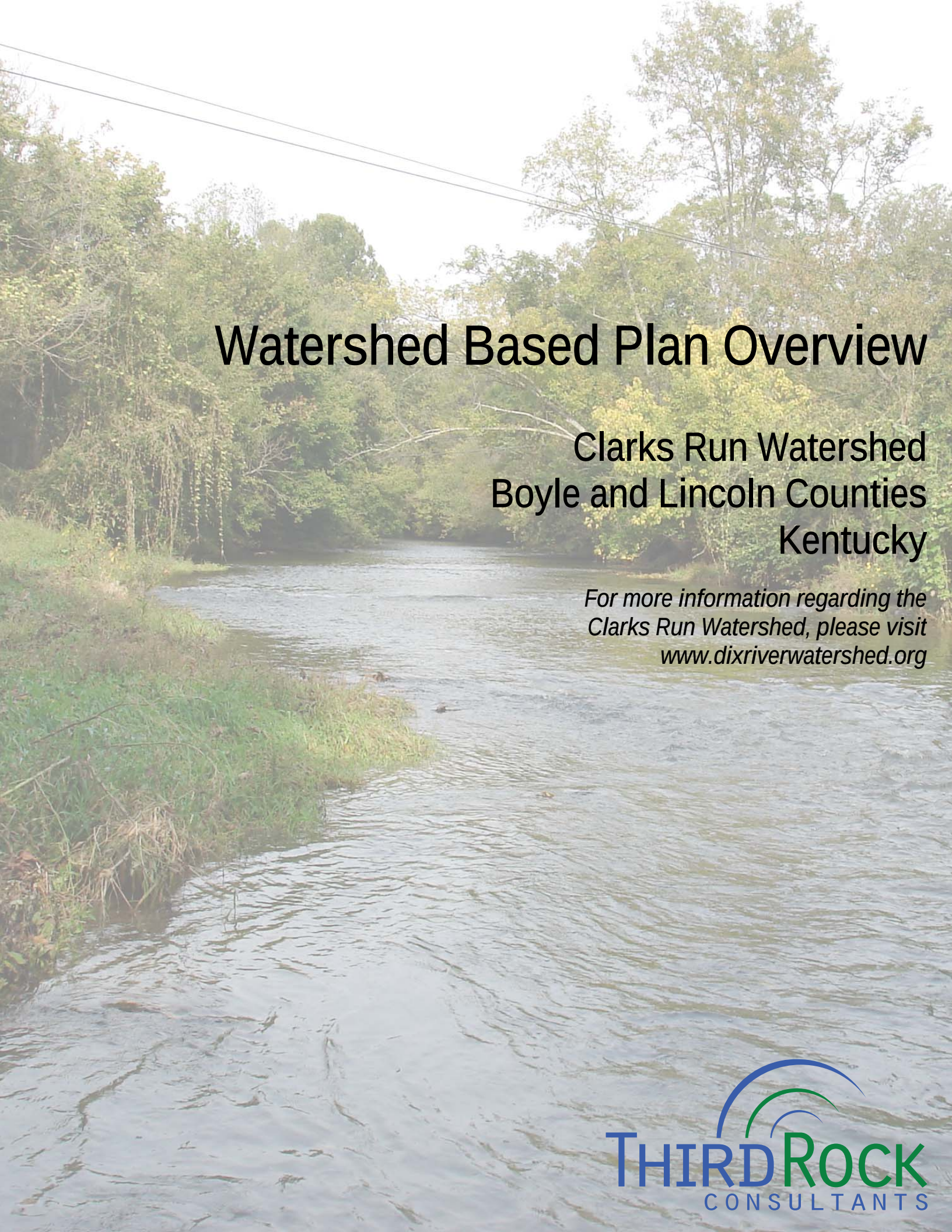

Watershed Based Plan Overview

Clarks Run Watershed
Boyle and Lincoln Counties
Kentucky

For more information regarding the Clarks Run Watershed, please visit www.dixriverwatershed.org

THIRD ROCK CONSULTANTS

BACKGROUND

The Clarks Run watershed covers approximately 28.5 square miles in Boyle and Lincoln County, including approximately two-thirds of the City of Danville as shown on Exhibit 1 on page 2. Clarks Run and Balls Branch are the major streams draining the watershed into the Dix River and eventually Herrington Lake. Initially, the 303(d) list of impaired surface waters in Kentucky, listed Clarks Run as impaired (nonsupporting) for aquatic life. This report listed pesticides and organic enrichment/low dissolved oxygen from the suspected sources of urban stormwater runoff and municipal point sources as the pollutants responsible for this impairment.

Sample Collection in Clarks Run

In an effort to develop solutions to the problems in the Clarks Run watershed, a four-year monitoring study was conducted. This study was used to develop a watershed based plan, which, according to the US Environmental Protection Agency is "a means to resolve and prevent water quality problems that result from both point source (single, localized sources, such as straight pipes) and nonpoint source (indirect sources, such as stormwater runoff) problems." The data produced from the study is also being used to develop Total Maximum Daily Load (TMDL) recommendations for the watershed. TMDLs identify pollutant sources and the amount of pollutants each source contributes in order to make recommendations for how much of each pollutant the stream can receive and remain healthy.

The monitoring study successfully identified the most prominent pollutants impairing the Clarks Run watershed and their sources. The *Clarks Run Watershed Based Plan* analyzes these impairments and indicates causes and solutions. The following is a brief summary of the *Clarks Run Watershed Based Plan*.

WATERSHED DESCRIPTION

Located in the Inner Bluegrass Ecoregion, the Clarks Run watershed contains undulating terrain with moderate rates of both surface runoff and groundwater drainage. Shale and siltstone geology underlie the region. Land use is approximately 70 percent agriculture, 10 percent residential development, 11 percent commercial/industrial, and 17 percent forest. Fifteen businesses hold permits to discharge in the watershed, including the City of Danville's wastewater treatment plant (WWTP).

Signage for Flow Measurement Equipment

MONITORING SUMMARY

A comprehensive water quality study of the watershed was conducted, which included collecting monthly samples from eight sites in the Clarks Run watershed over a one-year period from 2006 to 2007. In a follow up monitoring plan in 2007 and 2008, twenty sites, including six of the sites previously monitored, were investigated further because of pathogen and

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. 303d Listed streams obtained from the Kentucky Geological Survey at <http://www.uky.edu/KGS/gis/hydro.html>.

South 2nd Street
Reductions:
N: 16,700 lbs/yr (29%)
Human E.coli: 28.8 trillion CFU/yr (sewer/septic)
Cattle E.coli: 7.2 trillion CFU/yr (53 cattle)

Stanford Road
Reductions:
N: 1,400 lbs/yr (29%)
Human E.coli: 45.4 trillion CFU/yr (sewer)

KY 52
Reductions:
P: 2,500 lbs/yr (45%)
N: 173,000 lbs/yr (85%)
Human Ecoli: 3.3 trillion CFU/yr (sewer/septic)
Cattle Ecoli: 3.3 trillion CFU/yr (24 cattle)

US 127 Bypass
Reductions:
N: 9,000 lbs/yr (53%)
Human E.coli: 0.2 trillion CFU/yr (1 septic)
Cattle E.coli: 0.5 trillion CFU/yr (3 cattle)

Goggin Lane
Reductions:
Litter

Balls Branch Mouth
Reductions:
N: 11,200 lbs/yr (26%)
Human Ecoli: 10.9 trillion CFU/yr (7 septic)
Cattle Ecoli: 10.9 trillion CFU/yr (80 cattle)

Corporate Drive
Reductions:
N: 300 lbs/yr (2%)
Human E.coli: 2.6 trillion CFU/yr (2 septic)
Cattle E.coli: 6.0 trillion CFU/yr (44 cattle)

Balls Branch West
Reductions:
N: 5,500 lbs/yr (22%)
Human E.coli: 27.8 trillion CFU/yr (4 septic + Pump Station)
Cattle E.coli: 19.7 trillion CFU/yr (144 cattle)

Danville
Junction City
GARRARD
LINCOLN
Salt River
Mocks Branch
Spears Creek
Dix River
Clarks Run
Knoblick Creek
White Oak Creek
Balls Branch
Danville WWTP
South 2nd Street
Goggin Lane
KY 52
Balls Branch Mouth
Stanford Road
US 127 Bypass
Corporate Drive
Balls Branch West
33
150
127
34
37

- Water Quality Monitoring Site
- Impaired Stream
- Sewer Line
- Sewer
- Septic System
- Clarks Run Watershed
- City Boundary
- County Boundary

0.5 0 0.5 1 Miles

N

Site Name
Reductions:
P: #lbs phosphorus/yr (#%)
N: #lbs nitrogen/yr (#%)
Human E.coli: # trillion CFU/yr (# septic replacements or sewer)
Cattle E.coli: # trillion CFU/yr (# cattle restrictions)

Exhibit 1
Impaired Waters and Reduction Goals
Clarks Run Watershed
Boyle County, Kentucky

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habitat related impacts. In 2008 and 2009, nutrient samples were collected for eight months at the original eight sites due to quality related biases in the initial sampling. Sampling was conducted in a variety of conditions, including storm and low flow stream periods, as pollutant sources differ depending on specific conditions. The locations of these sites are shown in Exhibit 1.

WHAT ARE THE PROBLEMS?

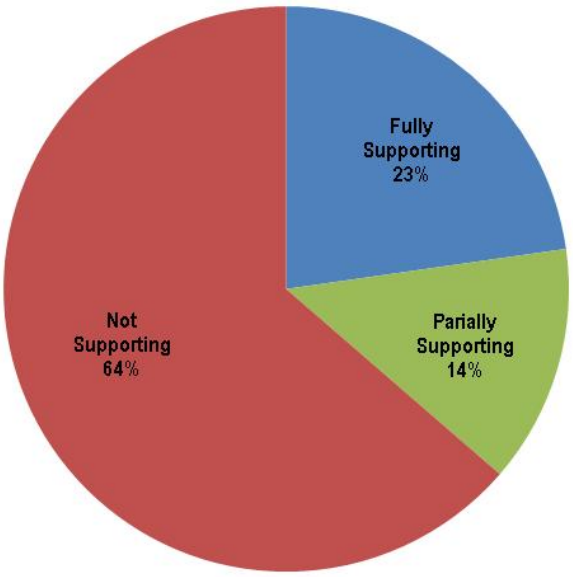
As a result of the monitoring study, additional streams in the Clarks Run watershed have been identified as impaired and listed on the 2008 303(d) list of impaired surface waters. Risks of disease due to human sewage and animal wastes have been identified as the most serious impairment to the watershed. Poor aquatic habitat is common throughout the watershed, while specific areas are polluted by excessive nutrients, which produce algal blooms and reaches levels toxic to fish and other aquatic life in certain areas. Dissolved ions and the rapid changes in water levels due to storm runoff are also significant problems in Clarks Run. Each of these impacts identified in the monitoring study are explained in more detail below.

Algal Blooms and Absent Riparian Zone on Sampled Stream

Habitat Assessment

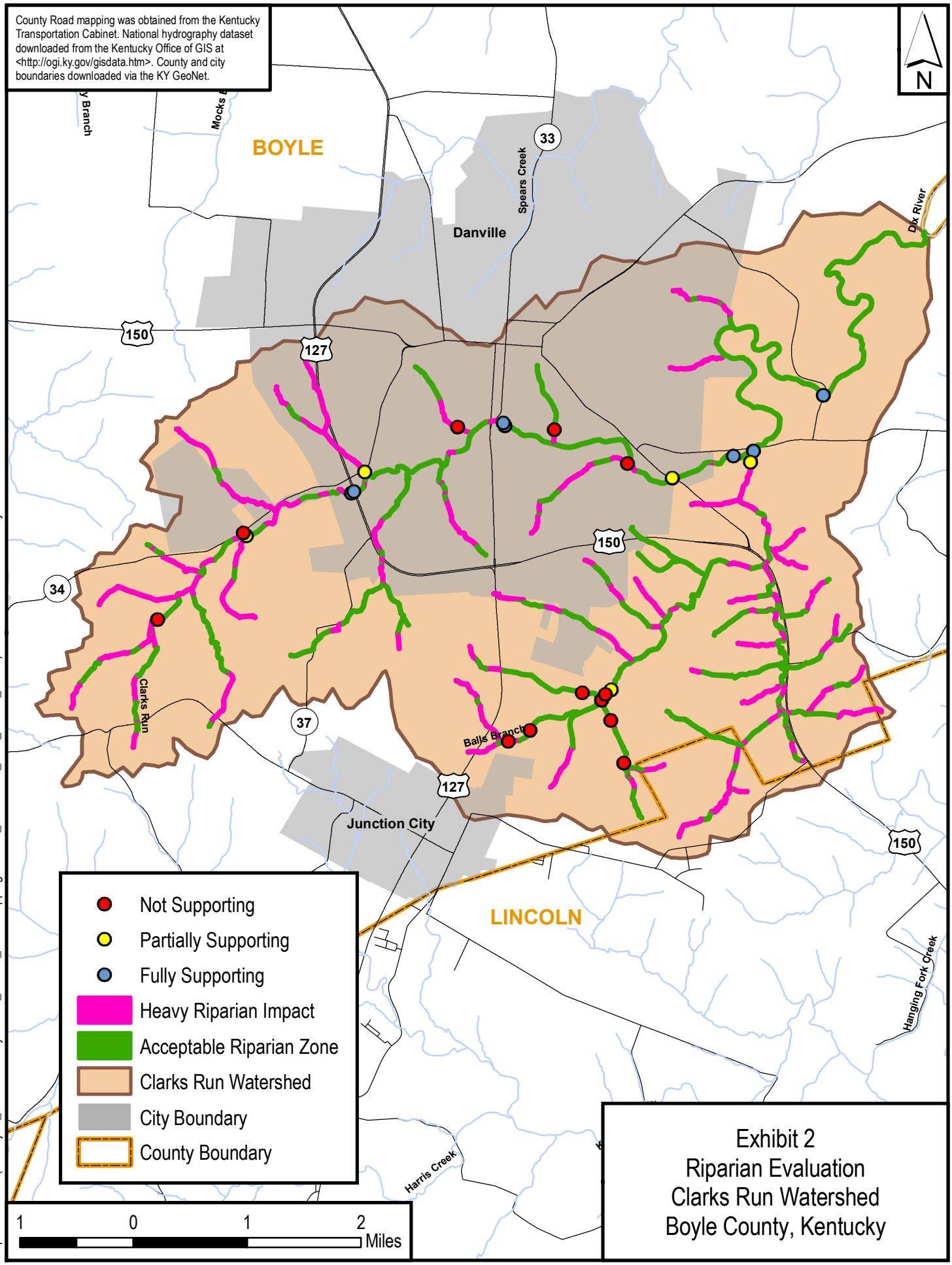
Habitat assessment evaluates the physical structure of streams to determine how these factors influence water quality. Healthy streams provide diverse habitat for numerous species, and the assessment also determines the potential for the stream to provide habitat. The Kentucky Division of Water has established three categories to rank the quality of the habitat a stream provides, listed in the order of best to worst: "fully supporting," "partially supporting," and "not supporting."

Figure 1 - Habitat Evaluation of Clarks Run



Of the twenty-two sites surveyed in Clarks Run, the majority of the sites were determined to have poor habitat, with over 75 percent either "not supporting" or only "partially supporting" habitat use. These designations are shown on Exhibit 2, on page 4. Although the reasons for the poor habitat designations differed from site to site, common trends were observed in the watershed.

Habitat was most commonly reduced throughout the watershed because the vegetated area surrounding the stream, called the riparian zone, was either absent or underdeveloped. The riparian zone is important because it provides wildlife habitat, reduces stream erosion, filters nutrients, traps sediment, and provides canopy cover to the stream. Improving the riparian area by vegetating


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
BOYLE
Danville
Spears Creek
Dix River
Mocks Branch
33
150
127
34
37
Clarks Run
Balls Branch
Junction City
LINCOLN
Hanging Fork Creek
Harris Creek
Not Supporting
Partially Supporting
Fully Supporting
Heavy Riparian Impact
Acceptable Riparian Zone
Clarks Run Watershed
City Boundary
County Boundary
1 0 1 2 Miles
Exhibit 2
Riparian Evaluation
Clarks Run Watershed
Boyle County, Kentucky
Map Document: (P:\Project_Files\Kentucky\5167E_KDOW_WBP\Mapping\GIS\CR_Watershed_Brief_Exhibit_2.mxd) 10/5/2009 -- 3:14:11 PM sje

the area within 60 feet of each stream bank with native plant species and reducing disturbance (human activity, livestock damage, etc.) will provide the greatest improvement to stream habitat.

In the agricultural areas of the watershed, such as Balls Branch West, some of the poorest habitats were frequently due to 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, although these impacts were usually less severe than those in agricultural areas.

In general, the habitat of streams and tributaries near the outer boundaries of the watershed was much more impacted than on the larger Clarks Run. Although the habitat of all streams in the watershed was not assessed, these trends appear representative of streams throughout the watershed.

At one site, Clarks Run at Goggin Lane, frequent dumping of garbage and other litter was observed and should be addressed.

Pathogens

Pathogens are organisms that are capable of causing disease, such as bacteria, viruses, protozoa, or fungi. Pathogens enter streams through sewage or animal wastes and present a health risk to people who use the streams recreationally. Because testing for individual pathogens is unfeasible, *E. coli* was sampled as an indicator of sewage or animal wastes in streams within the Clarks Run watershed. Results indicate that concentrations of *E. coli* often ranged from ten to one hundred times greater than the statewide limit. Thus, the most significant impact in Clarks Run is the fecal pollution of the watershed.

Because the concentrations of *E. coli* were relatively high, additional testing was conducted to identify the source of the fecal inputs and the relative concentrations of individual tributaries. 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. Other sampling sites were established along the main stem of Clarks Run and its tributaries, although the highest average concentrations in this area 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, currently being upgraded by the City of Danville. On the southern tributary to Balls Branch along Goose Pike, DNA tests indicate that cattle contributions were more significant at 50 percent, while human sources composed only 10 percent. The remaining percentage may be due to human, cattle, or other sources, but is currently unknown. It is expected that the western tributary to Balls Branch is similarly more influenced by cattle fecal 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 were identified from human and

cattle sources. 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.

Nutrients and Algal Blooms

Although nutrient levels are somewhat elevated throughout the Clarks Run watershed, concentrations of phosphorus and nitrogen compounds are well above acceptable levels at the two sites downstream from Danville's wastewater treatment plant (WWTP), which is located between Stanford Road and KY 52.

Concentrations of organic nitrogen and nitrate were approximately three times higher than those measured at most other locations in the watershed on average downstream of the WWTP near the overpass of KY 52 and also near Goggin Lane. In addition, unionized ammonia (a form of nitrogen) was also significantly elevated below the WWTP. Although no regulatory limits have been established for nitrate or organic nitrogen (TKN), concentrations were routinely above the average for the ecoregion. The elevated concentrations of these forms of nitrogen are created by the decomposition of human waste, animal manure, cleaning products, or fertilizer. For unionized ammonia, concentrations below the WWTP were found to exceed the regulatory standard. Levels above that standard have been found to impact fish and macroinvertebrate species and even cause death to aquatic organisms.

Phosphorus levels downstream of the WWTP were similarly two to three times higher than the concentrations at sites not influenced by the treatment plant. Sources of phosphorus include fertilizer, detergents, decomposition of plants or food, and human or animal waste.

Algal blooms are rapid increases in a stream's algal population and are caused by an abundance of nitrogen, phosphorus, and sunlight. Algal blooms were observed throughout the watershed, but were especially dense nearby Goggin Lane, where they were clogging the entire stream. Algal blooms also occurred at overpass of KY 52, but shading of the stream by tree canopy minimized the severity of these blooms.

Algal Bloom at Goggin Lane

Algal blooms impact streams in a number of ways. The unattractive appearance can detract from the recreational value of the stream, causing property values to decline. Because of their volume, they also reduce habitat for some aquatic species. Although the two sites monitored for nighttime dissolved oxygen levels were normal, algal blooms are known to cause fish kills by reducing nighttime dissolved oxygen concentration to toxic levels. No dissolved oxygen problems were detected in Clarks Run, most likely due to frequent aeration at riffles in the shallow streams.

Dissolved Ions

Conductivity is a measurement of the stream's ability to carry an electrical current. In streams, this is dependent on the concentration of inorganic dissolved solid ions such as nutrients, metals, or other compounds in the water. 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 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.

Stream Flashiness

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. In normal stream environments, most rainfall is absorbed into the ground, which filters out many nutrients and other pollutants as rainfall slowly passes into the stream. However, in areas with high percentages of impervious surfaces and efficient stormwater drainage systems, stormwater quickly flows into streams. This often causes elevated concentrations of nutrients and other pollutants, reduced habitat stability, and reduction of the aquatic species capable of inhabiting streams. As Danville has these attributes, the rapid fluctuation in water levels may be contributing to stream impacts.

HOW CAN WE FIX THE PROBLEMS?

Recommendations for improving the found aquatic impairments are multi-faceted. Exhibit 1 indicates the areas of impairment for pathogens and nutrients and estimates of the amount of reduction necessary to achieve watershed goals. Exhibit 2 indicates the areas in need of habitat improvement, specifically through riparian buffer reestablishment. Best Management Plan (BMP) recommendations focus on the bacteria as well as the physical and chemical impairments in the watershed. The watershed plan indicates action items, organizations, funding, and indicators of success that may be used to ensure progress on these plans. The specific BMPs are listed below by impairment.

For *bacteria*, BMPs are recommended to reduce both human and livestock inputs. Exhibit 1 shows areas in greatest need for bacterial input reduction, the relative proportions due to human and livestock sources, and the reductions necessary to meet water quality goals.

For human inputs, specific BMPs include:

- Identifying and replacing failing and improperly maintained septic systems or straight pipes.
- Identifying and repairing sewer collection system failures.

For livestock:

- Restricting agricultural grazing from the riparian zone and installing filter strips to reduce fecal input from runoff.

For elevated *nutrients*, the actions taken to address the bacterial sources should also reduce the nutrient sources. However, additional BMPs are necessary to reach the watershed goals including:

- Reducing WWTP limits on nitrogen and phosphorus.
- Constructing headwater and streamside urban nutrient reduction features.
- Constructing agricultural nutrient reduction BMPs.

For *physical stream impairments*, efforts should focus on stream stabilization and riparian habitat expansion and establishment. Exhibit 2 shows areas in need of physical improvements and riparian buffer re-establishment, which are primarily rural. In areas in which cattle are contributing to bacterial inputs, fencing cattle from the stream and allowing the riparian vegetation to establish may accomplish two goals. Other specific tasks include:

- Planting riparian trees to increase riparian vegetated width.
- Reduce stream flashiness by reducing or slowing stormwater runoff.
    - Stream restoration
    - Rain barrel installations
    - Increase enforcement of existing ordinances and regulations

Other BMPs should focus on *litter* and *public education*. Specific efforts should include:

- Enforcement of litter and dumping ordinances.
- Conducting community trash pickup days.
- Increasing public education by increasing accessibility to water quality related information.
- Encouraging community interest in stream improvement.
- Examining and recommending updates to local codes and ordinances.

ADDITIONAL INFORMATION

Detailed information and comprehensive analysis from the Clarks Run watershed is available in the *Watershed Monitoring Report* for the Dix River Watershed as well as in the C*larks Run Watershed Based Plan.* Both documents can be located online at www.dixriverwatershed.org. Hard copies of the watershed plan are also available at the Boyle County Public Library and Danville City Hall.