# Watershed Based Plan

## Clarks Run Watershed
## Boyle County, Kentucky

*Prepared for*
Kentucky Division of Water
200 Fair Oaks Lane
Frankfort, KY 40601

November 2, 2009

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Environmental Analysis & Restoration

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# 1. INTRODUCTION

## *1.1. Watershed Background*

The Kentucky Division of Water (KDOW) began working in the Dix River Basin in 1998, as a result of the 1998 Clean Water Action Plan, produced jointly by KDOW, the Natural Resources Conservation Service (NRCS), and the Division of Conservation (DOC). The federal requirements were for the state to jointly select five priority watersheds in Kentucky for targeted water quality improvements. The criteria for selection included:

- Portions of watershed are listed as impaired on the 303(d) list to US Environmental Protection Agency (US EPA)
- Areas are included in NRCS 1998 Environmental Quality Incentives Program (EQIP) Priority Watershed List
- Nonpoint source pollution issues are a priority
- Watershed area is a scale that can be managed
- History of demonstrated stakeholder support

Ultimately, the Dix River watershed was selected as one of several priority watersheds, which resulted in a doubling of 319(h) Nonpoint Source Funding to address the impairments in the watershed. The water quality problems in the Dix River watershed stem from documented impairments in Hanging Fork and Clarks Run and have contributed to impairments in Herrington Lake. Clarks Run was originally 303(d) listed for low dissolved oxygen and organic enrichment in 1990 (KDOW 1990).

KDOW sought public involvement for the purposes of addressing the water quality impairments in these watersheds. Two public meetings were held in Danville in January and March of 2006. Issues of concern were solicited and overwhelming pathogen contamination of the waterways was the most prominent concern of stakeholders.

From these meetings interested individuals were recruited to form the Dix River Watershed Council. The first Council meeting was on May 9, 2006. The stated objectives of the group, at that time, were to form a watershed council to:

- Provide input into watershed analysis and plan development
- Provide input into the development of the Total Maximum Daily Loads (TMDL) for Clarks Run, Hanging Fork and Herrington Lake
- Develop a more detailed watershed plan to reduce pollutants from point and nonpoint sources, including specific water quality management recommendations
- Identify funding sources to implement practices that can reduce pollutants
- Present draft watershed plan to stakeholders
- Implement remediation action identified in watershed plan

The Dix River Watershed Council has meet regularly since its inception, and sought public participation in a watershed planning process. On April 15, 2008, the Dix River Watershed Council suggested that subwatershed groups be formed to analyze the Clarks Run, Hanging Fork, and Upper Dix areas in a more focused manner. The Clarks Run watershed subgroup was organized to further investigate this watershed.

This watershed based plan presents the collaborative culmination of an extensive data collection and analysis effort, recruitment of partners and stakeholders in watershed interests, and remediation strategy development. The Dix River Council and Clarks Run focus group have outlined a comprehensive plan to address the watershed issues. This document is intended to address the nine minimum elements required in the US EPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*. These nine elements (a through h below) are as follows:

a. 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 watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan), as discussed in item (b) 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 (e.g., X numbers of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded stream bank needing remediation).
b. An estimate of the load reductions expected for the management measures described under paragraph (c) 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 (a) above (e.g., the total load reduction expected for dairy cattle feedlots; row crops; or eroded stream banks).
c. A description of the nonpoint source (NPS) management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.
d. 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. As sources of funding, States should consider the use of their 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.
e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.
f. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.
g. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.
h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

## *1.2. Goals*

In March 2007, a questionnaire was distributed to concerned citizens and stakeholders in the Clarks Run watershed. Based on the responses from representatives of agriculture, state and local government, and landowners, four goals for the Clarks Run watershed have been developed:

- Improve water quality in Clarks Run to ensure that recreational use is safe and enjoyable for the community.
- Educate the community on watershed issues to raise environmental awareness and create continuous lines of communication surrounding watershed issues.
- Improve the aquatic and riparian zone habitat in Clarks Run to encourage increased diversity and density of wildlife in proximity to Clarks Run.
- Support low impact development and redevelopment and other practices that will improve water quality.

## *1.3 Partners and Stakeholders*

As previously mentioned, the watershed planning effort was funded by the US EPA under a 319(h) grant through KDOW. The Dix River Watershed Council, formed in May 2006, and the Clarks Run Focus Group, formed in April 2008, comprise the team of partners and stakeholders who will work together to support the plan sponsor, the Clarks Run Focus Group, and accomplish the remediation activities detailed in this plan.

| Company / Affiliation | Name |
|---|---|
| Boyle County Conservation District | Bill Hundley |
| Boyle County Cooperative Extension Agent | Jerry Little |
| Boyle County Economic Development Partnership | Jody Lassiter |
| Boyle County Health Department | Jason Stevens, Roger Trent, Dan Troutman |
| Boyle County Judge Executive | Harold McKinney |
| Caldwell Stone | John Albright |
| Centre College | Rose-Marie Roessler |
| City of Danville Stormwater Utility | Josh Morgan |
| Clarks Run Environmental and Educational Corporation (CREEC) | Malissa McAlister, Preston Miles |
| Director of Public Works | Duane Campbell |
| Healthy Planets Initiative | Christine Missik |
| Herrington Lake Conservation League | Dave Jewett |
| KDOW | John Webb |
| Kentucky River Watershed Watch (KRWW) | Chris Barton |
| Landowner | Eben Henson, Tim Montgomery, Ken Douglass |
| Natural Resources Conservation Service | Brandon Campbell |
| Sharpe Construction Company | Joedy Sharpe |

# 2. WATERSHED INFORMATION

## *2.1. General Watershed Description*

### *2.1.1. Location*

The Clarks Run watershed (United States Geological Survey Hydrologic Unit Code, or HUC #05100205190) covers approximately 28.5 square miles or 18,219 acres in southeastern portion of Boyle (96.5 percent) and a small portion of Lincoln County (3.5 percent), Kentucky. About two-thirds of the City of Danville is located in the watershed as well as the northern part of Junction City. The Clarks Run Watershed is a tributary to the Dix River, which flows into Herrington Lake. Lancaster is located east of the watershed, Perryville to the west, and Harrodsburg and Burgin to the north. Exhibit 1 (page 5) shows the location of the Clarks Run watershed in relation to the surrounding area.

### *2.1.2. Hydrology*

Clarks Run flows for approximately 12 miles from its headwaters to the Dix River and has 53 miles of streams including tributaries and main stem within the entire watershed. The stream is predominantly high gradient bedrock with perennial flow (continuous flow year round) for the majority of the reach. Balls Branch is the only significant tributary to Clarks Run, with the confluence just upstream of the KY 52 overpass. Clarks Run streams are prone to flashy storm flows as a result of the high percentage of impervious surfaces, or surfaces which do not absorb water, associated with the City of Danville.

Located primarily in the Inner Bluegrass Ecoregion among others, the Clarks Run watershed contains undulating terrain with moderate rates of both surface runoff and subsurface drainage. Limestone with minor occurrences of shale and siltstone underlie the region.

The Midwestern Regional Climate Center station in Danville, Kentucky, reports that the average annual precipitation from 1971 to 2000 for Boyle County was 48.87 inches with 11.6 inches of snowfall. According to the *Garrard Lincoln County Soil Survey* (NRCS 2006) Waynesburg in Lincoln County, Kentucky had an average annual precipitation of 52.13 inches from 1961 to 1990. The average seasonal snowfall was 17.9 inches over this same time period.

No US Geological Survey (USGS) water stations are currently located in the Clarks Run watershed. From 1975 through 1986, a USGS gauge on Balls Branch tributary was in operation. The closest station currently in operation is located on the Dix River near Danville (USGS gauge 03285000), upstream of the Clarks Run confluence with the Dix River. Basic statistics on the discharge at this station are provided in Table 1 (page 6).

Although no USGS stations are located in the watershed, considerable flow data was collected for the 8 sampling sites during the March 2006 to February 2007 sampling period. These data will be summarized for use in the calculation of the loadings within the watershed.

As part of a yearlong water quality monitoring study in Clarks Run, two water level data loggers were utilized to evaluate the relationship between the daily stream water depth and the flow data captured. These data loggers captured daily changes in the water level at the mouth of Balls Branch and at the US 127 overpass of Clarks Run. Figures 1 and 2 (pages 6 and 7, respectively) graphically illustrate the results of this study.

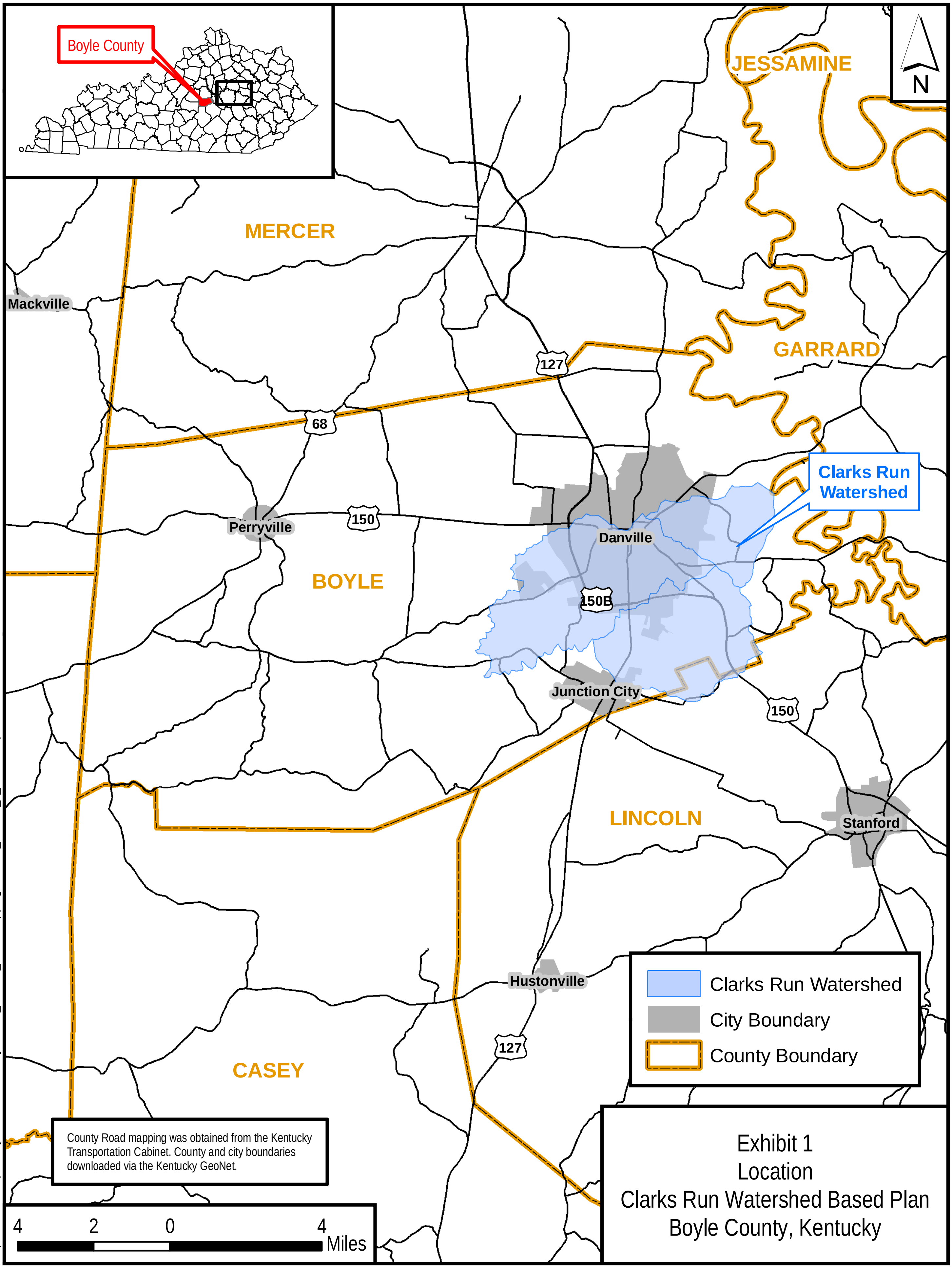


Exhibit 1
Location
Clarks Run Watershed Based Plan
Boyle County, Kentucky

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TABLE 1 – DISCHARGE STATISTICS AT USGS GAUGE 03285000, DIX NEAR DANVILLE

| PARAMETER | STATISTIC |
|---|---|
| Period of Record | 1943-2007 |
| Drainage Area (mi2) | 441 |
| Annual Mean Discharge (cfs) | 469 |
| Highest Daily Mean (cfs) | 1184 (in 1979) |
| Lowest Annual Mean (cfs) | 119 (in 1954) |
| Annual 7-day minimum | 0 (in 1944) |
| Annual runoff (cfsm) | 1.47 |
| Annual runoff (inches) | 20.03 |
| 10% discharge exceeds (cfs) | 1060 |
| 50% discharge exceeds (cfs) | 126 |
| 90% discharge exceeds (cfs) | 3.2 |

FIGURE 1 – WATER LEVEL AT BALLS BRANCH MOUTH, 2006-2007

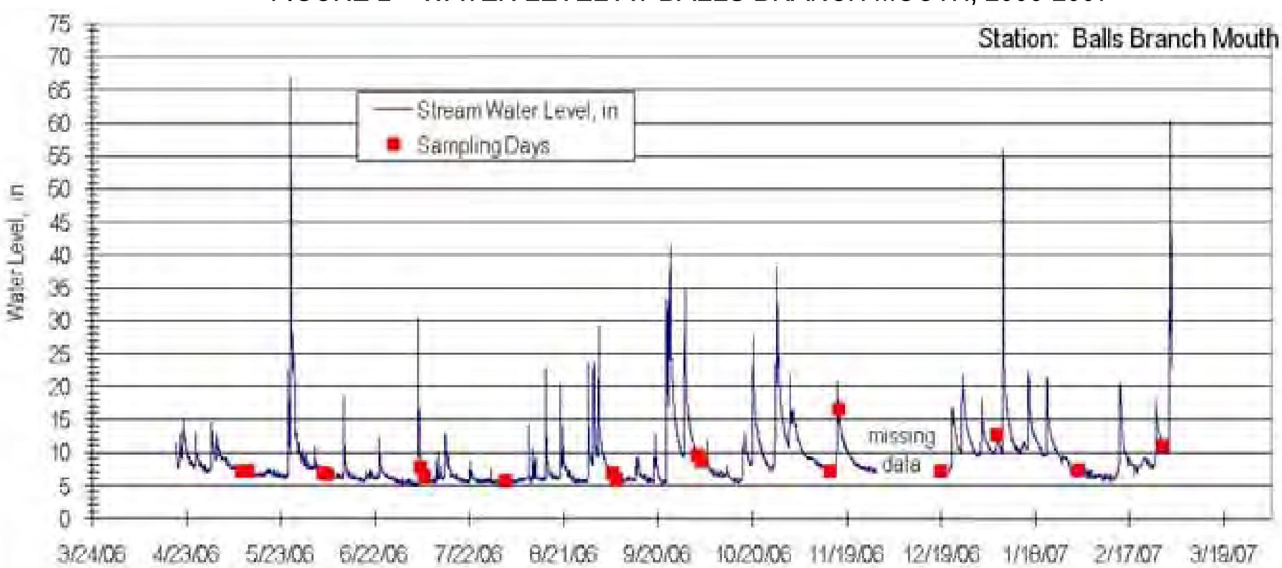
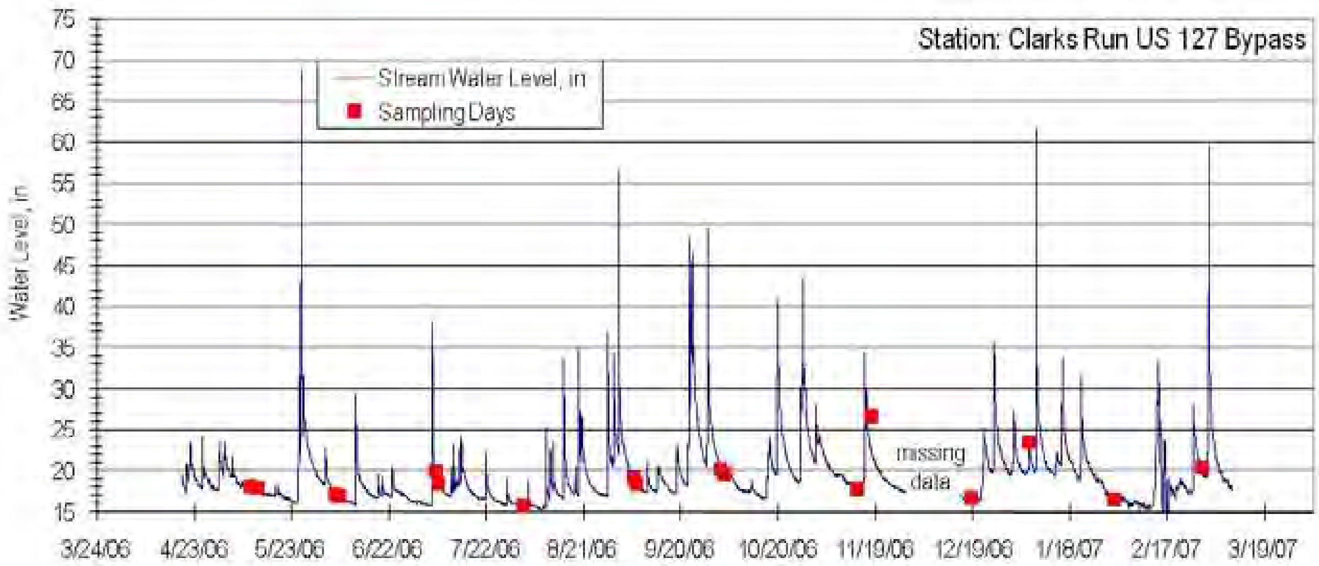


FIGURE 2 – WATER LEVEL AT CLARKS RUN US 127 BYPASS, 2006-2007




Cumulatively, Figures 1 and 2 indicate that the water levels in the stream show wide variance, increasing over 5 feet at the mouth of Balls Branch and as much as 4.5 feet at Clarks Run at US 127 Bypass. The hydrographs show that the streams exhibit a flashy response to storm events, quickly rising and falling in response to the runoff and groundwater influx. As shown in these figures, the water quality sampling conducted concurrently with these water level readings were usually measured during the lowering of the water level to base flow conditions subsequent to a storm, although several events did capture rising stream conditions. The water quality study is discussed further in Section 2.1.8 of this document.

### *2.1.3. Groundwater-Surface Interaction*

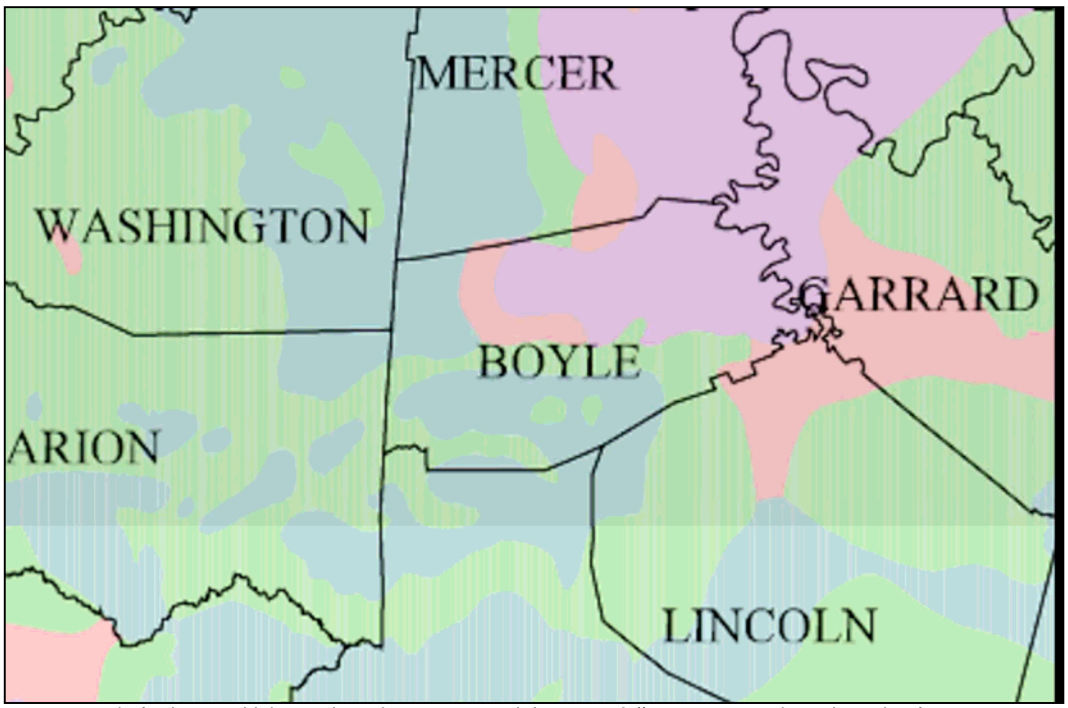
In order to evaluate the sensitivity of groundwater resources to water pollution, KDOW developed a hydrologic sensitivity index to quantify the regions of Kentucky (Ray *et al.* 1994). Based on groundwater recharge, flow, and dispersion rates, the index ranges from 1 (low) to 5 (high).

The sensitivity index in the Clarks Run watershed is largely a product of the underlying geology. The hydrology is strongly influenced by the amount of shale in the subsurface, which generally impedes the infiltration of precipitation. As shown in Figure 3 (page 8), a large portion of Clarks Run shows the highest karst sensitivity index (5) due to greater limestone influence. In the southern area of the watershed, karst sensitivity is lower (3) with potential for karst but not extensive development due to interbedded shales and limestone.

The hydrologic sensitivity ratings are well correlated with the potential for karst areas and known groundwater features in the watershed as mapped by the Kentucky Geological Survey. As shown in Exhibit 2 on page 9, major karst potential is found along the northern portion of the watershed, no potential along the central west to east band, and moderate karst potential to the south. Springs are mostly found in or nearby these karst potential areas. The groundwater wells scattered throughout the watershed utilize this resource for a variety of purposes.

In a karst study conducted by Ray 2002, three subsurface flow routes were identified in the Clarks Run watershed showing considerable geographic movement of groundwater in major karst areas, especially in the northeast portion of the watershed. The dye trace study was conducted in order to identify the source of a sewage contamination in Bull Spring which discharges 0.15 cfs at low flow and about 1 cfs at high flow. The source was traced to a pump station that was subsequently repaired. The study noted a rare complex artesian flow route with a perched spring. Thus, the relationship between surface water and groundwater resources in Clarks Run may be complex and the likelihood of a well developed karst flow in Clarks Run is high.

FIGURE 3 – HYDROLOGIC SENSITIVITY INDEX MAP OF COUNTIES SURROUNDING THE CLARKS RUN WATERSHED




Hydrologic Sensitivity Ratings from Low to High are as follows: Grey=1 (not shown), Blue = 2, Green=3, Pink=4, Purple=5 (from Ray *et al.* 1994).

### *2.1.4. Flooding*

Flooding is not a large concern in the Clarks Run watershed, but is more prevalent within and downstream of Danville city limits. A 100-year floodplain map of Clarks Run is shown on Exhibit 2 (page 9), but no floodplains areas have been identified for Balls Branch. The capacity of Clarks Run and its tributaries is generally adequate to handle more frequent storm events.

### *2.1.5. Water Supply*

Water withdrawals allow businesses and consumers to use local water resources to provide for drinking water, industrial wash water, and other water needs. Because surface water is a finite resource, the withdrawal of water from streams and lakes, particularly during low flow conditions, affects the quality and quantity of water and can cause impacts to the aquatic communities.

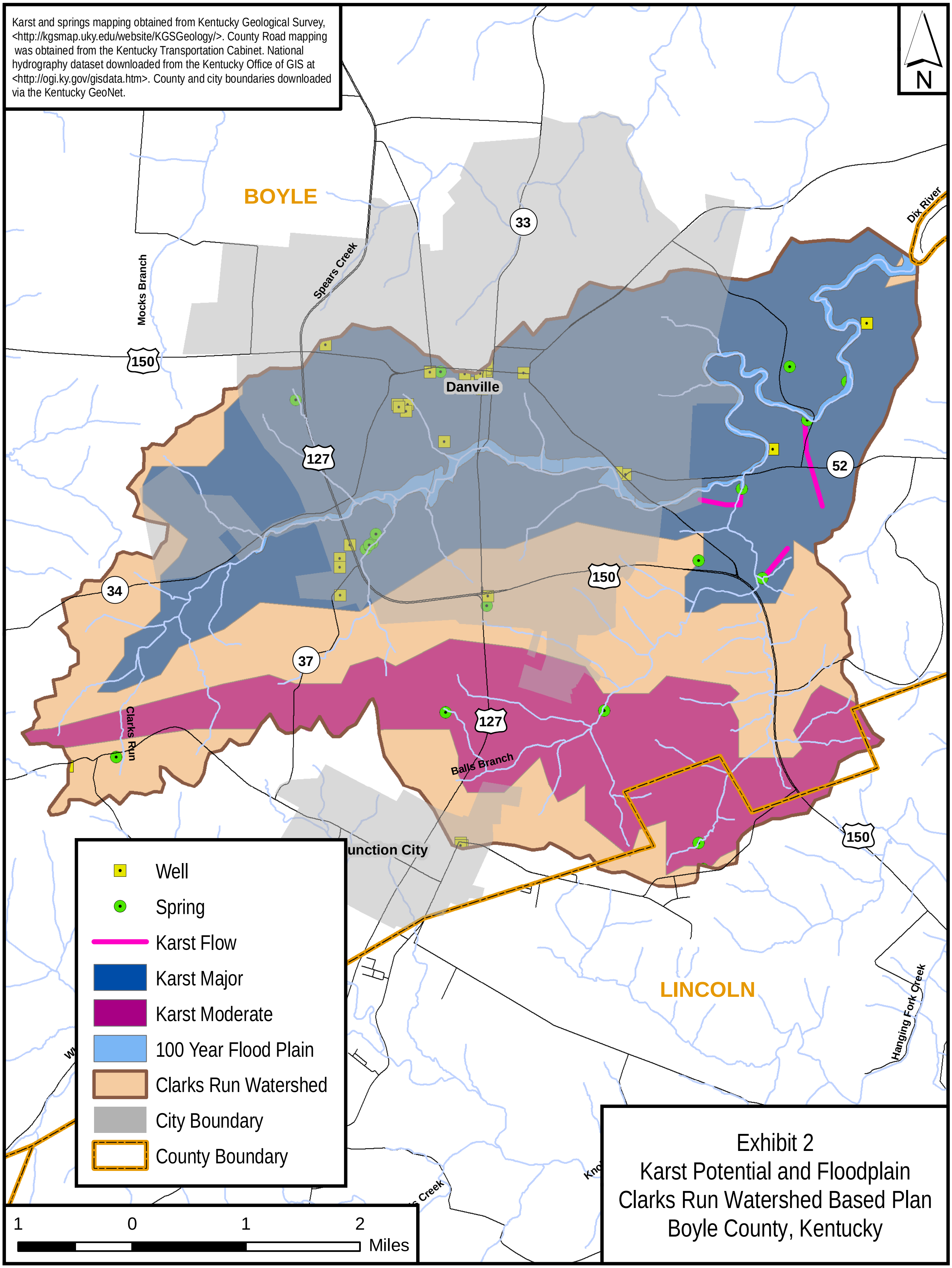



Exhibit 2
Karst Potential and Floodplain
Clarks Run Watershed Based Plan
Boyle County, Kentucky

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Drinking water in the Clarks Run watershed is provided primarily by two sources as shown on Exhibit 3 (page 11). The Danville City Water Works (PWSID 0110097) withdraws outside of the Clarks Run watershed, upstream of the confluence of Spears Creek with Lake Herrington. However, the water supplier provides drinking water to most residents of the watershed. The Parksville Water District (PWSID 0110345) covers a small portion of the western watershed area. According to the Bluegrass Area Development District (ADD) Water Resources Development Plan, 95 percent of the estimated population of 27,300 residents in Boyle County in 2020 will be on public water (Water Resources Development Commission 1999). This estimate assumes 375 customers and 68 miles of water line will be added in Boyle County from 2000 to 2020. In areas without public water, this report indicates that 35 percent of households rely on well water while 65 percent use other sources.

There are currently two known water withdrawal permits in the watershed. The Danville Country Club has a commercial permit for surface water withdrawal from Clarks Run at river mile 4.4. Caldwell Stone Company, Inc. has a mining permit to withdrawal from Clarks Run approximately 500 feet upstream of US-150 and from a mine pit impoundment in the quarry.

### *2.1.6. Watershed Management Activities*

Although this document represents the first comprehensive watershed based plan for the Clarks Run watershed, much planning has occurred in the watershed with regard to water infrastructure and zoning.

*Source Water Assessment and Protection Plan*

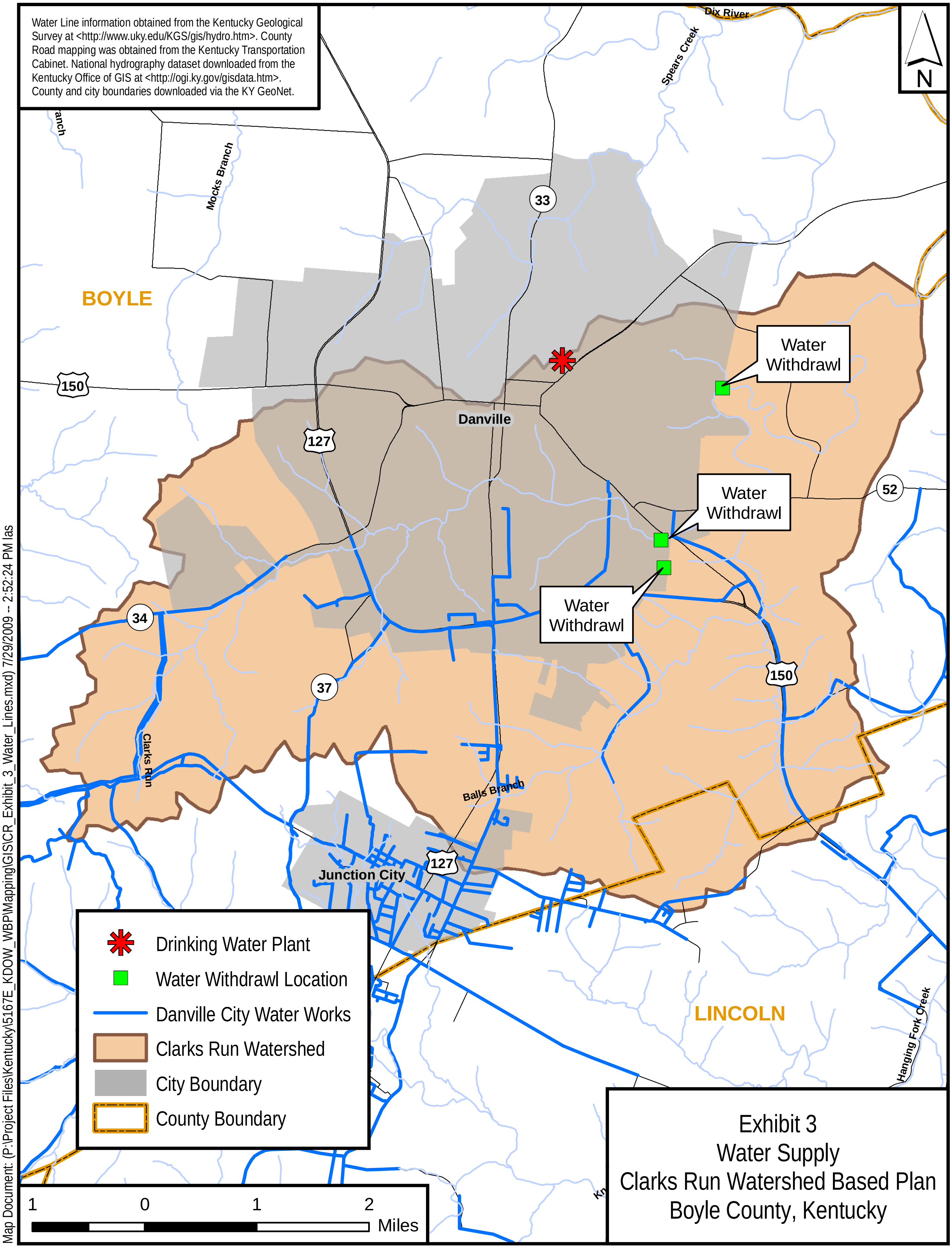
A "Source Water Assessment and Protection Plan" (SWAPP) is in place for Boyle County, which covers the analysis of potential pollutants and protection measures for drinking water supply systems. Danville City Water Works is covered in this plan as well as much of its service area under the Zone of Potential Impact. This plan provides a list of potential pollutant sources ranked according to their potential impact (Appendix A).

*Wastewater Facilities Plan*

The Clarks Run watershed is included in the 201 Facilities Plan for the City of Danville. Although a revised plan is currently under review as part of the revision process of the *Boyle County Comprehensive Plan*, Howard K. Bell Consulting Engineers, Inc. prepared the most recent (2006) update of the plan based on the existing Comprehensive Plan. The scope of the Danville Facilities Plan includes the wastewater planning and needs, environmental conditions, and the environmental impact of alternative wastewater treatment facilities in Danville, Junction City, and Perryville through 2025.

As of 2004, the City of Danville owns, operates, and maintains approximately 117 miles of gravity sewer lines, 9 miles of force main, and two municipal wastewater treatment facilities, and one off-site equalization facility.

The plan evaluates five options for the future needs of the cities of Danville, Junction City, and Perryville including no action, upgrading the existing Perryville wastewater treatment plant (WWTP), construction of a treatment facility on Spears Creek, construction of an equalization / aerated facultative lagoon at Spears Creek or an upgrade to the Spears Creek pump station, and pumping the additional flow from the Northpoint Training Center WWTP to the Danville WWTP for treatment. Of these five options, upgrading



Water Line information obtained from the Kentucky Geological Survey at <http://www.uky.edu/KGS/gis/hydro.htm>. County Road mapping was obtained from the Kentucky Transportation Cabinet. National hydrography dataset downloaded from the Kentucky Office of GIS at <http://ogi.ky.gov/gisdata.htm>. County and city boundaries downloaded via the KY GeoNet.
N
Dix River
Spears Creek
Mocks Branch
BOYLE
33
150
127
Danville
Water Withdrawl
Water Withdrawl
Water Withdrawl
52
34
37
150
Clarks Run
Balls Branch
127
Junction City
LINCOLN
Hanging Fork Creek
Drinking Water Plant
Water Withdrawl Location
Danville City Water Works
Clarks Run Watershed
City Boundary
County Boundary
1 0 1 2 Miles
Exhibit 3
Water Supply
Clarks Run Watershed Based Plan
Boyle County, Kentucky
Map Document: (P:\Project Files\Kentucky\5167E_KDOW_WBP\Mapping\GIS\CR_Exhibit_3_Water_Lines.mxd) 7/29/2009 -- 2:52:24 PM las

the existing Perryville WWTP and construction of an equalization / aerated facultative lagoon at Spears Creek was investigated as the selected alternatives in the plan over the next 20 years.

### Ordinances

In addition to these drinking water and wastewater plans, several ordinances have been passed by the City of Danville restricting land uses that might impact water quality. The full text of each of these ordinances is available online through the document center at the City of Danville's official website (www.danvilleky.org).

#### *Ordinance 1674, Erosion Prevention and Sediment Control Ordinance*

This ordinance was enacted

> "… *to protect property, prevent damage to the environment and promote the public welfare in Danville by guiding, regulating, and controlling the design, construction, and use of excavation, grading, and other similar activities which disturb or break the topsoil or result in the movement of soil. During construction, soils are the most vulnerable to erosion by wind and water. This eroded soil endangers water resources by reducing water quality, and causing the siltation of aquatic habitat for fish and other desirable species. Eroded soil also necessitates the repair and cleaning of storm sewers, ditches, and other facilities in the stormwater system. The regulations contained in this ordinance are intended to prevent soil erosion and to provide procedures for submission, review and approval of erosion control plans prior to soil disturbance.*"

#### *Ordinance 1675, Floodplain Construction Ordinance*

The floodplain construction ordinance was enacted in order to

> "… *promote the public health, safety and general welfare and to minimize public and private losses due to flood conditions in specific areas. The provisions of this article are intended to restrict or prohibit uses which are dangerous to health, safety and property due to water erosion hazards, or which result in damaging increases in erosion or in flood heights or velocities; to require that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction; to control the alteration of natural floodplains, stream channels, and natural protective barriers, which are involved in the accommodation of flood waters; to control filling, grading, dredging and other development which may increase erosion or flood damage; and to prevent or regulate the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards to other lands.*"

#### *Ordinance 1676, Illicit Discharge Ordinance*

According to the stated purpose of the ordinance, it serves to

> "*… provide for the health, safety, and general welfare of the citizens of Danville, Kentucky, through the regulation of non-stormwater discharges to the stormwater system. To the maximum extent practicable, the introduction of pollutants into the municipal storm sewer system shall be controlled in order to comply with requirements of the National Pollutant Discharge Elimination System (NPDES) permit process." The stated objectives of this ordinance are: "(1) To regulate*

*the contribution of pollutants to the municipal storm sewer system by non-stormwater discharges by any user, (2) To prohibit illicit connections and discharges to the municipal storm sewer system, and (3) To establish legal authority to carry out all inspection, surveillance and monitoring procedures necessary to ensure compliance with this ordinance*."

### *2.1.7. Regulatory Status of Waterways*

Kentucky assigns designated uses to each waterway based on the ways in which a waterway is utilized. All streams in the Clarks Run Watershed have four designated uses: warmwater aquatic habitat, domestic water supply, primary contact recreation, and secondary contact recreation. Warm water aquatic habitat indicates that the stream provides suitable habitat for desirable fish and aquatic organisms. Primary contact recreational use indicates that people can swim without risks to their health and secondary contact use indicates that people can canoe or boat with only occasional contact with the water without health risks. No special use protected waters are located in the watershed. Domestic water supply indicates use as drinking water.

The 303(d) List of Surface Waters (KDOW 2008) lists streams where the designated use water quality criteria are not met. This document lists the type of impairment as well as the pollutants and suspected sources of impairment. For the Clarks Run Watershed, Table 2 (page 14) lists the streams that appear on the 303(d) list. In the list, 19.2 miles of the 53 stream miles in the watershed (36.2 percent) are listed as impaired for primary contact recreation use due to a variety of pollutants and suspected sources. These streams, as shown on Exhibit 4 (page 15), include all of the higher order (mainstem) streams throughout the watershed. TMDL's to determine maximum pollution limits each waterbody can receive and still meet water quality criteria are in development for Clarks Run. Third Rock Consultants is developing a nutrient TMDL while KDOW is developing a bacteriological (*E. coli*) TMDL.

### *2.1.8. Water Quality Data*

In order to evaluate the water quality within the Clarks Run watershed, data was gathered from all available sources including scientific studies, government, and volunteer sources. As a result of this search, six significant sources of water quality data were located. These sources include a Master's thesis, KRWW volunteer sampling, the Kentucky Groundwater database, a USGS study of Lake Herrington, Kentucky Ecological Data Application System (EDAS), and a 319(h) grant funded comprehensive Clarks Run watershed study by Third Rock Consultants. These studies were conducted over multiple years, geographic areas, and parameters. Exhibit 5 (page 16) shows the locations of the monitoring sites from which the water quality data was collected. For ease of reference, the watershed drainage areas upstream of each Third Rock water quality monitoring site are shaded in Exhibit 5. Each of these studies is further described in the following sections.

#### Division of Water – Groundwater Database

Groundwater quality data from KDOW's consolidated groundwater database (KDOW 2007b) is summarized in Table 3 (page 14). The data is compiled from 7 sites over the time period between 1953 to 2001. Because the data is so infrequently collected, it is of negligible value to the current analysis. However, it does show some historically high total dissolved solids levels.

## TABLE 2 – 303(D) LISTED STREAMS IN THE CLARKS RUN WATERSHED

| STREAM NAME | COUNTY | RIVER MILES | POLLUTANT | SUSPECTED SOURCES | IMPAIRED USE |
|---|---|---|---|---|---|
| Clarks Run into Dix River | Boyle | 0.7 to 4.0 | *E. coli*; Nutrient/ Eutrophication Biological Indicators; Organic Enrichment (Sewage) Biological Indicators; Sedimentation/ Siltation | Municipal Point Source Discharges; Streambank Modifications/ destabilization; Unrestricted Cattle Access; Urban Runoff/Storm Sewers | WAH (Partial Support); PCR (Nonsupport) |
| Clarks Run into Dix River | Boyle | 4.0 to 6.3 | *E. coli*; Cause Unknown; Nutrient/Eutrophication Biological Indicators; Organic Enrichment (Sewage) Biological Indicators | Municipal Point Source Discharges; Source Unknown; Urban Runoff/Storm Sewers | WAH (Nonsupport); PCR (Nonsupport) |
| Clarks Run into Dix River | Boyle | 6.3 to 14.3 | *E. coli*; Sedimentation/ Siltation | Source Unknown; Streambank Modifications/destabilization | WAH (Partial Support); PCR (Nonsupport) |
| Balls Branch into Clarks Run | Boyle | 0.0 to 4.9 | *E. coli* | Agriculture; Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO) | PCR (Nonsupport) |

NOTE: WAH= Warm Water Aquatic Habitat; PCR = Primary Contact Recreation

## TABLE 3 – GROUNDWATER DATABASE WATER QUALITY SUMMARY FOR THE CLARKS RUN WATERSHED

| PARAMETER | UNITS | MAXIMUM | AVERAGE | # SAMPLES |
|---|---|---|---|---|
| Alkalinity | mg/L | 202 | 202 | 1 |
| Conductivity | uS/cm | 389 | 246 | 7 |
| Hardness | mg/L | 106 | 106 | 1 |
| Nitrate-Nitrogen | mg/L | 0.801 | 0.801 | 1 |
| Nitrite-Nitrogen | mg/L | 0.006 | 0.006 | 1 |
| Orthophosphate-Phosphorus | mg/L | 0 | 0 | 1 |
| pH | SU | 7.58 | 7.58 | 1 |
| Total Dissolved Solids | mg/L | 704 | 358 | 2 |

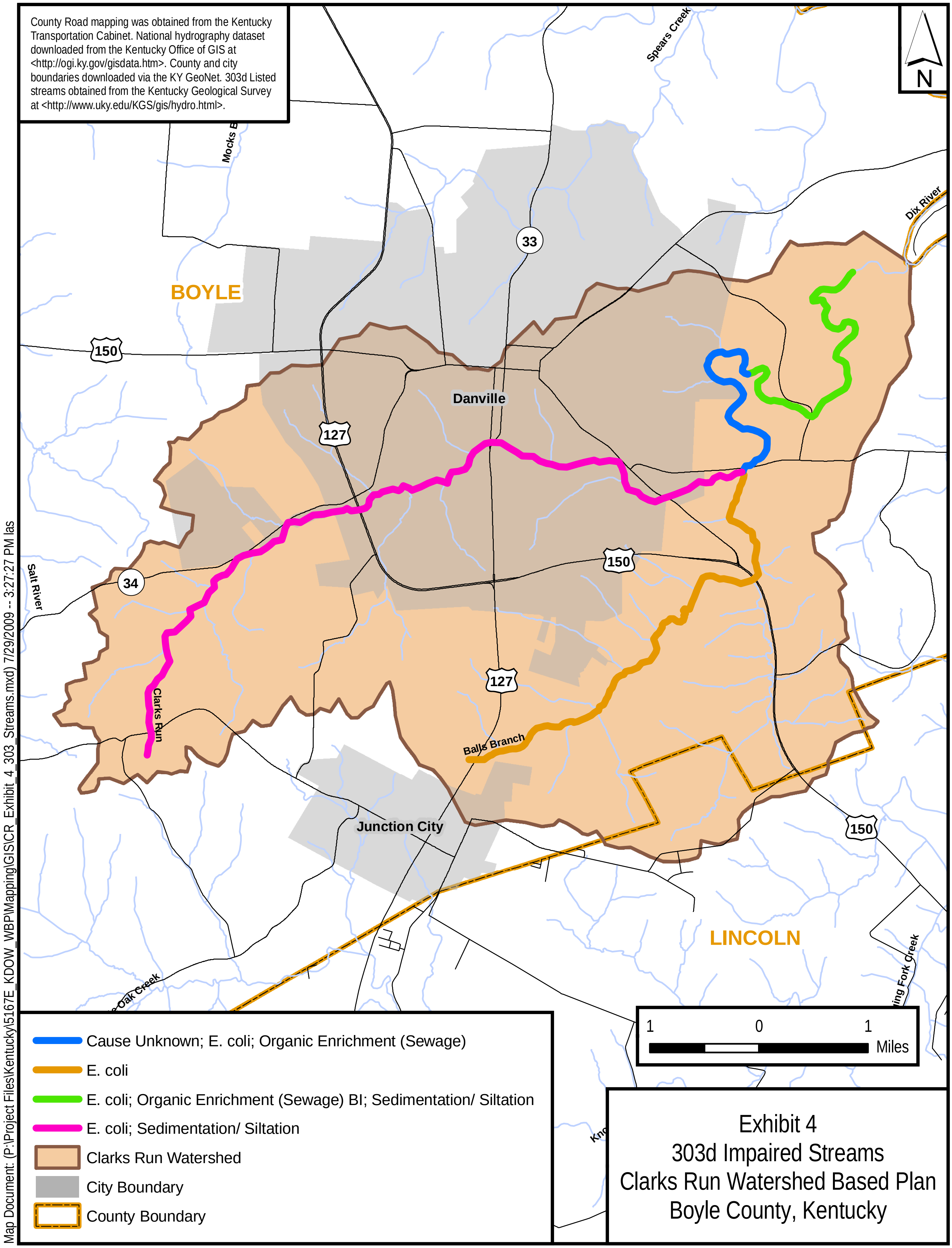



Exhibit 4
303d Impaired Streams
Clarks Run Watershed Based Plan
Boyle County, Kentucky

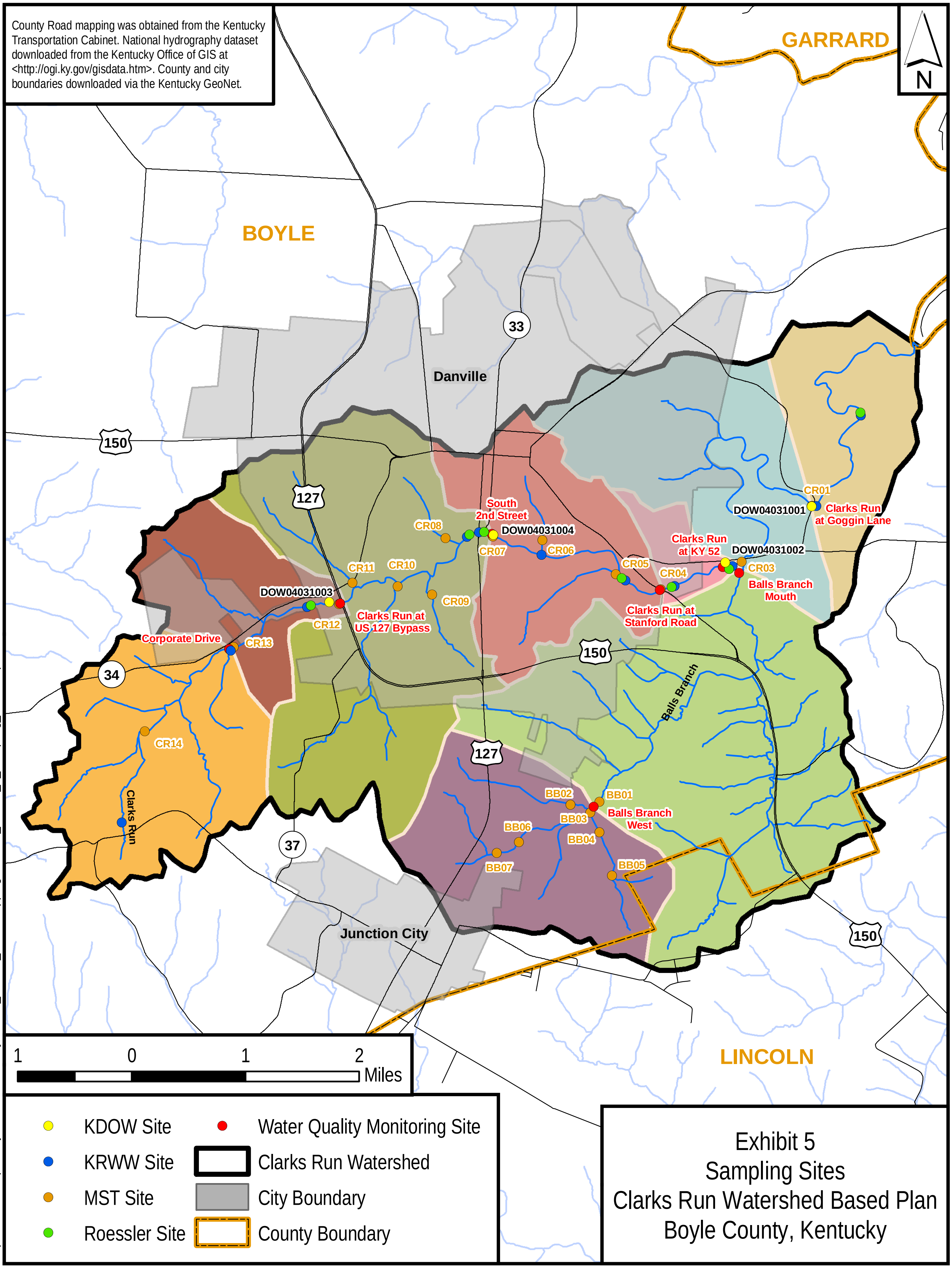



Exhibit 5
Sampling Sites
Clarks Run Watershed Based Plan
Boyle County, Kentucky

Map Document: (P:\Project Files\Kentucky\5167E_KDOW_WBP\Mapping\GIS\CR_Exhibit_5_Sampling_Site.mxd) 7/30/2009 -- 1:24:12 PM las

### 1999 USGS Herrington Lake Report

Herrington Lake, 1999 USGS Report indicates that Clarks Run represents 18 percent of the annual total nitrate load entering Lake Herrington and 14 percent of soluble reactive phosphorus. Clarks Run concentrations measured monthly in 1995 and 1996 range from 2.8 to 12 mg/L of nitrate and 0.08 to 1.1 mg/L of soluble reactive phosphorus. Sites were collected at a now defunct USGS gauge, which coincides with the KRWW site K014, discussed below. Another USGS gauge on Balls Branch tributary was in operation 1975 through 1986. Only peak discharge values are available.

### Kentucky River Watershed Watch and Citizens Action Plan

KRWW is a nonprofit organization that focuses on water quality monitoring and improvement efforts within the Kentucky River Basin. From 1999 to 2008, four sites within the Clarks Run Watershed have been monitored by the KRWW at sporadic frequencies. A summary of the survey data is provided in Appendix B. Some key findings include low dissolved oxygen (less than 4 mg/L) for 5 out of 10 measurements since 2000 at site K125. These low measurements appear to be due to low or no flow. Nitrate has been high (over 10 mg/L) at K014 and K240 in 2000, 2001, 2002 and 2005 while phosphorus has typically been below 1.

In 2003, an analysis of the KRWW data was conducted by KRWW with a focus on identifying sources of fecal coliform contamination. Eight sites were sampled for fecal coliform and total coliform using AC/TC ratios to determine the fecal age. Based on the results of this study, a Citizen's Action Plan (CAP) was compiled in 2004 and is presented in Appendix C.

The assessment found three significant conclusions as listed below:

1. There is a general decline in water quality as the stream passes through the city of Danville,
2. Increased fecal counts may not be associated with the wastewater treatment plant, but increased nutrient concentrations may be,
3. There is evidence of fecal contamination that may be human related, upstream of the wastewater treatment plant, near a downtown storm water drain, and in the far upstream reaches of Clarks Run.

The action items of this plan involved contacting local officials and organizing additional sampling activities. The management of these action items was largely absorbed into the CREEC.

### Rose-Marie Roessler's Master's Thesis

Rose-Marie Roessler, a biology lab instructor at Danville's Centre College, conducted her Master's thesis in Clarks Run entitled "Bioassessment of Water Quality of Clarks Run, Boyle County, Kentucky Using Chemical Parameters and Macroinvertebrates as Biological Indicators." The study included monthly sampling at seven sites from July 2002 to June 2003 to determine water quality utilizing macroinvertebrates, habitat, and water chemistry as the environmental measures. Water chemistry testing revealed fairly constant pH, temperature, and dissolved oxygen values with evidence for elevated nitrates, phosphates and particulate organic matter (POM). Analysis of the macroinvertebrate community revealed poor water quality along the length of Clarks Run as seen by the lack of similarity between sites. Mean orthophosphates and nitrate values were highest downstream of the wastewater treatment plant; however, it is worth noting that orthophosphates levels were noticeably elevated at downtown sites as well. Similarly, the biological community showed impacts from the treatment plant's discharge as all biological metrics, except one, indicated the poorest water quality at this site.

### Kentucky Division of Water Ecological Data Application System (KDOW EDAS)

A search of the KDOW EDAS indicated that 4 sites in the Clarks Run watershed have been monitored at variable frequencies for habitat and physio-chemistry as well as fish, diatom, and macroinvertebrate populations. This monitoring, conducted between 1982 and 2008 includes valuable data on the biotic life in Clarks Run. Table 4 indicates the health of the streams based on these biological indicators.

TABLE 4 – CLARKS RUN BIOASSESSMENT INDEX DATA

| SITE | DATE | DIATOMS | | MACROINVERTEBRATE | | FISH | | PHYSICAL HABITAT |
|---|---|---|---|---|---|---|---|---|
| | | TNI | INDEX | TNI | INDEX* | TNI | INDEX | |
| DOW04031001 Goggin Lane | 9/9/1982 | - | - | - | - | 205 | 8 – Very Poor | - |
| | 11/16/1995 | 510 | 56.8 - Excellent | 694 | 51.31 - Fair | 172 | 21 – Poor | - |
| | 7/30/2008 | - | - | - | - | 163 | 41 – Fair | 114 – Partial |
| DOW04031002 Upstream of KY 52 | 11/16/1995 | 501 | 21.8 – Poor | 360 | 23.93 - Poor | 4 | 12 – Very Poor | - |
| | 7/30/2008 | - | - | 313 | 55.56 - Fair | 404 | 62 – Excellent | 116 – Partial |
| DOW04031003 US 127 Bypass | 11/16/1995 | 501 | 46.4 - Good | 469 | 50.53 - Fair | 191 | 48 - Good | - |

TNI = Total Number of Individuals
*Only the 7/30/08 DOW04031002 macroinvertebrate sample was collected using semi-quantitative methods, all others were multi-habitat samples.

In general, these results indicate that a wide range of habitat and biological quality is present in Clarks Run. The diatom index ranged from excellent to poor, the macroinvertebrates from fair to poor, and fish from excellent to very poor. The 2008 survey information indicated fair and excellent scores for the parameters accessed. While this information may be used to provide some background, the biological data is not collected with sufficient frequency or at a sufficient number of sites to indicate changes in the watershed over time.

### KDOW – Third Rock Water Quality Monitoring Study and Microbial Source Tracking

Under a 319(h) grant from KDOW, Third Rock Consultants performed water quality monitoring from March 2006 to February 2007 on the Clarks Run watershed as a part of a larger monitoring effort for the Dix River Watershed and Herrington Lake.

Eight stations in the Clarks Run watershed were sampled on a monthly basis, at minimum, with intent to capture low, normal, and high flows. At all sites, monthly grab samples were collected and analyzed at Microbac Laboratories and CT Laboratories for the following parameters: ammonia ($NH_3$), total organic carbon (TOC), nitrate ($NO_3$), nitrite ($NO_2$), Kjeldahl nitrogen (TKN), orthophosphate (OP), total phosphorus (P), total suspended solids (TSS), total coliform, and *Escherichia coli* (*E. coli*). At 4 select sites, alkalinity, biochemical oxygen demand (BOD) 5-day, BOD 15-day, chlorophyll *a*, and turbidity were collected monthly, chloride collected quarterly, and periphyton twice during the recreation season. While onsite, conductivity, depth, discharge, dissolved oxygen (DO), pH, and water temperature were measured. US EPA Rapid Bioassessment Protocol (RBP) worksheets were completed at all sites during the initial and final site visits in order to evaluate habitat. Twenty-four-hour diurnal dissolved oxygen measurements were taken at two stations on August 16, 2006 and at two different locations on July 31, 2008 and August 6, 2008. To measure the fluctuations in the stream water levels, continuously monitoring pressure transducers were also established at two sites in the watershed.

Due to the excessively high total coliform and *E. coli* values observed from initial monitoring, the Clarks Run watershed was further investigated to identify and quantify the sources of pathogen pollution. Sampling was concentrated upstream of the Balls Branch West site due to the extremely high concentrations recorded in that area. The Microbial Source Tracking (MST) study involved identifying and characterizing sites for analysis, using *E. coli* and total coliform analysis for hotspot identification, and then utilizing DNA methods to trace the host sources.

In the MST study, 20 sampling sites in the watershed were characterized using the EPA RBP habitat analysis and were surveyed for visual signs of fecal inputs in July 2007. Because of drought conditions in 2007, sampling for *E. coli* and total coliform was delayed until May of 2008 when a storm event and a normal flow event were sampled. *E. coli* was utilized to indicate the pathogen loading of the watershed and the atypical to typical coliform colony ratio analysis (AC/TC) associated with the total coliform to indicate the fecal age and the general source. From these sites, 4 “hotspots” were chosen for DNA analysis. Samples were collected for an additional storm and / or normal flow event during June and July of 2008 for laboratory analysis by Source Molecular Laboratories using the following methods:

- Human Enterococcus ID
- Human Bacteroidetes ID
- Cow Enterococcus ID
- Cow Bacteroidetes ID

All samples that tested positive for any of these parameters were further analyzed by quantitative polymerase chain reaction (qPCR) methodology to quantify the relative contribution of each host source to the total. The quantitative contributions were produced based on comparisons to samples collected from the Danville wastewater treatment plant and a commercial stockyard.

A complete list of all sampling results collected during the water quality portion of the monitoring is compiled in Appendix D. Table 5 (page 20) provides a summary of the average monthly water quality data for each site. A summary of the MST monitoring results is also present in Appendix E. All data collection was performed in accordance with written Quality Assurance Project Plans (QAPP) (Appendix F). An evaluation of the data quality found all parameters acceptable for use except nitrogen and phosphorus, which had a known bias near the detection limit. In order to provide better quality data for nitrogen and phosphorus, monthly supplementary sampling was conducted for eight months in 2008 and 2009 for nutrient parameters, physiochemical parameters, total organic carbon, and biochemical oxygen demand. The results of this sampling are also attached in Appendix D, and summarized in Table 6 (page 21).

TABLE 5 – AVERAGE MONTHLY WATER QUALITY DATA FOR THIRD ROCK MONITORING, 2006-2007

| | UNIT | GOGGIN LN | BB MOUTH | BB WEST | KY 52 | STANFORD RD | SOUTH 2ND STR | US 127 BYPASS | CORPORATE DR |
|---|---|---|---|---|---|---|---|---|---|
| Conductivity | µS/cm | 581 | 395 | 368 | 641 | 574 | 504 | 396 | 352 |
| DO | mg/L | 12.3 | 12.6 | 10.7 | 11.1 | 10.2 | 10.5 | 10.3 | 13.8 |
| pH | SU | 8.35 | 7.90 | 7.94 | 8.04 | 8.00 | 7.95 | 7.92 | 8.17 |
| Temperature | F | 64.4 | 60.4 | 55.1 | 59.2 | 57.5 | 57.4 | 56.0 | 56.7 |
| Turbidity | NTU | 5.5 | 3.2 | 2.2 | 2.7 | 4.0 | 4.3 | 2.4 | 1.3 |
| Alkalinity | mg/L | 174 | 172 | | | 186 | 192 | | |
| BOD15 | mg/L | <2.0 | 2.3 | | 5 | <2.0 | <2.0 | | |
| BOD5 | mg/L | <2.0 | 1.5 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| TOC | mg/L | 2.7 | 1.9 | 1.2 | 3.1 | 1.8 | | 1.6 | 2.0 |
| Chloride | mg/L | 35 | 18 | 10 | 47 | 37 | 25 | 16 | |
| TKN | mg/L | 0.74 | 0.39 | 0.40 | 0.88 | 0.31 | 0.34 | 0.24 | 0.36 |
| NH3-N | mg/L | <0.023 | <0.023 | <0.023 | 0.049 | 0.048 | 0.049 | <0.023 | <0.023 |
| Un-ionized NH-3 | mg/L | 0.003 | 0.002 | 0.002 | 0.003 | 0.002 | 0.002 | 0.001 | 0.003 |
| NO3-N | mg/L | 4.65 | 1.38 | 1.43 | 7.30 | 1.39 | 1.48 | 1.12 | 0.56 |
| NO2-N | mg/L | <0.07 | <0.07 | <0.07 | <0.07 | <0.07 | <0.07 | <0.07 | <0.07 |
| OP | mg/L | 0.25 | 0.08 | 0.04 | 0.33 | 0.11 | 0.12 | 0.12 | 0.05 |
| TP | mg/L | 0.2 | 0.1 | 0.0 | 0.3 | 0.1 | 0.1 | 1.8 | 0.0 |
| TSS | mg/L | 5.8 | 5.4 | 10.0 | 6.5 | 5.3 | 5.7 | 3.3 | 3.3 |
| Chlorophyll *a* | mg/m3 | 463 | 149 | | 145 | 231 | 212 | | |
| Total Coliform | CFU/100mls | 27844 | 32007 | 45012 | 42667 | 202957 | 165098 | 25874 | 34345 |
| *E. coli* | CFU/100mls | 1255 | 2756 | 4151 | 3972 | 10296 | 8597 | 1589 | 2670 |

NOTE: Averages based on arithmetic means of all sampling events. For results below the detection limit, one half of the detection limit was used in averaging. Results greater than the range were not included in the averaging. DO = Dissolved Oxygen, BOD5 = 5-day Biochemical Oxygen Demand, TOC= Total Organic Carbon, TKN = Total Kjeldahl Nitrogen, NH-3 = Ammonia, NO3-N = Nitrate, NO2-N = Nitrite, OP= Orthophosphorus, TP = Total Phosphorus, TSS = Total Suspended Solids.

TABLE 6 – AVERAGE MONTHLY WATER QUALITY DATA FOR SUPPLEMENTAL MONITORING, 2008-2009

| | UNIT | GOGGIN LANE | BB MOUTH | BB WEST | CR KY 52 | STANFORD RD | S. 2ND STR | US 127 | CORPORATE DR. |
|---|---|---|---|---|---|---|---|---|---|
| Conductivity | mS/cm | 472.6 | 352.3 | 360.3 | 746.8 | 784.8 | 439.8 | 375.5 | 311.8 |
| DO | mg/L | 13.9 | 11.4 | 11.4 | 12.7 | 11.6 | 11.5 | 10.9 | 10.9 |
| pH | SU | 8.6 | 8.2 | 7.9 | 8.2 | 7.9 | 8.1 | 7.6 | 7.6 |
| Temperature | F | 54.0 | 52.3 | 49.5 | 53.6 | 49.4 | 50.3 | 48.5 | 48.8 |
| Turbidity | NTU | 4.7 | 9.5 | 12.7 | 4.5 | 7.3 | 6.1 | 8.3 | 10.0 |
| BOD | mg/L | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | 2.2 |
| TOC | mg/L | 2.9 | 2.4 | 1.8 | 3.2 | 2.1 | 2.1 | 2.1 | 2.8 |
| TKN | mg/L | 0.48 | 0.66 | 0.38 | 0.59 | 0.56 | 0.38 | 0.55 | 0.45 |
| NH3-N | mg/L | 0.129 | 0.286 | 0.136 | 0.244 | 0.322 | 0.128 | 0.124 | 0.136 |
| Unionized NH3 | mg/L | 0.020 | 0.009 | 0.004 | 0.014 | 0.017 | 0.007 | 0.003 | 0.003 |
| NO2-N | mg/L | 0.05 | <0.03 | <0.03 | 0.09 | 0.04 | <0.03 | <0.03 | <0.03 |
| NO3-N | mg/L | 5.67 | 1.88 | 1.99 | 7.77 | 2.09 | 1.98 | 1.80 | 1.11 |
| OP | mg/L | 0.134 | 0.051 | 0.027 | 0.182 | 0.069 | 0.065 | 0.065 | 0.037 |
| TP | mg/L | 0.184 | 0.093 | 0.047 | 0.269 | 0.104 | 0.098 | 0.087 | 0.056 |
| TSS | mg/L | 4.0 | 8.0 | 4.0 | 5.5 | 5.5 | 4.0 | 4.0 | 6.0 |

NOTE: Averages based on arithmetic means of all sampling events. For results below the detection limit, one half of the detection limit was used in averaging. Results greater than the range were not included in the averaging.
DO = Dissolved Oxygen, BOD5 = 5-day Biochemical Oxygen Demand, TOC= Total Organic Carbon, TKN = Total Kjeldahl Nitrogen, NH-3 = Ammonia, NO3-N = Nitrate, NO2-N = Nitrite, OP= Orthophosphorus, TP = Total Phosphorus, TSS = Total Suspended Solids.

Based on this data, risks of disease due to human sewage and animal wastes have been identified as the most serious impairment to the watershed. Poor aquatic habitat is common throughout the watershed, while specific areas are polluted by excessive nutrients, which produces algal blooms. Dissolved ions and the rapid changes in water levels due to storm runoff are also significant problems in Clarks Run.

Of the 23 sites surveyed in Clarks Run, the majority (14) of the sites were determined to be "not supporting" while 4 were "partially supporting" and 5 were "fully supporting" their habitat use. Habitat was most commonly reduced throughout the watershed because the vegetated area surrounding the stream, the riparian zone, was either absent or underdeveloped. In the agricultural areas of the watershed, such as Balls Branch West, some of the poorest habitats were frequently a result of impacts from cattle grazing along the creek and trampling the banks, creating erosion that impacts aquatic habitats with sediment. In urban areas, the rapid delivery of runoff to streams during storms was also causing erosion and the subsequent deposition of sediment into insect and fish habitats. However, these impacts were usually less severe than those in agricultural areas. Lower order (tributary) streams were generally more impacted than higher order (mainstem) streams. At one site, Clarks Run at Goggin Lane, frequent dumping of garbage and other litter was observed.

*E. coli* was sampled as an indicator of sewage or animal wastes in streams within the Clarks Run watershed. Concentrations of *E. coli* often ranged from ten to one hundred times greater than the water quality standard. Balls Branch West showed the highest concentrations of *E. coli* in the watershed; therefore, additional sampling sites focused on the upstream tributaries in this area. Along the main stem of Clarks Run and its tributaries, the highest average concentrations occurred at the crossing of Stanford Road.

In the Balls Branch subwatershed, the most concentrated input was traced to the neighborhoods clustered around US 127. Seventy percent of the contribution was indicated as human by DNA testing, and 15 percent was due to cattle. Much of this human contribution is suspected to have originated from overflows at the upstream sewage pump station, which has since been upgraded and repaired by the City of Danville. On the southern tributary to Balls Branch along Gose Pike, DNA tests indicate that cattle contributions were more significant (50 percent), while human sources were less abundant (10 percent). The remaining percentage is currently unknown and may be due to human, cattle, or other sources. Thus, both human and cattle inputs were impacting Balls Branch, but human sources caused the most concentrated inputs.

Along Clarks Run, DNA testing was conducted at two sites to identify fecal sources. At the Stanford Road crossing, 80 to 100 percent of the contribution was identified as human, while on a tributary to Clarks Run between South Second Street and the US 127 Bypass equal contributions (50/50) from human and cattle sources were identified. These results indicate that sewage systems, whether sewer or septic systems, is the source of the most concentrated fecal contributions and cattle sources contribute to a lesser degree.

It should be noted that the percentages of human and cattle fecal loading stated above are based on sampling conditions representative of dry weather sources. During dry weather sampling, point sources are more often captured while wet weather sampling during runoff conditions typically captures nonpoint source impacts.

Although nutrient levels are somewhat elevated throughout the Clarks Run watershed, concentrations of phosphorus and nitrogen compounds are often above limits at the two sites downstream from Danville's WWTP, which is located between Stanford Road and KY 52. TKN and nitrate, both forms of nitrogen, were present at Clarks Run at KY 52 and at Goggin Lane in concentrations averaging approximately three times higher than those measured at most other locations in the watershed. Un-ionized ammonia exceeded regulatory levels twice at Goggin Lane and once at US-150 during 2008-2009. Phosphorus levels downstream of the WWTP were similarly two to three times higher than the concentrations at sites not influenced by the treatment plant.

Algal blooms were observed throughout the watershed, but were especially dense at Goggin Lane, where they clogged the entire stream. Algal blooms also occurred at KY 52, but shading of the stream by the tree canopy minimized the severity of these blooms. No dissolved oxygen problems were detected in Clarks Run, most likely due to frequent aeration at riffles in the shallow streams.

All sites had conductivity levels averaging above levels in which sensitive aquatic insects, such mayflies, are impacted. Clarks Run at Goggin Lane, KY 52, Stanford Road, and South Second Street, the sites with the highest levels, each averaged levels that have been shown to impact fish species. The excessive nutrient concentrations, along with natural ions and other pollutants, contribute to these high conductivity values impairing the stream.

Although not specifically investigated as part of this study, stream gauging stations indicate that the streams of Clarks Run are "flashy," with large volumes of water rapidly flowing into and out of the stream system during storm events. Because Danville has high percentages of impervious surfaces and efficient stormwater drainage systems, the inflow of stormwater may be contributing to stream impacts.

#### *2.1.9. Water Quality Data Gaps*

Based on the evaluation of the known water quality data, several data gaps have emerged which will be important in furthering the goals of the watershed plan. These gaps represent either baseline data necessary to evaluate progress towards the watershed goals or data valuable in focusing remediation efforts. Five data gaps have been identified:

1. Straight Pipe / Septic Tank / Sewer Survey or Modeling
   Although much data is available and presented on the sanitary sewer system and the location of septic systems within the Clarks Run watershed (see Section 2.3 of this document), the functional status of known septic systems and the number and locations of illicit discharges from straight pipes are unknown. Several concentrated residential areas exist throughout the watershed that do not have sanitary sewer connections. Based on previous survey results, it appears that these areas may significantly contribute to excessive *E. coli* concentrations in Clarks Run. However sewer leaks or illicit discharges could also cause these contributions. A survey of these specific areas could verify these assumptions.

2. Cattle
   While fecal source assessments have quantified impacts of cattle within the watershed in this area, other stream impacts from cattle such as bank erosion, increased suspended sediment, and decreased riparian vegetation have not been surveyed in detail. Also the exact locations of the cattle source inputs have not been located. The locations of such impacts would aid in the direction of remediation projects.

3. Groundwater Flow Features
   Although some karst flow features have been mapped in the Clarks Run area, the abundance of limestone and the complexity of the existing features indicates the potential for additional groundwater features in the area. A more comprehensive assessment of groundwater features in Clarks Run would aid in effective remediation of sources.

4. Stream Flow / Flashiness
   One of the undetermined potential sources of degradation in Clarks Run relates to the flashiness of stream flow associated with Danville's high concentration of impervious areas. Impervious area is directly linked to increased velocities. When high water velocities are present, stream biota are effected through scour. One specific gap in the existing data is the direct relationship measure between excessive flows and benthic scour. Also, a flow comparison to a reference stream would be necessary for a true assessment of potential impacts.

5. Biological Data
   Though KDOW fish and benthic data have been collected periodically within Clarks Run, metric results are not consistent and sampling is not comprehensive enough to determine the extent of biological impairment within the entire watershed. Additional fish, benthic, and periphyton data collected at additional stations would determine the overall extent of biological impairment.

## *2.2. Natural Features of the Watershed*

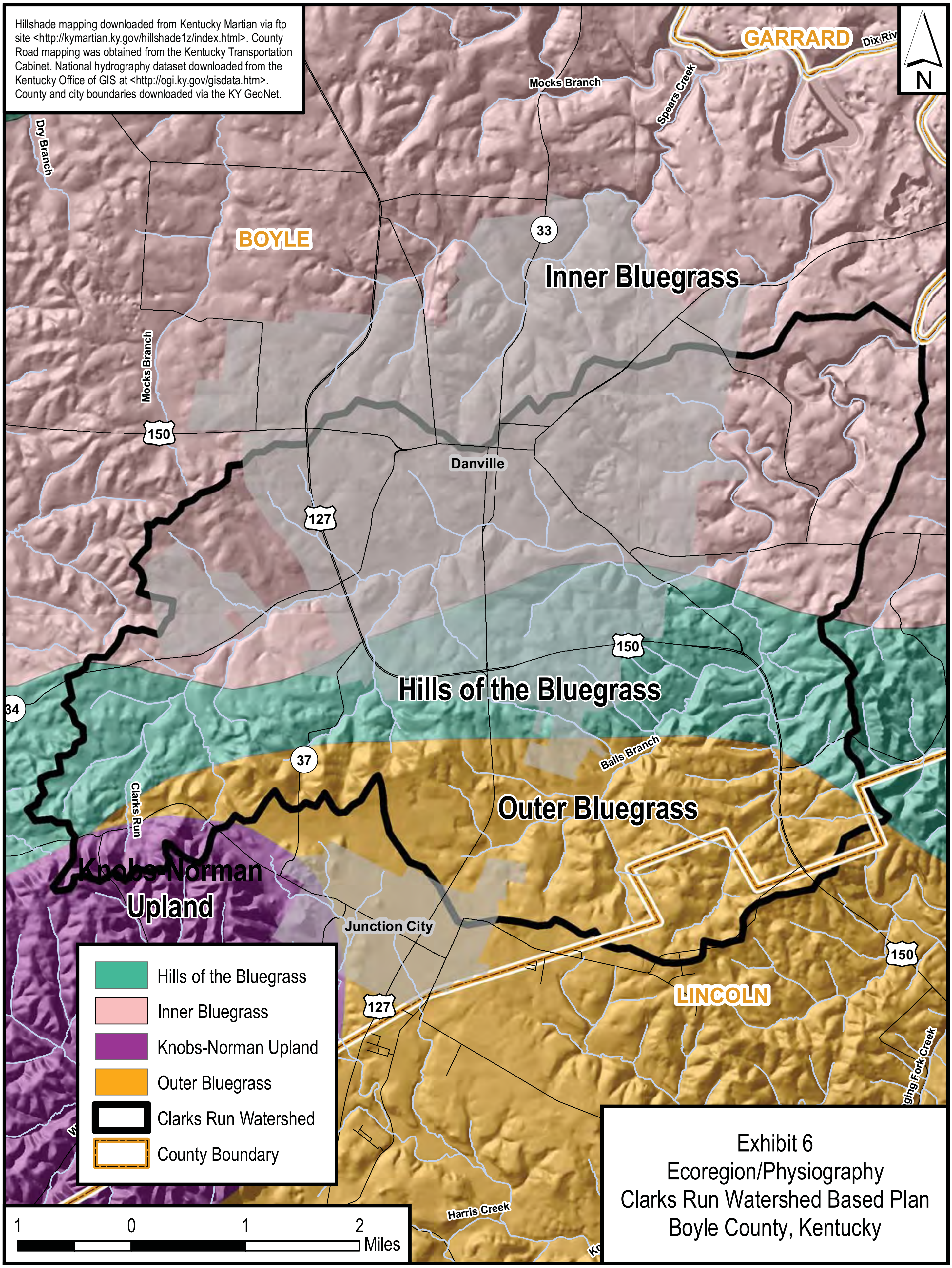
### *2.2.1. Physiography and Geology*

The Clarks Run watershed is located entirely within the Interior Plateau Level III ecoregion (Woods *et al.* 2002), but the watershed falls within four subdivisions of this ecoregion. These ecoregions are patterned after the underlying geology in west to east bands across the watershed area. Listed from north to south, these ecoregions are the Inner Bluegrass, the Hills of the Bluegrass, Outer Bluegrass, and the Knobs-Norman Upland ecoregion in a small portion of the southwestern portion of the watershed. A description of these ecoregions and the geology associated with them is shown in Exhibits 6 and 7 (pages 25 and 26). The following discussion of these areas is based upon the data presented in Woods *et al.* 2002 and Carey *et al.* 2004.

The nearly level to rolling Inner Bluegrass is a weakly dissected agricultural plain containing extensive karst, intermittent streams, and expanding urban-suburban areas that originally developed near major springs. The elevation at the Danville courthouse is 989 feet. The Inner Bluegrass is underlain by Middle Ordovician limestone and shale that is lithologically distinct from the rest of the Interior Plateau. Very fertile alfisols and mollisols have developed from the residuum of underlying phosphatic limestone; natural soil fertility is greater than in the Hills of the Bluegrass. The original open woodlands, savannas, and swamp forests have been largely replaced by agriculture and urban-suburban-industrial areas. In this ecoregion, some upland streams are very warm and have seasonally variable flows but others, fed by major springs, are colder and have plentiful perennial flow. In either case, they have moderate to low gradients, cobble or bedrock substrates, and fish assemblages that are similar to the Outer Bluegrass and the Hills of the Bluegrass. Algal blooms and low concentrations of dissolved oxygen often occur in this ecoregion especially where the riparian tree canopy has been removed.

The centrally located Hills of the Bluegrass ecoregion is lithologically unlike the Knobs, Inner, or Outer Bluegrass. Rocks of this region primarily contain higher percentages of shale layers, and therefore do not develop extensive karst features. Upland soils are fairly high in phosphorus, potassium, and lime but are not as naturally fertile as the Outer Bluegrass of which most of Clarks Run is composed; they commonly support young, mixed forests rich in white oak, hickory, and cedar. The Hills of the Bluegrass has steeper terrain, droughtier soils, lower soil fertility, higher drainage density, and is more erosion prone than the Outer Bluegrass ecoregion.

The rolling to hilly Outer Bluegrass in the south is known to contain sinkholes, springs, entrenched rivers, and intermittent and perennial streams over its entire range. Local relief is variable but is usually less than in the geomorphically distinct Knobs in the western area of the watershed. Elevations in the area are typically greater than 1,000 feet above sea level; however, Junction City is located 986 feet above sea level. The Outer Bluegrass ecoregion is mostly underlain by Upper Ordovician interbedded shales and limestones. This area is moderately karst prone. Natural soil fertility is higher than in the shale-dominated Hills of the Bluegrass. Currently, pastureland and cropland are widespread and dissected

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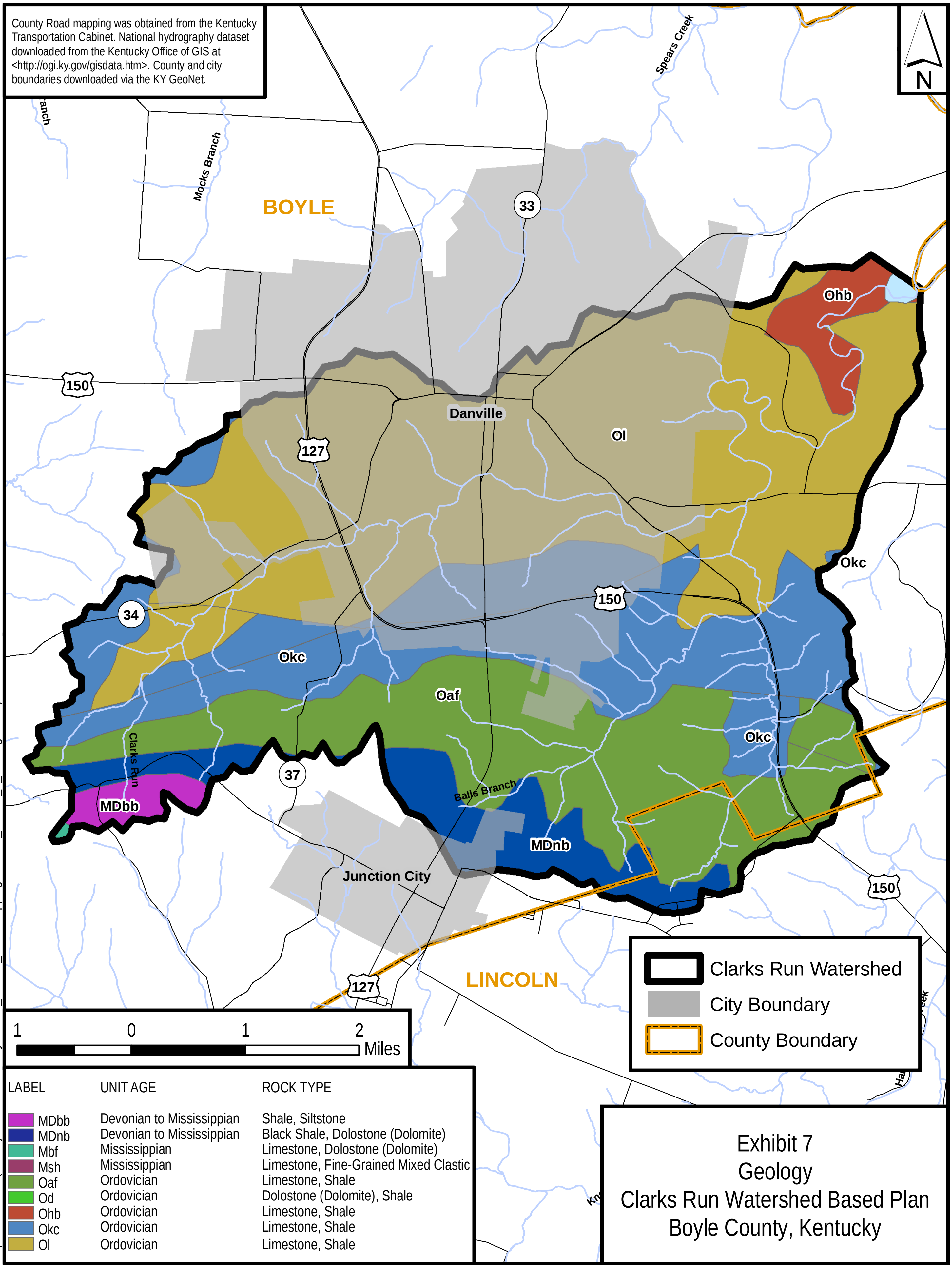



Map Document: (P:\Project Files\Kentucky\5167E_KDOW_WBP\Mapping\GIS\CR_Exhibit_7_Geologic.mxd) 7/30/2009 -- 1:58:17 PM las areas are wooded. At the time of settlement, open savanna woodlands were found on most uplands. On less fertile, more acidic soils derived from Silurian dolomite, white oak stands occurred and had barren openings. Cane grew along streams and was especially common in the east. Distinct vegetation grew in areas underlain by glacial drift. Upland streams have moderate to high gradients and cobble, boulder, or bedrock substrates.

The Knobs-Norman Upland ecoregion, in the southwestern watershed headwaters, is underlain by Devonian to Mississippian sedimentary rocks. Its characteristic rounded hills and ridges are mostly forested and divide the Bluegrass from the rest of the Interior Plateau. The more competent Mississippian siltstones and shale on the surface of this area limit wells to low volumes of water produced through fractures in fine-grained sedimentary rocks, and very few springs exist. Those that do occur have small discharges, or are seasonal "wet-weather" springs. Surface runoff is a more significant input to stream discharge. Inceptisols and Ultisols occur on slopes and support mixed deciduous forests. Narrow, high gradient valleys are also common. In addition, a few wide, locally swampy valley floors occur and are used for livestock farming, general farming, and woodland. Large amounts of geological, topographical, and ecological diversity characterize this ecoregion. The density of perennial upland streams is far greater than on nearby limestone plains.

### *2.2.2. Soils*

Soils data were analyzed using a geographic information system (GIS) to determine the predominant soil types (USDA/NRCS 2007a). Soils are typically assessed for various types of uses. The use types assessed are generally based on USDA soil property report descriptions (USDA/NRCS 2007b).

A summary of the soils of the Clarks Run watershed reveal that 3 percent of the watershed is susceptible to frequent flooding. Much of the watershed is not rated as prime farmland (38 percent), while 30 percent was rated as prime farmland or farmland of importance. The area is relatively limited for construction and development purposes: 53 percent of the watershed is somewhat or very limited for streets; 71 percent is limited or somewhat limited for excavation; 71 percent is limited or somewhat limited for commercial. On-site wastewater management, through septic systems, are very or somewhat limited in 71 percent of the watershed, indicating challenges for managing rural wastewater. A summary of the top 10 soil types is presented in Table 7 (page 28).

According to Craddock (1981), the Maury series is characterized by deep, well drained soils that formed in 1 foot to 2 feet of loess-like material over residuum of weathered limestone. These soils have moderate permeability and are found on karst ridgetops and side slopes (2 to 65 percent in this watershed). The Lowell series is characterized by deep, well drained soils that formed in residuum of weathered limestone, shale, and siltstone. These soils have moderately slow permeability and are found on ridgetops, side slopes (most are 6 to 12 percent in this watershed), benches, and foot slopes. The Caleast is characterized by deep, well drained soils that formed in residuum of weathered limestone. These soils have moderately slow permeability and are found on karst ridgetops and side slopes (2 to 12 percent in this watershed). The McAfee series is also characterized by moderately deep, well drained soils that formed in residuum of weathered limestone. These soils have moderately slow permeability and are found on karst ridgetops and side slopes (2 to 20 percent in this watershed; Craddock 1981).

TABLE 7 – DOMINANT SOILS OF THE CLARKS RUN WATERSHED

| SOIL TYPE NAME | SQUARE MILES | % AREA |
|---|---|---|
| Maury silt loam, 2 to 6 percent slopes | 5.19 | 18.3 |
| Lowell silt loam, 6 to 12 percent slopes | 2.67 | 9.4 |
| Caleast silt loam, 6 to 12 percent slopes | 2.45 | 8.6 |
| McAfee silt loam, 6 to 12 percent slopes | 2.12 | 7.5 |
| Caleast silt loam, 2 to 6 percent slopes | 1.72 | 6.1 |
| Lowell silt loam, 2 to 6 percent slopes | 1.62 | 5.7 |
| Eden silty clay loam, 6 to 20 percent slopes | 1.54 | 5.4 |
| Maury silt loam, 6 to 12 percent slopes | 1.08 | 3.8 |
| Lowell silt loam, 12 to 20 percent slopes | 1.04 | 3.7 |
| Nolin silt loam | 0.90 | 3.2 |
| Total: | 20.33 | 71.7 |

* US Department of Agriculture /NRCS, 2007a

### *2.2.3. Riparian Ecosystem*

The riparian ecosystem is important because it provides wildlife habitat, reduces stream erosion, filters nutrients, traps sediment, and provides canopy cover (shading) to the stream. Under optimal conditions, the riparian zone within 60 feet of each stream bank should be covered with native species of canopy and understory trees, shrubs, and herbaceous groundcover to provide the best habitat.

The vegetated riparian zone in the Clarks Run watershed is frequently underdeveloped and at times absent. A GIS analysis of USDA 2004 aerial images of the watershed indicated that 57 percent of the streams in the watershed are shaded, but only 23 percent of the streams are connected to some sort of contiguous forested area providing riparian habitat. Thus, 43 percent of the watershed has no riparian vegetation and approximately 34 percent has some canopy shading but still provides little continuous riparian habitat. The best habitat in the area is found along the higher order (mainstem) streams near the mouth of Clarks Run.

Impacts to the riparian corridor in Clarks Run are due to one of two factors. In the Danville area, development has encroached upon these areas. Residences and business often maintain the riparian corridor for aesthetics by regular mowing to the stream edge. Secondly, in pasture areas, cattle allowed to graze along the creek consume much of the streamside vegetation.

### *2.2.4. Fauna*

According to the Kentucky State Nature Preserve Commission (KSNPC), Boyle County contains several state and federally listed threatened, endangered, or special concern species. Table 8 (page 29) lists these species and communities. Management activities that increase the habitat of these species as well as the water quality are preferable and have greater opportunities for funding.

TABLE 8 – STATE OF FEDERALLY LISTED SPECIES AND COMMUNITIES

| CATEGORY | SCIENTIFIC NAME | COMMON NAME | KSNPC STATUS[1] | USESA STATUS[2] |
|---|---|---|---|---|
| Vascular Plants | *Calopogon tuberosus* | Grass Pink | E | |
| Vascular Plants | *Lesquerella globosa* | Globe Bladderpod | E | C |
| Vascular Plants | *Malvastrum hispidum* | Hispid Falsemallow | T | |
| Vascular Plants | *Viburnum molle* | Softleaf Arrowwood | T | |
| Freshwater Mussels | *Pleurobema clava* | Clubshell | E | LE |
| Insects | *Pseudanophthalmus conditus* | Hidden Cave Beetle | T | SOMC |
| Insects | *Pseudanophthalmus elongatus* | A Cave Obligate Beetle | S | |
| Insects | *Pseudanophthalmus puteanus* | Old Well Cave Beetle | T | SOMC |
| Reptiles | *Eumeces anthracinus* | Coal Skink | T | |
| Breeding Birds | *Ammodramus henslowii* | Henslow's Sparrow | S | SOMC |
| Breeding Birds | *Dolichonyx oryzivorus* | Bobolink | S | |
| Breeding Birds | *Nyctanassa violacea* | Yellow-Crowned Night-Heron | T | |
| Breeding Birds | *Passerculus sandwichensis* | Savannah Sparrow | S | |
| Breeding Birds | *Tyto alba* | Barn Owl | S | |
| Communities | | Siltstone/Shale Glade | | |

[1] Kentucky State Nature Preserve Commission (KSNPC) Status: E=Endangered, T=Threatened, S=Special Concern
[2] US Fish and Wildlife Service: US Endangered Species Act (USESA) Status: LE=Endangered, SOMC=Species of Management Concern

## *2.3. Human Activities Affecting Water Resource Quality*

### *2.3.1. Point Sources*

#### *2.3.1.1. KPDES Dischargers*

Fifteen permitted Kentucky Pollutant Discharge Elimination System (KPDES) facilities are or have been located in the Clarks Run watershed as shown in Table 9 (page 30). All dischargers to waters of Kentucky are required to obtain a KPDES permit including concentrated animal feeding operations (CAFO), combined sewer overflows (CSO), individual residences, Kentucky Inter-Municipal Operating Permits (KIMOP), mining, municipal, industrial, oil, and gas. These dischargers are shown on Exhibit 8 (page 31).

Each of these dischargers was reviewed to identify any sources struggling to meet permit conditions. Caterpillar, Denyo, National Office Furniture – Danville, Stevens Dispos All, Vicwest Steel, R R Donnelly, and Caldwell Stone had no listed permit violations.

TABLE 9 – KPDES DISCHARGERS IN THE CLARKS RUN WATERSHED

| KPDES ID | FACILITY | SIC CODE[1] / DESCRIPTION | COMMENTS |
|---|---|---|---|
| KY0001139 | Panasonic Home Appliance Company of America | SIC 3639 / Household Appliances | KPDES permit inactivated 5/16/08 |
| KY0002607 | Phillips Lighting Company | SIC 3229 / Pressed and Blown Glass and Glassware | Active |
| KY0057193 | Danville WWTP | SIC 4952 / Sewerage Systems | Active |
| KY0080616 | R R Donnelley & Sons Co. Danville Division | SIC 2752 / Commercial Printing, Lithographic | Active |
| KYG500126 | Kentucky Transportation Cabinet Boyle County Maintenance Garage | SIC 4173 / Bus Terminal & Service Facility | Active |
| KYG840008 | Caldwell Stone Company Inc | SIC 1422 / Crushed and Broken Limestone | Active |
| KYR001692 | Caterpillar Track Components | SIC 3531 / Construction Machinery and Equipment | Active |
| KYR001569 | Denyo Manufacturing Corporation | SIC 3519 / Internal Combustion Engines | Active |
| KYR001791 | National Office Furniture – Danville | SIC 2515 / Wood Household Furniture, Upholstered | This facility name was changed from “Flexcel” in February 2008 |
| KYR001010 | Stevens Dispos All | SIC 4953 / Refuse Systems | This facility name was changed to “BFI Danville TS” in March 2008 |
| KYR001736 | Vicwest Steel | SIC 3448 / Prefabricated metal buildings | Active |
| KYG910026 | Chevron #48851 | SIC 5541 / Gasoline Service Stations | KPDES general permit coverage inactivated 6/13/06 |
| KY0106739 | Elite Petroleum Inc. | SIC 5175 / Petroleum Bulk Stations & Terminals | Active |
| KYR000174 | The Allen Company of Winchester | SIC 1611 / Hwy & ST Const., Exc. Elev. Hwy | KPDES general permit coverage inactivated 5/23/06 |
| KYR001025 | Red Wing Shoe Company | SIC 3143 / Men’s Footwear, Except Athletic | KPDES general permit coverage inactivated 11/15/02 |

[1]SIC Code = Standard Industrial Classification Code

Of the existing permitted dischargers, some had occasional permit exceedances. The Panasonic Home Appliance Co. assembly plant has a permit for 3 intermittent discharges of stormwater to a tributary of Clarks Run. One violation for an exceedance of TSS was noted, but corrective actions have since addressed the problem. The Philips Lighting Co. facility manufactures leaded glass and other products for the lighting industry. The facility has five outfalls that showed occasional violations of the pH limit and more frequent violations of the lead limit. The Kentucky Transportation Cabinet Boyle County Maintenance Garage holds a general permit specific for highway maintenance facilities. Discharge monitoring reports revealed chloride limit violations, so the salt stored onsite is possibly a source of chloride pollution in Clarks Run. Although no violations are noted for the Caldwell Stone quarry, the

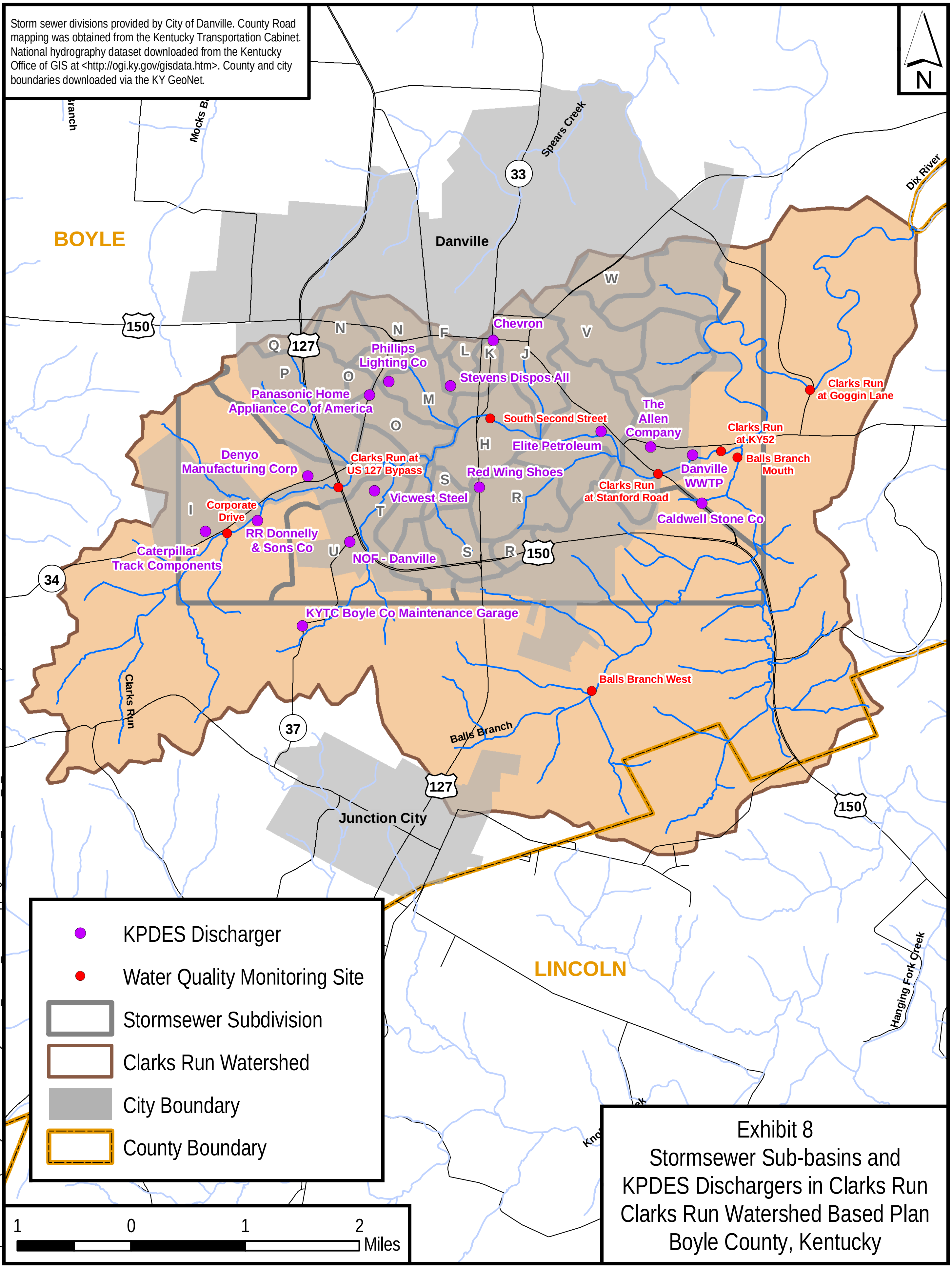



Exhibit 8
Stormsewer Sub-basins and KPDES Dischargers in Clarks Run
Clarks Run Watershed Based Plan
Boyle County, Kentucky

Map Document: (P:\Project Files\Kentucky\5167E_KDOW_WBP\Mapping\GIS\CR_Exhibit_8_Subwatersheds.mxd) 7/30/2009 -- 2:21:16 PM las facility is notable for the high volume of the discharge. Reported discharge volumes range from 432,000 to 4,320,000 gallons per month.

The Danville Sewage Treatment Plant is currently designed with a capacity of 6.5 million gallons per day. Based on a file review (Robson 2006) of the permit and compliance history, the following items were noteworthy. The plant was upgraded beginning in 1998 and ongoing until 2000. Another recent upgrade mentioned in an SSO report is the installation of a facultative lagoon. Upgrades included the new lagoon, two new clarifiers, settling tanks, and UV disinfection process. Records indicate that at one time the plant had a sewer sanction limiting additional tap-ons, though this sanction has since been lifted. A dye trace study performed in 2001 in the Balls Branch area detected a hole in the Clarks Run pump station (Ray 2002). A number of projects have been ongoing in the collection system to eliminate and reduce overflows, including line inspections, sewer rehabilitation, new pump stations, and new lines. The facility maintains a log and reports overflows. The facility has passed the biomonitoring test consistently since 1993. From 2003 to 2009, records showed only one low dissolved oxygen, one phosphorus, and one toxicity violation. The current phosphorus discharge limit is 1.0 mg/L. Monthly monitoring data indicate typical discharges between 0.6 and 0.9 mg/L. An ammonia nitrogen limit of 2.0 mg/L in the summer and 5.0 mg/L in the winter are currently established in the permit.

#### *2.3.1.2. Storm Water Management and Ordinances*

In order to control the effect of stormwater on water quality and flooding, several ordinances and manuals have been enacted by the City of Danville. These measures include a stormwater manual, a stormwater management fee system, and an illicit discharge ordinance. The NPDES Municipal Separate Storm Sewer System (MS4) Permit provides the six minimum measures Danville must meet to be in compliance with the Clean Water Act.

The Stormwater Manual provides guidance on the water quality and quantity specifications for new and existing development in Danville. Its stated purpose is “to provide standards to assure quality in the design and construction of stormwater infrastructure that becomes a part of that owned or regulated by the City of Danville by providing standard design criteria to the engineers who design the infrastructure.” As such, the manual provides technical standards of designing stormwater systems.

The City of Danville amended their Code of Ordinances in January 2008 to include a Stormwater Management Fee. This monthly service fee on all real property in the City of Danville is based on three factors “(1) the extent to which runoff from each property creates the need for the stormwater management program; (2) the amount of impervious area on each property; and (3) the cost of implementing a stormwater management program.” The intended uses of this stormwater fee are to address stormwater infrastructure, monitoring, maintenance, and improvement such that the city can remain compliant to the MS4 Phase II KPDES Permit. Specifically mentioned in the ordinance are the following uses:

1. The acquisition by gift, purchase, or condemnation of real property, and interests therein, necessary to construct, operate, and maintain stormwater management facilities.
2. All costs of administration and implementation of the stormwater management program, including the establishment of reasonable operation and capital reserves to meet unanticipated or emergency stormwater management requirements.

3. Engineering and design, debt service and related financing expenses, construction costs for new facilities, and enlargement or improvement of existing facilities.
4. Operation and maintenance of the stormwater system.
5. Monitoring, surveillance, and inspection of stormwater control devices.
6. Water quality monitoring and water quality programs.
7. Retrofitting developed areas for pollution control.
8. Inspection and enforcement activities.
9. Costs of public education related to stormwater and related issues.
10. Billing and administrative costs.
11. Other activities which are reasonably required.

Danville also has a construction site ordinance (#1674) and a post-construction regulation as part of the subdivision regulations (Resolution 051207)

#### *2.3.1.3. Municipal Separate Storm Sewer System (MS4)*

Under the NPDES MS4 Phase II permit, the City of Danville is required to meet the six minimum controls required by the US EPA. These controls include: 1) Public Education and Outreach, 2) Public Participation and Involvement, 3) Illicit Discharge Detection and Elimination, 4) Construction Site Runoff Control, 5) Post-Construction Runoff Control, and 6) Pollution Prevention/Good Housekeeping.

In order to comply with this permit, KDOW requires the City of Danville to submit a Stormwater Quality Management Plan every five years. Although the current operating permit is still in draft form, the City of Danville has made the five-year plan for 2008 to 2013 available on its website. This plan is attached in Appendix G.

Under this Master Plan, Danville has also divided its storm sewer drainage area into sub-basins in order to coordinate and prioritize stormwater projects. Currently, Danville is divided into sub-basins A through W as shown on Exhibit 8 (page 31). Sub-basins A through G are located in the Spears Creek and Mocks Branch watersheds while H through W are located in the Clarks Run watershed. A cross-reference between this sub-basins and the watershed divisions utilized in subsequent loading calculations is provided in Table 10 (page 34).

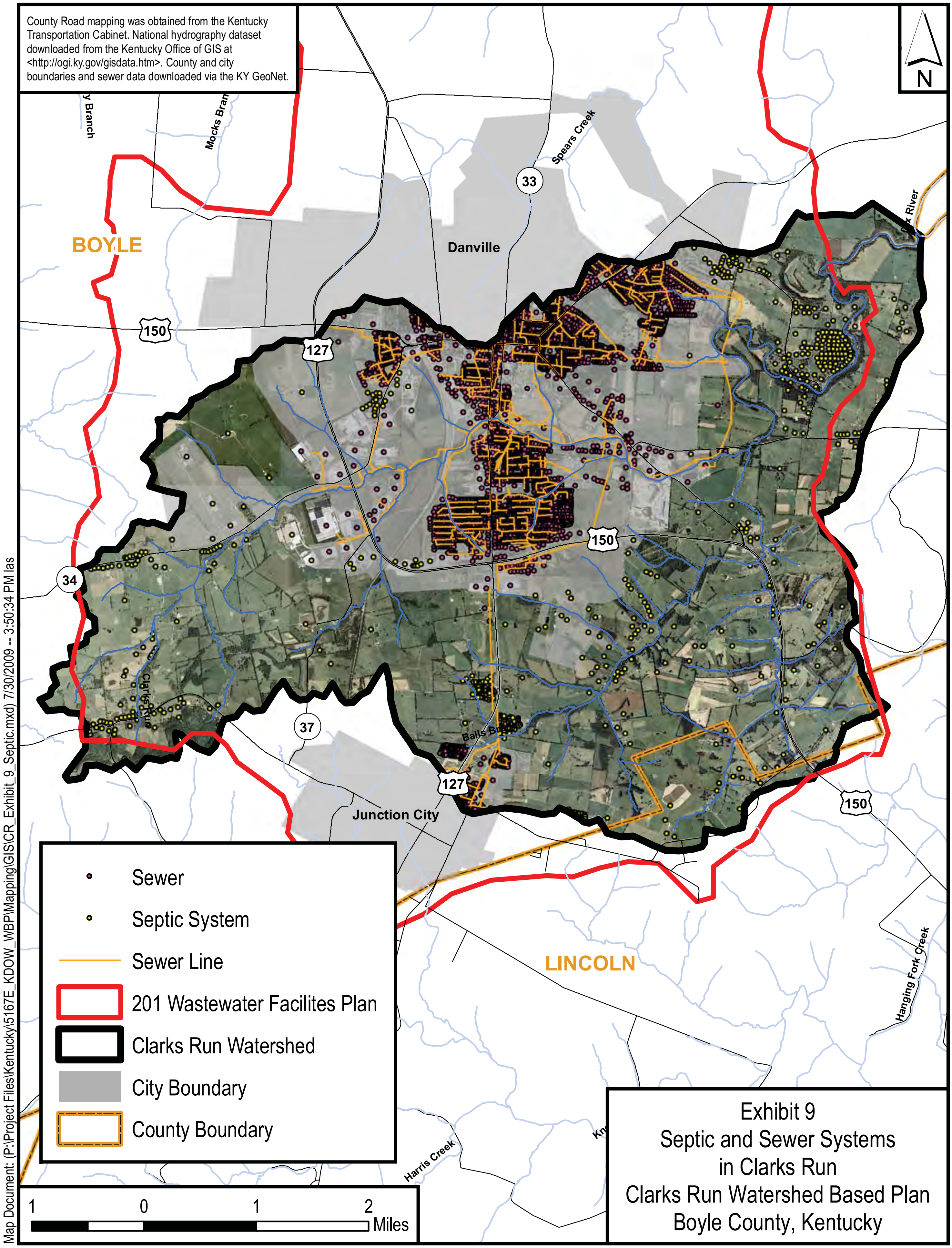
TABLE 10 – CROSS-REFERENCES BETWEEN SAMPLING SUBWATERSHEDS AND DANVILLE'S STORMWATER SUB-BASINS

| STATION | SUB-BASIN |
|---|---|
| Goggin Lane | W |
| | V |
| Balls Branch Mouth | Rural / Agricultural |
| Balls Branch West | Rural / Agricultural |
| Clarks Run at KY 52 | Wastewater Treatment Plant |
| Stanford Road US-150 | 3/4 H |
| | J |
| | K |
| | L |
| | R |
| S. 2nd Street | 1/4 H |
| | Some I |
| | M |
| | N |
| | O |
| | P |
| | Q |
| | S |
| | T |
| | U |
| US 127 Bypass | I |
| Corporate Drive | Small Part of I |
| | Rural / Agricultural |

Currently, sub-basin R, located within the Clarks Run watershed south of Baughman Avenue and west of Hustonville Road, is being targeted for remediation projects. Over $700,000 is directed towards nine projects in sub-basin R. The plans for each of these projects are currently available at www.danvilleky.org. The city has identified sub-basin E, outside of the Clarks Run watershed in northeastern Danville, as the future targeted watershed for stormwater improvements.

#### *2.3.1.4. Sanitary Sewer System*

As of 2004, the City of Danville owns, operates, and maintains approximately 117 miles of gravity sewer lines, nine miles of force main, two municipal wastewater treatment facilities, and one off-site equalization facility. The sanitary sewer collection system extends to Junction City and Perryville, and may extend to Hustonville (Lincoln County) in the future. This treatment system is shown in Exhibit 9 (page 35). Based on proximity to 2007 sanitary sewer lines and personal communication with personnel from the health department and wastewater utilities, individual residences and businesses believed to be discharging into the sanitary sewer system were identified (Exhibit 9). However, because the connection of individual residences and facilities to the sanitary sewer system have not been verified, illicit discharges are possible within these areas.


County Road mapping was obtained from the Kentucky Transportation Cabinet. National hydrography dataset downloaded from the Kentucky Office of GIS at <http://ogi.ky.gov/gisdata.htm>. County and city boundaries and sewer data downloaded via the KY GeoNet.
N
BOYLE
Danville
Spears Creek
33
150
127
34
37
127
150
150
Junction City
LINCOLN
Harris Creek
Hanging Fork Creek
Sewer
Septic System
Sewer Line
201 Wastewater Facilites Plan
Clarks Run Watershed
City Boundary
County Boundary
1 0 1 2
Miles
Exhibit 9
Septic and Sewer Systems
in Clarks Run
Clarks Run Watershed Based Plan
Boyle County, Kentucky
Map Document: (P:\Project Files\Kentucky\5167E_KDOW_WBP\Mapping\GIS\CR_Exhibit_9_Septic.mxd) 7/30/2009 -- 3:50:34 PM las

Since the acquisition of the Junction City sanitary sewer system, the infrastructure has been improved to address the frequent overflows from the pump stations. According to personal communications with Josh Morgan, Assistant City of Danville Engineer, Junction City previously had five pump stations with regular overflow problems. Of these five pump stations, only one continues to experience regular overflow problems (Morgan 2009). Construction of the Phylben Village / Airport Road sewer extension and package treatment plant began in June 2009 to address the malfunctioning onsite sewage units servicing approximately 150 dwelling units in the area. A 2009 State Planning and Environmental Assessment Report (SPEAR) for the City of Danville summarizing the 201 Facilities Plan (revised in 2006) is also provided in Appendix H.

### *2.3.2. Non-Point Sources*

Along its route through Boyle County, Clarks Run passes through different land uses, all of which can contribute different types of pollution or stresses to the creek. Land use assessments show that the primary land uses for the 28.5 $mi^2$ Clarks Run watershed are typical for the region and include agriculture (70 percent), residential/development (10 percent), commercial/industrial (11 percent), and forest (17 percent) according to 2001 US Geological Survey land use assessments. Table 11 compares USGS data from 1992 and 2001 and to National Land Use data from 2000. The data provided in this table should not be utilized for indicating a change over time, but rather to give an estimate of the relative accuracy of the land use data. Differences in technology, categorization, and accuracy between these data sets cause apparent discrepancies between years, such as an apparent drop in urban landuse from 1992 to 2000 and then a rapid increase in 2001. These land use estimates should be viewed cumulatively instead of individually to provide general estimates for the Clarks Run area. Exhibit 10 on page 37 and Table 12 (page 38) are based on National Land Use database categories.

TABLE 11 – LAND COVER IN THE CLARKS RUN WATERSHED

| LAND USE* | 1992[1] SQ MI (%)** | 2000[2] SQ MI (%)** | 2001[3] SQ MI (%)** |
|---|---|---|---|
| Forest | 5.9 (20.9%) | 6.4 (22.1%) | 4.9 (17.4%) |
| Wetland | 0.6 (2.0%) | 0 (0.01%) | 0.01 (0.05%) |
| Shrubland | -- | -- | 0.1 (0.3%) |
| Natural Grassland | -- | -- | 0.1 (0.4%) |
| Urban | 2.3 (8.1%) | 1.4 (4.9%) | 3.2 (11.4%) |
| Manmade Barren | 0.1 (0.4%) | 0.9 (3.3%) | -- |
| Urban Greenspace | -- | 1.0 (3.4%) | 2.9 (10.4%) |
| Natural Barren | -- | -- | 0.1 (0.2%) |
| Agriculture – Total | 19.4 (68.5%) | 18.6 (65.2%) | 19.9 (70.2%) |
| Agr. - Pasture | 15.1 (53.2%) | 15.3 (53.7%) | 15.1 (53.4%) |
| Agr. - Crop | 3.4 (11.9%) | 3.3 (11.5%) | 1.8 (6.4%) |
| Agr. - Other | 1.0 (3.5%) | -- | -- |

*Land cover categories changed as technology improved; this affected collection and reporting of data. The Urban Greenspace category was derived by Ky Division of Water staff; the original data were presented with all Urban Greenspace grouped within agricultural land categories, and thus is a subset of the Agricultural – Total category. Transportation related surfaces were placed under the "Manmade Barren" category for the National Land Cover Data set.

**Empty cells indicate that data for this category of land cover were not collected for that year.

[1] 1992 - US Geological Survey, 1999

[3] 2000 – National Land Cover Data Set

[3] 2001 - US Geological Survey, 2004

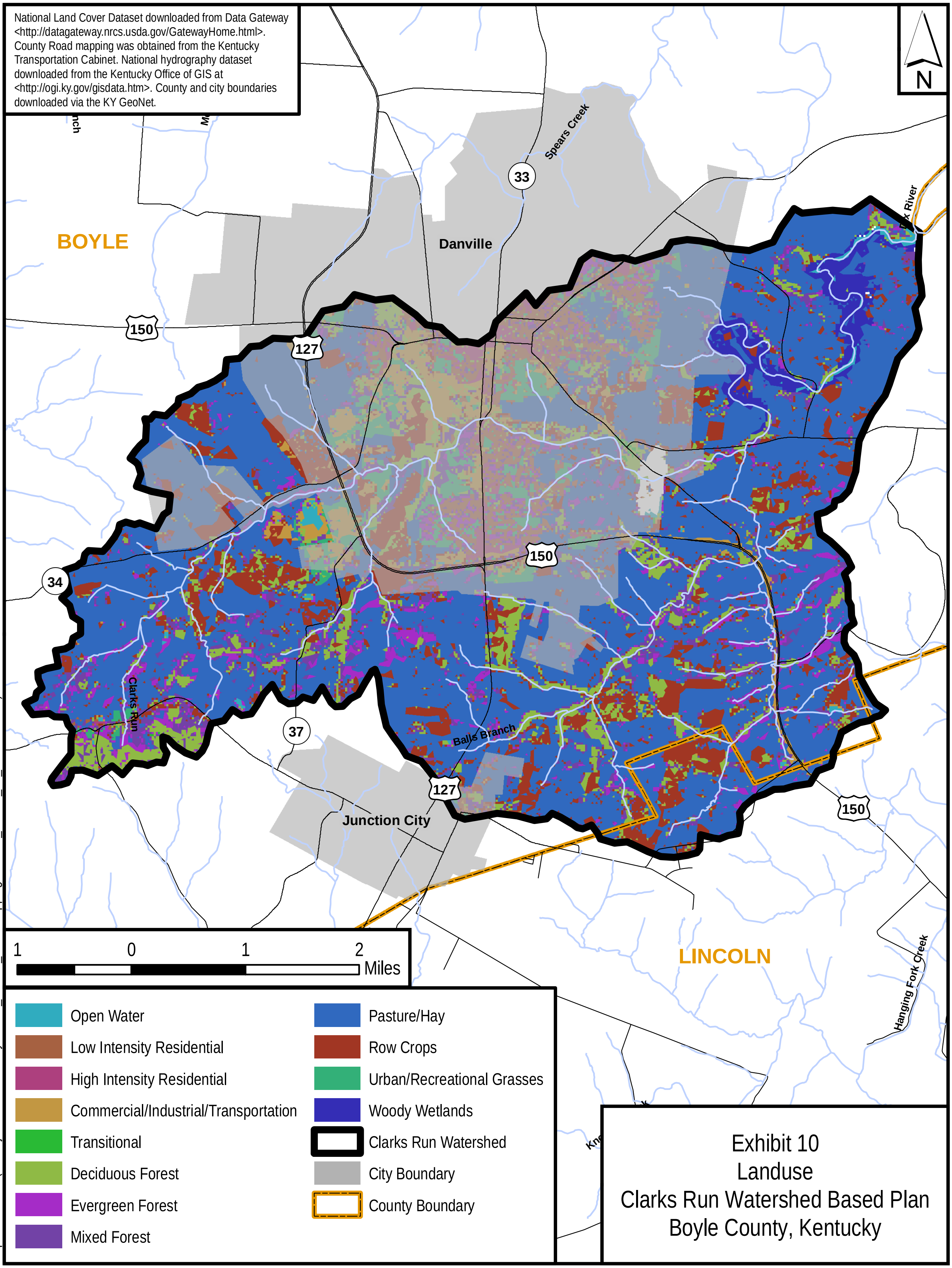



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TABLE 12 – CLARKS RUN LAND USE BY SUBWATERSHED

| SITE | URBAN (ACRES) | ROW CROPS (ACRES) | PASTURE/HAY (ACRES) | OTHER (ACRES) | FORESTED (ACRES) | TOTAL (ACRES) |
|---|---|---|---|---|---|---|
| Below Goggin | 1 | 83 | 840 | 41 | 322 | 1,287 |
| Goggin Ln | 302 | 119 | 1,140 | 4 | 438 | 2,003 |
| Balls Branch Mouth | 120 | 526 | 2,753 | 16 | 900 | 4,315 |
| Balls Branch West | 42 | 281 | 1,212 | 3 | 374 | 1,911 |
| KY 52 | 2 | 71 | 156 | 11 | 50 | 289 |
| Stanford Rd | 746 | 93 | 384 | 58 | 361 | 1,642 |
| S 2nd St | 849 | 480 | 1,293 | 23 | 868 | 3,512 |
| US 127 Bypass | 36 | 236 | 726 | 2 | 102 | 1,101 |
| Corporate Dr | 30 | 208 | 1,284 | 7 | 627 | 2,157 |
| Total | 2,127 | 2,097 | 9,787 | 164 | 4,043 | 18,218 |

The headwaters of the Clarks Run watershed are primarily agricultural with scattered residences, but the watershed becomes developed in and around the city limits of Danville. The Balls Branch portion of the watershed is primarily agricultural with some forest. Agriculture dominates the rural landscape of the watershed, especially cattle grazing. Cattle have been observed in streams within the watershed. For most of the agricultural area, sewer is not available, so most residences are on septic systems.

In the agricultural areas outside of the sanitary sewer coverage, one source of NPS pollution is onsite sewage treatment. While some illicit straight pipes (point sources) may be located in the watershed, most onsite treatment is conducted through septic systems. Typically, septic system failure can be detected by water falling back into the tanks when the tank is pumped, or by soil flooding due to lack of soil absorption. However, in soils with karst or epikarst subsurfaces, such signs of failure may not be detected due to drainage into the groundwater system. While Health Department records did not indicate the location of septic systems, the number and geographic locations of these facilities were mapped, as shown in Exhibit 9 (page 35), through correspondence between GIS analysts and County Health Department personnel (Halcomb *et al.* 2007; Carrier *et al.* 2007).

Cattle or other livestock operations are also a source of NPS pollution. Through direct inputs of fecal material or through runoff, these animals can raise the pathogen and nutrient levels of streams. Because of an abundance of pasturelands with direct access to streams, this is a prominent nonpoint source of pollution in agricultural areas. Cropland can also act as NPS due to the addition of fertilizers and pesticides, which may be carried through runoff to streams.

As Clarks Run enters Danville, it is crossed by a functioning railroad and passes by the railroad yard. In Danville, various urban threats to water quality exist, including two closed landfills, roadway crossings, streamside businesses, suspected sanitary sewer overflows or losses from the sanitary sewer collection system, and a high level of imperviousness. Impervious surfaces, such as roadways, rooftops, and other surfaces which water cannot penetrate can be sources of NPS, carrying road salts, oils, and other pollutants to streams through runoff. In residential areas, lawn fertilization and pesticide applications, carried to streams through the storm sewer system, can also contribute to NPS. Below KY 52 the remainder for the Clarks Run reach is agricultural and residential until the confluence with the Dix River another 4.3 miles downstream.

### *2.4. Demographics and Social Issues*

The demographics of the Clarks Run watershed provide an indication of how the watershed will develop as well as how and where education should be focused. According to the US Census Bureau, Boyle County is growing at a slower rate than the rest of Kentucky. As Table 13 shows, the urban population of the watershed has a higher level of education that the state as a whole, and as a county has higher median income.

TABLE 13 – COUNTY CENSUS DATA SUMMARY

| | DANVILLE | BOYLE COUNTY | KENTUCKY |
|---|---|---|---|
| Population | 15,477 | 27,697 | - |
| Median age | 36.7 | 36.9 | - |
| Average household size | 2.26 | 2.38 | 2.47 |
| Percent Growth (2000 to 2008)* | - | 4.5% | 5.6% |
| Education | | | |
| % High School Graduate or higher | 78.2% | 76.6% | 74.1% |
| % Bachelor's degree or higher | 22.7% | 19.3% | 17.1% |
| Income | | | |
| Median Household Income | $32,937 | $41,739** | $40,299** |
| % Population 16 years and older in Labor Force | 58.1 | 58.9 | - |
| Housing | | | |
| Total Housing Units | 6,734 | 11,418 | - |
| Occupied Units | 6,255 | 10,574 | - |
| % Owner Occupied | 61.7% | 69.3% | - |
| % Renter Occupied | 38.3% | 30.7% | - |
| % Mobile Homes | 3.6% | 6% | - |
| Median value of specified owner-occupied units | $91,700 | $86,400 | $86,700 |

Unless otherwise stated, results are from the 2000 U.S. Bureau of Census
*Based on U.S. Census Bureau: State and County QuickFacts 2009
**Based on State and County QuickFacts for 2007

Although farming is not a dominant profession within the watershed, much of the land outside of the city limits is used in farming. Agricultural statistics are on record, though they are compiled at the county level, making it difficult to specifically characterize the agricultural activities within the watershed. As shown in Table 14 on page 40, the average farm size in Boyle County is approximately 145 acres, with cattle farms being the most dominant. For 2009, 24,300 head of cattle are expected in Boyle County (NASS 2009). Assuming uniform distribution over pasture/hay land use, 0.43 cattle per acre of pasture/hay would be distributed throughout the county. Since land use estimates indicate that approximately 9787 acres of pasture/hay occur within Clarks Run, the total head of cattle within the watershed is estimated at 4,234 head. Of the agricultural farm use, hay production is most dominant, followed distantly by corn and soybeans.

TABLE 14 – AGRICULTURAL CENSUS FOR BOYLE COUNTY

| COUNTY NAME | BOYLE | |
|---|---|---|
| Farm Properties[1] | Year 2007 | % Change* |
| # of Farms | 649 | -9% |
| Land in Farms (Acres) | 94,233 | -4% |
| Average Size of Farm (Acres) | 145 | +5% |
| Farm Production Statistics[2] | Year 2009 | |
| Head of Cattle | 24,300 | |
| Acres All Hay Harvest | 29,200 | |
| Acres Corn Planted | 2,500 | |
| Acres Soybean Planted | 1,600 | |

*Percent change from 2002 to 2007. Plus or minus sign denotes increase or decrease.
[1]Farm Properties data from: 2007 Census of Agriculture County Profile. USDA National Agricultural Statistics Service (NASS) www.agcensus.usda.gov
[2]Farm Production Statistics from: USDA NASS, Kentucky Field Office. http://www.nass.usda.gov/ky

Tourist locations within Danville may create opportunities for improvement of stream water quality in conjunction with increasing the attractiveness of these sites. The location of some of these facilities can be found on Exhibit 11 (page 41). Multiple city parks are located throughout the city in proximity to Clarks Run or its tributaries. Constitution Square State Historic Park is located in Danville. Although not a tourist attraction, Centre College, located in Danville, may also be a willing participant in water quality projects, as well as beautification.

CREEC has developed a *Master Trails and Greenway Plan*, under which extensions to the existing trail along Clarks Run and its tributaries are proposed. These extensions include a length 2,000 feet towards Gose Pike as well as connections to the Cross Country Trail, Constitution Square Park, and towards US 150 and the Boyle County Industrial Park. Stream restoration, habitat improvement, or signage could be incorporated into this linear parks system.

## *2.5. Plan for Collecting More Data*

Five data gaps were specifically listed in Section 2.1.9: straight pipe/septic tank/sewer survey or modeling; cattle; groundwater flow features; stream flow/flashiness; and biological data. Of these five, a survey of the fecal sources within the urban area is critical to remediation. Methods of conducting such a survey are discussed in Section 6.

## *2.6. Summary and Conclusions*

### *2.6.1. Watershed Problems*

Based on the analysis of all monitoring results, multiple factors are impacting the water quality in the watershed. Fecal inputs, excess nutrients and resultant algal blooms, high conductivity, and narrow to no vegetated riparian zone width were problems prevalent throughout the Clarks Run watershed. At Goggin Lane, frequent dumping of garbage and other litter is a problem.

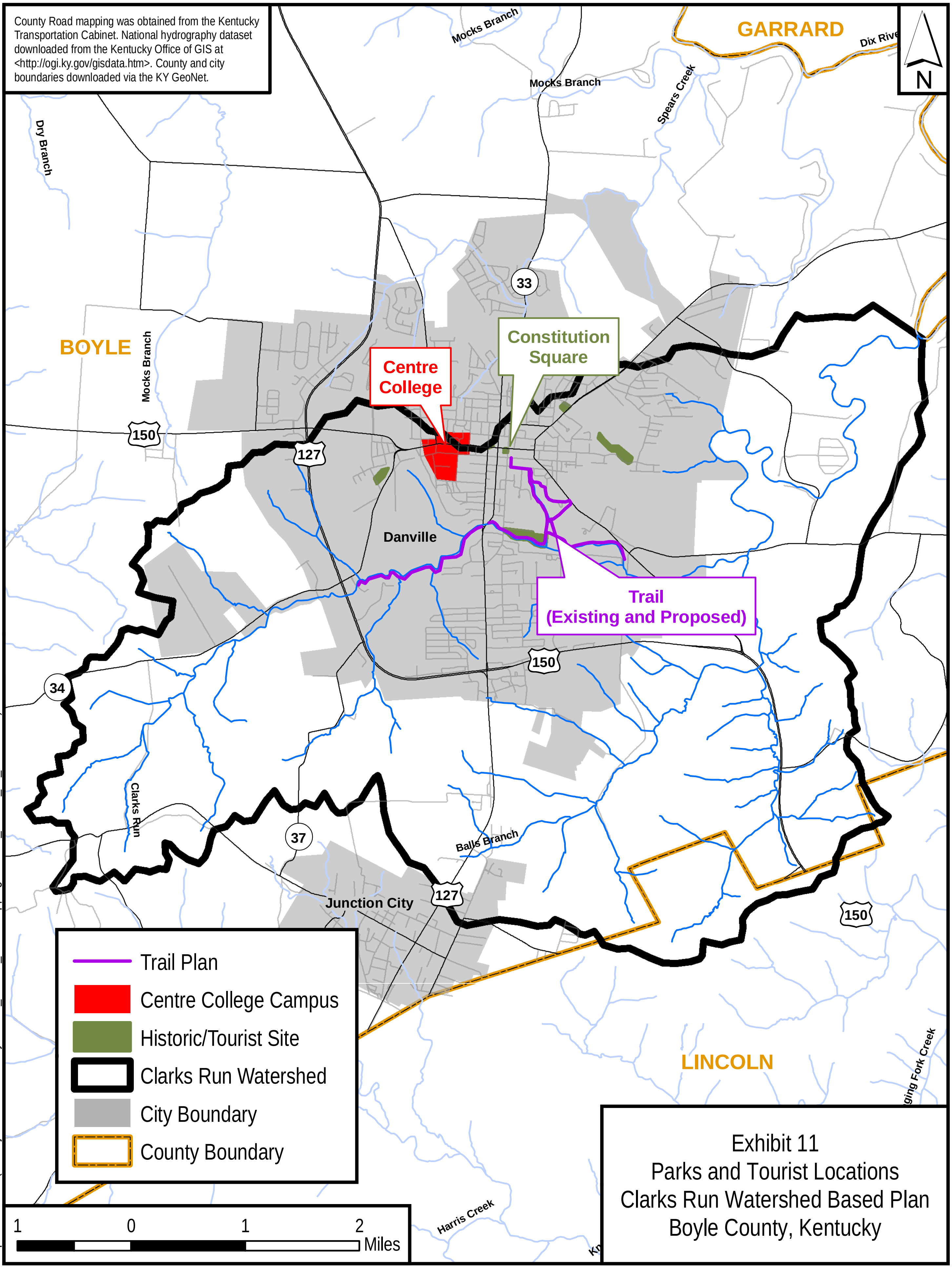



Exhibit 11
Parks and Tourist Locations
Clarks Run Watershed Based Plan
Boyle County, Kentucky

Map Document: (P:\Project Files\Kentucky\5167E_KDOW_WBP\Mapping\GIS\CR_Exhibit_11_Parks.mxd) 7/31/2009 -- 9:51:07 AM las

#### *2.6.2. Healthy Streams and Watershed Areas*

Although no locations in the watershed were found to be without *E. coli* problems, Clarks Run at the US 127 Bypass and at South Second Street were otherwise among the best sites monitored in the watershed.

#### *2.6.3. Areas and Streams with Challenges*

Riparian zone width and *E. coli* levels were the most severe problems throughout the watershed area; therefore, correction of these impairments should be an emphasis for remediation. These two impacts were especially evident on Balls Branch and its tributaries. In the Clarks Run watershed, habitat impairments were often more severe on first order tributaries than on the higher order Clarks Run main stem.

At Goggin Lane and KY 52, excessive nutrient problems are impacting the aquatic community due, in large part, to the upstream wastewater treatment plant. At Goggin Lane particularly, algal blooms completely overwhelmed the stream at times.

Reduction of the flashiness of the stream flow will be a challenge in this watershed due to the high degree of impervious surface in the Danville city area. However, recommendations will be made to reduce high-volume stormwater impacts to the stream in Section 4.

## 3. ANALYSIS OF IMPAIRMENTS

### *3.1. Analytical Methods*

#### *3.1.1. Water Quality Standards*

In order to evaluate the nature and extent of impairments in the Clarks Run watershed, results must be compared to applicable water quality benchmarks. The benchmarks used in this comparison were of multiple types, including legal limits as well as scientific evaluations.

For parameters are listed in 401 KAR 10:031, the legally binding surface water standards for warm water aquatic habitat in Kentucky were used as the benchmark. Specific criteria are listed for dissolved oxygen, pH, water temperature, chloride, un-ionized ammonia, fecal coliform, and *E. coli* as shown in Table 15 (page 43). Water quality standards for metals and pesticides/herbicides are also available, but have not been listed herein due to the infrequency in the data collection of these parameters in this watershed. For specific conductance, flow, total suspended solids, and alkalinity, specific standards are not provided, but 401 KAR 10:031 indicates than levels "shall not be changed to the extent that the indigenous aquatic community is adversely affected." Nutrients in surface waters are also to be regulated such that "where eutrophication problems may exist, nitrogen, phosphorus, 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."

For total phosphorus and total nitrogen, the Kentucky Division of Water has specified a numeric target for Clarks Run in association with the development of total maximum daily loads (TMDL). The TMDL is the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards, thus the target is used as the benchmark for these parameters. The TMDL target for total phosphorus is 0.3 mg/L and for total nitrogen the target is 2.0 mg/L.

TABLE 15 – KENTUCKY SURFACE WATER STANDARDS

| PARAMETER | UNIT | KY WQS | | ADDITIONAL COMMENTS |
|---|---|---|---|---|
| | | CHRONIC | ACUTE | |
| Dissolved Oxygen | mg/L | 5 | 4 | 5.0mg/L is minimum daily average; 4.0 mg/L is instantaneous minimum |
| pH | SU | 6.0/9.0 | | pH shall not fluctuate more than 1.0 SU over a period of 24 hours. |
| Temperature | deg. F | | 89 | |
| Chloride | mg/L | 600 | 1200 | |
| Ammonia, un-ionized | mg/L | | 0.05 | Un-ionized ammonia is determined based upon the pH, temperature, and total ammonia-N concentrations. |
| Fecal Coliform | cfu/100mls | 200 | 400 | There are not chronic and acute criteria for bacteria, but a geometric mean for five samples collected over 30-days and instantaneous criteria, respectively. |
| *E. coli* | cfu/ 100mls | 130 | 240 | |

Where no specific legal standard was present, benchmarks are provided for comparison purposes and have no regulatory / legal force. The US EPA Storage and Retrieval (STORET) database was used to provide comparisons based on 39576 results for the state of Kentucky and 18229 results from the Interior Plateau ecoregion of Kentucky collected between 1990 and 1997 (USEPA 2009a). For parameters for which data was sufficient data was available, Table 16 summarizes the number of sample results available, the arithmetic average, and the 25$^{th}$, 50$^{th}$, 75$^{th}$, and 95$^{th}$ percentiles. Percentiles indicate the value at which that percentage of the results is below when all the results are ranked from lowest to highest (for example, 25% of the results are below the 25$^{th}$ percentile). These results were used to evaluate whether results are low, moderate, or high.

TABLE 16 – USEPA STORET DATABASE BENCHMARKS

| PARAMETER | UNIT | INTERIOR PLATEAU | | | | | | STATEWIDE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | # SAMPLES | MEAN | PERCENTILE | | | | # SAMPLES | MEAN | PERCENTILE | | | |
| | | | | 25TH | 50TH | 75TH | 95TH | | | 25TH | 50TH | 75TH | 95TH |
| Ammonia Nitrogen, Total | mg/L | 3052 | 0.06 | 0.02 | 0.02 | 0.05 | 0.195 | 5877 | 0.06 | 0.01 | 0.01 | 0.05 | 0.2 |
| Nitrite and Nitrate | mg/L | 3049 | 1.02 | 0.27 | 0.69 | 1.28 | 3.34 | 5893 | 0.75 | 0.19 | 0.44 | 0.93 | 2.61 |
| Total Kjeldhal Nitrogen | mg/L | 2635 | 0.52 | 0.24 | 0.42 | 0.645 | 1.34 | 5223 | 0.44 | 0.16 | 0.32 | 0.57 | 1.21 |
| Phosphorus, Total | mg/L | 2832 | 0.16 | 0.03 | 0.08 | 0.19 | 0.63 | 5707 | 0.11 | 0.01 | 0.03 | 0.11 | 0.45 |
| Total Suspended Solids | mg/L | 131 | 75.6 | 16.5 | 35 | 76 | 357 | 174 | 70.6 | 12.3 | 32 | 72 | 355.5 |
| Turbidity | NTU | 1732 | 32.1 | 10 | 21 | 37.3 | 120 | 4998 | 12.0 | 0.05 | 0.59 | 9 | 69 |
| Conductivity | µS/cm | See Note | | | | | | 7044 | | | 295 | | 771 |
| Alkalinity, Total | mg/L | | | | | | | 4334 | | | 100 | | 202 |
| Carbon, Total Organic | mg/L | | | | | | | 4338 | | | 2.37 | | 6.76 |
| Sulfate | mg/L | | | | | | | 4345 | | | 34 | | 271 |

Note: Interior Plateau data not available for these parameters. Statewide values based on KDOW collected STORET data in USEPA 2006.

In cases where no STORET data was available, other applicable benchmarks were used to evaluate the water quality. The common KPDES permit of 10 mg/L was used to evaluate BOD levels. The conductivity level of 500 µS/cm is used as a benchmark considering levels above this limit may not be suitable for macroinvertebrates and fish (USEPA 2009b).

Habitat values are evaluated according to the standards found in KDOW's *Standard Methods for Assessing Biological Integrity of Surface Waters in Kentucky* (2008). Each habitat parameter is evaluated as "optimal," "suboptimal," "marginal," or "poor," and the total of these scores is evaluated as "fully supporting," "partially supporting," or "not supporting" according to the Bluegrass bioregion standards and the upstream watershed size, as shown in Table 17.

TABLE 17 – HABITAT CRITERIA FOR BLUEGRASS BIOREGION STREAMS

| RATING LEVEL | WADEABLE STREAM ($>5$ MI$^2$ WATERSHED) | HEADWATER STREAM ($<5$ MI$^2$ WATERSHED) |
|---|---|---|
| Fully Supporting | 130 and above | 156 and above |
| Partially Supporting | 114 – 129 | 142 – 155 |
| Not Supporting | 113 and below | 141 and below |

### *3.1.2. Comparison of Data to Water Quality Standards*

Based on the water quality data collected, four chemical parameters were found to exceed water quality benchmarks on a routine basis within the Clarks Run watershed: conductivity, total phosphorus, total nitrogen, and *E. coli*. As shown in Table 18 (page 45), all sites sampled in the Third Rock monitoring study exceeded the nitrogen and *E. coli* limits at least twice during the monitoring period. Un-ionized ammonia exceeded surface water standards twice at Goggin Lane and once at US-150. All sites except the mouth of Balls Branch and Clarks Run at Corporate Drive showed conductivity levels exceeding 500µS/cm. Only one site, Clarks Run at KY 52, showed routine exceedances of the phosphorus TMDL target.

Although dissolved oxygen impairments were originally identified in the Clarks Run watershed, no signs of such impairment were observed during the monitoring period. As previously discussed, although large algal blooms were observed, such blooms did not produce drops in the dissolve oxygen levels. Because sediment and siltation impairments have previously been identified in Clarks Run, Table 18 shows that TSS only occasionally exceeded the Interior Plateau 25$^{th}$ Percentile (10 mg/L) at Balls Branch West and Clarks Run at KY 52, but never exceeded the Interior Plateau 50$^{th}$ percentile (35 mg/L) at any site monitored. Thus, TSS is not considered as a major pollutant in Clarks Run based on these results.

### Stream Assessment

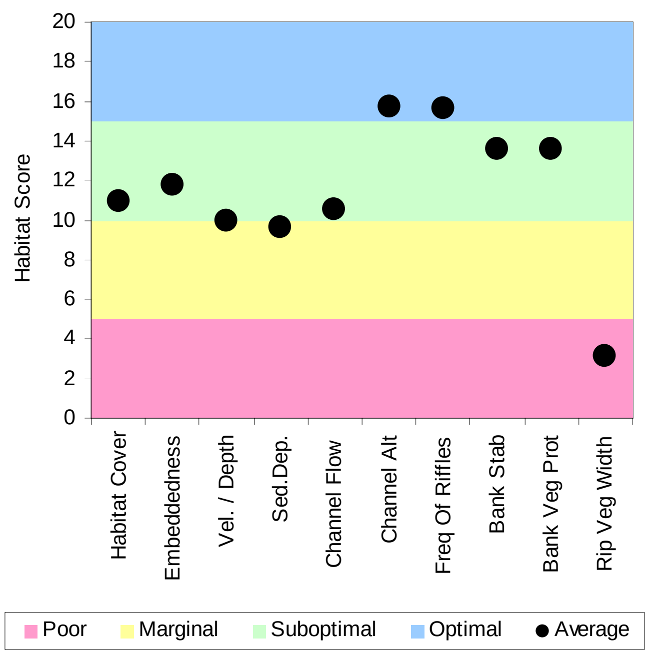
Of the 23 sites in the Clarks Run watershed assessed for habitat, 61 percent scored "not supporting," 17 percent were "partially supporting," and 22 percent were "fully supporting" their habitat use. Each of the ten categories assessed for habitat were rated from "optimal" to "poor" on a scale of 0 to 20 at each site. Figure 4 (page 45) shows the geometric average scores for each habitat category in relation to the poor to optimal ranges. For most categories, streams scored in the suboptimal range. The highest scoring categories were channel alteration and frequency of riffles, which each scored in the optimal range on average. However, on the other end, at a geometric average near 3, the riparian vegetative width stands out as the most significant habitat impairment causing sites to be scored as "not supporting" in the watershed.

TABLE 18 – NUMBER OF EXCEEDANCES OF WATER QUALITY BENCHMARKS IN CLARKS RUN

| SITE NAME | CONDUCTIVITY BENCHMARK (500 µS/CM) | TOTAL SUSPENDED SOLIDS BENCHMARK (10 MG/L) | TOTAL PHOSPHORUS TMDL TARGET (0.3 MG/L) | TOTAL NITROGEN TMDL TARGET (2.0 MG/L) | *E. COLI* GEOMEAN LIMIT (130 CFU/100MLS) |
|---|---|---|---|---|---|
| Goggin Ln | 17/25 | 0/12 | 1/8 | 8/8 | 9/11 |
| Balls Branch Mouth | 1/18 | 1/11 | 0/8 | 6/8 | 9/10 |
| Balls Branch West | 2/18 | 4/12 | 0/8 | 4/8 | 11/11 |
| Clarks Run KY 52 | 18/19 | 2/13 | 5/8 | 8/8 | 9/11 |
| Stanford Rd | 10/18 | 1/12 | 0/8 | 4/8 | 7/10 |
| South 2nd Str | 5/18 | 1/13 | 0/8 | 5/8 | 9/12 |
| US 127 Bypass | 2/19 | 0/12 | 0/8 | 4/8 | 9/11 |
| Corporate Dr | 0/18 | 0/11 | 0/8 | 4/8 | 8/10 |

NOTE: Green shading indicates at least two exceedances of the criteria were recorded in monthly sampling. Numbers based on Third Rock monitoring results for 2006-2009 for conductivity and total suspended solids, 2006-07 for *E. coli*, and 2008-09 for nitrogen and phosphorus. First number represents number of exceedances, second number is number of sampling events.

FIGURE 4 – AVERAGE CLARKS RUN HABITAT SCORES BY CATEGORY



In order to provide an indication of the habitat scores for stream reaches not monitored, a GIS assessment of the aerial photography was performed. As shown in Exhibit 12 (page 47), canopy trees shade 57 percent of the streams in the watershed, while 43 percent of streams completely lack riparianshading. The areas with canopy shading tend to be rated higher than those sites without shading, based on a visual comparison of the habitat scores. This aerial shading estimate may be used as a rough indicator of the areas in greatest need of riparian improvement. Thus, it is expected that approximately 40 to 50 percent of the stream reaches (about 23 stream miles) in the watershed are "partially supporting" or "not supporting" their habitat use.

### *3.1.3. Pollutant Load Prediction*

#### *3.1.3.1. Discharge*

The calculation of the pollutant loading in a watershed is a function of two variables: the concentration of the pollutant and the discharge. Because the sources of the pollution inputs into the watershed may vary by pollutant (runoff versus direct deposit, etc.), the discharge utilized in the loading calculations may vary by pollutant.

In order to predict the loadings for *E. coli*, an adjusted discharge for each watershed segment was determined based on monthly sampling at 8 sites from 2006 to 2007. The adjusted discharge for each site was determined by first adjusting the monthly measurements to account for bias in the sampling techniques (*i.e.* float method biases high, velocity propeller method biases low, and electromagnetic current meter is the most accurate). All sampling conditions were included in this average. Then, the geometric average measured discharge from each site was adjusted so that upstream and downstream discharge values showed agreement. This method of discharge calculation was utilized because the association of the *E. coli* inputs relative to leaching, exfiltration, overflows, and other methods were unknown and thus not categorized by flow events. Table 19 (page 48) shows the discharge values utilized in these loading calculations.

For nitrogen and phosphorus loading calculations, the measured flows were divided into two categories, low and moderate, for each watershed reach. Low flow events were defined as any event below the 50$^{th}$ percentile flow (10 cfs) at Goggin Lane. Moderate flow events exceeded this 50$^{th}$ percentile flow level. A high flow category was not analyzed because insufficient data was available to make such predictions. However, such events may have significant effects on the loading of Herrington Lake if high nutrient loadings are present with such events.

#### *3.1.3.2. E. coli*

A TMDL is currently in development by KDOW for the pathogen impairments in the Clarks Run watershed, but in order to direct remediation in this watershed plan the *E. coli* loading for the watershed has been calculated from the data collected by Third Rock. The annual loading value was derived from the following equation:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *E. coli* Loading | = | Concentration | x | Discharge | x | 31,536,000 | x | 283.2 |
| (cfu/year) | | (cfu/100mLs) | | (cfs) | | (seconds/ year) | | (100 mL/ cubic ft) |

Map Document: (P:\Project Files\Kentucky\5167E_KDOW_WBP\Mapping\GIS\CR_Exhibit_12_Shading.mxd) 7/31/2009 -- 10:01:08 AM las

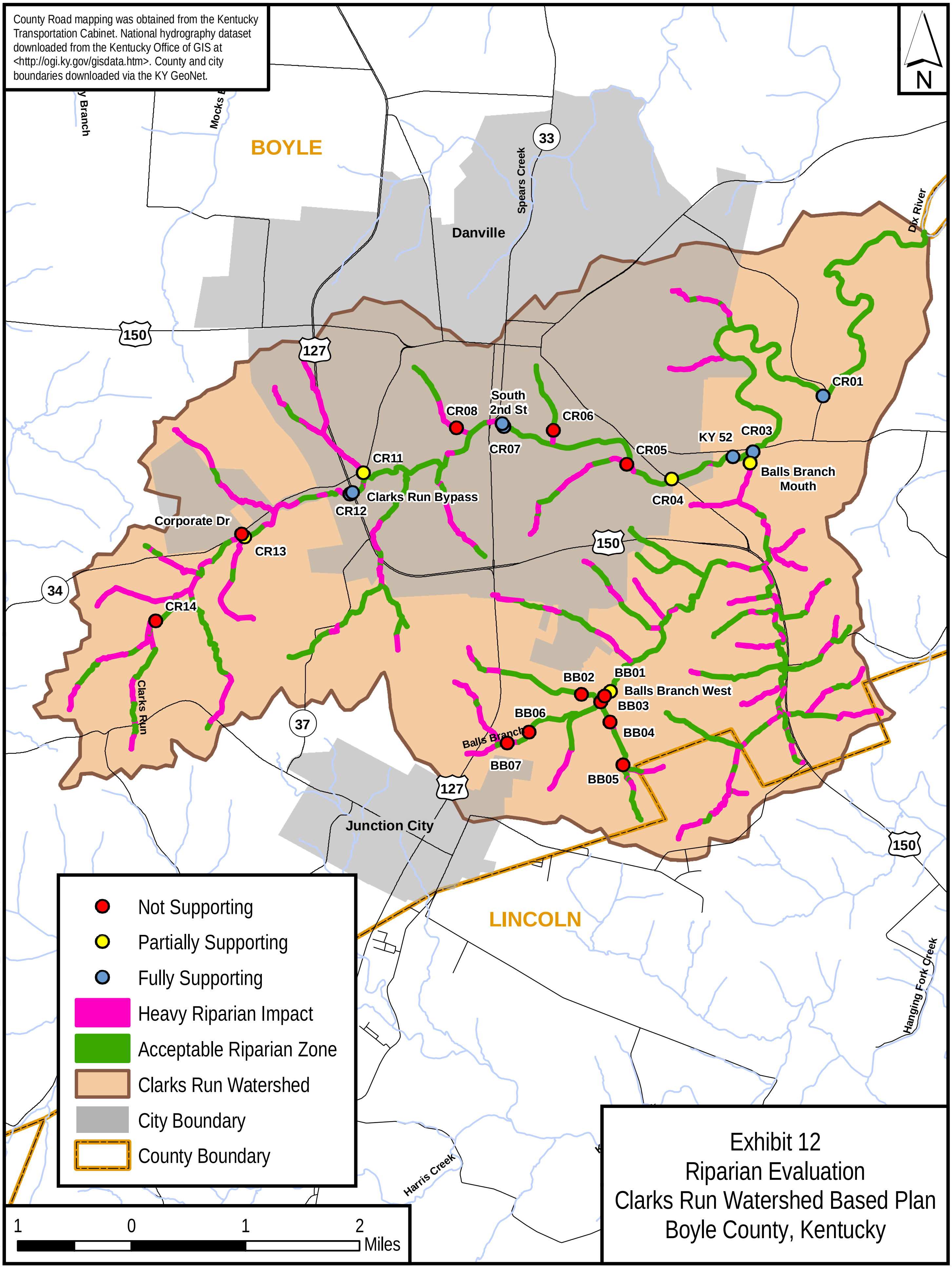


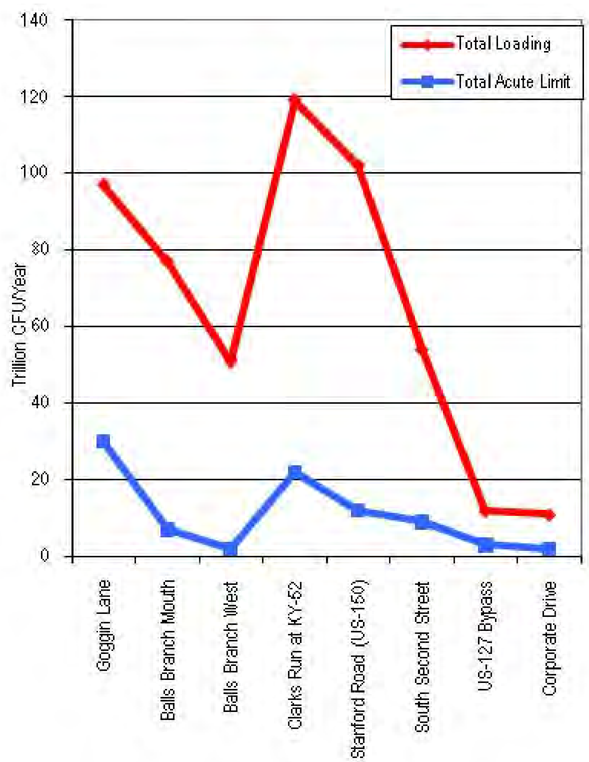

Exhibit 12
Riparian Evaluation
Clarks Run Watershed Based Plan
Boyle County, Kentucky

TABLE 19 – CLARKS RUN *E. COLI* LOADING AND UPSTREAM REDUCTION GOALS

| STATION | *E. COLI* GEOMETRIC AVERAGE (CFU/100MLS) | ADJUSTED DISCHARGE (CFS) | *E. COLI* LOADING (TRILLION CFU/YR) | *E. COLI* TARGET (TRILLION CFU/YR) | REDUCTION TO ACHIEVE TARGET (TRILLION CFU/YR) | % UPSTREAM REDUCTION TARGET |
|---|---|---|---|---|---|---|
| Goggin Lane | 417 | 26 | 97 | 30 | 67 | 69% |
| Balls Branch Mouth | 1439 | 6 | 77 | 7 | 70 | 91% |
| Balls Branch West | 2837 | 2 | 51 | 2 | 48 | 95% |
| Clarks Run at KY 52 | 702 | 19 | 119 | 22 | 97 | 81% |
| Stanford Road (US-150) | 1144 | 10 | 102 | 12 | 91 | 89% |
| South Second Street | 762 | 8 | 54 | 9 | 45 | 83% |
| US 127 Bypass | 540 | 3 | 12 | 3 | 9 | 76% |
| Corporate Drive | 609 | 2 | 11 | 2 | 9 | 79% |

Table 19 shows the *E. coli* loading for each of the 8 sites monitored during the Third Rock data collection study. The *E. coli* loadings are calculated using the geometric average concentrations to eliminate the bias towards high concentrations associated with the arithmetic average. The geometric mean limit of 130 cfu/100mls was used to calculate the reduction target. Reduction goals and the percent of upstream reduction necessary to reach this goal were calculated by taking the difference between loading and the reduction target. Figure 5 shows the total loading and the reduction goal for each station.

FIGURE 5 – TOTAL *E. COLI* LOADING IN THE CLARKS RUN WATERSHED

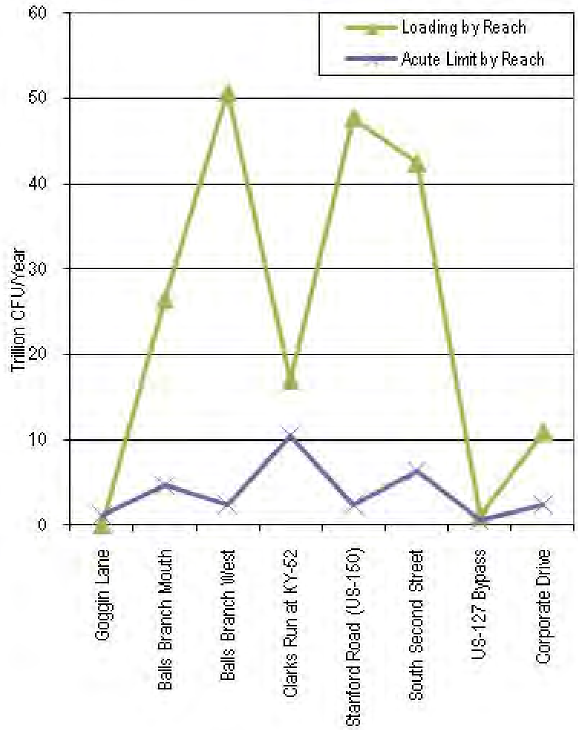


To calculate watershed reach specific loadings, the total loadings of upstream stations are subtracted from downstream sites. This reach specific loading provides a better indication of the geographic sources of load inputs. The loadings for each reach, and the reach specific reduction goals are shown in Table 20 and Figure 6.

TABLE 20 – CLARKS RUN REACH SPECIFIC *E. COLI* LOADING AND REDUCTION GOALS

| STATION | LOADING BY REACH (TRILLION CFU/YR) | *E COLI* TARGET BY REACH (TRILLION CFU/YR) | LOAD REDUCTION BY REACH (TRILLION CFU/YR) |
|---|---|---|---|
| Goggin Lane | 0 | 1.2 | - |
| Balls Branch Mouth | 26 | 4.6 | 21.8 |
| Balls Branch West | 51 | 2.3 | 48.3 |
| Clarks Run at KY 52 | 17 | 10.4 | 6.5 |
| Stanford Road (US-150) | 48 | 2.3 | 45.4 |
| South Second Street | 42 | 6.4 | 36.0 |
| US 127 Bypass | 1 | 0.6 | 0.6 |
| Corporate Drive | 11 | 2.3 | 8.6 |

FIGURE 6 – *E. COLI* LOADING BY REACH IN THE CLARKS RUN WATERSHED




Based on the reach specific loading values, the subwatershed areas associated with Balls Branch West, Stanford Road, and South Second Street show the heaviest loadings in the watershed, respectively. Balls Branch Mouth, Clarks Run at KY 52, Corporate Drive, and US 127 Bypass are each above the limit, but not as highly as the previously mentioned areas. According to these calculations, the high concentrations at Goggin Lane are solely the result of upstream inputs.

#### *3.1.3.3. Phosphorus and Nitrogen*

TMDLs for phosphorus and nitrogen are under development by Third Rock for the Clarks Run watershed, but since this document is not yet complete, loadings have been calculated from the data collected by Third Rock and preliminary TMDL flow computations. For phosphorus and nitrogen loading calculations, the average concentrations were based on geometric means of eight supplemental collection events, two with low flow and six with moderate flow. The daily loading values were calculated from the following equation:

| | | | | | | |
|---|---|---|---|---|---|---|
| Nutrient Loading | = Concentration | x | Discharge | x | 5.39 |
| (lbs/day) | (mg/L) | | ($ft^3$/sec) | | (mg*$ft^3$/L*sec to lbs/day) |

As with *E. coli* loading calculations, the total upstream loading, reach specific loadings, and reduction goals in order to meet water quality criteria have been calculated for total phosphorus and total nitrogen. The TMDL criteria of 2.0 mg/L for total nitrogen and 0.3 mg/L for total phosphorus were utilized in calculating the total and reach specific reduction goals. Concentrations for low and moderate flows were calculated from the arithmetic averages of the sample results.

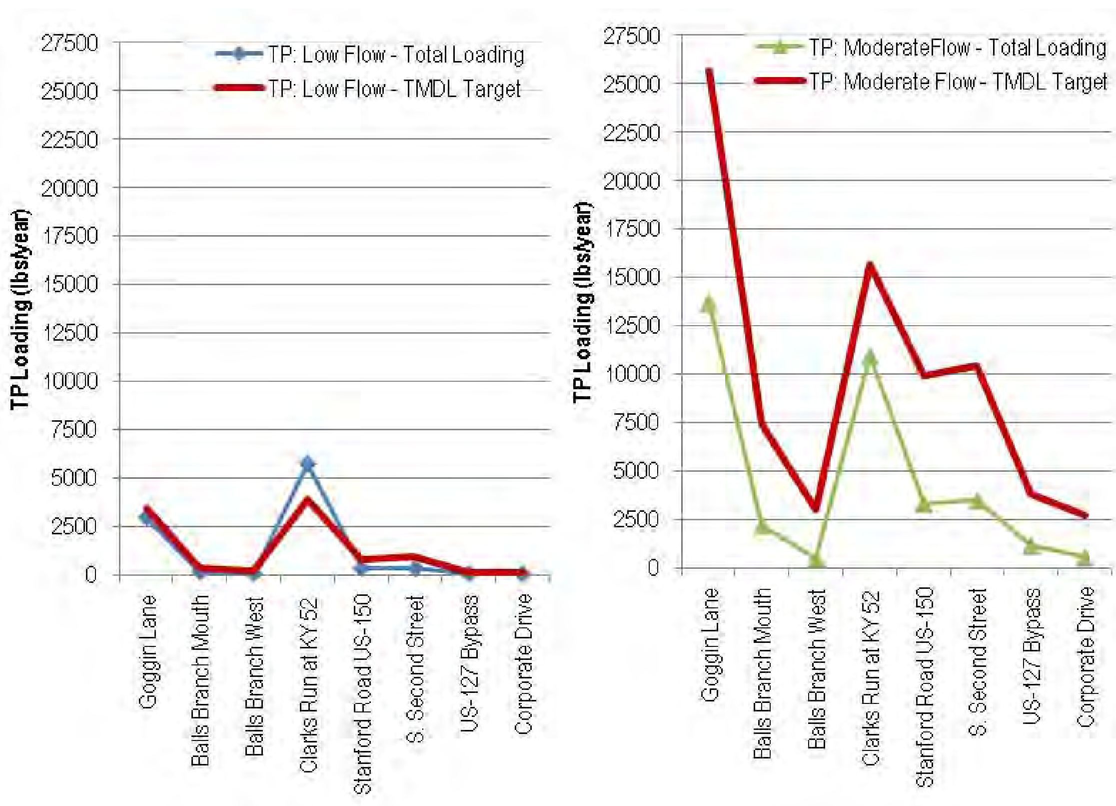
Tables 21 and 22 (pages 51 and 52) and Figures 7 and 8 (pages 51 and 52) show the total phosphorus and total nitrogen loading based on eight months of supplemental data collected by Third Rock in December 2008 to July 2009. The reduction goals and loading shown in these tables and figures are based on the total upstream loading. Reach specific loadings and reduction goals are also shown in Tables 23 and 24 (pages 53 and 54) and Figures 9 and 10 (pages 53 and 54). These reach specific goals were calculated by subtracting the upstream loading from the downstream sites. At several sites, the upstream reach specific target was greater than the downstream target due to reductions in the average flow measurements. Under these circumstances, the cumulative loading over this reach was compared to the highest reach specific goal.

Based on these results, total phosphorus loading only exceeds the TMDL target loading at KY 52, downstream of Danville's WWTP. A reduction of about 2,500 lbs/year of total phosphorus or 45 percent of the reach specific loading at that site is necessary to achieve the TMDL target on Clarks Run at KY 52. While total nitrogen loading can be found exceeding TMDL targets over a larger area of the watershed, the largest overall loading was measured at KY 52 as well. To achieve TMDL targets for nitrogen at this site, a reduction of about 173,000 lbs/year, or approximately 85 percent, of the current reach specific loading at moderate flow conditions must be achieved. This heavy loading can also be attributed to the WWTP. Excluding the loading from the WWTP, a cumulative reduction of 44,100 lbs/year of total nitrogen would be necessary to meet the TMDL target during moderate flow conditions throughout the rest watershed.

TABLE 21 – TOTAL PHOSPHORUS LOADING FOR CLARKS RUN

| STATION | LOW FLOW | | | | MODERATE FLOW | | | |
|---|---|---|---|---|---|---|---|---|
| | FLOW (CFS) | AVERAGE PHOSPHORUS CONCENTRATION (MG/L) | PHOSPHORUS LOADING (LBS/YR) | % REDUCTION TO ACHIEVE TARGET (0.3 MG/L) | FLOW (CFS) | AVERAGE PHOSPHORUS CONCENTRATION (MG/L) | PHOSPHORUS LOADING (LBS/YR) | % REDUCTION TO ACHIEVE TARGET (0.3 MG/L) |
| Goggin Lane | 5.8 | 0.26 | 2968 | - | 44 | 0.16 | 13855 | - |
| Balls Branch Mouth | 0.6 | 0.11 | 130 | - | 13 | 0.09 | 2303 | - |
| Balls Branch West | 0.4 | 0.05 | 39 | - | 5 | 0.05 | 492 | - |
| Clarks Run at KY 52 | 6.6 | 0.44 | 5715 | 32% | 26 | 0.21 | 10745 | - |
| Stanford Road US-150 | 1.4 | 0.12 | 331 | - | 17 | 0.1 | 3346 | - |
| S. Second Street | 1.6 | 0.1 | 315 | - | 18 | 0.1 | 3542 | - |
| US 127 Bypass | 0.2 | 0.08 | 31 | - | 7 | 0.09 | 1240 | - |
| Corporate Drive | 0.2 | 0.05 | 20 | - | 5 | 0.06 | 590 | - |

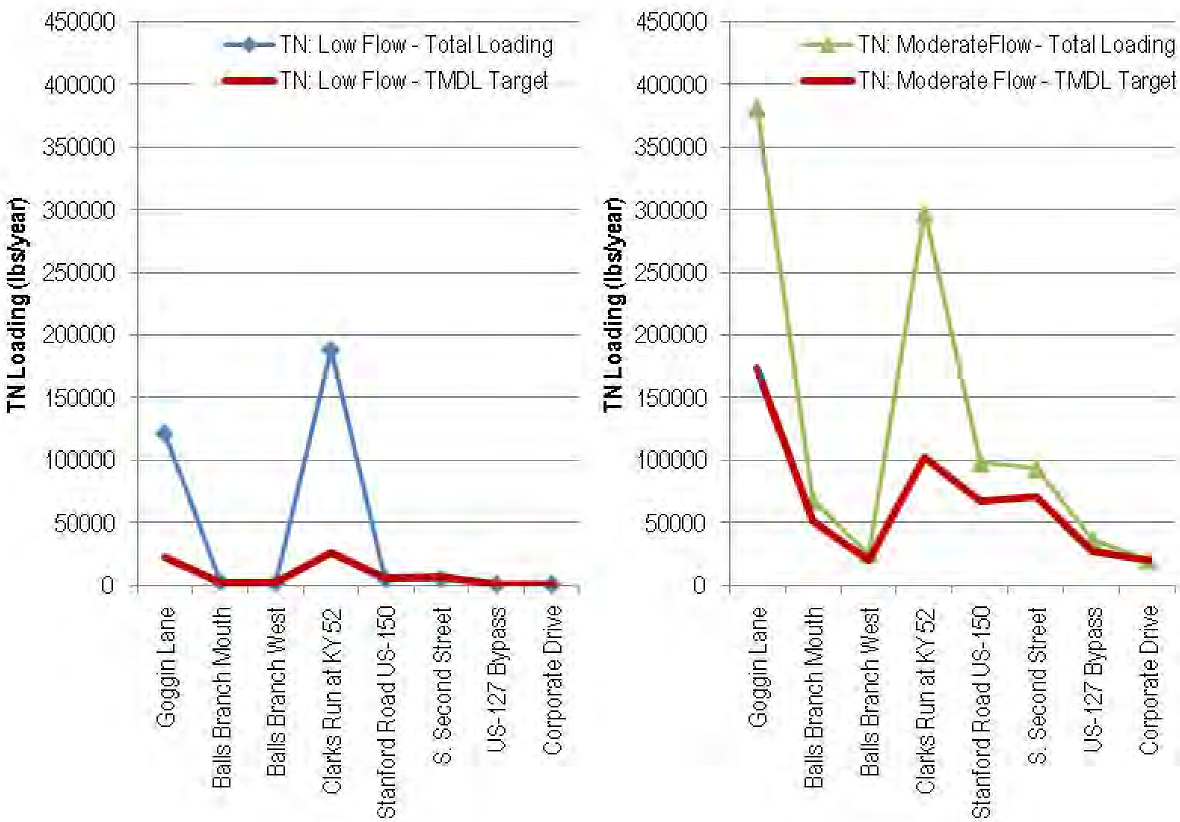
FIGURE 7 – TOTAL PHOSPHORUS UPSTREAM LOADING FOR LOW AND MODERATE FLOW CONDITIONS



## TABLE 22 – TOTAL NITROGEN LOADING FOR CLARKS RUN

| STATION | LOW FLOW | | | | MODERATE FLOW | | | |
|---|---|---|---|---|---|---|---|---|
| | FLOW (CFS) | AVERAGE NITROGEN CONCENTRATION (MG/L) | NITROGEN LOADING (LBS/YR) | % REDUCTION TO ACHIEVE TARGET (2.0 MG/L) | FLOW (CFS) | AVERAGE NITROGEN CONCENTRATION (MG/L) | NITROGEN LOADING (LBS/YR) | % REDUCTION TO ACHIEVE TARGET (2.0 MG/L) |
| Goggin Lane | 5.8 | 10.6 | 120976 | 81% | 44 | 4.4 | 381900 | 55% |
| Balls Branch Mouth | 0.6 | 2.0 | 2305 | - | 13 | 2.7 | 67832 | 25% |
| Balls Branch West | 0.4 | 1.2 | 956 | - | 5 | 2.6 | 25146 | 22% |
| Clarks Run at KY 52 | 6.6 | 14.5 | 187915 | 86% | 26 | 5.8 | 297542 | 66% |
| Stanford Road US-150 | 1.4 | 1.7 | 4615 | - | 17 | 2.9 | 98249 | 32% |
| S. Second Street | 1.6 | 1.5 | 4761 | - | 18 | 2.6 | 93395 | 24% |
| US 127 Bypass | 0.2 | 1.1 | 423 | - | 7 | 2.7 | 36862 | 25% |
| Corporate Drive | 0.2 | 0.5 | 213 | - | 5 | 2.0 | 20005 | 2% |

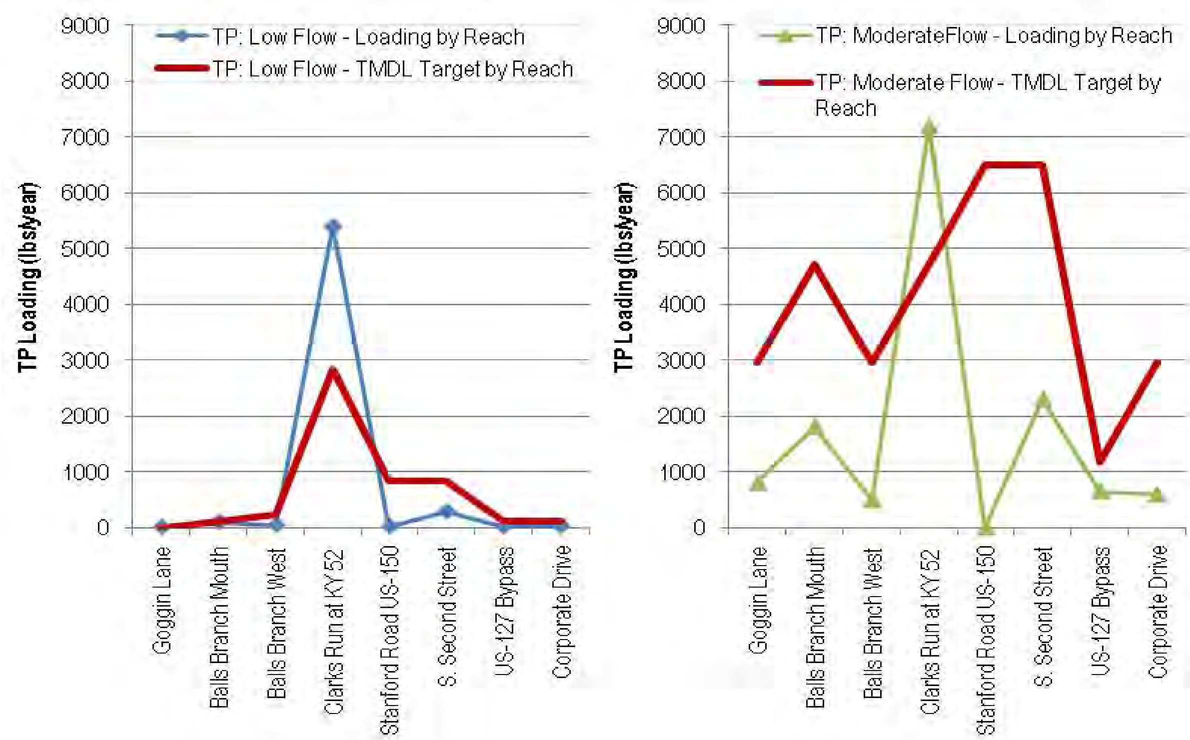
## FIGURE 8 – TOTAL NITROGEN UPSTREAM LOADING FOR LOW AND MODERATE FLOW CONDITIONS



## TABLE 23 – TOTAL PHOSPHORUS LOADING BY REACH

| STATION | LOW FLOW | | | MODERATE FLOW | | |
|---|---|---|---|---|---|---|
| | PHOSPHORUS LOADING BY REACH (LBS/YR) | TMDL LOADING TARGET (LBS/YR) | REDUCTION REQUIRED TO MEET TARGET (LBS/YR) | PHOSPHORUS LOADING BY REACH (LBS/YR) | TMDL LOADING TARGET (LBS/YR) | REDUCTION REQUIRED TO MEET TARGET (LBS/YR) |
| Goggin Lane | 0 | - | - | 807 | 2952 | - |
| Balls Mouth | 91 | 118 | - | 1811 | 4723 | - |
| Balls West | 39 | 236 | - | 492 | 2952 | - |
| Clarks at KY 52 | 5400 | 2952 | 2448 | 7203 | 4723 | 2480 |
| Stanford Road US-150 | 16 | 827 | - | 0 | 6494 | - |
| S. Second Street | 283 | | | 2303 | | |
| US 127 Bypass | 12 | 118 | - | 649 | 1181 | - |
| Corporate Drive | 20 | | | 590 | 2952 | - |

## FIGURE 9 – TOTAL PHOSPHORUS LOADING BY REACH FOR LOW AND MODERATE FLOW CONDITIONS

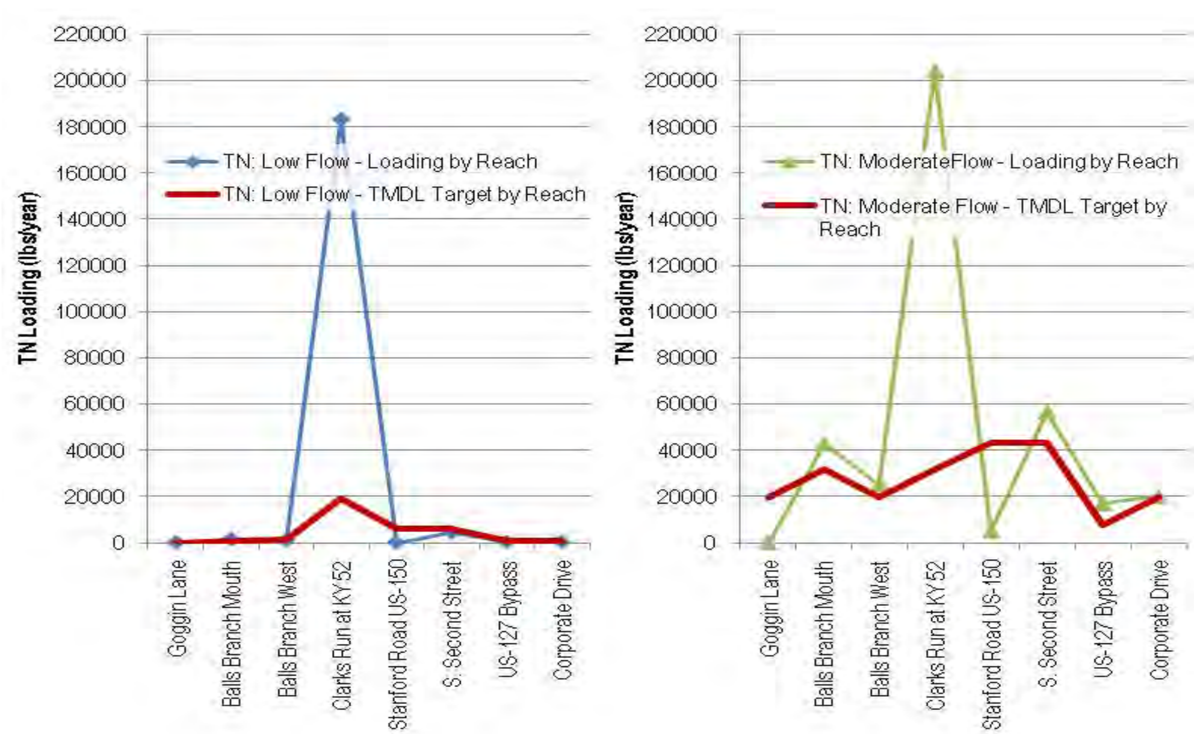


## TABLE 24 – TOTAL NITROGEN LOADING BY REACH

| STATION | LOW FLOW | | | MODERATE FLOW | | |
|---|---|---|---|---|---|---|
| | NITROGEN LOADING BY REACH (LBS/DAY) | TMDL LOADING LIMIT (LBS/DAY) | REDUCTION REQUIRED TO MEET LIMIT (LBS/DAY) | NITROGEN LOADING BY REACH (LBS/DAY) | TMDL LOADING LIMIT (LBS/DAY) | REDUCTION REQUIRED TO MEET LIMIT (LBS/DAY) |
| Goggin Lane | 0 | - | - | 0 | 19680 | - |
| Balls Branch Mouth | 1349 | 787 | 562 | 42686 | 31488 | 11198 |
| Balls Branch West | 956 | 1574 | - | 25146 | 19680 | 5466 |
| Clarks Run at KY 52 | 183154 | 18893 | 164262 | 204147 | 31488 | 172659 |
| Stanford Road US-150 | 0 | 6298 | - | 4854 | 43296 | 18091* |
| S 2nd Street | 4338 | | | 56533 | | |
| US 127 Bypass | 210 | 787 | - | 16858 | 7872 | 8986 |
| Corporate Drive | 213 | | | 20005 | 19680 | 325 |

*Calculated by the cumulative reduction from Stanford Road and S. Second Street locations due to a reduction in flow between sites.

## FIGURE 10 – TOTAL NITROGEN LOADING BY REACH FOR LOW AND MODERATE FLOW CONDITIONS



#### *3.1.3.4. Conductivity*

Conductivity is a "catch-all" measurement for dissolved ions in freshwater. Elevated conductivity can result from landscape disturbance, road salt application, industrial discharges, fertilization, pesticide application, excessive human/animal waste, or underlying geology among other causes. Due to the consistently elevated conductivity across the sites and between sampling events, it is believed that these levels are the combination of the significant limestone geology in the watershed and the fecal and nutrient contamination. Thus, the loading for conductivity has not been calculated, and such impairments will be addressed through practices applicable to the nutrient and *E. coli* problems.

## *3.2. Sources and Locations of Waterway Impairments*

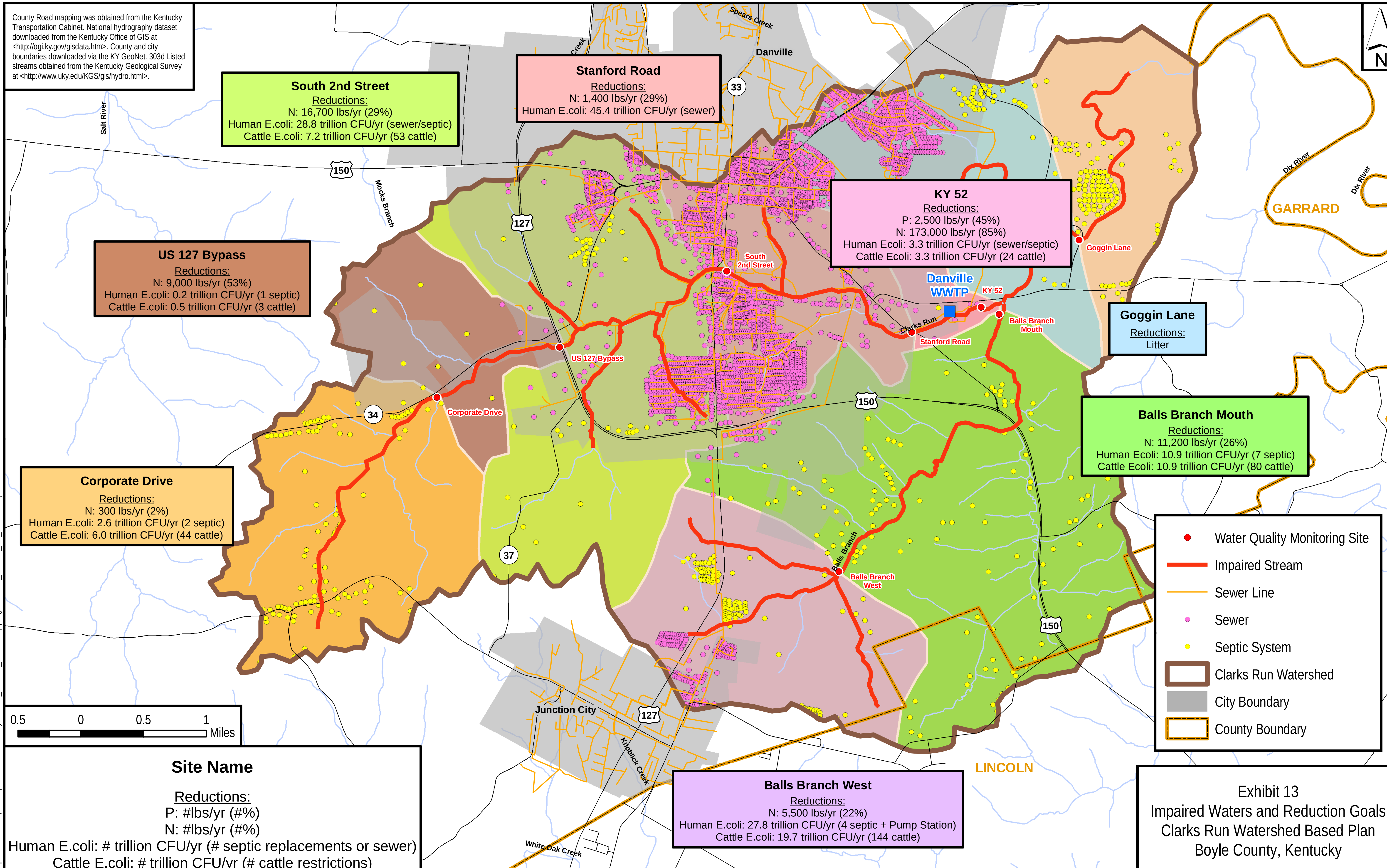
### *3.2.1. Impairments*

Based on the data thus presented, some of the 2008 303(d) listed impairments have been confirmed, some are found without support, and other unlisted impairments have been found as shown on Exhibit 13 (page 56).

For *E. coli*, the 19.2 stream miles of impairments listed on the 2008 303(d) list are confirmed, and an additional 5.6 miles of previously unlisted tributaries were also found to be impaired for *E. coli* during the MST sampling conducted in 2008. These unlisted impairments exceeded in-stream water quality criteria, but insufficient numbers of samples were collected in order to list the stream according to regulations (401 KAR 10:031). For Clarks Run miles 0.7 to 6.3, the listing for organic enrichment (sewage) biological indicators was confirmed by positive DNA testing for human fecal bacteria. Nutrient/eutrophication biological indicators are listed for Clarks Run miles 0.7 to 6.3. Based on this data, phosphorus was only found as an impairment downstream of the WWTP until the confluence with Balls Branch dilutes the concentrations. Like phosphorus, total nitrogen impairments were concentrated downstream of the WWTP. However, total nitrogen levels were above TMDL levels in all of Clarks Run below Corporate Drive, and also on Balls Branch. Due to the collected data, an un-ionized ammonia impairment will be listed on the upcoming 303(d) list for the area downstream of the WWTP. Sedimentation/siltation impairments are listed from Clarks Run mile 0.7 to 4.0 and from mile 6.3 to 14.3. Field data did indicate occasionally high suspended solid levels and some small reaches were observed with siltation impacts, but no widespread siltation or sedimentation impairments were observed over this reach. The highest TSS levels were found in the Balls Branch headwaters and not along Clarks Run.

*Algal Bloom at Goggin Lane During Un-ionized Ammonia Exceedance*

Habitat impairments were identified at 18 sites based on the comparison of the EPA's Rapid Bioassessment Protocol (RBP) to KDOW Bluegrass Bioregion standard. Based on GIS analysis, these 18 sites of impaired habitat appear to be correlated to approximately 23 stream miles based on narrow riparian zone width.

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### *3.2.2. Causes and Sources*

#### *3.2.2.1. E. coli*

In order to provide targeted BMPs to address the *E. coli* impairments in Clarks Run, the causes and sources of those impairments must be identified. The MST study was conducted in 2008 to provide a scientifically defensible estimate of relative contributions of cattle and human sources to the fecal loading. Other sources such as pets and wildlife could not be determined from such testing, but results showed overwhelmingly that human and cattle sources were the greatest contributions.

DNA testing was conducted at four locations, two on Clarks Run and two on Balls Branch within Clarks Run. All results are representative of low flow events except at Stanford Road, which also produced results for a wet weather event. At Stanford Road, testing indicated 80 percent human input and 10 percent cattle during the dry weather and 100 percent human in the wet weather event. A tributary of Clarks Run collecting from the "S" and "T" stormwater sub-basins revealed 50 percent human and 50 percent cattle input (see Exhibit 8 page 31). In Balls Branch, the most concentrated loading was traced to the neighborhoods clustered around US 127 with 70 percent human input and 15 percent cattle. As stated previously, the majority of the human input is suspected to be due to known overflows at the upstream pump station, which has since been repaired by the City of Danville. A tributary to Balls Branch along Gose Pike showed 50 percent cattle and 10 percent human sources. Where percentages do not total 100 percent, the remaining percentages could be due to human, cattle, or other sources but is currently unknown. For areas in the watershed where DNA testing was not conducted, the ratio between atypical and typical coliform colonies was used as a predictor of fecal ages, which can be extrapolated to predict sources. Throughout the watershed, sources were extremely fresh, indicating that direct or at least fresh human or cattle inputs are responsible for the high levels throughout the watershed. Land use and similarity to the areas in which DNA testing was conducted has been used to determine the relative percent contributions in Tables 25 and 26 (page 58).

For areas entirely or mostly treated by septic systems, estimates from the FecalTool from the US EPA's Better Assessment Science Integrating Point and Nonpoint Source Pollution (BASINS) model were utilized to calculate the approximate number of failing systems. Horsely and Whitten's (1996) estimated concentration of 1.00E+6 fecal coliform CFU/100mL in septic overcharge was converted to an *E. coli* concentration using the ratio of the geometric mean standards for each indicator (200 fecal coliform to 130 *E. coli*). Assuming a septic overcharge of 70 gallons/day/person and the average household size of 2.5, the average fecal overcharge input from one home was calculated as 1.58 trillion CFU/year. This rate is intended to serve as a rough estimate since many variables including the soil type, groundwater interaction, temperature, concentration of *E. coli*, and distance from the stream may all affect the input rate. Using this prediction however, 15 septic systems were predicted to be failing and in need of repair or maintenance as shown in Table 25 (page 58). The location of these failing systems should be determined based upon Health Department scouting for symptoms of systems in need of repair or replacement.

## TABLE 25 – HUMAN SOURCES OF *E. COLI* LOADING BY AREA OF EXCEEDANCE

| SUBWATERSHED | LOAD REDUCTION BY REACH (TRILLION CFU/YR) | % HUMAN | HUMAN FECAL LOADING REDUCTION (TRILLION CFU/YR) | ESTIMATED # SEPTIC SYSTEMS | ESTIMATED # SEWERED FACILITIES | % FACILITIES SEWERED | ESTIMATED # OF SEPTIC SYSTEM REPLACEMENTS[1] |
|---|---|---|---|---|---|---|---|
| Balls Branch Mouth | 21.8 | 50%[2] | 10.9 | 115 | 38 | 25% | 7 |
| Balls Branch West[3] | Middle Fork: 26.6 | 80% | 21.3 | 113 | 159 | 58% | 0, Pump Station Overflow[4] |
| | Other Tribs: 21.7 | 30% | 6.5 | | | | 4 |
| Clarks Run at KY 52 | 6.5 | 50%[2] | 3.3 | 1 | 6 | 86% | Unknown, Most sewer |
| Stanford Road | 45.4 | 100% | 45.4 | 0 | 1810 | 100% | 0, All Sewer |
| South Second Street | 36 | 80% | 28.8 | 41 | 758 | 95% | Unknown, Most sewer |
| US 127 Bypass | 0.6 | 25% | 0.15 | 7 | 3 | 30% | 1 |
| Corporate Drive | 8.6 | 30% | 2.58 | 95 | 0 | 0% | 2 |
| Total | 167.2 | 71% | 118.9 | 372 | 2774 | 88% | 15 |

[1] Assumes each septic system contributes 1.58 trillion CFU/yr
[2]Assumed based on land use and source tracking from similar areas.
[3]Divided loading between the middle fork (55%) and the other tributaries (45%) based on watershed area because of differing sources
[4]A known failing pump station was located upstream of this area. Loading is assumed to be due to that failure.

## TABLE 26 – CATTLE SOURCES OF *E. COLI* LOADING BY SUBWATERSHED AREA

| STATION | LOAD REDUCTION BY REACH (TRILLION CFU/YR) | % CATTLE | CATTLE FECAL LOADING (TRILLION CFU/YR) | ESTIMATED CATTLE IN WATERSHED[1] | APPROX. # CATTLE RESTRICTIONS REQUIRED[2] | ESTIMATED % CATTLE TO BE RESTRICTED |
|---|---|---|---|---|---|---|
| Goggin Lane | 0 | N/A | - | 493 | 0 | 0% |
| Balls Branch Mouth | 21.8 | 50% | 10.9 | 1191 | 80 | 7% |
| Balls Branch West[3] | Middle Fork: 25.5 | 20% | 5.1 | 524 | 144 | 27% |
| | Other Tribs: 20.9 | 70% | 14.6 | | | |
| Clarks Run at KY 52 | 6.5 | 50% | 3.3 | 67 | 24 | 35% |
| Stanford Road | 45.4 | 0% | - | 166 | 0 | 0% |
| South Second Street | 36 | 20% | 7.2 | 559 | 53 | 9% |
| US 127 Bypass | 0.6 | 75% | 0.5 | 314 | 3 | 1% |
| Corporate Drive | 8.6 | 70% | 6.0 | 555 | 44 | 8% |
| Total | 167.2 | 28% | 47.6 | 3869 | 347 | 9% |

[1]Assumes uniform distribution of cattle of 0.43 head per acre of pasture/hay based on USDA NASS, Kentucky Field Office. http://www.nass.usda.gov/ky and landuse estimates from the National Land Cover Data Set (2000).
[2]Assumes rate of yearly in-stream deposition of 0.137 trillion CFU *E. coli* / beef cow.
[3]Divided loading between the middle fork (55%) and the other tributaries (45%) based on watershed area because of differing *E. coli* source percentages.

In areas in which sewer systems were the dominant or only source of human fecal input, sewer system failure due to exfiltration, particularly during low flow conditions, is the cause of the most dominant source of *E. coli* input. However, the numbers of sewer line or connection failures causing the problem cannot be accurately predicted, nor could sewer inputs be differentiated from septic inputs in areas in which both treatment types were present. Locations of sewer system failure should be identified and either repaired or replaced with scouting concentrated in areas of the highest exceedances. For example, a failing pump station was assumed to be the cause of the 21.3 trillion CFU/year input along the middle fork of the western Balls Branch headwaters. Since this pump station has since been repaired, a 44 percent reduction in the loading in this subwatershed is expected. However, if field testing does not confirm this reduction, additional sewer lines or septic systems may need repair or replacement.

Sources of cattle fecal contributions to the watershed include both direct inputs and runoff. In order to provide an estimate of the reductions to cattle loadings necessary to meet the water quality goals, literature sources, field observations, and laboratory results were used to indicate the number of cattle to be excluded from the stream. Riparian corridor fencing can be used to restrict cattle access and direct deposition, and vegetative planting can decrease the loading in runoff.

According to the Metcalf and Eddy (1991) reference utilized in the BASINS modeling tool, beef cattle produce an average of 5.4 billion fecal coliform CFU/day/animal. Using the ratio between the water quality benchmarks for fecal coliform and *E. coli* (200:130), the daily fecal rate per head is calculated to be 3.51 billion CFU *E. coli*. In July and August, cattle are estimated to spend up to one third of their time in streams while they spend approximately one tenth of the time the rest of the year if access is available. This indicates that on a yearly basis, 0.137 trillion CFU *E. coli* / beef cow is the estimated direct deposition to streams. Using the estimate of 0.43 cattle per acre of pasture/hay, approximate numbers of cattle restrictions per watershed were calculated in Table 26 (page 58). In total, approximately 9 percent or 347 head of cattle in the watershed require fencing from the streams in order to meet cattle *E. coli* reduction goals. The location of these cattle restrictions is shown in Exhibit 13 (page 56).

#### *3.2.2.2. Nutrients*

As discussed previously, Danville's WWTP is the primary source of nutrient impairment in the watershed. Based on the loading at the KY 52 site just downstream of the treatment plant, a 45 percent reduction of total phosphorus (2500 lbs/year at moderate flow) and an 85 percent reduction of total nitrogen (173,000 lbs/year at moderate flow) are necessary to reduce the loading at this site to below TMDL target concentrations.

Although the greatest source of nitrogen input is the WWTP outfall, other sources of nitrogen are responsible for the remaining exceedances throughout the watershed. As shown in Table 27 (page 60), nitrogen reductions of about 27 percent during moderate flow will be necessary to meet TMDL target concentrations in five subwatersheds. Because the land use in these respective areas varies considerably from agricultural to urban, a variety of BMPs will be necessary to reduce the nitrogen input in the watershed.

#### *3.2.2.3. Habitat*

As discussed previously, habitat impairments are primarily due to narrow or lacking riparian vegetated widths. In residential areas, the narrow riparian zone is usually due to yard maintenance to the stream edge. In industrial and commercial areas, impacts are often due to impervious roadways, bridges, or right-of-way maintenance. In cattle pasture areas, grazing and trampling as well as mowing can lead to the narrow riparian width. The most common source of impairment is livestock grazing in Clarks Run.

TABLE 27 – TOTAL NITROGEN REDUCTIONS REQUIRED TO MEET TMDL AND ASSOCIATED LAND USES

| STATION | REDUCTION UNDER MODERATE FLOW (LBS/YEAR) | % REDUCTION OF TOTAL LOADING |
|---|---|---|
| Balls Branch Mouth | 11200 | 26% |
| Balls Branch West | 5500 | 22% |
| Stanford Road US-150 | 1400 | 29% |
| S 2nd Street | 16700 | 29% |
| US 127 Bypass | 9000 | 53% |
| Corporate Drive | 300 | 2% |
| TOTAL | 44100 | 27% |

### *3.2.3. Present and Future Stressors on the Watershed*

At present, the greatest stressors in the watershed are human fecal contributions, high nutrient outputs from the WWTP, cattle access to stream riparian areas, and high velocities of water from urban impervious surface.

The current establishment of the Stormwater Management Fund shows promise towards reducing nitrogen inputs as well as decreasing the velocity of stormwater entering Clarks Run. The strong involvement of local watershed and environmental groups such as CREEC, Healthy Planet Initiatives, Herrington Lake Conservation League, and KRWW show broad-based community interest and support of water quality improvements. In addition, the relationship between Centre College and these groups provides a large volunteer base for watershed projects.

The elimination of problems in the sewer collection system will remain a challenge for future watershed work. Obvious overflows and leaks have been detected through in-line video and field scouting; however, exfiltration sources are more difficult to detect.

Cattle production will continue to be a dominant land use in the rural portions of the watershed. Decreasing the detrimental influence of cattle grazing on stream habitat and water quality is currently a challenge and will continue to be one in the future. Encouraging participation of local farmers in cost share programs is often difficult without increased incentives.

# 4. IMPLEMENTATION PLAN

## *4.1. Goals and Objectives*

As previously stated, the watershed-planning group has established four goals for the Clarks Run watershed. These goals are:

1. Improve water quality for safe recreational use.
2. Improve community watershed education.

3. Increase diversity and density of aquatic and terrestrial wildlife in the stream riparian zone.
4. Improve codes and ordinances to protect and improve water quality.

These goals are intended to indicate the major concerns and desires of the community in relation to the waterbody, but objectives are required in order to achieve these goals. Objectives indicate specific problems in the watershed that need to be addressed and the causes of these problems. For the listed goals, the objectives are as follows:

1. Reduce human fecal inputs from septic tanks and sewer exfiltration to achieve water quality standards for pathogens.
2. Reduce fecal inputs from livestock to achieve water quality standards for pathogens.
3. Reduce algal blooms and eutrophication by decreasing nitrogen and phosphorus loading.
4. Increase stream habitat by expanding the riparian vegetated width.
5. Reduce the stream flashiness by reducing or slowing stormwater runoff.
6. Reduce litter in streams.
7. Increase knowledge of water quality issues such that citizens and local officials can address impairments with appropriate codes, ordinances, and other practices.

Best management practices (BMPs) to reach the goals and objectives were discussed by partners and stakeholders at the Clarks Run Focus Group Meeting on June 18, 2009. BMPs are practices utilized to change behavior, regulations, or to the physical watershed conditions to move towards meeting the watershed objectives. Recommended BMPs were evaluated and prioritized by the watershed group so that the most effective, feasible, and affordable methods were employed. Table 28 (pages 62 through 63) summarizes the BMPs and action items associated with each objective that were selected as a result of this meeting.

Although stakeholders were asked to numerically rank each BMP individually, only five responses were received. Most responses were favorable towards the suggested BMPs. A recommended BMP of merging Boyle County and City of Danville utilities to promote a cumulative watershed approach to water management was dropped because permit restraints made this option unfeasible. Meeting discussion generated ideas for additional BMPs, especially in the form of educational outreach, and clarified the responsible parties and action items associated with the recommended BMPs.

Also as a result of the stakeholders meeting, Rachel White of the Danville Housing Authority coordinated an additional meeting with Josh Morgan, Danville's Assistant City Engineer, to discuss planning on action items over which the City of Danville has the primary responsibility. Comments from this meeting were utilized to clarify the measurable milestones, and the best methods to ensure ease of implementation of the watershed plan by the city.

### *4.2. Action Item Worksheet*

In order to help achieve the project goals and objectives, the responsible parties, technical assistance, costs and funding, indicators of success, and measurable milestones are listed for each action item in Table 29 (pages 64 through 72). Outreach events and community education events, an essential component of watershed remediation, are included in this list. Exhibit 13 (page 56) indicates the locations of the *E. coli*, nitrogen, and phosphorus reduction targets according to subwatershed reaches. Table 9 (page 30) and Exhibit 8 (page 31) in Section 2.3.1 may be utilized to cross-reference these watershed

## TABLE 28 – BEST MANAGEMENT PRACTICES AND ACTION ITEMS

| OBJECTIVE | BMP | ACTION ITEMS |
|---|---|---|
| #1: Reduce human fecal inputs from septic tanks and sewer exfiltration | 1) Identify and replace failing and improperly maintained septic systems or straight pipes | 1) Field scouting to identify illicit discharges from straight pipes and to identify and confirm the numbers and locations of failing septic systems. |
| | | 2) Notify approximately 15 landowners and health department of field confirmed failing septic systems to allow for correction or enforcement. |
| | | 3) Educate community on septic tank maintenance and indicators of poor performance through distribution of the "Homeowner's Guide to Septic Systems" and household mailer. |
| | | 4) At least 15 septic systems will be rehabilitated in Balls Branch West, Balls Branch Mouth, US 127 Bypass, and Corporate Drive watershed areas. Others identified by field surveys addressed based on availability of funding. |
| | 2) Identify and repair failures in the sewer collection system | 1) City of Danville to work in conjunction with citizen volunteers and monitoring groups to increase watershed scouting for sanitary sewer exfiltration and illicit storm sewer connections using *E. coli* and conductivity monitoring in the Stanford Road and South Second Street watershed reaches. |
| | | 2) Continue in-line video inspections of sanitary sewer systems and pressure checks to target maintenance. |
| | | 3) Hotline for pollution prevention and notification with a link on the website to allow homeowners to report illicit discharges in the area |
| | | 4) Identify funding for sewer system repairs |
| #2: Reduce fecal inputs from livestock | 3) Restrict agricultural grazing from the riparian zone and install filter strips to reduce fecal input from runoff. | 1) Host a workshop or presentation on water quality issues and cost share programs at the Cattleman's Association and other agricultural organizations.<br>2) Develop a list of landowners with the largest portions of stream for targeted encouragement to improve riparian shading, vegetation, or fencing.<br>3) Utilize NRCS Cost Share practices for fencing (Practice #382), livestock exclusion (#472), and filter strip (#393) as well as other reduction alternatives. |
| #3: Reduce algal blooms and eutrophication by decreasing nitrogen and phosphorus loading. | 4) Reduce WWTP limits on nitrogen and phosphorus | Establish discharge limits on Danville's WWTP such that the TMDL targets for phosphorus (0.3 mg/L) and nitrogen (2.0 mg/L) are met. |
| | 5) Construction of headwater and streamside urban nutrient reduction features | Utilize Stormwater fund to direct the construction of urban nutrient reducing BMPs such as grassy swales, rain gardens, streamside wetlands, and other applicable infrastructure to the watershed between Stanford Rd to Corporate Dr. |
| | 6) Construction of agricultural nutrient reduction BMPs | Target landowners in Balls Branch and Corporate Drive/ US127 for the use of NRCS practices such as fencing, filter strips, animal waste control, riparian buffers and other nitrogen reduction techniques. |
| #4: Increase riparian vegetated width. | 7) Conduct riparian tree planting in rural areas | Utilize NRCS Cost share practices for riparian forested buffer (#391) and tree planting (#612). |

TABLE 28 – BEST MANAGEMENT PRACTICES AND ACTION ITEMS, CONTINUED

| OBJECTIVE | BMP | ACTION ITEMS |
|---|---|---|
| #5: Reduce the stream flashiness by reducing or slowing stormwater runoff. | 8) Stream restoration on some particularly eroded or impaired locations | Identify, design, and implement stream restoration on impaired reaches |
| | 9) Encourage the use of rain barrels to reduce runoff volume | Establishment of a rain barrel distribution program similar to Lexington's "Lily Program" to reduce stormwater runoff. |
| | 10) Increase enforcement of ordinances and regulations | Enforce erosion control Ordinances and stormwater permit post construction program. |
| #6 Reduce litter in streams | 11) Enforce litter and dumping ordinances | Post signs at Goggin Lane Overpass and along the pull off at Mansfield Road indicating the penalty for littering. |
| | 12) Conduct community trash pickup days | Organize community pickups along known areas of littered streams |
| #7: Increase knowledge of water quality issues such that citizens and local officials can address impairments with appropriate codes, ordinances, and other practices. | 13) Increase public education by increasing accessibility to water quality related information | 1) Develop an environmental resources display for the Boyle County Public Library and host an education event. |
| | | 2) Incorporate Bluegrass PRIDE's water quality education curriculum at local elementary and middle Schools |
| | | 3) City Council has appointed a commission to incorporate trail systems into the City of Danville's Master Plan. Utilize the Trail System integration into the riparian zone to increase public awareness of Clarks Run. |
| | | 4) Link the Danville's Stormwater website to the Dix River Watershed webpage as well as CREEC and other watershed organizations to increase access to the watershed based plan and citizen action opportunities |
| | | 5) Utilize the GreenTips section of the local paper to publish results of watershed plan and how homeowners can improve water quality in their area. |
| | 14) Encourage community interest in stream improvement | 1) Post signage throughout the watershed at trail systems and overpasses identifying the streams, watershed boundaries, and water quality information. |
| | | 2) Organize a World Water Monitoring Day to gain interest of community children in the water quality of the Clarks Run watershed. |
| | | 3) Provide a workshop to familiarize developers with improved techniques for low impact development |
| | 15) Examine and recommend updates to local codes and ordinances. | Revision of the Stormwater Manual to include more effective water quality ordinances with new MS4 permit. Recommendations from Bluegrass PRIDE's ordinance manual to be incorporated where relevant. |

## TABLE 29 – ACTION ITEMS WORKSHEET

**Objective 1:** Reduce human fecal inputs from septic tanks and sewer exfiltration

| Responsible Party | Technical Assistance | Total Costs | Funding Mechanism | Indicators | Milestones | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Short < 1 Year | Mid 1-3 Years | Long 3-7 Years | Extended 20+ |
| **BMP 1:** Identify and replace failing and improperly maintained septic systems or straight pipes | | | | | | | | |
| **Action Item 1:** Field scouting to identify illicit discharges from straight pipes and to identify and confirm the numbers and locations of failing septic systems based on health department indicators of failure with support from field conductivity, *E. coli* sampling, and optical brightener surveys*. Specifically, the expected number of failing systems by watershed includes Balls Branch West (5), Balls Branch Mouth (7), US 127 Bypass (1), and Corporate Drive (2). Actual numbers may be higher or lower based on field confirmation. Additional failing systems may be found in the South Second Street subwatershed, and if expected reductions due to the pump station repair are not achieve in the Balls Branch West area, additional failing septic systems located in that area. | | | | | | | | |
| CREEC, KRWW, Danville Stormwater and Wastewater Utilities | Boyle County Health Dept | Variable based on sampling required to locate | KRWW for sampling outside of city limits, Danville MS4 within limits | *E. coli*, conductivity, and optical brightener sampling results | Identification of 15 failing septic systems | As necessary to locate problem areas | As necessary to locate problem areas | - |
| **Action Item 2:** Notify approximately 15 landowners and health department of field confirmed failing septic systems or illicit discharges from straight pipes to allow for correction or enforcement. Actual numbers may be higher or lower based on field verification. Notifications would involve written letters or conversation with the landowner as well as a formal letter to the Boyle County Health Department. | | | | | | | | |
| CREEC, Danville Stormwater and Wastewater Utilities | Boyle County Health Dept | N/A | N/A | Notifications of landowners | Notification of 15 landowners | As necessary to remediate | As necessary to remediate | - |
| **Action Item 3:** Educate community on septic tank maintenance and indicators of poor performance through distribution of the "Homeowner's Guide to Septic Systems" and household mailer. The Homeowner's Guide should be distributed during door to door field surveys. A mailer containing the results of the data collection effort specific to each watershed area with septic systems (372 facilities in impaired areas), sources and causes, and solutions should be sent to each household in the watershed. | | | | | | | | |
| CREEC, HCLC, City of Danville, | Boyle County Health Dept | N/A | N/A | Material distributed. | - | Mailer to 372 septic owners | - | - |
| **Action Item 4:** At least 15 septic systems will be rehabilitated as identified in Action Item #1. As noted, if the repair to the pump station in Balls Branch West does not meet the expected reduction, additional septic systems would require servicing. Additional failing systems identified by field surveys will be addressed based on availability of funding. | | | | | | | | |
| Landowner | Boyle County Health Dept | $60,000 if all replaced, at $4000 each | Landowner Expense | *E.coli* | - | 15 rehabilitations | - | - |

*See Section 6 for information on sampling techniques.

## TABLE 29 – ACTION ITEMS WORKSHEET, CONTINUED

**Objective 1:** Reduce human fecal inputs from septic tanks and sewer exfiltration

| Responsible Party | Technical Assistance | Total Costs | Funding Mechanism | Indicators | Milestones | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Short < 1 Year | Mid 1-3 Years | Long 3-7 Years | Extended 20+ |
| BMP 2: Identify and repair failures in the sewer collection system | | | | | | | | |
| **Action Item 1:** City of Danville to work in conjunction with citizen volunteers and monitoring groups to increase watershed scouting for sanitary sewer exfiltration and illicit storm sewer connections using *E. coli*, conductivity, and optical brightener surveys in the Stanford Road and South Second Street watershed reaches. Expected reduction of 43.4 and 25.5 trillion CFU/year in Stanford Road and South Second Street subwatersheds, respectively. | | | | | | | | |
| CREEC, KRWW, Danville Stormwater and Wastewater Utilities | Danville City Engineer | Variable based on numbers of samples required to locate | Danville Stormwater and Wastewater Utilities | Identification and repair of problems, *E. coli*, conductivity, and optical brightener sampling results | As necessary to locate problem areas | As necessary to locate problem areas | As necessary to locate problem areas | - |
| **Action Item 2:** Continue in-line video inspections of sanitary sewer systems and pressure checks to target maintenance. | | | | | | | | |
| Danville Wastewater Utilities | Danville City Engineer | N/A | N/A | Identification and repair of problems, *E. coli* | # Repairs, Load Reduction | | | |
| **Action Item 3:** Hotline for phone notification and link on the Danville's website to allow homeowners to report illicit discharges in the area. In accordance with the storm water management master plan | | | | | | | | |
| City of Danville | N/A | N/A | N/A | Legitimate notifications on hotline and website | Hotline and web-link established | - | - | - |
| **Action Item 4:** Identify funding for sewer system repairs | | | | | | | | |
| Danville Wastewater Utilities | Danville City Engineer | N/A | N/A | Grants or Funding | Adequate Funding Levels Acquired | | | |

## TABLE 29 – ACTION ITEMS WORKSHEET, CONTINUED

**Objective 2:** Reduce fecal inputs from livestock

| Responsible Party | Technical Assistance | Total Costs | Funding Mechanism | Indicators | Milestones | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Short < 1 Year | Mid 1-3 Years | Long 3-7 Years | Extended 20+ |
| **BMP 3:** Restrict agricultural grazing from the riparian zone and install filter strips to reduce fecal input from runoff. | | | | | | | | |
| **Action Item 1:** Host a workshop or presentation on water quality issues at the Cattleman's Association and other agricultural organizations. Intended audience are livestock farmers from throughout Clarks Run. Presentation or workshop would present the results of the watershed plan and the areas of impairment, the BMPs which can be utilized for remediation, advantages for livestock health, and funding availability through the NRCS. The Conservation Stewardship program reward farmers for cost share participation would be highlighted. | | | | | | | | |
| CREEC, NRCS | Third Rock Consultants presentation | N/A | N/A | Sign In address list for the presentation | 1 workshop | 1 workshop | - | - |
| **Action Item 2:** Develop a list of landowners with the largest portions of stream for targeted encouragement to improve riparian shading, vegetation, or fencing. Such a list may be compiled by cross referencing PVA parcels with impaired stream length to personally approach landowners with the largest stream lengths about BMP implementation. Personal communication with these landowners may aid in increasing participation in cost share practices. The goal for cattle restriction should be the following percentages by watershed area: Balls Branch Mouth (7%), Balls Branch West (27%), Clarks Run at KY 52 (35%), South Second Street (9%), US 127 Bypass (1%), and Corporate Drive (8%). | | | | | | | | |
| Boyle County Extension Agent | Third Rock Consultants | N/A | N/A | Map / List | Map / List | - | - | - |
| **Action Item 3:** Utilize NRCS Cost Share practices for fencing (Practice #382), livestock exclusion (#472), and filter strip (#393). The need for each respective practice should be determined by the location of the property as well as the farmer's need. Fencing, exclusion, and filter strips will be most effective in reducing fecal inputs. Exhibit 13 should be used in focusing efforts. | | | | | | | | |
| Cattle farmers | NRCS | $37,800 for fencing | NRCS EQIP Cost share* | Length of stream enhanced, *E. coli* reduction | 1,500 feet of stream (3,000 feet of fence) per year over 6 years | | | |

## TABLE 29 – ACTION ITEMS WORKSHEET, CONTINUED

**Objective 3:** Reduce algal blooms and eutrophication by decreasing nitrogen and phosphorus loading.

| Responsible Party | Technical Assistance | Total Costs | Funding Mechanism | Indicators | Milestones | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Short < 1 Year | Mid 1-3 Years | Long 3-7 Years | Extended 20+ |
| **BMP 4:** Reduce WWTP limits on nitrogen and phosphorus | | | | | | | | |
| **Action Item:** Establish discharge limits on Danville's WWTP such that the TMDL targets for phosphorus (0.3 mg/L) and nitrogen (2.0 mg/L) are met. | | | | | | | | |
| KDOW, Danville Wastewater Utility | N/A | Unknown, would require plant upgrades | Unknown | Conformance to Reduced Limit for Nitrogen and Phosphorus | Upgrades to the treatment plant subsequent on the renewal at lower limits | | | |
| **BMP 5:** Construction of headwater and streamside urban nutrient reduction features | | | | | | | | |
| **Action Item:** Utilize Stormwater fund to direct the construction of urban nutrient reducing BMPs such as grassy swales, rain gardens, streamside wetlands, and other applicable infrastructure to the watershed between Stanford Rd to Corporate Dr. The magnitude of the effort required to reduce nitrogen loading to acceptable levels is difficult to estimate due to the heavy fecal loadings from human sources. Reduction of those septic failures, sanitary sewer exfiltration and overflows, and illicit discharges will reduce the nitrogen loading as well. Monitoring of nitrogen reductions subsequent to fecal load reduction should aid in determining the nitrogen BMPs required to meet reduction goals of 1400 lbs/year at Stanford Road (29%) and 16700 lbs/year at South Second Street (29%). | | | | | | | | |
| Danville City Engineer | Danville City Engineer, Environmental Consultants | Variable depending on projects | Danville Stormwater Management Fund | Reduction of Total Nitrogen | Achieve nitrogen reduction goals for areas other than WWTP in 5 years | | | |
| **BMP 6:** Construction of agricultural nutrient reduction BMPs | | | | | | | | |
| **Action Item:** Target landowners in Balls Branch, Corporate Drive/ US127 and CR-52 areas for the use of NRCS practices such as fencing, filter strips, animal waste control, riparian buffers and other nitrogen reduction techniques. Reduction goals of 11,200 lbs/year for Balls Branch at the Mouth (26%), 5,500 lbs/year for Balls Branch West (22%), and 9,000 lbs/year at US 127 Bypass (53%). | | | | | | | | |
| Cattle farmers, Row crop farmers | NRCS | $31,800 for fencing, additional for tree planting, etc. | NRCS EQIP Cost share* | Length of stream enhanced | Achieve nitrogen reduction goals in rural watersheds within 5 years | | | |

*Cost share will cover up to 75% or $7500 or $20,000 per year per landowner.

## TABLE 29 – ACTION ITEMS WORKSHEET, CONTINUED

**Objective 4:** Increase riparian vegetated width.

| Responsible Party | Technical Assistance | Total Costs | Funding Mechanism | Indicators | Milestones | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Short < 1 Year | Mid 1-3 Years | Long 3-7 Years | Extended 20+ |
| **BMP 7:** Conduct riparian re-vegetation in rural areas | | | | | | | | |
| **Action Item:** Utilize NRCS Cost share practices for fencing and if willing participants can be found for riparian forested buffer (#391) and tree planting (#612). Interest and list of landowners should be developed as in BMP 2: Action Items 2 and 3. Recommend that fencing and livestock restriction remain the primary focus of rural agricultural BMPs. In urban areas, general landowners may coordinate between CREEC and grant funding to enhance the riparian zone. | | | | | | | | |
| Cattle farmers, Row crop farmers, Landowners/ CREEC | NRCS | $37,800 for fencing, plus $195,550 per mile of tree planting | Agricultural: NRCS EQIP Cost share* Urban: Private landowner and CREEC | Length of stream enhanced | 1,500 feet of stream (3,000 feet of fence) per year over 6 years | | | |

*Cost share will cover up to 75% or $7500 or $20,000 per year per landowner.

## TABLE 29 – ACTION ITEMS WORKSHEET, CONTINUED

**Objective 5:** Reduce the stream flashiness by reducing or slowing stormwater runoff.

| Responsible Party | Technical Assistance | Total Costs | Funding Mechanism | Indicators | Milestones | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Short < 1 Year | Mid 1-3 Years | Long 3-7 Years | Extended 20+ |
| **BMP 8:** Stream restoration to decrease the water velocity | | | | | | | | |
| **Action Item:** Develop a list of landowners with the largest portions of stream for targeted encouragement to improve riparian shading, vegetation, or fencing. List should include channelized or eroded sections of stream. For instance, the large tributary to the north of Clarks Run near Corporate Drive would make an excellent site for stream restoration as well as providing educational opportunities for the nearby extension office and community college. Natural stream channel design techniques should be utilized to design restored reaches. | | | | | | | | |
| City and County Engineers | Environmental Consultants | By project | Danville storm water fund, KDFWR* in-lieu fee mitigation funds | Length of stream restored, reduction of stormwater velocities | Identification of opportunities | Design and planning | Implementation | - |
| **BMP 9:** Encourage the use of rain barrels to reduce runoff volume | | | | | | | | |
| **Action Item:** Establishment of a rain barrel distribution program similar to Lexington's "Lily Program" to reduce stormwater runoff. | | | | | | | | |
| Danville Engineer | Bluegrass PRIDE | Landowner purchased | Landowner purchased | Number of Rain Barrels Distributed | - | Program Implementation | - | - |
| **BMP 10:** Increase enforcement of ordinances and regulations | | | | | | | | |
| **Action Item:** Enforce erosion control ordinances as well as the Erosion Control Plans for development as mentioned in storm water management plan post construction program | | | | | | | | |
| Danville Engineer | City Engineer | N/A | N/A | Number of Inspections, violations distributed | Annual Activity | | | |

*Kentucky Department of Fish and Wildlife Resources

## TABLE 29 – ACTION ITEMS WORKSHEET, CONTINUED

**Objective 6:** Enforce litter and dumping ordinances

| Responsible Party | Technical Assistance | Total Costs | Funding Mechanism | Indicators | Milestones | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Short<br>< 1 Year | Mid<br>1-3 Years | Long<br>3-7 Years | Extended<br>20+ |
| **BMP 11:** Enforce litter and dumping ordinances | | | | | | | | |
| **Action Item:** Post signs at Goggin Lane Overpass and along the pull off at Mansfield Road indicating the penalty for littering. If signs do not reduce littering subsequent monitoring and enforcement should be applied. | | | | | | | | |
| KYTC / Boyle County Government | N/A | Sign supplies and installation | County Government | Reduction of Litter at site | Signs/ monitoring | | | |
| **BMP 12:** Conduct community trash pickup days. Goggin Lane and other impaired sites should be targeted | | | | | | | | |
| **Action Item:** Organize community pickups along known areas of littered streams | | | | | | | | |
| Boyle County Solid Waste Department / CREEC / Centre College Volunteers | N/A | N/A | N/A | Successful events | Annual event | | | |

## TABLE 29 – ACTION ITEMS WORKSHEET, CONTINUED

**Objective 7:** Increase knowledge of water quality issues such that citizens and local officials can address impairments with appropriate codes, ordinances, and other practices.

| Responsible Party | Technical Assistance | Total Costs | Funding Mechanism | Indicators | Milestones | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Short < 1 Year | Mid 1-3 Years | Long 3-7 Years | Extended 20+ |
| **BMP 13:** Increase public education by increasing accessibility to water quality related information | | | | | | | | |
| **Action Item 1:** Develop an environmental resources display for the Boyle County Public Library and host an education event. | | | | | | | | |
| Bluegrass PRIDE, Boyle County Library, Centre College, Local Educators | Local Elementary School Teachers | N/A | N/A | Exhibit and event | - | Exhibit and event | - | - |
| **Action Item 2:** Incorporate Bluegrass PRIDE's water quality education curriculum at local elementary and middle schools in drive to become a "Green School." | | | | | | | | |
| Bluegrass PRIDE, Local Educators | Bluegrass PRIDE | N/A | N/A | Local water quality education | - | Use in classrooms | - | - |
| **Action Item 3:** The current trail plan, developed by CREEC is shown on Exhibit 10. City Council has appointed a commission to incorporate trail systems into the City of Danville's Master Plan. Utilize the Trail System integration into the riparian zone to increase public awareness of Clarks Run. Descriptive signage along trails should indicate the value of riparian areas, wildlife, and other stream functions. | | | | | | | | |
| CREEC, Danville-Boyle County Convention and Visitors Bureau, City of Danville, Trail Commission | Environmental Consultant | $1,000 | Danville Stormwater Fund | Signs along stream and trail | - | Installation of 3 streamside signs | - | - |
| **Action Item 4:** Link the Danville's Stormwater website to the Dix River Watershed webpage as well as CREEC and other watershed organizations to increase access to the watershed based plan and citizen action opportunities | | | | | | | | |
| Danville City Engineer | N/A | N/A | N/A | Successful Link | Operational website links | - | - | - |
| **Action Item 5:** Utilize the GreenTips section of the local paper to publish results of watershed plan and how homeowners can improve water quality in their area. | | | | | | | | |
| Healthy Planet Initiative | UKWRRI | N/A | N/A | Articles | Quarterly | Quarterly | - | - |

## TABLE 29 – ACTION ITEMS WORKSHEET, CONTINUED

Objective 7: Increase knowledge of water quality issues such that citizens and local officials can address impairments with appropriate codes, ordinances, and other practices.

| Responsible Party | Technical Assistance | Total Costs | Funding Mechanism | Indicators | Milestones | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Short < 1 Year | Mid 1-3 Years | Long 3-7 Years | Extended 20+ |
| BMP 14: Encourage community interest in stream improvement | | | | | | | | |
| Action Item 1: Post signage throughout the watershed along major roadways and overpasses identifying the streams, watershed boundaries, and water quality information. | | | | | | | | |
| Danville City Engineer, KYTC | Danville City Engineer, KYTC | N/A | KYTC and City under Stormwater Program | Number of signs | Markers on all major roadways indicating streams and watershed boundaries | | | |
| Action Item 2: Organize a World Water Monitoring Day to gain interest of community children in the water quality of the Clarks Run watershed. Results are published online from around the world at http://www.worldwatermonitoringday.org/. Opportunity taken to educate local children and parents on Clarks Run water quality. | | | | | | | | |
| Danville City Engineer (storm water manager), CREEC | N/A | N/A | N/A | Participants at Event | Event | - | - | - |
| Action Item 3: Provide a workshop to familiarize developers with improved techniques for low impact development as stated under storm water management plan. | | | | | | | | |
| Danville City Engineer, KYTC, Bluegrass PRIDE | Danville City Engineer, KYTC, Bluegrass PRIDE | N/A | KYTC and City under Stormwater Program | Workshops | Annual Workshops | | | |
| BMP 15: Examine and recommend updates to local codes and ordinances. | | | | | | | | |
| Action Item: Revision of the Stormwater Manual to include more effective water quality ordinances with new MS4 permit. Develop local codes and ordinances to reduce the impact on riparian areas. The Center for Watershed Protection has developed the ordinance manual "Better Site Design: A Handbook for Changing Development Rules in Your Community" (available at www.cwp.org) which may be used to improve ordinances. The Southeast Watershed Forum also offers Growth Readiness workshops which may assist in watershed protection in conjunction with growth. Revisions are to allow flexibility to apply best low impact development and nutrient BMPs available. | | | | | | | | |
| Danville City Engineer | Southeast Watershed Forum, Center for Watershed Protection | N/A | N/A | Revisions to ordinances | Revisions subsequent to approved stormwater permit | | | |

areas to the Danville storm sewer sub-basins. A total of 15 BMPs are proposed for the remediation of water quality in Clarks Run.

Regarding Objective 1, the method of reducing the human fecal loading depends on the watershed area. In the Stanford Road area, with a loading of 45.4 trillion CFU/year, sanitary sewer is the only human source, so reduction should be achieved by identifying the sources of sewer overflows, exfiltration, and illicit discharges. The monitoring program proposed in Chapter 6 should be utilized in the effort. The South Second Street subwatershed is mostly sewered, but scattered septic systems are located in this area. Thus, field surveys in this area will search for indications of failure in either system to reduce the levels by 28.8 trillion CFU/year. The Balls Branch West subwatershed has the third highest human loading in Clarks Run (27.8 trillion CFU/year). However, this high loading is suspected to be due primary to the overflowing pump station which has since been repaired. Monitoring should evaluate the success of this repair and evaluate the need for further action at the first year evaluation. At the US 127 Bypass, Corporate Drive, and Balls Branch West area, the respective numbers of failing septic systems shown in Exhibit 13 (page 56) are estimates. Post-remediation monitoring should evaluate the need for additional replacements in the watershed. The suitability of the soils for onsite treatment, as described in Section 2.2.2, should be considered when evaluating these areas.

The total cost of remediation cannot be estimated due to a lack of information on the number of sewage repairs required to reduce these levels.

To address Objective 2, target goals for the number of cattle restrictions per watershed have been provided in Table 26 (page 58) and shown in Exhibit 13 (page 56). These goals assume that all reductions will be achieved through exclusion of cattle from the stream. If other agricultural BMPs can be utilized to reduce the input of cattle fecal material into Clarks Run, these estimates would be decreased. However, these estimates are provided in order to project the scope of work required to achieve the water quality goals.

To estimate the cost for excluding these 347 cattle from the stream, the length of stream associated with these cattle was estimated using the percentage of pasture/hay land use and cattle restriction required by subwatershed. An estimate of almost 2.3 miles of stream or 4.7 miles of fence would be required to meet these goals. According to the local NRCS agent (Renfro 2009), the current cost share assistance rate for fencing is about $2 per foot, giving an estimated total of $49,400 for cattle exclusion fencing in Clarks Run (Table 30, page 74). This cost estimate includes only cost-share assistance through the NRCS EQIP and excludes additional landowner costs, and other potential costs due to alternate water sources, improved stream crossings, and land easements. Such costs cannot be predicted without additional information on in stream cattle locations. As previously mentioned, actual costs may also vary if agricultural BMPs other than fencing are utilized or if post BMP monitoring indicates greater or lesser reductions than assumed in this document.

The reduction of nitrogen and phosphorus in the watershed will be primarily achieved through the reduction of Danville's WWTP limits and the subsequent reduction in the concentrations at the outfall. This reduction is almost five times greater than the rest of the reduction in the watershed combined. However, the amount of BMPs required to reduce the NPS nitrogen loading for the watershed is difficult to estimate.

TABLE 30 – CATTLE EXCLUSION COST ESTIMATE FOR CLARKS RUN

| STATION | APPROX. # CATTLE RESTRICTIONS REQUIRED | ESTIMATED LENGTH OF FENCE REQUIRED (FT) | COST ($2/FT OF FENCE) |
|---|---|---|---|
| Balls Branch Mouth | 80 | 5700 | $11,400 |
| Balls Branch West | 144 | 10200 | $20,400 |
| Clarks Run at KY 52 | 24 | 1700 | $3,400 |
| South Second Street | 53 | 3700 | $7,400 |
| US 127 Bypass | 3 | 300 | $600 |
| Corporate Drive | 44 | 3100 | $6,200 |
| Total | 234 | 24700 | $49,400 |

In the urban areas of Stanford Road and South Second Street the high fecal loading from sanitary sewer and other treatment system failures contributes much of the nitrogen loading. Thus, remediation efforts should focus on identifying and correcting these failures and monitoring the subsequent reduction in watershed nitrogen before planning watershed wide remediation techniques. It is recommended that the need for urban nitrogen reduction BMPs be reevaluated after the third year evaluation.

In the rural areas with nitrogen impairments including Balls Branch and US 127 Bypass, sources are primarily due to leaching septic systems, agricultural waste, and fertilizer application. A variety of BMPs can be used to reduce nitrogen levels from these sources. Table 31 (page 75) provides a list of BMPs utilized in the Potomac and Shenandoah Rivers in Virginia with the average pounds of nitrogen reduction per unit year. Agricultural land retirement is the practice of taking highly erodible or sensitive agricultural land out of crop production and/or grazing and converting it by planting with a permanent vegetative cover such as grasses, shrubs and/or trees. Grazing land protection uses rotational grazing practices in combination with watering facilities to minimize direct access to streams. Stream stabilization includes exclusion of grazing livestock from streams by fencing as well as bank stabilization. Cover crops, such as rye, wheat, or barley, are planted in the early fall without fertilization. In this way, leftover nitrogen from row crop fertilization does not leach into the soil and groundwater. It also reduces wintertime erosion of the soil. Grass filter strips or woodland buffers are established in the riparian area to filter runoff of sediment and nutrients from adjacent land uses. Livestock waste storage in structures or lagoons reduces nutrient loads that would otherwise enter the stream through runoff.

In combination, these BMPs should be applied over the rural areas in order to meet reduction goals over a five-year period. Some BMPs may reduce both *E. coli* and nitrogen levels. For example, if 14,000 feet of fencing are used to reduce cattle fecal contribution in Balls Branch West, an estimated 840 lbs/year (or about half of the reduction goal for nitrogen) may also be achieved in that watershed area. Similar calculations may be made in other subwatersheds to estimate reductions necessary, but the final number of BMPs to be implemented will ultimately be determined by the reduction achieved subsequent to BMP implementation.

TABLE 31 – TOTAL NITROGEN REDUCTION FROM AGRICULTURAL BMPS IN A VIRGINIA WATERSHED

| AGRICULTURAL BMPS | UNIT | COVERAGE | TOTAL NITROGEN REDUCTION (LBS/YEAR) | TOTAL NITROGEN REDUCTION (LBS/UNIT/YEAR) |
|---|---|---|---|---|
| Agricultural Land Retirement | acres | 27,445 | 282,530 | 10.29 |
| Grazing Land Protection | acres | 65,964 | 190,187 | 2.88 |
| Stream Fencing | linear foot | 246,370 | 15,635 | 0.06 |
| Streambank Stabilization | linear foot | 34,895 | 13,834 | 0.40 |
| Cover Crops | acres | 45,699 | 205,411 | 4.49 |
| Grass Filter Strips | acres | 2,013 | 20,932 | 10.40 |
| Woodland Buffer Filter Area | acres | 1,586 | 32,981 | 20.80 |
| Animal Waste Control Facilities | systems | 422 | 464,333 | 1100.32 |
| Agricultural Nutrient Management | acres | 429,187 | 1,207,809 | 2.81 |

Adapted from Virginia Department of Conservation and Recreation, "Achieving the Nonpoint Source Pollution Reduction Goal for the Shenandoah and Potomac Rivers in Virginia" (2001).

Because most of the riparian impacts are located in rural areas and because urban impacts would be difficult to re-vegetate due to the density of housing and roadways in close proximity in the stream, only habitat impacts in rural areas are addressed with BMPs. However, city-sponsored or community volunteer-led reforestation projects along urban riparian zones are encouraged. In agricultural areas, the riparian corridor may be reestablished in multiple ways including fencing, tree planting, or mowing restrictions. Some fencing is planned in order to address cattle fecal contributions, so additional benefits will be gained if volunteer tree species are allowed to grow in this riparian area. If additional trees are planted, the NRCS cost share practice specifies that an 8-foot by 8-foot spacing is preferable for seedlings (NRCS 2003). At this spacing, tree planting would require 538 seedlings per acre, or 3,911 per stream mile, assuming a 30-foot riparian zone on both banks. At a cost of approximately $50 per 100 seedlings, riparian zone reforestation would cost approximately $195,550 per mile of stream (excluding labor). Because riparian restoration is a lower priority for this watershed, additional tree plantings are not recommended at this time. Riparian reestablishment should be pursued through fencing and cattle restriction.

To reduce the velocity of water in the stream, a rain garden program should be pursued as well as retention basins, water infiltration BMPs, and stream restoration in areas of sufficient stream length. One stream restoration possibility is the unnamed tributary flowing into Clarks Run near Corporate Drive.

### *4.3. Expected Outcomes and Load Reductions*

The numerical load reductions expected to be achieved through the BMP implementation are summarized in Table 32 (page 76). Interim goals of reduction over 1, 3, and 7 year time periods are specified in terms of either *E. coli* loading or length of stream habitat restored. These load reductions were calculated based on the methods indicated in Sections 3 and 4.2. The loading reduction in each interim goal are the expected loading reductions during that period. When livestock are excluded from the stream, it is assumed that the riparian area inside the fenced area will remain unmowed and either planted with trees or allowed to be populated with volunteer tree species, which will gradually increase the stream shading.

TABLE 32 – LOAD REDUCTIONS BY OBJECTIVE

| WATERSHED AREA | INDICATORS TO MEASURE PROGRESS | TARGET VALUE (REACH SPECIFIC) | INTERIM GOALS SHORT-TERM < 1 YEAR | MID-TERM 1-3 YEARS | LONG-TERM 3-7 YEARS |
|---|---|---|---|---|---|
| **Objective 1:** Reduce human fecal inputs | | | | | |
| Balls Branch Mouth | *E. coli* | 10.9 trillion CFU/yr | - | 10.9 | - |
| Balls Branch West | | 27.8 trillion CFU/yr | 21.3 | 3.3 | 3.2 |
| Clarks Run at KY 52 | | 3.25 trillion CFU/yr | - | 3.25 | - |
| Stanford Road | | 45.4 trillion CFU/yr | 6.5 | 13.0 | 25.9 |
| South Second Street | | 28.8 trillion CFU/yr | 4.1 | 8.2 | 16.5 |
| US 127 Bypass | | 0.2 trillion CFU/yr | - | 0.2 | - |
| Corporate Drive | | 2.6 trillion CFU/yr | - | 2.6 | - |
| **Objective 2:** Reduce fecal inputs from livestock | | | | | |
| Balls Branch Mouth | *E. coli* | 10.9 trillion CFU/yr | 1.5 | 3.0 | 6.4 |
| Balls Branch West | | 19.7 trillion CFU/yr | 3.3 | 6.6 | 9.8 |
| Clarks Run at KY 52 | | 3.3 trillion CFU/yr | 0.5 | 1 | 1.8 |
| South Second Street | | 7.2 trillion CFU/yr | 1.0 | 2.0 | 4.2 |
| US 127 Bypass | | 0.5 trillion CFU/yr | - | 0.5 | - |
| Corporate Drive | | 6.0 trillion CFU/yr | - | 3.0 | 3.0 |
| **Objective 3:** Reduce algal blooms and eutrophication by decreasing nitrogen and phosphorus loading. | | | | | |
| Danville WWTP | Total Phosphorus | < 0.3 mg/L | Subsequent to new permit | | |
| Danville WWTP | Total Nitrogen | < 2.0 mg/L | | | |
| Balls Branch Mouth | | 11200 lbs/yr | 1600 | 3200 | 6400 |
| Balls Branch West | | 5500 lbs/yr | 750 | 1500 | 3250 |
| Stanford Road US-150 | | 1400 lbs/yr | 200 | 400 | 800 |
| S 2nd Street | | 16700 lbs/yr | 2500 | 5000 | 9200 |
| US 127 Bypass | | 9000 lbs/yr | 1200 | 2600 | 5200 |
| Corporate Drive | | 300 lbs/yr | 50 | 100 | 150 |
| **Objective 4:** Increase the riparian vegetated width. | | | | | |
| Balls Branch Mouth | Length of stream improved | 2850 lin. feet | 400 | 800 | 1650 |
| Balls Branch West | | 5100 lin. feet | 600 | 1500 | 3000 |
| Clarks Run at KY 52 | | 850 lin. feet | 100 | 250 | 500 |
| South Second Street | | 1850 lin. feet | 350 | 700 | 800 |
| US 127 Bypass | | 150 lin. feet | 100 | 50 | - |
| Corporate Drive | | 1550 lin. feet | 300 | 600 | 650 |

In order to monitor whether load reductions are achieved, monitoring for *E. coli*, total nitrogen, and stream discharge should be conducted subsequent to these time periods. The Boyle County Engineer in conjunction with the local NRCS offices should track improvements to the riparian corridor. The Interim Goals in Table 32 assume a rate of 1,500 feet of stream per year in the Clarks Run watershed will be addressed by cost share practices. At this rate, about 1.8 miles would be addressed over this time period. While this is far short of the total length of stream requiring improvement, this length of stream habitat improvement is the maximum expected to be feasible within this time period.

## 5. ORGANIZATION

As listed in Table 29 (pages 64 through 72), the implementation of the BMPs will include many individuals, agencies, officials, and volunteers:

- Bluegrass PRIDE
- Boyle County Engineer
- Boyle County Health Department
- Boyle County Library
- Boyle County Schools
- Cattle Farmers
- Centre College
- Clarks Run Watershed Focus Group
- Clarks Run Environmental and Educational Corporation (CREEC)
- Danville's City Engineer
- Danville's Trail Commission
- Danville's Wastewater Utility
- Danville's Stormwater Program
- Dix River Watershed Council
- Healthy Planet Initiatives
- Herrington Lake Conservation League (HLCL)
- Kentucky Division of Water
- Kentucky River Watershed Watch
- Kentucky Transportation Cabinet
- Landowners
- Natural Resources Conservation Service (NRCS)
- Third Rock Consultants
- University of Kentucky Water Resource Research Institute (UKWRRI)

The overall coordination of these groups will be spearheaded by the Clarks Run Focus Group and the Dix River Watershed Council.

## 6. MONITORING PLAN

The goal of this watershed plan is to improve the water quality of the Clarks Run watershed. Extensive background data has been collected in order to generate this document, but in order to evaluate progress on the effectiveness of the BMP implementation, additional data collection will be necessary. Should additional Section 319(h) grant funding be sought for this proposed data collection effort, a Quality Assurance Project Plan meeting federal standards would need to be provided.

Three types of monitoring are necessary to ensure effective remediation of impairments in Clarks Run: a human fecal source survey, benthic macroinvertebrate survey, and ongoing monitoring of the effectiveness of implemented BMPs. A description of each of these monitoring plans follows.

### *6.1. Human Fecal Source Survey*

In order to locate the sources of sanitary sewer, septic system failure, and illicit discharge, a visual field survey of the impaired area streams during low flow conditions should be conducted to detect obvious signs of failure. Pooling water, muddy soil, or strips of bright green grass are all signs of septic system failure, as is odor. Illicit discharges or sewer exfiltration can often be detected by signs of dry weather flow, suds, sewage, black staining, oil, and gas. During visual field observation a conductivity meter should be used to track jumps or drops in conductivity while walking the stream. Conductivity will typically be higher downstream and lower upstream of a system failure.

Once suspected locations of human fecal input are detected, a combination of *E. coli*, discharge, rainfall, and optical brightener sampling should be conducted to determine a confirmation of source areas. Optical brighteners are fluorescent white dyes added to detergents that may be used as signs of sanitary treatment system failure. The Optical Brightener Handbook http://www.8tb.org/projects/optbright_gs1.htm is written to allow citizen groups to conduct optical brightener surveys at a relatively inexpensive price (approximately $500 for supplies). However, because of the resources required to conduct the sampling effort, a private environmental consulting firm will likely need to be hired through a combination of city stormwater fees and/or grant funding.

### *6.2. Aquatic Biology Survey*

In order to monitor the biological indicators of health, benthic macroinvertebrate surveys should be conducted at three locations (one on Balls Branch, one above the WWTP, and one below the WWTP within the urban limits). Sampling should be conducted in year 1 prior to BMP improvements in order to establish a baseline, and be monitored at the 1-year, 3- year, 7-year, and 20-year milestones thereafter to measure improvements over time. Funding for sampling is to be provided by the City of Danville and the Boyle County Government.

The macroinvertebrate community at each station should sampled using methods developed by KDOW (KDOW 2008b). The semi-quantitative sampling method will involve the collection of two separate samples, riffle and multihabitat, at each station. The riffle sample should consist of four 0.25 $m^2$ samples collected from two separate riffles at each station. Riffle collections at each station should be composited to form one semi-quantitative sample. The qualitative, multihabitat sample should include three leafpacks; three jabs (with dipnet) in sticks/wood; three jabs in soft sediment; three jabs into undercut banks/submerged roots; three jabs into aquatic macrophyte beds; hand-picking of 15 rocks (large cobble/small boulder) from riffles, runs and pools; and visual searches of approximately 10 to 20 linear feet of large woody debris. Sub-samples from each qualitative microhabitat should be combined to form one composite sample for each station. Samples are to be preserved in 95 percent ethanol and returned to the laboratory for processing and identification. Identification should be performed on random 300-specimen subsamples from the riffle and multihabitat samples as described by KDOW (2008b). All organisms should be identified to the lowest possible taxonomic level so that macroinvertebrate community metrics can be calculated. A rapid bioassessment of habitat should also be assessed in conjunction with macroinvertebrate sampling.

### *6.3. Implementation Effectiveness Survey*

In order to measure the effectiveness of individual BMPs, monitoring should be performed both pre- and post-BMP implementation in order to assess the effectiveness of the practice. Depending on the expected loading reduction, total nitrogen or *E. coli* samples should be collected along with a measurement of flow so that loading may be calculated.

To monitor project wide progress on reduction goals, eight sites should be monitored during routine flow conditions (not critically low or storm flows) at the mouth of each of the subwatershed areas identified in Exhibit 13 (page 56). Three collection events should be conducted over a two month period at the end of 1, 3, and 7 years from the implementation of the watershed based plan to measure progress on achieving the project goals. Discharge, *E. coli,* and total nitrogen should be collected at each site and analyzed at an environmental laboratory for loading calculations. The loading from upstream site locations should be subtracted from downstream sites in order to allow the calculation of loading by watershed reach. Sampling will be conducted by CREEC and KRWW with reports published online and presented to the Clarks Run Watershed Focus Group.

Field observations and measurements provide data valuable for water quality assessment and modeling. Field sample collection directly affects the analytical results generated. The following standards apply to all data collection:

- All field measurements and sampling are to be performed such that the sample taken is representative of the stream sampled.
- Trained individuals shall collect all field data.
- During sampling, datasheets are used to record visual status of the habitat.
- GPS positioning and photographs are taken to accurately locate the sampling stations.
- Chain of Custody forms for samples are to be properly completed and maintained.
- Samples shall be protected by proper packing and transportation, preservation, and handling techniques before analysis.
- Flow computations will be based on velocity measurements at intervals across the stream cross-section.
- Any applicable field equipment will be calibrated regularly in accordance with the manufacturer's instructions.

# 7. EVALUATION PLAN

## *7.1. Approach*

At minimum, the implementation plan addressed in this watershed plan should be addressed at each of the interim goal periods: 1, 3, and 7 years after the publication of this document. The Clarks Run Focus Group and all partners in implementation should meet with KDOW to evaluate the success of this implementation plan. At this meeting, the effectiveness of the BMPs will be evaluated and alternative approaches will be considered where effectiveness or feasibility is minimal. The watershed plan is intended to be a living document, so developments in the watershed, new or changing partners and stakeholders, and even shifts in goals will need to be incorporated into the plan as time progresses.

## *7.2. Implementation*

At these interim evaluation meetings, the progress on the Action Items listed in Section 4 will be evaluated. This evaluation could include examining if the action is achieving its desired goal and/or determine whether the indicator or the stakeholder involved is the most effective for the task. As time passes, certain action items may also decrease in importance and may no longer need to be pursued. Other action items may need to be added to address developing issues, objectives, and goals. The effectiveness and frequency of the monitoring results should also be discussed during this evaluation meeting.

### *7.2. Adaptive Management*

As time progresses, the willingness of certain stakeholders to continue participation may change and other stakeholders may desire ways in which they can participate in the watershed improvement. Certain water quality goals may be quickly achieved while others may be found to be out of range. Changing concerns of stakeholders and participants should be noted and incorporated into the watershed plan along it to be flexible in addressing the changing concerns of the community.

## 8. PRESENTATION

This plan will be presented to political leaders, stakeholders, and the public through three means. A physical presentation of the plan will be given to the Clarks Run Watershed Focus Group, and other groups as deemed appropriate. A copy of the plan will be placed in the Boyle County Public Library and in Danville City Hall. The plan will also be posted online at www.dixriverwatershed.org. As updates to the plan occur, updated versions of the plan and associated documents will be maintained at these three locations.

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# APPENDICES

# APPENDIX A – SWAPP LIST OF CONTAMINANT SOURCES WITH SUSCEPTIBILITY RATING

# List of Contaminant Sources with Susceptibility Rating

## PWS ID: 0110097 System Name: DANVILLE CITY WATER WORKS

## Withdrawal ID Type: WaterWithdrawal ID (Surface Water)

**Withdrawal Source Information:**

**Withdrawal ID: 0213** **Latitude: 37.69389** **Longitude: -84.73389** **Collection Method: INT**

**Status: Active** **Area Dev. District: Bluegrass Area Development District** **County: BOYLE**

**Comments: This withdrawal source is located in a large reservoir.**

**Contaminant Source Information:**

| Site ID | Type | Name | Address | Quantity | Zone | Proximity Value | Contaminant Value | Likelihood of Release Value | Hydrologic Sensitivity | Numeric Rating | Susceptibility Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 494090_00 | Causes Rated High (305B) | Herrington Lake, Segment: Herrington Lake | County: GARRARD, MERCER, Basin: Kentucky River | 1 | 1 | 3 | 3 | 3 | 5 | 18 | High |
| Statewide | Row Crops (Land Cover) | Statewide Coverage of Row Crops (Land Cover) for Kentucky | The whole Kentucky state | 1 | 1 | 3 | 3 | 3 | 5 | 18 | High |
| 4267 | Superfund Sites - Active | City of Danville mercury release | Mailing/Site Address: DANVILLE, KY 40422, County Name: BOYLE | 1 | 1 | 3 | 3 | 3 | 5 | 18 | High |
| Statewide | Forest/Woodlands (Land Cover) | Statewide Coverage of Deciduous Forest (Land Cover) for Kentucky | The whole Kentucky state | 1 | 1 | 3 | 2 | 2 | 5 | 14 | Medium |
| Statewide | Forest/Woodlands (Land Cover) | Statewide Coverage of Evergreen Forest (Land Cover) for Kentucky | The whole Kentucky state | 1 | 1 | 3 | 2 | 2 | 5 | 14 | Medium |
| Statewide | Forest/Woodlands (Land Cover) | Statewide Coverage of Mixed Forest (Land Cover) for Kentucky | The whole Kentucky state | 1 | 1 | 3 | 2 | 2 | 5 | 14 | Medium |
| KY-34 | Major Roads (Interstates, Parkways, State Roads, and US Highways) 1 | KY-34 | Passing through (counties): BOYLE, GARRARD | 1 | 1 | 3 | 2 | 2 | 5 | 14 | Medium |
| Statewide | Pasture and Hay (Land Cover) | Statewide Coverage of Pasture & Hay (Land Cover) for Kentucky | The whole Kentucky state | 1 | 1 | 3 | 2 | 2 | 5 | 14 | Medium |
| Statewide | Power Lines with potential herbicide usage | Statewide Powerline of KY | The whole Kentucky state | 1 | 1 | 3 | 2 | 2 | 5 | 14 | Medium |
| KYV021003 | UIC Class 1, 2, and 5: 4 | STONEY POINT PIEDESTINARIAN BAPTIST CHURCH | Mailing/Site Address: OLD LEXINGTON ROAD, DANVILLE, KY 40422 | 1 | 1 | 3 | 2 | 2 | 5 | 14 | Medium |
| 494090_00 | Causes Rated High (305B) | Herrington Lake, Segment: Herrington Lake | County: GARRARD, MERCER, Basin: Kentucky River | 1 | 2 | 2 | 3 | 3 | 5 | 16 | High |
| Statewide | Row Crops (Land Cover) | Statewide Coverage of Row Crops (Land Cover) for Kentucky | The whole Kentucky state | 1 | 2 | 2 | 3 | 3 | 5 | 16 | High |
| Statewide | Urban and Recreational Grasses (Land Cover) | Statewide Coverage of Urban & Recreational Grasses (Land Cover) for Kentucky | The whole Kentucky state | 1 | 2 | 2 | 3 | 3 | 5 | 16 | High |

| Site ID | Type | Name | Address | Quantity | Zone | Proximity Value | Contaminant Value | Likelihood of Release Value | Hydrologic Sensitivity | Numeric Rating | Susceptibility Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| KYR000020 | Waste generator or transporter - no significant violation history | SKYWAY SYSTEMS INC | Mailing/Site Address: 2100 GLOBAL WAY, BLDG A9, HEBRON, KY 41048, County Name: BOONE | 1 | 2 | 2 | 3 | 1 | 5 | 14 | Medium |
| KYG400035 | KPDES Permit - Subdivision, School, Small Sewage Plant, Permitted Waste | WESTERFIELD RESIDENCE | | 1 | 2 | 2 | 2 | 3 | 5 | 13 | Medium |
| Statewide | Forest/Woodlands (Land Cover) | Statewide Coverage of Deciduous Forest (Land Cover) for Kentucky | The whole Kentucky state | 1 | 2 | 2 | 2 | 2 | 5 | 12 | Medium |
| Statewide | Forest/Woodlands (Land Cover) | Statewide Coverage of Evergreen Forest (Land Cover) for Kentucky | The whole Kentucky state | 1 | 2 | 2 | 2 | 2 | 5 | 12 | Medium |
| Statewide | Forest/Woodlands (Land Cover) | Statewide Coverage of Mixed Forest (Land Cover) for Kentucky | The whole Kentucky state | 1 | 2 | 2 | 2 | 2 | 5 | 12 | Medium |
| KY-1355 | Major Roads (Interstates, Parkways, State Roads, and US Highways) 1 | KY-1355 | Passing through (counties): GARRARD | 1 | 2 | 2 | 2 | 2 | 5 | 12 | Medium |
| KY-34 | Major Roads (Interstates, Parkways, State Roads, and US Highways) 1 | KY-34 | Passing through (counties): BOYLE, GARRARD | 1 | 2 | 2 | 2 | 2 | 5 | 12 | Medium |
| Statewide | Pasture and Hay (Land Cover) | Statewide Coverage of Pasture & Hay (Land Cover) for Kentucky | The whole Kentucky state | 1 | 2 | 2 | 2 | 2 | 5 | 12 | Medium |
| Statewide | Power Lines with potential herbicide usage | Statewide Powerline of KY | The whole Kentucky state | 1 | 2 | 2 | 2 | 2 | 5 | 12 | Medium |
| KYV079001 | UIC Class 1, 2, and 5: 4 | PLEASANT GROVE CHRISTIAN CHURCH | Mailing/Site Address: 394 HWY 34, LANCASTER, KY 40444, Phone: 8595484122, Contact: LEWIS SMITH | 1 | 2 | 2 | 2 | 2 | 5 | 12 | Medium |
| KYV021003 | UIC Class 1, 2, and 5: 4 | THE PRO SHOP/OLD BRIDGE GOLD COURSE | Mailing/Site Address: OLD BRIDGE ROAD, HWY 34, DANVILLE, KY 40422 | 1 | 2 | 2 | 2 | 2 | 5 | 12 | Medium |
| 011_B00005 | Bridges and Culverts | Bridge Number B00005 on KY-3042 (BRIDGE OVER HERRINGTON LAKE) | County: 011 (Boyle), Location: ON GARRARD - BOYLE CL | 1 | 3 | 1 | 3 | 3 | 5 | 14 | Medium |
| 011_B00007 | Bridges and Culverts | Bridge Number B00007 on KY-52 (LANCASTER ROAD) | County: 011 (Boyle), Location: 1 MI E-OF JCT US 150BUS. | 1 | 3 | 1 | 3 | 3 | 5 | 14 | Medium |
| 011_B00030 | Bridges and Culverts | Bridge Number B00030 on | County: 011 (Boyle), Location: .40 MI NOR. OF JCT KY 52 | 1 | 3 | 1 | 3 | 3 | 5 | 14 | Medium |
| 011_B00053 | Bridges and Culverts | Bridge Number B00053 on KY-34 (BROOMFIELD, MITCHELLSBURG, PARKSVILLE) | County: 011 (Boyle), Location: @ GARRARD CO LINE | 1 | 3 | 1 | 3 | 3 | 5 | 14 | Medium |
| 489554-02_ | Causes Rated High (305B) | Clarks Run, Segment: 4.3 to 6.6 (Unanamed tirbutary to Danville POTW) | County: BOYLE, Basin: Kentucky River | 1 | 3 | 1 | 3 | 3 | 5 | 14 | Medium |

| Site ID | Type | Name | Address | Quantity | Zone | Proximity Value | Contaminant Value | Likelihood of Release Value | Hydrologic Sensitivity | Numeric Rating | Susceptibility Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 494090_00 | Causes Rated High (305B) | Herrington Lake, Segment: Herrington Lake | County: GARRARD, MERCER, Basin: Kentucky River | 1 | 3 | 1 | 3 | 3 | 5 | 14 | Medium |
| Statewide | Row Crops (Land Cover) | Statewide Coverage of Row Crops (Land Cover) for Kentucky | The whole Kentucky state | 1 | 3 | 1 | 3 | 3 | 5 | 14 | Medium |
| Sewer System | Sewer Lines (Sewer Systems) | Owner Name: DANVILLE MUNICIPAL SEWER | County Name: Boyle | 1 | 3 | 1 | 3 | 3 | 5 | 14 | Medium |
| TIER II-46 | Tier II: Hazardous Chemical Use | AT&T | Address: DANVILLE POP, 1950 GOGGIN ROAD, DANVILLE, KY 40422, County Name: BOYLE | 1 | 3 | 1 | 3 | 3 | 5 | 14 | Medium |
| TIER II-818 | Tier II: Hazardous Chemical Use | CITY OF DANVILLE | Address: WATER FILTRATION FACILITY, 387 EAST LEXINGTON AVENUE, DANVILLE, KY 40422, County Name: BOYLE | 1 | 3 | 1 | 3 | 3 | 5 | 14 | Medium |
| Statewide | Urban and Recreational Grasses (Land Cover) | Statewide Coverage of Urban & Recreational Grasses (Land Cover) for Kentucky | The whole Kentucky state | 1 | 3 | 1 | 3 | 3 | 5 | 14 | Medium |
| 1662011-CIF | Underground Storage Tank - with Best Management Practices | DAIRY MART #274 | Mailing/Site Address: 650 E LEXINGTON AVE, DANVILLE, KY 40422 | 1 | 3 | 1 | 3 | 2 | 5 | 13 | Medium |
| 7295011-CR | Underground Storage Tank - with Best Management Practices | LYONS GREENLEAF ASHLAND (ABM #291-012) | Mailing/Site Address: 700 E LEXINGTON RD, DANVILLE, KY 40422 | 1 | 3 | 1 | 3 | 2 | 5 | 13 | Medium |
| KYR000021 | Waste generator or transporter - no significant violation history | COFFMAN SHELL | Mailing/Site Address: 554 LEXINGTON AVE, DANVILLE, KY 40422, County Name: BOYLE | 1 | 3 | 1 | 3 | 1 | 5 | 12 | Medium |
| KYR000022 | Waste generator or transporter - no significant violation history | E N JOHNSON OIL CO | Mailing/Site Address: 1211 LEBANON RD, DANVILLE, KY 40422, County Name: BOYLE | 1 | 3 | 1 | 3 | 1 | 5 | 12 | Medium |
| KYR000014 | Waste generator or transporter - no significant violation history | ROBERTSON'S SERVICE STATION | Mailing/Site Address: 9465 US HWY 27 S, WAYNESBURG, KY 40489, County Name: LINCOLN | 1 | 3 | 1 | 3 | 1 | 5 | 12 | Medium |
| 489554-01_ | Causes Rated Medium (305B) | Clarks Run, Segment: 0.0 to 4.3 (Mouth to Unnamed tributary (at Danville CC)) | County: BOYLE, Basin: Kentucky River | 1 | 3 | 1 | 2 | 3 | 5 | 11 | Medium |
| KY0053431 | KPDES Permit - Subdivision, School, Small Sewage Plant, Permitted Waste | HERRINGTON HAVEN SUBD | | 1 | 3 | 1 | 2 | 3 | 5 | 11 | Medium |
| Statewide | Forest/Woodlands (Land Cover) | Statewide Coverage of Deciduous Forest (Land Cover) for Kentucky | The whole Kentucky state | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| Statewide | Forest/Woodlands (Land Cover) | Statewide Coverage of Evergreen Forest (Land Cover) for Kentucky | The whole Kentucky state | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |

| Site ID | Type | Name | Address | Quantity | Zone | Proximity Value | Contaminant Value | Likelihood of Release Value | Hydrologic Sensitivity | Numeric Rating | Susceptibility Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Statewide | Forest/Woodlands (Land Cover) | Statewide Coverage of Mixed Forest (Land Cover) for Kentucky | The whole Kentucky state | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KY-1273 | Major Roads (Interstates, Parkways, State Roads, and US Highways) 1 | KY-1273 | Passing through (counties): BOYLE, LINCOLN | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KY-1805 | Major Roads (Interstates, Parkways, State Roads, and US Highways) 1 | KY-1805 | Passing through (counties): BOYLE | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KY-3042 | Major Roads (Interstates, Parkways, State Roads, and US Highways) 1 | KY-3042 | Passing through (counties): BOYLE | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KY-3373 | Major Roads (Interstates, Parkways, State Roads, and US Highways) 1 | KY-3373 | Passing through (counties): GARRARD | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KY-34 | Major Roads (Interstates, Parkways, State Roads, and US Highways) 1 | KY-34 | Passing through (counties): BOYLE, GARRARD | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KY-52 | Major Roads (Interstates, Parkways, State Roads, and US Highways) 1 | KY-52 | Passing through (counties): BOYLE, BREATHITT, ESTILL, GARRARD, LARUE, LEE, MADISON, MARION, NELSON | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KY-590 | Major Roads (Interstates, Parkways, State Roads, and US Highways) 1 | KY-590 | Passing through (counties): BOYLE, LINCOLN | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| US-27 | Major Roads (Interstates, Parkways, State Roads, and US Highways) 1 | US-27 | Passing through (counties): BOURBON, CAMPBELL, FAYETTE, GARRARD, HARRISON, JESSAMINE, LINCOLN, MCCREARY, PENDLETON, PULASKI | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| Statewide | Pasture and Hay (Land Cover) | Statewide Coverage of Pasture & Hay (Land Cover) for Kentucky | The whole Kentucky state | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| Statewide | Power Lines with potential herbicide usage | Statewide Powerline of KY | The whole Kentucky state | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| Statewide | Residential (Land Cover) | Statewide Coverage of Low Intensity Residential (Land Cover) for Kentucky | The whole Kentucky state | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KYV079002 | UIC Class 1, 2, and 5: 4 | BRYANT'S CAMP COTTAGES | Mailing/Site Address: BRYANT'S CAMP ROAD, LANCASTER, KY 40444, Contact: JAMES BRYANT | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KYV079002 | UIC Class 1, 2, and 5: 4 | CLIFFVIEW CENTER | Mailing/Site Address: 400 BRYANT'S CAMP ROAD, LANCASTER, KY 40444, Phone: 8597923333 | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |

| Site ID | Type | Name | Address | Quantity | Zone | Proximity Value | Contaminant Value | Likelihood of Release Value | Hydrologic Sensitivity | Numeric Rating | Susceptibility Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| KYV021002 | UIC Class 1, 2, and 5: 4 | CORNERSTONE ASSEMBLY OF GOD | Mailing/Site Address: HWY 34, LEXINGTON ROAD, DANVILLE, KY 40422 | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KYV021002 | UIC Class 1, 2, and 5: 4 | DANVILLE ANIMAL CLINIC | Mailing/Site Address: HWY 34, LEXINGTON ROAD, DANVILLE, KY 40422 | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KYV021001 | UIC Class 1, 2, and 5: 4 | HEDGEVILLE BAPTIST | Mailing/Site Address: 4700 LANCASTER ROAD, DANVILLE, KY 40422 | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KYV021002 | UIC Class 1, 2, and 5: 4 | THE CHURCH OF JESUS CHRIST AND LATTER DAY SAINTS | Mailing/Site Address: WATERWORKS ROAD, DANVILLE, KY 40422 | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| KYV021003 | UIC Class 1, 2, and 5: 4 | THE GENERAL STORE ON 34 | Mailing/Site Address: HWY. 34, LEXINGTON ROAD, DANVILLE, KY 40422 | 1 | 3 | 1 | 2 | 2 | 5 | 10 | Medium |
| 37150 | Oil and Natural Gas Lines | 100 | | 1 | 3 | 1 | 1 | 2 | 5 | 7 | Low |
| 2177 | Oil and Natural Gas Lines | DANVILLE | | 1 | 3 | 1 | 1 | 2 | 5 | 7 | Low |

**Total Count: High = 6 Medium = 57 Low = 2**

# APPENDIX B – KENTUCKY RIVER WATERSHED WATCH STUDY SUMMARY

## APPENDIX B – KENTUCKY RIVER WATERSHED WATCH (KRWW) STUDY SUMMARY*

| Parameter | Units | # Samples | | | | Average Results | | | |
|---|---|---|---|---|---|---|---|---|---|
| Site | | K543 | K240 | K014/K279 | K125 | K543 | K240 | K014/K279 | K125 |
| **Bacteriological** | | | | | | | | | |
| Fecal Coliform | CFU/100mLs | 1 | 4 | 14 | 8 | 6490 | 5250 | 4073 | 7766 |
| *E. coli* | CFU/100mLs | 0 | 1 | 4 | 3 | - | 907 | 1915 | 292 |
| **Nutrient** | | | | | | | | | |
| Total Phosphorus | mg/L | 1 | 3 | 5 | 5 | 0.03 | 0.36 | 0.56 | 0.13 |
| Sulfate | mg/L | 1 | 3 | 7 | 7 | 39.4 | 52.4 | 57.7 | 46.0 |
| **Pesticide/Herbicide** | | | | | | | | | |
| Alachlor | mg/L | 0 | 0 | 1 | 0 | - | - | 0 | - |
| Chloropyrifos | mg/L | 0 | 1 | 0 | 0 | - | 0 | - | - |
| Metolachlor | mg/L | 0 | 1 | 1 | 0 | - | 0.35 | 1.05 | - |
| **Physical/ Chemical** | | | | | | | | | |
| Dissolved Oxygen | mg/L | 3 | 7 | 18 | 14 | 6.6 | 8.3 | 8.0 | 5.0 |
| pH | SU | 3 | 8 | 19 | 10 | 7.5 | 8.0 | 7.9 | 7.5 |
| Temperature | C | 3 | 7 | 21 | 11 | 16 | 19 | 24.2 | 21.5 |
| Chlorides | mg/L | 1 | 3 | 8 | 8 | 28.6 | 167.5 | 214.4 | 24.0 |
| Conductivity | uS/cm | 1 | 4 | 10 | 10 | 576 | 964 | 898.2 | 509.4 |
| Hardness | mg/L | 0 | 2 | 4 | 4 | - | 226 | 231 | 202 |
| Total Organic Carbon | mg/L | 0 | 0 | 1 | 2 | - | - | 7 | 5.31 |
| Total Suspended Solids | mg/L | 1 | 3 | 8 | 8 | 4 | 20.5 | 4.5 | 49.6 |
| **Metals** | | | | | | | | | |
| Aluminum | mg/L | 1 | 3 | 0 | 5 | 0.220 | 0.280 | - | 0.416 |
| Antimony | mg/L | 1 | 3 | 0 | 5 | 0.006 | 0 | - | 0 |
| Arsenic | mg/L | 1 | 3 | 0 | 5 | 0.007 | 0 | - | 0 |
| Barium | mg/L | 1 | 3 | 0 | 5 | 0.050 | 0.043 | - | 0.052 |
| Beryllium | mg/L | 1 | 3 | 0 | 5 | 0.001 | 0 | - | 0 |
| Boron | mg/L | 1 | 3 | 0 | 5 | 0.080 | 0.607 | - | 0.082 |
| Calcium | mg/L | 1 | 3 | 0 | 5 | 75.70 | 73.80 | - | 52.26 |
| Chromium | mg/L | 1 | 3 | 0 | 5 | 0.012 | 0 | - | 0 |
| Cobalt | mg/L | 1 | 3 | 0 | 5 | 0.001 | 0.010 | - | 0.012 |
| Copper | mg/L | 1 | 3 | 0 | 5 | 0.003 | 0 | - | 0.006 |
| Gold | mg/L | 1 | 3 | 0 | 5 | 0.017 | 0 | - | 0 |
| Iron | mg/L | 1 | 3 | 0 | 5 | 0.220 | 0.160 | - | 0.512 |
| Lead | mg/L | 1 | 3 | 0 | 5 | 0.005 | 0 | - | 0 |
| Lithium | mg/L | 1 | 3 | 0 | 4 | 0.002 | 0.139 | - | 0.043 |
| Magnesium | mg/L | 1 | 3 | 0 | 5 | 13.600 | 9.410 | - | 12.886 |
| Manganese | mg/L | 1 | 3 | 0 | 5 | 0.070 | 0.016 | - | 0.133 |
| Nickel | mg/L | 1 | 3 | 0 | 5 | 0.002 | 0.006 | - | 0.004 |
| Phosphorus | mg/L | 1 | 2 | 0 | 2 | 0.030 | 0.300 | - | 0.060 |
| Potassium | mg/L | 1 | 3 | 0 | 5 | 3.800 | 7.950 | - | 5.046 |
| Selenium | mg/L | 1 | 3 | 0 | 5 | 0.006 | 0.000 | - | 0 |
| Silicon | mg/L | 1 | 3 | 0 | 5 | 4.410 | 2.730 | - | 2.346 |
| Silver | mg/L | 1 | 3 | 0 | 5 | 0.002 | 0 | - | 0 |
| Sodium | mg/L | 1 | 3 | 0 | 5 | 20.70 | 92.67 | - | 12.61 |
| Strontium | mg/L | 1 | 3 | 0 | 5 | 0.170 | 0.200 | - | 0.222 |
| Sulfur | mg/L | 1 | 3 | 0 | 5 | 15.80 | 17.99 | - | 11.70 |
| Thallium | mg/L | 1 | 3 | 0 | 5 | 0.021 | 0 | - | 0 |
| Tin | mg/L | 1 | 3 | 0 | 5 | 0.006 | 0 | - | 0 |
| Vanadium | mg/L | 1 | 3 | 0 | 5 | 0.004 | 0.010 | - | 0.008 |

*Site locations are mapped in Section 2.1.8 Exhibit 5 of this document.

# APPENDIX C – KENTUCKY RIVER WATERSHED WATCH CITIZEN'S ACTION PLAN FOR CLARKS RUN

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# CITIZEN ACTION PLAN (CAP)

**Watershed ___________Clark's Run_______________________**
**11 Digit Hydrologic Unit Code (HUC) ___05100205190______________**

## PART 1: ENVIRONMENTAL AND CULTURAL HISTORY

Part 1 of this CAP was prepared by Erman Caudill, Greg Epp, and Lindell Ormsbee of the Kentucky Water Research Institute (University of Kentucky) under contract to the Kentucky River Authority, as a product of the statewide Kentucky Watershed Management process.

OVERVIEW

***Geography.*** The Clarks Run watershed is in southeastern Boyle County. The land is in the inner subregion of the Bluegrass physiographic region, characterized by undulating terrain and moderate rates of both surface runoff and groundwater drainage. The watershed lies partly above fractured shales through which groundwater can easily move but which stores very little water. Other parts lie over interbedded clay shales and siltstones. There are also areas of interbedded shales and limestones (these are 20% limestone; water conduction is poor because of the clay content of the shale) and areas of interbedded limestones and shales (>20% limestone, allowing groundwater flow where the clay content is low enough).

***Waterways.*** Clarks Run empties into the Dix River east of Danville, near Little Needmore. Among the creeks that feed it is Balls Branch.

***Land and water use.*** Land in the watershed is more than 80% agricultural. It includes the southern half of Danville, and therefore is about 8% residential, and about 8% commercial or industrial. Five businesses and organizations hold permits for discharges into the creeks. See tables for details.

***Agency data assessment.*** Three assessed segments of Clarks Run include one that does not support its designated uses, based on biological and/or water-quality data. One fully supports its uses, and one only partially supports its uses. Organic enrichment from municipal point sources, urban runoff, and storm sewers contribute to the impairment of these streams. Pesticides from urban runoff also contribute in the nonsupporting segment. See tables for details.

***Watershed rankings.*** The ranking formula provides a preliminary ranking by synthesizing a broad spectrum of watershed characteristics, current conditions, and threats. This watershed ranks in the group with the lowest need for protection and/or restoration. This rating is for the watershed on average: particular sites and particular waters within the watershed may vary widely. See tables for details.

***Volunteer data.*** Data show high levels of bacteria indicative of fecal contamination in Clarks Run (above 200 colonies/ml). A significant amount of the triazine herbicide atrazine was detected (>1 microgram per liter); however, the concentration of atrazine was well below the EPA’s maximum contaminant level of 3 micrograms per liter. See tables for details.

WATERSHED DESCRIPTION TABLES

*Watershed Name:* Clarks Run *11-Digit Watershed Identity Number:* 05100205190



## *Summary of Basin Characteristics and Facilities*

### *General Land-use Characteristics:*

*Total Land Area (Acres):* 18,223

| | Acres | % of Total |
|---|---|---|
| *Residential Area:* | 1,441 | 7.9 |
| *Commercial Area:* | 1,201 | 6.6 |
| *Industrial Area:* | 180 | 1.0 |
| *Agricultural Area:* | 14,959 | 82.1 |
| *Rural and Wooded Area:* | 288 | 1.6 |
| *Other Land-use Area:* | 146 | 0.8 |

| | |
|---|---|
| *Number of Mine Permits:* | 0 |
| *Total Permitted Mining Area (Acres):* | 0 |
| *Number of Identified Wetland Areas:* | 6 |
| *Total Wetland Area (Acres):* | 4 |

### *Withdrawal and Discharge Sites:*

| | |
|---|---|
| *Number of Public Water Supplies and Water Withdrawal Sites:* | 1 |
| *Surface Water Withdrawals:* | 1 |
| *Groundwater Withdrawals:* | 0 |
| *No. of Potable Water Treatment Facilities:* | 0 |
| *Number of KPDES Discharge Permits:* | 10 |

### *Sampling Site Statistics:*

| | |
|---|---|
| *Number of USGS Gaging Stations:* | 0 |
| *Number of Kentucky Division of Water Sampling Sites:* | 0 |
| *Number of Kentucky Dept. of Fish and Wildlife Sampling Sites:* | 0 |
| *Number of US Forest Service Sampling Sites:* | 0 |
| *Number of US Army Corps of Engineers Sampling Sites:* | 0 |
| *Number of Kentucky River Watershed Watch Sampling Sites:* | 1 |
| *Number of Lexington-Fayette Urban Co. Gov. Sampling Sites:* | 0 |

*Watershed Name:* Clarks Run *11-Digit Watershed Identity Number:* 05100205190

## *Watershed Indicators and Ranking Categories:*

| Protection Ranking | Observed Impacts | Potential Impacts | Restoration Ranking | Overall Watershed Ranking |
|---|---|---|---|---|
| Medium | Low | High | Low | Low |

### *Protection Categories:*

| *Indicator* | *Value* | *Units* | *Range of All Watersheds* | *Mean of All Watersheds* |
|---|---|---|---|---|
| Wetland Areas | 4 | Acres | 0 - 106 | 12 |
| Surface Drinking Water Sources | 1 | No. of sources | 0 - 14 | 2 |
| Ground Drinking Water Sources | 0 | No. of sources | 0 - 17 | 1 |
| Groundwater Sensitivity | 3.78 | Score | 2 - 5 | 3.21 |
| KY Dept. of Fish and Wildlife Management Areas | 0 | Acres | 0 - 2951 | 93 |
| U.S. Forest Service Management Areas | 0 | Acres | 0 - 155253 | 12,600 |
| Kentucky State Park Areas | 0 | Acres | 0 - 1928 | 42 |
| Nature Preserves Commission Areas | 0 | Acres | 0 - 1430 | 32 |
| Nature Conservancy Areas | 0 | Acres | 0 - 2473 | 28 |
| Reference Reach Watersheds | 0.00 | Score | 0 - 100 | 3.08 |
| Outstanding Resource Watersheds | 0.00 | Score | 0 - 0 | 0.00 |
| Recognized Stream Resources | 0 | No. of resources | 0 - 8 | 1 |
| Kentucky Rivers Assessment Scores | 0.00 | Score | 0 - 11 | 1.80 |

### *Observed Impact Categories:*

#### *Human Health Impact Categories:*

| *Indicator* | *Value* | *Units* | *Range of All Watersheds* | *Mean of All Watersheds* |
|---|---|---|---|---|
| Flood Declarations | 1 | Number since 1970 | 0 - 10 | 4 |
| Water Supply Inadequacy | 0.00 | Score | 0 - 2 | 0.22 |
| Observed Impacts to Surface Drinking Water | 1.00 | Score | 1 - 1 | 1.00 |
| Observed Impacts to Fish Consumption | 1.00 | Score | 1 - 1 | 1.00 |
| Observed Impacts to Primary Water Contact | 1.00 | Score | 1 - 3 | 1.33 |
| Contamination Sites Impacting Human Health | 1 | Number of sites | 0 - 71 | 4 |

#### *Ecological Health Impact Categories:*

| *Indicator* | *Value* | *Units* | | |
|---|---|---|---|---|
| Observed Impacts to Aquatic Life | 1.64 | Score | 1 - 3 | 1.31 |
| Contamination Sites Impacting Ecological Health | 1 | Number of sites | 0 - 71 | 4 |

### *Potential Impact Categories:*

| *Indicator* | *Value* | *Units* | *Range of All Watersheds* | *Mean of All Watersheds* |
|---|---|---|---|---|
| Potential Contamination Sites | 8 | Number of sites | 1 - 121 | 12 |
| Potential Pesticide Loading | 17 | Est. sales in tons | 0 - 45 | 10 |
| Potential Fertilizer Loading | 399 | Est. tons applied | 0 - 2747 | 394 |
| Agricultural Erosion Potential | 3.41 | Est. tons erosion / acre | 0 - 9 | 3.20 |
| Livestock Operations Potential Impact | 8,035 | Animal units | 55 - 43826 | 7,021 |
| KPDES Discharge Violations | 18 | Number of violations | 0 - 541 | 39 |
| KY Division of Water Citizen Complaints | 3 | Number of complaints | 0 - 53 | 9 |
| Toxic Release Inventory | 1,000 | Score | 0 - 11547626 | 231,638 |
| Population Change Projection | 798 | Number of persons | -149 - 11030 | 448 |
| Population Not on Public Sewer Systems | 524 | Number of persons | 12 - 4511 | 1,114 |
| Mining Area | 0 | Acres | 0 - 6305 | 355 |
| Surface Water Runoff Potential | 73.84 | SCS Curve Number | 60 - 79 | 68 |
| KPDES Permitted Discharges | 10 | Number of sites | 0 - 56 | 6 |

*Watershed Name:* Clarks Run *11-Digit Watershed Identity Number:* 05100205190

## Stream and Waterbody Use Support Summary

| Total Stream Miles: 17.28 | Number of Segments | Stream Miles Assessed | Miles * Fully Supporting | Miles * Partially Supporting | Miles * Not Supporting | Miles * Threatened |
|---|---|---|---|---|---|---|
| *Segments Assessed:* | 3 | 13.9 | 7.3 | 4.3 | 2.3 | 0.0 |
| *Designated Uses* | | | | | | |
| *Aquatic Life:* | 3 | 13.9 | 7.3 | 4.3 | 2.3 | 0.0 |
| *Primary Contact:* | | | | | | |
| *Fish Consumption:* | | | | | | |
| *Drinking Water:* | | | | | | |

** Blank values indicate no assessed segments for this category.*

## Assessed Stream Segments and Waterbodies

| Stream or Waterbody Name * | Starting Milepoint | Ending Milepoint | Segment Length (miles) | Designated Uses * | Overall Level of Support |
|---|---|---|---|---|---|
| Clarks Run | 6.6 | 13.9 | 7.3 | AL | Fully Supporting |
| Clarks Run | 4.3 | 6.6 | 2.3 | AL | Not Supporting |
| Clarks Run | 0 | 4.3 | 4.3 | AL | Partially Supporting |

**Abbreviations: AL - Aquatic Life Support, PC - Primary Contact Recreation, SC - Secondary Contact Recreation, FC - Fish Consumption, DW - Drinking Water Supply, UT - Unnamed Tributary*

## Causes for Nonsupport or Impairment of Designated Uses

| Stream or Waterbody Name * | Starting Milepoint | Ending Milepoint | Segment Length (miles) | Impaired or Threatened Designated Use | Level of Support |
|---|---|---|---|---|---|
| Clarks Run | 0 | 4.3 | 4.3 | Aquatic Life Support | Partially Supporting |

*Possible Causes of Impairment:*
Organic enrichment/Low DO

*Possible Sources For Impairment:*
Major Municipal Point Source, Municipal Point Sources, Urban Runoff/Storm Sewers

| Stream or Waterbody Name * | Starting Milepoint | Ending Milepoint | Segment Length (miles) | Impaired or Threatened Designated Use | Level of Support |
|---|---|---|---|---|---|
| Clarks Run | 4.3 | 6.6 | 2.3 | Aquatic Life Support | Not Supporting |

*Possible Causes of Impairment:*
Organic enrichment/Low DO, Pesticides

*Possible Sources For Impairment:*
Major Municipal Point Source, Municipal Point Sources, Urban Runoff/Storm Sewers

**Abbreviations: UT - Unnamed Tributary*

*Watershed Name:* Clarks Run *11-Digit Watershed Identity Number:* 05100205190

## *Withdrawal Sites and Discharge Facilities:*

### *Public Water Supplies and Water Withdrawal*

| Facility | Origin of Source | Type of Facility | Permit ID Number |
|---|---|---|---|
| DANVILLE COUNTRY CLUB | Surface Water | Water Withdrawal Site | WW1146 |

### *KPDES Permitted Discharge Facilities*

| Facility | Type of Facility | KPDES Site ID Number |
|---|---|---|
| DANVILLE WTP | WATER SUPPLY | KY0090182 |
| DANVILLE WTP | WATER SUPPLY | KYG640084 |
| KTC BOYLE CO MAINT GARAGE | BUS TERMINAL & SERVICE FACILIT | KY0100170 |
| MATSUSHITA APPLIANCE CORP | HOUSEHOLD APPLIANCES, NEC | KY0001139 |
| PHILIPS LIGHTING CO | PRESSED & BLOWN GLASS & GWARE | KY0002607 |
| R R DONNELLEY & SONS CO | COMMERCIAL PRINT, LITHOGRAPHIC | KY0080616 |

## *Gaging Stations and Sampling Sites:*

### *KY River Watershed Watch Sampling Sites*

| Stream Name | KRWW Sample ID No. | Site Description |
|---|---|---|
| Clarks Run | K14 | N37 38' 21" W 84 43' 19" |

*Watershed Name:* Clarks Run *11-Digit Watershed Identity Number:* 05100205190

## Results from 1999 KY River Watershed Watch Sampling:

### Conventional Parameters:

*Sample ID Number:* K14 *Stream:* Clarks Run

**Physical Data (May):**

| | |
|---|---|
| pH | 8.5 |
| Temperature | 17 |
| Dissolved Oxygen | 11.5 |
| Alkalinity | |
| Total Hardness | |
| Chlorides | |
| Conductivity | |
| Total Organic Carbon | |
| Total Suspended Solids | |

**Fecal Data (July / August):**

| | Coliform Count | Strep Count | Coliform/Strep Ratio |
|---|---|---|---|
| July | 1100 | 500 | 2.2 |
| August | 580 | 890 | 0.65 |

Note: Most indicators are in milligrams per liter (mg/L) which is equivalent to parts per million (ppm). Temperature is in Celsius degrees. Alkalinity and hardness are as mg/L of calcium carbonate. Bacterial counts are in colonies per 100 milliliters. Conductivity units are micro-mhos per centimeter.

### Nutrient Parameters:

*Sample ID Number:* K14 *Stream:* Clarks Run

| | | | | | |
|---|---|---|---|---|---|
| Ammonia | | Orthophosphate as Phosphate | | Sulfate | |
| Ammonia Nitrogen | | Orthophosphate as Phosphorus | | | |
| Total Kjeldahl Nitrogen as NH3 | | Total Recoverable Phosphorus | | | |
| Total Kjeldahl Nitrogen as N | | | | | |
| Nitrate | | | | | |
| Nitrate Nitrogen | | | | | |

Note: All indicators are in milligrams per liter (mg/L) which is equivalent to parts per million (ppm).

### Metals and Mineral Parameters:

*Sample ID Number:* K14 *Stream:* Clarks Run

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Aluminum | | Calcium | | Lead | | Selenium | | Thallium | |
| Antimony | | Chromium | | Lithium | | Silicon | | Vanadium | |
| Barium | | Cobalt | | Magnesium | | Sodium | | Zinc | |
| Beryllium | | Copper | | Manganese | | Strontium | | | |
| Boron | | Iron | | Potassium | | Sulfur | | | |

Note: All indicators are in milligrams per liter (mg/L) which is equivalent to parts per million (ppm).

### Pesticide/Herbicide Parameters:

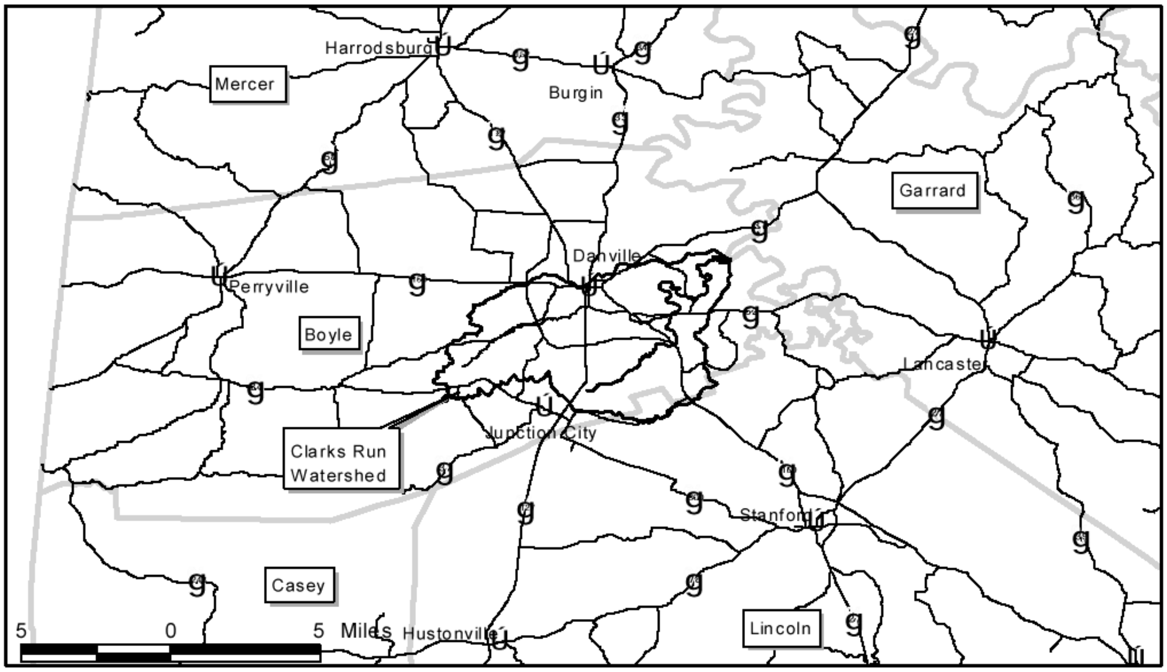
| Sample ID No. | Stream | 2,4-D | Chlorpyrifos | Triazines |
|---|---|---|---|---|
| K14 | Clarks Run | | | 1.05 |

Note: All indicators are in micrograms per liter which is equivalent to parts per billion (ppb).

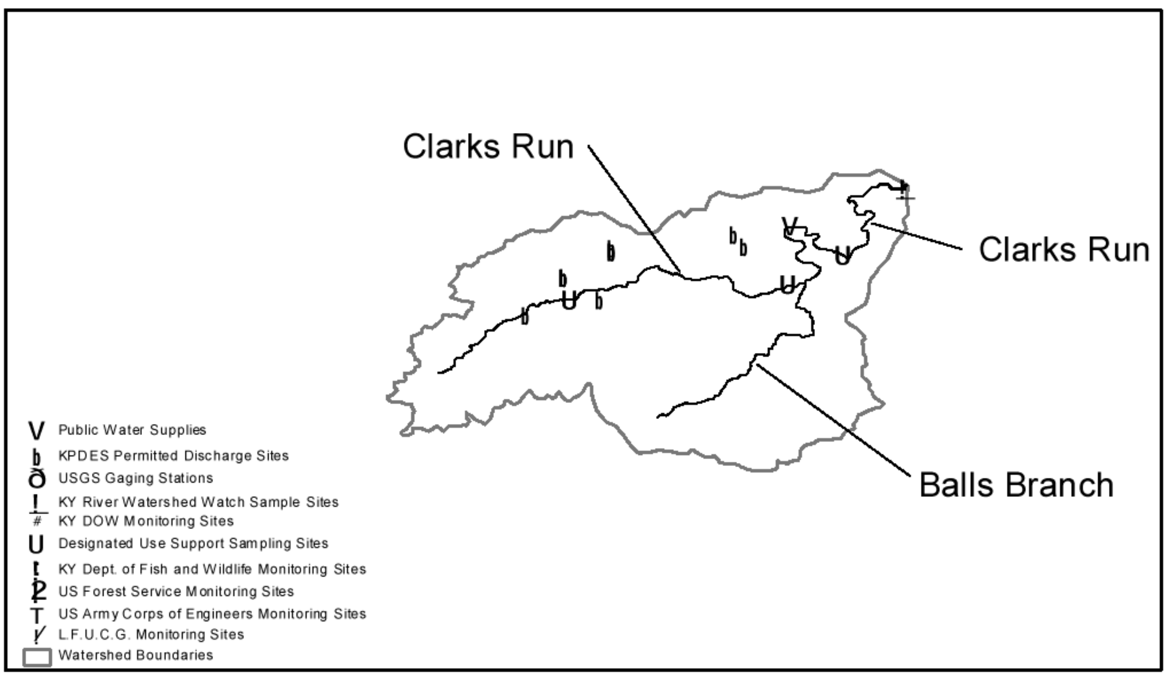
MAPS

# Clarks Run Watershed
# Watershed Number: 05100205190

Location Map




Watershed Features



## **PART 2: CITIZEN / SCIENTIFIC EXAMINATION**

Analysis of data collected between 1997 and 2003 for three sites on Clarks Run (Table1) suggested potential problems and highlighted the need for higher resolution monitoring. Water samples for fecal coliform analysis were taken from Clarks Run yearly at one or more sites each year between 1998 and 2003 (Table 2). Estimated numbers of colony forming units varied dramatically between years and between sites. However, the majority of samples were greater than 200 colonies/100ml, above the maximum concentration for recreational contact. In particular site K14, downstream of the city and the wastewater treatment plant consistently showed high levels of fecal coliform bacteria.

In 2003 the KRWW funded focused sampling for fecal coliform bacteria along the length of Clark's Run. In August 2003 seven sites were sampled (Figure 1) and in October 2003 one upstream site was added for a total of eight sites. In August fecal coliform concentrations were uniformly high across all sites ( > 2000 colonies/100ml). We observed a pattern of increased fecal concentration around site 3 (**upstream** of the wastewater treatment plant) with decreasing concentrations both upstream and downstream of this site. Sampling in October 2003 revealed the same pattern with two exceptions. Overall fecal counts were much lower in October (< 400 colonies/100ml) and the additional upstream site (site 8) showed dramatically higher fecal counts compared to nearby sites. In the October sampling the analysis laboratory at the University of Kentucky conducted a colony morphology study to determine possible sources of fecal contamination. This process utilizes the fact that, as fecal material ages, the number of "atypical" colonies declines at a fairly consistent rate. By assaying the number of atypical compared to typical colonies we can estimate the age of fecal bacteria populations. Very old populations may come from urban or agricultural runoff, while extremely fresh material may come from animals grazing in the creek or untreated human effluent. This analysis showed that the spikes in fecal colony counts at site 3 and site 8 were both associated with a low ratio of atypical bacteria. A low ratio was also measured at site 5, directly downstream of a major storm water drain.

In order to determine parameters that may be important for future study we have provided a preliminary analysis of chemical parameters sampled from this watershed. For each year we collated data from all sites sampled in the Kentucky River watershed. We calculated the values delineating quartiles of the distribution for each chemical parameter (i.e. 25%, 50%, 75%) and compared the values of parameters from Clarks Run samples to the values for the 3$^{rd}$ quartile of the combined data set. In this way we could identify parameters that showed values higher than 75% of all sites sampled in the Kentucky River Basin in each year (Table 3). Our analysis shows that site K14 had high concentrations of nutrients such as nitrate, phosphate, and ammonia and also had high concentrations of organic carbon. Although we have far fewer data for K125 and K180, it appears that these sites do not show particularly high nutrient concentrations. However, organic carbon and suspended solids are a potential problem at these sites.

Table1. Sampling sites

| Site Code | Stream | Latitude (dec.deg.) | Longitude (dec.deg.) | Years sampled |
|---|---|---|---|---|
| K14 | Clarks Run (downstream of Danville) | 37.65786 | -84.70554 | 1997-2003 |
| K125 | Clarks Run (upstream of Danville) | 37.65000 | -84.70800 | 2001-2003 |
| K180 | Clarks Run (downtown Danville) | 37.633017 | -84.762205 | 2001-2003 |

Table 2. Fecal coliform data

| Site code | Collection Date | Fecal Coliform Count (colonies per 100ml) |
|---|---|---|
| K14 | 07/08/1998 | >60000 |
| K14 | 07/16/1999 | 1100 |
| K14 | 07/10/2000 | 190 |
| K14 | 07/16/2001 | 460 |
| K14 | 07/30/2001 | 2500 |
| K180 | 07/16/2001 | 160 |
| K125 | 07/16/2001 | 190 |
| K14 | 07/2002 | 140 |
| K14 | 07/27/02 | 896 |
| K180 | 07/13/02 | 9000 |
| K180 | 07/27/02 | 1140 |
| K125 | 07/13/02 | 1900 |
| K125 | 07/27/02 | 95 |
| K14 | 07/12/03 | 3200 |
| K14 | 08/09/03 | 4336 |
| K14 | 08/09/03 | 4099 |
| K180 | 07/12/03 | 1400 |
| K125 | 07/12/03 | 800 |

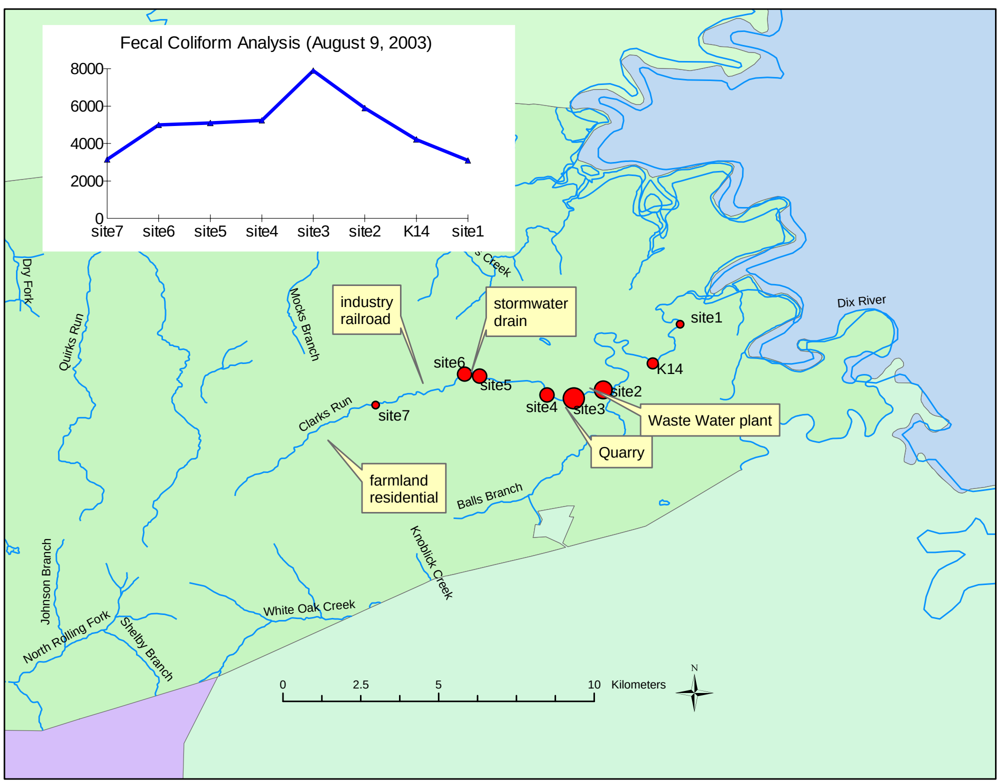



**Figure 1. Focused sampling sites and fecal coliform data from August 2003.**

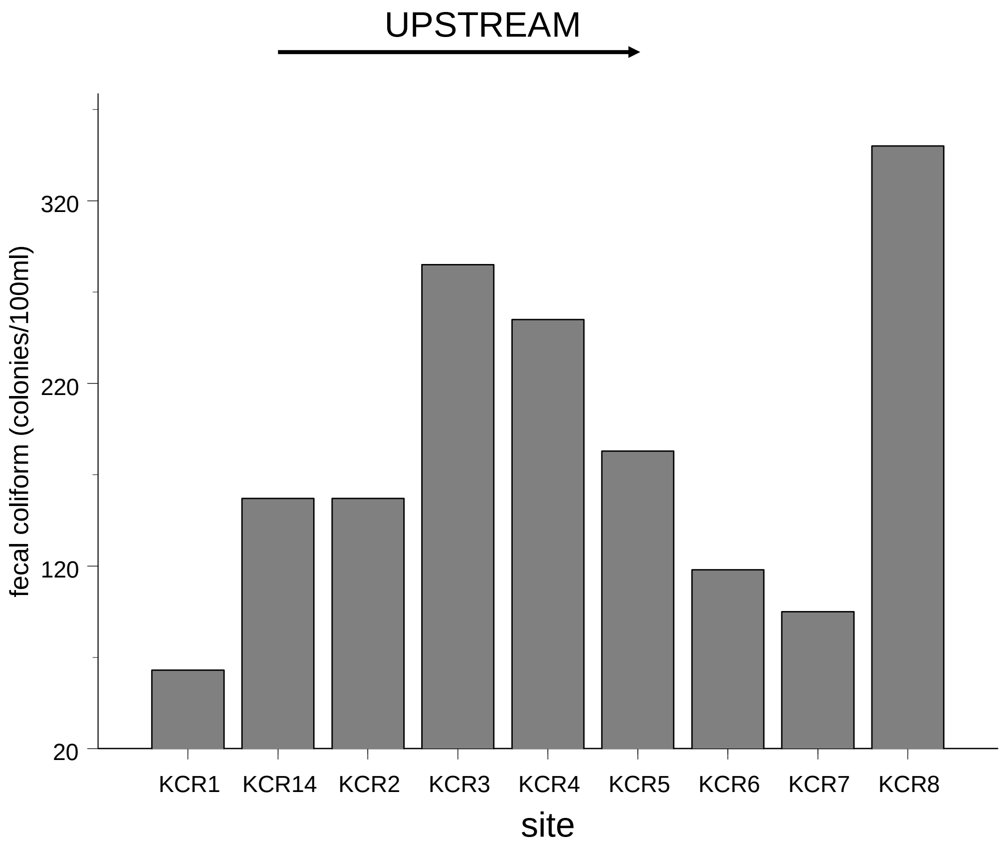



**Figure 2. Fecal Coliform data for October 2003**

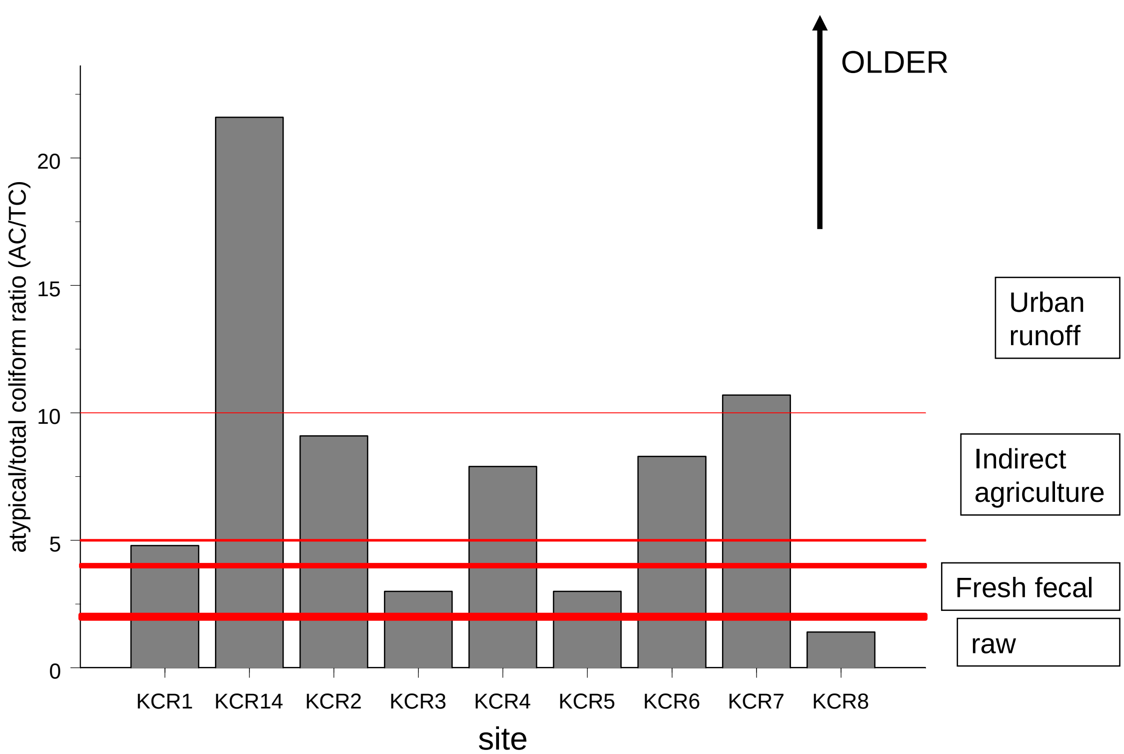



**Figure 3. Atypical colony analysis for October 2003**

Table 3. Potential parameters of concern for this watershed (1997-2002). Values for each sampling site are given along with the value demarcating the 3rd quartile of the distribution of values for all samples taken from the Kentucky River Basin that year. Data are shown only for parameters with values higher that 75% of all sampled sites (greater than the 3rd quartile value). Volunteers of the Kentucky River Watershed Watch collected all these data during yearly fall low-flow sampling events.

| Year | parameter | site | value | 3rd quartile for KY river basin |
|---|---|---|---|---|
| 1997 | Ammonia mg/L | K14 | 0.06 | Below detection limits |
| 1997 | TK-Nitrogen mg/L | K14 | 0.57 | 0.41 |
| 1997 | Organic carbon mg/L | K14 | 6.48 | 3.47 |
| 1998 | Nitrate/Nitrite mg/L | K14 | 4.30 | 0.90 |
| 1998 | Specific conductivity μmho/cm | K14 | 1100.00 | 695.00 |
| 1998 | Organic carbon mg/L | K14 | 7.10 | 6.50 |
| 1998 | Total Phosphorus mg/L | K14 | 1.30 | 0.27 |
| 2000 | Ammonia mg/L | K14 | 0.05 | 0.03 |
| 2000 | Nitrate mg/L | K14 | 13.60 | 1.27 |
| 2000 | Orthophosphate mg/L | K14 | 1.51 | 0.30 |
| 2000 | Total Phosphorus mg/L | K14 | 1.57 | 0.30 |
| 2001 | Suspended solids mg/L | K125 | 36.00 | 7.50 |
| 2001 | Chloride mg/L | K180 | 42.70 | 42.25 |
| 2001 | Organic carbon mg/L | K125 | 3.82 | 3.38 |
| 2001 | Organic carbon mg/L | K180 | 3.90 | 3.38 |
| 2002 | Nitrate mg/L | K14 | 33.9 | 2.24 |
| 2002 | Suspended Solids mg/L | K125 | 25 | 15 |
| 2002 | Conductivity μmho/cm | K14 | 1727 | 785 |

## PART 3: ASSESSMENT

Our preliminary assessment of the sampling data suggest that 1) there is a general decline in water quality as the stream passes through the city of Danville, 2) increased fecal counts may not be associated with the wastewater treatment plant, but increased nutrient concentrations may be, 3) there is evidence of fecal contamination that may be human related, upstream of the wastewater treatment plant, near a downtown storm water drain, and in the far upstream reaches of Clarks Run. Our activities over the next year will involve verifying and pinpointing the sources of the fecal contamination and documenting the scale of the nutrient contamination downstream.

## PART 4: ACTION ITEMS

1. An ACORN committee for this watershed will be formed to implement the action items in this CAP. Interested individuals should contact the area coordinator, Robert Ziemba (Ziemba@centre.edu).
2. The ACORN committee requests KRWW support for further fecal sampling in 2004 to verify the detected patterns.
3. The ACORN committee will establish contact with the appropriate city officials and determine what information the city of Danville has regarding nutrient loading and fecal coliform contamination in Clarks Run. We will work with these officials to determine potential causes and solutions to the contamination problems documented in this report.
4. The ACORN committee will establish contacts with local universities and high schools in order to design and implement educational activities regarding water quality in this watershed. Note: Rob Ziemba (Centre College) and Amy Farr (Boyle County High School) have already been in contact and will be developing joint sampling activities for students at both the college and high school level. New ideas and involvement by others is welcome.
5. The ACORN committee will organize a workshop held at Centre College to recruit new volunteers for the Kentucky River Watershed Watch. We will concentrate on sampling understudied areas of this and

surrounding watersheds.

This CAP was prepared by Robert Ziemba and was last revised on July 28, 2004.

Approved by the Kentucky River Watershed Watch (KRWW) Steering Committee:

______________________________ ______________________

Name Date

# APPENDIX D – THIRD ROCK MONTHLY MONITORING RESULTS BY STATION, 2006-2009

# Results for Water Quality Sites

## Clarks Run Watershed — GOGGIN LANE

| Date | Cond µS | DO mg/L | pH SU | Temp F | Turb NTU | Alk mg/L | BOD15 mg/L | BOD5 mg/L | TOC mg/L | Cl mg/L | TKN mg/L | NH3-N mg/L | Unionized NH3 mg/L | NO3N mg/L | NO2N mg/L | OP mg/L | TP mg/L | TSS mg/L | Chl A mg/m3 | TC #/100mls | E.coli #/100mls | Discharge cfs | Depth in |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/16/2006 | | | 8.43 | 56.4 | 6.19 | 148.19 | 3 | | | 31.93 | | | | | | | | | 48.6375 | >2000 | 290 | 73.1 | |
| 4/6/2006 | 560.2 | 14.22 | 8.64 | 53.2 | 1.54 | 143.42 | < 2 | < 2 | 4.1 | | 0.7484 | < 0.1 | 0.010 | 7.3 | < 0.15 | 0.2595 | 0.2765 | < 3 | 92.7195 | > 2010 | 310 | 12.52 | 8.7 |
| 4/24/2006 | 512 | 12.59 | 8.41 | 63.2 | 6.6 | | | | | | | | | | | | | | | | | 35.57 | 9.5 |
| 5/10/2006 | 645.9 | 8.3 | 7.88 | 63.2 | 0.7 | 160 | 2 | 4 | 3.5 | | 0.7326 | < 0.1 | 0.003 | 4.7 | < 0.15 | 0.2108 | 0.2216 | < 5 | 543 | 14500 | 1100 | 15.35 | 8.7 |
| 5/23/2006 | 557 | 13.88 | 8.32 | 65 | 0.55 | | | | | | | | | | | | | | | | | 6.18 | 7.1 |
| 6/5/2006 | 504 | 10.48 | 8.22 | 68.5 | 2.55 | 160 | 2 | < 2 | 1.9 | 36 | 1.2 | < 0.023 | 0.002 | 5.8 | < 0.07 | 0.34 | 0.23 | 2.4 | 67.261 | 10100 | 300 | 17.29 | 7.1 |
| 6/19/2006 | 730 | 9.7 | 7.87 | 70.7 | 1.9 | | | | | | | | | | | | | | | | | 8.35 | 6.7 |
| 7/7/2006 | 629.4 | 12 | 8.5 | 71.2 | 2.8 | | < 2 | < 2 | 2.7 | | 0.55 | < 0.023 | 0.003 | 4.7 | < 0.07 | 0.28 | 0.21 | 5.8 | 6.716 | 72300 | 2650 | 17.05 | 7.9 |
| 7/12/2006 | | | | | | | 2.6 | < 2 | | | | | | 4.1 | 0.14 | 0.21 | | | | | | | |
| 7/17/2006 | 568 | 14.5 | 9 | 82.5 | 3 | | | | | | | | | | | | | | | | | 11.23 | 6.7 |
| 8/2/2006 | 686 | 10.8 | 8.7 | 80 | 4.3 | 180 | | < 2 | 4 | | 1 | < 0.023 | 0.007 | | < 0.07 | 0.62 | 0.38 | 7.6 | 464 | 54600 | 3200 | 4.25 | 5.1 |
| 8/17/2006 | 723 | 13.98 | 8.32 | 74.8 | 4.4 | | | | | | | | | | | | | | | | | 9.04 | 7.1 |
| 9/6/2006 | 601 | 11.79 | 8.57 | 68.1 | 2.3 | 210 | | < 2 | 1.9 | 36 | 0.54 | < 0.023 | 0.004 | 6.3 | < 0.07 | 0.31 | 0.14 | 3.6 | 162.396 | 39900 | 4200 | 10.66 | 7.1 |
| 9/18/2006 | 622.8 | 13.5 | 8.71 | 71.8 | 1.3 | | | | | | | | | | | | | | | | | 7.4 | 7.1 |
| 10/3/2006 | 566 | 11.5 | 8.21 | 63.2 | | 200 | | 2.1 | 2.2 | | 0.59 | < 0.023 | 0.001 | 3.7 | < 0.07 | 0.23 | 0.14 | 3 | 218.57 | 53800 | 1000 | 36.85 | 9.5 |
| 10/16/2006 | 576.4 | 11.22 | 8.06 | 62 | 1.2 | | | | | | | | | | | | | | | | | 7 | 7.1 |
| 11/16/2006 | 390.9 | 9.26 | 7.77 | 53.8 | 46.3 | 150 | | < 2 | 3.6 | | 1.4 | < 0.023 | 0.000 | 1.9 | < 0.07 | 0.18 | 0.31 | 22 | 279.678 | < 1 | < 1 | 117.53 | 18. 1 |
| 12/18/2006 | 539.2 | 13.99 | 8.13 | 48.2 | | 170 | | < 2 | 2.7 | 45 | 0.84 | < 0.023 | 0.001 | 6.5 | < 0.07 | 0.13 | < 0.01 | 2.6 | 3117.6 | 500 | < 500 | 10.37 | 7.5 |
| 1/5/2007 | | | | | | 190 | < 2 | < 2 | 1.1 | | 0.37 | < 0.023 | | 3.3 | < 0.07 | 0.14 | 0.18 | 8.4 | | 4900 | 500 | | |
| 2/28/2007 | 460.2 | 17.5 | 8.5 | 43 | 2.8 | 200 | | < 2 | 2.1 | 25 | 0.21 | < 0.023 | 0.001 | 2.8 | < 0.07 | 0.12 | < 0.01 | 4.2 | 93.228 | | | 37.59 | 10.6 |
| Geometric Average | 574 | 12.1 | 8.34 | 63.5 | 2.7 | 172.3 | 2.2 | 2.1 | 2.5 | 34.2 | 0.66 | 0.03 | 0.002 | 4.3 | 0.08 | 0.2273 | 0.1256 | 4.8 | 157.5 | 4408 | 473 | | |
| Standard Deviation | 89 | 2.3 | 0.33 | 10.5 | 11 | 23.5 | 0.4 | 0.6 | 1 | 7.3 | 0.35 | 0.031 | 0.003 | 1.7 | 0.03 | 0.1353 | 0.1144 | 5.6 | 897.1 | 26732 | 1412 | | |

## Clarks Run Watershed — BALLS BRANCH MOUTH

| Date | Cond µS | DO mg/L | pH SU | Temp F | Turb NTU | Alk mg/L | BOD15 mg/L | BOD5 mg/L | TOC mg/L | Cl mg/L | TKN mg/L | NH3-N mg/L | Unionized NH3 mg/L | NO3N mg/L | NO2N mg/L | OP mg/L | TP mg/L | TSS mg/L | Chl A mg/m3 | TC #/100mls | E.coli #/100mls | Discharge cfs | Depth in |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4/6/2006 | 431.4 | 14.03 | 8.53 | 53.5 | | 161.6 | 2 | 2 | 2.5 | | 0.3981 | < 0.1 | 0.008 | 1.5 | < 0.15 | 0.0687 | 0.0887 | < 3 | 27.5894 | > 2010 | 1450 | 2.32 | 7.1 |
| 5/10/2006 | 119.1 | 12.73 | 8.18 | 65 | | 168 | 3 | 4 | 2.7 | | 0.5368 | < 0.1 | 0.006 | 0.92 | < 0.15 | 0.0571 | 0.0804 | < 5 | 356 | > 2010 | 13000 | 4.43 | 7.1 |
| 6/5/2006 | 335 | 22.6 | 7.95 | 73.5 | 2.15 | 140 | 2.6 | < 2 | 1.4 | 17 | 0.46 | < 0.023 | 0.001 | 1.2 | < 0.07 | 0.099 | 0.096 | < 2 | 72.807 | 8900 | 1000 | 2.09 | 6.7 |
| 7/6/2006 | 492.5 | 8.62 | 7.49 | 76 | 2.18 | | 2.7 | < 2 | 4 | | 1.1 | < 0.023 | 0.000 | 0.94 | < 0.07 | 0.076 | 0.051 | 4.6 | 2.285 | > 20100 | 5310 | 12 | 11 |
| 8/2/2006 | 472 | 4.9 | 7.3 | 69 | 2.3 | | | | | | | | | | | | | | | | | 0 | 0.2 |
| 9/6/2006 | 562 | 8.25 | 7.35 | 63.2 | 4.4 | 220 | | < 2 | 1.8 | 25 | < 0.1 | < 0.023 | 0.000 | 1.9 | < 0.07 | 0.18 | 0.13 | 6 | 114.603 | 37150 | 2050 | 1.31 | 11 |
| 10/3/2006 | 416 | 9.11 | 7.44 | 61.6 | | 170 | | 2 | 1.7 | | 0.45 | < 0.023 | 0.000 | 1.7 | < 0.07 | 0.12 | 0.049 | 5.4 | 219.526 | 73400 | 500 | 7.95 | 5.9 |
| 11/13/2006 | 395 | 15.1 | 8.4 | 52 | | 180 | | < 2 | 1.1 | | 0.34 | < 0.023 | 0.001 | 1.3 | < 0.07 | 0.11 | < 0.01 | < 2 | 415.374 | 32200 | 500 | 5.09 | 5.9 |
| 12/18/2006 | 396.9 | 14.27 | 8.14 | 48.8 | | 190 | | < 2 | 1.3 | 14 | 0.31 | < 0.023 | 0.001 | 1.2 | < 0.07 | < 0.01 | 0.095 | 2.6 | 67.055 | 12500 | < 500 | 2.26 | 4.7 |
| 1/5/2007 | | | | | | 160 | < 2 | < 2 | 1.6 | | 0.41 | < 0.023 | | 1.4 | < 0.07 | 0.066 | 0.18 | 23 | | 69800 | 2050 | | |
| 2/28/2007 | 328.2 | 16.25 | 8.18 | 41.2 | 5 | 160 | | < 2 | 1.2 | 16 | 0.25 | < 0.023 | 0.001 | 1.7 | < 0.07 | < 0.01 | < 0.01 | 6.2 | 63.529 | > 2010 | 1450 | 13.5 | 10.6 |
| Geometric Average | 370 | 11.62 | 7.88 | 59.4 | 2.98 | 170.9 | 2.43 | 2.14 | 1.78 | 17.6 | 0.373 | 0.031 | 0.033 | 1.34 | 0.082 | 0.058 | 0.057 | 4.49 | 74.736 | 12724 | 1542 | | |
| Standard Deviation | 119.9 | 5.06 | 0.46 | 11.2 | 1.38 | 22.7 | 0.44 | 0.63 | 0.9 | 4.8 | 0.264 | 0.032 | 0.003 | 0.33 | 0.034 | 0.051 | 0.052 | 6.19 | 148.346 | 26792 | 3862 | | |

# Results for Water Quality Sites

Clarks Run Watershed — BALLS BRANCH WEST

| Date | Cond µS | DO mg/L | pH SU | Temp F | Turb NTU | Alk mg/L | BOD15 mg/L | BOD5 mg/L | TOC mg/L | Cl mg/L | TKN mg/L | NH3-N mg/L | Unionized NH3 mg/L | NO3N mg/L | NO2N mg/L | OP mg/L | TP mg/L | TSS mg/L | Chl A mg/m3 | TC #/100mls | E.coli #/100mls | Discharge cfs | Depth in |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/16/2006 | | | 8.17 | 56.9 | | | | < 2 | < 0.7 | 9.565 | 0.1658 | < 0.1 | 0.004 | 2.524 | < 0.2 | 0.0465 | 0.0523 | 14.7 | | >2000 | 830 | 11.18 | |
| 4/6/2006 | 356.1 | 11.49 | 8.25 | 51.2 | | | | 2 | 1.7 | | 0.4123 | < 0.1 | 0.004 | 1 | < 0.15 | 0.0392 | 0.0795 | 16.7 | | > 2010 | > 2010 | 1.1 | 8.7 |
| 5/10/2006 | 393.6 | 10.5 | 8.09 | 62.9 | | | | 4 | 2.2 | | 0.2448 | < 0.1 | 0.005 | 0.69 | < 0.15 | 0.0391 | 0.0584 | 6 | | > 2010 | 3800 | 1.27 | 7.5 |
| 6/6/2006 | 354 | 8.58 | 7.69 | 61.1 | | | | < 2 | < 0.7 | | 0.26 | < 0.023 | 0.000 | 0.87 | 0.077 | 0.056 | 0.077 | 14.2 | | 20100 | 1800 | 0.07 | 5.1 |
| 7/6/2006 | 482.5 | 7.84 | 7.91 | 65.6 | 2.18 | | | < 2 | 2.5 | | 0.49 | < 0.023 | 0.001 | 1.7 | 0.13 | 0.12 | < 0.01 | 8.6 | | > 20100 | 4290 | 1.4 | |
| 8/2/2006 | | | | | | | | | | | | | | | | | | | | | | 0 | 0 |
| 9/5/2006 | 507 | 7.69 | 7.88 | 66 | | | | < 2 | 2.8 | | 0.86 | < 0.023 | 0.001 | 0.97 | < 0.07 | < 0.01 | < 0.01 | 20 | | 145450 | 12950 | 0.28 | 5.9 |
| 10/3/2006 | 311 | 9.17 | 7.83 | 63.2 | | | | < 2 | 0.85 | | 0.37 | < 0.023 | 0.001 | 1.7 | < 0.07 | 0.068 | < 0.01 | 6.6 | | 49500 | 3650 | 2.47 | 9.8 |
| 11/13/2006 | 343 | 12 | 8.1 | 49.1 | | | | < 2 | < 0.7 | | 0.26 | < 0.023 | 0.001 | 1.4 | < 0.07 | < 0.01 | < 0.01 | 5.4 | | 54100 | 2050 | 1.93 | 9.1 |
| 12/18/2006 | 366.1 | 11.93 | 8.04 | 48.7 | | | | < 2 | 1 | | 0.51 | < 0.023 | 0.001 | 1.1 | < 0.07 | < 0.01 | < 0.01 | 4.8 | | 16800 | 6750 | 0.8 | 7.1 |
| 1/31/2007 | 293.6 | 14.96 | 7.41 | 31.9 | | | | < 2 | < 0.7 | | 0.51 | < 0.023 | | 2 | < 0.07 | < 0.01 | < 0.01 | 7 | | 5040 | 630 | 4.24 | 7.1 |
| 2/27/2007 | 273.9 | 13.13 | 8.01 | 50 | | | | < 2 | < 0.7 | | 0.3 | < 0.023 | 0.001 | 1.8 | < 0.07 | < 0.01 | < 0.01 | 5.8 | | 24100 | 4760 | 5.79 | 10.6 |
| Geometric Average | 361.5 | 10.49 | 7.94 | 54.1 | 2.18 | | | 2.13 | 1.1 | 9.565 | 0.3615 | 0.034 | 0.001 | 1.33 | 0.09 | 0.02572 | 0.02 | 8.8 | | 13445 | 2838 | | |
| Standard Deviation | 75.8 | 2.4 | 0.24 | 10.3 | | | | 0.6 | 0.8 | | 0.1931 | 0.036 | 0.002 | 0.56 | 0.05 | 0.0346 | 0.03 | 5.4 | | 42021 | 3500 | | |

Clarks Run Watershed — CLARKS RUN AT KY-52

| Date | Cond µS | DO mg/L | pH SU | Temp F | Turb NTU | Alk mg/L | BOD15 mg/L | BOD5 mg/L | TOC mg/L | Cl mg/L | TKN mg/L | NH3-N mg/L | Unionized NH3 mg/L | NO3N mg/L | NO2N mg/L | OP mg/L | TP mg/L | TSS mg/L | Chl A mg/m3 | TC #/100mls | E.coli #/100mls | Discharge cfs | Depth in |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/16/2006 | | | 8.27 | 54.7 | | | 5 | 2 | 2.9 | 47.01 | 1.1066 | 0.1316 | 0.006 | 4.82 | < 0.2 | 0.3062 | 0.3077 | 10 | 144.73 | >2000 | 450 | 48.9 | |
| 4/6/2006 | 628.4 | 14.11 | 8.52 | 54.7 | | | | < 2 | 4.4 | | 0.7631 | < 0.1 | 0.008 | 13 | < 0.15 | 0.2859 | 0.3315 | < 3 | | 2010 | 40 | 9.47 | 5.9 |
| 5/10/2006 | 755.9 | 8.11 | 7.87 | 63.6 | | | | 4 | 4.3 | | 1.0072 | < 0.1 | 0.003 | 0.12 | < 0.15 | 0.2816 | 0.3325 | < 5 | | 10900 | 300 | 13.09 | 9.1 |
| 6/5/2006 | 597 | 9.44 | 7.86 | 70.4 | 3.15 | | | < 2 | 2.1 | | 0.98 | < 0.023 | 0.001 | 9.9 | < 0.07 | 0.49 | 0.45 | 4 | | 10100 | 400 | 7.9 | 7.9 |
| 7/6/2006 | 604.5 | 9.21 | 7.9 | 70.9 | 2.18 | | | < 2 | 3.7 | | 1.3 | 0.18 | 0.007 | 4.8 | < 0.07 | 0.3 | 0.3 | 7.2 | | > 20100 | 16500 | 28 | 8.7 |
| 8/2/2006 | 717 | 8.5 | 8.4 | 81 | | | | < 2 | 4.1 | | 0.75 | < 0.023 | 0.004 | 14 | < 0.07 | 0.68 | 0.57 | 5.6 | | 64900 | 1000 | 3.75 | 6.7 |
| 9/6/2006 | 621 | 8.5 | 8.03 | 66.5 | | | | 2.6 | 2 | | 0.88 | < 0.023 | 0.001 | 6.4 | < 0.07 | 0.39 | 0.36 | 21 | | 41650 | 500 | 11.02 | 8.7 |
| 10/3/2006 | 666 | 9.11 | 7.9 | 64.4 | | | | < 2 | 2 | | 0.68 | 0.074 | 0.002 | 5.2 | < 0.07 | 0.34 | 0.25 | 5 | | 40800 | 500 | 18.7 | 8.7 |
| 11/13/2006 | 650 | 13.7 | 8.3 | 53 | | | | < 2 | 2.7 | | 0.82 | 0.027 | 0.001 | 7.3 | < 0.07 | 0.32 | 0.28 | 4.4 | | 231000 | 22900 | 9.43 | 8.3 |
| 12/18/2006 | 616.1 | 12.8 | 8.11 | 51.4 | | | | < 2 | 2.9 | | 1.1 | < 0.023 | 0.001 | 9.1 | < 0.07 | 0.16 | 0.085 | 3.2 | | 3750 | 1000 | 7.24 | 7.9 |
| 1/31/2007 | 598.7 | 14.63 | 7.45 | 35.7 | | | | < 2 | 2.4 | | 0.36 | < 0.023 | 0.000 | 6.9 | < 0.07 | 0.29 | 0.041 | 7.2 | | 1460 | 100 | 5.59 | 7.1 |
| 2/28/2007 | 595.3 | 14.21 | 7.88 | 44.2 | | | | < 2 | 3.2 | | 0.8 | < 0.023 | 0.000 | 6 | < 0.07 | 0.16 | 0.11 | 6.2 | | | | 25.8 | 10.6 |
| Geometric Average | 639 | 10.82 | 8.04 | 57.9 | 2.62 | | 5 | 2.2 | 2.9 | 47.01 | 0.842 | 0.045 | 0.002 | 5.269 | 0.0867 | 0.3096 | 0.2327 | 5.8 | | 12573 | 702 | | |
| Standard Deviation | 220.7 | 2.71 | 0.3 | 12.6 | 0.69 | | | 0.6 | 0.9 | | 0.244 | 0.054 | 0.003 | 3.7948 | 0.0454 | 0.1404 | 0.1509 | 4.9 | | 67020 | 7913 | | |

# Results for Water Quality Sites

## Clarks Run Watershed — CLARKS RUN AT STANFORD RD (US-150) CROSSING

| Date | Cond µS | DO mg/L | pH SU | Temp F | Turb NTU | Alk mg/L | BOD15 mg/L | BOD5 mg/L | TOC mg/L | Cl mg/L | TKN mg/L | NH3-N mg/L | Unionized NH3 mg/L | NO3N mg/L | NO2N mg/L | OP mg/L | TP mg/L | TSS mg/L | Chl A mg/m3 | TC #/100mls | E.coli #/100mls | Discharge cfs | Depth in |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/16/2006 | | | 8.14 | 52.4 | | 149.21 | 3 | < 2 | 1.4 | 34.94 | 0.1192 | < 0.1 | 0.003 | 2.593 | < 0.2 | 0.1802 | 0.1386 | 11 | 134.33 | >2000 | 250 | 19.9 | |
| 4/6/2006 | 497.1 | 12.51 | 8.37 | 53.1 | | 159.58 | 2 | < 2 | 2.5 | | 0.1752 | < 0.1 | 0.006 | 0.68 | < 0.15 | 0.0456 | 0.0576 | < 3 | 53.7713 | > 2010 | 110 | 3.36 | 8.7 |
| 5/12/2006 | 488.2 | 8.85 | 7.96 | 55.8 | | 154 | < 2 | < 2 | 3.1 | | 0.2354 | < 0.1 | 0.003 | 0.72 | < 0.15 | 0.0983 | 0.1147 | < 5 | 232 | 8900 | 900 | 2.54 | 9.8 |
| 6/6/2006 | 533 | 7.61 | 7.62 | 61.7 | 5.2 | 200 | < 2 | < 2 | 1.2 | 28 | 0.15 | < 0.023 | 0.000 | 1.4 | < 0.07 | 0.12 | 0.15 | 5.6 | 271.709 | 10900 | 1100 | | |
| 7/6/2006 | 545.2 | 8.44 | 7.83 | 66.7 | 2.19 | | < 2 | < 2 | 2.3 | | 0.52 | < 0.023 | 0.001 | 2.3 | < 0.07 | 0.2 | 0.12 | 6 | 1.441 | > 20100 | 10900 | | |
| 8/2/2006 | 541 | 5.8 | 8 | 77 | 6 | | | | | | | | | | | | | | | | | 0 | 0.1 |
| 9/5/2006 | 561 | 8.55 | 8 | 66 | 3.3 | 230 | | < 2 | 1.1 | 22 | 0.13 | < 0.023 | 0.001 | 1.6 | < 0.07 | 0.14 | < 0.01 | 5.8 | 185.405 | 114100 | < 500 | 10.57 | 29.9 |
| 10/2/2006 | 508.8 | 9.85 | 8.01 | 60.2 | | 210 | | < 2 | 1.4 | | 0.21 | < 0.023 | 0.001 | 1.6 | < 0.07 | 0.2 | 0.13 | 4.4 | 342.973 | 50600 | 1550 | 11.47 | 11.4 |
| 11/13/2006 | 816 | 12.4 | 8.03 | 49 | | 210 | | < 2 | 2.2 | | 0.77 | 0.27 | 0.006 | 1 | < 0.07 | 0.13 | 0.13 | 2.2 | 76.236 | 1210000 | 86100 | 6.83 | 9.5 |
| 12/18/2006 | 757.7 | 10.98 | 7.88 | 48.5 | | 190 | | < 2 | 1.3 | 68 | 0.48 | 0.037 | 0.001 | 0.61 | < 0.07 | < 0.01 | < 0.01 | 4.4 | 927.023 | 7800 | < 500 | 4.08 | 8.7 |
| 1/5/2007 | | | | | | 170 | < 2 | < 2 | 1.5 | | 0.35 | < 0.023 | | 1.3 | < 0.07 | 0.09 | 0.17 | 11 | | 18400 | 1550 | | |
| 2/28/2007 | 488.4 | 16.89 | 8.2 | 41.7 | 3.1 | 190 | 3 | < 2 | 1.5 | 31 | 0.26 | < 0.023 | 0.001 | 1.5 | < 0.07 | 0.053 | < 0.01 | 3.6 | 80.562 | | | 13.11 | 14.2 |
| Geometric Average | 564.5 | 9.78 | 8 | 56.7 | 3.7 | 184.48 | 2.1 | < 2.0 | 1.7 | 34 | 0.259 | 0.045 | 0.037 | 1.258 | 0.0885 | 0.0906 | 0.0615 | 5 | 109 | 19477 | 1314 | | |
| Standard Deviation | 115.9 | 3.15 | 0.2 | 10.1 | 1.6 | 27.18 | 3.4 | 0 | 0.6 | 18.1 | 0.2042 | 0.076 | 0.002 | 0.64 | 0.047 | 0.0634 | 0.0609 | 2.9 | 266.8 | 375934 | 26810 | | |

## Clarks Run Watershed — SOUTH SECOND STREET

| Date | Cond µS | DO mg/L | pH SU | Temp F | Turb NTU | Alk mg/L | BOD15 mg/L | BOD5 mg/L | TOC mg/L | Cl mg/L | TKN mg/L | NH3-N mg/L | Unionized NH3 mg/L | NO3N mg/L | NO2N mg/L | OP mg/L | TP mg/L | TSS mg/L | Chl A mg/m3 | TC #/100mls | E.coli #/100mls | Discharge cfs | Depth in |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/16/2006 | | | 8.16 | 50 | | 147.18 | 5 | < 2 | | 24.041 | 0.1327 | < 0.1 | 0.003 | 2.689 | < 0.2 | 0.1177 | 0.0964 | 4.7 | 169.43 | >2000 | 1010 | 27.72 | |
| 4/6/2006 | 493.4 | 13.13 | 8.23 | 52.5 | | 165.64 | < 2 | < 2 | | | 0.191 | < 0.1 | 0.004 | 0.84 | < 0.15 | 0.0518 | 0.0811 | < 3 | 13.3998 | > 2010 | 80 | 3.42 | 9.1 |
| 5/12/2006 | 499.7 | 9.25 | 7.87 | 55.2 | | 158 | < 2 | < 2 | | | 0.604 | 0.2452 | 0.005 | 1.1 | < 0.15 | 0.0918 | 0.0875 | < 5 | 93 | 6200 | 100 | 7.69 | 9.1 |
| 6/6/2006 | 522 | 8.06 | 7.67 | 61.4 | 3.9 | 200 | < 2 | < 2 | | 29 | 0.42 | < 0.023 | 0.000 | 1.4 | < 0.07 | 0.12 | 0.094 | 4.4 | 127.212 | 20100 | 1200 | 2.58 | 7.9 |
| 7/6/2006 | 483.8 | 8.08 | 7.76 | 65.1 | 6 | | < 2 | < 2 | | | 0.48 | < 0.023 | 0.001 | 2.4 | < 0.07 | 0.13 | 0.1 | 6.6 | 7.431 | > 20100 | 5600 | 13 | 8.7 |
| 8/2/2006 | 556 | 6.3 | 8 | 77 | 2.6 | 230 | | < 2 | | | 0.31 | < 0.023 | 0.001 | 1.1 | < 0.07 | 0.22 | 0.022 | 6.8 | | 82600 | 500 | 0.47 | 3.2 |
| 9/5/2006 | 556 | 8.5 | 7.61 | 64.5 | 4.8 | 230 | | < 2 | | 20 | 0.24 | < 0.023 | 0.000 | 1.7 | < 0.07 | 0.16 | < 0.01 | 22 | 50.768 | 100700 | 3150 | 5.65 | 9.5 |
| 10/2/2006 | 494 | 9.58 | 7.87 | 59.4 | | 210 | | < 2 | | | 0.19 | < 0.023 | 0.001 | 1.6 | < 0.07 | 0.13 | 0.085 | 3.6 | 130.89 | 31200 | 500 | 11.27 | 9.8 |
| 11/13/2006 | 513 | 11.9 | 8 | 51 | | 220 | | < 2 | | | 0.8 | 0.15 | 0.003 | 1.1 | < 0.07 | 0.15 | 0.11 | 2.6 | 14.195 | 1210000 | 89500 | 6.24 | 8.7 |
| 12/18/2006 | 475.3 | 13.42 | 8.04 | 51.2 | | 210 | | < 2 | | 20 | 0.38 | < 0.023 | 0.001 | 0.84 | < 0.07 | 0.085 | < 0.01 | 2.4 | 1463.507 | 11550 | 500 | 2.28 | 5.5 |
| 1/5/2007 | | | | | | 160 | < 2 | < 2 | | | 0.14 | < 0.023 | | 1.3 | < 0.07 | 0.1 | 0.16 | 8.6 | | 21300 | 1000 | | |
| 2/27/2007 | 443.3 | 16.84 | 8.22 | 44.3 | 4.3 | 180 | | < 2 | | 30 | 0.24 | < 0.023 | 0.001 | 1.7 | < 0.07 | 0.052 | < 0.01 | 3 | 46.878 | 2240 | 20 | 15.41 | 13.4 |
| Geometric Average | 502.5629 | 10.09 | 7.946 | 56.777 | 4.1666 | 189.608 | 2.33 | <2 | | 24.2385 | 0.2956 | 0.0418 | 0.036 | 1.3877 | 0.0867 | 0.1085 | 0.0494 | 4.869 | 64.7313 | 18625 | 762 | | |
| Standard Deviation | 34.8948 | 3.22 | 0.213 | 9.2113 | 1.2438 | 30.6783 | 1.2247 | 0 | | 4.7737 | 0.2039 | 0.0715 | 0.002 | 0.5808 | 0.0454 | 0.047 | 0.0482 | 5.3704 | 443.4321 | 342912 | 25529 | | |

# Results for Water Quality Sites

Clarks Run Watershed — US-127 BYPASS

| Date | Cond µS | DO mg/L | pH SU | Temp F | Turb NTU | Alk mg/L | BOD15 mg/L | BOD5 mg/L | TOC mg/L | Cl mg/L | TKN mg/L | NH3-N mg/L | Unionized NH3 mg/L | NO3N mg/L | NO2N mg/L | OP mg/L | TP mg/L | TSS mg/L | Chl A mg/m3 | TC #/100mls | E.coli #/100mls | Discharge cfs | Depth in |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/16/2006 | | | 8.07 | 49.1 | | | | < 2 | 2.2 | 16.42 | 0.2531 | < 0.1 | 0.002 | 2.65 | < 0.2 | 0.109 | 0.0927 | 5.7 | | >2000 | >2000 | | |
| 4/7/2006 | 428.6 | 11.77 | 8.06 | 55.4 | | | | 2 | 2 | | 0.1468 | < 0.1 | 0.003 | 0.5 | < 0.15 | 0.043 | 0.0464 | < 3 | | 2010 | 450 | 0.48 | 10.6 |
| 5/12/2006 | 444.2 | 8.23 | 8.21 | 55.4 | | | | < 2 | 3.1 | | 0.3203 | < 0.1 | 0.004 | 0.12 | < 0.15 | 0.0142 | 0.0437 | < 5 | | 3600 | 200 | 0.87 | 18.9 |
| 6/6/2006 | 439 | 8.48 | 7.76 | 65.1 | 3.1 | | | < 2 | 0.87 | | 0.21 | < 0.023 | 0.001 | 0.62 | < 0.07 | 0.099 | 19 | 3 | | 13000 | 1800 | 1.12 | 18.1 |
| 7/7/2006 | 493.8 | 8.3 | 7.87 | 64.1 | 1.6 | | | < 2 | 1.4 | | 0.28 | < 0.023 | 0.001 | 1.8 | < 0.07 | 0.14 | 0.028 | 3 | | 72300 | 8200 | 3.5 | 11 |
| 7/12/2006 | | | | | | | | 2.6 | | | | | | 0.7 | < 0.07 | 0.12 | | | | | | | |
| 8/2/2006 | 176 | 6.1 | 8.1 | 78 | | | | | | | | | | | | | | | | | | 0 | 0.4 |
| 9/5/2006 | 536 | 6.8 | 7.76 | 66.1 | | | | < 2 | 1.3 | | 0.21 | < 0.023 | 0.001 | 1.2 | < 0.07 | 0.16 | < 0.01 | 4.6 | | 66700 | 3150 | 0.85 | 19.3 |
| 10/2/2006 | 458 | 9.01 | 7.71 | 59.5 | | | | < 2 | 1.6 | | < 0.1 | < 0.023 | 0.000 | 1.4 | < 0.07 | 0.16 | 0.11 | 3.8 | | 52200 | 500 | 3.78 | 20.9 |
| 11/13/2006 | 456 | 11.8 | 7.6 | 48.2 | | | | < 2 | 1.2 | | 0.33 | < 0.023 | 0.000 | 0.9 | < 0.07 | 0.11 | 0.011 | < 2 | | 39500 | 1000 | 1.63 | 18.9 |
| 12/18/2006 | 116 | 12.75 | 8.08 | 51.8 | | | | < 2 | 1.5 | | 0.3 | < 0.023 | 0.001 | 0.5 | < 0.07 | < 0.01 | < 0.01 | 2.6 | | 6700 | 500 | 1.05 | 18.1 |
| 1/31/2007 | 418.8 | 14.7 | 7.62 | 32 | | | | < 2 | < 0.7 | | 0.14 | < 0.023 | | 1.6 | < 0.07 | 0.33 | < 0.01 | 3.2 | | 2010 | < 100 | 3.15 | 12.2 |
| 2/27/2007 | 385.1 | 15.1 | 8.14 | 47.2 | | | | < 2 | 1.3 | | 0.22 | < 0.023 | 0.001 | 1.5 | < 0.07 | 0.049 | < 0.01 | 3.2 | | 728 | 40 | 6.88 | 21.7 |
| Geometric Average | 364.8 | 9.85 | 7.91 | 54.8 | 2.2 | | | 2 | 1.4 | 16.42 | 0.2148 | 0.034 | 0.001 | 0.88 | 0.09 | 0.078 | 0.044 | 3.4 | | 8571 | 780 | | |
| Standard Deviation | 130.1 | 3.59 | 0.22 | 11.8 | 1.1 | | | 0.2 | 0.7 | | 0.0767 | 0.036 | 0.001 | 0.71 | 0.05 | 0.0863 | 5.7176 | 1.1 | | 28319 | 2457 | | |

Clarks Run Watershed — CORPORATE DRIVE

| Date | Cond µS | DO mg/L | pH SU | Temp F | Turb NTU | Alk mg/L | BOD15 mg/L | BOD5 mg/L | TOC mg/L | Cl mg/L | TKN mg/L | NH3-N mg/L | Unionized NH3 mg/L | NO3N mg/L | NO2N mg/L | OP mg/L | TP mg/L | TSS mg/L | Chl A mg/m3 | TC #/100mls | E.coli #/100mls | Discharge cfs | Depth in |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4/7/2006 | 381.4 | 12.32 | 8.25 | 55.8 | | | | < 2 | 2.5 | | 0.4346 | < 0.1 | 0.005 | 0.36 | < 0.15 | 0.0193 | 0.039 | < 3 | | > 2010 | 590 | 0.46 | 7.9 |
| 5/10/2006 | 377.9 | 13.41 | 8.57 | 64.2 | | | | 3 | 3.2 | | 0.5208 | < 0.1 | 0.013 | < 0.11 | < 0.15 | 0.0133 | 0.0311 | < 5 | | > 2010 | 8300 | 1.05 | 7.9 |
| 6/6/2006 | 334 | 14.84 | 8.6 | 72.5 | 1.5 | | | < 2 | 2 | | 0.21 | < 0.023 | 0.004 | < 0.06 | < 0.07 | 0.05 | 0.091 | 2.4 | | 5600 | 800 | 1.38 | 5.9 |
| 7/7/2006 | 493.6 | 8.22 | 7.56 | 64.6 | 1 | | | < 2 | 1.2 | | 0.26 | < 0.023 | 0.000 | 1.8 | < 0.07 | 0.093 | 0.016 | < 2 | | 100000 | 14400 | 2.7 | 5.1 |
| 7/12/2006 | | | | | | | | < 2 | | | | | | 0.2 | < 0.07 | 0.069 | | | | | | | |
| 9/5/2006 | 485 | 10.03 | 7.85 | 67 | | | | < 2 | 2.3 | | 0.55 | < 0.023 | 0.001 | 0.4 | < 0.07 | 0.079 | < 0.01 | 2.2 | | 53550 | 1000 | | |
| 10/4/2006 | 389 | 10.23 | 7.81 | 59.5 | | | | < 2 | 2.7 | | 0.26 | < 0.023 | 0.000 | 0.75 | < 0.07 | 0.11 | 0.077 | 4.6 | | 92100 | 500 | 2.03 | 5.9 |
| 11/13/2006 | 8.7 | 17.6 | | 49 | | | | < 2 | 1.3 | | 0.32 | < 0.023 | | 0.43 | < 0.07 | 0.068 | < 0.01 | < 2 | | 17800 | 500 | 1.17 | 5.9 |
| 12/18/2006 | 348.4 | 18.62 | 8.71 | 54.3 | | | | < 2 | 1.3 | | 0.27 | < 0.023 | 0.003 | 0.12 | < 0.07 | < 0.01 | < 0.01 | 3.4 | | 3150 | 500 | 0.39 | 5.9 |
| 1/31/2007 | 376.4 | 16.17 | 7.8 | 32.8 | | | | < 2 | 1.4 | | 0.44 | < 0.023 | 0.000 | 1.1 | < 0.07 | < 0.01 | < 0.01 | 8 | | 1600 | 100 | 1.66 | 5.9 |
| 2/27/2007 | 328.2 | 16.74 | 8.37 | 47.6 | | | | < 2 | 1.9 | | 0.32 | < 0.023 | 0.001 | 0.86 | < 0.07 | < 0.01 | < 0.01 | 6 | | 960 | < 20 | 4.77 | 8.3 |
| Geometric Average | 264.5 | 13.38 | 8.16 | 55.5 | 1.2 | | | 2.1 | 1.9 | | 0.3414 | 0.031 | 0.001 | 0.36 | 0.08 | 0.0329 | 0.0206 | 3.4 | | 6985 | 647 | | |
| Standard Deviation | 133.3 | 3.55 | 0.42 | 11.6 | 0.4 | | | 0.3 | 0.7 | | 0.1191 | 0.033 | 0.004 | 0.53 | 0.03 | 0.0375 | 0.0302 | 2 | | 38153 | 4600 | | |

| Site | Date | Flow Event | Temperature (F) | Conductivity (mS/cm) | DO (mg/L) | pH (SU) | Turbidity (NTU) | Discharge (ft3/sec) | NO2 (mg/L) | NO2/NO3 (mg/L) | NO3 (mg/L) | NH3-N (mg/L) | TKN (mg/L) | TN (mg/L) | TP (mg/L) | OP (mg/L) | BOD (mg/L) | TOC (mg/L) | TSS (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goggin Ln | 12/8/2008 | low | 41.8 | 625 | 17.92 | 8.35 | 0.5 | 6 | 0.200 | | 9.400 | 0.034 | 0.80 | 10.40 | 0.200 | 0.170 | < 2.0 | 4.49 | |
| Goggin Ln | 1/6/2009 | moderate | 44.9 | 513 | 11.10 | 8.47 | opaque | 35 | <0.030 | | 3.890 | 0.065 | <0.20 | 3.89 | 0.131 | 0.078 | < 2.0 | 2.32 | 4 |
| Goggin Ln | 2/3/2009 | moderate | 40.4 | 404 | 13.02 | 8.13 | 8.6 | 62 | 0.018 | | 4.180 | 0.067 | 0.63 | 4.82 | 0.130 | 0.083 | < 2.0 | 2.04 | |
| Goggin Ln | 3/3/2009 | moderate | 42.4 | 411 | 16.75 | 8.70 | 5.3 | 36 | <0.030 | | 3.730 | 0.167 | 0.44 | 4.17 | 0.153 | 0.104 | < 2.0 | 2.08 | |
| Goggin Ln | 4/7/2009 | moderate | 47.7 | 423 | 13.88 | 8.47 | 8.1 | 67 | <0.030 | | 3.000 | 0.154 | 0.35 | 3.35 | 0.146 | 0.051 | < 2.0 | 1.78 | |
| Goggin Ln | 5/5/2009 | moderate | 60.1 | 432 | 12.79 | 8.54 | 6.1 | 53 | | 3.75 | | 0.200 | 0.48 | 4.23 | 0.209 | 0.219 | < 2.0 | 2.99 | |
| Goggin Ln | 6/2/2009 | low | 80.2 | 489 | 13.36 | 9.29 | 1.5 | 5 | 0.087 | | 10.000 | 0.170 | 0.71 | 10.80 | 0.312 | 0.284 | < 2.0 | 4.34 | |
| Goggin Ln | 7/1/2009 | moderate | 74.8 | 483 | 12.64 | 8.98 | 3.1 | 8 | 0.020 | | 5.480 | 0.177 | 0.36 | 5.86 | 0.187 | 0.082 | < 2.0 | 3.03 | |
| BB Mouth | 12/8/2008 | low | 46.1 | 402 | 11.43 | 7.98 | 0.0 | 0 | 0.100 | | 0.225 | 1.170 | 1.88 | 2.21 | 0.090 | 0.059 | < 2.0 | 3.68 | |
| BB Mouth | 1/6/2009 | moderate | 44.0 | 431 | 9.60 | 8.41 | slightly turbid | 12 | <0.030 | | 2.410 | 0.091 | 0.43 | 2.84 | 0.083 | 0.045 | < 2.0 | 2.28 | 8 |
| BB Mouth | 2/3/2009 | moderate | 38.3 | 271 | 13.35 | 8.17 | 16.5 | 23 | <0.030 | | 3.650 | 0.054 | 0.64 | 4.29 | 0.092 | 0.060 | < 2.0 | 1.96 | |
| BB Mouth | 3/3/2009 | moderate | 41.7 | 321 | 16.21 | 8.55 | 9.0 | 10 | <0.030 | | 2.040 | 0.208 | 0.43 | 2.47 | 0.066 | 0.035 | < 2.0 | 1.65 | |
| BB Mouth | 4/7/2009 | moderate | 45.7 | 306 | 12.71 | 8.25 | 26.0 | 13 | <0.030 | | 2.040 | 0.192 | 0.49 | 2.53 | 0.107 | 0.025 | < 2.0 | 2.01 | |
| BB Mouth | 5/5/2009 | moderate | 60.6 | 354 | 11.27 | 8.59 | 9.6 | 14 | | 1.18 | | 0.151 | 0.33 | 1.51 | 0.058 | 0.042 | < 2.0 | 2.78 | |
| BB Mouth | 6/2/2009 | low | 71.6 | 355 | 6.29 | 7.71 | 1.8 | 1 | 0.023 | | 1.130 | 0.171 | 0.55 | 1.70 | 0.124 | 0.088 | < 2.0 | 2.74 | |
| BB Mouth | 7/1/2009 | moderate | 70.5 | 378 | 9.97 | 8.10 | 3.8 | 3 | <0.030 | | 1.690 | 0.253 | 0.50 | 2.19 | 0.119 | 0.053 | < 2.0 | 2.21 | |
| BB West | 12/8/2008 | low | 38.5 | 700 | 13.29 | 7.52 | 12.1 | 0 | <0.030 | | 0.622 | 0.027 | 0.29 | 0.91 | 0.038 | 0.051 | < 2.0 | 2.55 | |
| BB West | 1/6/2009 | moderate | 44.3 | 401 | 9.52 | 8.01 | opaque | 3 | <0.030 | | 2.600 | 0.066 | 0.37 | 2.97 | 0.045 | 0.030 | < 2.0 | 1.62 | 4 |
| BB West | 2/3/2009 | moderate | 40.6 | 219 | 12.21 | 7.72 | 14.7 | 10 | <0.030 | | 3.860 | 0.037 | 0.31 | 4.17 | 0.046 | 0.021 | < 2.0 | 2.22 | |
| BB West | 3/3/2009 | moderate | 35.6 | 273 | 14.87 | 7.84 | 7.1 | 4 | <0.030 | | 2.530 | 0.213 | 0.33 | 2.86 | 0.029 | <0.010 | < 2.0 | 1.03 | |
| BB West | 4/7/2009 | moderate | 45.9 | 244 | 11.21 | 7.91 | 29.2 | 7 | <0.030 | | 2.570 | 0.180 | 0.45 | 3.02 | 0.054 | 0.016 | < 2.0 | 1.18 | |
| BB West | 5/5/2009 | moderate | 56.9 | 339 | 10.81 | 8.05 | 9.0 | 5 | | 0.67 | | 0.194 | 0.20 | 0.87 | 0.043 | 0.017 | < 2.0 | 2.12 | |
| BB West | 6/2/2009 | low | 68.0 | 358 | 7.41 | 7.79 | 8.2 | 1 | 0.047 | | 0.650 | 0.183 | 0.81 | 1.50 | 0.065 | 0.033 | < 2.0 | 2.17 | |
| BB West | 7/1/2009 | moderate | 65.9 | 348 | 11.80 | 8.27 | 8.4 | 1 | <0.030 | | 1.110 | 0.192 | 0.25 | 1.36 | 0.053 | 0.021 | < 2.0 | 1.73 | |
| KY-52 | 12/8/2008 | low | 44.7 | 836 | 17.07 | 8.21 | 0.0 | 8 | 0.382 | | 11.900 | 0.112 | 0.46 | 12.74 | 0.307 | 0.197 | < 2.0 | 5.12 | |
| KY-52 | 1/6/2009 | moderate | 46.3 | 1740 | 9.86 | 8.35 | opaque | 24 | 0.069 | | 5.270 | 0.880 | 1.34 | 6.68 | 0.148 | 0.084 | < 2.0 | 2.50 | 6 |
| KY-52 | 2/3/2009 | moderate | 40.4 | 491 | 13.18 | 8.06 | 6.2 | 37 | 0.023 | | 4.400 | 0.101 | 0.73 | 5.15 | 0.152 | 0.096 | < 2.0 | 1.86 | |
| KY-52 | 3/3/2009 | moderate | 41.7 | 808 | 17.56 | 8.40 | 3.9 | 21 | 0.020 | | 5.090 | 0.170 | 0.75 | 5.86 | 0.219 | 0.163 | < 2.0 | 2.62 | |
| KY-52 | 4/7/2009 | moderate | 48.0 | 514 | 12.34 | 8.10 | 10.1 | 40 | 0.018 | | 3.470 | 0.205 | 0.42 | 3.91 | 0.189 | 0.066 | < 2.0 | 2.06 | |
| KY-52 | 5/5/2009 | moderate | 59.5 | 465 | 10.36 | 8.21 | 6.7 | 30 | | 4.09 | | 0.153 | 0.69 | 4.78 | 0.361 | 0.253 | < 2.0 | 3.67 | |
| KY-52 | 6/2/2009 | low | 75.0 | 573 | 10.36 | 8.17 | 1.6 | 5 | 0.091 | | 16.000 | 0.124 | <0.20 | 16.09 | 0.582 | 0.503 | < 2.0 | 4.66 | |
| KY-52 | 7/1/2009 | moderate | 72.8 | 547 | 10.59 | 8.44 | 3.3 | 7 | 0.031 | | 8.240 | 0.210 | 0.24 | 8.51 | 0.197 | 0.093 | < 2.0 | 3.36 | |
| WWTP | 6/2/2009 | low | 23.3 | 621 | 8.15 | 7.81 | 3.9 | | 0.033 | | 21.400 | 0.224 | 0.39 | 21.82 | 0.953 | 0.626 | 2.02 | 5.28 | |
| Stanford Rd | 12/8/2008 | low | 35.4 | 777 | 11.44 | 7.23 | opaque | 1 | 0.115 | | 1.300 | 0.273 | 0.56 | 1.97 | 0.097 | 0.085 | < 2.0 | 2.27 | |
| Stanford Rd | 1/6/2009 | moderate | 44.2 | 2360 | 9.46 | 8.55 | slightly turbid | 12 | 0.086 | | 3.780 | 1.250 | 1.35 | 5.22 | 0.108 | 0.072 | < 2.0 | 1.83 | 6 |
| Stanford Rd | 2/3/2009 | moderate | 37.7 | 464 | 13.29 | 7.86 | 9.2 | 24 | <0.030 | | 3.310 | 0.047 | 0.52 | 3.83 | 0.100 | 0.072 | < 2.0 | 1.78 | |
| Stanford Rd | 3/3/2009 | moderate | 34.9 | 828 | 16.42 | 7.97 | 4.5 | 16 | 0.019 | | 2.190 | 0.186 | 0.39 | 2.60 | 0.063 | 0.039 | < 2.0 | 1.55 | |
| Stanford Rd | 4/7/2009 | moderate | 45.4 | 495 | 11.68 | 7.92 | 12.0 | 26 | <0.030 | | 1.990 | 0.199 | 0.46 | 2.45 | 0.098 | 0.036 | < 2.0 | 1.74 | |
| Stanford Rd | 5/5/2009 | moderate | 57.6 | 424 | 9.84 | 8.01 | 5.6 | 22 | | 1.63 | | 0.231 | 0.31 | 1.94 | 0.099 | 0.096 | < 2.0 | 2.83 | |
| Stanford Rd | 6/2/2009 | low | 71.5 | 461 | 5.78 | 7.59 | 5.9 | 2 | 0.021 | | 0.763 | 0.198 | 0.60 | 1.38 | 0.147 | 0.099 | < 2.0 | 2.80 | |
| Stanford Rd | 7/1/2009 | moderate | 68.8 | 468 | 14.84 | 8.33 | 6.4 | 2 | <0.030 | | 1.270 | 0.195 | 0.27 | 1.54 | 0.122 | 0.056 | < 2.0 | 2.22 | |
| S. 2nd Str | 12/8/2008 | low | 40.7 | 579 | 12.50 | 8.12 | 0.2 | 1 | 0.094 | | 1.220 | 0.045 | 0.32 | 1.63 | 0.084 | 0.074 | < 2.0 | 2.30 | 4 |
| S. 2nd Str | 1/6/2009 | moderate | 45.1 | 499 | 9.75 | 8.81 | opaque | 16 | <0.030 | | 2.600 | 0.085 | 0.55 | 3.15 | 0.101 | 0.063 | < 2.0 | 1.91 | |
| S. 2nd Str | 2/3/2009 | moderate | 39.3 | 392 | 13.01 | 8.01 | 10.1 | 26 | <0.030 | | 3.420 | <0.030 | 0.40 | 3.82 | 0.108 | 0.071 | < 2.0 | 1.91 | |
| S. 2nd Str | 3/3/2009 | moderate | 37.2 | 404 | 15.59 | 8.04 | 5.8 | 12 | <0.030 | | 2.370 | 0.177 | 0.29 | 2.66 | 0.086 | 0.054 | < 2.0 | 1.64 | |
| S. 2nd Str | 4/7/2009 | moderate | 46.0 | 377 | 12.38 | 8.02 | 11.2 | 28 | <0.030 | | 2.040 | 0.143 | 0.41 | 2.45 | 0.089 | 0.045 | < 2.0 | 1.75 | |
| S. 2nd Str | 5/5/2009 | moderate | 58.1 | 411 | 9.54 | 8.16 | 5.8 | 21 | | 1.71 | | 0.208 | 0.29 | 2.00 | 0.088 | 0.084 | < 2.0 | 2.70 | |
| S. 2nd Str | 6/2/2009 | low | 68.3 | 411 | 7.89 | 7.69 | 4.3 | 2 | 0.035 | | 0.886 | 0.152 | 0.47 | 1.39 | 0.107 | 0.075 | < 2.0 | 2.63 | |
| S. 2nd Str | 7/1/2009 | moderate | 67.8 | 445 | 11.61 | 8.24 | 5.3 | 2 | <0.030 | | 1.340 | 0.202 | 0.33 | 1.67 | 0.118 | 0.057 | < 2.0 | 2.13 | |
| US-127 | 12/8/2008 | low | 34.8 | 569 | 11.65 | 6.83 | 0.0 | 0 | <0.030 | | 0.457 | 0.025 | 0.46 | 0.92 | 0.087 | 0.065 | < 2.0 | 1.85 | |
| US-127 | 1/6/2009 | moderate | 44.8 | 398 | 9.74 | 7.39 | 13.9 | 4 | <0.030 | | 2.710 | 0.056 | 0.37 | 3.08 | 0.102 | 0.072 | < 2.0 | 2.06 | 4 |
| US-127 | 2/3/2009 | moderate | 38.2 | 304 | 12.44 | 7.64 | 11.0 | 10 | <0.030 | | 3.870 | 0.042 | 0.70 | 4.57 | 0.099 | 0.115 | < 2.0 | 2.00 | |
| US-127 | 3/3/2009 | moderate | 34.1 | 355 | 14.55 | 7.50 | 8.9 | 4 | <0.030 | | 2.520 | 0.146 | 0.36 | 2.88 | 0.085 | 0.059 | < 2.0 | 1.66 | |
| US-127 | 4/7/2009 | moderate | 44.8 | 313 | 11.16 | 7.71 | 17.2 | 12 | <0.030 | | 1.850 | 0.186 | 1.10 | 2.95 | 0.086 | 0.033 | < 2.0 | 2.09 | |
| US-127 | 5/5/2009 | moderate | 56.8 | 339 | 10.02 | 7.89 | 9.1 | 8 | | 1.14 | | 0.162 | 0.24 | 1.38 | 0.083 | 0.066 | < 2.0 | 2.99 | |
| US-127 | 6/2/2009 | low | 67.4 | 333 | 6.50 | 7.63 | 2.4 | 0 | <0.030 | | 0.364 | 0.195 | 0.84 | 1.20 | 0.071 | 0.050 | < 2.0 | 2.04 | |

| Site | Date | Flow Event | Temperature (F) | Conductivity (mS/cm) | DO (mg/L) | pH (SU) | Turbidity (NTU) | Discharge (ft3/sec) | NO2 (mg/L) | NO2/NO3 (mg/L) | NO3 (mg/L) | NH3-N (mg/L) | TKN (mg/L) | TN (mg/L) | TP (mg/L) | OP (mg/L) | BOD (mg/L) | TOC (mg/L) | TSS (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US-127 | 7/1/2009 | moderate | 66.7 | 394 | 11.50 | 8.18 | 3.9 | 0 | <0.030 | | 0.828 | 0.177 | 0.29 | 1.12 | 0.084 | 0.058 | < 2.0 | | |
| Corporate Dr. | 12/8/2008 | low | 37.5 | 248 | 11.34 | 7.32 | 0.7 | 0 | <0.030 | | 0.293 | 0.048 | 0.41 | 0.70 | 0.073 | 0.045 | 2.16 | 3.37 | |
| Corporate Dr. | 1/6/2009 | moderate | 43.1 | 387 | 10.43 | 8.39 | opaque | 4 | <0.030 | | 2.560 | 0.072 | 0.52 | 3.08 | 0.070 | 0.061 | < 2.0 | 2.78 | 6 |
| Corporate Dr. | 2/3/2009 | moderate | 36.4 | 253 | 12.92 | 7.54 | 13.5 | 6 | <0.030 | | 2.330 | 0.027 | 0.54 | 2.87 | 0.083 | 0.045 | < 2.0 | 3.03 | |
| Corporate Dr. | 3/3/2009 | moderate | 35.1 | 315 | 14.69 | 6.37 | 13.4 | 3 | <0.030 | | 1.580 | 0.204 | 0.56 | 2.14 | 0.051 | 0.032 | < 2.0 | 1.98 | |
| Corporate Dr. | 4/7/2009 | moderate | 43.9 | 267 | 11.62 | 7.68 | 29.3 | 5 | <0.030 | | 0.981 | 0.171 | 0.68 | 1.67 | 0.068 | 0.019 | < 2.0 | 2.74 | |
| Corporate Dr. | 5/5/2009 | moderate | 57.6 | 311 | 10.80 | 7.83 | 11.0 | 9 | | 1.82 | | 0.195 | 0.26 | 2.08 | 0.059 | 0.039 | < 2.0 | 3.48 | |
| Corporate Dr. | 6/2/2009 | low | 68.5 | 347 | 6.46 | 7.50 | 0.5 | 0 | <0.030 | | 0.010 | 0.189 | 0.34 | 0.35 | 0.023 | <0.010 | < 2.0 | 2.33 | |
| Corporate Dr. | 7/1/2009 | moderate | 68.1 | 366 | 8.98 | 8.02 | 1.4 | 0 | <0.030 | | <0.015 | 0.178 | 0.29 | 0.29 | 0.019 | 0.019 | < 2.0 | 2.53 | |

# APPENDIX E – THIRD ROCK MICROBIAL SOURCE TRACKING RESULTS SUMMARY

# Watershed Division: BALLS BRANCH WEST

## Habitat Assessments:

Best Site: BB1


Worst Site: BB05

One of the sites in Balls Branch West was "partially supporting" in its designated use (BB1), and all other sites were "not supporting". Many sites had riparian zones less than 15 feet from the stream, at times grazed to the stream edge. BB3, BB5, and BB6 appear negatively affected by immediate cattle access to the stream. BB5 is an actively eroding, entrenched stream with large silted pools lacking habitat. BB3 lacks riparian width due to grazing and BB6 lacks in-stream habitat. BB4 is entrenched and lacks velocity/depth variations.

## Field Observed Fecal Inputs:


Cattle along BB6

Pump station upstream of BB7

Evidence of cattle in the streams was found in four locations. A pump station upstream of BB7 may contribute to fecal inputs during overflows as may the residences on septic systems in the area. Signs of raccoons, deer, and other small mammals were found, but these are not expected to be significant contributors.

## MST Results:

All sites exceed the Kentucky recreational water maximum limit of 240cfu/100mls by at least a factor of ten, and in some cases is a hundredfold greater. The AC/TC ratios are mostly below 2, indicating a fresh source - human more so than cattle at the sites with the lowest ratios.

*E. coli* concentrations were highest during the wet event along the tributary monitored by sites BB03, BB06, and BB07, with concentrations decreasing with dilution further downstream. Source identification results for the dry MST event at BB03 area show that the fecal contribution from humans comprises 70% of the total and cattle 15%. Together these results indicate that the neighborhoods clustered around US 127 are the primary contributors to the input in this area. Waste water from the neighborhood around Old US 127/Hustonville Road and McBee Drive as well as the one near Bonta Lane is treated by septic systems, while all others are on sewers. Overflows at the pump station could also contribute to the impairment.

In the areas upstream of BB4 and BB5, cattle contributes more significantly at 50% during the dry MST event, while the human component is present at 10% despite relatively few residences in this area. Although confirmatory MST testing was not conducted along BB2, it is expected that source inputs would be similar to BB4 - BB5.

# Watershed Division: BALLS BRANCH WEST

Habitat Assessment: Optimal, Suboptimal, Marginal, Poor
Supporting Use: Fully, Partially, Not Supporting

| Site Name | BB1 | BB2 | BB3 | BB4 | BB5 | BB6 | BB7 |
|---|---|---|---|---|---|---|---|
| Date | 7/12 | 7/13 | 7/12 | 7/13 | 7/13 | 7/12 | 7/13 |
| Epifaunal Substrate / Available Cover | 14 | 14 | 9 | 13 | 4 | 4 | 12 |
| Embeddedness | 18 | 18 | 11 | 16 | 9 | 12 | 18 |
| Velocity / Depth Regime | 9 | 5 | 7 | 5 | 4 | 7 | 5 |
| Sediment Deposition | 14 | 10 | 8 | 9 | 8 | 11 | 16 |
| Channel Flow Status | 17 | 1 | 8 | 4 | 3 | 8 | 7 |
| Channel Alterations | 15 | 20 | 18 | 18 | 19 | 15 | 14 |
| Frequency Of Riffles (or Bends) | 18 | 17 | 16 | 8 | 19 | 13 | 11 |
| Bank Stability - Left Bank | 9 | 8 | 6 | 7 | 6 | 6 | 7 |
| Bank Stability - Right Bank | 8 | 5 | 8 | 7 | 4 | 8 | 6 |
| Bank Vegetation Protection - Left Bank | 9 | 9 | 4 | 7 | 3 | 6 | 5 |
| Bank Vegetation Protection - Right Bank | 7 | 7 | 7 | 8 | 1 | 8 | 8 |
| Riparian Vegetation Zone Width - Left Bank | 5 | 9 | 1 | 2 | 1 | 1 | 1 |
| Riparian Vegetation Zone Width - Right Bank | 7 | 4 | 4 | 3 | 0 | 10 | 1 |
| **Total Habitat Assessment Score** | **150** | **127** | **107** | **107** | **81** | **109** | **111** |

Field Observed Fecal Inputs:

| Site Name | Date | Human | Cattle/Horse | Goats | Wildlife | Domestic Pets | Avian | None Observed | Description |
|---|---|---|---|---|---|---|---|---|---|
| BB1 | 7/12/2007 | | | | X | | | | Small mammal holes along reach |
| BB2 | 7/13/2007 | | X | | X | | | | Deer, raccoon, and cattle tracks |
| BB3 | 7/12/2007 | | X | | | | | | Cattle fecal matter and tracks throughout reach |
| BB4 | 7/13/2007 | | | | X | | | | Raccoon tracks |
| BB5 | 7/13/2007 | | X | | | | | | Cattle in stream- fecal material observed |
| BB6 | 7/12/2007 | | X | | X | | | | Cattle fecal matter and tracks throughout reach |
| BB7 | 7/13/2007 | X | | | X | X | | | Pump station upstream, Tracks from 4 local cats |

MST Results:

| Site | | BB1 | BB2 | BB3 | BB4 | BB5 | BB6 | BB7 |
|---|---|---|---|---|---|---|---|---|
| Dry Event | *E. coli* (CFU/100mls) | 2700 | 26000 | 3400 | 5000 | 23000 | 4400 | 3600 |
| | AC/TC Ratio | 1.2 | 1.0 | 0.2 | 2.4 | 0.3 | 0.9 | 0.4 |
| | %Human | | | ~70 | | ~10 | | |
| | %Cattle | | | ~15 | | ~50 | | |
| Wet Event | *E. coli* (CFU/100mls) | 13400 | 24000 | 22000 | 2700 | 4100 | 92000 | 144000 |
| | AC/TC Ratio | 0.9 | 3.9 | 2.0 | 2.3 | 1.2 | 1.4 | 2.7 |
| | %Human | | | NIL | | | | |
| | %Cattle | | | NIL | | | | |

# Watershed Division: CLARKS RUN

## Habitat Assessments:

Best Site: CR01

Worst Site: CR10

Four of the sites in Clarks Run were scored as “fully supporting” in their designated use, three were “partially supporting,” and six were “not supporting.” CR12 provided the best habitat in the area, with optimal ratings in five of the ten categories. As is common throughout the Dix River Watershed, the riparian zone width received the poorest ratings, falling far short of the optimal width of at least 60 feet. CR10, with the lowest habitat score, had eroding banks with marginal vegetative protection, riparian width, sediment deposition, and flow status.

## Field Observed Fecal Inputs:

*Nematodes as indicator of sewage overflow upstream of CR08*

Human fecal sources are prevalent throughout this area, with indicators of a sewer overflow observed at an intermittent / perennial tributary upstream of CR08 behind the train depot. According to railroad workers near this site, a sewage smell and toilet paper are regularly observed in this stream. The stream contained an abundance of nematodes, an indicator of a sewage overflow. Other overflows of this nature may be present, but were not observed. Small urban wildlife was commonly observed but not expected to be a significant contributor.

## MST Results:

All sites exceed the Kentucky recreational water maximum limit of 240 cfu/100mls, with dry event samples ranging from 9800 at CR09 to 360 at CR14. Wet event samples were significantly higher, ranging from 117,000 at CR04 to 1500 at CR07.

At CR04, 80% of the dry MST event and 100% of the wet MST event were attributed to human sources. This site is located upstream of the WWTP, but the sewer main draining most of southern Danville runs parallel to the stream for a large portion of the upstream reach. Overflows or exfiltration from the sewer system are indicated as the primary cause of impairment in the upstream area. At CR09, MST testing showed equal contribution from human and cattle sources during a dry event.

In areas where MST was not performed, low AC/TC ratios indicate a fresh human source. In the headwater areas, upstream of CR11 and CR12, higher AC/TC ratios indicate that more aged inputs from livestock sources may be greater contributors to the pathogen impairment.

# Watershed Division: CLARKS RUN

Habitat Assessment: Optimal, Suboptimal, Marginal, Poor
Supporting Use: Fully, Partially, Not Supporting

| Site Name | CR01* | CR03* | CR04* | CR05 | CR06 | CR07* | CR08 | CR09 | CR10 | CR11 | CR12* | CR13* | CR14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 7/27 | 7/27 | 7/27 | 7/27 | 7/27 | 7/27 | 7/27 | 7/30 | 7/30 | 7/30 | 7/30 | 7/30 | 7/30 |
| Epifaunal Substrate / Available Cover | 13 | 15 | 16 | 11 | 12 | 14 | 10 | 11 | 10 | 12 | 15 | 14 | 13 |
| Embeddedness | 16 | 9 | 5 | 8 | 12 | 15 | 11 | 11 | 13 | 16 | 14 | 15 | 11 |
| Velocity / Depth Regime | 13 | 12 | 17 | 10 | 11 | 17 | 9 | 11 | 11 | 16 | 15 | 17 | 11 |
| Sediment Deposition | 13 | 10 | 2 | 6 | 10 | 13 | 6 | 6 | 6 | 10 | 18 | 13 | 10 |
| Channel Flow Status | 18 | 16 | 17 | 13 | 12 | 17 | 10 | 10 | 10 | 15 | 16 | 17 | 13 |
| Channel Alterations | 18 | 16 | 17 | 20 | 11 | 15 | 15 | 10 | 20 | 14 | 15 | 15 | 15 |
| Frequency Of Riffles (or Bends) | 18 | 18 | 15 | 16 | 20 | 18 | 16 | 17 | 13 | 17 | 16 | 18 | 16 |
| Bank Stability - Left Bank | 10 | 9 | 9 | 5 | 7 | 10 | 5 | 4 | 2 | 8 | 9 | 10 | 8 |
| Bank Stability - Right Bank | 9 | 9 | 9 | 5 | 7 | 10 | 5 | 4 | 2 | 8 | 9 | 10 | 8 |
| Bank Vegetation Protection - Left Bank | 6 | 7 | 8 | 8 | 9 | 9 | 9 | 3 | 5 | 10 | 9 | 9 | 8 |
| Bank Vegetation Protection - Right Bank | 8 | 7 | 8 | 9 | 9 | 9 | 9 | 3 | 5 | 10 | 9 | 9 | 8 |
| Riparian Vegetation Zone Width - Left Bank | 2 | 2 | 2 | 6 | 1 | 1 | 3 | 2 | 5 | 3 | 4 | 1 | 0 |
| Riparian Vegetation Zone Width - Right Bank | 4 | 2 | 2 | 3 | 1 | 1 | 3 | 2 | 3 | 3 | 4 | 1 | 0 |
| **Total Habitat Assessment Score** | **148** | **133** | **127** | **120** | **122** | **149** | **111** | **94** | **85** | **142** | **153** | **149** | **121** |

*Habitat Scores are a composite of multiple evaluations by multiple samplers.

Field Observed Fecal Inputs:

| Site Name | Date | Human | Cattle/Horse | Goats | Wildlife | Domestic Pets | Avian | None Observed | Description |
|---|---|---|---|---|---|---|---|---|---|
| CR1 | 7/27/2007 | X | X | | X | | | | Adjacent wildlife, residences could have minimal impact, cattle upstream about 600 yards. |
| CR3 | 7/27/2007 | X | X | | X | | X | | Cattle with stream access, WWTP upstream, nearby residence, ducks in stream, raccoon tracks |
| CR4 | 7/27/2007 | X | | | X | | X | | Raccoons, waterfowl, adjacent industry |
| CR5 | 7/27/2007 | X | | | X | | | | Adjacent residence, wildlife tracks - raccoons, muskrat |
| CR6 | 7/27/2007 | X | | | X | | X | | Birds and other wildlife |
| CR7 | 7/27/2007 | X | | | X | | X | | Mixed use area |
| CR8 | 7/27/2007 | X | | | X | | | | Small wildlife; sewer overflow observed on upstream tributary |
| CR9 | 7/27/2007 | X | | | X | | | | Small wildlife or upstream human sources |
| CR10 | 7/27/2007 | X | | | X | | | | Upstream residences, abundant wildlife |
| CR11 | 7/27/2007 | X | | | X | | | | Commercial areas, wildlife |
| CR12 | 7/27/2007 | | X | | X | | | | Cattle upstream, wildlife |
| CR13 | 7/27/2007 | X | X | | X | | | | Cattle access with fresh feces, adjacent residences, commercial area, raccoon tracks |
| CR14 | 7/27/2007 | X | | | X | | | | Primarily human potential, but some small wildlife |

# Watershed Division: CLARKS RUN (continued)

MST Results:

| Site | | CR1 | CR3 | CR4 | CR5 | CR6 | CR7 | CR8 | CR9 | CR10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Dry Event | *E. coli* (CFU/100mls) | 1120 | 3100 | 2300 | 1220 | 3200 | 2500 | 2200 | 9800 | 1480 |
| | AC/TC Ratio | 2.1 | - | 6.3 | 0.1 | 0.8 | 6.0 | 0.2 | 0.3 | 3.3 |
| | %Human | | | ~80 | | | | | ~50 | |
| | %Cattle | | | ~10 | | | | | ~50 | |
| Wet Event | *E. coli* (CFU/100mls) | 20000 | 34000 | 117000 | 2900 | 1500 | 47000 | 10600 | 5200 | 15900 |
| | AC/TC Ratio | 0.7 | 0.3 | 2.0 | 1.7 | 4.5 | 2.1 | 0.8 | 2.4 | 2.3 |
| | %Human | | | ~100 | | | | | | |
| | %Cattle | | | NIL | | | | | | |

| Site | | CR11 | CR12 | CR13 | CR14 |
|---|---|---|---|---|---|
| Dry Event | *E. coli* (CFU/100mls) | 900 | 1330 | 370 | 360 |
| | AC/TC Ratio | 12.5 | 8.3 | 0.1 | 0.1 |
| Wet Event | *E. coli* (CFU/100mls) | 5300 | 31000 | 14100 | 3200 |
| | AC/TC Ratio | 1.3 | 2.7 | 5.2 | 2.8 |

# APPENDIX F – QUALITY ASSURANCE PROJECT PLAN

# Quality Assurance Project Plan

## Monitoring, Assessment, and TMDL Development for the Dix River Watershed

*Prepared for*
Kentucky Environmental and Public Protection Cabinet
May 17, 2006
Revised August 30, 2006

*Prepared by*
Third Rock Consultants, LLC
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Lexington, KY 40503
859.977.2000
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# Quality Assurance Project Plan

## Monitoring, Assessment, and TMDL Development for the Dix River Watershed

*for*

Kentucky Environmental and Public Protection Cabinet
Department for Environmental Protection
Division of Water
14 Reilly Road
Frankfort, KY 40601

*May 18, 2006*
*Revised August 30, 2006*

THIRD ROCK CONSULTANTS

www.thirdrockconsultants.com

Environmental Analysis & Restoration

# Distribution and Review List

Quality Assurance Program Plan for Dix River Watershed
Revision: 1, Dated: August 30, 2006

## 1) Third Rock Consultants, LLC

President and QA Manager

Molly Foree — Date: August 30, 2006

**Project Administrator**

Gerry Fister — Date: August 30, 2006

**Data Manager**

Marcia Wooton — Date: August 30, 2006

**Water Quality Modeler**

Jennifer Shelby — Date: August 30, 2006

## 2) GRW Engineers, Inc.

**Water Quality Modeler**

Mary Beth Robson — Date: August 30, 2006

## 3) CT Laboratories

**Laboratory Director**

David Berwanger — Date: August 30, 2006

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## APPENDICES – FIGURES AND TABLES

# 1. Project Management

## 1.1 Introduction

This Quality Assurance Project Plan (QAPP), prepared by Third Rock Consultants, LLC (Third Rock), was approved by the Kentucky Division of Water (KDOW). This QAPP covers the planning, implementation, and assessment procedures necessary to meet the minimum data quality objectives (DQOs) for the monitoring, assessment, and TMDL development for the Dix River Watershed, Kentucky.

Third Rock is committed to producing quality data that will assist the Division of Water in the development of their watershed plan. This QAPP is designed to provide a complete plan for achieving all project data quality objectives. However, effective communication is required to ensure all parties properly implement the plan. Any quality feedback, questions, or concerns related to the project should be communicated to the project administrator or quality manager to facilitate appropriate analysis and resolution.

## 1.2 Project Organization

### 1.2.1 Kentucky Division of Water, Primary Data User

The monitoring, assessment, and TMDL development activities conducted by Third Rock Consultants, LLC for the Dix River Watershed will be under the jurisdiction and oversight of the Kentucky Division of Water (KDOW) Watershed Management Branch. Lee Colten serves as the KDOW Project Manager, providing overall direction and guidance to the project. Third Rock's project administrator will communicate directly with Mr. Colten to ensure that all project objectives are satisfied.

Eric Liebenauer serves as the KDOW Water Quality Modeler. In this capacity, he provides guidance for Third Rock's Water Quality Modeling for Clark's Run and will perform the modeling for the Hanging Fork based on the data provided by Third Rock.

### 1.2.2 Third Rock Personnel and QA Responsibilities

The implementation of the project plan requires effective operation of the project team. Figure 1, Dix River Organizational Chart, identifies the parties that comprise the Dix River Project Team and the lines of authority and communication under which this team operates. The specific roles and responsibilities of each key party are documented below.

- ***Project Administrator***

Gerry Fister will serve as the Project Administrator. Mr. Fister is responsible for the overall completion of the project to the requirements of the KDOW. In this capacity, he is responsible for overall project administration, personnel, scheduling, and completion of all data quality objectives. Additionally, he maintains project financials and contracts and submits reports to the KDOW. Mr. Fister serves as the primary contact with the Kentucky Division of Water.

- ***Field Logistics Coordinator***

Tony Miller will serve as the field logistics coordinator. Mr. Miller visually assessed the watershed for nonpoint source pollutants and determined site selection per the TMDL modeling requirements. He additionally researched and built the equipment associated with the Periphyton sampling. Mr. Miller is responsible for report generation, internal technical assistance, and public communications.

- ***Water Quality Modelers***

Jennifer Shelby in conjunction with Mary Beth Robson of GRW Engineers will serve as the Water Quality Modelers. Together they are responsible for the TMDL modeling of the Clark's Run load allocation and training of the KDOW on modeling calibration, application, and manipulation. In the modeling capacity, they are responsible for selection and setup of the modeling reaches, setup of modeling climate, calibration of the model for all parameters, preparation of the modeling summary, and selection of sensitivity scenarios. As trainers, they are responsible to enable the Division of Water staff to evaluate the effects of the new nutrient criteria on the load allocations.

- ***Quality Assurance Manager***

Molly Foree will serve as the Quality Assurance Manager. Ms. Foree is responsible for review of the QAPP, field operations procedures, and data documentation procedures that will help ensure field and laboratory data generated meet data quality objectives. Ms. Foree will remain independent of the data collection. She is responsible for the maintenance and distribution of the approved QAPP.

- ***Data Manager and Sampling Coordinator***

Marcia Wooton will serve as the Data Manager and Sampling Coordinator. Ms. Wooton is responsible for the review of laboratory analytical results and coordination of sampling events. As sampling coordinator, she is responsible to ensure that the sampling procedures and schedule is implemented by the sampling technicians. Ms. Wooton communicates with the laboratories to ensure holding requirements and other data quality objectives are met. Additionally, she notifies the laboratory of sampling bottle preparation needs. As Data Manager, Ms. Wooton reviews analytical data generated by the laboratory and the field, including the COMPASS tables, and ensures that it conforms to the requirements of this QAPP.

- ***Sampling Technicians***

Cory Bloyd will serve as the Primary Sampling Technician with the support of John Davis, Dan Miller, Tony Miller, Johnny Varner, and Steve Evans. Sampling Technicians are responsible for implementing the sampling procedures and schedule as coordinated by the Data Manager and Sampling Coordinator.

### 1.2.3 Subcontractor Responsibilities

#### 1.2.3.1 CT Laboratories of Baraboo, Wisconsin

The analytical subcontractors for the laboratory portion of this project will be CT Laboratories of Baraboo, Wisconsin for all laboratory parameters except Total Coliform / *E. coli* which will be provided by Microbac Laboratories of Lexington, Kentucky. The laboratory will be responsible for analysis of samples delivered such that data quality objectives are met. The laboratory will implement and document QA/QC activities to support the results of the analyses performed on the samples. All analyses are expected to be conducted in accordance with the specified analytical methods, the laboratories QA manual, and this QAPP. Eric Korthals, laboratory project manager, is responsible for ensuring conformance of the laboratory.

The following provides a general summary of the QA responsibilities of key laboratory personnel:

- ***Laboratory Director***

David Berwanger will serve as the Laboratory Director for CT Laboratories. The Laboratory Director is responsible for the supervision of all functional aspects of the laboratory and has authority in a legally binding capacity for all laboratory decisions and operational issues. Responsibilities may include, but are not limited to, overseeing personnel training, equipment and systems maintenance, laboratory safety, monitoring scheduling and status of work, approval of Standard Operating Procedures, implementing preventive and corrective actions, and cost control. The Laboratory Director is responsible for ensuring laboratory personnel implement internal lab QA/QC procedures and comply with applicable regulations.

- ***Laboratory Quality Assurance Director***

Dan Elwood will serve as the Laboratory Quality Assurance Director for CT Laboratories. The Laboratory Quality Assurance Director has authority over and is responsible for the direction of all laboratory QA activities, and is independent of laboratory production functions. The Laboratory Quality Assurance Director's responsibilities include development, documentation, and evaluation of quality assurance/quality control (QA/QC) procedures and policy. He/she conducts internal audits, reviews data reports, compiles and evaluates method performance, trains staff in QA/QC requirements, tracks non-conformances and corrective actions, prepares quality documents and reports, reviews standard operating procedures, and reports findings and quality issues to the Laboratory Director. A primary responsibility of the Quality Assurance Director is to verify that all personnel have a clear understanding of the QA program, know their roles relative to one another, and appreciate the importance of their roles to the overall success of the program.

- ***Laboratory Information System Managers***

David Berwanger and Jason Remley will serve as the Information Systems (IS) Managers for CT Laboratories. The IS Manager's responsibility includes development and maintenance of the software and hardware components of laboratory operations. He/she ensures all systems are operating and validates any computer programs involved in the data reduction, generation and reporting process. The IS Manager serves as the database administrator for the Laboratory Information Management System(LIMS). The IS Manager is responsible for producing data in COMPASS format for this project.

- ***Laboratory Project Manager***

Eric Korthals will serve as the Laboratory Project Manager for CT Laboratories. Project Managers are the Third Rock's primary point of contact for laboratory analytical services. The Laboratory Project Manager's duties involve performing as a client-laboratory liaison for project work, working with customers to identify project-specific requirements, and aiding them, throughout the laboratory, to meet their data quality objectives. Project managers review analytical results to ensure project data and QC requirements have been satisfied, prepare narrative reports where applicable, and monitor project work so deadlines are met. They are responsible for seeing that clients are informed of any quality problems as soon as possible. Project Managers work directly with the laboratory managers and laboratory staff involved in their assigned projects to keep staff informed of QA/QC requirements and to monitor work progress. They also work closely with Third Rock and KDOW to develop work plans and DQOs for current and future work.

## 1.3 Problem Definition and Background

Herrington Lake, in the Kentucky River Basin, was formed by the impoundment of the Dix River. As is common with many reservoirs, Herrington Lake is subject to excessive nutrient loading resulting from point and nonpoint source contributions within the watershed. The Dix River watershed has 24 permitted wastewater-discharge sites and Herrington Lake directly receives wastewater from 6 of the 24 wastewater-discharge sites. In addition, the Dix River watershed contains failing septic systems, agricultural activities including numerous cattle with free access to streams, and development / construction activities. This abundant nutrient input has lead to the deterioration of water quality, problematic algal blooms, and subsequent fish kills.

Herrington Lake was listed in the 2004 303(d) report as 1st priority impaired waterbody for aquatic life (non-support) and fish consumption (partial-support). The major tributaries to the reservoir, Dix River, Clarks Run, and Hanging Fork, were also cited in the 2004 303(d) report as having segments listed as 1st priority impaired in regards to aquatic life support and primary contact (non-support and partial support). The cited reasons for impairment are primarily low levels of dissolved oxygen (DO) and high levels of bacteria. Sources of both impairments stem from agricultural runoff, septic-tank leakage, urban/suburban stormwater runoff, and wastewater treatment plant (WWTP) discharges (USGS 2000).

As part of KDOW's 1998 Clean Water Action Plan, the Natural Resources Conservation Service (NRCS) and KDOW jointly selected five priority watersheds in Kentucky for targeted water quality improvement. The Dix River was selected as one of these priority watersheds. KDOW has committed to form a watershed council to provide input on watershed analysis and plan development. Between 2006 and 2007, KDOW intends to:

- Develop TMDLs for subwatersheds of the Dix River including Clarks Run, Hanging Fork and Herrington Lake (a TMDL, or Total Maximum Daily Load, identifies pollutant sources and the amount of pollutants from each source, and makes recommendations for pollutant loads a stream can handle without violating water quality standards).
- Develop a watershed plan to reduce pollutants from point and non-point sources
- Identify funding sources to implement practices that can reduce pollutants
- Present a draft watershed plan to the watershed council and various stakeholders, and
- Begin implementing remediation actions identified in watershed plan

In order to assist the KDOW in meeting these goals, Third Rock Consultants, LLC has been contracted to identify nutrient and bacteria sources throughout the Dix River watershed and conduct a modeling study in support of a TMDL for nutrients and dissolve oxygen for Clarks Run. Additionally, KDOW will calculate a TMDL for bacteria for Hanging Fork from data provided by the Third Rock sampling effort.

## 1.4 Project Description

### 1.4.1 Summary

Third Rock Consultants' ultimate goal coincides with the Kentucky Division of Water: to remove the tributaries upstream of Herrington Lake (and ultimately Herrington Lake) from the 303(d) list of impaired streams by providing information that will focus water quality improvement actions.

In order to accomplish this goal, specific project tasks of Third Rock are as follows:
1. Identify sites for monitoring on the Dix River watershed that includes Clarks Run and Hanging Fork
2. Perform monitoring and laboratory analysis of the Dix River Watershed providing provide high quality water data for the purpose of determining the source and extent of impairment in the tributaries of Herrington Lake
3. Prioritize sources of impairments and develop a TMDL modeling study for nutrients and dissolved oxygen on Clarks Run.
4. Provide training to KDOW staff on TMDL model
5. Generate ideas for non-point source solutions

Figure 2, Dix River Project Schedule, in the appendix, provides the scheduled time period over which these objectives are expected to be achieved. In general, the sampling effort will last twelve calendar months followed by a 90-day modeling effort and modeling report composition. Additionally, Third Rock will provide continued support to the DOW after TMDL modeling with the further development of allocations, load reductions, and an implementation plan. For each of the goals specified above, a summary of the tasks associated with accomplishing each goal is presented in more detail in the following sections.

### 1.4.2 Site Identification and Preparation

Prior to the establishment of monitoring locations, all major reaches in Clarks Run and Hanging Fork (Hydrologic Unit Level 14 Code (HUC14) and smaller) were visually surveyed to optimally locate sampling stations relative to nonpoint and point source contribution. The sites were marked with GPS waypoints and photographed.

Site locations on the Dix River, Clarks Run, and Hanging Fork were chosen by Third Rock in conjunction with KDOW to characterize the dissolve oxygen, nutrients, sediment, and coliform loadings and to facilitate modeling of these parameters. Sites are located downstream of known problem areas to quantify potential pollutant contribution. Two types of sampling sites are located in the watershed, *select* and *non-select* stations.

#### Non-select stations

Non-select stations are sampled during low, normal, and high flows. Permanent monuments (survey pins) were established to standardize water collection, flow measurement, and photograph locations at each station. Cross-section measurements were completed at each station to support discharge computation. For each cross-section, three reference points were established. Two of the points, located on opposite sides of the bank, were located for subsequent section measurements. The third point will be located for reference of stage readings. Stage reference points may be located on a bridge, established with pins (rebar), or a sturdy overhanging limb. Water samples will be collected from all identified stream stations throughout the entire watershed according to the monthly field schedule prepared by the Data Manager and Sampling Coordinator.

### Select stations

All sampling and preparation that applies to non-select stations also applies to select stations with the addition of several parameters. Select stations additionally have a stormwater sampling component. Passive high flow samplers will be used to assess the peak nutrient and bacterial contribution during heavy rainfall events. Passive high flow sampling device locations will be determined and installed by October 2006. Select stations will also sampled for additional analytical parameters (see Table 1). Six select stations will additionally be mounted with continuous monitoring pressure transducer water level recorders; Drakes Creek, Dix Above, Knob Lick, Hanging Fork 150, Clarks Run Bypass, and Balls Branch Mouth.

The locations of all sampling stations are mapped on either Figure 3, Watershed Overview Map; Figure 4, Hanging Fork and Clarks Run Map; or Figure 5, Dix River Map found in the appendix. For each subwatershed, the following summarizes the station locations and considerations in their establishment.

#### Clarks Run

Eight sites (four select and four non-select) in the Clarks Run subwatershed were established.

#### Hanging Fork

In the Hanging Fork watershed, fourteen stations (six select and eight non-select) were established.

#### Dix River

Seven stations (one select and six non-select) in this section of the watershed were located upstream of the Hanging Fork convergence with the Dix River.

## 1.4.3 Monitoring

Monitoring, which includes, field observations and measurements, provide data valuable for water quality assessment and modeling. Field sample collection directly affects the analytical results generated by the laboratories. Effective monitoring is essential to determining the source and extent of the impairments in the tributaries of Herrington Lake and Dix River Watershed.

For twelve months, monthly *grab samples* will be taken at *all sampling stations and analyzed* as listed in Table 1, Sample / Results Summary for Dix River Watershed. Grab samples from all sites are collected for laboratory analysis for total and ortho-phosphorus, nitrate and nitrite, total kjeldahl nitrogen, ammonia, total organic carbon (TOC), total suspended solids (TSS), total coliform and *E. coli*. Field measurements for dissolved oxygen, temperature, conductivity, flow, and pH will be made at all sites as well.

In addition to these parameters, some sites will have further analysis. The Hanging Fork select stations and all Clark Run stations will be analyzed for 5-day biochemical oxygen demand (BOD5) for the dissolved oxygen modeling. Also, grab samples from the Clarks Run select stations will be analyzed for 15-day BOD. Chlorophyll *a* and alkalinity will be collected monthly and chlorides quarterly for all select stations.

Sampling events for these collections shall coincide adequately with high, low, and medium flow events. The high-flow samples at the *select stations* will be collected using the *passive high flow sampling* for all of the above chemical parameters. Sampling periods will coincide with elevated flow from November to April with a goal of capturing one high flow event per month following a seven day dry period. The schedule will also be managed to ensure that low and medium flow events are captured. Methods for passive high flow sampling will consist of a low-tech sampler based on methods presented in Subcommittee on Sedimentation, 1961. Sample bottles are mounted on an in-stream frame and filled as the stream rises. Once the stream recedes samples will be collected for analysis.

During the recreational period (May – October), Third Rock will dispatch sampling technicians to collect samples from Hanging Fork during a high flow period. Because the passive high flow samplers would bias total coliform and *E. coli* results, technicians will be in the watershed as the storm event occurs to allow collection of these samples during the hydrographic rise of the stream. This storm event should occur after a relatively dry period.

*Periphyton:* Periphyton will be collected from natural substrate at the select stations and measured from chlorophyll *a* and multihabitat samples. Chlorophyll *a* will be collected by agitating 0.25$m^2$ of natural substrate, according to KDOW protocol. Multihabitat periphyton samples will be collected twice per year (critical period) for species identification. The in-stream substrate will be selected for sampling relative to its occurring abundance in order to accurately represent periphyton taxa from different habitat.

*Dissolved Oxygen:* Dissolved oxygen will be measured during every sampling event. During the low-flow summer period, 24 hour diurnal dissolved oxygen will be measured once at two select sites, one of which will be located at Clarks Run / KY52. The other site will be determined based on results of initial sampling.

*Flow:* Discharge, or flow, will be determined at all sites during each of the monthly site visits. Velocity and depth will be measured at intervals sufficient to characterize stream flow. Discharge will be computed as the sum of each velocity times the corresponding flow area. Pressure transducers are additionally mounted at six sites.

*Physical Habitat Assessment:* An EPA Rapid Bioassessment Protocol (RBP) worksheet will be completed at each site twice during the sampling year, once during the initial reconnaissance and once at the end of the year. Estimates of type, density, and aerial coverage of rooted aquatic plants (or lack thereof) will be determined by observation during monthly field visits. Physical channel condition will be characterized using Rosgen classification during this same period. For determining correlates for emergent plant and periphyton growth, canopy cover will be estimated using a spherical densitometer once during peak leaf out and turbidity will be measured using a turdidimeter during periphyton (chlorophyll *a*) sampling.

### 1.4.4 Modeling

The TMDL modeling study of Clarks Run will address the following:
- Nutrients (nitrogen and phosphorus)
- Biochemical Oxygen Demand (as an indicator of organic enrichment)
- Dissolved Oxygen

The EPA model, Qual2K, will be used to predict pollutant concentrations based on environmental conditions during critical periods. Qual2K is a modernized version of Qual2E and is a one-dimensional steady state model.

Third Rock will deliver a TMDL document using the format outlined in the guidance document titled *Requirements for Kentucky DOW TMDL Documents*. This document includes descriptions of all relevant background information, summary, water body details, monitoring history, current monitoring effort, and modeling report. The steps required in creating this document are outlined below:

- Select modeling reach
  - Review existing in-stream data
    - Data will include all biological, chemical, and flow.
  - Find known point and nonpoint source pollutants.
    - Review land use mapping and aerials
    - Review available source loading data
    - Develop prediction tool for nonpoint source loading and relation to field data
- Segment reaches
  - Using land use cover and items above
- Select target time period (periods)
  - Review measured data, load data
  - Review all available flow data and precipitation records
  - Determine critical flow
- Set up Model Reaches
  - Input downstream point, lat/long, elevation (either USGS topographic or other available data)
  - Select velocity/depth computation method for each reach. Assign algae, SOD coverage coefficients.
    - Use Excel/VBA program named 'Shade.xls' or other estimate of daily shade factors
    - Review site photographs.
- Set up Model Climate: air temperature, dew point, wind speed (and height of measurement) and cloud cover
  - Find hourly data source close to project
  - Obtain data, format, QA/QC, input into model
  - Light and heat coefficients

- Point sources
  - Assign flow and chemical constituents (average of discharge monitoring report data, monthly operating data, or other)
  - Make assumptions about missing data, defend
  - Tributaries are not modeled explicitly but can be represented as point sources
- Non Point Sources
  - Assign flow and chemical constituents
- Select Rates: determine rates, constants, coefficients to use;
  - Calibrate model for spatial concentrations
  - Calibrate model for temporal dissolved oxygen concentrations
- Run sensitivity analyses for any parameters for which Third Rock does not have data and other parameters to determine model sensitivity
- Prepare modeling summary (estimate 20 pages)
- Select sensitivity scenarios for TMDL
  - Meet with KDOW to discuss load reductions
  - Run 10 scenarios
  - Summarize results

### 1.4.5 Training

After TMDL completion, Third Rock will provide continued support to KDOW with the further development of allocations, load reductions, and an implementation plan.

Two days of training regarding the model are anticipated with KDOW staff. This training will serve to describe the calibration of the model, the appropriate applications of the model, and the techniques for changing loads and parameters within the model. The training will include hands-on demonstration of the water quality model and creation of output tables and graphs. Training will also demonstrate how to apply the model to the anticipated, but not yet promulgated, nutrient criteria. This training will enable Division of Water staff to evaluate the effects of new nutrient criteria on load allocations.

### 1.4.6 Nonpoint Source Pollution Abatement

Practical solutions for known impairments will be recommended for the most significant pollutant sources. The feasibility of these solutions will be judged by cost, landowner cooperation, and long-term predicted success. Solutions will include on-the-ground best management practices, as well as potential funding options and the agencies responsible for implementing the funding.

# 1.5 Quality Assurance Objectives

## 1.5.1 General Quality Objectives

The overall project data quality objective (DQO) is to provide information that will lead to improved water quality and the removal of the tributaries upstream of Herrington Lake (and ultimately Herrington Lake) from the 303(d) list of impaired streams and reservoirs. Reaching this objective requires that data generated and used for modeling must be of sufficient quantity and quality to support:

- Determination of the source and extent of impairment to the tributaries of Herrington Lake.
- Development of a TMDL model for nutrients on Clarks Run by Third Rock.
- Development of a TMDL model for pathogens on Hanging Fork by KDOW

The following items detail the performance criteria for the measurement process associated with water quality sampling, water quality processing, and TMDL development for this project.

## 1.5.2 Field Objectives

Field observations and measurements provide data valuable for water quality assessment and modeling. Field sample collection directly affects the analytical results generated by the laboratories. The following specific tasks apply:

- Chain of Custody forms are to be completed such that custody of samples is traceable and accurate from the time of sampling until received by the laboratory.
- Samples are to be protected by proper packing and transportation, preservation and handling techniques in order to maintain the integrity of the sample.
- Cross-sectional measurements shall be sufficient to accurately characterize the flow area.
- Temporary markers and GPS positioning are established to ensure maximum repeatability in data collection position and to facilitate locating the sites by multiple parties.
- Field equipment will be calibrated in accordance with the manufacturer's instructions in order to meet the specified accuracy and precision criteria. Equipment calibration logs will be maintained.
- Grab collections are made to obtain samples chemically representative of the site during the time period and flow rate during which it is sampled.
- Total organic carbon shall be sampled with minimum headspace in order to minimize the impact of the volatilization of organic carbon.
- Habitat assessments are conducted in order to provide stream supporting capabilities, context to analytical assessments, record visual changes in the habitat and reference to measure remediation impact.

- EPA Rapid Bioassessment Protocol (RBP) are measured in order to provide a quantitative score of the waterbody indicating the quality of the environment.
- Photographs are taken to indicate and provide visualization for significant changes in the habitat throughout the duration of the sampling.
- Flow shall be measured with sufficient quality to determine the loadings of individual parameters at the time of collection.
- Periphyton and chlorophyll *a* sampling shall be conducted such that the surfaces sampled are representative of the site surfaces, algal speciation and growth levels.
- Passive high flow sampling shall be conducted such that the non-point nutrient runoff is captured at its peak.
- The pressure water level recorder measurements are used to establish more comprehensive flow measurements throughout the sampling period. These recorders are downloaded at a frequency to ensure all measurements are gathered.

### 1.5.3 Laboratory Analytical Objectives

The objective of the analytical parameters is to identify numeric or measurable indicators and target values that can be used to evaluate the TMDL and the restoration of water quality. Each parameter has a specific purpose that fits into this overall objective and shall meet the quality standards established in Table 2, Methods, Analytes, and Data Quality Indicators for the Dix River Watershed, and below.

- For modeling purposes, nutrient sampling will be conducted during varying flow events. The results of the nutrient samples will be used for modeling purposes and to rank and assess source pollutant levels. Nutrient sampling detection levels are similar to recent studies in the area (Lake Herrington study) and are adequate for modeling purposes.
- 15-day biochemical oxygen demand will be measured to determine the slow-acting oxygen demand, typically exerted by the nitrogenous components. It will be used as part of the oxygen balance of the stream and will indicate the downstream impact of oxygen demanding pollutant sources.
- 5-day carbonaceous biochemical oxygen demand will be measured to determine the short to moderated acting oxygen demand. It will also be used as part of the oxygen balance of the stream.
- Total suspended solids indicate a broad class of substances that may originate from natural or pollution sources. TSS may include phytoplankton, non-living particles containing nutrients and inorganic solids. As such, they affect the oxygen and nutrient balances (by mechanisms such as settling, recycling and light extinction).
- Total phosphorus will be measured to determine the phosphorus present in organic and inorganic forms. Phosphorus is a necessary nutrient for algae growth and contributes to eutrophication in Herrington Lake. It also affects the oxygen balance.
- Ortho phosphorus will be measured to determine the dissolved, inorganic phosphorus. This is the form most readily available for organism (algae) uptake. It is present in wastewater and is released during decay and recycling of particulate material.

- Nitrite as N is an intermediate product in both the nitrification and denitrification reactions that occur in natural waters. It is also a component of the total amount of nitrogen available, and as such affects algae growth and the oxygen balance.
- Nitrate as N is a form of nitrogen available for algae growth. As such it represents a pollutant contributing to eutrophication of Herrington Lake and impacts the oxygen balance. It is formed by the nitrification reaction in natural streams and is a pollutant found in agricultural runoff and wastewater.
- Ammonia as N is another form of nitrogen available for algae growth. It is present in sewage and agricultural runoff and affects the oxygen balance.
- Chloride is a conservative compound (*i.e.*, it does not react, settle or otherwise leave the water column) and may be used as a tracer for water flow. It contributes to specific conductance levels.
- Total Kjeldahl nitrogen is a measurement of the sum of total organic nitrogen plus ammonia. These forms of nitrogen represent nearly all the oxidizable nitrogen and therefore affect the oxygen balance of the stream.
- Total organic carbon measures living and dead organic matter, as well as indicating possible presence of herbicides and pesticides (which are generally organic compounds). Carbon is important for algae growth and organic particles can bind with nutrients and toxics.
- Alkalinity is the measure of the buffering capacity of the water, measured as calcium carbonate. Alkalinity is related to hardness, which affect metals' toxicity to fish.
- Total coliforms and *E. coli* samples will be collected to determine primary bacterial input locations. This sampling will be performed in Hanging Fork and Clarks Run to ensure that bacterial loadings are estimated for the bulk of the Dix River watershed. The analytical objective for both total coliform and *E. coli* is to establish a dilution series yielding real values for both analytes. To this end, the minimum detection limit is set at 1 MPN and the maximum as necessary to achieve real numbers. This dilution series will be continuously monitored and adjusted to achieve real numbers. For values reported as "greater than," modeling constraints will determine the proper use of the values.
- Chlorophyll *a* is an essential component of photosynthesis and is used as an indicator of phytoplankton concentration.
- Periphyton will be collected from natural substrate for two purposes:
  - First, monthly samples will be collected for chlorophyll *a* analysis. Results will be extrapolated to determine an algal biomass estimate as an indirect indicator of nutrient loading.
  - Second, because dominance of certain algal taxa can also indicate nutrient loading, multihabitat periphyton samples will be taken for species identification. The in-stream substrate will be collected relative to its occurring abundance in order to accurately represent periphyton taxa from different habitat.
- 24-hour Diurnal Dissolved Oxygen will be measured to examine the temporal dissolved oxygen dynamics. While algae (and other green plants) are photosynthesizing during the day, they produce oxygen. During the night, they respire and consume oxygen. Measuring the changes in oxygen demand over 24 hours will illustrate this and indicate

the amount of oxygen demand caused by photosynthetic organisms. (Note, temperature also influences the oxygen cycle and will also be measured during the 24-hour period.)

### 1.5.4 Data Quality Indicators

Data Quality Indicators (DQIs) are qualitative or quantitative descriptors of data quality. The quality of field and analytical data is most often assessed in terms of the DQIs including: Precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity. A review of these indicators follows.

For laboratory data, the laboratory performs the initial review of the results and compares them with the DQIs. Cause analysis and corrective actions are taken if necessary and deviations from the DQIs are noted with appropriate data qualifiers. The Data Manager performs a secondary review of the data to assess the conformance of the laboratory data in conjunction with field quality controls to the DQIs.

For field data, the Data Manager provides the initial review of data quality, and additional review is provided as the data is compiled and evaluated by the modelers, et al.

#### 1.5.4.1 Precision

Precision is the measure of agreement among repeated measurements of the same property under identical, or substantially similar conditions; calculated as either the range or as the standard deviation. Precision uncertainties will be measured through the collection of duplicate and split samples on 10 percent of collections that provide the overall measurement precision. The laboratory additionally performs duplicate samples with each analysis batch and is required to meet the requirements in Table 2, Methods, Analytes, and Data Quality Indicators for the Dix River Watershed. Subtracting the analytical precision from the overall precision provides the sampling precision.

The precision of RBP scores and general habitat assessment precision is controlled by the level of experience of the personnel conducting the assessment. Since the accuracy of the result is determined by the experience of the personnel recording the measurement, precision of results is also to be controlled by employment of high quality personnel. The initial and final RBP scores are assessed by personnel with a Master's degree and 5 years of experience in fieldwork. All personnel involved in assessment have been trained to properly conduct these assessments.

#### 1.5.4.2 Bias

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. Laboratories control bias by performing regular QC charting with which the acceptance windows for accuracy measurements are adjusted.

### 1.5.4.3 Accuracy

Accuracy is a measure of the overall agreement of a measurement to a known value; it includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations. Accuracy will be determined in the field through the use of spiked samples (10 percent of samples). For the laboratory, laboratory control samples (LCS) of known value and matrix spikes are used to measure accuracy according to Table 2.

### 1.5.4.4 Representativeness

Representativeness is a qualitative term that expresses the degree to which a portion accurately and precisely represents the whole. Representativeness in the field is achieved by adherence to applicable KDOW and EPA sampling methods. Homogenization of sample before analysis in the laboratory achieves representativeness. Samples are expected to be as representative as possible throughout the field and laboratory process.

### 1.5.4.5 Comparability

Comparability is a qualitative term that expresses the measure of confidence that one data set can be compared to another and can be combined for decisions to be made. Comparability of water chemistry results will be ensured through strict adherence to KDOW and EPA sampling and laboratory methods. Comparability of physio-chemical results will be ensured through regular probe calibration. Comparability of habitat data will be ensured through strict adherence to sampling protocols developed by the KDOW for in-stream habitat.

### 1.5.4.6 Completeness

Completeness is a measure of the amount of valid data needed to be obtained from a measurement system. It is expected that planned sampling will be 100 percent completed unless stream sites dry during summer months. Sites will not be relocated to avoid sampling overlap. A dry site will reflect zero nutrient and bacterial contribution of that section of the watershed.

### 1.5.4.7 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of variable interest. Sensitivity for this project is achieved by adherence to the reporting limits listed in Table 2. Reporting limits are determined by a calculation based upon the method detection limit for analytical methods and instrumentation.

Sensitivity of sampling methods depends on the technique as well as the intent. The passive high-flow samplers will be constructed to simulate a grab sample but will be sensitive to the rate of water rise such that the analytical impact will be minimal.

## 1.6 Documentation and Records

### 1.6.1 General

In order to provide quality consulting to the KDOW, traceability and maintenance of documentation and records is essential. All records relating in any manner whatsoever to the project, or any designated portion thereof; which are in the possession of Third Rock shall be made available, upon request of the KDOW. Additionally, these records shall be available to any applicable regulatory authority and such authorities may review, inspect and copy these records. These records shall be retained for at least 3 years after the project is approved and closed by the EPA.

Third Rock will deliver a TMDL document using the format outlined in the guidance document titled *Requirements for Kentucky DOW TMDL Documents*. This document includes descriptions of all relevant background information, summary, water body details, monitoring history, current monitoring effort, and modeling report. Additionally, Third Rock will provide continued support to KDOW after TMDL Proposed Scope of Work completion with the further development of allocations, load reductions, and an implementation plan.

Third Rock will also deliver analytical data in a COMPASS format for all sampled stations. The number of stations and laboratory parameters for all project-monitoring stations is detailed on the attached spreadsheet. Hardcopy of data will also be presented to KDOW if requested. A specific list of the documentation to be included in the final report is listed below.

### 1.6.2 QAPP Management and Distribution

Key to these goals is the distribution of the most recent version of this QAPP to all parties listed on the distribution list once the QAPP has been reviewed and approved. The QA manager is responsible for ensuring that all applicable parties perform documented review of the QAPP. If, because of deviations in the QAPP, revisions are required, the QA manager shall ensure that all parties review the revised version. The current revision and the date of the revision shall be documented in the upper left hand corner of the QAPP pages. The QAPP shall be redistributed after all parties have reviewed the document.

### 1.6.3 Information Included in the Reporting Packages

A reporting package will consists of field data, chain-of-custody forms, and analytical laboratory reports. Specifically the final package will include copies of the following:

- Field observations recorded in the Sampling Technicians' field notebook
- EPA Rapid Bioassessment Protocol (RBP) worksheet (Figure 6)
- Data characterization and water quality datasheet (Figure 7)
- GPS Positioning and photographs
- Completed Chain-of-custody forms (Figure 8, uncompleted example)
- Analytical Laboratory Reports (Figure 9)

- Chlorophyll *a* Datasheets (Figure 10)

### 1.6.4 Data Reporting Package Format and Documentation Control

Data reporting packages will contain a consistent format and will be compiled initially during the quarterly meetings with KDOW and ultimately within the final report. Electronic data will be presented in Microsoft Word and/or Access (COMPASS format).

### 1.6.5 Data Reporting Package Archiving and Retrieval

The original copies of all field notes, field data sheets, lab sheets, chain-of-custody forms, and lab reports will be maintained and stored at Third Rock Consultants for the required document retention period for the grant. At the end of the required period, the documents will be archived in Third Rock's warehouse. Copies of all electronic data will be archived in specified Third Rock computer files. The laboratory shall also maintain all records associated with the analytical results including laboratory notebooks, bench sheets, instrument calibration and sequence logs, preparation logs, maintenance logs, etc. for the retention period of the grant.

# 2 Data Generation and Acquisition

## 2.1 Sampling

### 2.1.1 Sampling Process Design

The total area of the Dix River Watershed includes approximately 282,000 acres in central Kentucky and has been divided into several sub basins for the purposes of this project, as seen in Figure 3.

The lower Dix River Watershed includes the western edge of Garrard County, part of northern Lincoln County, and eastern portions of Boyle and Mercer Counties. The land is characterized by undulating terrain and moderate rates of both surface runoff and groundwater drainage. Most of the watershed lies above thick layers of easily dissolved limestone. Groundwater flows through channels in the limestone, so caves and springs are common in regions with this geology. Land use in the watershed is 90 percent agricultural and 5 percent residential. The surface waters of the watershed supply the drinking water for the municipal system in Danville. Businesses and organizations hold permits for discharges into the creeks. For the purposes of this project this watershed has been further divided into the Herrington Lake, Clarks Run, and Hanging Fork subwatersheds. Clarks Run and Hanging Fork are of particular concern for this project.

The lower Dix River watershed includes the river itself from the confluence with the Kentucky River near High Bridge to the mouth of Gilberts Creek southwest of Lancaster. Herrington Lake makes up much of this stretch of the Dix River. Among the creeks that feed the river within this watershed are Hawkins Branch, Boone Creek, White Oak Creek, McKecknie Creek, Tanyard Branch, Cane Run, and Rocky Fork. The watershed also receives water from the Dix River (upper), Logan Creek, Spears Creek, Mocks Branch, Hanging Fork Creek which drains approximately 18,000 acres, and Clarks Run which drains approximately 61,000 acres.

The assessed river segments in this watershed fully support their designated uses, based on biological and/or water-quality data. Herrington Lake does not support its designated uses, because of excess nutrient enrichment from a variety of sources. Phosphorus levels in the Dix River are elevated enough to cause potential nutrient enrichment problems (> 0.1 mg/L).

The upper Dix River watershed covers approximately 202,000 acres, in southern Garrard County, western Rockcastle County, and eastern Lincoln County. The land is characterized by undulating terrain, moderate to rapid surface runoff, and moderate rates of groundwater drainage. The watershed lies partly above fractured shales through which groundwater can easily move but which stores very little water.

The upper watershed of the Dix River includes the headwaters down to the mouth of Gilberts Creek just west of Gilbert (at US 27 between Lancaster and Stanford). Among the creeks that feed it are Negro Creek, Turkey Creek, Copper Creek, Fall Lick, Drakes Creek, Harmons Lick, Walnut Flat Creek, Cedar Creek, Stingy Creek, Turkey Creek, and Gilberts Creek. Land use in the Upper Dix watershed is

60 percent agricultural and almost 40 percent rural and wooded. Businesses and organizations hold permits for discharges into within this watershed.

In order to assess the load allocations for these areas, the following site types and as well as anticipated site visits are allocated as follows:

| Watershed | Select Sites | Non-select Sites | Sampling Events |
|---|---|---|---|
| Clarks Run | 4 | 4 | 96 |
| Hanging Fork | 6 | 8 | 168 |
| Upper Dix River | 1 | 7 | 96 |

The sampling and processing schedule is detailed in Table 1, on a monthly basis. From March 2006 to March 2007, monthly *grab samples* will be taken at *all stream stations*. From November to April, *passive high flow sampling* will be conducted at the *select stations* with a goal of capturing one high-flow per month with a seven-day antecedent dry period. Because of the requirements to sample low, medium, and high flow events, the sampling events will be scheduled on a monthly basis by the Data Manager and Sampling Coordinator to maximize the potential of capturing these flow events. Scheduling of the sampling is on Third Rock's Work Schedule, which represents a comprehensive scheduling of all projects for which Third Rock is employed.

Site locations for the Dix River, Clarks Run, and Hanging Fork were chosen by Third Rock and GRW to specifically characterize the pollutant loadings and to facilitate modeling of these parameters in conjunction with dissolved oxygen. Spatial and temporal assumptions have specifically determined sampling location and the timing of sampling event. Stations will characterize pollutant contribution associated with specific sources of concern. Timing of sampling events will look at varying pollutant concentrations that could fluctuate with stream flow and volume. Samples will coincide will low, normal, and high flows. To determine nutrient loading associated with storm run-off, *passive high flow sampling* will be conducted at the *select stations* for all chemical parameters. Sampling periods will coincide with elevated storm-water flow with a goal of capturing one high-flow per month during that period that has a seven-day antecedent dry period though actual high flow sampling will be determined by rain intensity. Methods for passive high flow sampling will consist of a low-tech sampler.

During the elevated storm water flow, total coliform and *E. coli* will be sampled directly since the passive high flow sampling technique would bias the results. Technicians will be dispatched just prior to the storm to ensure the samples are collected during the elevated period.

#### 2.1.1.1 Sampling Station Locations and Specifications

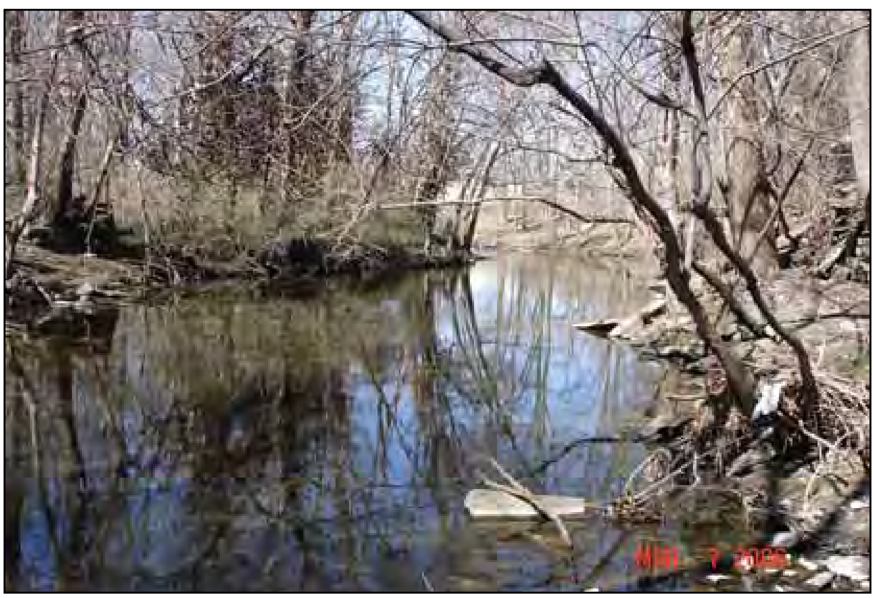
The specific criteria for site location are discussed below. Due to logistical constraints, stations are commonly located in close proximity to bridge crossings or culverts. Care is taken when locating stations so that sampling sites are far enough away from the bridges or culverts to minimize the influence of the inherent hydrologic modification caused by the anthropogenic modifications. A photograph of each sampling location (above each site) as well as the latitude and longitude (in that order) and a brief summary of the site conditions are included.

## *Clarks Run*

Sites in the Clarks Run subwatershed have been located to discern nutrient and bacterial contributions from non-point sources (primarily cattle and residential), industrial facilities, potential sewage collection failures, and point-source contributions. The specific reasons for site selection are described below:

*Corporate Drive- This non-select site is located in the headwater of Clarks Run. Based on land use, the location of this site corresponds primarily to NPS nutrient and bacterial contributions consisting primarily of agriculture with some residential sources. Located at 37.627177,-84.797265.*

*Clarks Run Bypass - Non-select site at the Danville US127 Bypass for characterizing potential nutrient and bacterial contribution from industrial and some residential sources. Located at 37.627177, -84.797265.*

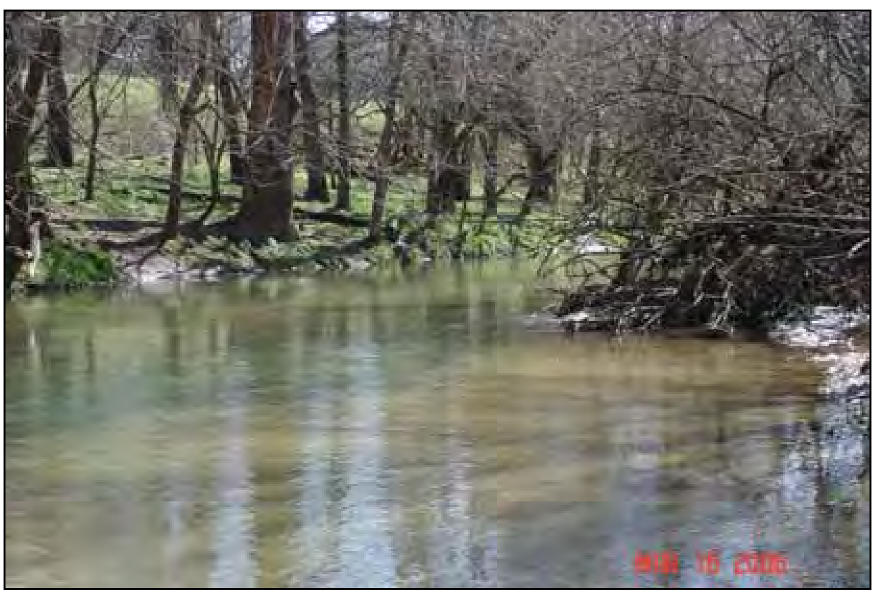


*Second Street/Clarks Run – Select site to characterize the nutrient and bacterial levels directly attributed to a suspected sewage influx and before the WWTP outfall. This site is just downstream of Second Street. The extra storm-water sampling component of this select site will help insure an accurate representation of the pollutant loadings due to nonpoint source (NPS) and sewage contributions. Located at 37.635754,-84.772877.*

*Clarks Run/KY52 – The primary select site, located above the KY52 bridge and above the confluence with Balls Branch, will assess the nutrient additions attributed to the Danville WWTP. Storm-water sampling at this select station will assess how nutrient concentrations from many sources vary with flow. Located at 37.631264, -84.735969.*

*Clarks Run/Hwy 150 – Select Site to identify the nutrient and bacteria concentrations and potential industrial pollutants above the Danville WWTP. Storm water sampling could also discern the increased pollutant loads associated with heavy rainfall events. This site is located immediately downstream of a quarry discharge and just below the Highway 150 bridge. Located at 37.628470, -84.746087.*

*<u>DOW Clarks</u> - Select site at a historical DOW sampling location that will estimate the combined nutrient and bacterial contribution of Clarks Run and Balls Branch at all flow regimes. This site is just below Goggin Rd Bridge. Located at 37.638916, -84.721632.*



*<u>Balls Branch Mouth</u>- Select site to specifically characterize the NPS pollutant contribution from the entire Balls Branch watershed. Located at near the Balls Branch – Clarks Run confluence, 37.630455, -84.733358*

***Balls Branch West** - Non-select site further up the watershed for pinpointing potential NPS contributions. Located at a Balls Branch bridge, 37.600947, -84.757055.*

## *Hanging Fork*

The Hanging Fork watershed is characterized primarily by agriculture (graze land) with a scattering of small communities having sanitary sewer outfalls. Stations are positioned to help pinpoint the location of major sources of nutrient and bacteria contribution from this watershed.

***West Hustonville** – Non-select site located in the upper reach of Hanging Fork. This station is positioned to estimate nutrient and bacterial loadings from headwater contributions upstream from Hustonville's WWTP outfall. Located at 37.470801, -84.821043*

*Baughman Creek - Non-select site located to estimate nutrient loading attributed to Baughman Creek watershed. This site is located immediately downstream of a school permitted discharge and before the Hustonville WWTP outfall. Located at 37.471207, -84.820744.*

*McKinney Branch - Non-select site located on a medium sized sub-watershed expected to have a significant NPS pollutant contribution. Located at 37.479748, -84.771170.*

*<u>Chicken Bristle</u> - Select site on the main stem of Hanging Fork located to characterize the nutrient and bacterial contributions of point and non-point sources and specifically the contributions from Hustonville's WWTP outfall. Located at 37.481364, -84.769010.*

*<u>Frog Branch</u> - Non-select site characterizing NPS loading in a distinct sub-watershed of Hanging Fork. Located at 37.505012, -84.758855.*

***Peyton Creek*** ***- Non-select characterizing NPS loading in a distinct sub-watershed. Located at 37.497558, -84.744313.***


***McCormick Church*** ***- Select site situated at this location for the purpose of estimating nutrient and bacterial loadings (point and non-point) from a group of several small drainages. Located at 37.526615, -84.742887.***

*Blue Lick - Non-select site located to estimate the agricultural NPS component of a medium sized drainage. Located at 37.527845, -84.731109.*

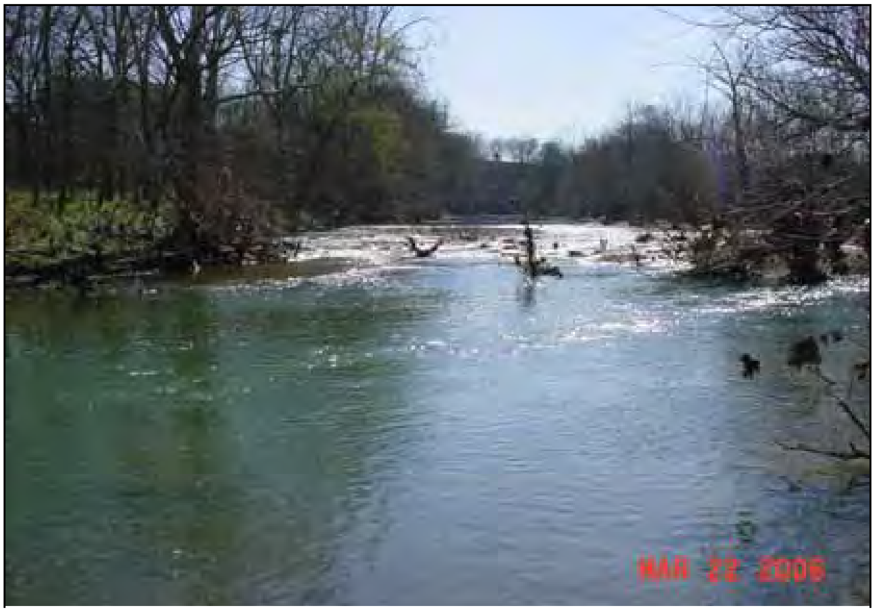

*Junction City - Non-select site that drains a residential/agricultural area west of Junction City. Located at 37.566007, -84.806433.*


*<u>Oak Creek</u> - This select site will catch the urban runoff (and outfall) from the majority of Junction City as well as an agricultural drainage. Located at 37.558674, -84.790585.*

*<u>Moores Lane</u> - Non-select site to determine specific sub-watershed contribution of Harris Creek. Located at 37.544012, -84.781899.*


***<u>Knob Lick Creek</u> - Select site will catch some additional drainage from Junction City plus the accumulation of potential pollutants from all the sites above. Located at 37.551944, -84.730426.***


***<u>Hanging Fork/Hwy 150</u> - Non-select site located here to estimate the accumulation of potential pollutants near the convergence of two large subwatersheds. Located at 37.573390, -84.700117.***




*<u>Hanging Fork Mouth</u> - Select site located to estimate the total loading of nutrients and bacteria attributed to the Hanging Fork watershed. Located at 37.623639, -84.680562.*

## *Upper Dix River*

The sites in this section of the watershed are located upstream of the Hanging Fork confluence with the Dix River. Similar to the Hanging Fork subwatershed, this area contains primarily agricultural grazed with rural residences and small communities (with WWTP outfalls). Though the data from these sites will not specifically be used for TMDL calculation, the resultant information will help determine and rank the significance of nutrient, TSS, and bacteria contribution of this drainage to Herrington Lake.


*<u>Gum Sulfur</u> – This non-select station was located to account for the nutrient contribution of a WWTP outfall at Brodhead. Located at 37.427359, -84.452234.*


*Copper Creek - This non-select station was located at the mouth of Copper Creek to account for NPS runoff from a significant subwatershed with an abundance of cattle. The stream section immediately upstream of the site is listed as partially supporting for aquatic life. Located at 37.455167, -84.471822.*

*Crab Orchard – This non-select station was located to account for a Dix River W W outfall from the community of Crab Orchard. Due to lack of access, station could not be located directly below outfall. The first available sampling location was determined to be the KY 39 bridge because of braided channel issues directly upstream. Located 37.490419, -84.512426.*


*<u>Drakes Creek</u> - This non-select site encompasses two large drainages with an abundance of cattle (Drakes and Harmons Creeks). Located at 37.504822, -84.518456.*


*<u>Gilberts Creek</u> - Site was located to catch the pollutant contribution of the Gilberts Creek drainage (primarily NPS) and also an unnamed tributary with a point-source (KPDES storm water discharge) that carries urban runoff for the city of Lancaster. Located at 37.571167. -84.596938.*


*White Oak - Located directly below Lancaster's WWTP outfall. Data from this site will characterize nutrients and bacteria level contributions from the facility. Located at 37.605136, -84.592481.*


*Dix above HF - This select station will measure the NPS nutrient runoff associated with the Dix River above Hanging Fork. Located at 37.602466, -84.634587.*

*Dix DOW (below HF) - Non-select site at a historic DOW location. Data from this site will estimate the pollutant loads from the combination Dix and Hanging Fork. Located at 37.640959, -84.662930.*

#### 2.1.1.2 Inaccessibility Contingency Planning

If sample sites must be relocated due to unseen issues, the site will be relocated to best suit the desired goal of the project. New sites will be given new names and IDs to maintain consistency of results.

If samples cannot be collected at a station due to dry conditions, the station will not be relocated. The effective loading of pollutants will be zero and modeled as such. If a site cannot be reached during the specified sampling period, a re-sampling event will be scheduled as soon as possible to best estimate the conditions at the time of the specified sampling period.

#### 2.1.1.3 Critical vs. Non-Critical Parameters

Critical Parameters are those parameters that are absolutely necessary for the completion of the project. The high-flow samples from select stations (using passive high flow samplers) will be designated as "critical" due to the importance in timing the collection and retrieval of the water sample.

Because they are directly tied to the objectives of the study, the following parameter are also considered critical:

- Biochemical Oxygen Demand, 5-Day Carbonaceous
- Phosphorus, Total and Ortho
- Nitrate as N

- Ammonia as N
- Total Kjeldahl Nitrogen
- Total coliforms and *E. coli*
- Chlorophyll *a*
- Physiochemical Measurements
- Habitat, at least once
- Photographs, at least once
- Flow

All other parameters are either supplemental or could be estimated (derived) from the other measurements based on previous monitoring or typical surface water interactions and are therefore designated as non-critical.

#### 2.1.1.4 Sources of Variability

Sources of variability associated with field sampling are inherent and often unquantifiable. For example, environmental conditions associated with climate (e.g., microhabitat fluctuations in temperature, rainfall, etc. between stations) and flow (e.g., timing of samples in regards to measuring the transport of pollutants in an identical water mass as it travels downstream) are typical forms of variability in a field sampling project of this type and often cannot feasibly be accounted for. The variability associated with environmental conditions in this project will be lessened to a degree by the efficient timing of sample collection during specific weather conditions and flow regimes. Using three teams for data collection will reduce temporal variation in samples.

In the field, variability associated with equipment is primarily limited to the water quality probes and measuring devices. Variability associated with these devices can be found in Table 2. The Hydrolab DS5 multi-probe is equipped with four primary sensors, pH, dissolved oxygen, conductivity, and temperature. Turbidity may also be measured on the Hydrolab or by turbidimeter. The velocity current meter may fitted with two propellers depending on the depth and the amount of flow present. The smaller propeller requires less depth to measure the velocity but is less sensitive. Variance in flow measurements may additionally be compounded by objects in the stream which impede flow (i.e. algal growth) or by the number of points sampled across the flow area.

To reduce the variability associated with flow measurements made by velocity meter, several procedures are conducted. To increase accuracy in streams with large variables in depth or velocity, measurement intervals are reduced from 3 ft to sizes that better characterize the entire cross-section. The first and last velocities are also measured closer to the banks to reduce error. Because water velocities may change at larger depths, streams deeper than 2.5 ft are measured at two depths. Algal growth that may interfere with the proper functioning of the propeller of the velocity current meter is scraped away from the location of the measurement to reduce this variability. Repeating the float technique three times reduces variability in simple float estimation of velocity.

In addition to field equipment, the Rapid Bioassessment Protocol (RBP) worksheets can be a source of potential variability during physical stream assessment. The intrinsic subjectivity of the physical habitat scoring using the EPA RBP method is a concern for the Dix River Watershed project. To ensure consistency and accuracy with this assessment, Third Rock staff undergoes yearly in-house training that strictly pertains to the EPA RBP scoring protocol. Training methods are based on tutorials provided first-hand to Third Rock by U.S. Army Corps of Engineers (Louisville District). In addition to this training, sampling stations on the Dix River project RBP sheets are also consistently filled out by the same experienced biologist at all sites. Assessments are performed by personnel with a Master's degree and 5 years of experience in fieldwork.

Variability in regards to water sample collection will be minimized by a strict adherence to collection protocols. Consistent field personnel will also reduce variability associated with collection.

### 2.1.2 Sampling Methods

During all sampling activities, sampling methods and gear will utilized is analogous to EPA and KDOW recommendations. Specific methods are detailed in the following sections. All samples are to be collected in bottles according to the analytical methods referenced in Table 3, Summary of Project Sampling and Analytical Requirements.

#### 2.1.2.1 Grab Sample Collection

Samples shall be collected directly from the source. When collecting samples, latex gloves shall be used to prevent contamination. The sampling technician will collect the sample by submersing a decontaminated rinsed stainless-steel bucket into source as to obtain a representative aliquot. Submersion shall only be to the bucket mid-depth, taking caution not to scrape the bottom of the source minimizing excess solids. An appropriate sized bucket relative to the bottle(s) being collected shall be used. The bucket size should be sufficient to completely fill the sample bottle(s) from a single submersion. Take care to avoid overfilling in bottles containing preservative. Fill pre-labeled collection bottle(s), per method specifications, directly from the bucket.

Stream samples will be collected from the thalweg (or low water channel) just above the stream bottom. Bottles will be filled to near 100 percent capacity. Efforts will be made not to stir up sediments during collection. Proper field data sheets will be completed. Samples will be labeled accordingly, placed on ice, and delivered to CT Laboratories Laboratory within the required holding time(s). Proper chain-of-custody procedures will be followed to ensure accuracy in sample reporting. Field quality controls, as specified in Section 2.3: Quality Control will be collected at this time.

Care will be taken when filling total organic carbon (TOC) sample bottles to avoid unnecessary agitation of water and to ensure complete filling of bottle, as headspace in the bottle will cause bias of results due to volatilization of organic carbon.

#### 2.1.2.2 On-site Assessment

During initial setup of the site locations, several tasks were completed at each station:

- Permanent monuments (survey pins) were established to standardize water collection, flow measurement, and photograph locations at each station.

- Passive high flow storm-water sampling device locations were determined and installed (select stations only).
- Cross-sectional measurements were completed at each station to support discharge computation. For each cross-section, three reference points were established. Two of the points, located on opposite sides of the bank, were located for subsequent section measurements. The third point was located for reference of stage (tape-down) readings. Stage reference points may be located on a bridge, established with pins (rebar), or a sturdy overhanging limb.

This work was done to aid in the measurements as listed below:

## 2.1.2.2.1 Habitat

During habitat assessment, at the initial and final station visits, a thirty-minute visual inspection will be completed at each stream sampling station or reach.  Ten habitat parameters will be assessed, according to Methods of Assessing Biological Integrity of Surface Waters in Kentucky (KDOW 2002), including epifaunal substrate (quantity and variety of substrate), embeddedness and pool substrate characterization (measurement of silt accumulation and type and condition of bottom substrate, respectively), velocity/depth regime & pool variability (combination of slow-deep, slow-shallow, fast-deep, and fast-shallow habitats and measurement of the mixture of pool types, respectively), sediment deposition (accumulation in pools), channel flow status (the degree that the channel is filled with water), channel alteration (measurement of large-scale changes in the shape of the channel), frequency of riffles & channel sinuosity (sequence of riffles and meandering of the stream, respectively), bank stability (measure of erosion), bank vegetation (amount of vegetative protection), and riparian vegetative zone width (width of the natural vegetation from the edge of the stream bank through the riparian zone).  All of these criteria are rated (1 to 10) and combined to obtain a habitat score (0 to 200) that can be compared to a reference condition.  Use attainment can be estimated based on the habitat score.

Once during the period of peak leaf out, the canopy cover will be estimated using a spherical densitometer.  To use the spherical densitometer, the instrument is held level, 12 to 18 inches in front of the body and at elbow height so that the Sample Technicians head is just outside of the grid area.  Each square on the grid is divided in four and systematically counted for canopy openings.  The total count is multiplied by 1.04 to obtain a percent of the overhead area NOT occupied by canopy.  The difference between this number and 100 provides the estimated percent canopy coverage.  Four readings shall be recorded and averaged while facing north, south, east, and west.

## 2.1.2.2.2 Flow

In order to determine stream discharge or flow (Q), measure the flow area (A) and water velocity (V). Flow is calculated according to the following equation for increments across the stream.

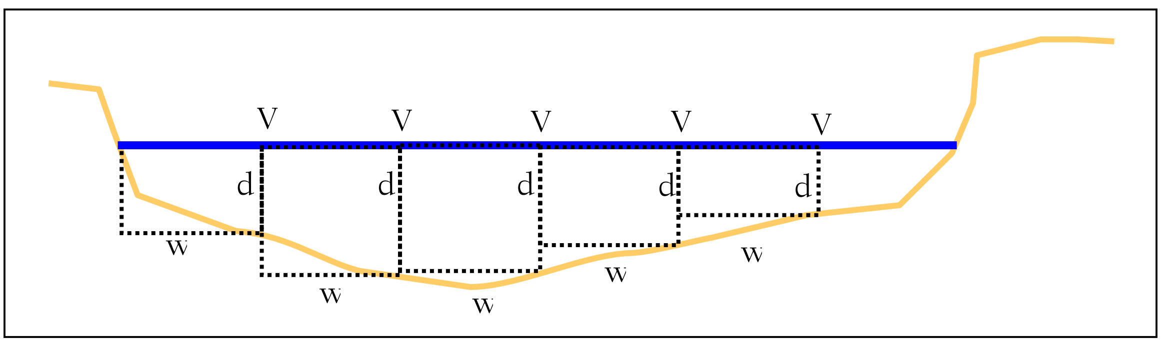
$$Q = V * A$$

where:
Q = Discharge or Flow ($ft^3$/sec)
V = Velocity  (ft/sec)
A = Flow Area  ($ft^2$)

In order to measure the flow area, three methods are used. For all stations, a stream cross section is surveyed (via Total Station). For six select stations, this information can be used in conjunction with a pressure transducer water level recorder (Infinities USA) to determine the flow area. If the water level is measured at the cross-section with a staff gauge or marked with pins on the stream bank, the flow area can also be calculated. Alternatively, the stream may be waded at the cross-section to determine depth and breadth at the time of the sampling visit. Velocity can be measured by a current meter or a floating object.

On a monthly basis, the flow for all streams low enough to wade will be measured according to USGS 2000. Velocity and water depth are measured at intervals across the stream sufficient to characterize discharge. A 100-ft tape is stretched across the stream in the established cross-section to indicate the intervals. Typically, stream depth and velocity are measured at 3 ft intervals across the stream. The interval is adjusted as necessary to thoroughly characterize the entire cross-section of flow. Points should be closer together if there is a lot of variation in the depth or velocity of the cross-section. Notes are made during the data collection to indicate any special conditions observed.

The approximate area of each flow box is the depth of water at a given point multiplied by the width of the flow box. This concept is illustrated in the figure below. The convention for calculating flow is to apply a measured velocity and stream depth to the width between that station and the previous station. To increase the accuracy of flow calculation, the first and last velocity and depth measurements should be made as close to the banks as is feasible.




Stream cross-section showing intervals where water depth and velocity are measured. Flow will be calculated for each "box" (flow area for each box is d * w) and summed to obtain the flow for the entire stream.

At each station within the cross-section, velocity is measured with a General Oceanic current meter mounted on a rod, where velocity is indicated by the number of revolutions of the propeller over a given time interval. The individual using the velocity meter should hold the rod vertically in the profile with the meter parallel to the direction of stream flow and stand at least 1 ft downstream and to the side of the velocity meter so as not to interfere with the current. Velocity is measured for approximately 60 seconds.

Average velocity is measured at 0.6 of total stream depth when the depth is less than 2.5 ft. When the stream is deeper than 2.5 ft, velocity is measured at 0.2 and 0.8 of the total depth and the average of the two readings is used as the average velocity at that point for discharge calculations. Discharge (Q) is calculated for each interval of the stream where velocity and depth are measured and total stream discharge is calculated as the summation of the discharge from each interval. Water depth is also recorded at a single known point in the stream during each visit.

When the stream is too deep to wade with the current meter, stream velocity is roughly estimated using a floating object. The float can be any buoyant object, such a partially filled plastic water bottle. Ideally, it needs to be heavy enough so that about an inch of it is below the water line. When the floating object cannot be retrieved from the stream, a "weighty" yet compact piece of stick/wood is used. When feasible, a 50 ft section of stream is measured for the float test. The float is released out into the stream in a location most representative of the entire stream and the time is recorded for it to travel the known distance. If the float moves too fast for accurate measurement, a longer travel distance will be measured. The simple float estimation of velocity will be repeated for a total of three trials. The surface velocity values obtained by this method are corrected to represent mid-depth velocity (Daugherty *et al.* 1985).

$$mid - depth\ stream\ velocity = 0.8 \times surface\ velocity$$

Discharge during high flow is estimated using this velocity measurement, cross-section information, and depth measured from the pressure transducer water level recorder, staff gauge, or pins on the bank.

At stream velocities below the measurable range of the current meter, the propeller will not turn. If the stream velocity is too low to be accurately measured by the current meter, it may be necessary to estimate stream velocity using the simple float. If the velocity is below the limit of the current meter, the stream will still be waded and water depth will be recorded at intervals across the stream. The velocities obtained by the float test (three trials) during low flow conditions will be compared to the known lower limit of the meter.

## 2.1.2.2.3 Physio-chemical measurements

Temperature, dissolved oxygen, conductivity, and pH will be measured during field sampling of the streams with a Hydrolab water quality instrument. Operation of the Hydrolab instrument is conducted in conformance to the Hydrolab operation manual (Hydrolab, 1997).

During the low-flow summer period, 24 hour diurnal dissolved oxygen will be measured with the Hydrolab once at two select sites, one of which will be located at Clarks Run / KY52. The other site will be determined based on results of initial sampling. The Hydrolab will be deployed for a 24-hour period during which its data-logging feature will store the dissolved oxygen data.

Global Positioning System coordinates will be obtained using a Garmin GPS or the equivalent, accurate to ±5-40m. Readings are measured in NAD83. Internal SOPs and manufacturer's instructions will be followed to record these measurements.

### 2.1.2.3 Periphyton Sampling

Periphyton sampling is to be done in accordance with the *Methods for Assessing Biological Integrity of Surface Waters in Kentucky* (KDOW 2002). To meet these objectives, the Sampling Logistics Coordinator built a Periphyton Substrate Vacuum. Based on KDOW 2002 methods, this vacuum consists of a 3-inch diameter PVC pipe used in conjunction with a neoprene rubber gasket attached to a hand operated pump. To sample periphyton from stations, the gasket end of the PVC is pressed against the bedrock substrate so that the periphyton within the area enclosed can be dislodged with a stiff bristle brush. The hand operated pump is then inserted into the PVC pipe (still being pressed against the bedrock) and the periphyton is pumped into a filer flask using the hand operated pump. Five replicates are taken for a total area of 0.25m$^2$. This portion is sent to the laboratory for analysis by a modified version of Douglas 1958.

### 2.1.2.4 Chlorophyll *a*

Chlorophyll *a* samples will be filtered in Third Rock's lab before transporting to CT Laboratories for analysis. Initially, the time, date, and volume of the sample will be recorded on a Third Rock bench sheet (Figure 10). A measured volume of water from each sample will be filtered through 0.45μm cellulose membrane filters. For each sample, water will be filtered and particulate matter will be collected on three membrane filters, folded in half and enclosed within aluminum foil. Each sample will then be placed in a zip-lock bag, labeled with the filtered volume of water, and frozen before delivery to the lab. The bench sheet will accompany the filtered sample with the information regarding date/time of collection, date/time of filtration, volume of filtered sample and area of aspiration.

### 2.1.2.5 Passive High Flow Sampling

Sampling periods will include an elevated storm flow between November and April with a goal of capturing one high flow per month during that period with a seven-day antecedent dry period. Methods for passive high flow sampling will consist of a low-tech sampler based on methods presented in Subcommittee on Sedimentation, 1961. Sample bottles are mounted on an in-stream frame. Bottles fill with water as the stream rises. Once the bottles fill, samples will be collected for analysis. Technicians will frequently observe the sites when conditions are optimum for filling the bottles from the high flow.

### 2.1.2.6 Pressure Transducer Water Level Recorder

At 6 of the 11 select locations, stream water level is continuously monitored using a pressure water level recorder (Infinities, USA). These sites include Drakes Creek, Dix Above, Knob Lick, Hanging Fork 150, Clarks Run Bypass, and Balls Branch Mouth. The pressure sensor measures water depth and digitally records the data on a user defined interval. For this project, the device records water level readings every 20 minutes. The pressure sensor is accurate to +/- 0.1 percent of the measurement range and the resolution is 0.01 inches.

### 2.1.2.7 Sampling Equipment

For the purposes of this project, the following equipment will be utilized in the sampling effort:
- Periphyton Substrate Vacuum
- Filtration Apparatus
- Hydrolab MS5 and associated probes
- Rising stage passive high flow sampling apparatus
- Infinities USA continuous pressure transducer water level recorder
- General Oceanic current meter
- Garmin GPS
- Turbidimeter
- Spherical Densiometer

### 2.1.2.8 Decontamination and Sample Integrity

During all sampling events, precautions will be taken to ensure the integrity of the collected sample. These tasks include:
- Labeling sample bottles with time and date before filling with water to ensure ink legibility.
- Traceable custody shall be documented from the time of sampling until delivered to the laboratory.
- Wearing latex gloves during all sampling events to avoid potential sample contamination.
- Rinsing sampling equipment between sites with deionized water
- Avoidance of streambed sediment agitation during sample collection
- Immediate placement of sample bottles in ice-filled coolers
- Wrapping chlorophyll *a* bottles in aluminum foil (until filtered) to block light penetration
- Prompt delivery to laboratory for analysis

Cleaning and decontamination of the sampling equipment includes:
- For standard collection parameters, the stainless steel collection bucket will be rinsed three times with site stream water.
- The Hydrolab is to be rinsed with soapy water and rinsed with D.I. water daily. The instrument is to be rinsed with D.I. water between use at each sampling site.
- All rinsate is to be disposed of into the watershed, downstream of the sampling site, as the constituents do not represent a threat to the watershed area.

### 2.1.2.9 Problems and Corrective Action

Known or suspected deviations from sampling methods, the protocols of this QAPP, or other applicable protocols are to be reported to the Project Administrator. These incidents are documented by email to the project folder and the Project Administrator. All project related emails are to be sent to a central project electronic folder for recall and storage. If the deviation represents a serious flaw with sampling methodology, sampling results, or modeling methods, corrective action will be taken based on recommendations the project administrator receives from the KDOW.

### 2.1.3 Sample Handling and Custody

#### 2.1.3.1 Chain-of-Custody

Chain-of-custody (COC) forms will be completed for all samples collected in the field and will follow each sample throughout sample processing. A Chain-of-Custody form is a controlled document used to record sample information and ensure the traceability of sample handling and possession is maintained from the time of collection through analysis and final disposition. A sample is considered in custody if it is:

- In the individual's physical possession,
- In the individual's sight,
- Secured in a tamper-proof way by that individual, or secured in an area restricted to authorized personnel.

The Data Manager and Sampling Coordinator shall create COCs and provide to the Sampling Technicians. All information shall be documented on the COC in black or blue waterproof permanent ink including field physio-chemical measurements and custody information.

The Sampling Technician shall initiate sample custody at the time the sample is collected. Field custody documentation shall include:

- Verification of Sample Identification
- Number of Sample Bottles Collected
- Collection Date
- Collection Time
- Collector's Signature

The Sampling Technician shall maintain possession of the sample until custody is transferred to the laboratory or another party. The COC shall accompany the sample from the time of collection until it is relinquished. Field custody is relinquished by signature, with date and time, of the Sampling Technician in the designated area on the COC.

#### 2.1.3.2 Sample Handling and Transport

The Sampling Technician is responsible to ensure that lids to all bottles are secured properly and tight to prevent leakage. All samples shall be collected and preserved as specified in Table 3, Summary of Project Sampling and Analytical Requirements. Glass bottles are placed in appropriate bubble wrap material to protect against breakage during shipment.

Sample bottles are placed in coolers lid side up. Samples are transported according to method storage requirements. Samples requiring storage at 4 ± 2°C are placed inside plastic bags to ensure that sample labels stay dry during transport. The bagged samples are placed in an appropriately sized cooler in order best pack the samples with an adequate amount of ice, ensuring the appropriate temperature is maintained until arrival at the laboratory. Additionally, loose ice is placed around the bagged samples.

Samples coolers should be of adequate size to allow ice to surround all sample bottles. It is the responsibility of the Sampling Technician to ensure that coolers are properly packed and that they have sufficient cooler space on their vehicle for their daily sample load. Coolers shall be secured during transport such that significant disturbance of the samples is avoided.

Upon receipt at the laboratory, the sample custodian shall review the COC for completeness and accuracy. Anomalies shall be documented. The laboratory shall measure sample temperature upon receipt; determine if sample aliquots have been placed in appropriate bottles and properly preserved, by verification with pH strips, as applicable; findings shall be documented on COC, and inspect the sample for proper identification and bottle integrity; any discrepancies and/or bottle damage shall be documented on the COC.

#### 2.1.3.3 Sample Labeling and Identification

Empty samples bottles are shipped from the analytical laboratory with preprinted information to assist in the proper identification of samples. These labels indicate Third Rock's name and project identification, and the expected parameters to be analyzed from that bottle. Sampling Technicians are responsible for recording the sampling station, which serves as the sample identifier, as well as the date and time of the collection on each sample bottle as well as on the COC. In the event that a preprinted label could not be obtained from the laboratory, the Sampling Technician would be responsible for recording the information listed on these labels on the sample. If possible, apply labels before sampling as moisture on the sampling bottles can make adhesion of the label to the bottle difficult.

## 2.2 Analytical Procedures

Water samples will be analyzed for several parameters following standard methodology as listed in Table 3. Modifications to the prescribed and/or pre-approved analytical methods will not be made without the knowledge and consent of Third Rock's Project Administrator.

As current regulations do not specify specific target limits for the analytes involved, the laboratories regular reporting limits were cited for this project. The reporting limits of the analytical laboratory are recorded in Table 2, along with other performance criteria, and are for analyses of samples within the calibration ranges for the individual methods. The reporting limits of individual sample may be raised if a dilution is required to quantify the target compound(s) within the acceptance range.

Since dissolved oxygen is of special concern for this project, three types of analyses for biochemical oxygen demand were selected. BOD-5 is the standard analysis of biochemical oxygen demand over a period of 5 days. BOD-15 is a modification of the BOD-5 in which the samples are allowed to incubate for a period of 15 days.

In order to properly analyze the parameters associated with the project, the laboratory is required to calibrate and maintain instrumentation and equipment. A list of the key equipment / instrumentation includes:

- Spectrophotometer
- Inorganic Flow or Discrete Autoanalyzer
- Ion Chromatograph
- Air Incubator
- Carbon Elemental Analyzer
- Dissolved Oxygen Meter

### 2.2.1 Problem Resolution and Corrective Action

The laboratory is required to maintain a corrective action and cause analysis system in order to address deviations and client complaints. When a deviation from an internal procedure or external method or protocol is found or a client has a complaint about the data results or service, the laboratory shall document these incidents and begin a cause analysis to determine the source or sources of the problem. Once the source(s) is (are) identified, the laboratory shall institute corrective action to achieve compliance. Evidence of completion of this corrective action and follow up evaluation of the effectiveness of the action, as necessary shall demonstrate compliance.

### 2.2.2 Sample Disposal Procedures

In general, samples are disposed of 30 days after results have been reported to the client. All sample bottle labels are removed or obliterated prior to disposal.

Hazardous wastes are returned to the client for disposal. The lab maintains status as a limited quantity generator of hazardous waste. As such, other hazardous solid wastes are disposed of in a hazardous waste designated dumpster and sent directly to an in state permitted landfill.

Non-hazardous aqueous samples are disposed of by pouring the neutralized sample into a conventional drain to the municipal sewage treatment system. Non-hazardous solid wastes (including emptied bottles from aqueous samples) are disposed of by placing in a dumpster for municipal landfill disposal.

### 2.2.3 Turn around Times

It is the expectation of Third Rock Consultants that laboratory analyses are completed before the next scheduled sampling event, where possible.

## 2.3 Quality Control

Chemical data quality will be ensured through strict adherence to KDOW (2002b, 1995). Approximately 10 percent of water samples will be duplicated or split and sent to CT Laboratories for analysis.

- Field Duplicate Sample

Approximately five percent of all samples taken in the field are duplicated. To perform a field duplicate, the Sampling Technician shall consecutively collect two representative aliquots, independent of one another, from the same source by the grab collection technique.

- Field Split Sample

Approximately five percent of all samples taken in the field are split. To perform a field split sample, the Sampling Technician shall evenly divide the contents of one grab collection into two sets of sampling bottles. To ensure the split is representative, sample bottles are each filled in three rounds of filling each bottle one third of the total volume.

To ensure that data of known and documented quality are generated in the laboratory , the QC criteria described in this section must be met for all analyses, as applicable. The Laboratory QA Director is responsible for monitoring and documenting procedure performance, including the analysis of control samples, blanks, matrix spikes, and duplicates.

- Blanks

A method blank (MB) is prepared at a frequency of one per 20 field samples depending on the specific method. The MB is analyzed at the beginning of every analytical run and prior to the analysis of any samples. MB results are acceptable if the concentrations of the target analyte does not exceed the reporting limit (RL). If any target analyte concentration in the MB exceeds the RL, the source of contamination must be identified and eliminated. Analysis of samples cannot proceed until a compliant MB is obtained.

- Duplicates

A duplicate sample (DUP) or duplicate matrix spike sample (MSD) is prepared at a frequency of one per 20 field samples depending on the specific method. The relative percent difference (RPD) between duplicate samples, for samples having analyte concentrations greater than their respective reporting limit, or between a matrix spike (MS) and matrix spike duplicate (MSD), must be within the acceptance ranges. If the QC criteria for duplicate sample or spike analyses are not satisfied, the cause of the problem must be determined and corrected. If the problem adversely affected the entire analysis batch, all samples in the batch must be reanalyzed.

- Matrix Spikes

Spikes (MS) are prepared every 20 field samples for each matrix, depending on the specific method. Spike recoveries must fall within the acceptance ranges. If the QC criteria for the matrix spike analyses are not satisfied, the cause of the problem must be determined and corrected. If the problem adversely affected the entire analysis batch, all samples in the batch must be reanalyzed.

- Laboratory Control Samples

A laboratory control sample (LCS) is second-source to the calibration standards and must be prepared at a frequency of one per every 20 field samples depending on the specific method requirements. The LCS results are acceptable if the percent recovery of each analyte is within the determined acceptance range. If the LCS results do not meet specification, sample analyses must be stopped until the problem is corrected, and all associated samples in the analysis batch must then be reanalyzed.

### 2.3.1 Calculations

The following calculations are used in the interpretation of the data provided by the quality controls:

- Accuracy

For LCSs, calibration standards or additional QC samples of known concentration, accuracy is quantified by calculating the *percent recovery* (%R) of analyte from a known quantity of analyte as follows:

$$\%R = \frac{V_m}{V_t} \times 100$$

where:

$V_m$ = measured value (concentration determined by analysis)
$V_t$ = true value (concentration or quantity as calculated or certified by the manufacturer)

A matrix spike (MS) sample or a matrix spike duplicate (MSD) sample is designed to provide information about the effect of the sample matrix on the digestion and measurement methodology. A known amount of the analyte of interest is added to a sample prior to sample preparation and instrumental analysis. To assess the effect of sample matrix on accuracy, the %R for the analyte of interest in the spiked sample is calculated as follows:

$$\% R = \frac{(SSR - SR)}{SA} \times 100$$

where:
SSR = spiked sample result
SR = sample result
SA = spike added

- Precision

When calculated for duplicate sample analyses, precision is expressed as the *relative percent difference* (RPD), which is calculated as:

$$RPD (\%) = \frac{| S - D |}{( S + D ) / 2} \times 100$$

where:
S = first sample value (original result)
D = second sample value (duplicate result)

## 2.4 Instrument / Equipment Maintenance and Calibration

All sampling equipment will be maintained and calibrated according to manufacturer recommendation.

The Hydrolab runs on battery power and thus the charge must be maintained by charging on a daily basis. Calibration shall be completed in accordance with the user manual (Hydrolab, 1997) on a weekly basis.

All supplies are acquired through Third Rock Consultants' vendors. The members on this vendor list have applied quality control measures that have resulted in recurring quality.

All maintenance on laboratory equipment is conducted in accordance with manufacturers' recommendations. These requirements are described in the laboratories' standard operating procedures and appropriate instrument maintenance manuals. The applicable laboratory is responsible for ensuring that timely maintenance is conducted and that sufficient spare parts are on hand for necessary maintenance and repair procedures.

The frequency of maintenance performed depends on the equipment; laboratory maintenance is scheduled and conducted daily, monthly, weekly, quarterly, semiannually, and annually, as required. A few maintenance needs (e.g., accidental breakage, part failure) are not covered by the general maintenance schedule, and such maintenance is performed as needed.

Specific instrument calibration requirements can and do vary slightly depending on the particular method and the project and regulatory requirements for the project. Detailed descriptions of specific calibration requirements are provided in the laboratory analytical method SOP for each method.

## 2.5 Non-Direct Measurements

Non-direct measurements include any measurements or data that will be used during this project that will not be directly measured by Third Rock or its subcontracted partners.

The EPA model, Qual2K, will be used to predict pollutant concentrations based on environmental conditions during critical periods. Qual2K is a modernized version of Qual2E and is a one-dimensional steady state model. When modeling, weather data will be obtained from a third party source, such as the National Climatic Data Center. Also pollutant source assessment relies on non-direct measures (i.e. land use, watershed characterization) when modeling loads from nonpoint sources.

## 2.6 Data Management

Records are to be stored until 3 years after the close of the project. An efficient and effective data management system is necessary to maintain and store all project related data.

The laboratory is expected to maintain all records associated with the analytical results; including laboratory notebooks, bench sheets, instrument calibration and sequence logs, preparation logs, maintenance logs, etc.; for the retention period of the grant according to their internal data management procedures.

All field and laboratory data and results will be reviewed, organized, and stored by Third Rock's Data Manager and Sampling Coordinator. In order to accomplish this task, the sampling technician shall submit completed field datasheets and copies of measurements in field notebooks to the Data Manager upon return to the office. The Data Manager will calculate all flows and review the datasheets for completeness. If the sampling technician submits samples to the laboratory, he/she shall obtain a copy of the relinquished COC and submit it to the Data Manager. If the sampling technician relinquishes the COC to the Data Manager, the Data Manager shall similarly obtain a copy of the relinquished COC to retain for recording purposes.

The field data and the COC are stored by the Data Manager until results are received from the analytical laboratory. Hardcopy of the results from the laboratory are reviewed for completeness and for outlier results (i.e. ortho-phosphorus less than total phosphorus, dissolved organic carbon less than total organic carbon, etc). Laboratory results and field measurements are then entered into an electronic "Analytical Monthly Summary" spreadsheet to be submitted, by the Project Administrator, to KDOW once all data for a month is received and entered. Once the "Analytical Monthly Summary" has been submitted to the KDOW, the Data Manager organizes and stores the hardcopies of all information in the designated project folder in the central files.

Third Rock will also deliver analytical data in a COMPASS format to the KDOW as each COC is completed for all sampled stations. The laboratory is responsible to submit the data in the required COMPASS template to the Data Manager once the analytical COC is completed. The Data Manager then enters the field measurements into this database and forwards the database to the Project Administrator. The Project Administrator reviews the file for completeness and then submits the file to the KDOW.

To ensure that data entry is accurate and consistent between the pdf laboratory reports, electronic COMPASS template and the monthly analytical results review, the Data Manager is responsible to hand enter all results from the pdf report into the monthly analytical results review. Using a custom designed verification program within the Access data entry template, a report is generated showing deviations between the COMPASS template and the monthly analytical results. Each deviation is documented and investigated by the Data Manager.

All project related correspondence is documented by an email system. All project related emails are "CC"ed to the Third Rock assigned project file folder for traceability and storage. All other electronic files are stored on a central project drive accessible to the appropriate Third Rock personnel.

# 3 Assessment and Oversight

## 3.1 Assessment and Response Actions

Assessment and response actions are necessary to ensure that this QAPP is being implemented as approved. For a general summary of these assessments see Table 4 Dix River Watershed Assessment and Management Reports. The Kentucky Division of Water (KDOW) quality assurance officer (QAO) may freely review all field and laboratory techniques as requested. Any identified problems will be corrected based on recommendations by the QAO. The KDOW will also review analytical results on a monthly basis.

### 3.1.1 Laboratory Assessments

To ensure conformance with this QAPP and the applicable regulations, certifications, and methods by which the laboratory operates, the laboratory performs several assessment measures. To ensure that the analyst is capable of performing the requested analytical methods to specifications, each analyst is required to acceptably demonstrate this ability prior to conducting sample analyses. The analyst must conduct four replicate analyses of a known standard and achieve precision and accuracy equal to or better than the acceptance ranges for laboratory duplicates and laboratory control samples, respectively.

The laboratory is also required to participate in at least one blind performance evaluation study each year. Performance Evaluation (PE) studies provide an independent assessment of the accuracy of its analyses and maintain laboratory accreditations. All PE analyses performed by the laboratory are performed by the same analysts and using the same procedures that are used for routine sample analyses for the analyte(s) of interest. The PE results must satisfy the PE acceptance criteria specified by the PE provider. After an evaluation of the PE results is received, any results outside of acceptance limits are investigated and corrective actions taken to prevent recurrence of the problem. All findings must be documented and available for review.

The laboratory is also required to have routinely scheduled internal and external audits. The laboratory QA Director or their appointee on an annual basis performs internal audits. Certification bodies usually on a biannual basis perform external audits. In each case, the findings of the audit, both positive and negative are documented, and the corrective response to the cited deviations is required within thirty days of receipt of the audit report. Corrective actions are submitted to the auditing body for review and approval.

### 3.1.2 Field Assessments

The QA manager is responsible for the overall conformance of Third Rock to the general procedures, protocols, and methods established by this QAPP and internal project related procedures. To ensure overall conformance to this QAPP, the QA manager schedules and manages a weekly status meeting for this project. At this meeting, the status of progress on project related objectives is discussed and concerns addressed. The Project Administrator is responsible for compiling the minutes of these meetings for review by the QA Manager. These minutes are stored electronically in the project files. The QA Manager may apply spot assessments including supervision of field activities or requests for documentation of the reviews specified herein. The QA Manager may also periodically review the project correspondence files to ensure that all deviations are properly documented and resolved.

To ensure accurate data entry for flow calculations and field data entry into COMPASS templates, all entries and calculations are verified by an independent review. Deviations are documented and corrected accordingly. For those COMPASS entries that are also in the monthly analytical results table, quality assurance is maintained by use of the verification report as in the laboratory data entry.

The Field Logistics Coordinator conducts field procedural audits at the project level. On a quarterly basis, at minimum, the Field Logistics Coordinator will supervise and assess the sampling technicians the following for conformance:

- Calibration and maintenance of field equipment
- Sample collection techniques
- Field measurements and documentation
- Sample handling and custody documentation

The Field Logistics Coordinator will document the review of these items in emails to the Project Administrator. Deviations for the methods specified will be noted, and if necessary, corrective actions will be implemented as specified by the Project Manager. Spot assessments may be applied to ensure that an action is properly corrected. All corrective actions will similarly documented by email correspondence in the project file.

## 3.2 Reports to Management

Third Rock will prepare a final report that includes the TMDL modeling results and will describe all methods and findings of this project. The final report will satisfy all requirements for the grant.

Prior to the completion of that report, reports on the progress and assessment of the project objectives are produced as summarized in Table 4. All reports are expected to list the personnel or organization responsible for producing the report and the date prepared for traceability purposes.

# 4 Data Validation and Usability

## 4.1 Data Review, Verification, and Validation

Initial review of all analytical data is performed by the laboratory against the data quality indicators specified in this QAPP. Corrective actions are taken, if possible while the samples are still within the method specified holding time. Data quality flags are applied to the laboratory results that do not meet these requirements.

Third Rock's Data Manager performs an additional review of the laboratory data as well as the field data. This review, performed within one week of receipt of the results, assesses the completeness and accuracy of the data. Evaluation of the data is made against the DQIs as listed in Table 2. Any data points that seem suspect or require additional analysis are identified during this review. Decisions to reject or additionally qualify the data will be made at the discretion of Third Rock.

## 4.2 Verification and Validation Methods

The Water Quality Modelers will conduct Third Rock's final review of all data associated with the modeling of the Clarks Run. In this review, they will incorporate all necessary data into a final TMDL document to submit to the KDOW. The final review of all data not associated with this modeling effort will be conducted by the KDOW.

Statistical measures will be used to quantify differences between observed data and model predictions. Such techniques as comparisons of means, regression analysis, and relative error can provide information of model adequacy and error. In addition, model sensitivity analysis will be conducted to determine the effect of model input parameters

The QA Manager will also inspect the final documents to ensure each document is complete and that consistent and appropriate formatting is applied.

## 4.3 Reconciliation with User Requirements

In the final TMDL document, descriptions of all relevant background information, summary, water body details, monitoring history, current monitoring effort, modeling report, and public involvement will be detailed. Included in this document will be an overall assessment of the data quality and the uncertainty involved in the results.

Load calculations developed from the data will show loads for point sources and nonpoint sources. Example calculations will exhibit the manner in which these loads were calculated. Documentation will be provided for any assumptions made during these calculations, including any data that was rejected or qualified.

In the calculation of the TMDLs specific methodology utilized and any limitations of the model or calculations and of existing data, including data gaps, will be provided.

Based on the model provided by Third Rock, the Division of water will work with the stakeholders in the community to assign the specific load allocations. Margins of Safety are built into assignment of these loads. An implementation plan to reduce the loads will be formulated by KDOW.

# 5 References

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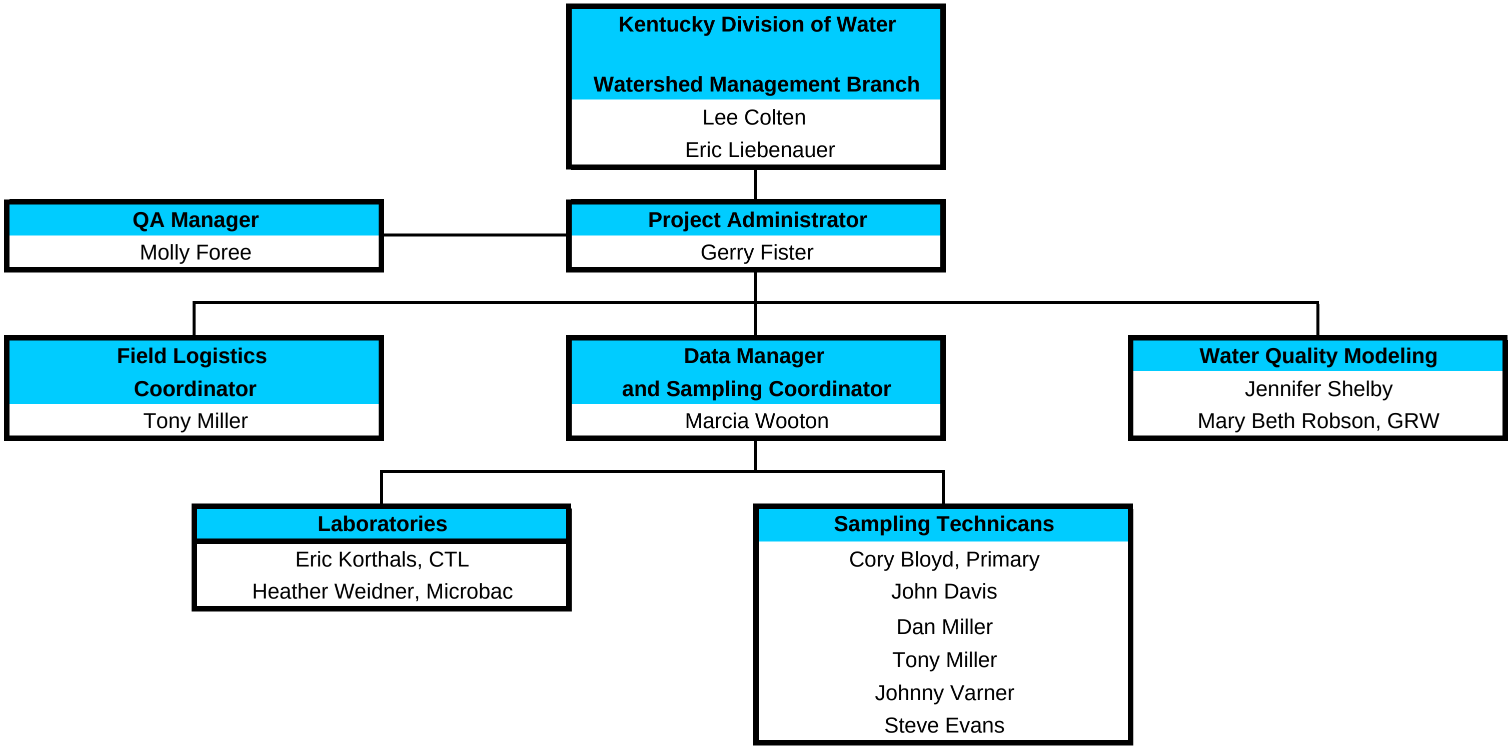
# APPENDICES

# APPENDIX A

## FIGURE 1:
## DIX RIVER ORGANIZATIONAL CHART

# Figure 1: Dix River Organizational Chart



# APPENDIX B

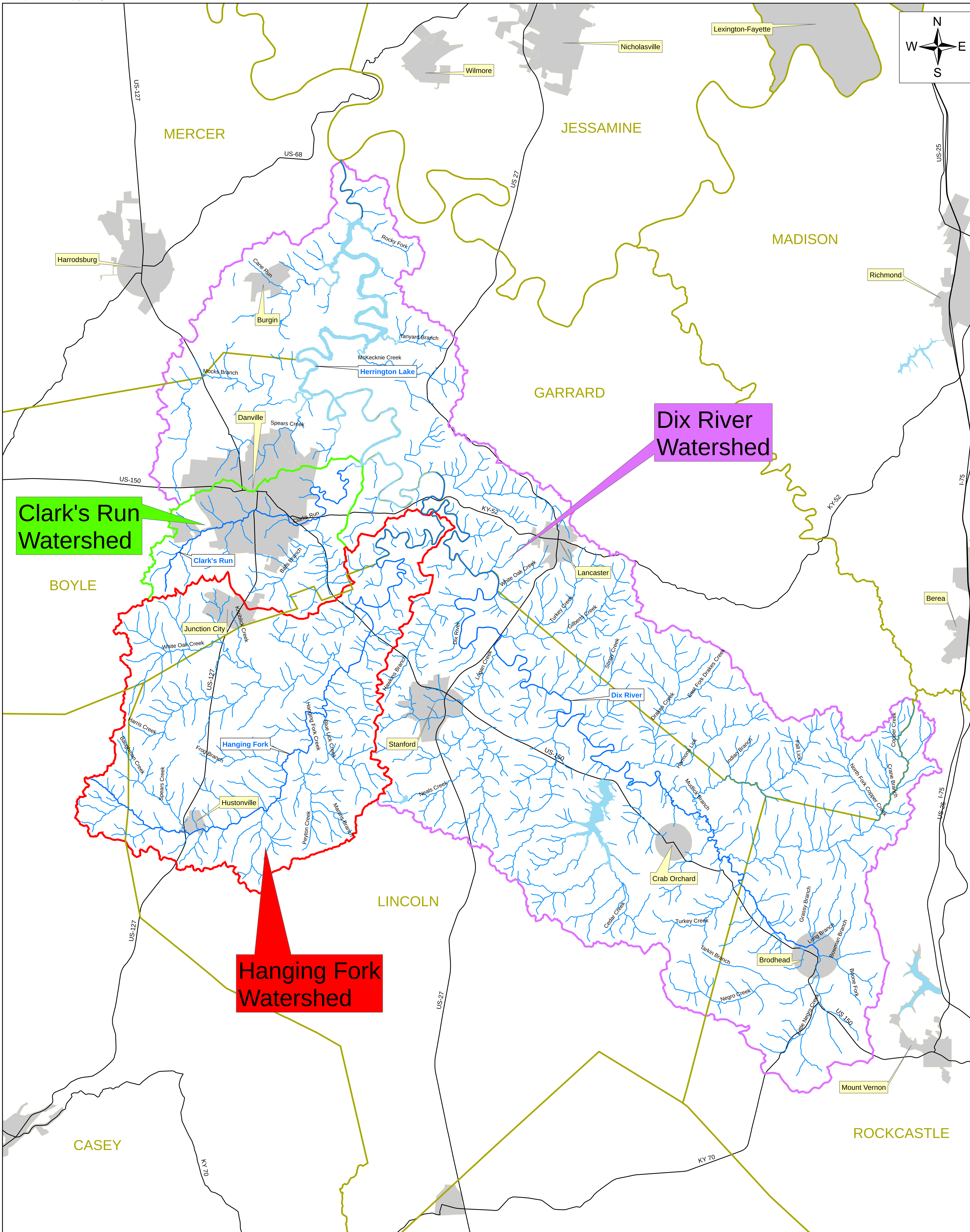
# FIGURE 2:
# DIX RIVER PROJECT SCHEDULE

Figure 2: Dix River Project Schedule

| Event | Project Schedule |
|---|---|
| Site Identification and Preparation | January - February 2006 |
| Monitoring and Laboratory Analysis | March 2006 - March 2007 |
| Grab Sampling | March 2006 - March 2007 |
| Passive High Flow Sampling | November 2006 - April 2007 |
| Canopy Coverage | Summer 2006 |
| 24 hour Dinural Dissolve Oxygen | Summer 2006 |
| EPA Rapid Bioassessment Protocol | March 2006, March 2007 |
| TMDL modeling on Clarks Run. | April 2007 |
| TMDL model training to KDOW staff | May 2007 |
| Nonpoint Source Pollution Abatement | May 2007 |

# APPENDIX C

## FIGURE 3:
## WATERSHED OVERVIEW MAP




SHEET
1 OF 1

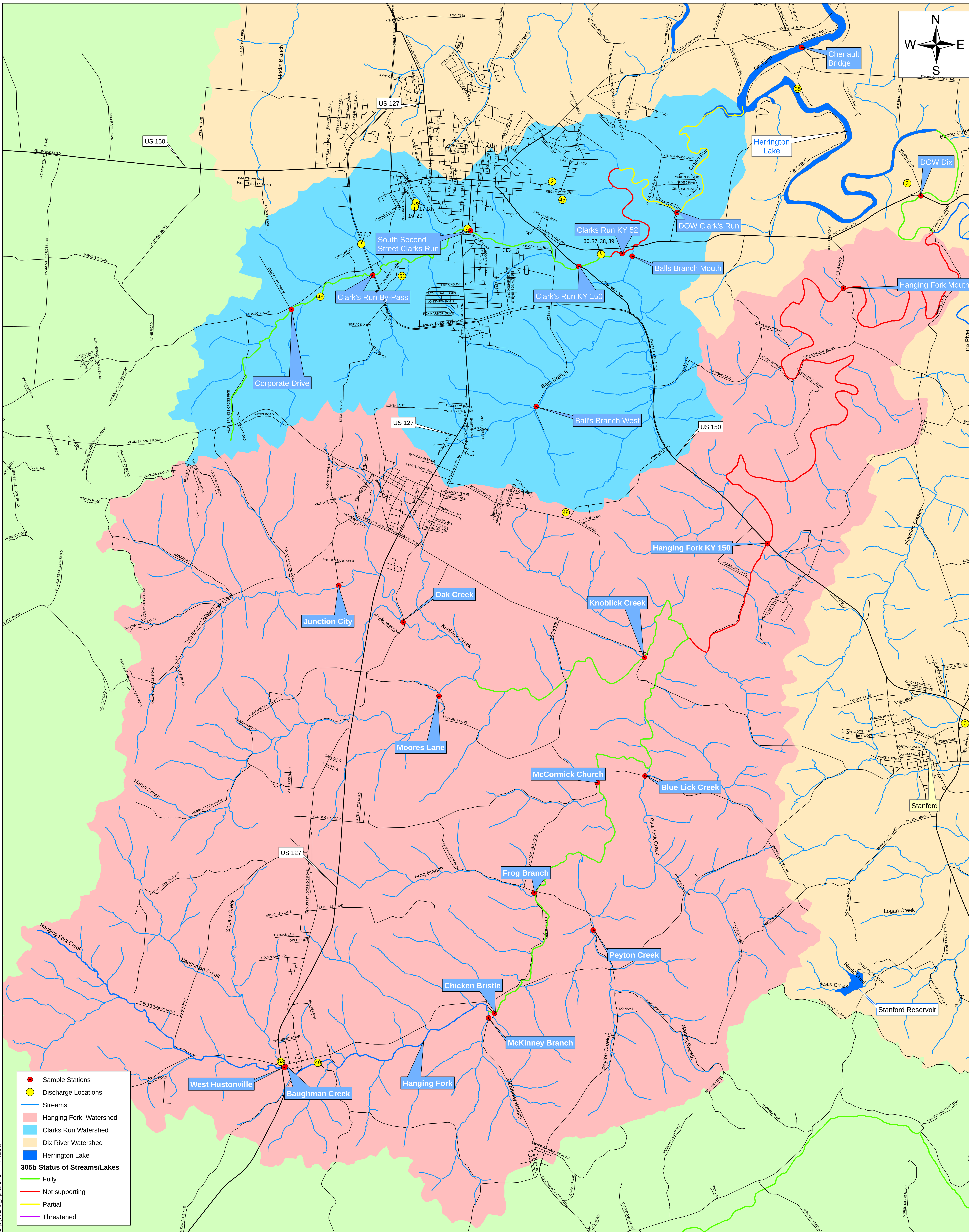
Watershed Overview

Kentucky UNBRIDLED SPIRIT

THIRD ROCK CONSULTANTS

# APPENDIX D

# FIGURE 4:
# HANGING FORK AND CLARKS RUN MAP




SHEET
1 OF 1

0 0.5 1 2 Miles

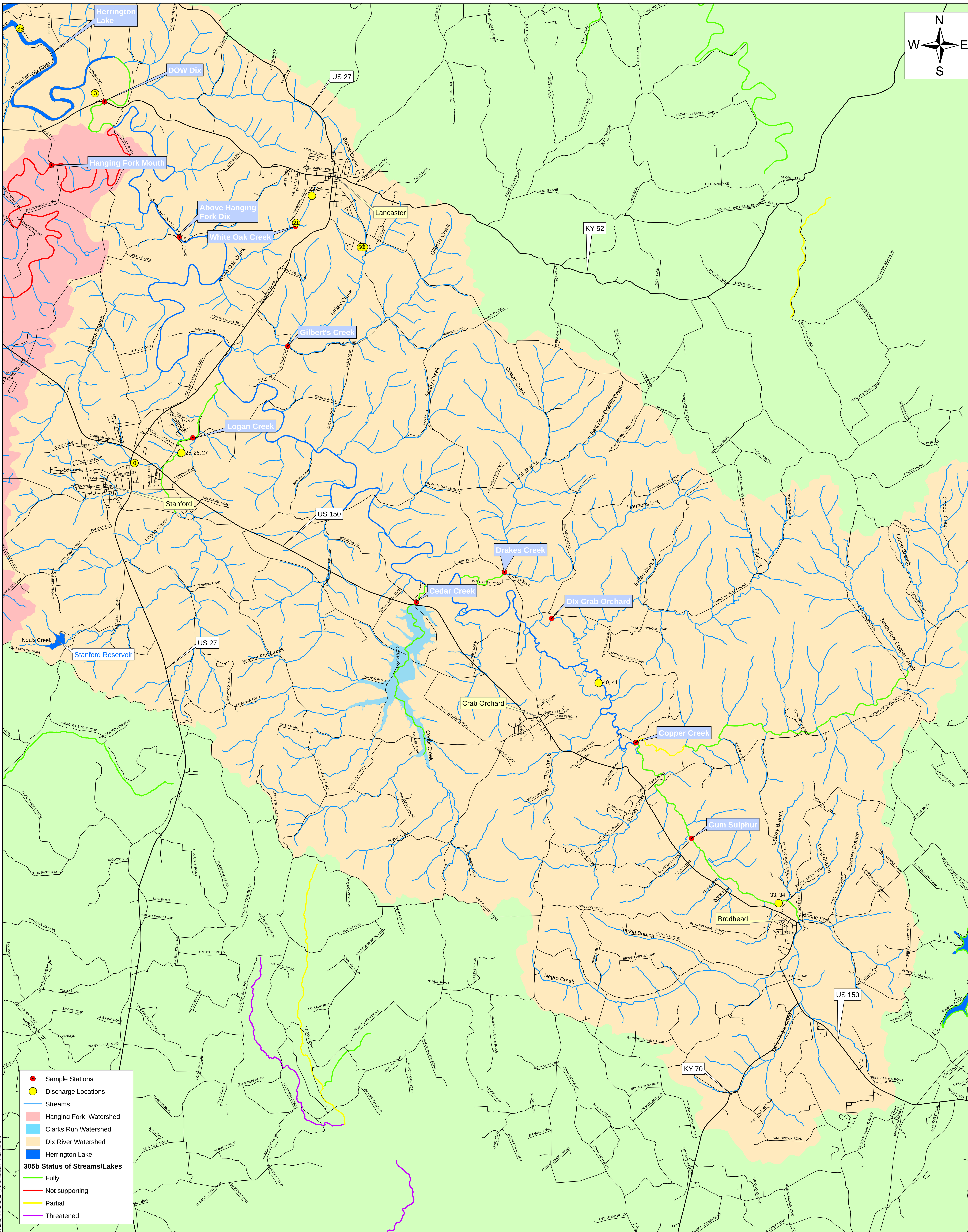
Hanging Fork
and Clarks Run

Kentucky UNBRIDLED SPIRIT

THIRD ROCK CONSULTANTS

# APPENDIX E

# FIGURE 5:
# DIX RIVER MAP




SHEET
1 OF 1

0 0.5 1 2
Miles

Dix River

Kentucky UNBRIDLED SPIRIT

THIRDROCK CONSULTANTS

# APPENDIX F

## FIGURE 6:
## EPA RAPID BIOASSESSMENT PROTOCOL (RBP) WORKSHEET

# DIX RIVER PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET

| Station ID: | Stream Name: | Project #: |
|---|---|---|
| Station type (select/nonselect): | Watershed: | Form Completed by: |
| Collection Date/Time: | Investigators: | Location: |

**Picture #s:**

| | |
|---|---|
| **WEATHER CONDITIONS** | **Now** / **Past 24 Hours**<br>☐ storm (heavy rain) ☐<br>☐ rain (steady rain) ☐<br>☐ showers (intermittent) ☐<br>____% ☐ % cloud cover ☐_____%<br>☐ clear/sunny ☐<br><br>**Has there been a heavy rain in the last 7 days?**<br>☐ Yes ☐ No<br>Air Temperature ______°F<br>Other_____________________________________ |
| **STREAM CHARACTERIZATION** | **Stream Subsystem**<br>☐ Perennial ☐ Intermittent<br>**Estimate # of intermittent tributaries above this station _________**<br><br>**Do the tributaries appear to contribute to any NPS pollution? _____**<br>**If yes, explain: _________________________** |
| **INSTREAM FEATURES** | **Estimated Reach Length __________** yards<br>**Estimated Stream Width:**<br>Pools:__________ Runs:__________ Riffles:__________<br>**High Water Mark: _____** ft<br>**Estimated Stream Depth:**<br>Pools:__________ Runs:__________ Riffles:__________<br>**Proportion of reach represented by Morphology Types**<br>☐ Riffle_______% ☐ Run ________%<br>☐ Pool ________%<br>**Channelized** ☐ Yes ☐ No<br>**Stream Flow:**<br>☐ Flooding ☐ Bankful ☐ High ☐ Normal<br>☐ Low ☐ Pooled ☐ Dry |
| **AQUATIC VEGETATION/FUNGUS** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rotted floating ☐ Free floating<br>☐ Floating Algae ☐ Attached Algae<br>**Indicate the macrohabitats sampled for periphyton:**<br>☐ Riffle ☐ Run ☐ Pool<br>**Indicate the microhabitat sampled for periphyton and its relative proportion:**<br>Rocks_____ Woody Debris ____ Bedrock ____ Vegetation ____ Artificial Substrate ____ Other ____<br>**Estimate periphyton coverage:**<br>☐ Dense (>75%) ☐ Moderate (50-75%) ☐ Sparse (15-50%) ☐ Absent (<15%)<br>**Is the periphyton coverage consistent over entire reach? ____**<br>**If no, describe differences in bottom coverage:**<br>**Is sewage fungus preset?**<br>☐ Yes ☐ No<br>**Describe the extent of the fungus coverage:**<br>☐ Dense (>75%) ☐ Moderate (50-75%) ☐ Sparse (15-50%) ☐ Absent (<15%)<br>**Describe the extent of organic sediment accumulation:**<br>☐ Dense (>75%) ☐ Moderate (50-75%) ☐ Sparse (15-50%) ☐ Absent (<15%) |

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| | |
|---|---|
| **WATER QUALITY** | **Temperature**__________°F<br>**Specific Conductance**____________µS/cm<br>**Dissolved Oxygen** ______mg/L, ______% Sat<br>**pH**_______________ (Standard Units)<br>**Turbidity** ___________NTU<br>**WQ Instrument Used**_______________<br>☐ Hydrolab MS5 ☐ Hydrolab Quanta<br>☐ Lamotte 2020 (turb) ☐ Other______________<br><br>**Water Odors**<br>☐ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☐ Other __________<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Globs ☐ Flecks<br>☐ None ☐ Other ____________________________<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly Turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _________ |
| **SEDIMENT/ SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☐ None<br>☐ Other ______________________________<br>**Oils**<br>☐ Absent ☐ Slight ☐ Moderate ☐ Profuse<br><br>**Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper Fiber ☐ Sand<br>☐ Relict Shells ☐ Other _______________<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☐ Yes ☐ No<br><br>**Sedimentation:** ☐ Heavy ☐ Moderate ☐ Slight ☐ None |

## Modified RBP Worksheet

| | | |
|---|---|---|
| Riparian Vegetation:<br>Dominate Type: Dom. Tree/Shrub Taxa:<br>❑ Trees ❑ Shrubs<br>❑ Grasses ❑ Herbaceous<br>Number of strata ____ | Canopy Cover:<br>❑ Fully Exposed (0-25%)<br>❑ Partially Exposed (25-50%)<br>❑ Partially Shaded (50-75%)<br>❑ Fully Shaded (75-100%) | **Note the approximate length of stream that is affected by the following:**<br>Stream diversion________________<br>Stream straightening________________<br>Concrete streambank/bottom___________ |

| Substrate ❑Est. ❑P.C. | **Riffle_______%** | **Run_______%** | **Pool_______%** |
|---|---|---|---|
| Silt/Clay (<0.06 mm) | | | |
| Sand (0.06 – 2 mm) | | | |
| Gravel (2-64 mm) | | | |
| Cobble (64 – 256 mm) | | | |
| Boulders (>256 mm) | | | |
| Bedrock | | | |

| **Habitat** | **Condition Category** | | | |
|---|---|---|---|---|
| **Parameter** | **Optimal** | **Suboptimal** | **Marginal** | **Poor** |
| **1. Epifaunal Substrate/ Available Cover** | Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient). | 40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **2. Embeddedness** | Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. | Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment. | Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment. | Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **3. Velocity/Depth Regime** | All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.) | Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). | Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low). | Dominated by 1 velocity/ depth regime (usually slow-deep). |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

| | | | | |
|---|---|---|---|---|
| **4. Sediment Deposition** | Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition. | Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools. | Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent. | Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **5. Channel Flow Status** | Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Water fills >75% of the available channel; or <25% of channel substrate is exposed. | Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Very little water in channel and mostly present as standing pools. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **6. Channel Alteration** | Channelization or dredging absent or minimal; stream with normal pattern. | Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present. | Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted. | Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **7. Frequency of Riffles (or bends)** | Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important. | Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15. | Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25. | Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **8.Bank Stability (score each bank)** Note: determine left or right side by facing downstream. | Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected. | Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars. |
| SCORE _____ (LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE _____ (RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **9. Vegetative Protection** (score each bank) | More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | 70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | 50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height. |
| SCORE _____(LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE _____(RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **10. Riparian Vegetative Zone Width** (score each bank riparian zone) | Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | Width of riparian zone 12-18 meters; human activities have impacted zone only minimally. | Width of riparian zone 6-12 meters; human activities have impacted zone a great deal. | Width of riparian zone <6 meters: little or no riparian vegetation due to human activities. |
| SCORE _____(LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE _____(RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

**Total Score**

[ ]

## LAND USES IN THE WATERSHED

**1. Specific uses identified** (check as many as apply)

| | Streamside | 100—200 Yards |
|---|---|---|
| **Residential:** | | |
| Single-family housing | . | . . |
| Apartment building | . | . . |
| Lawns | . | . . |
| Playground | . | . . |
| Parking lot | . | . . |
| Other ______________ | . | . . |
| | | |
| **Commercial / Industrial / Institutional:** | | |
| Commercial development | . | . . |
| (stores, restaurants) | . | . . |
| Auto repair/gas station | . | . . |
| Factory/Power plant | . | . . |
| Sewage treatment facility | . | . . |
| Water treatment facility | . | . . |
| Institution (e.g., school, offices) | . | . . |
| Landfill | . | . . |
| Automobile graveyard | . | . . |
| Bus or taxi depot | . | . . |
| Other ______________ | . | . . |
| | | |
| **Forest / Parkland:** | | |
| Recreational park | . | . . |
| National/State Forest | . | . . |
| Woods/Greenway | . | . . |
| Other ______________ | . | . . |
| | | |
| **Agricultural / Rural:** | | |
| Grazing land | . | . . |
| Cropland | . | . . |
| Animal feedlot | . | . . |
| Isolated farm | . | . . |
| Old (abandoned) field | . | . . |
| Fish hatchery | . | . . |
| Tree farm | . | . . |
| Other ______________ | . | . . |

**2. Additional activities in the watershed** (check as many as apply)

| | Streamside | 100—200 Yards |
|---|---|---|
| **Construction** | . | . . |
| Building construction | . | . . |
| Roadway | . | . . |
| Bridge construction | . | . . |
| Other ______________ | . | . . |
| | | |
| **Logging** | | |
| Selective logging | . | . . |
| Intensive logging | . | . . |
| Lumber treatment facility | . | . . |
| | | |
| Other ______________ | . | . . |
| | | |
| **Mining** | | |
| Strip mining | . | . . |
| Pit mining | . | . . |
| Abandoned mine | . | . . |
| Quarry | . | . . |
| Other ______________ | . | . . |

**Recreation**

Biking/Off-road vehicle trails . . .
Horseback riding trail . . .
Boat ramp . . .
Jogging paths/hiking trail . . .
Swimming area . . .
Fishing area . . .
Picnic area . . .
Golf course . . .
Campground/trailer park . . .
Power boating . . .
Other ______________ . . .

## VELOCITY MEASUREMENT DATA

Infinity Depth and Time:

Notes: **LEOW =** **REOW =** **DEPTH =**

** 0 = Left Bank (when looking downstream)

| Distance from L Bank (ft) | Total Depth (ft) | Depth of Avg. Velocity (0.6, 0.2, or 0.8D) | Starting Count | Ending Count | Time (~1min) | Notes |
|---|---|---|---|---|---|---|
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| | | | | | | **Total Stream Discharge ($ft^3$/sec) =** |

* Stand at least 1' downstream of meter

* When D<2.5', avg V occurs at 0.6D

* When D>2.5', measure V at 0.2D and 0.8D (then will average these values)

Updated 5/10/06 mlw

# APPENDIX G

# FIGURE 7:
# DATA CHARACTERIZATION AND WATER QUALITY DATASHEETS

# DIX RIVER PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET

| **Station ID:** | **Stream Name:** | **Project #:** |
|---|---|---|
| **Station type (select/nonselect):** | **Watershed:** | **Form Completed by:** |
| **Collection Date/Time:** | **Investigators:** | **Location:** |

**Picture #s:**

| | |
|---|---|
| **WEATHER CONDITIONS** | **Now** / **Past 24 Hours**<br>☐ storm (heavy rain) ☐<br>☐ rain (steady rain) ☐<br>☐ showers (intermittent) ☐<br>____% ☐ % cloud cover ☐_____%<br>☐ clear/sunny ☐<br>**Has there been a heavy rain in the last 7 days?**<br>☐ Yes ☐ No<br>Air Temperature ______°F<br>Other_____________________________________ |
| **STREAM CHARACTERIZATION** | **Stream Subsystem**<br>☐ Perennial ☐ Intermittent<br>**Estimate # of intermittent tributaries above this station _________**<br>**Do the tributaries appear to contribute to any NPS pollution? _____**<br>**If yes, explain: _________________________** |
| **INSTREAM FEATURES** | **Estimated Reach Length __________** yards<br>**Estimated Stream Width:**<br>Pools:__________ Runs:__________ Riffles:__________<br>**High Water Mark: _____** ft<br>**Estimated Stream Depth:**<br>Pools:__________ Runs:__________ Riffles:__________<br>**Proportion of reach represented by Morphology Types**<br>☐ Riffle_______% ☐ Run ________%<br>☐ Pool ________%<br>**Channelized** ☐ Yes ☐ No<br>**Stream Flow:**<br>☐ Flooding ☐ Bankful ☐ High ☐ Normal<br>☐ Low ☐ Pooled ☐ Dry |
| **AQUATIC VEGETATION/FUNGUS** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rotted floating ☐ Free floating<br>☐ Floating Algae ☐ Attached Algae<br>**Indicate the macrohabitats sampled for periphyton:**<br>☐ Riffle ☐ Run ☐ Pool<br>**Indicate the microhabitat sampled for periphyton and its relative proportion:**<br>Rocks_____ Woody Debris ____ Bedrock ____ Vegetation ____ Artificial Substrate ____ Other ____<br>**Estimate periphyton coverage:**<br>☐ Dense (>75%) ☐ Moderate (50-75%) ☐ Sparse (15-50%) ☐ Absent (<15%)<br>**Is the periphyton coverage consistent over entire reach? ____**<br>**If no, describe differences in bottom coverage:**<br>**Is sewage fungus preset?**<br>☐ Yes ☐ No<br>**Describe the extent of the fungus coverage:**<br>☐ Dense (>75%) ☐ Moderate (50-75%) ☐ Sparse (15-50%) ☐ Absent (<15%)<br>**Describe the extent of organic sediment accumulation:**<br>☐ Dense (>75%) ☐ Moderate (50-75%) ☐ Sparse (15-50%) ☐ Absent (<15%) |

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**WATER QUALITY**

**Temperature**__________°F

**Specific Conductance**____________µS/cm

**Dissolved Oxygen** ______mg/L, ______% Sat

**pH**_______________ (Standard Units)

**Turbidity** ___________NTU

**WQ Instrument Used**_______________
☐ Hydrolab MS5 ☐ Hydrolab Quanta
☐ Lamotte 2020 (turb) ☐ Other_____________

**Water Odors**
☐ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other _________

**Water Surface Oils**
☐ Slick ☐ Sheen ☐ Globs ☐ Flecks
☐ None ☐ Other ___________________________

**Turbidity (if not measured)**
☐ Clear ☐ Slightly Turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other ________

**SEDIMENT/ SUBSTRATE**

**Odors**
☐ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other _____________________________

**Oils**
☐ Absent ☐ Slight ☐ Moderate ☐ Profuse

**Deposits**
☐ Sludge ☐ Sawdust ☐ Paper Fiber ☐ Sand
☐ Relict Shells ☐ Other ______________

**Looking at stones which are not deeply embedded, are the undersides black in color?**
☐ Yes ☐ No

**Sedimentation:** ☐ Heavy ☐ Moderate ☐ Slight ☐ None

## VELOCITY MEASUREMENT DATA

Infinity Depth and Time:

Notes: **LEOW =** **REOW =** **DEPTH =**

** 0 = Left Bank (when looking downstream)

| Distance from L Bank (ft) | Total Depth (ft) | Depth of Avg. Velocity (0.6, 0.2, or 0.8D) | Starting Count | Ending Count | Time (~1min) | Notes |
|---|---|---|---|---|---|---|
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| | | | | | | **Total Stream Discharge ($ft^3$/sec) =** |

* Stand at least 1' downstream of meter

* When D<2.5', avg V occurs at 0.6D

* When D>2.5', measure V at 0.2D and 0.8D (then will average these values)

Updated 5/10/06 mlw

# APPENDIX H

## FIGURE 8:
## CHAIN-OF-CUSTODY FORMS

**COC#** **CHAIN OF CUSTODY** **PAGE 1 OF 1**

Client:

Project Name:

Project #:

Collected By: Third Rock Consultants -

Third Rock Consultants Project Contact: Marcia L. Wooton

Third Rock Consultants Phone #: 859-977-2000

## Third Rock Consultants

## COMPASS Reporting

**Project Code/Short Name:** HERTMDL

**Medium:** Water - ambient surface

**Sample Purpose Description:** Sampling effort to collect nutrients, pathogens, and other water quality data in Herrington Lake and associated tributaries.

# EXAMPLE Chain of Custody

**(customized per event i.e. watershed, parameters, laboratory specifics, etc.)**

*** * Preservation Code**

AA - Ascrobic Acid
AC - NH4Cl
E - EnCore
HA - HCl
M - Methanol
NA - HNO3
SA - H2SO4
SH - NaOH
SS - Na2SO3
ST - Na2S2O3
ZA - Zinc Acetate
O - Other ________________

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | * * Preservation Type | - | - | - | SA | SA | - | SH/ZA | | | | |
| | | | | | | | Requested Analysis | CBOD5, TSS, SO4 | CBOD5, SO4 | TSS, SO4 | TKN, NH3, P-T | TOC | P-O, NO2, NO3 | Sulfide | | | | |
| Sample I.D. | Station Name | County | Zone-Depth | Collection Date | Collection Time | Grab / Comp | Filt'd Y/N | 32oz P | 32oz P | 32oz P | 8oz P | 4oz P | 16oz P | 16oz P | | | Lab # | Comments |
| | | | | | | | | | | | | | | | | | | |
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| Reliquished By: | Date/Time | Received By: | Date/Time |
|---|---|---|---|
| | | | |
| | | | |

Properly Preserved: Yes / No

Bottles Intact: Yes / No

Temp. @ Receipt: _____°C By: _____________

**Laboratory: ADD "day", highlighted in yellow, to sample id (without any spaces).**

**COMPASS Reporting Notes:** Previous information provided for Project Level Data Description is now the Sample Purpose Description; Project Level Data Description field is now for Case Narrative from laboratory.

# APPENDIX I

# FIGURE 9:
# ANALYTICAL LABORATORY REPORTS

2520 Regency Rd.
Lexington, KY 40503
Phone: 859-276-3506
Toll Free: 800-489-3506
Fax: 859-278-5665
E-mail: info@envirodatagroup.com

Microbac

*Accredited Lab Data for Today's Environment*

# Analytical Results

Third Rock Consultants
Attn: Marcia Wooton
2514 Regency Rd

Lexington, KY 40503

cc: pdf

Chain of Custody: 45643
Project Name: Dix River TMDL-Hanging Fork
Project Number: 5167
Report Reference:45643-20060426103701

Date/Time Received: 04/13/2006 09:05
Temperature Upon Receipt: 2 C

Collector: Client
Client Manager: Heather Weidner

**Laboratory Sample #:** 482663 **Client Sample ID:** Chicken Bristle **Sampled:** 04/12/2006 13:45
**Sample Replicate #** 1

**Biochemical Oxygen Demand-Carbonaceous** **Method:** EPA 405.1 **Prep. Method:** N/A
Analyzed by CDP on April 14, 2006 at 08:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Oxygen Demand, Biochemical, 5-Day/ | < 2.00 | mg/L | 2.00 | N/A | |

**Total Coliform** **Method:** SM9223 **Prep. Method:** N/A
Analyzed by TWL on April 13, 2006 at 15:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Total Coliform | > 2,010 | MPN | 0 | N/A | D |
| Ecoli | 360 | MPN | 0 | N/A | D |

**Specific Conductance (Field)** **Method:** EPA120.1 **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 13:45.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Specific Conductance (Field) | 302.0 | umhos/cm | N/A | N/A | |

**Dissolved Oxygen (Field)** **Method:** EPA360.1 **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 13:45.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Dissolved Oxygen (Field) | 13.88 | mg/L | N/A | N/A | |

**pH (Field)** **Method:** EPA150.1/SW9045 **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 13:45.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| pH (Field) | 8.55 | S.U. | N/A | N/A | |

**Temperature F (field)** **Method:** EPA170.1 **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 13:45.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Temperature (Field) | 61.9 | Fahrenheit | N/A | N/A | |

**Turbity (Field)** **Method:** **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 13:45.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Turbidity | NA | | | N/A | |

Results reported on a Wet Weight Basis

Issued: 4/26/2006

**Laboratory Sample #:** 482663 **Client Sample ID:** Chicken Bristle **Sampled:** 04/12/2006 13:45

**Sample Replicate #** 1

**Inorganic Anions** **Method:** EPA 300 **Prep. Method:** N/A

Analyzed by KTL on April 14, 2006 at 11:05.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Nitrite | < 0.150 | MG/L | 0.15 | N/A | |
| Nitrogen, Nitrate | 1.30 | MG/L | 0.11 | N/A | |

**Carbon, Total Organic Sub** **Method:** N/A **Prep. Method:** N/A

Analyzed by SUB LAB on at .

| | | | | | |
|---|---|---|---|---|---|
| Carbon, Total Organic | 2.00 | mg/L | N/A | N/A | |

**Ammonia Nitrogen** **Method:** EPA 350.1 **Prep. Method:** N/A

Analyzed by JEE on April 18, 2006 at 10:33.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Ammonia | < 0.100 | mg/L | 0.100 | N/A | |

**Ortho-Phosphate Phosphorus** **Method:** EPA 365.2 **Prep. Method:** N/A

Analyzed by JPM on April 14, 2006 at 09:55.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Phosphorus, Ortho-Phosphate | 0.033 | mg/L as P | 0.010 | N/A | |

**Total Phosphorus** **Method:** EPA 365.1 **Prep. Method:** EPA365.1

Analyzed by JPM on April 14, 2006 at 14:51. Prepped by JPM on April 14, 2006 at 10:50.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Phosphorus, Total | 0.039 | mg/L as P | 0.010 | N/A | |

**Total Kjeldahl Nitrogen** **Method:** EPA 351.2 **Prep. Method:** EPA 351.2

Analyzed by JPM on April 18, 2006 at 16:16. Prepped by JPM on April 18, 2006 at 11:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Total Kjeldahl | 0.259 | mg/L | 0.100 | N/A | |

**Total Suspended Solids** **Method:** EPA 160.2/160.4 **Prep. Method:** N/A

Analyzed by KTL on April 17, 2006 at 18:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Solids, Total Suspended | < 5.00 | MG/L | 5 | N/A | |

**Total Alkalinity** **Method:** EPA 310.1 **Prep. Method:** N/A

Analyzed by JEE on April 14, 2006 at 12:15.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Alkalinity, Total | 131 | mg/L CaCO3 | 5.00 | N/A | |

**Laboratory Sample #:** 482667 **Client Sample ID:** Peyton Creek **Sampled:** 04/12/2006 15:00

**Sample Replicate #** 1

**Total Coliform** **Method:** SM9223 **Prep. Method:** N/A

Analyzed by TWL on April 13, 2006 at 15:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Total Coliform | > 2,010 | MPN | 0 | N/A | D |
| Ecoli | 1,650 | MPN | 0 | N/A | D |

Microbac

Chain of Custody: 45643
Project Name: Dix River TMDL-Hanging Fork
Project Number: 5167

*Accredited Lab Data for Today's Environment*

**Laboratory Sample #:** 482667 **Client Sample ID:** Peyton Creek **Sampled:** 04/12/2006 15:00

**Sample Replicate #** 1

**Specific Conductance (Field)** **Method:** EPA120.1 **Prep. Method:** N/A

Analyzed by FIELD on April 12, 2006 at 15:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Specific Conductance (Field) | 327.1 | umhos/cm | N/A | N/A | |

**Dissolved Oxygen (Field)** **Method:** EPA360.1 **Prep. Method:** N/A

Analyzed by FIELD on April 12, 2006 at 15:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Dissolved Oxygen (Field) | 11.91 | mg/L | N/A | N/A | |

**pH (Field)** **Method:** EPA150.1/SW9045 **Prep. Method:** N/A

Analyzed by FIELD on April 12, 2006 at 15:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| pH (Field) | 8.63 | S.U. | N/A | N/A | |

**Temperature F (field)** **Method:** EPA170.1 **Prep. Method:** N/A

Analyzed by FIELD on April 12, 2006 at 15:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Temperature (Field) | 67.5 | Fahrenheit | N/A | N/A | |

**Turbity (Field)** **Method:** **Prep. Method:** N/A

Analyzed by FIELD on April 12, 2006 at 15:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Turbidity | NA | | | N/A | |

**Inorganic Anions** **Method:** EPA 300 **Prep. Method:** N/A

Analyzed by KTL on April 14, 2006 at 12:53.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Nitrite | < 0.150 | MG/L | 0.15 | N/A | |
| Nitrogen, Nitrate | 2.40 | MG/L | 0.11 | N/A | |

**Carbon, Total Organic Sub** **Method:** N/A **Prep. Method:** N/A

Analyzed by SUB LAB on at .

| | | | | | |
|---|---|---|---|---|---|
| Carbon, Total Organic | 1.90 | mg/L | N/A | N/A | |

**Ammonia Nitrogen** **Method:** EPA 350.1 **Prep. Method:** N/A

Analyzed by JEE on April 18, 2006 at 10:35.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Ammonia | < 0.100 | mg/L | 0.100 | N/A | |

**Ortho-Phosphate Phosphorus** **Method:** EPA 365.2 **Prep. Method:** N/A

Analyzed by JPM on April 14, 2006 at 09:57.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Phosphorus, Ortho-Phosphate | 0.069 | mg/L as P | 0.010 | N/A | |

**Total Phosphorus** **Method:** EPA 365.1 **Prep. Method:** EPA365.1

Analyzed by JPM on April 14, 2006 at 14:52. Prepped by JPM on April 14, 2006 at 10:50.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Phosphorus, Total | 0.080 | mg/L as P | 0.010 | N/A | |

**Laboratory Sample #:** 482667 **Client Sample ID:** Peyton Creek **Sampled:** 04/12/2006 15:00

**Sample Replicate #** 1

**Total Kjeldahl Nitrogen** **Method:** EPA 351.2 **Prep. Method:** EPA 351.2

Analyzed by JPM on April 18, 2006 at 16:17. Prepped by JPM on April 18, 2006 at 11:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Total Kjeldahl | 0.552 | mg/L | 0.100 | N/A | |

**Total Suspended Solids** **Method:** EPA 160.2/160.4 **Prep. Method:** N/A

Analyzed by KTL on April 17, 2006 at 18:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Solids, Total Suspended | 7.00 | MG/L | 5 | N/A | |

**Laboratory Sample #:** 482668 **Client Sample ID:** McKinney Branch **Sampled:** 04/12/2006 12:30

**Sample Replicate #** 1

**Total Coliform** **Method:** SM9223 **Prep. Method:** N/A

Analyzed by TWL on April 13, 2006 at 15:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Total Coliform | > 2,010 | MPN | 0 | N/A | D |
| Ecoli | 590 | MPN | 0 | N/A | D |

**Specific Conductance (Field)** **Method:** EPA120.1 **Prep. Method:** N/A

Analyzed by FIELD on April 12, 2006 at 12:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Specific Conductance (Field) | 399.2 | umhos/cm | N/A | N/A | |

**Dissolved Oxygen (Field)** **Method:** EPA360.1 **Prep. Method:** N/A

Analyzed by FIELD on April 12, 2006 at 12:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Dissolved Oxygen (Field) | 12.04 | mg/L | N/A | N/A | |

**pH (Field)** **Method:** EPA150.1/SW9045 **Prep. Method:** N/A

Analyzed by FIELD on April 12, 2006 at 12:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| pH (Field) | 8.41 | S.U. | N/A | N/A | |

**Temperature F (field)** **Method:** EPA170.1 **Prep. Method:** N/A

Analyzed by FIELD on April 12, 2006 at 12:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Temperature (Field) | 59.7 | Fahrenheit | N/A | N/A | |

**Turbity (Field)** **Method:** **Prep. Method:** N/A

Analyzed by FIELD on April 12, 2006 at 12:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Turbidity | NA | | | N/A | |

**Inorganic Anions** **Method:** EPA 300 **Prep. Method:** N/A

Analyzed by KTL on April 14, 2006 at 12:55.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Nitrite | < 0.150 | MG/L | 0.15 | N/A | |
| Nitrogen, Nitrate | 1.90 | MG/L | 0.11 | N/A | |

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**Laboratory Sample #:** 482668 **Client Sample ID:** McKinney Branch **Sampled:** 04/12/2006 12:30

**Sample Replicate #** 1

**Carbon, Total Organic Sub** **Method:** N/A **Prep. Method:** N/A

Analyzed by SUB LAB on at .

| | | | | | |
|---|---|---|---|---|---|
| Carbon, Total Organic | 2.00 | mg/L | N/A | N/A | |

**Ammonia Nitrogen** **Method:** EPA 350.1 **Prep. Method:** N/A

Analyzed by JEE on April 18, 2006 at 10:38.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Ammonia | < 0.100 | mg/L | 0.100 | N/A | |

**Ortho-Phosphate Phosphorus** **Method:** EPA 365.2 **Prep. Method:** N/A

Analyzed by JPM on April 14, 2006 at 09:58.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Phosphorus, Ortho-Phosphate | 0.068 | mg/L as P | 0.010 | N/A | |

**Total Phosphorus** **Method:** EPA 365.1 **Prep. Method:** EPA365.1

Analyzed by JPM on April 14, 2006 at 14:53. Prepped by JPM on April 14, 2006 at 10:50.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Phosphorus, Total | 0.076 | mg/L as P | 0.010 | N/A | |

**Total Kjeldahl Nitrogen** **Method:** EPA 351.2 **Prep. Method:** EPA 351.2

Analyzed by JPM on April 18, 2006 at 16:18. Prepped by JPM on April 18, 2006 at 11:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Total Kjeldahl | 0.371 | mg/L | 0.100 | N/A | |

**Total Suspended Solids** **Method:** EPA 160.2/160.4 **Prep. Method:** N/A

Analyzed by KTL on April 17, 2006 at 18:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Solids, Total Suspended | < 5.00 | MG/L | 5 | N/A | |

**Laboratory Sample #:** 482669 **Client Sample ID:** Baughman Creek **Sampled:** 04/12/2006 10:00

**Sample Replicate #** 1

**Total Coliform** **Method:** SM9223 **Prep. Method:** N/A

Analyzed by TWL on April 13, 2006 at 15:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Total Coliform | > 2,010 | MPN | 0 | N/A | D |
| Ecoli | 340 | MPN | 0 | N/A | D |

**Specific Conductance (Field)** **Method:** EPA120.1 **Prep. Method:** N/A

Analyzed by FIELD on April 12, 2006 at 10:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Specific Conductance (Field) | 275.9 | umhos/cm | N/A | N/A | |

**Dissolved Oxygen (Field)** **Method:** EPA360.1 **Prep. Method:** N/A

Analyzed by FIELD on April 12, 2006 at 10:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Dissolved Oxygen (Field) | 11.28 | mg/L | N/A | N/A | |

**pH (Field)** **Method:** EPA150.1/SW9045 **Prep. Method:** N/A

*Accredited Lab Data for Today's Environment*

**Laboratory Sample #:** 482669 **Client Sample ID:** Baughman Creek **Sampled:** 04/12/2006 10:00
**Sample Replicate #** 1

**pH (Field)** **Method:** EPA150.1/SW9045 **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 10:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| pH (Field) | 8.11 | S.U. | N/A | N/A | |

**Temperature F (field)** **Method:** EPA170.1 **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 10:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Temperature (Field) | 54.6 | Fahrenheit | N/A | N/A | |

**Turbity (Field)** **Method:** **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 10:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Turbidity | NA | | | N/A | |

**Inorganic Anions** **Method:** EPA 300 **Prep. Method:** N/A
Analyzed by KTL on April 14, 2006 at 12:56.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Nitrite | < 0.150 | MG/L | 0.15 | N/A | |
| Nitrogen, Nitrate | 1.30 | MG/L | 0.11 | N/A | |

**Carbon, Total Organic Sub** **Method:** N/A **Prep. Method:** N/A
Analyzed by SUB LAB on at .

| | | | | | |
|---|---|---|---|---|---|
| Carbon, Total Organic | 1.90 | mg/L | N/A | N/A | |

**Ammonia Nitrogen** **Method:** EPA 350.1 **Prep. Method:** N/A
Analyzed by JEE on April 18, 2006 at 10:43.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Ammonia | < 0.100 | mg/L | 0.100 | N/A | |

**Ortho-Phosphate Phosphorus** **Method:** EPA 365.2 **Prep. Method:** N/A
Analyzed by JPM on April 14, 2006 at 09:59.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Phosphorus, Ortho-Phosphate | 0.081 | mg/L as P | 0.010 | N/A | |

**Total Phosphorus** **Method:** EPA 365.1 **Prep. Method:** EPA365.1
Analyzed by JPM on April 14, 2006 at 14:54. Prepped by JPM on April 14, 2006 at 10:50.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Phosphorus, Total | 0.065 | mg/L as P | 0.010 | N/A | |

**Total Kjeldahl Nitrogen** **Method:** EPA 351.2 **Prep. Method:** EPA 351.2
Analyzed by JPM on April 18, 2006 at 16:19. Prepped by JPM on April 18, 2006 at 11:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Total Kjeldahl | 0.530 | mg/L | 0.100 | N/A | |

**Total Suspended Solids** **Method:** EPA 160.2/160.4 **Prep. Method:** N/A
Analyzed by KTL on April 17, 2006 at 18:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Solids, Total Suspended | < 5.00 | MG/L | 5 | N/A | |

Accredited Lab Data for Today's Environment

Chain of Custody: 45643
Project Name: Dix River TMDL-Hanging Fork
Project Number: 5167

**Laboratory Sample #:** 482670 **Client Sample ID:** West Hustonville **Sampled:** 04/12/2006 11:15
**Sample Replicate #** 1

**Total Coliform** **Method:** SM9223 **Prep. Method:** N/A
Analyzed by TWL on April 13, 2006 at 15:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Total Coliform | > 2,010 | MPN | 0 | N/A | D |
| Ecoli | 530 | MPN | 0 | N/A | D |

**Specific Conductance (Field)** **Method:** EPA120.1 **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 11:15.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Specific Conductance (Field) | 237.7 | umhos/cm | N/A | N/A | |

**Dissolved Oxygen (Field)** **Method:** EPA360.1 **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 11:15.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Dissolved Oxygen (Field) | 13.01 | mg/L | N/A | N/A | |

**pH (Field)** **Method:** EPA150.1/SW9045 **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 11:15.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| pH (Field) | 8.57 | S.U. | N/A | N/A | |

**Temperature F (field)** **Method:** EPA170.1 **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 11:15.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Temperature (Field) | 55.7 | Fahrenheit | N/A | N/A | |

**Turbity (Field)** **Method:** **Prep. Method:** N/A
Analyzed by FIELD on April 12, 2006 at 11:15.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Turbidity | NA | | | N/A | |

**Inorganic Anions** **Method:** EPA 300 **Prep. Method:** N/A
Analyzed by KTL on April 14, 2006 at 12:57.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Nitrite | < 0.150 | MG/L | 0.15 | N/A | |
| Nitrogen, Nitrate | 1.10 | MG/L | 0.11 | N/A | |

**Carbon, Total Organic Sub** **Method:** N/A **Prep. Method:** N/A
Analyzed by SUB LAB on at .

| | | | | | |
|---|---|---|---|---|---|
| Carbon, Total Organic | 1.80 | mg/L | N/A | N/A | |

**Ammonia Nitrogen** **Method:** EPA 350.1 **Prep. Method:** N/A
Analyzed by JEE on April 18, 2006 at 10:45.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Ammonia | < 0.100 | mg/L | 0.100 | N/A | |

**Ortho-Phosphate Phosphorus** **Method:** EPA 365.2 **Prep. Method:** N/A
Analyzed by JPM on April 14, 2006 at 10:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|

**Laboratory Sample #:** 482670 **Client Sample ID:** West Hustonville **Sampled:** 04/12/2006 11:15

**Sample Replicate #** 1

**Ortho-Phosphate Phosphorus** **Method:** EPA 365.2 **Prep. Method:** N/A

Analyzed by JPM on April 14, 2006 at 10:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Phosphorus, Ortho-Phosphate | 0.017 | mg/L as P | 0.010 | N/A | |

**Total Phosphorus** **Method:** EPA 365.1 **Prep. Method:** EPA365.1

Analyzed by JPM on April 14, 2006 at 14:55. Prepped by JPM on April 14, 2006 at 10:50.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Phosphorus, Total | 0.019 | mg/L as P | 0.010 | N/A | |

**Total Kjeldahl Nitrogen** **Method:** EPA 351.2 **Prep. Method:** EPA 351.2

Analyzed by JPM on April 18, 2006 at 16:22. Prepped by JPM on April 18, 2006 at 11:30.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Nitrogen, Total Kjeldahl | 0.403 | mg/L | 0.100 | N/A | |

**Total Suspended Solids** **Method:** EPA 160.2/160.4 **Prep. Method:** N/A

Analyzed by KTL on April 17, 2006 at 18:00.

| Parameter | Result | Units | Reporting Limit | Client Limit | Qualifiers |
|---|---|---|---|---|---|
| Solids, Total Suspended | < 5.00 | MG/L | 5 | N/A | |

**All samples were received intact and properly preserved unless otherwise noted.**
**The results reported relate only to the samples tested.**
**This report shall not be reproduced except in full, without written approval of this laboratory.**

A2LA ACCREDITED
**Lab#: 100343**

Submitted by: Heather J Weidner

Client Manager: Heather Weidner
Please contact Heather Weidner with any questions.

Specific tests covered by the A2LA accreditation meet the requirements of the A2LA accreditation standard. Please refer to http://www.envirodatagroup.com/EDG_A2LA_Accredited_Analytes.pdf on our website for a list of our current A2LA accreditations.

Microbac

*Accredited Lab Data for Today's Environment*

## Data Qualifiers

| Qualifier | Description |
|---|---|
| A | E. coli present. |
| A' | E. coli absent. |
| B | Analyte detected in associated MB. |
| C | Sample result confirmed. |
| D | Results reported from dilution. |
| E | Analyte concentration exceeds calibration range. |
| F | Unable to analyze due to sample matrix interference. |
| H | Sample was received or analyzed past the established holding time. |
| J | Estimated concentration. |
| K | Sample contained lighter hydrocarbon fractions. |
| L | Sample contained heavier hydrocarbon fractions. |
| M | MS and/or MSD recovery outside acceptance limits. |
| N | Presumptive evidence of analyte present. |
| O | Sample hydrocarbon pattern does not match calibration standard pattern. |
| P | Percent difference between primary and secondary column concentrations exceeds acceptance limit. |
| Q | LCS outside acceptance limits. |
| R | Data unusable. |
| S | Surrogate outside acceptance limits on initial and reanalysis. |
| S' | Surrogates diluted below detection. |
| T | Sample received improperly preserved. |
| U | Analyte not detected. |
| W | Raised quantitation or reporting limit due to limited sample volume. |
| Y | Replicate/Duplicate precision outside acceptance limits. |
| Z' | Calibration criteria exceeded but for this situation acceptable by method. |
| Z | Calibration criteria exceeded. |
| M' | Result from Method of Standard Additions (MSA). |
| Q' | LCS/LCD analyzed due to insufficient sample for MS/MSD. |

The uncertainty of analytical results can be calculated using the following equation:

$$n = t*s/1.414$$

where

- t=12.706 (Students t value for 95% confidence interval of two replicates)
- s= standard deviation of sample and duplicate data
- 1.414 is square root of the number of replicates (two)

**Abbreviations**

| | |
|---|---|
| Laboratory Control Sample | (LCS) |
| Laboratory Control Duplicate | (LCD) |
| Matrix Spike | (MS) |
| Matrix Spike Duplicate | (MSD) |
| Method Blank | (MB) |

# APPENDIX J

# FIGURE 10:
# CHLOROPHYLL a DATASHEET

# CHLOROPHYLL-a DATA SHEET
# DIX RIVER PROJECT

| *SAMPLE ID* | *COLLECTOR* | *WATERSHED* | *DATE/TIME COLLECTED* | *DATE/TIME FILTERED* | *VOLUME FILTERED* | *TOTAL # FILTER PADS* | *AREA COLLECTED* |
|---|---|---|---|---|---|---|---|
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**Filtering Technician Signature: ___________________________**

Form updated 5/10/06 mlw

THIRD ROCK CONSULTANTS

# APPENDIX K

## TABLE 1:
## RESULTS SUMMARY FOR DIX RIVER WATERSHED PROJECT

# Table 1: Sample / Results Summary for Dix River Watershed

| Parameters | Analyte Name | Clarks Run Select | Clarks Run Non-Select | Hanging Fork Select | Hanging Fork Non-Select | Dix River Select | Dix River Non-Select | TOTAL |
|---|---|---|---|---|---|---|---|---|
| **Sites** | Number of Sites | 4 | 4 | 6 | 8 | 1 | 8 | 31 |
| Parameters | Analyte Name | Number of samples* | | | | | | |
| **Total P** | Phosphorus, Total | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **Ortho-P** | Phosphorus, Ortho | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **NO2** | Nitrite as N | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **NO3** | Nitrate as N | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **TKN** | Total Kjeldahl Nitrogen | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **NH3-N** | Ammonia as N | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **TOC** | Organic Carbon, Total | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **TSS** | Solids, Total Suspended | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **TC/EColi** | Total Coliform / E. coli | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **DO** | Dissolved Oxygen | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **Temp** | Temperature | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **Cond** | Conductivity | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **Flow** | Flow | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **pH** | pH | 48 | 48 | 60 | 96 | 12 | 96 | 360 |
| **Turbidity** | Turbidity | 39 | - | 42 | - | 12 | - | 93 |
| **CBOD5** | Biochemicial Oxygen Demand, 5-Day Carbonaceous | 48 | 48 | 60 | - | 12 | - | 168 |
| **CBOD15** | Biochemicial Oxygen Demand, 15-Day Carbonaceous | 48 | - | - | - | - | - | 48 |
| **Chlorides** | Chloride | 16 | - | 20 | - | 4 | - | 40 |
| **Chloro a** | Chlorophyll a | 48 | - | 60 | - | 12 | - | 120 |
| **Alkalinity** | Alkalinity | 48 | - | 60 | - | 12 | - | 120 |
| **Periphyton** | Periphyon | 8 | - | 12 | - | 2 | - | 22 |
| **24hr. Diurnal DO** | 24hr. Diurnal Dissolved Oxygen | 2 total from 2 sites | | | | | | 2 |

***NOTE: Number of samples indicates the expected total number of samples collected at the specified sites over the entire sampling period.**

# APPENDIX L

## TABLE 2:
## METHODS, ANALYTES, AND REPORTING LIMITS FOR THE DIX RIVER WATERSHED

# Table 2: Methods, Analytes, and Data Quality Indicators for the Dix River Watershed

| Parameters | Analyte Name | Units | Reporting Limit | Precision Criteria (%RPD) | Accuracy Criteria MS (% Uncertainty) | Accuracy Criteria LCS (% Uncertainty) |
|---|---|---|---|---|---|---|
| **CBOD15** | Biochemicial Oxygen Demand, 15-Day Carbonaceous | mg/L | 2 | 20 | N/A | 15 |
| **CBOD5** | Biochemicial Oxygen Demand, 5-Day Carbonaceous | mg/L | 2 | 20 | N/A | 15 |
| **TSS** | Solids, Total Suspended | mg/L | 3 | 20 | N/A | 20 |
| **Total P** | Phosphorus, Total | mg/L as P | 0.4 | 20 | 10 | 10 |
| **Ortho-P** | Phosphorus, Ortho | mg/L as P | 0.14 | 20 | 10 | 10 |
| **NO2** | Nitrite as N | mg/L as N | 0.1 | 20 | 20 | 10 |
| **NO3** | Nitrate as N | mg/L as N | 0.1 | 20 | 20 | 10 |
| **NH3-N** | Ammonia as N | mg/L as N | 0.1 | 20 | 10 | 10 |
| **Chlorides** | Chloride | mg/L | 1 | 20 | 20 | 10 |
| **TKN** | Total Kjeldahl Nitrogen | mg/L | 0.1 | 20 | 10 | 10 |
| **TOC** | Organic Carbon, Total | mg/L | 0.7 | 20 | 10 | 10 |
| **Alkalinity** | Alkalinity | mg/L CaCO3 | 7 | 20 | 20 | 20 |
| **Turbidity** | Turbidity | NTU | 0.01 | N/A | 10 | 10 |
| **pH** | pH | S.U. | 0-14 | N/A | N/A | 5 |
| **DO** | Dissolved Oxygen | mg/L | 1 | N/A | N/A | 10 |
| **Temp** | Temperature | °F | 40 | N/A | N/A | 5 |
| **Cond** | Conductivity | umhos/cm | 1 | N/A | N/A | 10 |
| **Flow** | Flow | ft3/sec | 0.33 for small, 0.20 for large | N/A | N/A | N/A |
| **TC/EColi** | Total Coliform / E. coli | MPN | 0 | 20 | N/A | N/A |
| **Chloro a** | Chlorophyll a | ug/L | N/A | 20 | N/A | 10 |
| **Periphyton** | Periphyon | NA | NA | NA | N/A | NA |
| **24hr. Dinural DO** | 24hr. Dinural Dissolved Oxygen | mg/L | 1 | N/A | N/A | 15 |

*Definitions:*
RPD = Relative Percent Difference
LCS = Laboratory Control Sample
MS= Matrix Spike

# APPENDIX M

## TABLE 3:
## SUMMARY OF PROJECT SAMPLING AND ANALYTICAL REQUIREMENTS

# Table 3: Summary of Project Sampling and Analytical Requirements

| Parameters | Analyte Name | Method | Minimum Sample Volume | Containers | Preservation | Maximum Hold Time |
|---|---|---|---|---|---|---|
| **CBOD15** | Biochemicial Oxygen Demand, 15-Day Carbonaceous | EPA 405.1 MOD or SM5210B MOD | 1 L | Plastic | Cool $4^{o}C$ | 48 hrs |
| **CBOD5** | Biochemicial Oxygen Demand, 5-Day Carbonaceous | EPA 405.1 MOD or SM5210B MOD | 1 L | Plastic | Cool $4^{o}C$ | 48 hrs |
| **TSS** | Solids, Total Suspended | EPA 160.2 | 1 L | Plastic | Cool $4^{o}C$ | 7 days |
| **Total P** | Phosphorus, Total | EPA 365.1 or 365.4 | 50mL | Plastic | Cool $4^{o}C$, $H_2SO_4$ to pH <2 | 28 days |
| **Ortho-P** | Phosphorus, Ortho | EPA 300.0 or 365.2 | 250mL | Plastic | Cool $4^{o}C$ | 48 hrs |
| **NO2** | Nitrite as N | EPA 300.0 | 50ml | Plastic | Cool $4^{o}C$ | 48 hrs* |
| **NO3** | Nitrate as N | EPA 300.0 | 50mL | Plastic | Cool $4^{o}C$ | 48 hrs* |
| **NH3-N** | Ammonia as N | EPA 350.1 | 500mL | Plastic | Cool $4^{o}C$, $H_2SO_4$ to pH <2 | 28 days |
| **Chloride** | Chloride | EPA 300.0 | 25mL | Plastic | Cool $4^{o}C$ | 28 days |
| **TKN** | Total Kjeldahl Nitrogen | EPA 351.2 | 50mL | Plastic | Cool $4^{o}C$, $H_2SO_4$ to pH <2 | 28 days |
| **TOC** | Organic Carbon, Total | EPA 415.1 | 25mL | Amber Glass | Cool $4^{o}C$, $H_2SO_4$ to pH <2 | 28 days |
| **Alkalinity** | Alkalinity | EPA 310.1 or 310.2 | 100mL | Plastic | Cool $4^{o}C$ | 14 days |
| **Turbidity** | Turbidity | EPA 180.1 | Sufficient volume to submerge probe | Direct source measurement | NA | On-Site [1] |
| **pH** | pH | EPA 150.1 | | | NA | Immediately/On-Site |
| **DO** | Dissolved Oxygen | EPA 360.1 | | | NA | Immediately/On-Site |
| **Temp** | Temperature | EPA 170.1 | | | NA | Immediately/On-Site |
| **Cond** | Conductivity | EPA 120.1 | | | NA | On-Site [1] |
| **Flow** | Flow | USGS Modified | NA | NA | NA | NA |
| **TC/EColi** | Total Coliform / E. coli | SM 9223 | 100mL | Glass/Plastic, Sterile | Cool <$10^{o}C$, $Na_2S_2O_3$ (No $Cl_2$) | 24 hrs |
| **Chloro a** | Chlorophyll a | SM 10200H** | Varies | Amber Glass | *** | **** |
| **Periphyton** | Periphyton | Douglas, 1958 | Varies | Amber Glass | See Note[2] | NA |
| **24hr. Dinural DO** | 24hr. Dinural Dissolved Oxygen | EPA 360.1 | Sufficient volume to submerge probe | Direct source measurement | NA | Immediately/On-Site |

* Optional preservation of 250 mL with H2SO4 (1+1) to a pH <2 results in a holdtime of 28 days for Nitrate-Nitrite.

** Trichromatic

*** Cool, $4^{o}C$, Protect From Light - Wrap Amber Glass Bottle in Aluminum Foil

**** Concentrate sample as soon as possible after collection. *Filter* samples from waters w/ pH =/> 7.0 can be placed in air tight bag and stored frozen for 3 weeks; *filter* samples from waters w/ pH <7.0 should be processed as soon as possible to prevent chlorophyll degradation.

[1] Samples can be collected for laboratory analysis: Turbidity - 100mls, plastic, cool $4^{o}C$, 48hr hold; Conductivity - 100mls, plastic, cool $4^{o}C$, 24hr hold if sample is unfiltered/28 day hold if sample is filtered through 0.45um membrane filter.

[2] Lugol's iodine solution, 0.3mL per 100mL of sample

# APPENDIX N

## TABLE 4:
## DIX RIVER WATERSHED ASSESSMENT AND MANAGEMENT REPORTS

# Table 4: Dix River Watershed Assessment and Management Reports

| Assessment Type | Frequency | Purpose | Internal or External | Parties Responsible for Performing | | Method of Reporting |
|---|---|---|---|---|---|---|
| | | | | Performing Assessments | Responding to Assessments | |
| KDOW Audit | As requested | Ensure conformance to project objectives | External | KDOW | Parties of concern | Corrective Action Response |
| Laboratory Demonstration of Capability | Prior to initial analysis | Ensure analyst is capable of performing the method to specifications. | Internal | Laboratory QA Director | Laboratory Analysts | Internal Lab documentation |
| Laboratory Performance Evaluation | Annually, at minimum | Independent assessment of the accuracy of its analyses | External | Laboratory QA Director | Laboratory Analysts | Internal Lab documentation |
| Laboratory Internal Audits | Annually, at minimum | Ensure conformance to methods, regulations, and procedures. | Internal | Laboratory QA Director | Laboratory Analysts | Internal Lab documentation |
| Laboratory External Audits | usually biannually | Ensure conformance to methods, regulations, and procedures. | External | Regulatory Body | Laboratory QA Director | Internal Lab documentation |
| Project Status Meeting | Weekly | Evaluate the status on project related objectives and concerns | Internal | QA Manager | Project Administrator | Status Meeting Minutes |
| Field Systems Audit | Quarterly, at minimum | Assess sampling technicians adherence to proper documentation and protocols. | Internal | Field Logistics Coordinator | Sampling Technicians | Email Correspondance |
| Analytical Results Review | Monthly | Assess progress and results of analytical findings of each station. | External | KDOW | Project Administrator | Analytical Monthly Summary |

# APPENDIX G – NPDES MS4 PHASE II STORMWATER MANAGEMENT PLAN

# NPDES MS4 Phase II Storm Water Management Program

Permit Term 2

## 2008-2013

| Task | BMP- Activity Description | Milestone Product/Measurable Goal | Measure(s) of Success | Responsible Party | Year 1 PY 08-09 | Year 2 PY 09-10 | Year 3 PY 10-11 | Year 4 PY 11-12 | Year 5 PY 12-13 |
|---|---|---|---|---|---|---|---|---|---|
| **1. PUBLIC EDUCATION AND OUTREACH** | | | | | | | | | |
| | A. Cooperative Efforts with KYTC | | | | | | | | |
| 1 | KYTC MS4 Workshops and Meetings | Attend meetings and workshops hosted by KYTC that educate and promote MS4 communities in Stormwater quality issues and new developments in Stormwater program management. | Number of meetings attended. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 2 | Signage along State Highways | Develop implementation plan with KYTC to install and maintain stormwater quality signage along highways. | Number of signs installed. | City, KYTC | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 3 | Stormwater Website Linkage | Exchange website information with KYTC to insure links between sites, and current and correct information. | Number of updates and links to KYTC website, and number of unique hits to Local website. | City, KYTC | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 4 | KYTC Attendance at Meetings | Invite KYTC to participate in public education and training meetings held by the City. | Number of meetings attended by a KYTC representative and the number of meetings in which an invitation was extended to KYTC. | City, KYTC | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 5 | Stormwater Quality Survey | Assist the KEEC effort to execute a statewide survey of all MS4's. Including receiving the final data compiled by KEEC in the survey. | Document data compiled from the survey, and document changes to current program suggested by survey results. | City, KEEC | | Survey | Analyze Results | Survey | Analyze Results |
| | B. Local MS4 Activities | | | | | | | | |
| 1 | Public Education Contract with Environmental non-profit organization | Continue contractual agreement with Bluegrass Pride to develop public education and outreach material, and host and develop public education meetings and seminars with local officials, citizens and schools. | Contract agreement documents, number of meetings held, and public outreach documents distributed by Pride. | City, PRIDE | Evaluate the current contract and adjust as needed | Evaluate the current contract and adjust as needed | Evaluate the current contract and adjust as needed | Evaluate the current contract and adjust as needed | Evaluate the current contract and adjust as needed |
| 2 | Distribute Stormwater Quality Education and Outreach Materials | Place brochures and flyers at locations in the City to reach a broad audience, such as City Hall, the Library and local businesses. Place documents on the website and direct citizens to the site to view. | Number of materials placed and the locations the were utilized. Number of hits on the documents page of the website. | City, PRIDE | Evaluate previously used materials, and adjust as needed | Evaluate previously used materials, and adjust as needed | Evaluate previously used materials, and adjust as needed | Evaluate previously used materials, and adjust as needed | Evaluate previously used materials, and adjust as needed |
| 3 | Educational materials for schools and other organizations | Utilize Bluegrass Pride to develop educational material and programs to distribute and facilitate with schools and other interested organizations. | Number of materials and programs developed by the City and Pride. Number of meetings held and materials distributed by the City and Pride. | City, PRIDE | Identify materials and programs to be developed | Evaluate the current materials and programs, and adjust as needed | Evaluate the current materials and programs, and adjust as needed | Evaluate the current materials and programs, and adjust as needed | Evaluate the current materials and programs, and adjust as needed |
| 4 | Stormwater Quality Education Workshops and Seminars for local officials and agencies | Host and present stormwater quality workshops for local officials, agencies, and other interested stakeholders. Provide information to local media to promote attendance and public opinion. | Number of meetings held and sign in sheets from meetings to document the number of attendees at the meetings. Document local media coverage of meetings. | City, PRIDE | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 5 | Website Maintenance and Enhancement | Continue to maintain the the local stormwater website including adding additional material when made available and keeping the information up to date. Add new features to the website including links to other sites and a stormwater online newsletter. | Number of hits on website. | City | Evaluate the current website and add the newsletter and links | Evaluate the website, and adjust as needed | Evaluate the website, and adjust as needed | Evaluate the website, and adjust as needed | Evaluate the website, and adjust as needed |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6 | Collaborate with local Environmental Agencies | Attend meetings held by local environmental agencies such as the Clarks Run Environmental and Educational Corporation, and the Dix River Watershed Council. Educate these groups on the current trends in the Stormwater Quality industry. | Number of meetings attended. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| **2. PUBLIC INVOLVEMENT/PARTICIPATION** | | | | | | | | | |
| | A. Cooperative Efforts with KYTC | | | | | | | | |
| 1 | Co-Permittee Agreement Continuation and Update | Invite KYTC to participate in public involvement and participation activities conducted by the City. | Number of activities attended by a KYTC representative and the number of activities in which an invitation was extended to KYTC. | City, KYTC | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| | B. Local MS4 Activities | | | | | | | | |
| 1 | Local Environmental Agency Public Involvement Activities | Coordinate with local environmental agencies such as the Clarks Run Environmental and Educational Corporation, and the Dix River Watershed Council to host and promote public involvement activities such as stream cleanup and stream buffer | Number of activities hosted by the City and the local environmental agencies. Number of people that attended the activities. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 2 | Environmental Non-Profit Organization Contract for Public Involvement | Continue contractual agreement with Bluegrass Pride to develop and host public involvement activities with local school and college students, and other interested citizens, such as storm drain stenciling, stream cleanup, and rain barrel distribution. | Number of activities hosted by the City and Pride for public involvement. Number of people that attended the activities. | City, PRIDE | Evaluate the current contract and adjust as needed | Evaluate the current contract and adjust as needed | Evaluate the current contract and adjust as needed | Evaluate the current contract and adjust as needed | Evaluate the current contract and adjust as needed |
| 3 | Stormwater Utility Public Involvement Credits | Establish a credit system for the new City Stormwater Utility that will promote public involvement in Stormwater quality issues, such as structural bmp installation and pollution prevention programs. | Document credits made available to citizens and the rewards for these credits. Number of citizens that participate in the credit program. | City | Evaluate the Utility for possible inclusion of credits for stormwater quality | Evaluate the current credit program, adjust as needed | Evaluate the current credit program, adjust as needed | Evaluate the current credit program, adjust as needed | Evaluate the current credit program, adjust as needed |
| 4 | Low Impact Development Education | Educate local developers and engineers on the benefits of Low Impact Development, and provide incentives for such development. | Number of developers and engineers that have attended meetings concerning Low Impact Development | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| **3. ILLICIT DISCHARGE DETECTION AND ELIMINATION (IDDE)** | | | | | | | | | |
| | A. Cooperative Efforts with KYTC | | | | | | | | |
| 1 | IDDE Operations and Procedures Coordination | Establish a Operating Policy agreement with KYTC concerning the detection and elimination of illicit discharges. | Document the agreement. Number of illicit discharges detected and eliminated on KYTC property. | City, KYTC | Pursue Agreement | Evaluate the agreement, adjust as needed | Evaluate the agreement, adjust as needed | Evaluate the agreement, adjust as needed | Evaluate the agreement, adjust as needed |
| 2 | Mapping of KYTC Stormwater System | Request plans and mapping data from KYTC concerning the Stormwater system in state right-of-way. Map stormwater system in state right-of-way that is currently unknown. | Document plans received from the state. Document new mapping data collected by the City. Number of feet and structures mapped. | City | Request data and incorporate into current mapping, collect new data in field | Collect new data in field, update mapping data | Collect new data in field, update mapping data | Collect new data in field, update mapping data | Collect new data in field, update mapping data |
| 3 | KYTC Notification of IDDE in State Right-of-Way | Notify KYTC when illicit discharges are detected and eliminated, as per agreement made in Item 3.A.1 | Number of illicit discharges detected and eliminated in KYTC Right-of-Way. Documentation of IDDE process. | City | Report to KYTC | Report to KYTC - ongoing | Report to KYTC - ongoing | Report to KYTC - ongoing | Report to KYTC - ongoing |
| | B. Local MS4 Activities | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Maintain and Update Stormwater System Mapping | Complete the unmapped areas of the City as per the Stormwater System Evaluation and Maintenance Plan (SWEMP) that has been developed by the City. Update the mapping with any new developments. | Number of outfalls, feet of pipe, and drainage structures mapped by the City. Number of Sub-basins mapped. | City | Complete Sub-basin mapping specified in SWEMP | Complete Sub-basin mapping specified in SWEMP | Complete Sub-basin mapping specified in SWEMP | Complete Sub-basin mapping specified in SWEMP | Complete Sub-basin mapping specified in SWEMP |
| 2 | Detect and Eliminate Illicit Discharges | Develop and implement an enforcement policy relative to illicit discharges. Eliminate all known illicit discharges. | Number of discharges detected, number of discharges eliminated, number of violation notices distributed. | City | Develop enforcement policy, implement IDDE program. | Evaluate IDDE program, adjust as needed | Evaluate IDDE program, adjust as needed | Evaluate IDDE program, adjust as needed | Evaluate IDDE program, adjust as needed |
| 3 | Public Notification of Discharges through Website and Hotline | Launch a hotline for pollution prevention and notification, install notification link on website. | Number of legitimate notifications on the hotline. Number of legitimate notifications on the website. | City | Maintain hotline and web link | Maintain hotline and web link | Maintain hotline and web link | Maintain hotline and web link | Maintain hotline and web link |
| 4 | Outfall Inspections | Complete inspections of all known outfalls during dry weather flows. Document condition and flow for all outfalls. | Document inspection reports on outfalls. Number of outfalls inspected. Percent of known outfalls inspected. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 5 | Stormwater Inlet Stenciling | See Item 2.B.2 | Number of stormwater inlets stenciled. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 4. | CONSTRUCTION SITE STORM WATER RUNOFF CONTROL | | | | | | | | |
| | A. Cooperative Efforts with KYTC | | | | | | | | |
| 1 | KEPSC Qualified Inspector Program Participation | Determine if a Qualified inspector requirement is necessary for the City. If so, establish program to train all local contractors for future projects. | Ordinance require Inspection Qualification. Number of contractors trained. | City | Evaluate the KEPSC Program for possible requirement, begin training if necessary | Evaluate the KEPSC Program for possible requirement, begin training if necessary | Evaluate the KEPSC Program for possible requirement, begin training if necessary | Evaluate the KEPSC Program for possible requirement, begin training if necessary | Evaluate the KEPSC Program for possible requirement, begin training if necessary |
| 2 | KYTC Compliance with all Local Ordinances and Design Manuals | Provide KYTC with local ordinances and design manuals. Participate in a plan review process for KYTC projects within the MS4. | Number of KYTC projects in MS4, and percentage compliant with requirements. | City, KYTC | Provide KYTC with local ordinances and manuals, implement review process | Continue review process, provide KYTC with updates if necessary | Continue review process, provide KYTC with updates if necessary | Continue review process, provide KYTC with updates if necessary | Continue review process, provide KYTC with updates if necessary |
| | B. Local MS4 Activities | | | | | | | | |
| 1 | Erosion Prevention and Sediment Control Ordinance for Construction Sites | Keep the Erosion Prevention and Sediment Control Ordinance up to date and current with the industry. | Necessary revisions and number of revisions made to ordinance. | City | Evaluate the current ordinance, and adjust as needed | Evaluate the current ordinance, and adjust as needed | Evaluate the current ordinance, and adjust as needed | Evaluate the current ordinance, and adjust as needed | Evaluate the current ordinance, and adjust as needed |
| 2 | Evaluate and Review Stormwater Pollution Prevention Plans for Construction Projects | Continue to improve review process for SWPP plans for Construction sites. Continue review process for all Construction Sites. | Number of SWPP's reviewed and accepted, number of plans rejected. Document review process for SWPP's. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 3 | Inspection of Construction Sites for Erosion Prevention and Sediment Control | Continue to improve inspection process for correct implementation of SWPPP for all construction sites. Continue current inspection program for all construction | Number and location of inspections executed. Document inspection process for construction sites. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 4 | Enforcement of Erosion Prevention and Sediment Control Ordinance | Evaluate current enforcement process and improve if necessary. Enforce the ordinance on construction sites that are out of compliance. | Number of violations documented. Number of penalties distributed, such as stop work orders or fines. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| **5.** | **POST-CONSTRUCTION STORM WATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT** | | | | | | | | |
| | A. Cooperative Efforts with KYTC | | | | | | | | |

# NPDES MS4 Phase II Storm Water Management Program

Permit Term 2

## 2008-2013

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Karst policy | Evaluate KYTC Karst policy for possible adoption into the local design manual. If acceptable, revise the local design manual. | Document of KARST policy in local design manual. Number of projects that utilized the KARST policy. | City | Review KYTC Karst policy and add to local design manual if acceptable | Evaluate the policy, and adjust as needed | Evaluate the policy, and adjust as needed | Evaluate the policy, and adjust as needed | Evaluate the policy, and adjust as needed |
| | B. Local MS4 Activities | | | | | | | | |
| 1 | Ordinance and Design Manual for Post-Construction BMP's for New Development and Redevelopment in the MS4 | Keep the local Design Manual for Post-Construction BMP's up to date and current with the industry. | Document necessary revisions to the current design manual. Number of revisions made to design manual. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 2 | Post-Construction BMP Plan Review Process for New Development and Redevelopment | Evaluate the current review process for BMP plans and improve if necessary. Continue review program on all new development and redevelopment projects within the MS4. | Document revisions made to the BMP plan review process. Number of plans reviewed and accepted. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 3 | BMP Inspections for New Development and Maintenance | Evaluate the current BMP Inspection process and improve if necessary. Continue the inspection program on all newly installed BMP's and existing BMP's as specified in the Stormwater System Evaluation and Maintenance Plan | Document revisions made to the BMP inspection process. Number of BMP's inspected in newly developed projects. Number of BMP's inspected in the SWEMP. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| **6. POLLUTION PREVENTION/GOOD HOUSEKEEPING FOR MUNICIPAL OPERATIONS** | | | | | | | | | |
| | A. Cooperative Efforts with KYTC | | | | | | | | |
| 1 | KYTC Environmental Handbook | Utilize the KYTC Environmental Handbook to train MS4 employees. | Number of employees trained using the KYTC Handbook. Number of KYTC Environmental Handbooks distributed to employees. | City | Acquire the Handbook from KYTC, develop training materials | Train Employees | Train Employees | Train Employees | Train Employees |
| | B. Local MS4 Activities | | | | | | | | |
| 1 | Municipal Facilities BMP Plans | Develop BMP Plans for all Municipal Facilities, evaluate plans to insure correct utilization. | Number of facilities with up to date BMP plan. Number of inspections executed on municipal facilities | City | Develop BMP plans for all municipal facilities | Implement and Inspect each facility | Implement and Inspect each facility | Implement and Inspect each facility | Implement and Inspect each facility |
| 2 | Sweep streets to prevent pollutants from entering storm drains | Continue street sweeping program, improve documentation of streets swept and pollutants collected. | Amount of pollutants collected by the truck. Amount of curb miles swept by the truck. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 3 | Employee Training for Pollution Prevention and BMP Plans | Train all employees on the methods and importance of stormwater pollution prevention. Review BMP Plans of each facility with the employees at that location. | Number of training sessions held. Number of employees trained. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| **7. Reviewing, Reporting, and Record Keeping** | | | | | | | | | |
| | A. Cooperative Efforts with KYTC | | | | | | | | |
| 1 | Annual Information Sharing Report | Include KYTC reports with local MS4 reports submitted to the DOW. Deliver local annual MS4 reports to KYTC to include in their annual report. | MS4 submittals to KYTC and KYTC submittals to MS4. | City, KYTC | Annual activity | Annual activity | Annual activity | Annual activity | Annual activity |
| | B. Local MS4 Activities | | | | | | | | |
| 1 | Stormwater Master Plan Review | Review the current SWMP to insure that it is up to date, revise if necessary. Notify the DOW of any revisions. | Document revisions made to the SWMP. Number of revisions made. | City | Evaluate SWMP, and adjust as needed | Evaluate SWMP, and adjust as needed | Evaluate SWMP, and adjust as needed | Evaluate SWMP, and adjust as needed | Evaluate SWMP, and adjust as needed |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2 | Record Keeping | Retain copies of all reports, data, & NOI required by this permit for a period of three years. | Catalog of records for all 6 MCMs for submittal in annual report - digital record keeping. | City | Annual Activity | Annual Activity | Annual Activity | Annual Activity | Annual Activity |
| 3 | Reporting | Submit annual reports to the DOW, including update of progress for all projects reference in the SWMP, and additional projects completed by the MS4 to improve stormwater quality. | Document annual report submitted to the DOW. | City | Annual Report | Annual Report | Annual Report | Annual Report | Annual Report |

# APPENDIX H – DANVILLE SPEAR

Steven L. Beshear
Governor

Leonard K. Peters
Secretary

**Energy and Environment Cabinet**
Department for Environmental Protection
Division of Water
200 Fair Oaks, 4th Floor
Frankfort, Kentucky 40601
Phone: (502) 564-3410
www.water.ky.gov

MEMORANDUM

TO: R Bruce Scott, Commissioner
Department for Environmental Protection

FROM: Anshu Singh, Supervisor, Wastewater Planning Section
Water Infrastructure Branch, Division of Water

DATE: July 1, 2009

SUBJECT: State Planning and Environmental Assessment Report (SPEAR)
City of Danville
Boyle County, Kentucky
AI ID: 366; PLN20060001

The justification for this project as prepared by the State (attached) has been reviewed and the project may proceed as proposed.

RECOMMEND: Anshu Singh, Section Supervisor — Date: 7/1/09

CONCURRENCE: Shafiq S. Amawi, Branch Manager — Date: 7/1/09

CONCURRENCE: Peter T. Goodmann, Assistant Director — Date: 7/6/2009

APPROVED: R. Bruce Scott, Commissioner — Date: 7/6/09

AS
Attachments

Steven L. Beshear
Governor

Energy and Environment Cabinet
Department for Environmental Protection
Division of Water
300 Fair Oaks Lane
Frankfort, Kentucky 40601
Phone: (502) 564-2150
www.dep.ky.gov

Leonard K. Peters
Secretary

R. Bruce Scott
Commissioner

# STATE PLANNING AND ENVIRONMENTAL ASSESSMENT REPORT (SPEAR)

**Regional Facilities Plan**
City of Danville, Boyle County Kentucky
AI 366; PLN20060001

The city of Danville has submitted for approval by the Energy and Environment Cabinet (EEC) a regional facility plan titled ***201 Facilities Plan Update*** dated July, 2005 (revised January, 2006). In accordance with KRS Chapter 224 and 401 KAR 5:006, the Department for Environmental Protection (DEP) has prepared a State Planning and Environmental Assessment Report (SPEAR) that summarizes the regional facility plan.

The DEP is required to conduct reviews of the potential environmental impacts of projects applying for funding by the Clean Water State Revolving Fund in accordance with the procedures contained in the State Revolving Fund Operating Agreement between the Environmental Protection Agency Region IV and the Commonwealth of Kentucky. The DEP has included this required review in the attached SPEAR. The DEP has determined that the projects in the SPEAR will not have a significant effect on the environment when all mitigative measures in Section F of the SPEAR are implemented.

The SPEAR contains information supporting this determination in the following sections: A) Project Summary; B) Existing Environment; C) Existing Wastewater Facilities; D) Need for Project; E) Alternatives Analysis; F) Environmental Consequences, Mitigative Measures; G) Public Participation and User Rates; and H) Sources Consulted.

Interested persons are encouraged to submit comments on this SPEAR within 40 days of the above date. The EEC will take no action on this project until after the State Clearinghouse review and public comment period has ended, and will evaluate all comments before a decision is made to proceed with approval of the Regional Facilities Plan or awarding of SRF funds for this project. Send comments to Ms. Anshu Singh, Supervisor, Wastewater Planning Section, Water Infrastructure Branch, Division of Water, 200 Fair Oaks 4th Floor, Frankfort, Kentucky 40601, or by e-mail to anshu.singh@ky.gov, or call her at (502) 564-3410, extension 4805.

Sincerely,

R. Bruce Scott, Commissioner
Department for Environmental Protection

RBS/AS

**STATE PLANNING AND ENVIRONMENTAL ASSESSMENT REPORT (SPEAR)**
**City of Danville Boyle County, Kentucky**
**(AI# 366, PLN20060001)**

## A. Project Summary

**Proposed Facilities:** The City of Danville, Boyle County, owns and operates 6.5 million gallons per day (mgd) Danville wastewater treatment plant (WWTP) and 0.10 mgd Perryville wastewater treatment plant (WWTP); and the wastewater collection and transportation systems in Danville, Junction City and Perryville. The City submitted a ***201 Facilities Plan Update*** in July 2005 (revised January 2006), in which it has proposed cost effective, technically and environmentally sound, and implementable alternatives to meet its 20 year wastewater needs. The proposed alternatives include, but are not limited to, expanding Perryville WWTP, building a new equalization basin/aerated facultative lagoon in Spears Creek Watershed for managing future wastewater needs, and extending sewer lines throughout the service area. The twenty year planning period is divided into three phases (Figure 1).

**Phase I (0- 2 years):** This phase will involve improvements to Perryville WWTP, pump station upgrades and installation of new sewer collector. Improvements to Perryville WWTP will include construction of the screening chamber; installation of an influent flow monitor and chemical feed system for phosphorus reduction. It will also include retrofitting the existing influent pump station, replacing the existing slow sand filters with a lagoon polishing reactor and two circular clarifiers, upgrading the lagoon effluent pumps, and constructing a new office control building. Wastewater transportation and collection facilities will be extended to different areas in the City of Danville and Junction City. This will include construction of gravity sewer from Toombs Curve pump station (which will be eliminated) along Balls Branch to a point south of the existing Danville WWTP. A new Balls Branch pump station will be constructed to pump the wastewater to the Danville wastewater treatment facility. York lane pump station will be upgraded and force main will be redirected away from Mitchell Street pump station collection system. Horky's Field pump station will be upgraded and a section of trunk sewer line will be replaced. Sewer services will be extended to unserved portion of Radio Tower. Sewer service will also be extended along the west by-pass of the City of Danville (Figure 1). The cost of improvements at the WWTP is estimated at $613,250; while the combined cost of rehabbing existing infrastructure and installing new one is estimated at $6,618,928.

**Phase II (3 - 10 years):** During this phase wastewater services will be extended to unsewered areas in the City of Danville, Junction City and Perryville (Figure 1). It will involve installation of gravity sewers, force mains and pump stations. The total cost of implementing phase II is estimated to be $14,238,893.

**Phase III (11 – 20 years):** This phase will include construction of a new equalization/aerated facultative lagoon on Spears Creek, a new screening facility and the upgrade of Spears Creek pump station. In addition, wastewater transportation and collection facilities will be extended to unsewered areas in the City of Danville, Junction City and Perryville (Figure 1). The cost of building the new lagoon is estimated at $2,337,500 and the estimated cost of extending new collector sewers is $10,067,888.

The engineering firm that prepared the facilities plan is H. K. Bell Consulting Engineers, Inc. The project is located in the Bluegrass Area Development District and within the area covered by the Columbia Regional Office of the Division of Water (DOW).

**Funding Status:** Funding can be obtained from different sources such as Community Development Block Grant (CDBG), USDA Rural Development (RD), Kentucky Infrastructure Authority (KIA) and others. The city will explore all options for each phase. The table below describes one possible funding scenario for phase I projects.

| | **100% KIA Loan (3%-20Y)** | **$1,000,000 Grant + KIA loan (3%-20Y)** | **RD 50% Grant + 50% Loan (4.75%-40Y)** |
|---|---|---|---|
| **Collection System** | | | |
| Project Cost | $6,618,928 | $6,618,928 | $6,618,928 |
| Grant Amount | $0 | $1,000,000 | $3,309,464 |
| Loan Amount | $6,618,928 | $5,618,928 | $3,309,464 |
| Estimated Annual Payment | $440,501 | $373,949 | $184,969 |
| **Wastewater Treatment Plant** | | | |
| Project Cost | $613,250 | $613,250 | $613,250 |
| Grant Amount | $0 | $0 | $306,625 |
| Loan Amount | $613,250 | $613,250 | $306,625 |
| Estimated Annual Payment | $40,812 | $40,812 | $17,138 |

## B. Existing Environment

**Topography**: Boyle County is located in central Kentucky and straddles the Bluegrass and Mississippian Plateau Regions. The topography of the project area is gently rolling with local reliefs of 60 to 100 feet. Portions of the Muldraugh (Highland Rim) Escarpment lie within the project area. The escarpment contains a number of isolated hills and knobs. The topography ranges from 750 feet above mean sea level (amsl) to 1,080 feet amsl.

**Soils**: The USGS soil survey for Mercer and Boyle Counties indicates the presence of four major soil types in the project area: the Maury-Caleast Association, the Eden-Lowell Association, the Caleast-Maury Association and the Tilsit-Trappist Association. The soils of the Maury-Caleast Association are generally level to sloping, well-drained, deep soils that have clayey subsoil, formed in residuum of weathered limestone. The soils of the Eden-Lowell Association are steep to gently sloping, well-drained, moderately deep, and deep soils that have clayey subsoil; formed in residuum of weathered interbedded limestone, siltstone and shale. The soils of the Caleast-Maury Association are sloping to nearly level, well-drained, deep soils that have clayey subsoil; formed in residuum of weathered limestone. The soils of the Tilsit-Trappist Association are nearly level to steep, moderately well drained and well drained, deep and moderately deep soils that have loamy or clayey subsoil; formed in residuum or colluvium of weathered limestone, siltstone or shale. All these soil types are high in clay content with low permeability which limits the use of septic tank fields.

**Geology:** Boyle County is underlain by plane, bedded sedimentary rock of the Ordovician, Devonian and Mississippian Ages. The Boyle Formation, Clays Ferry Formation and Garrard Formation occur in the project area. The Boyle Formation is found in the level areas around Junction City and is of the Middle Devonian Age. It is olive gray to brownish gray dolomite and ranges from 20 to 60 feet in thickness. Caleast soils are predominant on this formation. The Clays Ferry Formation underlies the higher areas in the southern portion of the project area. It is of the Upper Ordovician Age and is approximately 280 feet thick. It is gray or light olive gray. Lowell and Eden soils are predominant on this formation. The Garrard Formation is found in the eastern portion of the project area in the vicinity of the Brumfield Fault and is of the Upper Ordovician Age. It is medium gray to orange gray and is approximately 60 feet thick. Lowell and Eden soils are predominant on this formation.

**Surface Waters:** The Danville/Junction City portion of the planning area is located within the Kentucky River Basin Management Unit. The Perryville portion of the planning area is located within the Salt River Basin Management Unit.

The Danville/Junction City portion of the planning area is drained by the Dix River, the Perryville portion of the planning area flows to the Chaplin River. One Special Water (401 KAR 10:026 and 10:030 [www.lrc.state.ky.us/kar/titles.htm]) occurs in the Planning Area, Doctors Fork of Chaplin River, from mouth to confluence of Begley Branch (stream miles 0.0 – 3.8). Water quality assessments relevant to the planning area are detailed in table below.

| Assessed Segments (source: 2008 Integrated Report) | | |
|---|---|---|
| **Waterbody & Segment** | **Designated Use(s) Support** | **Pollutant(s)** |
| Clarks Run 0.7 to 4.0 | **Partial Support:** Warmwater Aquatic Habitat | Sedimentation/Siltation; Nutrient/Eutrophication Biological Indicators; Organic Enrichment (Sewage) Biological Indicators |
| Clarks Run 4.0 to 6.3 | **Non-support**: Warmwater Aquatic Habitat, Primary Contact Recreation | Nutrient/Eutrophication Biological Indicators; Organic Enrichment (Sewage) Biological Indicators; Impairment Unknown; *E. coli* |
| Dix River 33.3 to 36.1 | **Full Support:** Secondary Contact Recreation | N/A |
| Doctors Fork 0.0 to 3.8 | **Full Support:** Warmwater Aquatic Habitat | N/A |
| Hanging Fork of Dix River 0.0 to 15.85 | **Non-support**: Primary Contact Recreation **Full Support:** Warmwater Aquatic Habitat | *Escherichia coli*; Fecal Coliform |
| Mocks Branch 1.6 to 5.7 | **Partial Support:** Warmwater Aquatic Habitat | Sedimentation/Siltation |
| Spears Creek 0.1 to 6.3 | **Partial Support:** Warmwater Aquatic Habitat | Sedimentation/Siltation; Nutrient/Eutrophication Biological Indicators |

There are no approved TMDL segments relevant to the planning area.

The following Dix River stream segments associated with the planning area are included in a pathogen TMDL which is currently under development by DOW:

| Stream Name | County | River Miles | Pollutant |
|---|---|---|---|
| Clarks Run into Dix River | Boyle | 0.7 to 4.0 | Nutrient/Eutrophication Biological Indicators |
| Clarks Run into Dix River | Boyle | 4.0 to 6.3 | Nutrient/Eutrophication Biological Indicators |
| Baughman Creek | Lincoln | 0.0 to 4.6 | *Escherichia coli* |
| Clarks Run into Dix River | Boyle | 6.3 to 14. | *Escherichia coli* |
| Balls Branch into Clarks Run | Boyle | 0.0 to 4.9 | *Escherichia coli* |
| Copper Creek into Dix River | Lincoln | 0.0 to 2.2 | *Escherichia coli* |
| Dix River into Kentucky River | Rockcastle | 73.35 to 78.7 | *Escherichia coli* |
| Dix River into Kentucky River | Lincoln | 64.3 to 73.35 | *Escherichia coli* |
| Dix River into Kentucky River | Lincoln | 36.1 to 43.8 | *Escherichia coli* |
| Dix River into Kentucky River | Garrard | 33.3 to 36.1 | *Escherichia coli* |
| Drakes Creek into Dix River | Lincoln | 1.15 to 7.3 | *Escherichia coli* |
| Frog Branch | Lincoln | 0.0 to 3.4 | *Escherichia coli* |
| Gilberts Creek into Dix River | Lincoln | 0.0 to 1.25 | *Escherichia coli* |
| Hanging Fork | Lincoln | 27.6 to 32.2 | *Escherichia coli* |
| Hanging Fork | Lincoln | 24.15 to 27.6 | *Escherichia coli* |
| Hanging Fork | Lincoln | 15.85 to 24.15 | *Escherichia coli* |
| Hanging Fork | Lincoln | 0.0 to 15.85 | *Escherichia coli*, Fecal Coliform |
| Harris Creek | Lincoln | 0.0 to 6.25 | *Escherichia coli* |
| Knoblick Creek | Lincoln | 0.0 to 4.8 | *Escherichia coli* |
| Logan Creek | Lincoln | 0.0 to 3.15 | *Escherichia coli* |
| McKinney Br. | Lincoln | 0.0 to 1.9 | *Escherichia coli* |
| Peyton Creek | Lincoln | 0.0 to 4.1 | *Escherichia coli* |
| White Oak Creek | Garrard | 0.0 to 2.8 | *Escherichia coli* |
| White Oak Creek | Lincoln | 0.0 to 3.4 | *Escherichia coli* |

Sources for these pollutants include loss of riparian habitat, managed pasture grazing, municipal point source discharges, non-irrigated crop production, failing onsite treatment systems, streambank modifications/destablization, livestock (grazing or feeding operations), agriculture, unrestricted cattle access and urban runoff/storm sewers.

Additionally, the following water quality impairments for Herrington Lake also have a TMDL under development:

| Lake Name | County | Area | Pollutant |
|---|---|---|---|
| Herrington Lake | Garrard | 2940 acres | Dissolved Oxygen |
| Herrington Lake | Garrard | 2940 acres | Nutrient/Eutrophication, Biological Indicators |

Third Rock Consulting has collected data, the USEPA has agreed to do the modeling and the DOW will write the TMDL.

Three Division of Water Priority Watersheds are associated with the Danville planning area: **Clarks Run** (pollutants of concern: organic enrichment (OE)/low dissolved oxygen (DO) and nutrients; sources: municipal point sources), **Dix River – Herrington Lake** (Lake: metals, nutrients and OE/low DO Stream: pathogens, siltation, OE/low DO; sources: agriculture, land disposal and internal nutrient cycling) and **Herrington Lake-Hanging Fork Creek** (pathogens; source: agriculture).

The following water service providers have Source Water Assessment and Protection (SWAP) areas relevant to the planning area: Zone 1 - 3 Danville City Water Works and North Point Training Center; Zone 3 Wilmore Water Works and Harrodsburg Municipal Water Department. There are no Wellhead Protection Areas in the planning areas.

Danville City Water Works is the drinking water provider for Danville, Junction City and Perryville.

**Groundwater:** The area is underlain by Ordovician limestone and shales. Karst development may be present. All of the known wells in and near the Danville area are monitoring wells with a couple of wells that are listed as irrigation wells. Groundwater flow is generally swift with very little filtration due to the karst and epi-karst flow in the area. This can allow any groundwater contamination to reach Lake Harrington, which is used as a drinking water source.

## C. Existing Wastewater Facilities

Wastewater Treatment Plants: The City of Danville owns and operates the Danville WWTP that discharges to Clarks Run at mile point 26.2 pursuant to Kentucky Pollutant Discharge Elimination (KPDES) Permit No. KY0057193. Its major components include an offsite and onsite equalization/aerated facultative lagoon equipped with pumps and floating aerators, mechanical sewage grinder for screening, oxidation ditches, clarifiers, ultra violet disinfection, post aeration, and sludge processing facility. The sludge is disposed of at Tri–K landfill located in Lincoln County, a Department for Environmental Protection approved facility. The WWTP has a permitted hydraulic capacity of 6.5 mgd. The annual average flow rate is 4.25 mgd with 2.25 mgd available for growth. The effluent quality is generally within the permitted limits.

The City of Danville assumed ownership of the Perryville system in 2003. The Perryville WWTP has a capacity of 0.1 mgd and discharges to Chaplin River at mile point 80.3 pursuant to KPDES Permit No. KY0028355. It is a three cell aerated lagoon facility with chlorination and dechlorination systems. The plant is hydraulically overloaded and is usually out of compliance with its discharge permit limit.

The monthly average effluent limits of both the WWTPs are as follows:

| Parameter | Danville WWTP | Perryville WWTP |
|---|---|---|
| $CBOD_5$ (mg/l) | 10 | 10 |
| TSS (mg/l) | 30 | 30 |
| Ammonia Nitrogen (mg/l) | 2 (summer)/5 (winter) | 4 (summer)/10 (winter) |
| Total Phosphorus (mg/l) | 1 | Monitor |
| Dissolved Oxygen (mg/l) | 7 | 7 |
| Fecal Coliform (N/100ml) | 200 | Excluded from the permit |
| *Escherichia coli* (N/100ml) | Not included in the permit | 130 |

Collection System: The city of Danville owns and operates the wastewater collection and transportation system in Danville, Junction City and Perryville. This system includes 117 miles of gravity sewer, 9 miles of force main and 14 pump stations. The City of Danville conducted inflow and infiltration (I/I) analysis that indicated the presence of excessive I/I in Danville collection system. The City has been working towards reducing I/I problems since 1976. It has constructed several miles of trunk sewers and eliminated 19 problematic pump stations. The city is in the process of decommissioning two more problematic pump stations in Junction City and rehabilitating the Clark Run pump station. The City has five full time employees assigned exclusively to maintain, repair and rehabilitate the collection system. The City has a maintenance vehicle equipped with an in-line video camera, pipe rodding and cleaning equipment; and cement grouting equipment. Each of the pump stations are checked and maintained a minimum of five days each week. The City of Danville is aware of the excessive I/I in the Perryville wastewater collection system but since it assumed the ownership of this system recently it has not had the opportunity to address the problems yet. The city will perform more SSES work and undertake rehabilitation projects in Clark Run and Spear Creek Watershed to reduce I/I both in Danville and Perryville wastewater collection systems as a part of this facility plan.

## D. Need for Proposed Facility

Recently, there has been rapid growth in Danville's planning area and the population in Danville and Junction City area is expected to increase from 18,938 in 2005 to 24,862 in 2025. In addition, 0.3 mgd Northpoint Training Center WWTP, serving the Commonwealth of Kentucky, Department of Corrections, located in northeastern Boyle County, is in the process of being decommissioned and all flow diverted to the Danville WWTP which currently has capacity. This plant was old and experiencing numerous problems but more importantly the discharge location was within two miles of the City of Danville's raw water intake in Herrington Lake. In an effort to regionalize, the DOW approved the City of Danville's Regional Facilities Plan in 2005 to decommission the Northpoint Training center WWTP and connect to the Danville WWTP. To meet the projected growth the City of Danville needs to increase the WWTP capacity to 7.44 mgd. On the other hand, the Perryville WWTP is rated at 0.1 mgd but the annual average flow rate in 2008 was 0.146 mgd. The plant is hydraulically overloaded and there are I/I problems. In addition, the population in Perryville is expected to increase from 774 in 2005 to 821 in 2025 which will increase the wastewater volume. Therefore, it is necessary to expand the WWTP and upgrade the collection system to correct the I/I problems and meet the future wastewater needs of the community. Furthermore, these projects are expected to improve the water quality of the local streams.

## E. Alternative Analysis

### Perryville Wastewater Treatment System

**Alternative No. 1 "No Action":** This alternative involves no expansion or upgrade to the existing WWTP. The only action that will occur will be routine day to day operation and maintenance. But the Perryville WWTP is already overloaded. The system is rated at 0.1 mgd but in 2008 the annual flow rate was 0.146 mgd and failed to meet the effluent permit limits. Therefore, this alternative is not feasible and no further consideration will be given.

**Alternative No. 2 Upgrade the Existing Perryville WWTP:** The design capacity of the Perryville WWTP is 0.10 mgd and the average daily flow for 2008 was 0.146 mgd. Furthermore, the population of Perryville is expected to grow from 774 in 2005 to 821 in 2025. Therefore, it is necessary to consider an upgrade to the existing facility. This alternative involves adding inlet screening structure, influent flow meter, chemical feed system for phosphorus removal, two circular clarifiers, polishing lagoon, upgrade of lagoon effluent pumps and building new control/office building. The total project cost for upgrading the Perryville WWTP is estimated to be $613,250 with a 20 year present worth of $ 1,219,826. **This is the selected alternative as it is the most cost effective.**

The proposed monthly average discharge is as follows:

| Parameter | May 1-October 31 | November 1- April 30 |
|---|---|---|
| $CBOD_5$ (mg/l) | 10 | 10 |
| TSS (mg/l) | 30 | 30 |
| Ammonia Nitrogen (mg/l) | 4 | 7 |
| Total Phosphorus (mg/l) | Monitor | Monitor |
| Total Nitrogen (mg/l) | Monitor | Monitor |
| Dissolved Oxygen (mg/l) | 7 | 7 |
| Total Residual Chlorine (mg/l) | 0.011 | 0.011 |
| *Escherichia coli* (N/100ml) | 130 | 130 |
| Reliability Classification | Grade I | |

### Danville Wastewater Treatment System

**Alternative No. 1 "No Action":** This alternative involves no expansion or upgrade to the existing WWTP. The only action that will occur will be routine day to day operation and maintenance. Eventually the existing facilities will degrade and fail to meet the needs of

Danville and Junction City since the area is experiencing rapid growth. Potential failure and/or overloading of these facilities can have a detrimental effect on the local communities and the surrounding natural environment. Therefore, this alternative is not feasible and no further consideration will be given.

**Alternative No. 2 Building a New WWTP on Spears Creek:** This alternative proposes the construction of a 1.5 mgd WWTP in the Spears Creek watershed utilizing the oxidation ditch process. The following unit processes will be included; influent pump station, mechanical cleaned bar screen, grit collection and dewater system, oxidation ditches, chemical feed system, secondary clarifiers, biosolids pump station, ultraviolet disinfection, flow measurement, solid concentration basins, solid handling facilities, and office control building. The total project cost for this alternative is estimated to be $6,194,375. This alternative is not selected because it is not cost effective.

**Alternative No. 3 Aerated Facultative Lagoon Process**: This alternative proposes the construction of a 1.5 mgd WWTP in the Spears Creek watershed utilizing the aerated facultative lagoon process. The following unit processes will be included: influent pump station, mechanical cleaned bar screen, aerated facultative lagoon, biological nitrification tower, chemical feed, system secondary clarifiers, biosolids pump station, ultraviolet disinfection, flow measurement, and office control building. The total project cost for this alternative is estimated to be $3,753,750. This alternative is not selected because it is not cost effective.

**Alternative No. 4 Upgrade the Spears Creek Pump Station:** This alternative proposes the upgrade of the Spears Creek Pump Station to accommodate the projected wastewater flows and to include wastewater from the North point WWTP abandonment. This will involve Spears Creek Pump Station upgrade; and construction of a new oxidation ditch and a circular clarifier. The total project cost for this alternative is estimated to be $2,818,750. This alternative is not selected because it is not cost effective.

**Alternative No. 5 Building a New Equalization Aerated Facultative Lagoon on Spears Creek:** This alternative proposes the construction of an aerated facultative lagoon in the Spears Creek watershed in the City of Danville. The following unit processes will be included: influent pump station, mechanically cleaned bar screen, aerated facultative lagoon, biological and upgrade to Spear Creek Pump Station. The total project cost for this alternative is estimated to be $2,337,500 with a 20 year present worth of $3,407,674. **This is the selected alternative because it is the most cost effective.**

The proposed monthly average discharge is as follows:

| Parameter | May 1-October 31 | November 1- April 30 |
|---|---|---|
| $CBOD_5$ (mg/l) | 8 | 8 |
| TSS (mg/l) | 30 | 30 |
| Ammonia Nitrogen (mg/l) | 2 | 4 |
| Total Phosphorus (mg/l) | 1 | 1 |
| Total Nitrogen (mg/l) | Monitor | Monitor |
| Dissolved Oxygen (mg/l) | 7 | 7 |
| Total Residual Chlorine (mg/l) | 0.019 | 0.019 |
| *Escherichia coli* (N/100ml) | 130 | 130 |
| Reliability Classification | Grade 1 | |

**Collection System in Danville, Junction City and Perryville**

**Alternative No. 1 No Action:** This alternative involves no expansion or modification to the existing collection system. This alternative was rejected from consideration because it does not meet the current and future needs of the planning area from an economic development or environmental standpoint. Water quality in the area would likely degrade, as soils within the planning area are not conducive to on-site disposal. This alternative was not considered environmentally feasible and was eliminated from further consideration.

**Alternative No 2 Provide Collection and Transportation Services:** This alternative will improve the wastewater collection and transportation facilities in the City of Danville, Junction City and Perryville. Under Phase I the Toombs Curve pump station in Junction City will be abandoned and gravity sewer will be constructed from the pump station site, along Balls Branch, to a point south of the existing Danville WWTP. A new Balls Branch pump station will be constructed to pump the wastewater to the Danville WWTP. Additional improvements to the Junction City collection system will involve upgrading the York Lane pump station and redirection of the force main away from the Mitchell Street pump station collection system which will reduce overflows both at the York Lane and Mitchell Street pump station. Within the City of Danville, improvements will include upgrade to the existing Horky's Field pump station along with replacement of a section of existing trunk sewer line in east Danville; extension of sanitary sewer service to unserved portion of the Radio Tower area and areas along the west by-pass of the city of Danville. The total cost of the project is estimated at $6,618,928. During Phase II and III wastewater collection and transportation services will be extended to other areas in the City of Danville, Junction City and Perryville. This will involve construction of gravity sewers, force mains, interceptors and pump stations. The total estimated cost for all three phases is $24,306,781. **This is the selected alternative.**

The city also proposes to conduct Sanitary Sewer Evaluation Surveys (SSES) in Spears Creek and Clark Run watershed and Perryville area to identify and assess level of I/I. The estimated cost for conducting SSES is $322,000. Additional rehabilitation work will be carried out to reduce I/I in both the Spears Creek and Clark Run watershed. The estimated cost to accomplish the rehabilitation work is estimated at $753,000.

## E. Environmental Consequences and Mitigative Measures

Impacts on Archeological Sites and Historic Properties:
The Kentucky Heritage Council (KHC) indicated in its May 3, 2006, letter that the proposed project has the potential to impact archeological sites eligible for listing on the National Register of Historic Places. The proposed lagoon on Spears Creek and any other new lines not adjacent to existing right of ways will need to be surveyed by a professional archeologist. The archeological report must be submitted to the KHC for review and approval prior to commencement of construction.

Impacts on Wetlands and Streams:
The U.S. Fish & Wildlife Service (USFWS), in a June 28, 2006, letter indicates that no significant adverse impacts to wetlands or federally listed endangered or threatened species are anticipated from the proposed projects.

Impacts on Forests:
There are currently no state forests or state champion big trees located in the project area. However, special care should be taken around the existing trees that will remain after the construction is complete. Heavy equipment should be kept away from the base of the tree to prevent wounding of the trunk or surface roots. Construction traffic should be routed away from the dripline of the tree to lessen the severity of soil compaction. Compacted soil reduces the amount of water available to the tree, and this lack of water can cause added stress. Stressed trees are vulnerable to insect and disease infestation. After construction is completed, consider replanting back suitable tree species that will conform to the local tree planting ordinance.

Impacts on Air:
Kentucky Division for Air Quality Regulation 401 KAR 63:010 Fugitive Emissions states that no person shall cause, suffer, or allow any material to be handled, processed, transported, or stored without taking reasonable precaution to prevent particulate matter from becoming airborne. Additional requirements include the covering of open bodied trucks, operating outside the work area transporting materials likely to become airborne, and that no one shall allow earth or other material being transported by truck or earth moving equipment to be deposited onto a paved street or roadway. Please note the Fugitive Emissions Fact Sheet located at http://www.air.ky.gov/homepage_repository/e-Clearinghouse.htm

Kentucky Division for Air Quality Regulation 401 KAR 63:005 states that open burning is prohibited. Open Burning is defined as the burning of any matter in such a manner that the products of combustion resulting from the burning are emitted directly into the outdoor atmosphere without passing through a stack or chimney. However, open burning may be utilized for the expressed purposes listed on the Open Burning Fact Sheet located at http://www.air.ky.gov/homepage_repository/e-Clearinghouse.htm

Environmental Justice
According to the 2000 Census Bureau, 87.3 percent of the people in Boyle County are white, the median household income is $36,648 per year, and 13.3 percent of the people are below the poverty level. There are no environmental justice issues for the proposed project.

Other Impacts
Impacts to the natural environment in and around the project area will be minimum and temporary in nature. The only foreseeable impacts include those associated with any construction project such as noise abatement, traffic disturbances and air pollution.

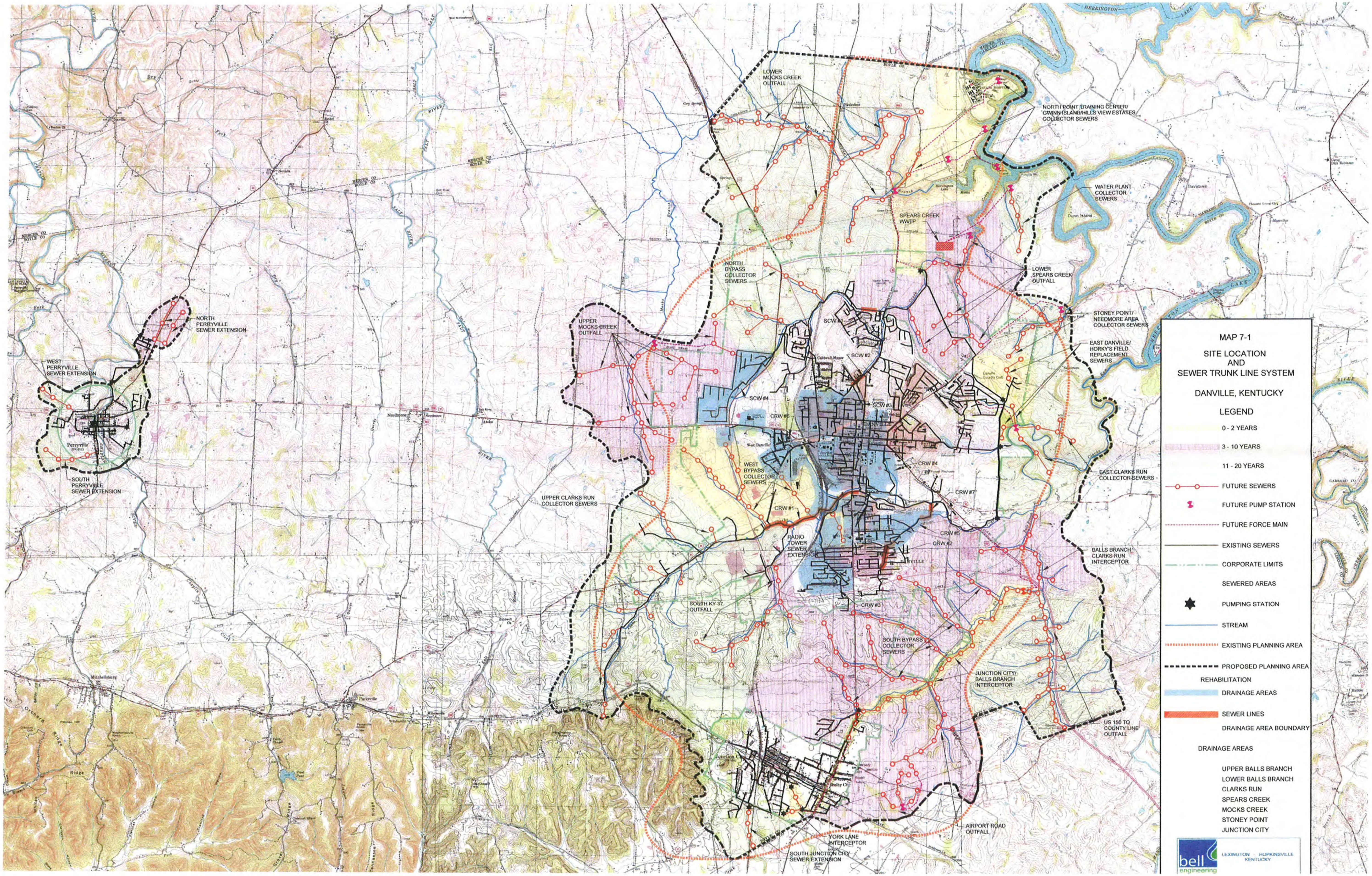
## G. Public Participation and User Rates

A public hearing regarding the regional facilities plan was held on November 10, 2005. No verbal or written comments were submitted during the public comment period. This agency is not aware of any unresolved significant public objections, which may have been voiced before or after this hearing in relation to this project. The current monthly sewer rates based on 4,000 gallons of usage are $ 12.16 for Danville, $27.23 for Junction City and $31.30 for Perryville. The rates are expected to increase by $3 to $4 depending on the amount of grants the city can secure.

## H. Sources Consulted

Kentucky Department of Fish & Wildlife Resources
Kentucky Division for Air Quality
Kentucky Division of Forestry
Kentucky Division of Waste Management
Kentucky Division of Water
Kentucky Heritage Council
Kentucky State Clearinghouse
Kentucky Transportation Cabinet
Natural Resources Conservation Service Web Soil Survey
U.S. Fish & Wildlife Service
Boyle County
H.K. Bell Consulting Engineers, Inc.
Judge-Executive, Boyle County
Bluegrass Valley Area Development District

FIGURE 1


MAP 7-1
SITE LOCATION AND SEWER TRUNK LINE SYSTEM
DANVILLE, KENTUCKY
LEGEND
0 - 2 YEARS
3 - 10 YEARS
11 - 20 YEARS
FUTURE SEWERS
FUTURE PUMP STATION
FUTURE FORCE MAIN
EXISTING SEWERS
CORPORATE LIMITS
SEWERED AREAS
PUMPING STATION
STREAM
EXISTING PLANNING AREA
PROPOSED PLANNING AREA
REHABILITATION
DRAINAGE AREAS
SEWER LINES
DRAINAGE AREA BOUNDARY
DRAINAGE AREAS
UPPER BALLS BRANCH
LOWER BALLS BRANCH
CLARKS RUN
SPEARS CREEK
MOCKS CREEK
STONEY POINT
JUNCTION CITY
bell engineering
LEXINGTON HOPKINSVILLE KENTUCKY
LOWER MOCKS CREEK OUTFALL
NORTH POINT TRAINING CENTER/ OMNN ISLAND/HILLS VIEW ESTATES COLLECTOR SEWERS
WATER PLANT COLLECTOR SEWERS
SPEARS CREEK WWTP
LOWER SPEARS CREEK OUTFALL
STONEY POINT/ NEEDMORE AREA COLLECTOR SEWERS
EAST DANVILLE/ HORKY'S FIELD REPLACEMENT SEWERS
NORTH BYPASS COLLECTOR SEWERS
UPPER MOCKS CREEK OUTFALL
NORTH PERRYVILLE SEWER EXTENSION
WEST PERRYVILLE SEWER EXTENSION
SOUTH PERRYVILLE SEWER EXTENSION
Perryville
UPPER CLARKS RUN COLLECTOR SEWERS
WEST BYPASS COLLECTOR SEWERS
RADIO TOWER SEWER EXTENSION
EAST CLARKS RUN COLLECTOR SEWERS
BALLS BRANCH CLARKS RUN INTERCEPTOR
SOUTH KY 37 OUTFALL
SOUTH BYPASS COLLECTOR SEWERS
JUNCTION CITY/ BALLS BRANCH INTERCEPTOR
US 150 TO COUNTY LINE OUTFALL
AIRPORT ROAD OUTFALL
YORK LANE INTERCEPTOR
SOUTH JUNCTION CITY SEWER EXTENSION
SCW #1
SCW #2
SCW #3
SCW #4
CRW #1
CRW #2
CRW #3
CRW #4
CRW #5
CRW #6
CRW #7
West Danville
HERRINGTON LAKE