/2019 event have on the required reductions.

Table 5-14: E. coli Loading and Target Reductions Using Arithmetic Mean

Site ID	Area (Acres)	Calculated Load (CFU per year)	Benchmark Load (CFU per year)	Required Reduction (CFU per year)	% Target Reduction
WH-1	641	1.20E+14	1.33726E+12	1.18663E+14	99%
WH-2	1213	2.81E+14	2.02002E+13	2.608E+14	93%
WH-3	9664	3.86E+15	1.69442E+14	3.69056E+15	96%
WH-4	458	1.54E+15	7.67797E+13	1.46322E+15	95%
WH-7	779	1.12E+15	9.15312E+12	1.11085E+15	99%
WH-8	933	1.78E+14	1.66986E+12	1.7633E+14	99%
WH-9	6464	1.07E+16	2.4758E+14	1.04524E+16	98%
WH-10	670	1.45E+15	9.89675E+12	1.4401E+15	99%
WH-11	388	1.19E+15	2.42746E+13	1.16573E+15	98%
WH-13	4225	3.14E+15	3.05552E+13	3.10944E+15	99%
WH-14	2088	7.08E+15	1.36233E+14	6.94377E+15	98%
WH-16	612	2.96E+15	1.57573E+13	2.94424E+15	99%
WH-17	918	9.78E+14	8.15671E+12	9.69843E+14	99%
WH-19	3359	1.37E+14	5.48527E+13	8.21473E+13	60%
WH-20	2815	1.25E+13	1.77033E+13	-5.2033E+12	0%
WH-21	138	4.35E+14	2.11462E+13	4.13854E+14	95%
WH-22	601	2.64E+14	4.82068E+12	2.59179E+14	98%
WH-23	13016	1.21E+16	2.87336E+14	1.18127E+16	98%

5.4.2 NUTRIENT AND TSS LOADING

Pollutant load predictions and target load reductions for nitrate-nitrogen, total phosphorous, and total suspended solids were derived from the following formula:

Nutrient/TSS Loading = Concentration x Discharge x 1968.80
(lbs/yr) (mg/L) (cfs) (Annual Load Conversion)

Table 5-15: NO3-N Loadings and Target Loadings

Site ID	Area (Acres)	Calculated Load (pounds/year)	Benchmark Load (pounds/year)	Required Reduction (pounds/year)	% Reduction Required
WH-1	641	3645.743673	874.422745	2771.320928	76%
WH-2	1213	22569.53403	13208.74083	9360.793195	41%
WH-3	9664	111121.3055	110796.7699	324.5356	0.3%
WH-4	458	148797.537	50205.60782	98591.92918	66%
WH-7	779	12162.23343	6195.700984	5966.532444	49%
WH-8	933	3244.6601	1091.909178	2152.750922	66%
WH-9	6464	153836.3277	161890.7555	-8054.427778	0%
WH-10	670	10874.58476	6471.402381	4403.182375	40%
WH-11	388	25490.05459	15872.95916	9617.095425	38%
WH-13	4225	12148.72498	19979.81591	-7831.09093	0%
WH-14	2088	176838.1803	89081.77111	87756.4092	50%
WH-16	612	26653.0809	10303.5427	16349.5382	61%
WH-17	918	12640.0149	5333.606323	7306.408572	58%
WH-19	3359	53019.49148	35867.72044	17151.77104	32%
WH-20	2815	7770.865738	11576.06622	-3805.200482	0%
WH-21	138	124643.6243	13827.33467	110816.2896	89%
WH-22	601	6320.204066	3152.201683	3168.002383	50%
WH-23	13016	582335.0333	187886.5937	394448.4396	68%

For TSS, nitrate-nitrogen and total phosphorous, the above formula was used for each sampling event and then all the values were averaged, using the arithmetic mean, together to obtain an average annual load. Some sampling results for nitrate-nitrogen, total phosphorous, and total suspended solids were reported to be below the detection limit. Since an exact value could not be assigned to these results, the value of the detection limit was utilized in the load calculations. Although a portion of WH is on the 303(d) list for impaired streams, no TMDLs have been approved by KDOW. The water quality benchmark concentrations in Table 5-2 were used for target load calculations, which were: 0.5 mg/L for total phosphorous; 2.0 mg/L for nitrate-nitrogen; and 80 mg/L for total suspended solids. Based on these calculations, the calculated and target loadings for nitrate-nitrogen are shown in Table 5-15, for total phosphorous in Table 5-16 and for total suspended solids in Table 5-17.

Table 5-16: Total Phosphorus Loadings and Target Loadings

Site ID	Area (Acres)	Calculated Load (pounds/year)	Benchmark Load (pounds/year)	Required Reduction (pounds/year)	% Reduction Required
WH-1	641	808.837988	97.75092	711.087068	88%
WH-2	1213	5130.142535	151.5976	4978.544935	97%
WH-3	9664	22082.37845	965.6964	21116.68205	96%
WH-4	458	19570.90497	914.5076	18656.39737	95%
WH-7	779	5283.414889	1496.288	3787.126889	72%
WH-8	933	600.1059616	1575.04	-974.9340384	0%
WH-9	6464	33961.93389	13486.28	20475.65389	60%
WH-10	670	5679.18796	1082.84	4596.34796	81%
WH-11	388	4609.680314	776.6916	3832.988714	83%
WH-13	4225	7045.97918	8022.86	-976.88082	0%
WH-14	2088	31500.47695	4232.92	27267.55695	87%
WH-16	612	3873.279525	1358.472	2514.807525	65%
WH-17	918	2487.179394	1890.048	597.1313945	24%
WH-19	3359	3503.927554	6359.224	-2855.296446	0%
WH-20	2815	1256.002829	5394.512	-4138.509171	0%
WH-21	138	18492.21364	284.4916	18207.72204	98%
WH-22	601	1646.126081	1082.84	563.2860806	34%
WH-23	13016	77490.47133	25102.2	52388.27133	68%

Nitrate-nitrogen loadings were above the benchmark load at the following five sites: WH-4, WH-16, WH-17, WH-21, and WH-23. All of these sites correlate with sites identified to have a high number of nitrogen exceedances in section 5.3.1. Only site WH-23 had total phosphorus loading above the benchmark. High nutrient levels at site WH-23 are expected being downstream of the wastewater treatment plant. Total suspended solids loadings were below target loadings at each site. Total suspended solids does not appear to be a critical parameter of concern within WH and no further analysis will be performed in this report.

Table 5-17: TSS Loadings and Target Loadings

Site ID	Area (Acres)	Calculated Load (pounds/year)	Benchmark Load (pounds/year)	Required Reduction (pounds/year)	% Reduction Required
WH-1	641	11945.13229	15640.1472	-3695.014914	0%
WH-2	1213	420193.8201	24255.616	395938.2041	94%
WH-3	9664	1507474.111	154511.424	1352962.687	90%
WH-4	458	674196.0014	146321.216	527874.7854	78%
WH-7	779	925287.4098	239406.08	685881.3298	74%
WH-8	933	29363.3392	252006.4	-222643.0608	0%
WH-9	6464	2543697.138	2157804.8	385892.3376	15%
WH-10	670	674872.3847	173254.4	501617.9847	74%
WH-11	388	167143.312	124270.656	42872.656	26%
WH-13	4225	902957.305	1283657.6	-380700.295	0%
WH-14	2088	1412876.431	677267.2	735609.2313	52%
WH-16	612	193941.4081	217355.52	-23414.11187	0%
WH-17	918	186903.1154	302407.68	-115504.5646	0%
WH-19	3359	366754.1538	1017475.84	-650721.6862	0%
WH-20	2815	131264.813	863121.92	-731857.107	0%
WH-21	138	901113.211	45518.656	855594.555	95%
WH-22	601	150866.1394	173254.4	-22388.26062	0%
WH-23	12504	1632291.177	4016352	-2384060.823	0%

Table 5-18: Conductivity Range at Each Site

Site ID	Minimum Conductivity	Maximum Conductivity
WH-1	375	828
WH-2	386	757
WH-3	334	693
WH-4	174	728
WH-7	308	871
WH-8	394	807
WH-9	375	717
WH-10	151	864
WH-11	484	1151
WH-13	251	589
WH-14	244	920
WH-16	153	654
WH-17	199	987
WH-19	249	851
WH-20	249	781
WH-21	79	828
WH-22	126	1119
WH-23	383	811

Conductivity is often used to estimate the total ion concentration of surface water and as an alternative measure of dissolved solids. Conductivity can vary as a function of flow. As flow decreases, the concentration of total dissolved solids may also increase, in turn increasing conductivity. Elevated conductivity can result from a number of factors, including the geology of the area, failing sewage systems, industrial discharges, fertilization, chemical application, and land disturbance. It is believed that elevated levels of conductivity occur within WH due to a combination of the limestone geology and clay soils of the region, and bacteria and nutrient contamination. Due to the limited flow information and suspected causes of contamination, loading for conductivity was not calculated. The practices applicable to reduction in E. coli and nutrient loadings will also address reductions in conductivity loading. Conductivity will not be analyzed separately from E. coli and nutrients in the remainder of this report. Table 5-18 indicates the highest and lowest conductivity values for each site.

5.4.3 ACHIEVING POLLUTANT LOAD REDUCTION TARGETS

The amount of pollutant reductions are presented in the previous sections for the West Hickman Watershed. Varying levels of reductions are required and proposed Best Management Practices (BMPs) will be presented in the following sections to address the pollutant reductions. To achieve benchmark pollutant levels, the following BMPs are suggested.

- Basin retrofit – 40 basins
- Tree planting – 28 acres
- Wetland – 8.5 acres
- Stream restoration – 13,000 feet
- Riparian vegetation – 4,500 feet
- Fecal matter control – 5 investigations
- Bank stabilization – 33,300 feet

Sanitary sewer investigation, repair, and sanitary sewer overflow removals are proposed to achieve significant E. coli reductions. Sanitary sewer investigation is proposed to be completed around specific neighborhoods with the goal of identifying sanitary sewer lateral leaks and repair deficiencies. Multiple sanitary sewer overflows exist in WH through various trunks. Many of these trunks are proposed to be removed or replaced as part of the LFUCG Remedial Measures Plan Program. Repairs and replacements with the Remedial Measures Program are anticipated to be completed by the end of 2026 in compliance with the Consent Decree deadlines. The load reduction obtained through replacement or repair will be difficult to estimate because fecal amounts are impacted by the magnitude of existing damage, flow demand in a subwatershed and fecal concentrations. Achieved reductions are proposed to be obtained through a two stage approach of project construction and post construction monitoring will be used. Based on these results, additional reduction needs will be identified. For suspended solids, phosphorus, and nitrogen loading, estimated load reductions were calculated for each BMP. Achieving significant reductions for pollutants will take the corporation and hard work of local government, non-profits, and volunteers.

6 BEST MANAGEMENT PRACTICES

6.1 GOAL, OBJECTIVE, AND BMP OVERVIEW

6.1.1 PUBLIC EDUCATION AND OUTREACH STRATEGY

The public education and outreach in the West Hickman watershed started with a dedicated effort of the creation of the West Hickman Watershed Council in 2017. Meetings were held by LFUCG staff to inform the public of water quality issues in WHW on at least an annual basis. LFUCG began the watershed-focused monitoring efforts in WHW in 2018 and completed the full watershed-focused monitoring in 2019. In summer of 2019, LFUCG advertised for an engineering consultant. The kickoff meeting with the selected consultant, Palmer Engineering, was held on August 7, 2019.

Originally it was intended to have West Hickman Watershed Council meeting at least biannually, but ideally quarterly, during the preparation of the WMP. The following meetings were held:

- October 1, 2019 – This meeting formally introduced the watershed management plan concept, explained a stakeholder survey on setting goals and objectives, and invited attendants to get involved through joining a subcommittee to aid in plan development. A total of 14 people attending this meeting. The low attendance was attributed to a location that proved to be difficult to locate. No interest was expressed in joining the presented subcommittees. The results of the stakeholder survey is discussed in Section 6.1.3.
- January 16, 2021 – This meeting was held in a more familiar location in the watershed and resulted in attendance by approximately 40 people. Results of the stakeholder survey were presented and proposed goals and working objectives were reviewed. Potential action items in the watershed were recorded for the future. The meeting lasted over two hours and included lots of valuable discussion and input.

With the rest of the world, the WMP public education and outreach plan was halted due to the global COVID-19 pandemic in March 2020. During the first wave of the pandemic from March 2020 through July 2020, the project was essentially put on hold as the hopes were that the virus would pass and plans could continue after the pause. By the end of summer 2020, it became apparent, that COVID-19 would be a cause for concern until at least a vaccine was publically available for all citizens. The sampling results were also delayed due to the global pandemic. Water quality data from KDOW was originally anticipated in May 2020, but results started to become available in September 2020 with all the final data not available until November 2021, further delaying report preparation process. In fall 2020, the project team shifted focus on brainstorming ways to engage the public virtually.

A virtual meeting of the West Hickman Watershed Council was held on Zoom on November 12, 2020. This meeting reviewed the now proposed goals and objectives based on the feedback from the January 16, 2020 meeting, summarized the sampling results from KDOW and LFUCG, and presented an online GIS mapping tool that was designed to collect public input on areas of concern, potential BMPs, and other information that the public would like to express to the project team. These digital data collection efforts are discussed in Section 6.1.5. Approximately 19 people attended the virtual meeting based on the number of registrations during the meeting.

With the hope of a return to normally brought by the availability of the COVID-19 vaccine in early 2021, the project team again temporarily paused to allow time for vaccination of the general public. During this

time, the information collected from the online mapping was utilized to create a list of potential BMPs and associated action Items that would aid in pollutant reductions to be meet the goals and objectives previously identified. It was the aim of the project team to hold an in-person public meeting in the early fall of 2021 to allow for vaccination of people in all priority groups.

As the fall grew closer, the Delta variant began to surge, again halting plans for in-person gatherings. Since the previous interactive map for data collection was successful, the project team proposed to create another map that indicated the proposed BMPs and action Items using a similar format. This effort is discussed fully in Section 6.1.6. To promote this map and try to engage more members of the community, two identical presentations of the West Hickman Watershed Council were made on Zoom:

- November 30, 2021 (7 PM, Tuesday evening) – approximately 10 attendants registered
- December 12, 2021 (4 PM, Sunday afternoon) – approximately 11 attendants registered

Before these meetings, the majority of this plan (chapters 2-5) was published on the Hickman Creek Conservancy website for community members to review and provide feedback. Information provided during the meeting, included descriptions of the types of proposed BMPs and demonstration on how they could be viewed on the online mapping platform. The meetings were promoted on social media through NextDoor and Facebook and notice was also provided to LFUCG City Council members for publication in their newsletters. Outreach and educations efforts will continue through presentation of the plan in 2022. The format of the meetings will be determined by the future pandemic and local health regulations for gathering. Regardless of conditions, the full draft will be promoted by social media, email and e-newsletters.

6.1.2 HICKMAN CREEK CONSERVANCY

Hickman Creek Conservancy (HCC) began forming in 2017 when efforts began to coordinate for the West Hickman Watershed. Through the meetings held by the council, leadership emerged, including enough interested individuals to incorporate a non-profit focused on the watershed. Hickman Creek Conservancy was incorporated on Jan 1, 2019, and is a 501c3 nonprofit organization. Funding to begin the organizational and outreach work for the HCC was provided by a Kentucky River Authority grant in 2019. HCC partnered with the LFUCG Division of Water Quality and Kentucky River Watershed Watch to help promote Lexington's Volunteer Focused Watershed Monitoring Program in order to increase volunteer involvement. HCC partnered with the LFUCG Division of Environmental Services to assist with the outreach involved with the watershed planning process for the West Hickman Watershed. HCC's status as a 501c3 non-profit enables them partner with local residents in order to fund projects using the LFUCG's Stormwater Quality Projects Incentive Grant Program. HCC works to build relationships and identify opportunities using this and other sources of funding. As the implementation of the WMP moves forward, HCC will be in integral partner. HCC also aided in publication of the West Hickman Watershed Council meeting through the website, Facebook, and other social media presence. HCC will continue to host the virtual map and final plan. LFUCG hires HCC annually to upkeep their website and maintain education.

6.1.3 WEST HICKMAN STAKEHOLDER SURVEY

A stakeholder survey was developed in September 2019 and responses were solicited until December 31, 2019 to aid in Watershed Management Plan direction and development of goals and objectives. These surveys were distributed by the following methods:

- September 2019 Hickman Creek Conservancy Meeting

- October 2019 West Hickman Watershed Council Meeting
- Email blasts through LFUCG with existing listserv and posts on social media apps
- Direct paper mailing to all property owners with parcels over 2 acres.

A total of 88 responses were received, which included 12 paper copy responses and 76 survey monkey (online survey website) responses. The survey included the following two questions:

1. How and why is West Hickman Watershed important to you?
2. What would you like to see come out of the Watch Hickman Watershed Plan?

Each question had 10 predetermined responses which were to be ranked based on importance from one to ten. One represented the most important while ten represented the least important. The first question, why is WH important to you, had the following ten responses:

- Water quality
- Erosion prevention
- Wildlife habitat
- Finite natural resource
- We live there!
- Aesthetic appeal
- Health concerns
- Quality of life
- Recreation
- Property values

The most important factor was ranked by the responses as water quality, followed by erosion prevention, wildlife habitat and finite natural resource. Table 6-1 provides average rankings for all ten responses to question one.

Table 6-1: Average Response Rankings for Survey Question One

Water Quality	3.19
Erosion Prevention	4.52
Wildlife Habitat	4.68
Finite Natural Resource	4.92
We live there!	5.06
Aesthetic Appeal	5.42
Health Concerns	5.82
Quality of Life	5.95
Recreation	7.04
Property Values	7.26

The second question, what would you like to come out of the WHWMP, had the following ten responses:

- Reduction of pollutants
- Increased native plantings
- Habitat creation
- Increased aesthetics
- Reduction of algae
- Education opportunities
- Safe stream recreation
- Funding opportunities
- Maintain/increase property value
- Community events

The most important take-away was reduction of pollutants, followed by increased native plantings and habitat creation. Table 6-2 provides average rankings for all ten response to question two.

Table 6-2: Average Response Rankings for Survey Question Two

Reduction of Pollutants	2.59
Increased Native Plantings	3.9
Habitat Creation	3.93
Increased Aesthetics	5.08
Reduction of Algae	5.55
Education Opportunities	5.7
Safe Stream Recreation	5.96
Funding Opportunities	6.92
Maintain/Increase Property Value	7.14
Community Events	7.54

6.1.4 GOAL AND OBJECTIVE SELECTION

To direct BMP selection, the project team, with the assistance of stakeholders, established goals and objectives for the WHW. Goals and objectives were selected based on existing watershed data, sampling results, stakeholder input, and engineering judgment. Public input was solicited through the stakeholder survey discussed in Section 6.1.3 and discussed in detail in the meeting of the West Hickman Watershed Council in January 2020. A list of potential goals was developed by the project team to be evaluated. The four goals that were considered for WHW were:

1. Improve water quality for aquatic life and recreational uses.
2. Improve stream and riparian zone habitat to support a healthy aquatic and terrestrial ecosystem.
3. Increase environmental awareness in the community, and provide educational resources about improving the watershed to area residents.
4. Improve aesthetic appeal of the stream corridors and waterways to encourage engagement with nature.

Goal selection provided a broad plan of action, but identified priorities that were not strictly measurable or tangible. Objectives were selected to assist in achieving the above identified goals. Objectives identified specific issues in the watershed and allowed for measurable benchmarks to be established to determine if they were accomplished. Specific discussions were held with key stakeholders on the measureable portions of the proposed objectives to provide realistic results in the watershed. For example, a meeting was held with Kentucky American Water to discuss their specific concerns and potential partnerships in November 2019. Table 6-3 provides information on which goals are addressed by each objective. The objectives included for consideration in WHW were:

1. Reduce nutrient impacts to benchmark concentration or by 50% to improve water quality and aesthetic appeal within 10 years.
2. Reduce total suspended solids (TSS) to benchmark concentrations through stormwater treatment, storage, redirection, and green infrastructure within 10 years.
3. Promote infiltration of stormwater flows to decrease velocity, reduce erosion, and remove pollutants through the installation of a minimum of one new structural or retrofitted measure per year.
4. Expand, maintain, and/or preserve stream riparian zone to a minimum of 25 feet on 1000 linear feet of the stream banks and waterbodies to filter runoff, reduce erosion, increase habitat, and promote citizen engagement per year.
5. Stabilize stream banks to reduce erosion and sediment inputs through a minimum of one project or a combination of projects totaling at least 1000 feet every three years.
6. Restore stream channel dimensions, pattern, and profile for improved habitat and recreational use through a minimum of one project per every five years.
7. Increase native plants throughout the watershed through a minimum of one acre of additional area per year.
8. Reduce human fecal inputs throughout the watershed to benchmark concentrations to allow for safe recreational use by 2026.
9. Reduce non-human fecal inputs throughout the watershed by 50% to allow for safe recreational use by 2030.
10. Inform the public of the water quality status and water quality impairments in West Hickman Watershed at least once per year.
11. Develop a minimum of two targeted educational materials for problem areas or water quality concerns per year.
12. Remove a minimum of 1 ton of trash and debris clogging waterways and enhance attraction to the area per year.
13. Engage the community and encourage recreation within the waterways through a minimum of two events per year.

Table 6-3: Goals Addressed by Each Objective

Objectives	Goal A: Water Quality	Goal B: Habitat	Goal C: Awareness	Goal D: Aesthetics
1	X	X		X
2	X	X		X
3	X	X	X	
4	X	X	X	X
5	X	X		X
6	X	X		X
7	X	X	X	X
8	X	X	X	
9	X	X	X	
10			X	
11	X	X	X	X
12	X	X	X	X
13			X	

6.1.5 PROJECT SOLICITATION ONLINE MAP

In an effort to provide an innovative way to collect data without having in-person public meetings. The project team and HCC collaborated to create an interactive GIS-based online map to collect community feedback. The map was hosted on the HCC website and allowed for stakeholders in the watershed to identify a concern or potential BMP in the watershed. The idea for the map was mimicked after a previous effort by the LFUCG Division of Planning efforts for bicycles and pedestrian improvements. The map allowed stakeholders to navigate to a map online in a fashion similar to Google Maps, pin a location, and submit information to the project team. An area was available for upload of photographs or other supplemental data that they would like for the project team to see. A screenshot of the interface is shown in Figure 6-1. The online map was launched on September 14, 2020 and closed for public input on December 2, 2020. A total of 27 responses were received from stakeholders. The information collected was utilized to propose BMPs and direct Action Items.

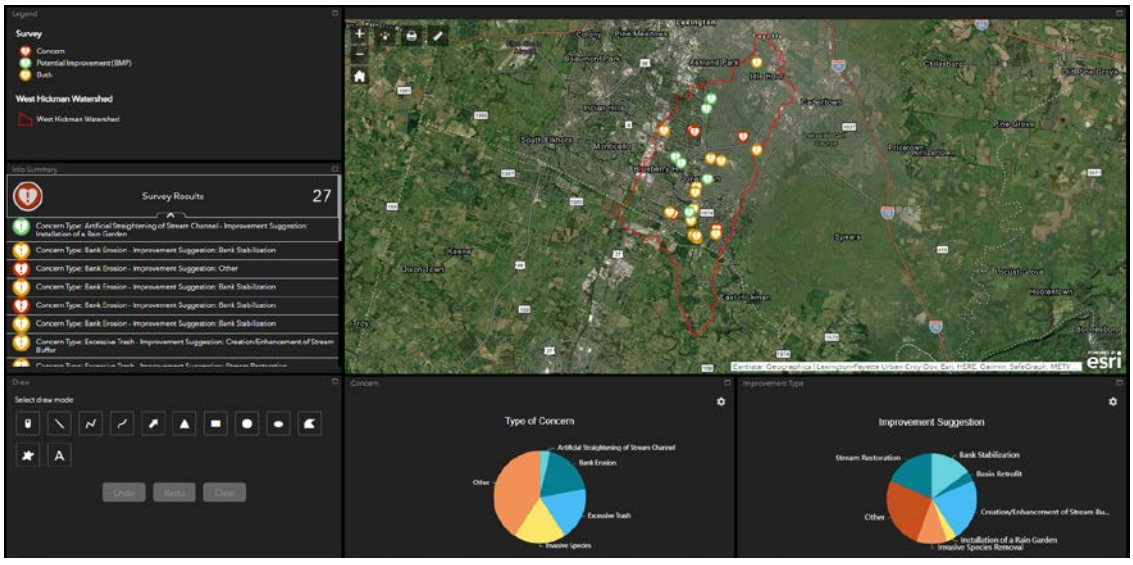


Figure 6-1: Project Solicitation Online Map Interface

6.1.6 PROPOSED BMPS ONLINE MAP

In November 2021, the project team developed an online map of all proposed BMPs recommended to date based on required pollutant reductions, stakeholder input, and engineering judgement. Proposed BMPs were displayed with a symbol for one of the following categories: basin retrofit, tree planting, wetland, stream restoration, sanitary sewer investigation, riparian vegetation, stream restoration/bank stabilization, green BMP, fecal matter control, bank stabilization, dam removal, riparian vegetation and bank stabilization, stream restoration/wetland and trash removal. Each project can be selected on the map to provide coordinates and more details on how the BMP will be implemented and expected results. Due to the amount of remaining work of the Remedial Measures Plan in West Hickman, the remaining sanitary trunk line projects are also shown and can be selected to provide name, project cost, and expected completion year.

This map was hosted on the HCC website and can be viewed by all interested parties. This map was presented at the virtual meetings on November 30 2021 and December 12, 2021. A screenshot of the interface is shown in Figure 6-2. The map was mostly designed as an information tool, but did allow for public comment. The map was closed for public comment on December 20, 2021. Two comments on proposed BMP additions were received by the project team through this public outreach effort.

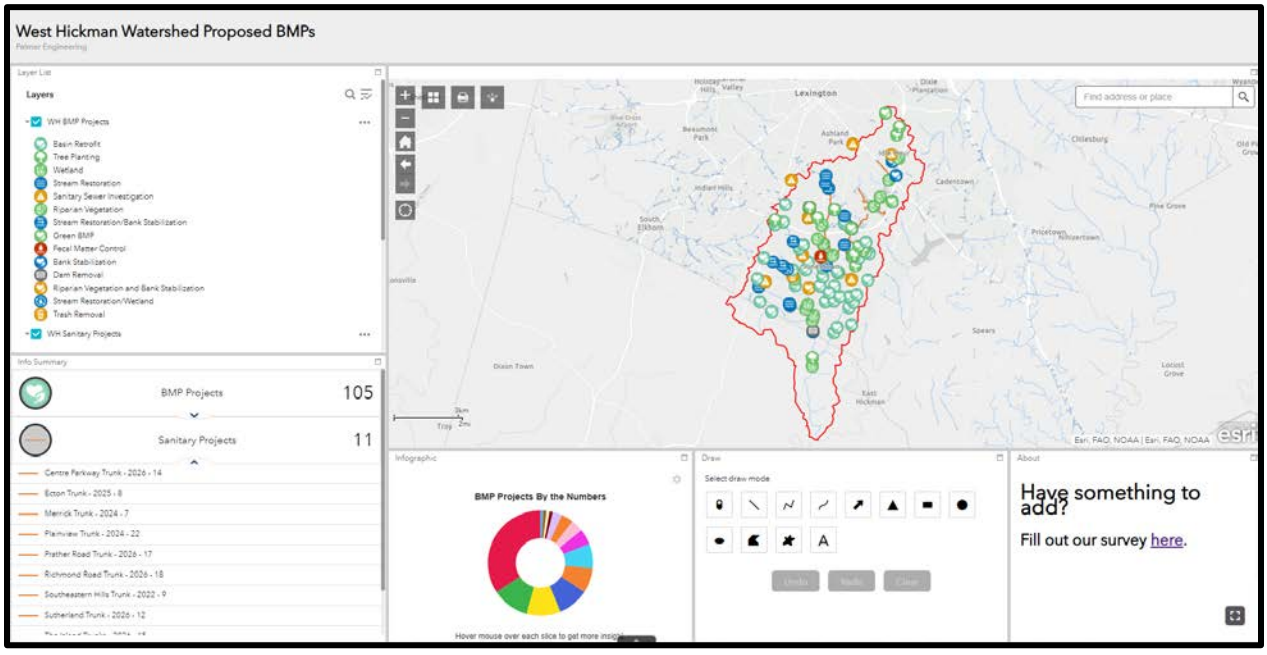


Figure 6-2: Proposed BMPs Online Map Interface

6.1.7 BMP FEASIBILITY

The project team took several items into consideration when evaluating the feasibility of a BMP for inclusion in the WMP. These considerations are discussed in the following sections.

6.1.7.1 STAKEHOLDER COOPERATION

Property ownership, private or public, will have a significant impact on the feasibility of construction in the watershed. Publicly owned lands, with the major stakeholder being the LFUCG, are much more likely to receive support. BMPs installed in publically owned lands have the advantages of easier funding

methods, streamlined coordination, and avoiding the need obtain landowner permission and participation. Proposed projects involving multiple landowners will often require long periods of time to coordinate with private parties who may all decide to terminate their cooperation at any time. Projects with public or a single private owner are preferred. Additionally, Jessamine County has jurisdiction over the majority of sub watershed WH-23. Jessamine County has previously communicated lack of funding to participate in this plan.

6.1.7.2 URBAN LIMITS

The vast majority of West Hickman Watershed exists in heavily urbanized city limits. This includes residential, commercial and industrial land uses. These land uses are all tightly packed and leave limited room for BMP options, which often call for drastic expansion of riparian width and development of wetlands. Private property acquisition represents a high cost. WH-21 in the upland areas of the watershed is particularly impacted by this limit as the entire watershed is tightly packed, privately owned residential homes. In areas with high development, green infrastructure is recommended to implement BMPs within the bounds of the existing constructed environment.

6.1.7.3 CONSENT DECREE REQUIREMENTS

The Consent Decree (United States 2006) contains compliance measures that relate to the storm sewer system, sanitary sewer system, and additional environmental projects. The Consent Decree requires implementation of remediation to the West Hickman Watershed sanitary sewer lines. Consent Decree schedules will not necessarily align with the goals presented in this plan. Proposed reduction estimations are made to incorporate the expected achievements under the Remedial Measures Plan.

6.2 BMP IMPLEMENTATION PLAN

6.2.1 SUMMARY OF BMPs

Eleven specific categories of BMPs have been identified for implementation in West Hickman. Implementing these BMPs in West Hickman is the primary action item proposed in this plan. Figure 6-3 provides a map of all suggested BMPs in the watershed labeled by BMP type. Table 6-4 provides an overview of suggested BMPs ordered by sub-watershed. This table lists, for every suggested BMP, geographic coordinates and street address. Each BMP is briefly described including which specific pollutants are addressed. The table provides responsible parties for cost and maintenance, estimate of project cost and information on what technical assistance may need to be provided to the community. Each BMP has listed amounts for load reduction for each of the four impairments. Many BMPs will address multiple pollutants. The table provides a list of possible funding sources to be explored on each project. Finally, a rough project time-table is proposed which lists short, medium and long term milestones. The following sections will summarize each BMP and detail how each will address pollutant concerns.

6.2.1.1 BASIN RETROFIT

A detention basin is an excavated area of land designed to capture stormwater and slowly release downstream. This provides advantages to water quality and quantity. Basins control the maximum volume of water which can flow out during storm events by installing small outlet pipes and orifices. A network of detention basins throughout the West Hickman Watershed can decrease the flashiness of the system. Water will be held back when flows are highest and then released when flow has calmed down. This impact on water volume helps reduce forces within the stream which contribute over time to bank erosion and damage to in-stream plant life. Trapping storm water in a single pervious area also allows for polluted

water to seep into the groundwater table where bacteria and microbes in the soil can naturally reduce pollutant levels over time. Basin retrofit BMPs propose to perform an analysis of existing basins with focus on determining how they can be improved by widening or redesign of the outlet structure and incorporation of additional measures to promote infiltration or uptake of water. A total of thirty six basin retrofit BMPs are suggested. Basin retrofits are expensive, but provide an immediate and significant improvement to water quality. Basin retrofits address goals 1, 4 and objectives 1, 2, 3, 4, 5, 6, and 12. In 2012, LFUCG completed an assessment of many basins and wetlands in WHC to determine which were suitable for potential improvements. This full assessment is located in APPENDIX A of this plan. The basin retrofit data sheets are located in Appendix A of the full assessment. Only some of the assessed basins and wetlands were selected for BMP implementation. The WHWMP BMP ID # is provided on all data sheets which describe a basin and wetland included in this plan. These data sheets specifically discuss which retrofit options are most appropriate for each site.

6.2.1.2 TREE PLANTING

Tree planting provides a number of unique benefits to the watershed. Tree leaves provide canopy cover when planted along the streambank which can reduce water temperatures and enable habitable conditions for in-stream life. Tree's extensive root systems help to stabilize soils both near the stream to reduce degradation of the stream bank and upstream to reduce sediment runoff erosion. Tree's roots will also uptake nutrients (nitrogen and phosphorus) from overland and groundwater flow as part of their natural growth processes. This update will reduce concentrations flowing in to the stream. Trees directly provide habitat to birds and small mammals who contribute to the ecological diversity of the West Hickman Watershed. Trees also provide a sense of beauty and appreciation for the natural environment which helps to increase community commitment to maintaining the quality of West Hickman Creek. Twelve tree planting BMPs are suggested. Tree planting on an individual scale is less expensive than other proposed BMPs and will not provide their benefits for a long period of time. The LFUCG Urban Forestry Management Plan provides recommendations which can be followed to qualify for grant funding. Tree planting addresses goals 1, 2, 4 and objectives 1, 2, 5, 6, 8, and 9.

6.2.1.3 WETLAND

Wetlands provide many of the same benefits as basin retrofits. Wetlands are areas of land which are permanently or seasonally flooded with water. During storm events, wetlands have the capacity to fill up and hold extra water which decreases flood risk and decreases downstream flow volumes. Sediments will also settle out in these wetlands resulting in lower TSS downstream. Wetlands often contain characteristic aquatic plants and offers one of the most biologically diverse environments of plant and animal life. Underwater soils in wetlands are blocked off from oxygen in the air, resulting in anoxic processes. Denitrifying bacteria in these soils utilize the oxygen from nitrate in a process which releases harmless N_2 gas. This results in the perfect conditions for nutrient reduction in groundwater. Wetlands have also been shown to reduce human fecal concentrations. Wetlands also trap and hold carbon for long periods of time which helps to reduce the severity of CO_2 emissions contributing to global warming. Eleven Wetland BMPs are suggested. Wetland development can be both cheap and expensive depending on the existing potential for wetland in an area. Wetland development addresses goals 1, 2, 4 and objectives 1, 2, 3, 4, 5, 7, 8 and 9. In 2012, LFUCG completed an assessment of many basins and wetlands in WHC to determine which were suitable for potential improvements. This full assessment is located in APPENDIX A of this plan. The basin retrofit data sheets are located in Appendix A of the full assessment. Only some of the assessed basins and wetlands were selected for BMP implementation. The WHWMP BMP ID # is provided on all data sheets which describe a basin and wetland included in this plan. These data sheets specifically

discuss which retrofit options are most appropriate for each site.

6.2.1.4 STREAM RESTORATION

Stream restoration is an all-inclusive process addressing the environmental health of a stream to support bio-diversity, recreation, flood management or landscape development. West Hickman Creek has been degraded over time due to natural and human induced factors. Frequent spans of WHC experience severe undercutting where high flow velocities over time have dug into the stream banks, first degrading the side slopes from at a smooth angle to a flat side, then cutting down and lowering the elevation of the stream bed. These changes result in streams which are more at risk for erosion and further damage because water is flowing faster and banks are less protected. West Hickman Creek is also at risk from nutrient pollution as discussed in previous chapters which makes streams uninhabitable to many forms of plant and animal life. Stream habitats have eroded over time along with the channel degradation. Fast stream flows and weak banks compound to make streams dangerous for human recreation.

Stream restoration BMPs proposed to holistically address these problems by redesigning the stream and implementing many small scale technologies which promote stream health. Restoration begins with earthwork, the stream channel will be raised to its natural level at a steady slope to reduce velocities. Side slopes will be redesigned to better resist erosion. The stream channel will often also be altered from straight and narrow to wide and windy. A curvy channel will produce much more turbulence in the water which will reduce flow velocities. Stream habitat will further be improved with instillation of in-stream structures such as rocks and large logs for fish and critters to enjoy. Finally, stream anatomy will be addressed by installing a system of pools, riffles and runs. This provides variation from deeper wider ponds to thin higher stretches with rock bedding where flow velocities pick up. Pools, riffles and runs will increase the biodiversity of a stream by providing wide range of habitats for fish and insects. Sixteen stream restoration BMPs are suggested. Stream restoration is expensive and requires maintenance over time, but provides an immediate and significant improvement to stream health. Stream restoration addresses goals 1, 2, 4 and objectives 1, 2, 5, 6, 7, 8, and 9.

6.2.1.5 SANITARY SEWER INVESTIGATION

Historically, storm and sanitary systems in the United States were designed as combined sewer systems or dedicated sanitary sewer systems. Dedicated sanitary sewer systems are different than combined systems in that they are not designed to collect stormwater. LFUCG does not maintain any combined sewer systems. Dedicated sanitary sewer systems do occasionally release raw sewage when maximum capacity is reached as SSOs. Sewer systems can back up and overflow into homes or public areas, releasing raw sewage. LFUCG has multiple sanitary sewer projects which are planned to be completed over the next few years through the Remedial Measures Plan. Reported SSOs will be targeted for removal as well as investigation to locate unreported SSOs. Sanitary sewer investigation BMPs will further investigate potential breaks, leaks, or cross contamination in areas not associated with the Remedial Measures Plan. Issues may also be present on sanitary sewer laterals, which are owned and maintained by individual property owners instead of LFUCG. Some private lines, built between 1950 and 1970, are Orangeburg pipes made of hot pitch and wood pulp. These pipes were mass produced due to their inexpensiveness but have proven to be vulnerable to water damage over time. Each individual property owner would be responsible to ensure private lines are maintained to avoid groundwater pollution.

In addition to replacement of existing sanitary systems, it is vital to perform regular maintenance on existing systems. To perform these checks, technicians will access the sewer systems through manholes and run a small CCTV camera through each length of pipe in a way which provides a clear view of the

inside of each length of pipe. Investigators will look for cracks, leaks, holes and areas where pipes are disconnected, all which allow for sewage to escape the system and contaminate groundwater. LFUCG completes much of this work as a part of their Capacity, Management, Operation and Maintenance (CMOM) program, but additional investigations in some areas are warranted, especially on private lines. Thirty four sanitary Sewer BMPs are suggested. Sanitary sewer BMPs can be inexpensive for monitoring and expensive for replacement, depending on the defect found. Sanitary sewer investigation addresses goals 1, 2 and objectives 1, 8 and 9.

6.2.1.6 RIPARIAN VEGETATION

Riparian vegetation is a powerful tool, provided by nature, to fight nutrient and fecal pollution in West Hickman. Riparian vegetation, or a riparian buffer, is the area of land on each side of a stream. Riparian vegetation includes grass, flowers, shrubs, bushes, vines, weeds and trees. Types of vegetation will vary based on the unique ecosystem of each stream. Optimally, riparian buffers will be designed in such a way that larger plants such as trees line the streambanks directly and smaller shrubs and grasses will fill in as one gets further away from the stream. The riparian buffer provides many benefits to stream health. The buffer acts as a physical barrier to stormwater flow, slowing it down and reducing in-stream velocities. Root systems also intertwine with soils upstream and along streambanks to stabilize and resist the potential for erosion. Through the process of bio-filtration, plants also absorb nitrogen, phosphorus and fecal matter in their natural processes of growth thus reducing pollution to the stream. Finally the riparian buffer provides a healthy ecosystem for wildlife along the stream.

Riparian buffers naturally occur along all streams. Recommended width of the riparian buffer depends on the primary motivation one has. For bank stabilization, 10 feet is recommended. For erosion control, 30 to 100 feet is needed. For water quality, 20 to 170 feet has been shown to be effective. For aquatic and overland habitat, up to 300 feet may be recommended. Over time, humans have encroached upon the area in an effort to utilize as much land as possible and to appreciate the natural beauty of the stream. Homeowners with streams on their property will often trim their lawn right up to the edge of the streambank, eliminating the riparian buffer. In public areas where development is more feasible, riparian buffers are proposed for development along at-risk lengths of West Hickman. In private areas, education practices are proposed to ensure homeowners understand the benefits of the riparian buffer in an effort to preserve them for years to come. Eight riparian vegetation BMPs are suggested. Riparian vegetation can be totally free if allowed to grow on its own. More expensive options include larger scale planting of trees and shrubs in long stretches of WHC.

One point to consider for riparian vegetation in private locations such as residential backyards are the willingness for private owners to allow the vegetation on their property. Riparian vegetation can vary in aesthetic appeal. Heavily clustered weeds and shrubs can be considered ugly by some. More appealing vegetation such as wildflowers often take years to grow. Many homeowners prefer to maximize the space they own, and bushy riparian vegetation is far from the tidy lawn most homeowners are accustomed to. In these cases, it will be important to give homeowners ownership of the buffer. This can be done by providing a catered list of native plants for homeowners to select from. This list can include plants with shorter above ground length and wider rooting depths to maximize the below ground support and minimize above ground visual impact. Riparian vegetation addresses goals 1, 2, 4 and objectives 1, 2, 3, 4, 6, 7, 8 and 9.

6.2.1.7 GREEN BMP

Green BMP is a broad category describing technologies and methods which can be used to promote health

in the West Hickman Watershed. One example of a green BMP is permeable pavement. While most pavement acts as a water slide for rain to travel as fast as possible to West Hickman, picking up nutrient and fecal pollution, permeable pavement allows water to seep through and into the groundwater table. This helps to decrease stream velocities and serve as a filter for pollutants. Green BMPs are required for new developments in Lexington, including infiltrating a volume of water on site after an increase in impervious area. This is done through installation of extended detention basins, bio-retention zones and rain gardens. Bioswales are an additional developmental BMP. Bioswales are channels designed to convey stormwater downstream while removing maximum amounts of debris and pollutions. This is done by lining the swale with heavy vegetation. Many measures are suggested for education on an individual scale. This includes rain barrels, composting, planting, and downspout disconnections. Green BMPs include methods with address every goal and objective.

6.2.1.8 FECAL MATTER CONTROL

Fecal matter can pollute in to West Hickman from many sources. Both human and animal fecal matter have been found to pollute West Hickman Creek in significant levels. Human sources are directly addressed through other proposed BMPs such as the Remedial Measures Plan projects and sanitary sewer investigation. Animal fecal matter can runoff into the stream from farm and domestic animals if not properly controlled. Lexington is more at risk from dog and cat fecal matter in residential areas. Public education BMPs aim to educate pet owners on the dangers of unattended fecal matter and to encourage sustainable disposal. Birds such as ducks and geese who live in and around West Hickman will also produce fecal pollution directly into the stream. These birds can be deterred from being near stream banks with the instillation of the riparian buffer. Geese tend to graze where they have open sight lines, access to water, and where they can see and escape predators. The reasons making urban ponds attractive to geese are the same reasons that they are unattractive to their natural predators, there is no cover. Where geese graze they leave fecal pollution. To reduce the problem, the goals are to reduce food, reduce preferred nesting and brood-rearing areas, and increase the sense of insecurity from danger. Trees and vegetation will also defend the stream by reducing pollutant levels in contaminated water.

The USDA will be consulted to address wildlife fecal pollution to discuss options on what LFUCG can do to control populations to sustainable levels. Five fecal matter control BMPs are suggested. Fecal matter control ranges in price depending on which BMP is utilized. Fecal matter control addresses goals 1, 2 and objectives 1, and 9.

6.2.1.9 BANK STABILIZATION

Destabilized banks increase risk of stream bank erosion and further degradation over time. Eroded banks result in conditions where water will travel faster which puts the stream more at risk. Erosion will lead to deep cuts in the stream bank and loss of structural integrity so that large volumes of soil can slump and wash away in the stream. This destroys bank vegetation and results in heavy soil pollution downstream. Bank stabilization can be carried out lining the soil large rocks or gabion baskets (metal cages filled with smaller rocks). This protection can also be provided through more natural means with logs, twigs and plants which promote stream habitat. Three bank stabilization BMPs are suggested. Bank stabilization is moderately expensive but provides an immediate and often critical safety net for bank health. Bank stabilization addresses goals 1, 2, 4 and objectives 2, 4, 5, and 6.

6.2.1.10 DAM REMOVAL

In the US, many historically constructed dams are no longer needed for water control and have been left

in disrepair. The unnecessary dam and eroded banks can cause a safety risk and result in significant sediment accumulation and poor aquatic habit. Removal of the dam can eliminate safety risks associated with steep banks, improve water quality and ecological habitat, and improve aesthetics. This is particularly the case for the one suggested BMP that falls in this category in the West Hickman Watershed. A previous study, preliminary design, and cost estimation was completed by the joint project team of Ridgewater, EcoGro, and Stantec Consulting Services for the Veterans Park Dam. The full text of this report is provided in APPENDIX C. Dam removal addresses goals 1, 4 and objectives 5 and 6.

6.2.1.11 TRASH REMOVAL

As with most urban environments in the United States, West Hickman is at risk from improper human waste disposal. Trash from plastic bags and Styrofoam cups to tires and mattresses can be found in WHC and its tributaries. Trash can include the discussed pollutants of nutrients, fecal and more dangerous pollutants such as toxins and carcinogens. Regularly held public cleanups and education on the effects of waste disposal in to the stream can help to reduce pollution in WHC. One trash Removal BMPs is suggested. Trash removal is often done by a force of volunteers, but requires coordination which can be difficult in some neighborhoods and typically has to be repeated at regular intervals to remain effective. Trash removal addressed objectives 1, 2, 3, 4 and goals 10, 12 and 13.

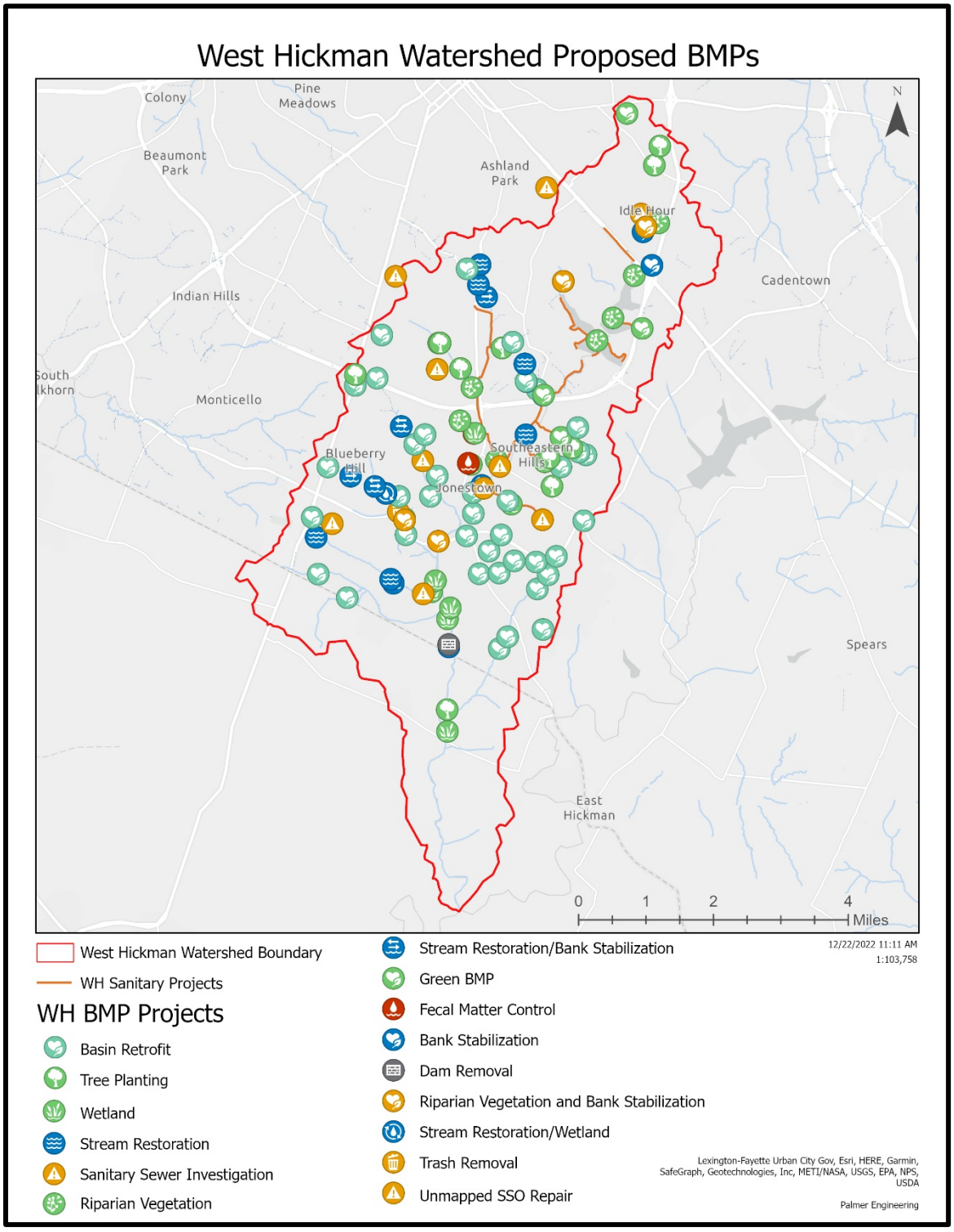


Figure 6-3: Proposed BMP Location Map

Table 6-4: Proposed West Hickman BMPs and Action Item List

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
00-01	Public Education and Outreach	N/A	N/A	General Public	Educate the public on proper disposal of pet waste. Provide pet waste disposal stations and organize efforts to maintain.	9	WAH / Trash and Debris	HCC, HOA and NA	$1 per copy, material design costs of $2,000-$5,000					319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Material Preparation	Educational Package Development and initial implementation	Ongoing Implementation	Ongoing Implementation
00-02	Public Education and Outreach	N/A	N/A	General Public	Educate the public on proper disposal of litter and debris. Encourage/organize trash collection efforts. Provide trash collection and recycling containers in areas commonly used by the public.	8	WAH / Trash and Debris	HCC, HOA and NA	$1 per copy, material design costs of $2,000-$5,000					319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Material Preparation	Educational Package Development and initial implementation	Ongoing Implementation	Ongoing Implementation
00-03	Public Education and Outreach	N/A	N/A	General Public	Provide education opportunities to allow the public to engage with nature	7	Education and Outreach	LFUCG, HCC	Varies by event					HCC, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Material Preparation	Educational Package Development and initial implementation	Ongoing Implementation	Ongoing Implementation
00-04	Public Education and Outreach	N/A	N/A	General Public	Establish Stream Access Points	6	Education and Outreach	LFUCG, HCC	Minimal					HCC, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Access Coordinaiton	Ongoing Implementation	Ongoing Implementation	Ongoing Implementation
00-05	Public Education and Outreach	N/A	N/A	General Public	Educate the public on measures they can implement at their home and for relatively low costs (downspout disconnections, pervious pavers, rain gardens, rain barrels, etc)	5	Education and Outreach	LFUCG, HCC	$1 per copy, material design costs of $2,000-$5,000					HCC, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Material Preparation	Educational Package Development and initial implementation	Ongoing Implementation	Ongoing Implementation
00-06	Tree Planting	N/A	N/A	General Public	Educate the public on native plant and tree benefits and encourage planting; provide resources and tools to complete installation	12	Education and Outreach	LFUCG, HCC	Vaires based on scope					HCC, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Material Preparation	Educational Package Development and initial implementation	Ongoing Implementation	Ongoing Implementation
00-07	Trash Removal	N/A	N/A	General Public	Identify additional locations of high trash accumulation and organize removal	1	WAH / Trash and Debris	LFUCG DEP, LFUCG Parks, Keep Lexington Beautiful Commission	Varies by event					HCC, Keep Lexington Beautiful's Great American Cleanup	Cleanup Event Coordination, Supplies	Continue annual cleanup event	Continue annual cleanup event	Continue annual cleanup event
01-01	Basin Retrofit	37.9657	-84.47865	Between Trout Court and Man O'War	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, limit mowing to protect utilities only, native plantings, and expanding basin on Church property	140	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		4.334540154	1.752863832	14.1067259	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
01-02	Basin Retrofit	37.96253	-84.48043	4815 Hartland Woods Court	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, addition of meanders in flow path, forebay, native plants, and trees, and removal of excessive trash/debris	139	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		26.19057495	10.59132225	85.23701453	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
01-03	Basin Retrofit	37.96016	-84.48274	1221 Kenesaw Village Dr	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, tree and native vegetation planting, and incorporation of no mow buffers	138	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		39.28586242	15.88698337	127.8555218	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
01-04	Basin Retrofit	37.9533	-84.48151	4829 Chaffney Lane	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional native and tree plantings, and installation of educational BMPs	137	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		7.870267772	3.182692335	25.61372287	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
01-05	Basin Retrofit	37.95007	-84.49089	4700 Brookside Way	Retrofit basin to create a wetland, install trees and native vegetation to increase infiltration, incorporate no mow buffers, and install educational BMPs	136	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		103.452771	41.83572287	336.6862074	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
01-06	Basin Retrofit	37.95205	-84.48912	4865 Tates Creek Road	Retrofit basin to expand the existing wetland areas by 0.5 acres, install trees and native vegetation to increase infiltration, incorporate no mow buffers, and install educational BMPs	135	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale	65457617188	1.309528747	0.441305094	4.794582067	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
01-07	Riparian Vegetation	38.00173	-84.50362	Landsdowne neighborhood	Install 1300 ft of riparian buffer to aid in pollutant removal and removal of wildlife fecal matter and nutrients	119	WAH / Habitat Improvement, TSS, Nutrients	Landsdowne NA, HCC	$15 - $20 / lin ft riparian	3.90702E+11	97.5	91	58344	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Plant Materials, Maintenance Supplies, Botanist / Biologist, Volunteer Support	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
02-01	Basin Retrofit	37.96266	-84.52971	264 Southpoint Dr	Basin retrofit to improve pollutant removal and infiltration, including planting of trees and native vegations, incorporation of no mow buffers, and nautralization of the stream channel	118	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		786.599258	296.158615	5776.03247	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
02-02	Basin Retrofit	37.95867	-84.5235	4545 Mandeville Way	Basin retrofit to improve pollutant removal and infiltration, including planting of trees and native vegations, incorporation of no mow buffers, and nautralization of the stream channel	117	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		559.8319044	210.7795548	4110.869956	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
02-03	Sanitary Sewer Investigation	N/A	N/A	Southpoint neighborhood	Investigate 185 potential sources of sanitary sewer lateral leaks and repair deficiences in the WH-02 subwatershed.	95	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	Video Inspection at $350/hour	2.90358E+14	2960	1480		319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
02-04	Riparian Vegetation	38.00173	-84.50392	Landsdowne neighborhood	Install 10,000 ft of riparian buffer to aid in pollutant removal and removal of wildlife fecal matter and nutrients	82	WAH / Habitat Improvement, TSS, Nutrients	Landsdowne NA, HCC	$15 - $20 / lin ft riparian	3.0054E+12	750	700	448800	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Plant Materials, Maintenance Supplies, Botanist / Biologist, Volunteer Support	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.
03-01	Riparian Vegetation and Bank Stabilization	37.96823	-84.50398	Belleu Wood park	Stabilize stream banks and remove invasive species; install native plants and trees; install stormwater wetlands adjacent to stream to filter runoff from neighborhood prior to entering the stream channel	28	WAH / Habitat Improvement, TSS, Nutrients	Belleau Wood NA, LFUCG Parks, HCC	$15 - $20 / lin ft riparian, $15 - $20 per foot of bank stabilization		15	14	8976	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Plant Materials, Maintenance Supplies, Botanist / Biologist, Volunteer Support	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate. Bank stabilization will require consultants design and installation.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
03-02	Wetland	37.96154	-84.5046	Park North of Clearwater Way	Create 1 acre of stormwater wetland and route neighborhood drainage through wetland prior to entering stream channel	107	WAH / Habitat Improvement, Nutrients, TSS, E. coli	LFUCG Parks, LFUCG DWQ, Consultants	Wetland: $30,000 - $40,000 / acre		969.0005318	259.5307947	8202.807401	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding, private funding	Designers, Contractors	Phase I: 1) Meet with Parks staff to evaluate support, 2) Secure funding, 3) Project Design	Phase II: 1) Conduct pre- and post construction monitoring, 2) Construction	Ongoing monitoring and maintenance
03-03	Basin Retrofit	37.96932	-84.5109	Retention pond near Man-o-war and clearwater, 4000 clearwater way	Basin retrofit to improve pollutant removal and infiltration, including wetland creation, installation of forebay, and native plantings	109	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		1857.109848	596.8754553	13974.09109	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
03-04	Basin Retrofit	37.96912	-84.4979	941 Chas Drive	Investigate basins for retrofit to increase infiltration, reduce stormwater velocities, and increase settling time	108	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		21.17571092	6.805877483	159.3396931	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
03-05	Wetland	37.95967	-84.5054	Veterans Park	Create 1 acre of stormwater wetland and route neighborhood drainage through wetland prior to entering stream channel	106	WAH / Habitat Improvement, Nutrients, TSS, E. coli	LFUCG Parks, LFUCG DWQ, Consultants	Wetland: $30,000 - $40,000 / acre		1023.210352	274.05	8661.705717	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding, private funding	Designers, Contractors	Phase I: 1) Meet with Parks staff to evaluate support, 2) Secure funding, 3) Project Design	Phase II: 1) Conduct pre- and post construction monitoring, 2) Construction	Ongoing monitoring and maintenance
03-06	Fecal Matter Control	38.00173	-84.50362	Areas of open water	Investigate options for reduction of fecal matter from wildlife through limiting access to the water through a riparian buffer, coordination with the USDA, or other means	115	WAH, Water Quality, Bacteria	LFUCG DWQ, Consultants	$3500 per area	1.7885E+14	9.73	3.65		319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
03-07	Green BMP	37.969776	-84.502032	Belleau Woods Park south / Veterans Park	Increase access along West Hickman with a new trail connecting Belleau Woods Park south and Veterans Park	96	WAH / Water Quantity, TSS, P, N	LFUCG Parks, LFUCG DWQ, Consultants	$150 per linear foot of trail construction					319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Designers, Contractors	Option investigate and analysis	Implementation	Monitoring and maintenance

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
04-01	Stream Restoration	37.96112	-84.51363	Adjacent to Brookridge Greenway, Private Property	Repair 50 ft of stream channel at storm sewer outlet and install riparian buffer	51	WAH / Habitat Improvement, Nutrients, TSS	LFUCG Parks/ Landowners/ LFUCG DWQ, Urban County Council, WRWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 -$15 / cubic foot	15027001191	4	3.5	2244	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
04-02	Stream Restoration	37.9618	-84.5142	End of Creek Valley Way (1st culdesac)	Repair 150 ft of stream channel at location of scour and install riparian buffer	50	WAH / Habitat Improvement, Nutrients, TSS	Landowners, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot	45081003573	12	10.5	6732	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
04-03	Stream Restoration	37.96888	-84.53019	Higbee Mill Road Tributary at Cobblestone Rd & Old Nicholasville Rd	540 ft of stream restoration and greenway connectivity to reduce pollutants, including invasive species removal, bank stabilization, and native plantings	49	WAH / Habitat Improvement, Nutrients, TSS	Landowners, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot	1.35243E+11	36	31.5	20196	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
04-04	Basin Retrofit	37.97226	-84.531	4305 Cobblestone Knoll Dr	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, forebay, native plants, and trees, and removal of trash/debris	86	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		1854.05403	454.2470225	2088.270361	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
04-05	Stream Restoration	37.96177	-84.5142	Brookridge Greenway	Repair 350 ft of stream channel at location of headcut and install 50 ft wide riparian buffer	48	WAH / Habitat Improvement, Nutrients, TSS	LFUCG DWQ, Urban County Council, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot	52594504168	28	24.5	15708	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
04-06	Sanitary Sewer Investigation	37.97119	-81.52675	Pickway Neighborhood	Investigate 60 potenial sources of sanitary sewer lateral leaks and repair deficiences in the Pickway neighborhood or adjacent areas.	22	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	Video Inspection at $350/hour	9.417E+13	960	8920		LFUCG Water Quality Incentive Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance

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04-07	Sanitary Sewer Investigation	37.97119	-81.52675	Full Subwatershed	Investigate 1,115 potenial sources of sanitary sewer lateral leaks and repair deficiences.	21	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	Video Inspection at $350/hour	6.99997E+14	17840	360		LFUCG Water Quality Incentive Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
04-08	Unmapped SSO Repair	N/A	N/A	Full Subwatershed	Investigate 15 reported and identify possible unreported sanitary sewer overflow locations	20	WAH / Water Quantity, P, N, E. coli	LFUCG DWQ		N/A	75000	7500		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
07-01	Stream Restoration/Wetland	37.97631	-84.51521	Meadowbrook Golf Course	Stream restoration to reduce pollutants and investigate creating 0.5 acres of streamside wetlands, including bank stabilization, native plantings, and channel naturalization	120	WAH / Habitat Improvement, TSS, Nutrients	LFUCG DWQ, Urban County Council, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot, Wetland: $30,000 - $40,000 / acre	65457617188	58.13022872	284.8	452.9788152	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
07-02	Stream Restoration/Bank Stabilization	37.97748	-84.51759	Meadowbrook Park	400 ft of stream restoration to reduce pollutants and investigate creating streamside wetlands, including bank stabilization, native plantings, and infiltration practices	122	WAH / Habitat Improvement, TSS	LFUCG Parks,WHWC, Consultant(s)	Stream Restoration: $400 - 600 / foot for design and construction, Excavation: $12 - $15 / cubic foot, $15 - $20 per foot of bank stabilization	1.20216E+11	32	28	17952	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
07-03	Stream Restoration/Bank Stabilization	37.97922	-84.52279	Tributary adjacent to East Tiverton Way (Nicholasville Road to Havard), Multiple private property owners along East Tiverton Way	1000 ft of sream restoration to reduce pollutants and remove excessive trash, including protecting existing utility infrastructure	121	WAH / Habitat Improvement, TSS	Landowners, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot, $15 - $20 per foot of bank stabilization	3.0054E+11	80	70	44880	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance

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07-04	Basin Retrofit	37.98078	-84.52764	3820 Nicholasville Rd	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional native and tree plantings, and installation of educational BMPs	129	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		42.8465506	16.66034279	296.7831238	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
07-05	Basin Retrofit	37.97581	-84.51235	3745 Camelot Dr	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional native and tree plantings, and installation of forebay	128	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		54.7338558	21.28257204	379.1223442	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
07-06	Trash Removal	37.97319	-84.51257	Forest View Town Home Association	Removal of excessive/trash and debris	87	WAH / Trash and Debris	LFUCG DEP, LFUCG Parks, Keep Lexington Beautiful Commission, Forest View Town Home Association	Varies by event					HCC, Keep Lexington Beautiful's Great American Cleanup	Cleanup Event Coordination, Supplies	Continue annual cleanup event	Continue annual cleanup event	Continue annual cleanup event
07-07	Wetland	37.972071	-84.511215	Drainage ditches north of Manowar and clearwater, Fox Harbour Units 3A	Create 0.5 acres of terranced wetland and plant native vegetation and trees	127	WAH / Habitat Improvement, Nutrients, TSS, E. coli	Landowners, LFUCG DWQ, Consultants	Wetland: $30,000 - $40,000 / acre		2.73669279	13.408	21.32563186	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding, private funding	Designers, Contractors	1) Contact property owners to evaluate support, 2) Secure funding	Design and Construction	Ongoing monitoring and maintenance
07-08	Unmapped SSO Repair	N/A	N/A	Full Subwatershed	Investigate 10 reported and identify possible unreported sanitary sewer overflow locations	116	WAH / Water Quantity, P, N, E. coli	LFUCG DWQ		N/A	50000	5000		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
07-09	Misc. Riparian Vegation Enhancement/ Bank Stablilization	N/A	N/A	Full Subwatershed	Stabilize 12,000 ft of stream banks and remove invasive species; install native plants and trees; install stormwater wetlands adjacent to stream to filter runoff from neighborhood prior to entering the stream channel	110	WAH / Habitat Improvement, TSS, Nutrients		$15 - $20 / lin ft riparian, $15 - $20 per foot of bank stabilization	N/A	960	840	538560	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Plant Materials, Maintenance Supplies, Botanist / Biologist, Volunteer Support	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate. Bank stabilization will require consultants design and installation.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.

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08-01	Basin Retrofit	37.97926	-84.50421	Kirklevington Park, 396 Redding Rd	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional native and tree plantings, and incorporation of no mow buffers	61	WAH / Water Quantity, TSS, P, N	LFUCG Parks, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		2.835470498	4.576302124	67.9161777	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact park employees to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
08-02	Basin Retrofit	37.97581	-84.50566	Nicholasville Road/New Circle Road Interchange	Retrofit basin to improve pollutant removal and infiltration, including channel stabilization, debris removal, additional native and tree plantings, and incorporation of no mow buffers	60	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		0.043955984	4.751564759	1.052849043	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
08-03	Basin Retrofit	37.97292	-84.49647	3200 Nicholasville Rd	Retrofit basin to improve pollutant removal and infiltration, including adding capacity to reduce velocities and increase settling time	59	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		12.22100166	2.525080179	292.7216916	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
08-04	Sanitary Sewer	N/A	N/A	Landsdowne neighborhood	RMP WH-05: 4500 ft of Landsdowne South Trunk Replacement (WH-08 portion)	33	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$3,550,000	2.8251E+13	288	108		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
08-05	Fecal Matter Control	N/A	N/A	Areas of open water	Investigate options for reduction of fecal matter from wildlife through limiting access to the water through a riparian buffer, coordination with the USDA, or other means	81	WAH, Water Quality, Bacteria	LFUCG DWQ, Consultants	$3500 per area	1.7885E+14	9.73	3.65		319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
09-01	Stream Restoration/Bank Stabilization	37.97765	-84.49465	Nicholasville Road/New Circle Road Interchange	Potential for up to 3,000 linear feet of stream restoration, including instatllation of native trees and vegatation	56	WAH / Habitat Improvement, TSS	LFUCG DWQ, Urban County Council, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot, $15 - $20 per foot of bank stabilization	9.0162E+11	240	210	134640	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance

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09-02	Basin Retrofit	37.97647	-84.49652	3200 Nicholasville Rd	Retrofit basin to improve pollutant removal and infiltration, including routing flow to swale, additional native and tree plantings, and increasing capacity to increase settling time	89	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		1318.563355	65.95394112	28111.28674	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
09-03	Wetland	37.98119	-84.49693	2650 Wilhite Court, Atkins Propertyy Unit 2B SEC 1	Create 0.25 acres of wetland in existing detention/retention pond through creating infiltration areas, additional native and tree plantings, trash removal, and public education	88	WAH / Habitat Improvement, Nutrients, TSS, E. coli	Landowners, LFUCG DWQ, Consultants	Wetland: $30,000 - $40,000 / acre		9.538218713	2.932975666	228.7702371	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding, private funding	Designers, Contractors	1) Contact property owners to evaluate support, 2) Secure funding, 3) Design and Construction	Ongoing monitoring and maintenance	Ongoing monitoring and maintenance
09-04	Fecal Matter Control	37.981407	-84.497551	Areas of open water	Investigate options for reduction of fecal matter from wildlife through limiting access to the water through a riparian buffer, coordination with the USDA, or other means	98	WAH, Water Quality, Bacteria	LFUCG DWQ, Consultants	$3500 per area	1.7885E+14	9.73	3.65		319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
09-05	Sanitary Sewer	N/A	N/A	Southeastern Hills neighborhood	SSO Removal through Southeastern Hills Trunk Replacements	80	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$2,140,000	N/A	5000	500		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
09-06	Sanitary Sewer	N/A	N/A	Southeastern Hills neighborhood	RMP WH-09: 4000 ft of Southeastern Hills Trunk Replacement	79	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$2,140,000	2.5112E+13	256	96		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
10-01	Tree Planting	37.98625	-84.50684	Kirklevington Park	Parks Naturalization Program at Kirklevington Park and 3 acres of additional tree plantings in the area	42	WAH / Habitat Improvement	LFUCG Parks, WHWC	$15 - $20 / lin ft for Native Planting / Invasive Removal, Annual maintenance		11.1	1.92	816	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed
10-02	Tree Planting	37.9964	-84.52178	Nicholasville Road/New Circle Road Interchange	8 acres of tree planting in or adjacent to the New Circle Road interchange	41	WAH / Habitat Improvement	WHWC	$15 - $20 / lin ft for Native Planting / Invasive Removal, Annual maintenance		29.6	5.12	2176	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed

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10-03	Basin Retrofit	37.99457	-84.52177	3200 Nicholasville Rd	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional native and tree plantings, and velocity reduction/energy dissipation techniques	47	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		68.80654302	26.78473839	428.9142129	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
10-04	Basin Retrofit	37.99579	-84.5171	2650 Wilhite Court	Retrofit basin to improve pollutant removal and infiltration, including trash and litter removal, additional native and tree plantings, and public education	46	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		71.44168722	27.81053688	445.3407147	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
10-05	Basin Retrofit	38.00309	-84.51608	2387 Professional Heights Drive	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional native and tree plantings, and velocity reduction/energy dissipation techniques	45	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		37.96559608	14.77909679	236.6633033	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
10-06	Basin Retrofit	37.98625	-84.50684	396 Redding Rd	Retrofit basin to improve pollutant removal and infiltration, including additional native and tree planting and public education	44	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		51.23891501	19.94608178	319.4042011	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
10-07	Basin Retrofit	37.9846	-84.50903	3501 Laredo Dr	Retrofit basin to improve pollutant removal and infiltration, including adding capacity to reduce velocities and increase settling time, concrete channel removal, and planting native vegetation and trees	43	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		780.7834669	303.9402938	4867.111636	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance

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10-08	Stream Restoration/Bank Stabilization	37.98763	-84.51194	Wildwood Park	500 ft of stream restoartion to repair erosion, stabilize banks, remove litter/debris, and create a more natural channelform	17	WAH / Habitat Improvement, TSS	LFUCG Parks,WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot, $15 - $20 per foot of bank stabilization	1.5027E+11	40	35	22440	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
10-09	Sanitary Sewer Investigation	37.981845	-84.507316	Around Outfall 45044	Investigate potenial sources of sanitary sewer lateral leaks and repair deficiences in the WH-10 subwatershed.	14	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	Video Inspection at $350/hour	6.278E+12	160	60		319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
10-10	Sanitary Sewer	N/A	N/A	Wildwood Park	RMP-19: Wildwood Park Trunk Replacement	26	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$1,120,000	1.5695E+13	160	60		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
10-11	Sanitary Sewer	N/A	N/A	Landsdowne neighborhood	SSO Removal through Lansdowne South Trunk	25	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$3,550,000	N/A	15000	1500		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
10-12	Sanitary Sewer	N/A	N/A	Landsdowne neighborhood	RMP-05: Lansdowne South Trunk Replacement (WH-10 portion)	24	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$3,550,000	5.0224E+12	51.2	19.2		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
11-01	Tree Planting	37.977524	-84.479616	Armstrong Mill Park	Parks Naturalization Program at Armstrong Mill Park and 1.6 acres of additional tree plantings in the area	103	WAH / Habitat Improvement	LFUCG Parks, WHWC	$15 - $20 / lin ft for Native Planting / Invasive Removal, Annual maintenance		5.92	1.024	435.2	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed
11-02	Wetland	37.97449	-84.48833	Millcreek Elementary Wetland	Increase wetland size by 0.5 acres, repair erosion of previous project, and remove trash/debris	102	WAH / Habitat Improvement, Nutrients, TSS, E. coli	FCPS, LFUCG DWQ, Consultants	Wetland: $30,000 - $40,000 / acre	65457617188	106.3296378	30.09594194	1531.479301	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding, private funding	Designers, Contractors	1) Contact school officials to evaluate support, 2) Secure funding, 3) Design and Construction	Ongoing monitoring and maintenance	Ongoing monitoring and maintenance

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
11-03	Basin Retrofit	37.97168	-84.47277	Veridian Apartments, Armstrong Mill and Man O'War	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional native and tree plantings, and incorporation of no mow buffers	105	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		0.671336144	0.228021019	8.5949688	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
11-04	Basin Retrofit	37.97504	-84.48906	1216 Appian Circle	Retrofit basin to improve pollutant removal and infiltration, including public education, additional native and tree plantings, and incorporation of no mow buffers	104	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		2168.290653	736.4654027	27760.14768	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
11-05	Sanitary Sewer Investigation	37.97186	-84.48164	Melody Village and River Park neighborhoods	Investigate 80 potenial sources of sanitary sewer lateral leaks and repair deficiences in the Melody Village and River Park neighborhoods or adjacent areas.	58	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	Video Inspection at $350/hour	5.0224E+13	1280	480		319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
11-06	Unmapped SSO Repair	N/A	N/A	Full Subwatershed	Investigate 4 reported and identify possible unreported sanitary sewer overflow locations	57	WAH / Water Quantity, P, N, E. coli	LFUCG DWQ		N/A	20000	2000		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
13-01	Tree Planting	37.982278	-84.480203	Gainesway Park	Parks Naturalization Program at Gainesway Park and 1 acre of additional tree plantings in the area	64	WAH / Habitat Improvement	LFUCG Parks, WHWC	$15 - $20 / lin ft for Native Planting / Invasive Removal, Annual maintenance		3.7	0.64	272	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed
13-02	Tree Planting	37.98401	-84.47529	Pimlico Pkwy at Center Pkwy downstream	Invasive species removal and replanting with 0.75 acres of native tree; removal of trash and debris	63	WAH / Habitat Improvement	WHWC	$15 - $20 / lin ft for Native Planting / Invasive Removal, Annual maintenance		2.775	0.48	204	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed
13-03	Basin Retrofit	37.98282	-84.47231	Pimlico Pkwy at Center Pkwy upstream	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional native and tree plantings, and slope stabilization	68	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		51.83537228	32.47385984	3235.276889	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance

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13-04	Stream Restoration	37.98622	-84.48521	West Hickman Creek: Armstrong Mill Rd to Gainesway Dr to New Circle Rd	Potential for up to 4,000 linear feet of stream restoration, including instatllation of native trees and vegatation and removal of concrete channel	23	WAH / Habitat Improvement, Nutrients, TSS	Landowners, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot	1.20216E+12	320	280	179520	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
13-05	Basin Retrofit	37.98743	-84.47407	On golf course	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional native and tree plantings, and slope stabilization	67	WAH / Water Quantity, TSS, P, N	Tates Creek Golf Course, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		19.50305882	12.21828976	1217.27293	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
13-06	Basin Retrofit	37.98079	-84.47767	1301 Centre Parkway	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional native and tree plantings, trash/litter removal, cleaning of built-up sediment, repair/re-instalaltion of bar screens and incorporation of no mow buffers	66	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		25.91768614	1.894308491	1617.638445	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
13-07	Basin Retrofit	37.98331	-84.47379	3474 Pimlico Parkway	Retrofit basin to improve pollutant removal and infiltration, including erosion repair, additional native and tree plantings, and increasing capacity to promote longer settling times	65	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		56.15498664	35.18001482	3504.883297	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
13-08	Fecal Matter Control	37.981663	-84.481184	Areas of open water	Investigate options for reduction of fecal matter from wildlife through limiting access to the water through a riparian buffer, coordination with the USDA, or other means	83	WAH, Water Quality, Bacteria	LFUCG DWQ, Consultants	$3500 per area	8.9425E+13	4.865	1.825		319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
13-09	Wetland	37.981663	-84.481184	Gaineswy Park	Algae control & litter control needed, renew 1.3 acres of floating wetland and additional BMPs to promote infiltration	62	WAH / Habitat Improvement, Nutrients, TSS, E. coli	LFUCG Parks, LFUCG DWQ, Consultants	Wetland: $30,000 - $40,000 / acre	1.7019E+11	38.80903524	24.31311121		319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding, private funding	Designers, Contractors	Phase I: 1) Meet with Parks staff to evaluate support, 2) Secure funding, 3) Project Design	Phase II: 1) Conduct pre- and post construction monitoring, 2) Construction	Ongoing monitoring and maintenance

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13-10	Green BMP	37.98579	-84.47769	Coldstream & Crimson King Cts, stream corridor between school land and private property owners	1000 ft of stream corridor enhancement/repair or infilration project between school land and residences on Coldstream Ct, Crimson King Ct and Center Pkwy, removal of invasive species	40	WAH / Habitat Improvement, TSS, P, N	Private Landowners, FCPS, Consultants	$50 - $150 / rain barrel, $500 - $2,000 / rain garden, $15 - $20 / lin ft riparian	3.0054E+11	80	70	44880	319 Grant, LFUCG Water Quality Incentive Grant, Neighborhood Sustainability Grant, KAWC Grant, Lily Raintainer Program	BMP Design and Installation Assistance, Planting Supplies, Education	Educational Package Development and initial implementation	Ongoing Implementation	Monitoring and maintenance
13-11	Sanitary Sewer	N/A	N/A	Centre Parkway	SSO Removal from Centre Parkway Trunk Replacement	39	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$950,000	N/A	10000	1000		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
13-12	Sanitary Sewer	N/A	N/A	Centre Parkway	RMP-14: 3500 ft of Centre Parkway Trunk Replacement	38	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$950,000	2.1973E+13	224	84		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
13-14	Sanitary Sewer	N/A	N/A	Sutherland Area	SSO Removal from Sutherland Trunk Replacment	37	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$1,820,000	N/A	20000	2000		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
13-15	Sanitary Sewer	N/A	N/A	Sutherland Area	RMP-12: 2000 ft of Sutherland Trunk Replacement	36	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$1,820,000	1.2556E+13	128	48		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
13-16	Sanitary Sewer	N/A	N/A	Tates Creek Corridor	SSO Removal from West Hickman Trunk E Replacement	35	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$8,700,000	N/A	10000	1000		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
13-17	Sanitary Sewer	N/A	N/A	Tates Creek Corridor	RMP-10: 4800 ft of West Hickman Trunk E Replacment	34	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$8,700,000	3.01344E+13	307.2	115.2		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
14-01	Wetland	37.98193	-84.49152	Tributary between Willowood and Armstrong Mill on WQ lots, Wagers Property	0.5 acres of Wetland or infiltration basin creation	94	WAH / Habitat Improvement, Nutrients, TSS, E. coli	Landowners, LFUCG DWQ, Consultants	Wetland: $30,000 - $40,000 / acre	65457617188	1129.613733	384.417844	17555.29571	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding, private funding	Designers, Contractors	1) Contact property owners to evaluate support, 2) Secure funding, 3) Design and Construction	Ongoing monitoring and maintenance	Ongoing monitoring and maintenance

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14-02	Riparian Vegatation	37.98859	-84.49933	3099 Kirklevington Drive	0.5 acres of Wetland or infiltration basin creation	18	WAH / Habitat Improvement, TSS, Nutrients	HCC	$15 - $20 / lin ft riparian		230.5468964	78.45720909	3582.922926	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Plant Materials, Maintenance Supplies, Botanist / Biologist, Volunteer Support	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.
14-03	Wetland	37.986487	-84.496149	retention basin near tates creek and new circle, Tates creek subdivision	Install floating wetlands and riparian vegetation; incorporate no mow zones	93	WAH / Habitat Improvement, Nutrients, TSS, E. coli	Landowners, LFUCG DWQ, Consultants	$3 - $15 / sq. ft - Total cost dependent on size of floating biohabitats		7.068343241	2.405421597	109.8489264	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding, private funding	Designers, Contractors	1) Contact property owners to evaluate support, 2) Secure funding	Design and Construction	Ongoing monitoring and maintenance
14-04	Fecal Matter Control	37.986455	-84.496355	Kirklevington Neighborhood	Investigate options for reduction of fecal matter from wildlife through limiting access to the water through a riparian buffer, coordination with the USDA, or other means	101	WAH, Water Quality, Bacteria	LFUCG DWQ, Consultants	$3500 per area	2.68275E+14	14.595	5.475		319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
14-05	Sanitary Sewer Investigation	37.99728	-84.504205	Lansdowne neighborhood	Investigate 20 potenial sources of sanitary sewer lateral leaks and repair deficiences in the Lansdowne neighborhood or adjacent areas.	32	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	Video Inspection at $350/hour	1.2556E+13	320	160		LFUCG Water Quality Incentive Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
14-06	Sanitary Sewer Investigation	37.99728	-84.504205	Brookhaven neighborhood	Investigate 30 potenial sources of sanitary sewer lateral leaks and repair deficiences in the Brookhaven neighborhood or adjacent areas.	31	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	Video Inspection at $350/hour	1.2556E+13	320	160		LFUCG Water Quality Incentive Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
14-07	Sanitary Sewer	N/A	N/A	Merrick neighborhood	SSO Removal from Merrick Trunk Replacement (WH-14 Portion)	85	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$3,880,000	N/A	25000	2500		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
14-08	Sanitary Sewer	N/A	N/A	Merrick neighborhood	RMP-07:Merrick Trunk Replacement	84	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$3,880,000	3.70402E+13	377.6	141.6		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance

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14-09	Unmapped SSO Repair	N/A	N/A	Full Subwatershed	Investigate 7 reported and identify possible unreported sanitary sewer overflow locations	30	WAH / Water Quantity, P, N, E. coli	LFUCG DWQ		N/A	35000	3500		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
16-01	Tree Planting	37.99743	-84.49922	Behind the Signature Club of Landsdowne	Invasive species removal and replanting with 2 acres of native trees and wildflowers	11	WAH / Habitat Improvement	WHWC	$15 - $20 / lin ft for Native Planting / Invasive Removal, Annual maintenance		7.4	1.28	544	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed
16-02	Tree Planting	38.00173	-84.50362	Zandale Park	Parks Naturalization Program at Zandale Park and additional acre of tree plantings in the area	10	WAH / Habitat Improvement	LFUCG Parks, WHWC	$15 - $20 / lin ft for Native Planting / Invasive Removal, Annual maintenance		3.7	0.64	272	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed
16-03	Riparian Vegetation	37.994212	-84.496783	Landsdowne neighborhood	Install riparian buffer to aid in pollutant removal and removal of wildlife fecal matter and nutrients	2	WAH / Habitat Improvement, TSS, Nutrients	Landsdowne NA, HCC	$15 - $20 / lin ft riparian	52594504168	28	24.5		319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Plant Materials, Maintenance Supplies, Botanist / Biologist, Volunteer Support	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.
16-04	Sanitary Sewer Investigation	38.013008	-84.513138	Glendover neighborhood	Investigate 100 potenial sources of sanitary sewer lateral leaks and repair deficiences in the Glendover neighborhood or adjacent areas.	3	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	Video Inspection at $350/hour	6.278E+13	1600	800		LFUCG Water Quality Incentive Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
16-05	Sanitary Sewer	N/A	N/A	Merrick neighborhood	SSO Removal from Merrick Trunk Replacement (WH-16 Portion)	4	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$3,880,000	6.278E+13	15000	1500		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
17-01	Stream Restoration/Bank Stabilization	38.00951	-84.49362	Centenary United Methodist Church	Remove 200 ft of concrete channels and create natural stream channels, install riparian vegetation, and promote infiltration	90	WAH / Habitat Improvement, TSS	Landowners, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot, $15 - $20 per foot of bank stabilization	60108004764	15	13.6	8976	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
17-02	Tree Planting	38.0009	-84.49032	Lansdowne Merrick Park	Parks Naturalization Program at Lansdowne Merrick Park and additional 3.85 acres of tree plantings in the area	112	WAH / Habitat Improvement	LFUCG Parks, WHWC	$15 - $20 / lin ft for Native Planting / Invasive Removal, Annual maintenance		6.949948912	0.181570379	1047.2	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed
17-03	Tree Planting	38.0009	-84.49032	Lansdowne Merrick Park	Invasive Species Removal and installation of 2.5 acres of trees and native vegetation	111	WAH / Habitat Improvement	LFUCG Parks, WHWC	$15 - $20 / lin ft for Native Planting / Invasive Removal, Annual maintenance		6.949948912	0.181570379	680	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed
17-04	Stream Restoration	38.01497	-84.49504	Tates Creek Road at Cottage Grove Lane	Remove 430 ft of concrete channels and create natural stream channels, install riparian vegetation, and promote infiltration	92	WAH / Habitat Improvement, Nutrients, TSS	Landowners, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot	1.29232E+11	32.25	29.24	19298.4	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
17-05	Stream Restoration	38.01159	-84.49539	Tates Creek Road between Alumni and Old Dobbins Road	Remove 200 ft of concrete channels and create natural stream channels, install riparian vegetation, and promote infiltration	91	WAH / Habitat Improvement, Nutrients, TSS	Landowners, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot	60108004764	15	13.6	8976	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
17-06	Sanitary Sewer	N/A	N/A	Ecton neighborhood	SSO Removal from Ecton Trunk Replacement	100	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$1,550,000	N/A	45000	4500		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
17-07	Sanitary Sewer	N/A	N/A	Ecton neighborhood	RMP WH-08: 4700 ft of Ecton Trunk Replacement	99	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$1,550,000	2.95066E+13	300.8	112.8		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
17-08	Detention Basin	38.01427	-84.4978	The Church of Jesus Christ of Latter-day Saints	Construct new basin to improve pollutant removal and infiltration, additional native and tree plantings	114	WAH / Water Quantity, TSS, P, N, E. coli	Landowners, WHWC, Consultant(s)		1.08069E+12	423	166.5	16678.8	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
17-09	Retention Pond	38.00188	-84.488	Landsdowne-Merrick Park	Construct new basin to improve pollutant removal and infiltration, additional native and tree plantings	113	WAH / Water Quantity, TSS, P, N, E. coli	Landowners, WHWC, Consultant(s)		6.69351E+11	262	103.1	10330.4	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
19-01	Stream Restoration	37.99	-84.48	Private Resident on Chinoe	150 ft of stream restoration to provide stabilization and nature stream channel form; stabilize storm sewer outlet	132	WAH / Habitat Improvement, Nutrients, TSS	Landowners, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot	450810035 73	11.25	10.2	6732	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
19-02	Stream Restoration	38.00	-84.49	Tributary near Pinas Bay Dr, Freeland Dr and Pepperhill Rd	Remove 1250 ft of concrete channels and create natural stream channels, install riparian vegetation, and promote infiltration	131	WAH / Habitat Improvement, Nutrients, TSS	Landowners, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot	3.75675E+11	93.75	85	56100	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
19-03	Basin Retrofit	38.00	-84.49	3843 Fleetwood Dr	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional 0.12 acres of native and tree plantings, and public education	152	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		42.8725252	16.12337157	1385.874363	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
19-04	Basin Retrofit	37.99	-84.48	1117 Chinoe Rd	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional 0.31 acres of native and tree plantings, repair damaged infrastructure, and public education	151	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		59.26110516	22.2867399	1915.642851	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
19-05	Green BMP	N/A	N/A	Landsdowne-Merrick neighborhood	Utilize the results of the Lansdowne Merrick Feasibility Study to install green BMPs or other infiltration practices that reduce velocities and increase detention time for settling, particurally no-mo zones propoting riparian buffers	143	WAH / Water Quantity, TSS, P, N	Private Landowners, HCC	$50 - $150 / rain barrel, $500 - $2,000 / rain garden, $15 - $20 / lin ft riparian					319 Grant, LFUCG Water Quality Incentive Grant, Neighborhood Sustainability Grant, KAWC Grant, Lily Raintainer Program	BMP Design and Installation Assistance, Planting Supplies, Education	Educational Package Development and initial implementation	Ongoing Implementation	Monitoring and maintenance
19-06	Stream Restoration	38.00	-84.49	3105 Warrenwood Wynd	1000 ft of stream restoration to provide stabilization with rock cages to reduce high levels of bank erosion, riparian buffer to reduce flow velocities and stabalize banks	130	WAH / Habitat Improvement, Nutrients, TSS	Landowners, WHWC, Consultant(s)	Stream Restoration: $400 - $600 / foot for design and construction, Excavation: $12 - $15 / cubic foot	1.5027E+11	75	68	44880	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
19-07	Sanitary Sewer	N/A	N/A	Tates Creek Corridor	SSO Removal from West Hickman Trunk F Replacement	142	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$4,950,000	N/A	50000	5000		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
19-08	Sanitary Sewer	N/A	N/A	Tates Creek Corridor	RMP WH-11: West Hickman Trunk F Replacement	141	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$4,950,000	2.44842E+13	249.6	93.6		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
20-01	Bank Stabilization	38.01486	-84.45818	Home Depot, 2397 Richmond Road, 40502	Stabilize 800 ft of stream banks and remove invasive species; install native plants and trees; investigate presence of oils and grease; remove trash and litter	134	WAH / Habitat Improvement, TSS	Private landowners, Consultants, Contractors	$15 - $20 per foot of bank stabilization	2.40432E+11	60	54.4	35904	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Evaluate landowner support. Engineers to evaluate appropriate grading, vegetation, and stabilization techniques and exact lengths to be addressed. Secure funding	Design and Construction	Ongoing monitoring and maintenance

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
20-02	Bank Stabilization	38.02053	-84.46009	Idle Hour Park	Stabilize 700 ft of stream banks and remove invasive species; install native plants and trees	133	WAH / Habitat Improvement, TSS	Private landowners, Consultants, Contractors	$15 - $20 per foot of bank stabilization	2.10378E+11	52.5	47.6	31416	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Evaluate landowner support. Engineers to evaluate appropriate grading, vegetation, and stabilization techniques and exact lengths to be addressed. Secure funding	Design and Construction	Ongoing monitoring and maintenance
20-03	Riparian Vegetation	38.02203	-84.45672	Quantrell Cadillac	Remove invasive species and replant with 0.31 acres of native vegetation	126	WAH / Habitat Improvement, TSS, Nutrients	Idle Hour Neighbors Alliance / Idle Hour Drive NA, HCC	$15 - $20 / lin ft riparian	40583722656	1.822323938	1.113342091	58619.69266	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Plant Materials, Maintenance Supplies, Botanist / Biologist, Volunteer Support	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.
20-04	Green BMP	38.00421	-84.46027	251 Chippen Dale Circle	Retrofit basin to improve pollutant removal and infiltration, including concrete channel removal, additional 0.12 acres of native and tree plantings, forebay installation, and no mow encouragement	150	WAH / Water Quantity, TSS, P, N	Private Landowners, Consultants	$50 - $150 / rain barrel, $500 - $2,000 / rain garden, $15 - $20 / lin ft riparian	15709828125	6.748722256	0.454754446	2724.284116	319 Grant, LFUCG Water Quality Incentive Grant, Neighborhood Sustainability Grant, KAWC Grant, Lily Raintainer Program	BMP Design and Installation Assistance, Planting Supplies, Education	Educational Package Development and initial implementation	Ongoing Implementation	Monitoring and maintenance

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
20-05	Riparian Vegetation	38.002142	-84.469959	Reservoir 3	Install 245 ft of riparian buffer to aid in pollutant removal and removal of wildlife fecal matter and nutrients from Reservior 3	125	WAH / Habitat Improvement, TSS, Nutrients	Lake Area NA, Lakeview Estates NA, HCC	$15 - $20 / lin ft riparian	73632305835	8.340880135	5.620400696	448.3717608	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Plant Materials, Maintenance Supplies, Botanist / Biologist, Volunteer Support	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.
20-06	Riparian Vegetation	38.005973	-84.466544	Reservoir 2	Install 565 ft of riparian buffer to aid in pollutant removal and removal of wildlife fecal matter and nutrients from Reservior 2	124	WAH / Habitat Improvement, TSS, Nutrients	Lakeview Island Security & Maintenance Association, HCC	$15 - $20 / lin ft riparian	1.69805E+11	0.063137295	0.042544299	3.394003961	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Plant Materials, Maintenance Supplies, Botanist / Biologist, Volunteer Support	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.
20-07	Riparian Vegetation	38.013135	-84.461979	Reservoir 1	Install 774 ft of riparian buffer to aid in pollutant removal and removal of wildlife fecal matter and nutrients from Reservior 1	123	WAH / Habitat Improvement, TSS, Nutrients	HCC	$15 - $20 / lin ft riparian	2.32618E+11	0.015414791	0.01038707	0.828636419	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Plant Materials, Maintenance Supplies, Botanist / Biologist, Volunteer Support	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.
20-08	Sanitary Sewer	N/A	N/A	Plainview neighborhood	RMP WH-22: 1900 ft of Plainview Trunk Replacement	149	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	In RMP budget	1.19282E+13	121.6	45.6		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
20-09	Sanitary Sewer	N/A	N/A	Plainview neighborhood	SSO Removal from Plainview Trunk Replacement	148	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	In RMP budget	N/A	20000	2000		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
20-10	Sanitary Sewer	N/A	N/A	Richmond Road	RMP WH-18: 3600 ft of Richmond Road Trunk Replacement	147	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$1,700,000	2.26008E+13	230.4	86.4		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
20-11	Sanitary Sewer	N/A	N/A	Prather Road	RMP WH-17: 5000 ft of Prather Road Trunk Replacement	146	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$2,070,000	3.139E+13	320	120		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
20-12	Sanitary Sewer	N/A	N/A	Reserviors	SSO Removal from the Island Trunks Replacement	145	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$990,000	N/A	5000	5		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
20-13	Sanitary Sewer	N/A	N/A	Reserviors	RMP WH-15: 2000 ft of The Island Trunks Replacement	144	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	$990,000	1.2556E+13	128	48		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
21-01	Sanitary Sewer Investigation	38.027993	-84.480776	Ashland Park neighborhood	Investigate 120 potenial sources of sanitary sewer lateral leaks and repair deficiences in the Ashland Park neighborhood or adjacent areas.	55	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	Video Inspection at $350/hour	1.2556E+13	1920	1600		LFUCG Water Quality Incentive Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
21-02	Unmapped SSO Repair	N/A	N/A	Full Subwatershed	Investigate 25 reported and identify possible unreported sanitary sewer overflow locations	54	WAH / Water Quantity, P, N, E. coli	LFUCG DWQ		N/A	125000	12500		LFUCG	Consultants, Designers, Contractors, Monitoring	Design and Construction	Monitoring and maintenance	Monitoring and maintenance
21-03	Misc. Riparian Vegation Enhancement/ Bank Stablilization	N/A	N/A	Full Subwatershed	Stabilize 19,100 ft of stream banks and remove invasive species; install native plants and trees; install stormwater wetlands adjacent to stream to filter runoff from neighborhood prior to entering the stream channel	27	WAH / Habitat Improvement, TSS, Nutrients		$15 - $20 / lin ft riparian, $15 - $20 per foot of bank stabilization	2.50048E+15	1528	1337	857208	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Plant Materials, Maintenance Supplies, Botanist / Biologist, Volunteer Support	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate. Bank stabilization will require consultants design and installation.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.
22-01	Tree Planting	38.035019	-84.456487	Johnson Heights Park	Parks Naturalization Program at Johnson Heights Park and additional 1.56 acres of tree plantings in the area	53	WAH / Habitat Improvement	LFUCG Parks, WHWC	$15 - $20 / lin ft for Native Planting / Invasive Removal, Annual maintenance		5.772	0.9984	424.32	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
22-02	Green BMP	38.04053	-84.46352	740 Statesman Way, multiple private residences	Retrofit basin to improve pollutant removal and infiltration, including litter/debris/sediment removal, additional 0.25 acres of native and tree plantings, forebay installation, and no mow encouragement	29	WAH / Water Quantity, TSS, P, N	Private Landowners, Consultants	$50 - $150 / rain barrel, $500 - $2,000 / rain garden, $15 - $20 / lin ft riparian	32728808594	9.851566957	3.955258125	224.8327183	319 Grant, LFUCG Water Quality Incentive Grant, Neighborhood Sustainability Grant, KAWC Grant, Lily Raintainer Program	BMP Design and Installation Assistance, Planting Supplies, Education	Educational Package Development and initial implementation	Ongoing Implementation	Monitoring and maintenance
22-03	Sanitary Sewer Investigation	38.023535	-84.460498	Idle Hour neighborhood	Investigate 120 potenial sources of sanitary sewer lateral leaks and repair deficiences in the Idle Hour neighborhood or adjacent areas.	15	WAH / Water Quantity, TSS, P, N, E. coli	LFUCG DWQ	Video Inspection at $350/hour	7.5336E+13	1920	720		LFUCG Water Quality Incentive Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Option investigate and analysis	Implementation	Monitoring and maintenance
22-04	Tree Planting	38.03179	-84.457669	1825 Liberty Rd	Tree planting in and around detention basin and public education	52	WAH / Habitat Improvement	WHWC	$15 - $20 / lin ft for Native Planting / Invasive Removal, Annual maintenance		11.1	1.92	816	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed
22-05	Misc. Riparian Vegation Enhancement/ Bank Stablilization	N/A	N/A	Full Subwatershed	Stabilize 500 ft of stream banks and remove invasive species; install native plants and trees; install stormwater wetlands adjacent to stream to filter runoff from neighborhood prior to entering the stream channel	13	WAH / Habitat Improvement, TSS, Nutrients		$15 - $20 / lin ft riparian, $15 - $20 per foot of bank stabilization	1.5027E+11	40	35	22440	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Plant Materials, Maintenance Supplies, Botanist / Biologist, Volunteer Support	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate. Bank stabilization will require consultants design and installation.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.	Average of 1,000 linear feet / year through volunteer efforts throughout the watershed. Use of contractors for clearing will increase this rate.
23-01	Bank Stabilization	37.95034	-84.50173	West Hickman Creek in Veterans Park at Rockbridge Road	200 ft of bank stabilization, invasive species removal, and trash removal at the bridge near Rockbridge Road	19	WAH / Habitat Improvement, TSS	LFUCG Parks, Consultants, Contractors	$15 - $20 per foot of bank stabilization	60108004764	16	14	8976	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Evaluate landowner support. Engineers to evaluate appropriate grading, vegetation, and stabilization techniques and exact lengths to be addressed. Secure funding	Design and Construction	Ongoing monitoring and maintenance
23-02	Basin Retrofit	37.96655	-84.4931	1132 Shagbark Lane, private resedential	Retrofit basin to improve pollutant removal and infiltration, including 160 ft of concrete channel removal, additional native and tree plantings, and public education	78	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		610.0117425	125.8937475	2216.266479	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
23-03	Basin Retrofit	37.96929	-84.49047	1133 Narrow Lane, private resedential	Retrofit basin to improve pollutant removal and infiltration, including 162 ft of concrete channel removal, additional native and tree plantings, and public education	77	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		610.0117425	125.8937475	2216.266479	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
23-04	Basin Retrofit	37.96284	-84.49092	4501 Langley Circle, private reseidence	Retrofit basin to improve pollutant removal and infiltration, including 730 ft of concrete channel removal, adding meanders into the channel, additional native and tree plantings, and installation of forebay	76	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		610.0117425	125.8937475	2216.266479	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
23-05	Basin Retrofit	37.96272	-84.4952	4390 Clearwater Way	Retrofit basin to improve pollutant removal and infiltration, including 250 ft of concrete channel removal, additional native and tree plantings, and public education	75	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		610.0117425	125.8937475	2216.266479	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
23-06	Basin Retrofit	37.96471	-84.48299	3900 Rapid Run	Retrofit basin to improve pollutant removal and infiltration, including increasing capacity to lengthen settling time and reduce velocities, additional 0.25 acres of native and tree plantings, and public education	74	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		85.40164395	17.62512466	310.277307	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
23-07	Basin Retrofit	37.9649	-84.48768	3900 Crosby Dr	Retrofit basin to improve pollutant removal and infiltration, including bank stabilization, additional 0.91 acres of native and tree plantings, and public education	73	WAH / Water Quantity, TSS, P, N	Landowners, Consultants, WHWC	$80 / sq. ft concrete removal; $3 - $30 / linear ft for bioswale		1368.012334	282.3293183	4970.199205	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Phase I: 1) Contact landowners to evaluate support, 2) Secure funding, 3) Conduct feasibility study and design	Phase II: 1) Secure funding, 2) Conduct pre- and post construction monitoring, 3) Implement BMPs.	Ongoing monitoring and maintenance
23-08	Wetland	37.955091	-84.502011	Veterans Park 1, 650 Southpoint	Create 1 acre of wetland and plant native vegetation and trees	71	WAH / Habitat Improvement, Nutrients, TSS, E. coli	LFUCG Parks, LFUCG DWQ, Consultants	Wetland: $30,000 - $40,000 / acre	1.30915E+11	244.004697	41.96458252	997.3199155	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding, private funding	Designers, Contractors	Phase I: 1) Meet with Parks staff to evaluate support, 2) Secure funding, 3) Project Design	Phase II: 1) Conduct pre- and post construction monitoring, 2) Construction	Ongoing monitoring and maintenance

BMP ID.	Type	Latitude	Longitude	Target Audience or Area	Best Management Practice Description and Action Items	Priority	Impairment / Pollutant Addressed	Responsible Parties	Estimated Cost	Estimated Bacteria Load Reduction (CFU / year)	Estimated Nitrogen Load Reduction (TN) (lbs/year)	Estimated Phosphorus Load Reduction (TP) (lbs/year)	Estimated TSS Reduction (lbs/year)	Funding Source(s) / Program(s)	Technical Assistance Needed	Short Term Milestones (0-5 Years)	Mid-Term Milestones (5-10 Years)	Long-Term Milestones (10-25 Years)
23-09	Wetland	37.956959	-84.501411	Veterans Park 2, 651 Southpoint	Create 1 acre of wetland and plant native vegetation and trees	70	WAH / Habitat Improvement, Nutrients, TSS, E. coli	LFUCG Parks, LFUCG DWQ, Consultants	Wetland: $30,000 - $40,000 / acre	1.30915E+11	225.7043447	38.81723883	922.5209218	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding, private funding	Designers, Contractors	Phase I: 1) Meet with Parks staff to evaluate support, 2) Secure funding, 3) Project Design	Phase II: 1) Conduct pre- and post construction monitoring, 2) Construction	Ongoing monitoring and maintenance
23-10	Wetland	37.936051	-84.50203	WWTP	Create 1 acre of stormwater wetland and route neighborhood drainage through wetland prior to entering stream channel	69	WAH / Habitat Improvement, Nutrients, TSS, E. coli	Landowners, Nicholasville Utilities, Consultants	Wetland: $30,000 - $40,000 / acre	1.30915E+11	1049.220197	180.4477048	4288.475637	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding, private funding	Designers, Contractors	1) Contact property owners to evaluate support, 2) Secure funding	Design and Construction	Ongoing monitoring and maintenance
23-11	Dam Removal	37.950755	-84.501776	Veterans Park	Remove Veterans Park Dam as detailed in report by Ridgewater/EcoGro	97	WAH, Water Quality, Bacteria	LFUCG Parks, Consultants	$300,000					319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Dam Removal	Monitoring and maintenance	Monitoring and maintenance
23-12	Tree Planting	37.93974	-84.502089	WWTP	Construct terraced wetland and plant 2.5 acres of trees	72	WAH / Habitat Improvement	WHWC	$15 - $20 / lin ft for Native Planting / Invasive Removal, Annual maintenance		6.44	1.127	625.6	319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed	Add one acre of additional native plants/trees per year in watershed
23-13	Sanitary Sewer Investigation	37.93974	-84.502089	WWTP	Investigate ways to continue to remove nutrients from the WWTP effluent below required discharge limits.	16	WAH / Habitat Improvement, Nutrients	LFUCG		N/A	30000	3000		319 Grant, LFUCG Water Quality Incentive Grant, KAWC Grant, Designated city or state funding	Consultants, Designers, Contractors, Monitoring	Investigate means for additional nutrient removal beyond required discharge limits to aid in meeting benchmark standards	Investigate means for additional nutrient removal beyond required discharge limits to aid in meeting benchmark standards	Investigate means for additional nutrient removal beyond required discharge limits to aid in meeting benchmark standards

6.2.2 EXPECTED OUTCOMES AND LOAD REDUCTIONS

Section 5.4 outlined, for each sub watershed and for each pollutant, the total level of expected pollutant load and the reduction required to reach the LFUCG Division of Water Quality benchmarks given in Table 5-2. These calculations help to provide a summary for identifying potential sources, as elaborated in Section 5.3.1, and inform on the magnitude of BMPs needed to eliminate concerns in each area. Major pollutants include non-point source inputs such as animal waste and lawn fertilizer overuse. Point source contributors such as the industries studied in Section 5.2.3, sanitary sewers, and the wastewater treatment plant can be addressed on an individual scale.

Predicted levels of success for BMP application is variable based on a number of factors. Many BMPs provide benefit to multiple pollutants. The wide range of BMP effects and the ever changing nature of a stream ecosystem further complexity of expectations. Critical to each sub watershed is the willingness for communities to engage with, invest in and maintain projects on a long-term scale. Objectives have been proposed to address each of the primary risk factors to West Hickman Creek.

- Objective 1 addresses nutrient pollution.
- Objective 2, 3, 4 and 5 address sedimentation and erosion.
- Objectives 6 and 7 addresses habitat impairments.
- Objectives 8 and 9 address fecal pollution.
- Objectives 10, 11, 12 and 13 address all pollutants through education and outreach.

Table 6-4: Proposed West Hickman BMPs and Action Item List provides a comprehensive list of all suggested BMPs in the West Hickman Watershed. Based on predicted load reductions, successful implementation of the following quantities of suggested BMPs will result in the load reductions required to reach the LFUCG Division of Water Quality Benchmarks:

- Basin retrofit – 40 basins
- Tree planting – 28 acres
- Wetland – 8.5 acres
- Stream restoration – 13,000 feet
- Riparian vegetation – 4,500 feet
- Fecal matter control – 5 investigations
- Bank stabilization – 33,300 feet

BMPs outside of the recommendations presented in this plan may be determined more effective on a case-by-case basis than what is suggested in this plan and should be evaluated as necessary. Implementation monitoring, as outlined in Section 7.4, should be performed to ensure BMPs are implemented and maintained and educate on how to better address watershed health in the future. The West Hickman Watershed and Lexington community is ever changing. This reinforces the need for monitoring and evaluation of implemented BMPs to ensure that WHC is treated with care into the future. Pollutant load reduction spreadsheet calculations can be found in APPENDIX G. Stream flow to BMP locations were approximated using the United States Geological Survey StreamStats Application and are located in APPENDIX B.

6.2.2.1 E. COLI

E. coli was one of the most impaired categories in the West Hickman Watershed. All sites had multiple exceedances with some sites exceeding for almost all samples. Of 18 sample sites, 13 required E. coli

reductions to meet the project benchmarks. Ten sites require reductions greater than 45% of the existing load. WH-16 required the largest percent reduction at 77%, WH-22 requires 70%, and WH-9 requires 69%. To compare total volumes (CFU per year), WH-9 requires 5.4 x 10^{14} CFU, WH-14 requires 2.5 x 10^{14}, and WH-3 requires 1.4 x 10^{14}.

To reduce pollution from human fecal sources, sanitary sewer trunk replacement BMPs are proposed for sites WH-8, WH-9, WH-10, WH-12, WH-14, WH-16, WH-17, WH-19, WH-20 as a part of the LFUCG Remedial Measures Plan. Some sites have multiple sections of trunk replacement. Sanitary sewer investigation is proposed for WH-2, WH-4, WH-10, WH-11, WH-14, WH-16, WH-21 and WH-22. Fecal matter control is suggested for sites WH-3, WH-8, WH-9, WH-13 and WH-14. This includes investigation of options for reduction of fecal matter from wildlife by limiting access to the water with riparian buffer and coordination with the USDA. This BMP has been chosen for sub-watersheds which are more at risk from wildlife pollution. Wetland projects are proposed for WH-3, WH-7, WH-9, WH-11, WH-12, WH-14 and WH-23. Public education is proposed for every sub watershed to address pet waste disposal.

Sanitary sewer investigation load reduction is gathered from published paper from Horsley and Whitten, 1996 and KDOW, 2015. Calculations assume the following:

- A number of deficient laterals are identified based on the age of the homes and the size of the lots and repaired with an input rate of 2.5 people per home for sanitary sewer investigations, including:
    - 70 gallons/day of effluent produced per person
    - 6.5 x 10^5 CFU/100mL concentration of E. coli in effluent
- Estimated load reductions from expanded wetland and fecal matter control are gathered from published TMDL Report by Ormsbee et al. Calculations assume 5 geese, 10 ducks and 2 raccoons per square mile per day. This is then converted to per acre per year.
- Geese removal load reduction is gathered from the EPA Bacterial Indicator tool, assuming a number of geese removed from direct fecal waste input based on the MST data and amount of open water available in the area.
- Public education load reduction is estimated based on 50% of all the domestic pet waste in each subwatershed is disposed of properly based on average domestic pets per acre as assumed by Ormsbee.

With all proposed projects implemented, E. coli loading is modeled to be reduced below benchmark loads at all sites.

6.2.2.2 NUTRIENTS

Nutrient pollution in West Hickman Creek is less of a concern than E. coli, but still needs to be addressed. Five sub watershed require reductions to meet benchmark levels for nitrogen-nitrate. These sites are WH-4, WH-16, WH-17, WH-21 and WH-23. Only one sub watershed, WH-23 requires total phosphorus reduction. Of the five sites exceeding benchmark loads for nitrogen, WH-17 is least critical with required reduction of only 4%. WH-4 and WH-16 require 30% reductions. WH-21 requires a reduction of 53% and WH-23 requires a reduction of 65%. Highest magnitudes of total nitrogen reduction required span from 341,440 pounds per year at WH-23 to 22,420 pounds per year at WH-4 and 15,500 pounds per year at WH-21. Site WH-23 requires a total phosphorus reduction of 14%. Nutrient pollution is often reduced by BMPs which are not primarily targeted to reduce nutrients. As a result, all sub watersheds are planned to receive nutrient reductions as a by-product of BMPs addressing other issues.

- Basin retrofits are proposed in WH-1, WH-2, WH-3, WH-4, WH-7, WH-8, WH-9, WH-10, WH-11, WH-13, WH-19 and WH-23. Most sub watersheds have multiple proposed basin retrofits.
- Fecal matter control is suggested for sites WH-3, WH-8, WH-9, WH-13 and WH-14. This includes investigation of options for reduction of fecal matter from wildlife by limiting access to the water with riparian buffer and coordination with the USDA. This BMP has been chosen for sub-watersheds which are more at risk from wildlife pollution.
- Riparian vegetation installation is proposed in WH-1, WH-2, WH-3, WH-14, WH-16, and WH-20.
- Sanitary sewer trunk replacements are proposed in WH-8, WH-9, WH-10, WH-12, WH-14, WH-16, WH-17, WH-19, WH-20. Some sites have multiple sections of trunk replacement. These replacements are already under way by LFUCG as a part of the Remedial Measures Plan.
- Sanitary sewer investigation is proposed for WH-2, WH-4, WH-10, WH-11, WH-14, WH-16, WH-21 and WH-22.
- Stream restoration is proposed for sites WH-4, WH-7, WH-9, WH-10 WH-13, WH-17, and WH-19.
- Tree planting is proposed for sites WH-10, WH-11, WH-13, WH-16, WH-17, WH-22 and WH-23.
- Wetland projects are proposed for WH-3, WH-7, WH-9, WH-11, WH-12, WH-14 and WH-23.
- Public education is proposed for every sub watershed to address pet waste disposal.

Expected reductions were calculated in the following manner:

- Basin retrofits and wetlands play a similar role in trapping nutrients and area assumed to provide a 30% reduction as gathered from the New Jersey Stormwater BMP manual.
- Riparian vegetation is modeled to provide a 7.5% reduction as gathered from the Chesapeake Stormwater Network.
- Trunk replacement is assumed to provide a reduction of 6.4 lb/ft/year following the same assumptions as the Cane Run BMP. This assumes the bacteria of 1 person per 100 feet of trunk replacement.
- Sanitary sewer reductions are assumed to be 16 lb/ft/year using the same assumptions as the Cane Run WBP per laterals identified and repaired with an input rate of 2.5 people per home.
- Geese removal reduction is assumed to be 0.937 lb/ft/year from Nutrient Additions by Waterfowl to Lakes and Reservoirs: Predicting Their Effects on Productivity and Water Quality.
- Tree planting is assumed to provide 3.7 lb/ft/year from the Pollutant load credit tool by the Center for Watershed Protection based on 1 tree per 300 sqft and 145 trees per acre.
- Public education reductions due to better handling of pet waste area assumed to be 4.09 lb/ft/year using the same assumptions as the Cane Run WBP.

6.2.2.3 TSS AND EROSION

All sites fall within benchmark loads for TSS. TSS will be further increased as a secondary effect from many of the BMPs proposed at other sites. TSS load reductions will not be discussed in depth. Load reductions as shown in APPENDIX G were calculated using the following assumptions:

- 80% TSS reduction for basin retrofits as outlined in the New Jersey Stormwater manual
- 90% TSS reduction for wetlands as outlined in the New Jersey Stormwater manual
- 44.88 pounds of sediment removal per linear foot for bank stabilization and stream restorations

6.2.2.4 HABITAT

Objectives 4, 6 and 7 involve improving the habitat and riparian zone. Stream habitat improvements will

come naturally as a result of decreased pollution and increased channel stability. Some BMPs more directly address stream habitat. Riparian vegetation instillation is proposed in sites WH-1, WH-2, WH-3, WH-14, WH-16, and WH-20. Stream restoration is proposed for sites WH-4, WH-7, WH-9, WH-10 WH-13, WH-17, and WH-19. Tree planting is proposed for sites WH-10, WH-11, WH-13, WH-16, WH-17, WH-22 and WH-23. Wetland projects are proposed for WH-3, WH-7, WH-9, WH-11, WH-12, WH-14 and WH-23.

It is unrealistic to expect all areas of the watershed to meet habitat rating benchmarks within the planning timeframe of ten years. The project team has set an objective of improving habitat at a rate of 1,000 linear feet per year. Improving the habitat will be considered providing a 25 foot buffer on either side of the stream (50 feet total width) by maintaining undisturbed filter strips, tree planting, constructing streamside wetlands, and allowing for unmowed natural vegetation along the channel or other similar activities.

6.2.3 PRIOTIZATION PROCESS

Prioritization has been completed in two steps. First by subwatershed, then by BMP type. These were combined for each BMP in each subwatershed to rank every suggested BMP. Subwatersheds were scored based on two metrics of E. coli and nitrogen pollution, since those were the two pollutants with the highest amount of exceedances of benchmarks. The first metric was the percentage of samples exceeding benchmark levels as provided in Table 5-10. The second metric was percent reduction of yearly loads needed to achieve benchmark levels as provided in Table 5-13 and Table 5-15. E. Coli values were given a weighting of 1 and nitrogen was given a weighting of 0.8 because E. coli is slightly more critical of a concern in West Hickman. Each total score was divided by the maximum score (2.0 at WH-16) to normalize the score on a scale from 0 to 1. Table 6-5 provides a summary for input values and scores used for subwatershed prioritization. Full results are detailed in APPENDIX H. It is recommended that attention is focused early on to implement BMPs in high priority subwatersheds such as WH-16, WH-10 and WH-22.

Table 6-5: Subwatershed Prioritization

Site ID	E. Coli Exceedance %	E. Coli Reduction %	Nitrogen Exceedance %	Nitrogen Reduction %	Raw Score	Normalized Score	Rank
WH-1	0.27	0.00	0.00	0.00	0.27	0.13	16
WH-2	0.47	0.30	0.00	0.00	0.77	0.38	14
WH-3	0.56	0.46	0.00	0.00	1.02	0.51	12
WH-4	0.53	0.20	0.31	0.31	1.23	0.61	7
WH-7	0.47	0.00	0.00	0.00	0.47	0.23	15
WH-8	0.80	0.58	0.00	0.00	1.38	0.69	4
WH-9	0.50	0.69	0.00	0.00	1.19	0.59	8
WH-10	0.87	0.60	0.00	0.00	1.47	0.73	2
WH-11	0.47	0.56	0.00	0.00	1.03	0.51	11
WH-13	0.80	0.57	0.00	0.00	1.37	0.68	5
WH-14	0.50	0.65	0.00	0.00	1.15	0.57	9
WH-16	0.75	0.77	0.30	0.30	2.00	1.00	1
WH-17	0.40	0.49	0.04	0.04	0.96	0.48	13
WH-19	0.13	0.00	0.00	0.00	0.13	0.07	17
WH-20	0.07	0.00	0.00	0.00	0.07	0.03	18
WH-21	0.20	0.00	0.53	0.53	1.05	0.52	10
WH-22	0.71	0.70	0.00	0.00	1.41	0.71	3
WH-23	0.25	0.08	0.65	0.65	1.36	0.68	6

In addition to rank order, sub watersheds were mapped based on percent exceedances of E. coli and nutrients. See Figure 6-4 and Figure 6-5 for these maps. Each BMP type was scored through ranking from 1 to 13 on the following metrics: cost, feasibility, benefit, quickness of result. One represented the lowest score while thirteen represented the highest score. Each ranking was summed together and divided by the maximum ranking to normalize the score on a scale from 0 to 1. Table 6-6 provides a summary for BMP rankings and scores used for BMP prioritization.

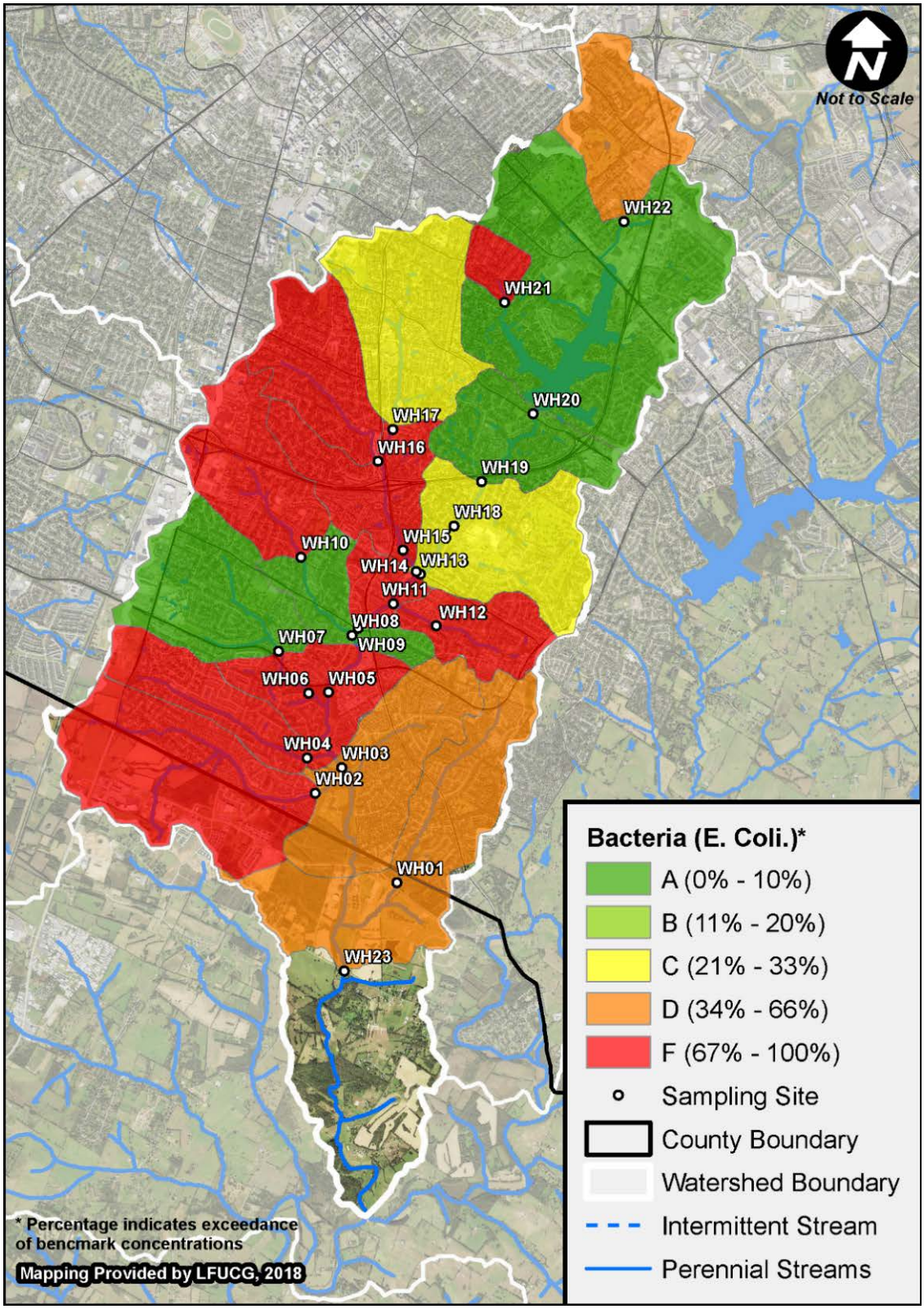

Figure 6-4: Subwatershed E. coli Prioritization

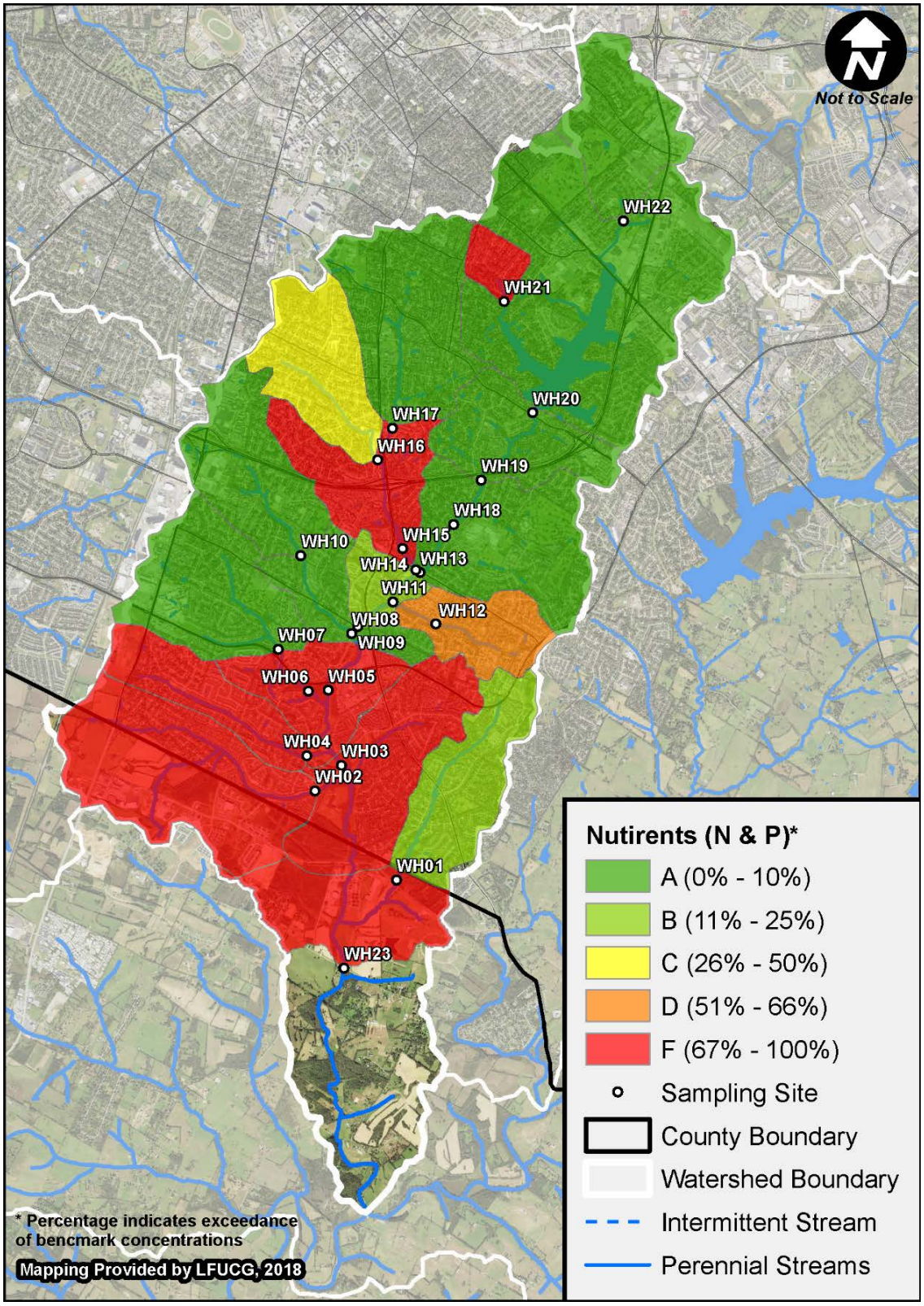

Figure 6-5: Subwatershed Nutrient Prioritization

Table 6-6: BMP Type Ranking Framework

	Ranking							
BMP Type	BMP ID Number	Cost	Feasibility	Benefit	Quickness of Result	BMP SCORE	Normalized Score	Total Rank
Bank Stabilization	1	6	5	9	10	30	0.75	4
Basin Retrofit	2	4	4	10	7	25	0.63	11
Dam Removal	3	3	3	6	8	20	0.50	13
Fecal Matter Control	4	9	8	3	3	23	0.58	12
Green BMP	5	12	9	2	4	27	0.68	7
Public Education and Outreach	6	7	10	4	5	26	0.65	8
Riparian Vegetation	7	10	12	11	2	35	0.88	2
Sanitary Sewer	8	5	6	7	9	27	0.68	6
Sanitary Sewer Investigation	9	11	7	8	6	32	0.80	3
Stream Restoration	10	2	2	13	12	29	0.73	5
Trash Removal	11	13	13	1	13	40	1.00	1
Tree Planting	12	8	11	5	1	25	0.63	10
Wetland	13	1	1	12	11	25	0.63	9

To rank each individual suggested BMP project, the subwatershed score and BMP score were summed together and divided by the maximum ranking to normalize the score on a scale from 0 to 1. Each project was given a rank from 1 to 152 from lowest to highest combined subwatershed and BMP score. This full ranking table is provided in APPENDIX H.

7 IMPLEMENTATION

7.1 IMPLEMENTATION ORGANIZATION

The WHWMP is a dynamic, public document that is intended to assist in protection and enhancement of water quality within the WHC in Lexington, Fayette Kentucky and Nicholasville, Jessamine County Kentucky. Upon approval of this plan, the focus in West Hickman will transition to strictly implementation. Since the goals of the WHWMP align with those of the HCC, HCC will work with LFUCG to develop a central WHWMP Implementation Coordinator. Ideally a full time watershed coordinator position would be developed and filled to support this plan due to the significant amount of time and resources that will be required. The WHWMP Implementation Coordinator will pursue BMP installation and construction; assist in securing funding through grants and other sources; ensure the WHWMP is implemented in a manner consistent with its intent; provide targeted outreach and education; and provide a main point of contact for volunteers and those interested in specific projects.

To successfully implement the BMPs selected in Section 6, a collaborative effort will be required from many individuals, officials, and agencies. The WHWMP Implementation Coordinator cannot be solely relied on for implementation; the following groups/people must also be involved:

- Bluegrass Greensource
- Community Volunteers
- Fayette County Extension Office
- Fayette County Health Department
- Fayette County Public Libraries
- Fayette County Schools
- Friends of Wolf Run
- Hickman Creek Conservancy
- Kentucky American Water Company
- Kentucky Division of Water
- Kentucky River Basin Coordinator
- Kentucky River Watershed Watch
- Kentucky Water Resources Research Institute
- LFUCG Planning and Zoning
- LFUCG Department of Environmental Services
- LFUCG Department of Water Quality
- LFUCG Department of Parks and Recreation
- LFUCG Department of Engineering
- LFUCG Mayor's Office
- Neighborhood/Homeowners Associations
- Property Owners within the Watershed
- University of Kentucky

The WHWMP Implementation Coordinator will be primarily responsible for organization and management of the above listed parties with the assistance of the HCC and LFUCG.

7.2 PLAN PRESENTATION AND OUTREACH

Prior to submittal of the draft WHWMP to KDOW or EPA, a draft version of the plan was made available for public review on the HCC. A two week public comment period was held from January 10 to January 30, 2022. Ten comments were received. Following incorporation of these comments and a final review by the project team, the draft plan was submitted to KDOW and EPA in February 2022.

LFUCG, the West Hickman Watershed Council, and HCC will present the objectives and recommendations of this plan to the general public through a series of events planned for 2022. HCC has committed through a contract with LFUCG to maintain the HCC website to host the WHWMP and announce participation events to the general public. HCC will be maintain the official digital copy of the WHWMP and any updates to the plan will be provided to them. It is the intent of the HCC to also maintain the interactive map showing the proposed BMPs and extend the map to track progress of project completion. HCC will hold a minimum of two events in conjunction with the project team to inform the public of the completion of the planning efforts and promote implementation. No physical hard copies of the WHWMP are anticipated due to the difficulty in ensuring updates.

7.3 FINANCIAL REQUIREMENTS AND BUDGETING

Proposed BMP projects in WHW will demand substantial financial resources. In applicable cases, potential funding sources were provided for BMP projects, this can be viewed in Table 6-4. Expected funding sources included local agency budgets, sanitary sewer user fees and grant programs. A summary of these sources are provided below. Effective implementation of this plan will require a diverse selection of funding sources beyond what is proposed in this plan.

7.3.1 US EPA 319(H) GRANTS

319(h) grants are provided to the Kentucky Nonpoint Source (NPS) Pollution Control Program by the US EPA through the Clean Water Act. These funds can be used to pay for 60 percent of the total cost for qualifying projects, but require a 40 percent non-federal match. Grants are available for watershed projects with priority selection given to projects provided in or addressing concerns discussed in a watershed management plan. The Kentucky NPS Pollution Control Program accepts project proposal forms year round with deadlines to qualify for the current federal funding cycle. More information on US EPA 319(h) Grants can be found on the Kentucky Division of Water website: http://water.ky.gov.

7.3.2 LFUCG STORMWATER QUALITY PROJECTS INCENTIVE GRANT PROGRAM

LFUCG Stormwater Quality Projects Incentive Grants are offered to any project in Lexington which will improve water quality, address stormwater runoff, and provide public education. Typical annual funding is about $1 million. LFUCG DOW reviews applications and presents recommendations to the Water Quality Fees Board. Grants are categorized as Class A neighborhood grants, Class B infrastructure grants, and Class B education grants. Class A grants are offered to any neighborhood, community, or homeowners associations incorporated with the Commonwealth of Kentucky that represent single family homeowners or farms. Class B grants are offered to owners and tenants of non-farm, non-single-family residential facilities including businesses, schools, churches, and non-profits located in Fayette County who pay a Water Quality Management Fee. Additional information can be found online on the LFUCG website: http://www.Lexington ky.gov.

7.3.3 USDA-NRCS EQIP PROGRAM

The USDA-NRCS Environmental Quality Incentive Program (EQIP) offers technical and financial resources to agricultural producers. These funding sources would be most applicable to projects in the more rural portions of the watershed in Jessamine County. The grant addresses natural resource concerns and aims to deliver environmental benefits such as improved water and air quality, conserved ground and surface water, reduced soil erosion and sedimentation or improved or created wildlife habitat. Program participants can receive resources to implement conservation practices to address natural resource concerns on their land.
Local USDA Service Centers such as the FSA Service Center Office (Fayette County Farm Service Agency) and FSA State Office (Kentucky State Farm Service Agency) can be visited in person for more information or to apply. Additional details may be found at: www.nrcs.usda.gov/getstarted.

7.3.4 STATE COST SHARE

Two programs, the Kentucky Soil Erosion and Water Quality Cost Share Program and the Kentucky Soil Stewardship Program helps landowners address active soil erosion, water quality and environmental problems associated with their farming or woodland operation. These programs aim to help agricultural operations protect soil and water resources and to implement agriculture water quality plans. These funding sources would be most applicable to projects in the more rural portions of the watershed in Jessamine County.

This financial and technical assistance program was established by the 1994 Kentucky General Assembly. The program was revised by Kentucky Revised Statute 146.115 so that funds may be administered by local conservation districts and the Kentucky Soil and Water Conservation Commission. Prioritized projects include animal waste-related problems, agricultural district participants and producers who have their Agriculture Water Quality plans on file with their local conservation districts. The Kentucky General Assembly sources funding through direct appropriations to the program from the Tobacco Settlement Funds and from funds provided by the Kentucky Department of Agriculture.

Agricultural operations eligible for cost share include agriculture and animal waste control facilities; streambank stabilization; animal waste utilization; vegetative filter strips; integrated crop management; pesticide containment; sinkhole protection; pasture and hay land forage quality; heavy use area protection; rotational grazing system establishment; water well protection; forest land and cropland erosion control systems; closure of agriculture waste impoundment; on-farm fallen animal composting; soil health management; precision nutrient management; strip intercropping system; livestock stream crossing and riparian area protection.

7.3.5 KENTUCKY AMERICAN WATER ENVIRONMENTAL GRANT PROGRAM

The American Water's Environmental Grant Program, hosted by Kentucky American Water, offers funds to innovative, community-based environmental projects to improve, restore, or protect the watersheds, surface water and/or groundwater supplies in Kentucky communities. In the programs first 15 years, KAW has awarded more than $195,000. Additional details may be found at KAWC's website: www.kentuckyamwater.com.

7.3.6 KENTUCKY DEPARTMENT OF FISH AND WILDLIFE'S STREAM TEAM PROGRAM

The Kentucky Department of Fish and Wildlife's Stream Team offers landowners free repairs to eroded and unstable streams or wetlands. The Stream Team completes stream restoration projects throughout Kentucky. The Stream Team, is staffed by stream restoration specialists in the Kentucky Department of Fish and Wildlife Resources (KDFWR). The team works with private landowners to identify potential stream restoration projects. Funding is sourced from the Mitigation Fund. No state tax general funds or hunting/fishing license dollars are used.

Eligible projects must fulfill criteria including a minimum of 1,000 feet of stream with unstable, eroding banks. Landowners must agree to a permanent easement often 50 feet wide on each side of the restored stream. Both sides of the stream must be accessible. Often times multiple landowners may be incorporated. Typical work is done on small streams from permanent flow to streams which may go dry in late summer. Landowner concerns are heard and included as project goals. These may include fords across the stream, fencing, and access to water for livestock. More information about this program is available at http://fw.ky.gov/Fish/Pages/Stream-Team-Program.aspx.

7.3.7 PARTNERS FOR FISH AND WILDLIFE PROGRAM

The Partners for Fish & Wildlife program offers funding, materials, equipment, labor and expertise to private landowners to improve fish and wildlife habitat. The program excels in voluntary community stewardship for fish and wildlife conservation. More than 90% of Kentucky's land is held in private ownership so it is vastly important to encourage and support private owners to maintain high quality habitat to enjoy today and pass on to future generations. The Partners for Fish & Wildlife works with conservation organizations, state and federal agencies and tribes. More information about this program is available at https://www.fws.gov/frankfort/partners.html.

7.3.8 KEEP LEXINGTON BEAUTIFUL'S GREAT AMERICAN CLEANUP

The Keep Lexington Beautiful's Great American Cleanup™ events are sponsored on a local, state, and national scale. Keep Lexington Beautiful provides supplies for litter removal, graffiti removal, recycling, clothing collection, stream cleanups, beautification, and community improvement events. Interested participants can sign up through registration forms available through the Keep Lexington Beautiful Commission, typically posted annually to their website (https://www.keeplexingtonbeautiful.com/).

7.4 MONITORING IMPLEMENTATION AND SUCCESS

Results of the WHWMP can be measured in terms of not only water quality sampling results and load reductions, but also in terms of implementation progress, education efforts, and behavior modifications. Changes in behavior of the general public can be slow, but impactful in the long run.

7.4.1 IMPLEMENTATION AND OUTREACH TRACKING

HCC plans to track BMP implementation progress over time utilizing the online mapping tool discussed in Section 6.1.6. This online tool will provide a centralized location to store both BMP-specific and programmatic data for WHW. Relevant BMP information can be added to the GIS database that is displayed in the map. Housing this information in a central location will enable HCC to track completion of some objectives that can be completed by small groups, such as trash collection or native vegetation planting. HCC will also maintain records of those in attendance for their meetings and outreach events. Meeting minutes and sign-in sheets will be available on their website. LFUCG will evaluate and provide

feedback to HCC during their annual council meeting. Increased participation will be an indicator of success for education and outreach focused Action Items.

7.4.2 WATER QUALITY MONITORING

With the anticipated completion of all the sanitary sewer consent decree projects in WHW by the end of 2026, no additional water quality monitoring is expected until after that date. To allow stabilization of the watershed following the completion of the projects, repeat water quality monitoring of subwatersheds where RMP projects were completed and sites downstream is recommended in 2028-2030. Upon installation of half of all proposed BMPs in a sub-watershed, LFUCG MS4 division will begin sampling the associated stream site as identified in this plan. Sampling will occur bi-monthly for one year. Sampling results will be compared against LFUCG water quality benchmarks to gage implementation effectiveness. Each individually installed project will develop their own set of evaluation criteria in addition to any criteria required by KDOW or USACE for permit compliance to evaluate the effectiveness and success of the measure. Water quality monitoring is not anticipated for each installed BMP.

7.5 EVALUATION AND UPDATING OF THE PLAN

Evaluation of the plan should be conducted following the monitoring activities described in Section 7.4. The WHWMP Implementation Coordinator should organize a meeting with watershed stakeholders to discuss the collected results. The effectiveness of the BMPs should be discussed. Alternative approaches should be considered in areas where BMPs are shown to not be feasible and/or effective. Each Action Item detailed in Table 6-4 should be considered. Discussion should include if the Action Item is achieving the desired objective, if it should be continued to be pursued, and if the designated outcome indicator is the most effective measure. The effectiveness of public outreach activities should be evaluated based on the number of persons in attendance and the implementation of BMPs discussed at the activity (such as the number of rain barrels installed). As implementation progresses, the prioritization of Action Items may be altered based on a change in stakeholder involvement, project goals, or a variety of other factors. The WHWMP is intended to be a living document, so modifications should be made based on changing conditions. Changes in water quality are influenced by many factors and implementation efforts may take considerable time before changes can be observed in monitoring data.

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