2017

A Summary of the Kentucky River Watershed Watch 2016 Water Sampling Results

Kentucky Water Resources Research Institute

A Summary of the

Kentucky River Watershed Watch

2016 Water Sampling Results

Watershed Watch is a non-profit organization that was formed in 1997 to support a citizen monitoring effort, improve and protect water quality by raising community awareness, and promote the goals of the Clean Water Act and other water quality initiatives.

Report Produced by the

Kentucky Water Resources Research Institute

Funded by the

Kentucky River Authority

TABLE OF CONTENTS

APPENDIX A: FIGURES

APPENDIX B: TABLES

CHAPTER 1: INTRODUCTION

Background

This report documents the results of the 2016 Kentucky River Watershed Watch sampling effort, which was supported through funding and other contributions from the Kentucky River Authority, the Kentucky Division of Water, and the Virginia Environmental Endowment. Kentucky River Watershed Watch is a volunteer organization with the following goals:

- To provide current data on general water quality conditions to local stream based organizations working to protect their watershed
- To provide widespread screening for potential water quality problems to resource management agencies
- To provide auxiliary information to assist resource management agencies in meeting specific operational and management objectives
- To identify specific impacts to water quality through targeted observations and measurements

The 2016 sampling effort was conducted according to KRWW's Annual Workplan. (See "About," then "Work Plan" on organization's website at www.krww.org.) Detailed sampling results for 2016 and past years are also posted on the KRWW web site at http://www.krww.org.

2016 Sampling Site Overview

During 2016, Kentucky River Watershed Watch volunteers collected water samples from 168 sites at streams, rivers and lakes throughout the Kentucky River Basin, from Letcher County in the southeastern region to Carroll County in the northernmost region.

The Kentucky River Basin extends over much of the central and eastern portions of the state and is home to approximately 710,000 Kentuckians. The watershed includes all or part of 42 counties and drains over 7,000 square miles with a tributary network of more than 15,000 miles. A map of the watershed with the associated counties and sub-basins is shown in Figure 1 (see Appendix A for all figures). For the purpose of watershed management, the river basin has been subdivided into smaller sub-basins, or watersheds, using the USGS Hydrologic Unit Code (HUC) classification system. The sub-basins shown in Figure 1 are classified as HUC-8 watersheds and include the South, Middle and North Forks of the Kentucky River, the Central Kentucky River and Lower Kentucky River Basins. These areas can be further subdivided to outline smaller 11-digit HUC watersheds, which drain into the larger HUC-8 waterways, as shown in Figures 2-4. Most KRWW samplers focus on these smaller watersheds when assessing and applying their water quality findings.

Water quality data were collected during three different events between May and September of 2016. A listing of the types of data collected, sampling dates, and number of samples is provided in the table below.

Table 1: Summary of 2016 Kentucky River Watershed Watch Sampling Events

Sampling Event	Dates	# of Sites Sampled
Spring Pathogen Event	May 12—16	109
Summer Pathogen Event	July 7—11	102
Fall Pathogen Event	September 9 –12	136
Fall Nutrients	September 9—12	134
Fall Metals	September 9—12	24

The location of the 168 sites sampled in 2016 are shown in Figure 5. The 2016 sampling sites were highly concentrated in the central and southeastern regions of the Kentucky River Basin. A detailed index of the 2016 KRWW sampling sites is provided in Table B1 (see Appendix B).

2016 Flow Conditions

In order to provide a basis for interpreting the sampling results, it is important to understand the associated stream flow conditions. For example, data collected during low flow or dry conditions may be more indicative of the impact of "point source" discharges, mainly from pipes. Data collected following a storm may be more reflective of the impacts of "non-point" pollutant discharges, or pollution that is picked up from stormwater runoff.

An indication of the stream flow conditions during the sampling period may be obtained by examination of USGS (United States Geological Survey) stream flow records. To begin to understand streamflow variation during the 2016 sampling season, five separate USGS gaging stations were selected. Stream flow plots for each station, showing the mean daily flow rates during the three sampling efforts, are shown in Figures 6-10. (Daily stream flow values for these tables can be found on the USGS website at http://ky.water.usgs.gov). Figure 11 shows a comparison of flow levels at each of the 5 stations during the three sampling events.

The flow graphs illustrate the varying flow conditions present during the 2016 KRWW sampling season. Typically, lower flows indicate that a concurrent sampling event is more likely to capture point sources, such as sewage from leaking sanitary sewer infrastructure or straight pipes. Higher flows can indicate a recent precipitation event, and sampling may capture more nonpoint source contributions, such as septic system runoff, livestock waste from pastureland or fertilizer runoff from lawns or crops.

It is important to realize that generalizations about flow levels relative to pollutant concentrations can be complicated by a variety of factors, and as with most scientific investigations, will require more data to fine tune the meaning of the sampling results. Complicating factors include:

- Higher flows can mobilize pollutants that have accumulated in the stream, raising their concentrations.
- Higher flows can cause sanitary sewer overflows that can increase pollutants (i.e., pathogens, nutrients).
- Long term sampling results help explain connections between elevated pollutant levels and higher water volumes. For example, if the measured concentration is lower during high flows then this is likely due to dilution or have the pollutant sources actually been reduced? If the measured concentration is higher during higher flows, is this due to stormwater runoff carrying more pollutants into the stream, or are instream pollutants (perhaps in the stream sediments) being mobilized by the higher flows?

Regardless, it is important to consider flow levels, as well as flow rates and precipitation records, when evaluating the meaning of water sampling results.

Spring Sampling Event: Moderately high to very high flows were observed at the time of the Spring Sampling Event in May 2016, and flows were either peaking or beginning to decline from a peak flow level. Thus, runoff pollutant contributions may have been the cause of high E .coli observations during this event.

Summer Pathogen Sampling Event: The flows during the July event were also high, especially in the upper (southeastern) region of the Kentucky River Basin. In locations where rainfall was reported leading up this sampling event, higher E. coli readings could be attributed to runoff contributions.

Fall Sampling Event: Lower flows were observed across the basin during the fall nutrient/chemical/metals sampling event in September, and very little rainfall was recorded for the prior 48 hours. Thus, this event appears to have been a true "low flow" event, where concentrations of pollutants may be more concentrated than normal and runoff from stormwater was not a contributing factor.

CHAPTER 2: DATA COLLECTION AND ANALYSIS

Physical/Chemical Field Data

General physical/chemical field data (dissolved oxygen, pH, water temperature, observed flow level, recent rainfall and conductivity) were collected at each sample site during the four separate basin wide sampling periods. A summary of the physical/chemical data collected during this period is provided in Table B2.

Dissolved Oxygen

A dissolved oxygen value less than 5.0 mg/L is problematic for aquatic organisms, causing increased susceptibility to environmental stresses, reduced growth rates, mortality and an alteration in the distribution of aquatic life. The normal range for dissolved oxygen in freshwater streams is between 6.5 mg/L and 8.5 mg/L.

Dissolved oxygen is inversely proportional to water temperature, with higher levels of dissolved oxygen corresponding to lower temperatures. According to temperature, there are maximum dissolved oxygen concentrations, with 14.6 mg/L being the absolute maximum. Thus, dissolved oxygen results greater than 14.6 mg/L are not possible. Additionally, samplers can check the likelihood of their findings by cross-checking it with a dissolved oxygen vs temperature table (see http://water.epa.gov/type/rsl/monitoring/vms52.cfm).

Thirty-four readings showed dissolved oxygen levels less than 5.0 mg/L, the level at which aquatic life becomes critically stressed. The sampling sites with 2016 readings less than 5.0 mg/L are noted in bold font in Table B2.

pH

A pH value less than 6 signifies acidic conditions in which toxic heavy metals are more soluble, and therefore more available for uptake by aquatic life. At pH values greater than 9, toxic ammonia concentrations increase. Thus, a pH between 6 and 9 indicates that the waterbody is within a safe pH range for the survival of aquatic life. **One of the pH readings, for site #744 on Cane Run in Scott County, was greater than 9, and none of the sites had readings below 6.**

Temperature

In addition to having its own toxic effect, water temperature affects the solubility and the toxicity of many other water quality parameters. Generally, the solubility of solids increases with increasing temperature, while gases tend to be more soluble in cold water. An important physical relationship exists between the amount of dissolved oxygen in a body of water and its temperature. The warmer the water, the less dissolved oxygen. Colder water can maintain greater dissolved oxygen concentrations.

None of the sites had a temperature reading that exceeded 31.7° Celsius, which is Kentucky's water quality standard for protection of aquatic life in warm water streams.

Flow/Rainfall

Based on visual observations, the flow rate in the streams was assessed using the following numerical equivalents:

0 – Dry

1 – Ponded

2 – Low

3 – Normal

4 – Bank Full

5 – Flood

The visual flow assessments during the 2016 KRWW sampling season varied greatly, with higher flows observed during the spring and summer pathogen sampling events and lower flows recorded during the fall event.

Recent rainfall was also recorded by samplers, as an estimate of precipitation during the 48-hour period prior to the sampling event. Results were recorded as zero, 0.1, 0.5, 1.0, 1.5 or > 1.5 inches.

Spring (May) Sampling Event: Flows were mainly bankfull (4) to flooding (5) for the spring E. coli event, with reports of 0.1 to > 1.5 inches of recent rainfall.

Summer (July) Sampling Event: The second pathogen sampling event in July was also conducted during mainly bankfull to flood conditions. Rainfall recordings varied widely for the prior 48-hour period, ranging from zero to > 1.5 inches.

Fall (September) Sampling Event: Low to normal flows were reported during the September sampling event, which is typical in the fall. Recent rainfall recordings for the fall event were very low, with reports from zero to 0.1 inches. Thus, the influence of runoff pollutant contributions should be very minimal for the fall sampling findings.

Conductivity

Conductivity is a measurement of the ability of an aqueous solution to carry an electrical current. Conductivity measurements are used to determine levels of total inorganic dissolved solid ions, such as nutrients, metals, or other compounds. Indirect effects of high conductivity levels are primarily the elimination of plants needed for food or habitat and the decline of sensitive aquatic species, such as mayflies and fish.

The USEPA recently established a criterion of 500 µS/cm for streams in Central Appalachia. In central Appalachia, the conductivity of headwater streams is naturally between 100 and 200 µS/cm. This is important because the plants, insects and animals in local streams have adapted to living in this level of conductivity. Recent studies conducted by the EPA show that when the conductivity in central Appalachian streams rises to about 300 mS/cm, the plants, insects and animals begin to be affected. When the conductivity of these streams goes above 500 µS/cm, the plants, insects and animals are drastically affected. And when the conductivity measures above 1,000 µS/cm, everything in the stream is effectively dead. [NOTE: KDOW sampling has shown that some pollutant-tolerant aquatic life is present at conductivity levels greater than 1,000 µS/cm.] In other regions of the country the natural conductivity may be higher or lower than in central Appalachia, and the plants, insects and animals there will have adapted over thousands of years to live within those natural conductivity levels.

Of 301 field conductivity readings, 153 (or 51%) were reported as being greater than 500 microSiemens/cm (µS/cm).

Turbidity

Turbidity is a measure of water clarity and how much the material suspended in the water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt and sand), algae, plankton, microbes, and other substances. Higher turbidity increases water temperatures, because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen because warm water holds less dissolved oxygen than cold water. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of oxygen. Suspended materials can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and benthic macroinvertebrates. Sources of turbidity include soil erosion, waste discharge, urban runoff, eroding streambanks, large numbers of bottom feeders which stir up bottom sediments and excessive algal growth (USEPA, www.epa.gov/owow/monitoring/volunteer/stream/vms55.html). The state of Kentucky has not issued water quality standards for turbidity.

Turbidity results were based on subjective observations at the time of sampling. Volunteers rated the turbidity of the waterbody on a scale of 0 (clear) to 3 (turbid). *For the fall sampling event, turbidity was also assessed by the analytical lab (Kentucky Geological Survey) and could serve as a comparison value to this subjective rating.*

Bacteriological Indicator

A number of pathogenic (disease causing) viruses, bacteria, and protozoans can enter a water body via fecal contamination. Human illness can result from drinking water or swimming in water that contains pathogens. Eating shellfish harvested from such waters may also result in human illness.

Unfortunately, direct testing for pathogens is impractical. Pathogens are rarely present in large numbers, and many are difficult to cultivate in the lab. Instead, microbiologists look for "indicator" species – so called because their presence indicates that fecal contamination may have occurred. The indicators most commonly used today include: total coliforms, fecal coliforms, and Escherichia coli. Each of these bacteria are normally prevalent in the intestines and feces of warm-blooded animals, including humans. The indicator bacteria themselves are not usually pathogenic. All but E. coli are composed of a number of species of bacteria that share common characteristics such as shape, habitat, or behavior. E. coli is a single species in the fecal coliform group. It should be pointed out that when a water sample is determined to contain E. coli, that does not necessarily mean that the dangerous strain (i.e. E. coil O157:H7) is actually present. It is probably not; however, it does indicate recent fecal contamination.

Escherichia coli (E. coli)

The bacteria, E. coli, is commonly found in the intestines of healthy humans and animals and produces the K and B–complex vitamins that are then absorbed for nutritional benefit. The presence of E. coli in water indicates fecal contamination and the potential for waterborne disease. EPA recommends E. coli as the best indicator of health risk from water contact in recreational waters. Kentucky has transitioned from a fecal coliform standard to an E. coli standard.

The state criteria for E. coli are based on the designated use of the particular stream and may be summarized as follows: *Primary Contact Recreation* (swimming from May 1 thru Oct 31): E. coli shall not exceed 130 colonies per 100 ml as a monthly geometric mean based on not less than 5 samples per month; nor exceed 240 colonies per 100 ml in 20 percent or more of all samples taken during the month [Note: As a result of the sampling frequency requirement with the first criteria, the state of Kentucky uses the 240 colonies per 100-ml criteria for classifying streams .

Bacteriological Sampling Results

E. coli sampling was conducted three times in the Kentucky River basin during 2016, in May, July and September. Samplers who were able to participate in each of these events were given a good picture of E. coli levels throughout the 2016 recreation season and could see how levels may fluctuate with varying rainfall amounts and flow levels. The E. coli results are provided in Table 3 and a corresponding map in Figure 12 shows the location of the sampled sites. In the table of results, average values that are in bold text are greater than the safe swimming standard.

Chemical Indicators

General chemical data (chlorides, conductivity, total suspended solids, and sulfate) were collected at 103 sampling locations during the month of September. The individual results are shown in Table B6.

Chlorides

Chlorides are salts resulting from the combination of the gas chlorine with a metal. However, the chloride that is measured in the water sample is actually not the salt, but the dissolved (or dissociated) chloride anion (Cl^-). Fish and aquatic communities cannot survive in waters with high levels of chlorides. The state of Kentucky requires that chloride levels be less than 250 mg/L in domestic water supplies. Criteria for protection of aquatic life require levels of less than 600 mg/L for chronic (long-term) exposure and 1200 mg/L for short-term exposure. **During the 2016 KRWW sampling season, the highest chloride value of 398 mg/L was observed at Site #792 on West Hickman Creek in Fayette County.** One other result from Lower Howard's Creek in Clark County exceeded the drinking water supply standard, and no results exceeded the acute or chronic aquatic life criteria for chlorides.

Conductivity

Conductivity is a measurement of the ability of an aqueous solution to carry an electrical current. Conductivity measurements are used to determine mineralization, or total dissolved solids. Indirect effects of excess dissolved solids are primarily the elimination of desirable food plants and habitat-forming plant species. For Kentucky, water quality criteria have been established only for the mainstem of the Ohio River. The limit is 800 microSiemens/cm or 500 mg/L total dissolved solids. The USEPA also recently established conductivity criteria for support of aquatic life in Central Appalachian streams of 500 microsiemens/cm.

During the 2016 KRWW sampling season, lab conductivity values ranged from 108 mS/cm from Creeches Creek in Wolfe County (Site #3482) to 2,648 mS/cm at Sandlick Creek in Letcher County (Site #756). Sixty-nine percent of the lab readings of conductivity were greater than the KRWW unofficial aquatic life standard of 500 mS/cm.

<u>Turbidity</u>

Turbidity is a measure of water clarity and how much the material suspended in the water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt and sand), algae, plankton, microbes, and other substances. Sources of turbidity include soil erosion, waste discharge, urban runoff, eroding streambanks, large numbers of bottom feeders which stir up bottom sediments and excessive algal growth.

Higher turbidity increases water temperatures, because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen because warm water holds less dissolved oxygen than cold water. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of oxygen. Suspended materials can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and benthic macroinvertebrates.

There are no quantitative criteria for turbidity. The Kentucky Water Quality Standards for aquatic life state that suspended solids "shall not be changed to the extent that the indigenous aquatic community is adversely affected" and "the addition of settleable solids that may adversely alter the stream bottom is prohibited." **During the 2016 sampling season, the highest turbidity reading of 42.2 NTU was observed at McKecknie Creek in Garrard County (#1030).**

<u>Sulfate</u>:

The most common form of sulfur in well-oxygenated waters is sulfate. Sulfates (SO_4^{-2}) can be naturally occurring or the result of municipal or industrial discharges. When naturally occurring, they are often the result of the breakdown of leaves that fall into a stream, of water passing through rock or soil containing gypsum and other common minerals, or of atmospheric deposition. Point sources include sewage treatment plants and industrial discharges such as tanneries, pulp mills, and textile mills. Runoff from coal mining operations and fertilized agricultural lands also contributes sulfates to water bodies.

High levels of sulfate in drinking water (> 250 mg/L) can produce an objectionable, astringent taste and can have laxative effects. Generally, older children and adults become accustomed to sulfate in drinking water, but infants are more sensitive to its effects and water high in sulfate (> 400 mg/L) should not be used for baby formula. Sulfate can be removed from drinking water through processes involving ion exchange, reverse osmosis or distillation, but carbon filtration does not remove it.

When sulfate is less than 0.5 mg/L, algal growth will not occur. The state water quality standard for sulfate in drinking water supplies is 250 mg/L. Typically, KRWW sites that exceed the drinking water supply standard for sulfate are located in the coal mining region of southeastern Kentucky and result from groundwater flowing through bedrock with higher sulfur content.

Only 15 of the 134 sulfate concentrations exceeded the state drinking water supply standard of 250 mg/L. The greatest sulfate reading of 1,717 mg/L occurred at site #756 on Sandlick Creek in Letcher County. Sulfate results are displayed in <u>Table 4</u>. Values that exceed the standard are shown in bold while the highest values are shaded.

<u>Nutrient Indicators</u>

Oxygen demanding materials and plant nutrients are among the most common substances discharged to the environment by man's activities, through wastewater facilities and by agricultural, residential, and storm water runoff. The most important plant nutrients, in terms of water quality, are phosphorus and nitrogen. In general, increasing nutrient concentrations increase the potential for accelerated growth of aquatic plants, including algae. Nuisance plant growth can create imbalances in the aquatic community, as well as cause aesthetic and access issues. High densities of phytoplankton (algae) can cause wide fluctuations in pH and dissolved oxygen.

Total phosphorus (TP) is commonly measured to determine phosphorus concentrations in surface waters. TP includes all of the various forms of phosphorus (organic, inorganic, dissolved, and particulate) present in a sample. Phosphorus is one of the key elements necessary for growth of plants and animals. Phosphates are made up of phosphorus and exist in three forms: orthophosphate, metaphosphate (or polyphosphate) and organically bound phosphate. Each compound contains phosphorous in a different chemical formula. *Ortho* forms are produced by natural processes and are found in sewage. *Poly* forms are used for treating boiler waters and in detergents. In water, they change into the *ortho* form. Organic phosphates are important in nature. Their occurrence may result from the breakdown of organic pesticides that contain phosphates. They may exist in solution, as particles, loose fragments, or in the bodies of aquatic organisms.

In addition to man-made sources, some phosphorus loadings may occur naturally from the watershed soils and underlying geology. Due to background total phosphorus levels in the Kentucky River Basin of as high as 0.25 mg/L, those sites with average total phosphorus concentrations of 0.3 mg/L can be noted as potentially problematic. The informal total phosphorus standard of 0.3 mg/L has been adopted by the KRWW Scientific Advisory Committee as an appropriate level of concern for water quality sampling conducted in the Kentucky River Basin. This value has also been recommended for use as an unofficial benchmark by the Kentucky Division of Water.

Nitrogen is routinely analyzed at most Kentucky ambient sampling sites in the forms of ammonia and ammonium (NH_3/NH_4), total Kjeldahl nitrogen (TKN), and nitrite and nitrate (NO_2/NO_3). Ammonia and ammonium are readily used by plants. TKN is a measure of organic nitrogen and ammonia in a sample. Nitrate is the product of aerobic transformation of ammonia, and is the most common form used by aquatic plants. Nitrite is usually not present in significant amounts.

Nutrient transport, particularly during the months of April through June, has been identified as one of the primary factors controlling the size of the hypoxic zone that forms during the summer in the northern Gulf of Mexico. The Gulf hypoxic zone is an area where oxygen levels drop too low to support most life in bottom and near-bottom waters. A Mississippi River/Gulf of Mexico Watershed Nutrient Task Force was created in 1997 to address the Massachusetts-size dead zone that is threatening the Gulf's fisheries. In 2008, the Task Force identified Kentucky and Indiana as two of the top six among 31 states contributing excess nitrogen and phosphorus to the Gulf from sources such as sewage treatment plants, farms and power plant emissions. It recommended that Kentucky, and other states contributing the most to the problem, enact new nutrient reduction strategies by 2013. A reassessment report was released in 2013, detailing progress made and outlining continuing plans to reduce nutrient impacts to the Gulf hypoxic zone (http://water.epa.gov/type/watersheds/named/msbasin/upload/hypoxia_reassessment_508.pdf).

Kentucky currently has no official numerical standards or criteria for phosphorus or nitrogen in state waterways, but is working toward developing these standards. The state drinking water supply standard for nitrate-nitrogen, which is a measurement of the nitrogen portion of the nitrate (NO_3) molecule, is 10 mg/L. In order to monitor nutrient effects on aquatic life, KRWW is using a proposed standard of 3 mg/L for total nitrogen, because this level has been demonstrated to produce nutrient-rich conditions supporting algal blooms, along with other aquatic habitat threats.

Nutrient Sampling Results

In addition to chemical data, general nutrient data were also collected at sampling sites during September. A summary of the nutrient data collected during this period is provided in Table 5. **Twenty-two of 134 (16%) of the sampling results exceeded the aquatic life benchmark total nitrogen level of 3 mg/L. Twenty-five of the nitrate results reported by the KGS lab were above the 10 mg/L drinking water standard for the state of Kentucky.** The highest total nitrogen (11.6 mg/L) and nitrate (48 mg/L) readings were both reported from Site #765 on South Elkhorn Creek in Scott County.

Forty-eight of 134 stations (or 36%) had total phosphorus readings in excess of 0.3 mg/l. The highest recorded phosphorus reading of 2.16 mg/l was detected at Site #1087 from an unnamed tributary in Fayette County. Values in Table 5 that exceed the standard 5 are shown in bold while the highest values are shaded.

Metal Indicators

In addition to chemical and nutrient data, metals data were collected at 24 sampling sites in September 2016. Out of the 30 different metals tested during the 2016 KRWW sampling season, 14 metals are associated with specific water quality limits (aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, nickel, silver, thalium, zinc). Drinking water supply standards are available for thirteen metals (antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, nickel, selenium, thallium and zinc). Warm water aquatic life standards are available for eleven metals (aluminum, arsenic, cadmium, chromium, copper, iron, lead, nickel, selenium, silver and zinc). Descriptions of each of the metals sampling parameters are provided in **Appendix C.**

The sampling results for metals are provided in Table B7. **There were no detections of 13 of the 30 metal parameters; Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Gold, Lead, Selenium, Silver, Thallium, Tin and Vanadium. Of the detections observed for the remaining metals parameters, these detections only exceeded associated water quality standards for iron. Eight readings were above the drinking water supply standard for iron (0.3 mg/L), and one site, #3548 on Millers Creek in Estill County, also exceeded the chronic aquatic life criteria of 1 mg/L. Values that exceed the water quality standards are shown in bold, while the highest values of each metal are shaded.**

CHAPTER 3: EXECUTIVE SUMMARY

During 2016, Kentucky River Watershed Watch samplers collected water quality data from 168 sites throughout the Kentucky River Basin. These sites were sampled up to three different times for bacteria or pathogens, and for chemicals/nutrients/metals in the fall. In most cases, the site was also assessed in the field for basic physical and chemical parameters such as pH, temperature, dissolved oxygen and conductivity.

None of the reported pH readings for 2016 were less than 6, and only one reading was greater than 9. Eleven percent (34 of 304) of the dissolved oxygen readings were below the minimum threshold of 5 mg/l that is recommended for supporting aquatic life. Although no temperature readings exceeded the maximum recommended for support of aquatic life, over 50% of field conductivity readings were greater than the unofficial aquatic life standard of 500 microsiemens/cm.

In 2016, E. coli was analyzed at three different times, in May, July and September. In May, when recent rains had occurred and streamflows were higher than normal, 24% of the sites produced E. coli levels greater than the Kentucky safe swimming standard. In July, when some rainfall also preceded the sampling event, 37% of sites exceeded the standard. And, in September, when little to no rainfall had occurred and streamflows were low, 15% of sites had E. coli readings above the standard.

The chemical analysis of samples in September showed that 69% had high laboratory-measured conductivity values (e.g. > 500mS/cm). As a comparison, 59% of field readings from the September event produced high conductivity readings.

Although only 16% of sites exceeded the aquatic life benchmark for total nitrogen levels, several of the nitrogen readings were exceptionally high. These high level sites should be further investigated for nearby nutrient sources, such as failing sewer or septic systems, livestock with direct access to the creek, manure applications to cropland, or high numbers of pets or wildlife in the area. The timing of the sampling event in September does not suggest that lawn or crop fertilizers are a likely source. A higher number of sites showed exceedances for total phosphorus, as can be expected in the Bluegrass region where soil and bedrock contributions are higher than average. Forty-eight of 134 sites (36%) displayed total phosphorus levels of concern (above 0.3 mg/L) for support of aquatic life.

Metals were analyzed for water samples from 24 sampling sites in September 2016. The only metal that displayed levels greater than associated water quality standards was iron, with the highest reading seen at Site #3548 on Millers Creek in Estill County.

Flows and rainfall were generally higher during the May and July events of the 2016 sampling season, with some peaks in streamflow just prior to these events. These conditions may enable a comparison of E. coli levels from the May and July events to the September event. The earlier samples are more likely to capture runoff pathogen sources (septic systems, pasture land, pet waste), and the later, dry weather event is more likely to capture point sources (sewer line leakage or straight pipes).

In summary, the following sampling sites have been targeted for more in-depth sampling and water quality management efforts due to 2016 sampling results of concern. These sites are indicated on the map in Figure 18.

2016 KRWW Sites of Concern

South Elkhorn Creek Watershed, Fayette County
#794, #3010, #3478 – Town Branch
Conductivity, E. coli, Nitrogen, Phosphorus
#3137 – Wolf Run
Conductivity, E. coli
#3390 – Wildcat Chase
Conductivity, E. coli, Phosphorus
#3487 – Cave Creek
Conductivity, E. coli

North Fork Kentucky River Watershed
#756 – Sandlick Creek, Letcher County
Conductivity, Sulfate
#1143 – Dry Fork, Letcher County
Conductivity, Sulfate
#1243 – Long Branch, Letcher, County
Conductivity, pH Sulfate
#820 – North Fork Kentucky River, Perry County
Conductivity, E. coli, Sulfate
#875 – Right Fork Carr Creek, Perry County
Conductivity, E. coli, Sulfate
#3271 – North Fork Kentucky River, Breathitt County
Conductivity, Sulfate

Other Sites
#792 – West Hickman Creek, Fayette County
Dissolved Oxygen, Conductivity, Chlorides

#954 – Spring, Woodford County
E. coli, Nitrogen, Phosphorus

#1030 – McKecknie Creek, Garrard County
E. coli, Nitrogen, Phosphorus

#3283 – Lower Howards Creek, Clark County
Conductivity, E. coli, Chlorides

#3401 – Cutshin Creek, Leslie County
Conductivity, E. coli, Sulfate

#3405 – Beech Fork, Leslie County
Conductivity (need to check for metals in 2017)

APPENDIX A: FIGURES

Figure 1—Kentucky River Basin, Counties and Sub-Basins (8-Digit HUCs)

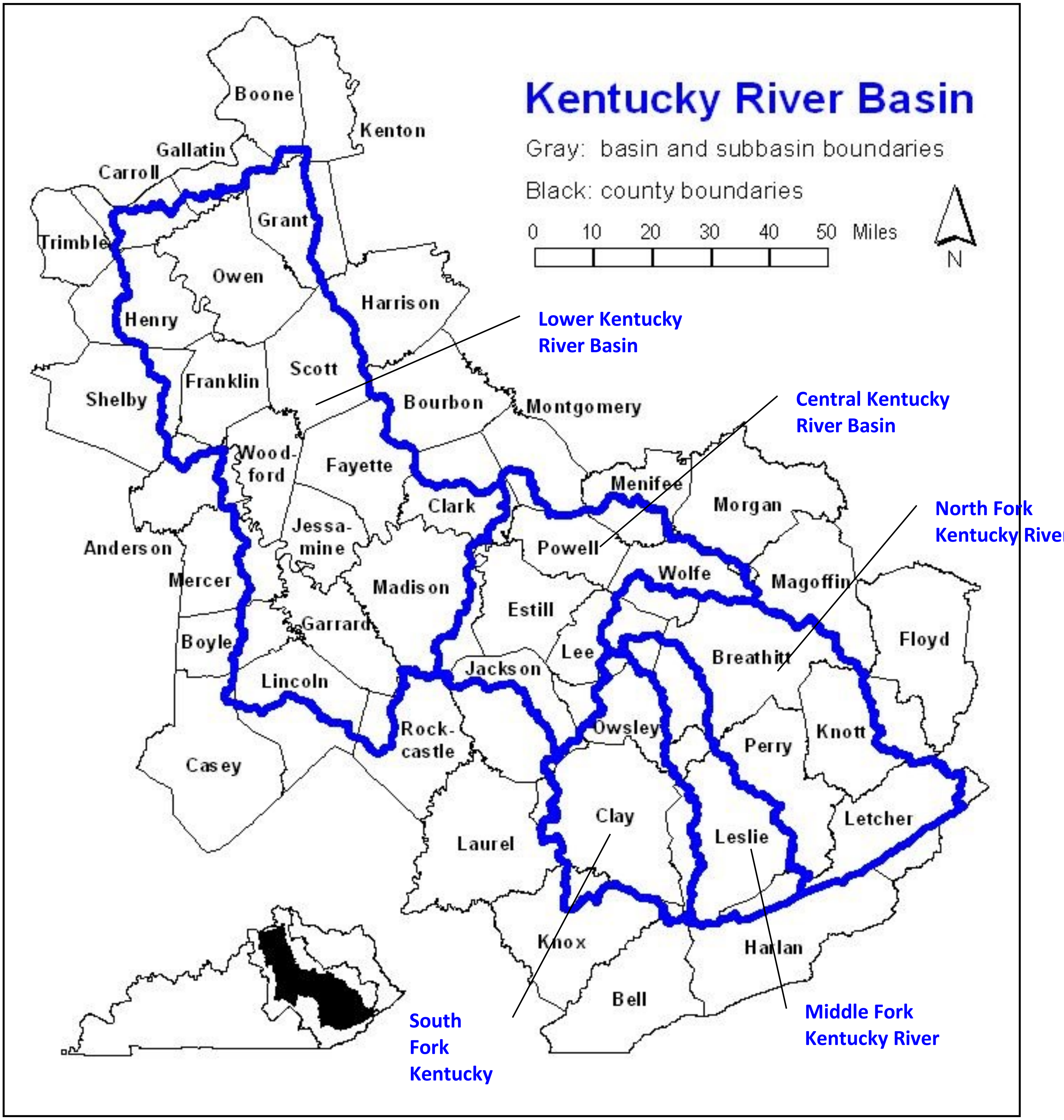


Figure 2—Kentucky River Northern Region

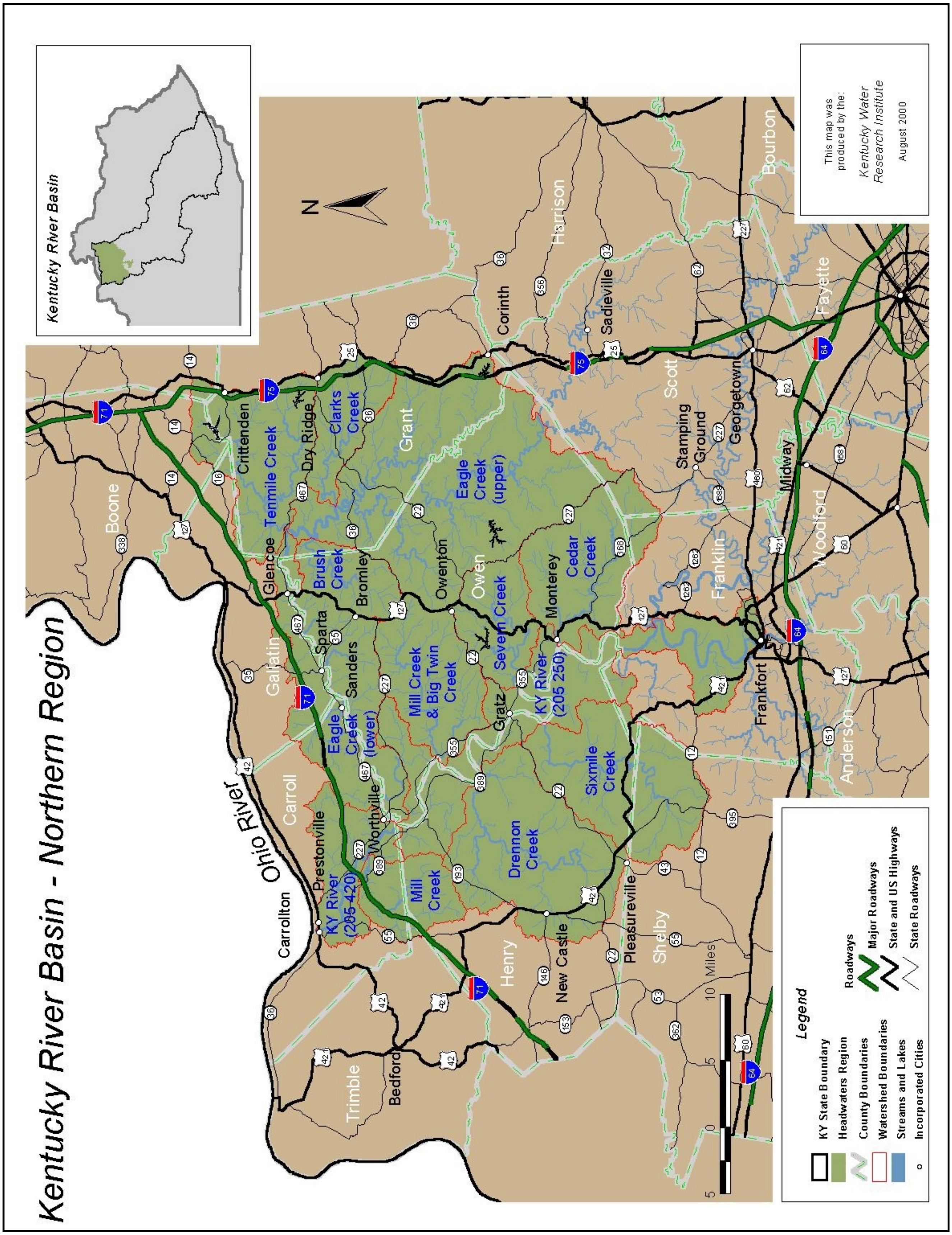


Figure 3—Kentucky River Central Region

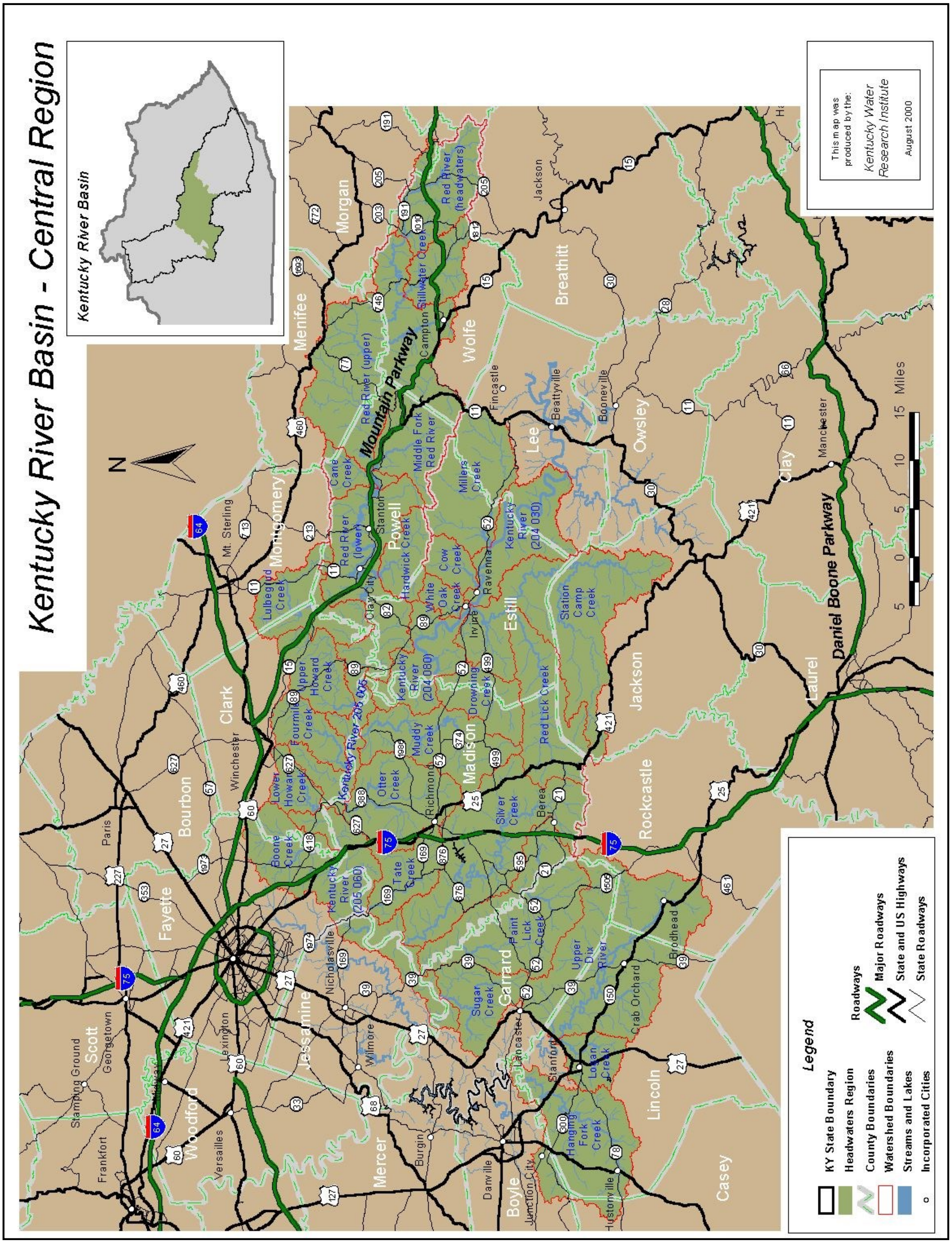


Figure 4—Kentucky River Southern Region

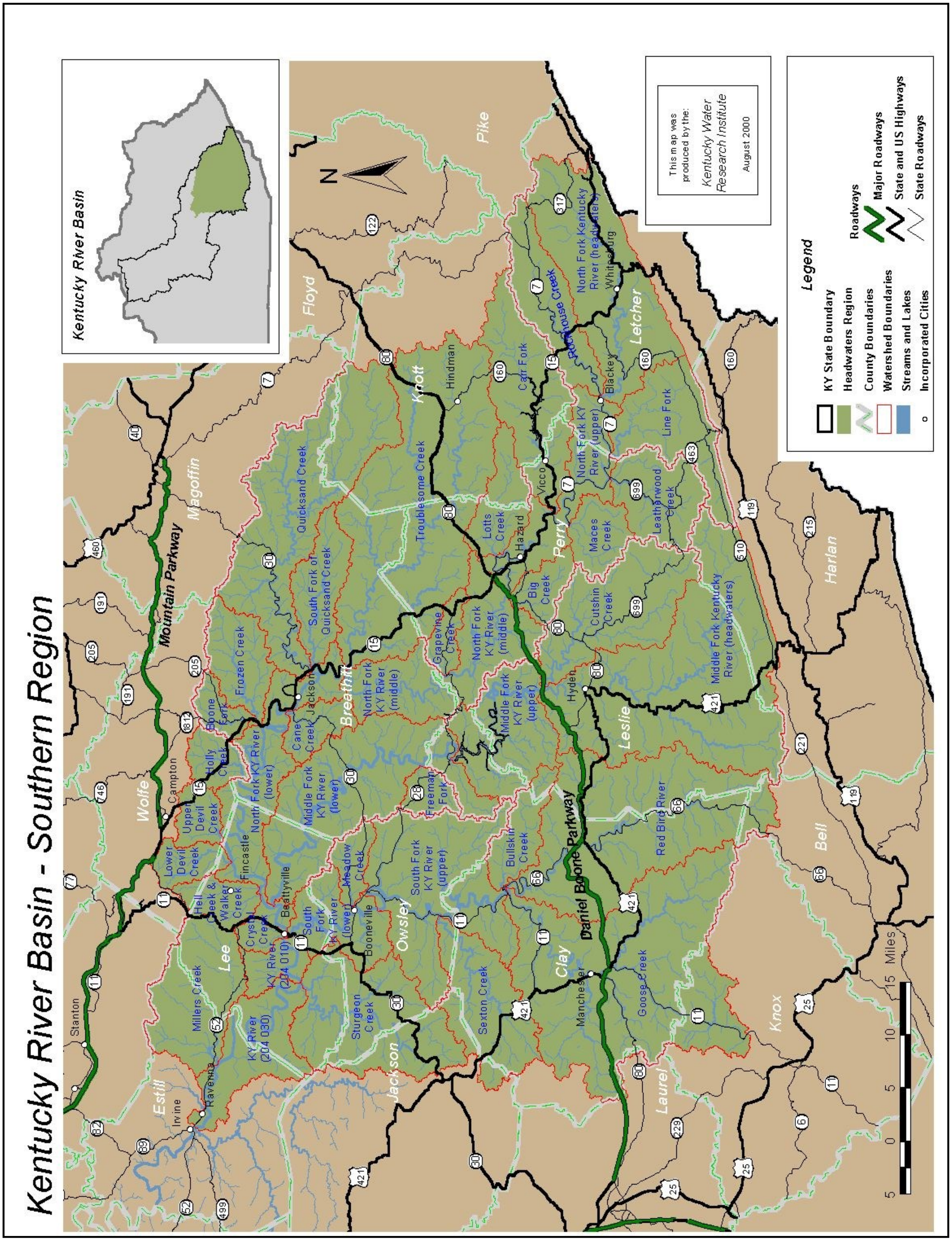


Figure 5
2016 Kentucky River Watershed Watch Sampling Sites

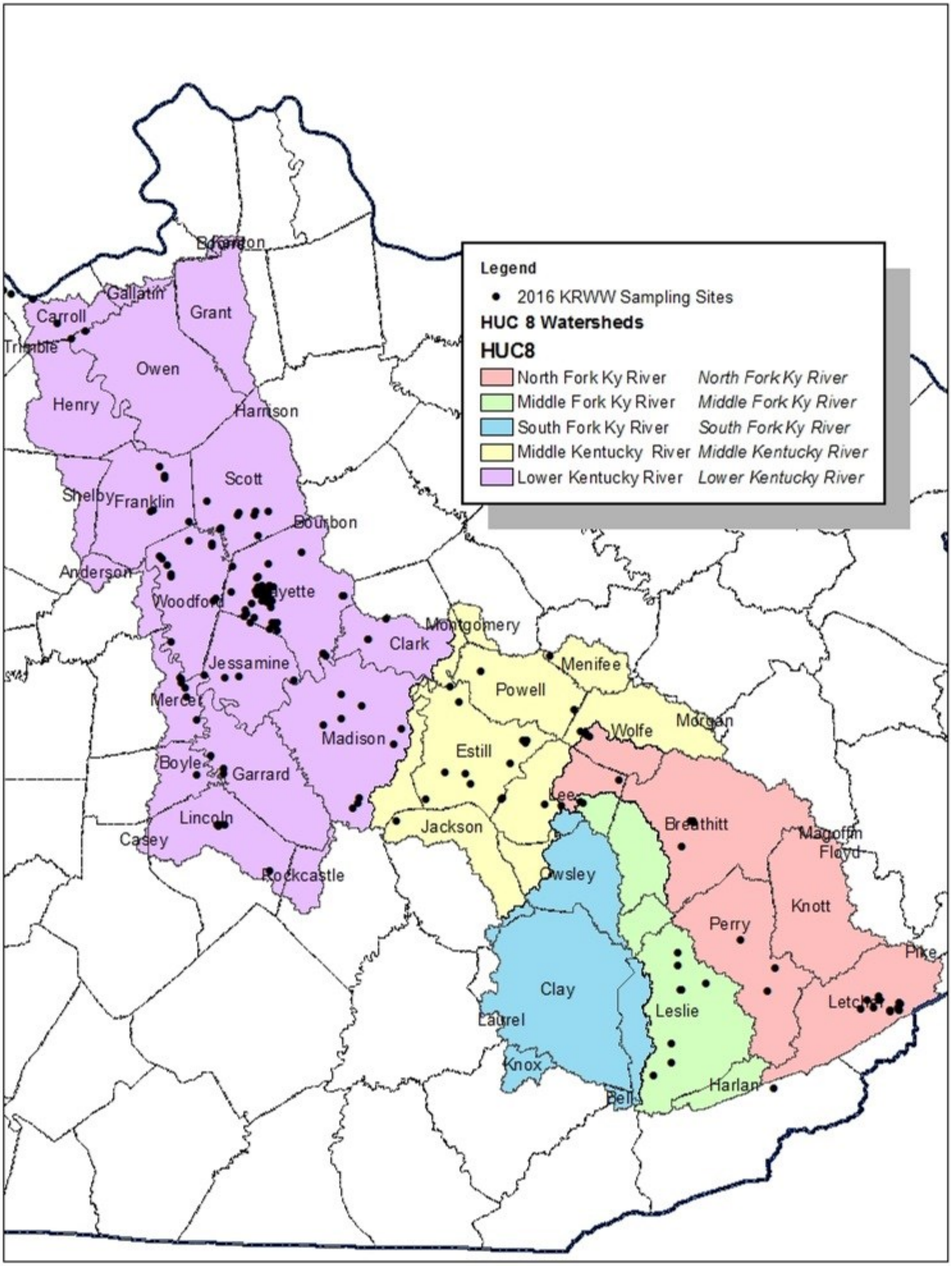


Figure 6

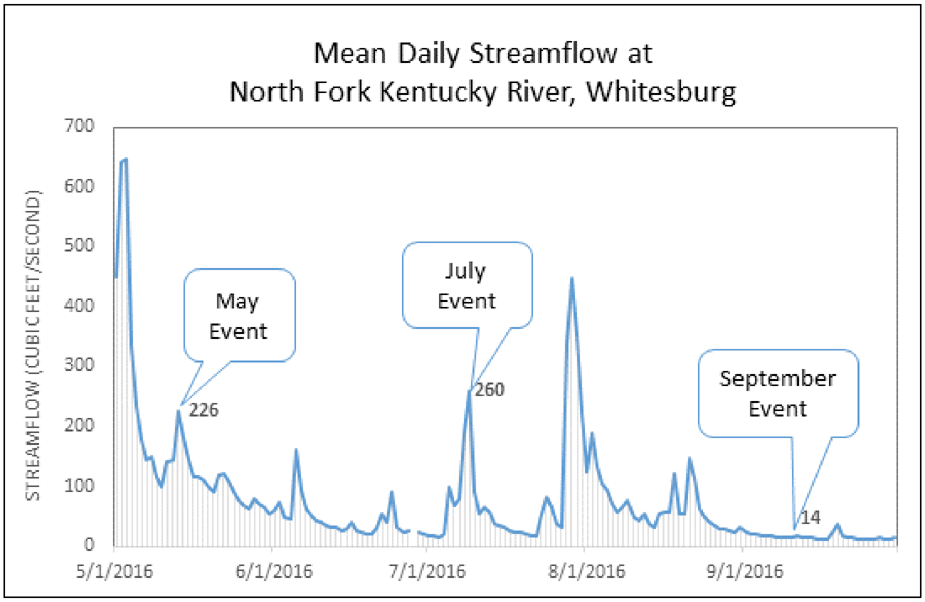


Figure 7

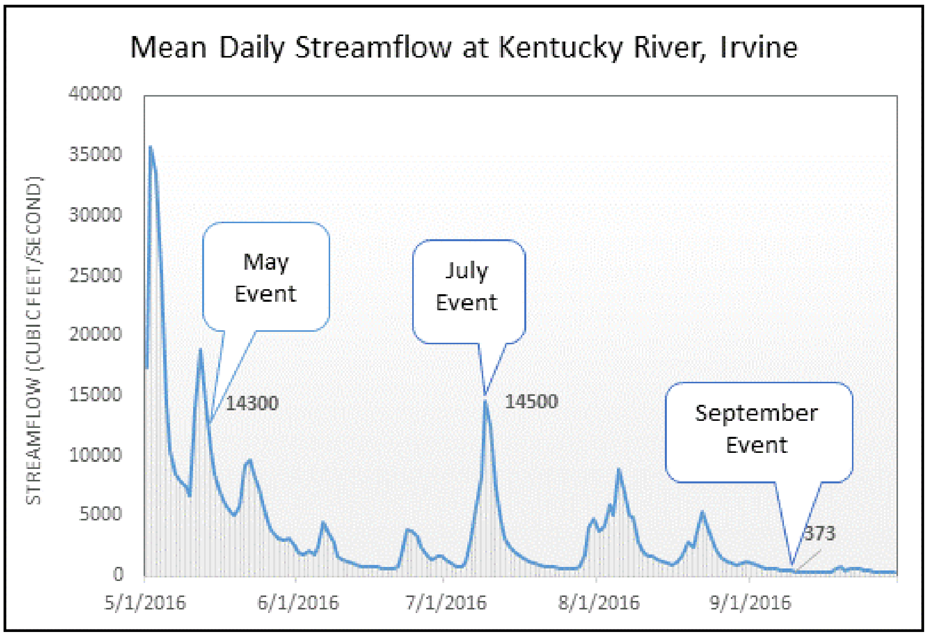


Figure 8

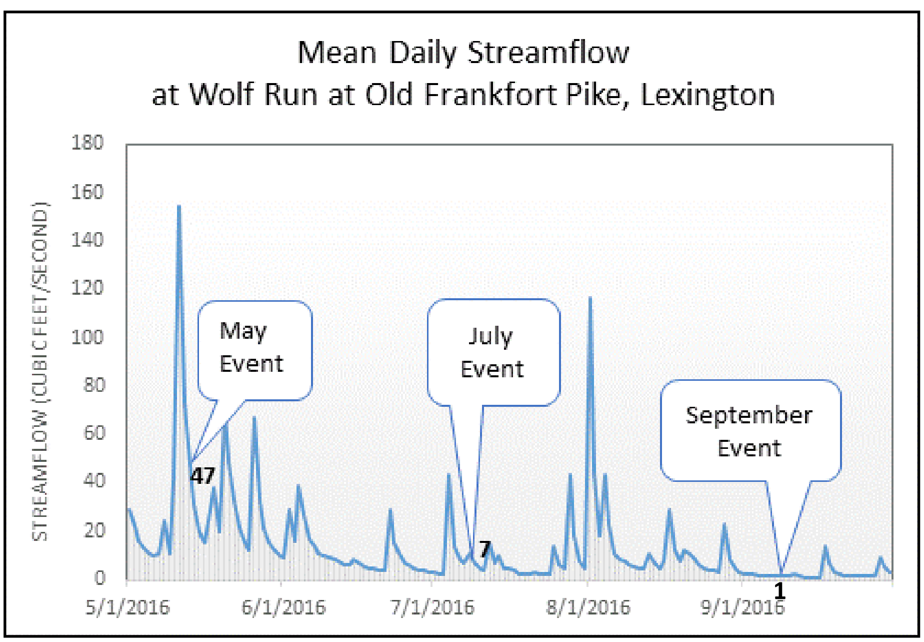


Figure 9

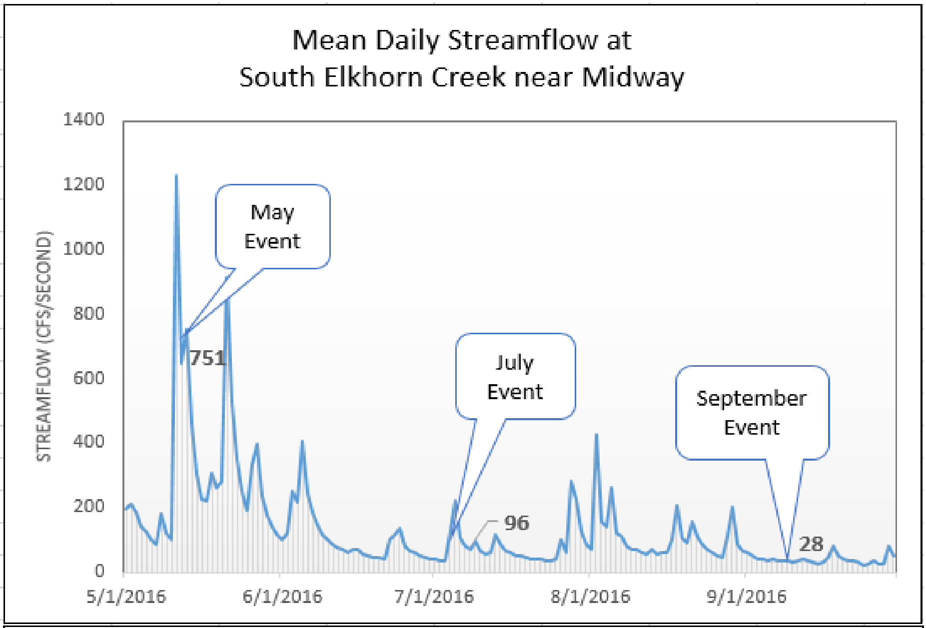


Figure 10

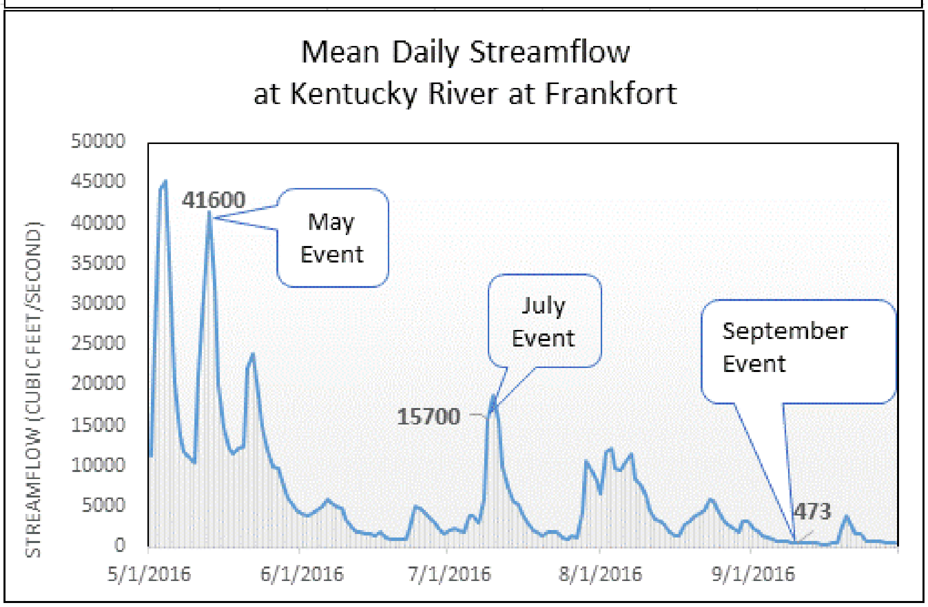


Figure 11

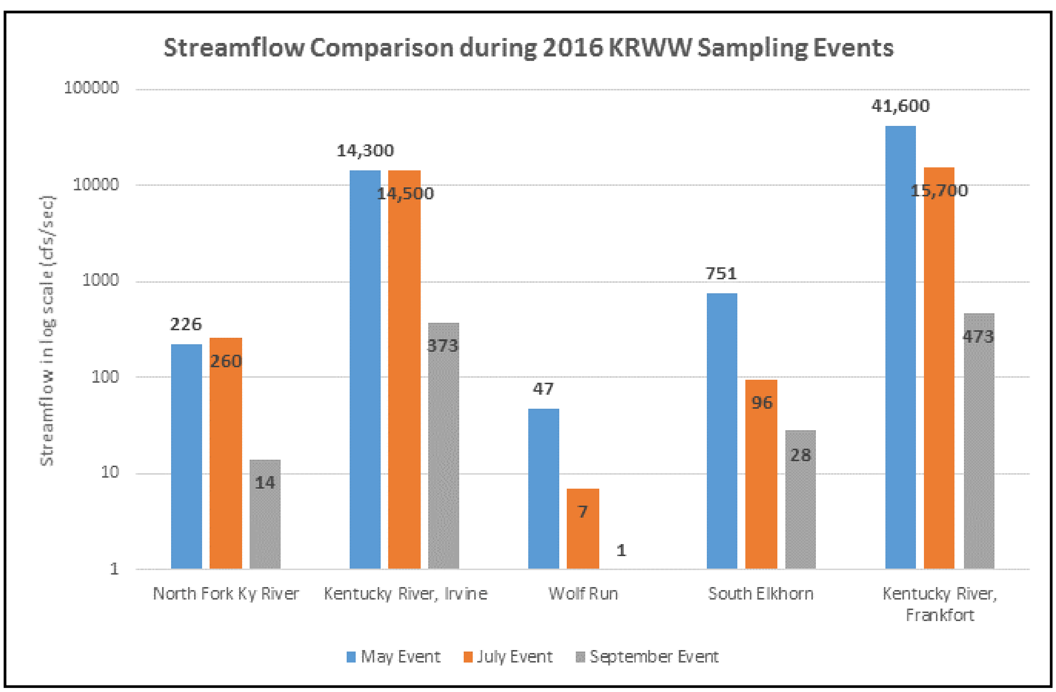


Figure 12
2016 KRWW Pathogen Sampling Results

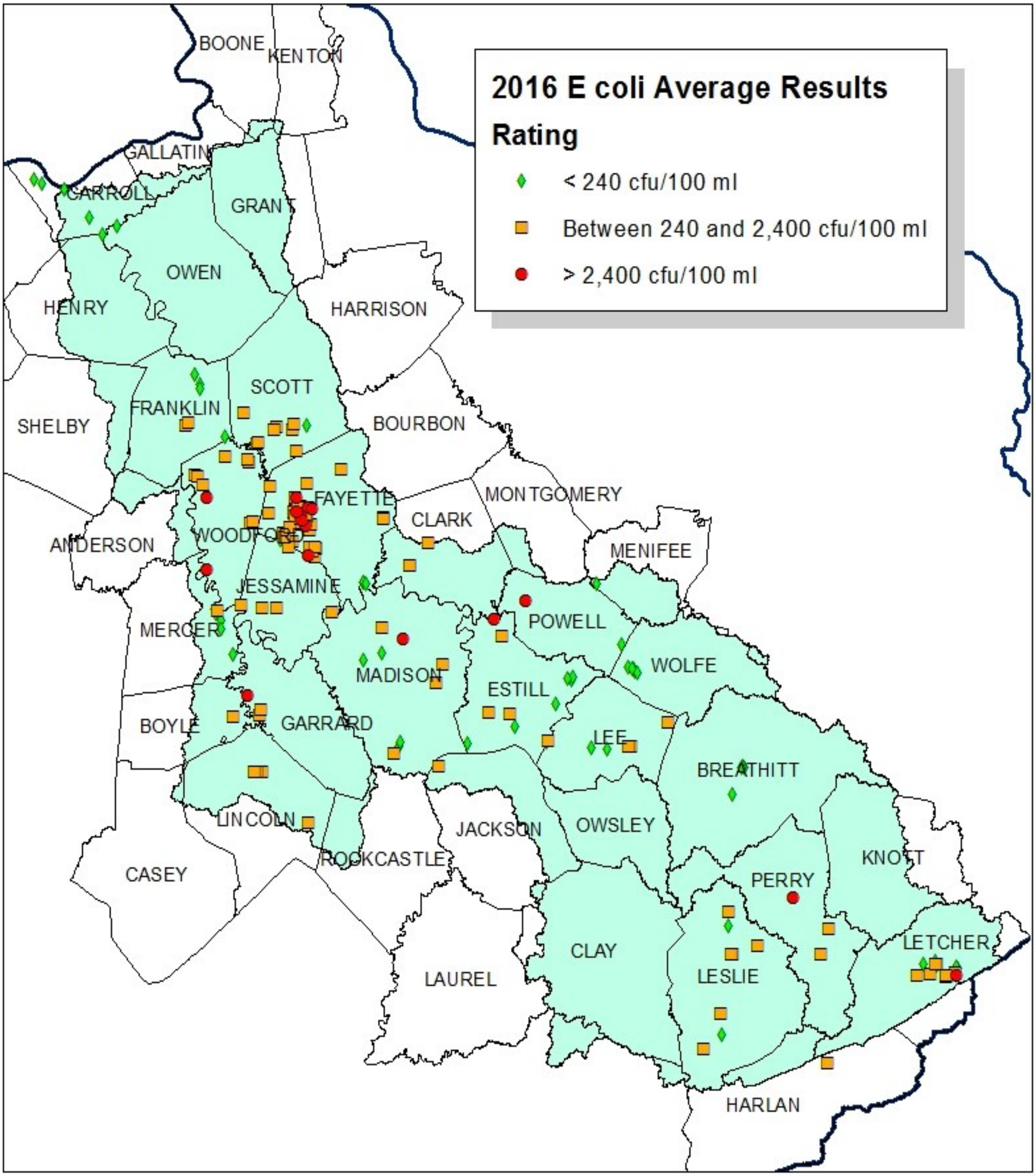


Figure 13
2016 KRWW Nitrogen Sampling Results

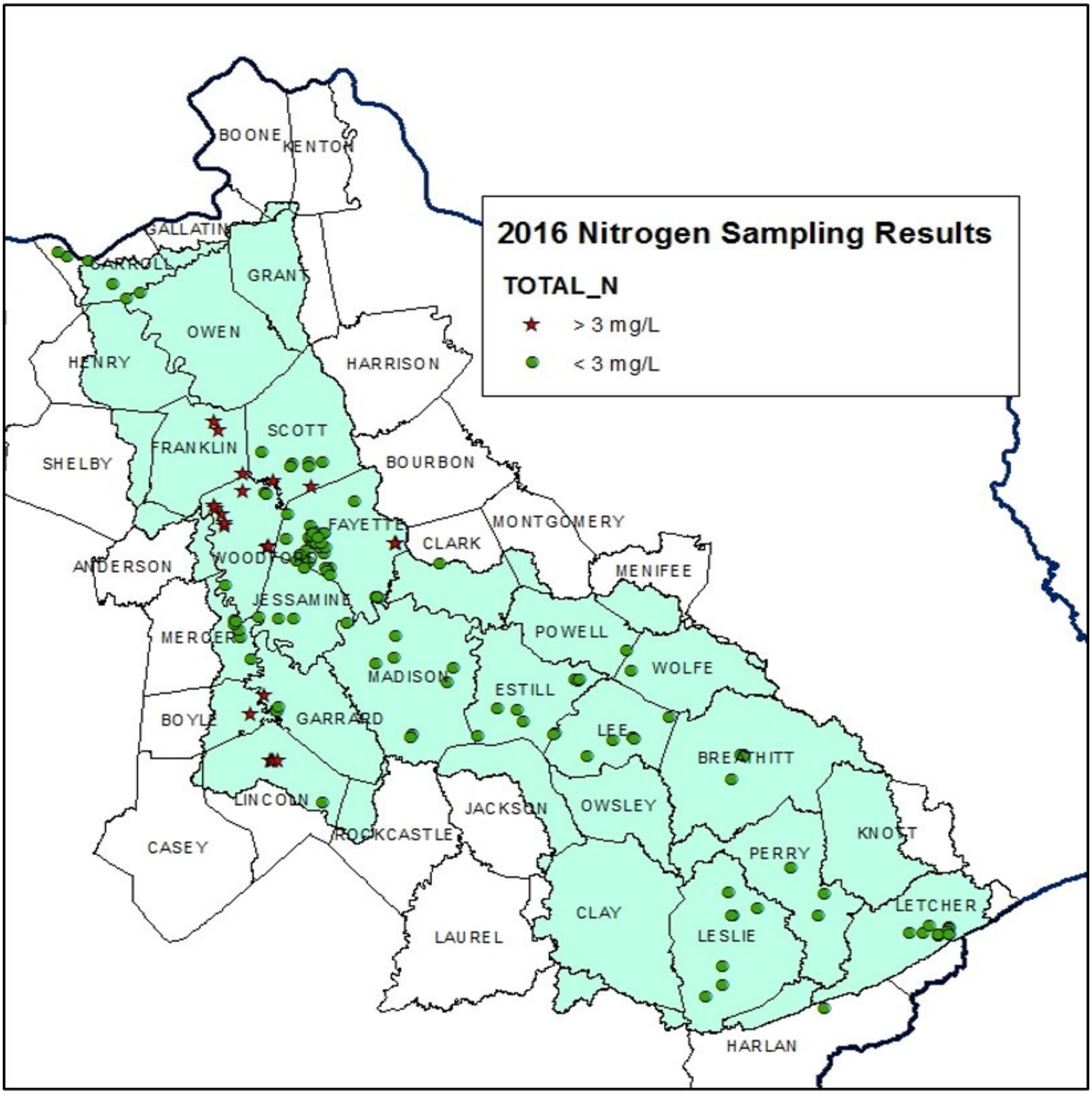


Figure 14
2016 KRWW Phosphorus Sampling Results

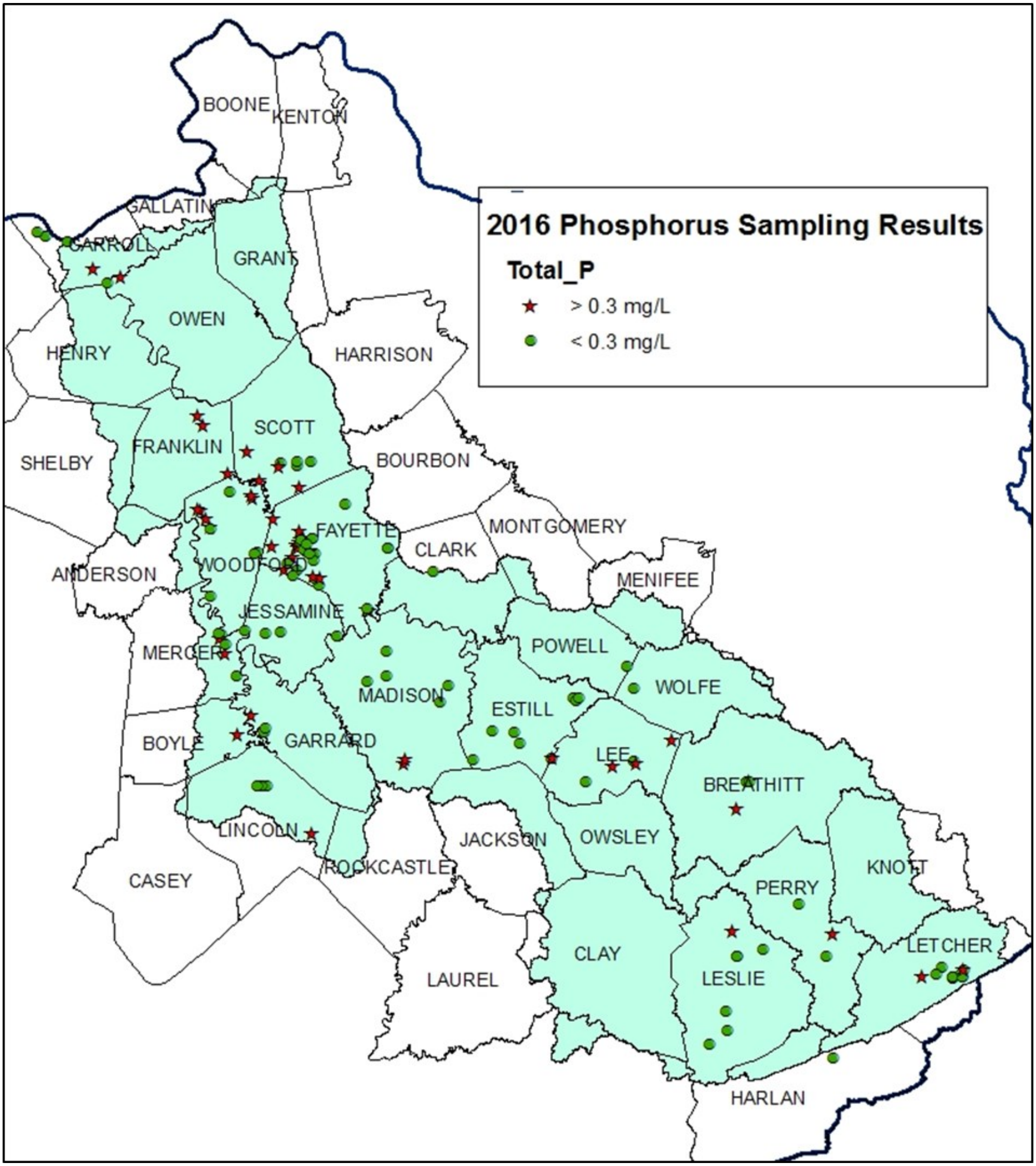


Figure 15
2016 KRWW Nutrient Sampling Results

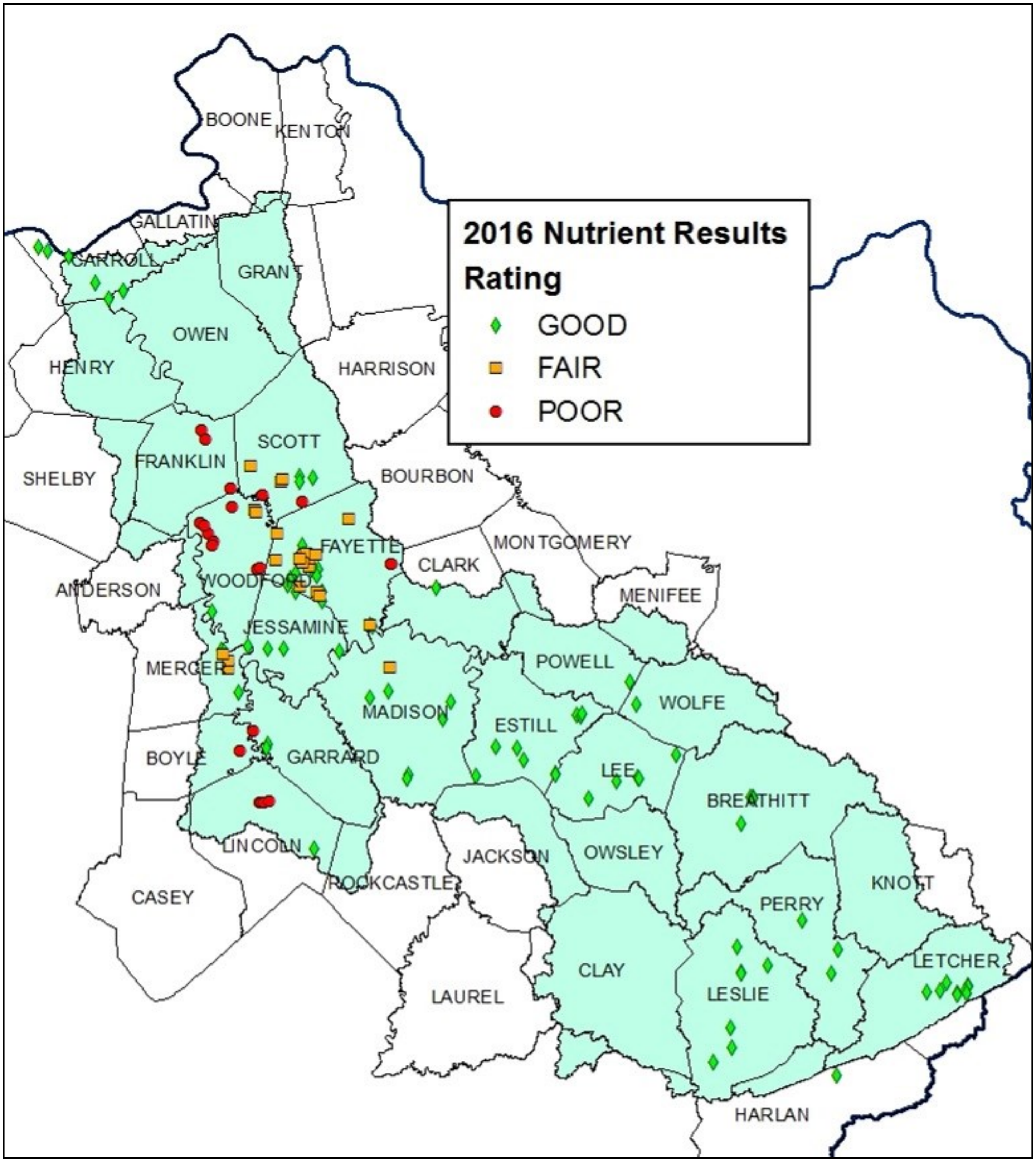
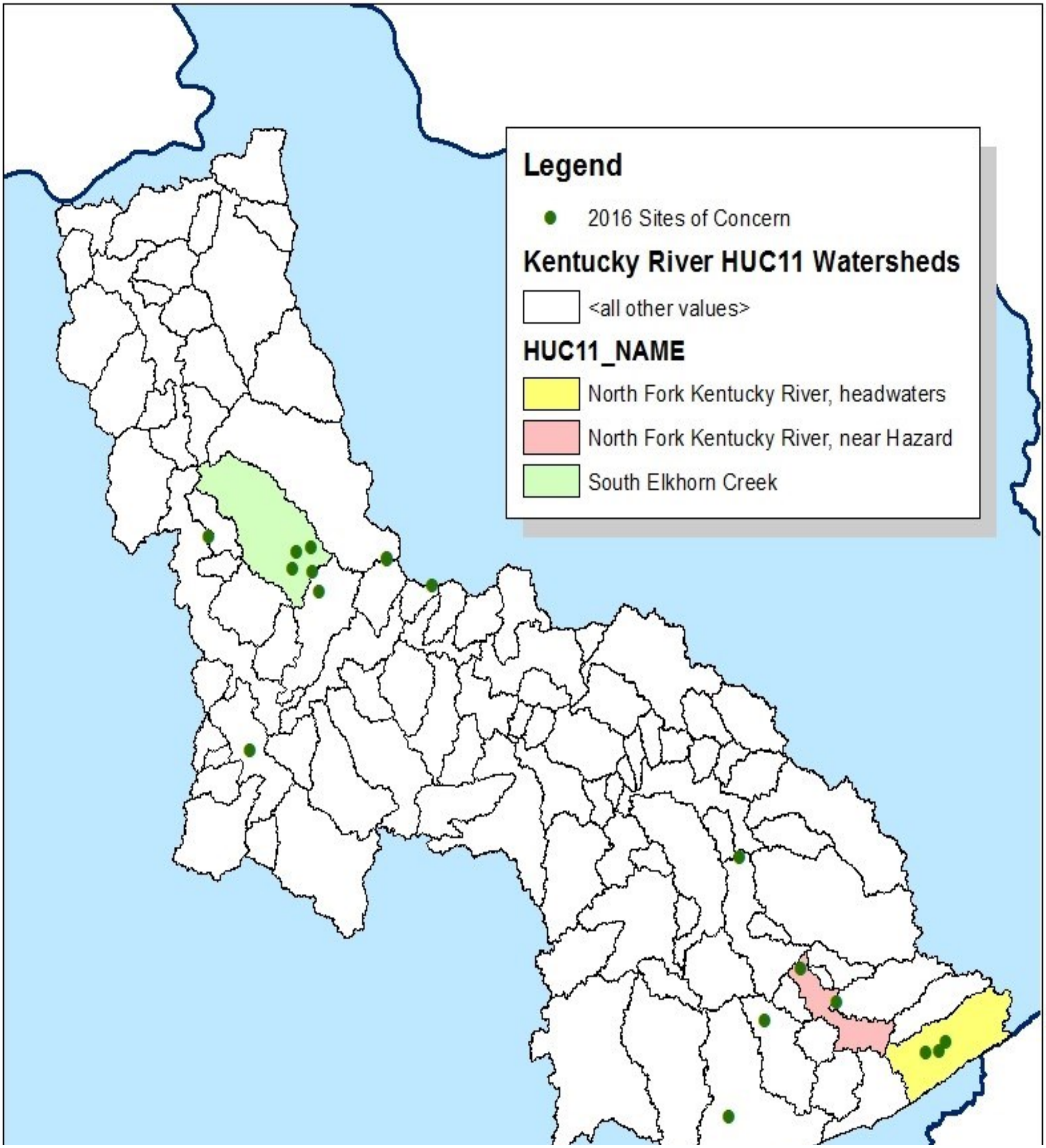


Figure 16
2016 KRWW Sampling Sites of Concern



APPENDIX B: TABLES

Table 2

2016 KRWW Field Sampling Results

NOTE: Values that exceed water quality standards or benchmarks are noted in ***bold*** *text.*

Site ID#	Stream	Sampling Date	Flow	Rainfall (inches)	Turbidity	Dissolved Oxygen (mg/L) *	pH	Temperature (°C)	Conductivity (microsiemens /cm)	Assessment R (red)=poor Y(yellow)=fair G(green)=good
Water Quality Standards						Aquatic Life > 5 mg/L	9-Jun	31.2?C	500 Us/cm	
741	Lees Branch	5/13/2016	4	>1.5	0	6.4	7.5	12	390	G
741	Lees Branch	7/8/2016	2	0.1	0	7.31	6.69	20.6	444	
741	Lees Branch	9/10/2016	2	0	0	6.01	7.35	22.3	456	
744	Cane Run	5/13/2016	4	0.5	1	8.5	7.75	18	460	Y
744	Cane Run	7/10/2016	3	1.5	0	6	8	19		
744	Cane Run	9/9/2016	2	0.1	0	**4.6**	8	25		
753	Clarks Run	9/9/2016	2	0	0		8	23	**650**	Y
755	North Elkhorn Creek	5/13/2016	5	0.5	1	7.4	7.75	18	450	G
755	North Elkhorn Creek	7/9/2016	4	1.5	0	7	7.75	23		
755	North Elkhorn Creek	9/9/2016	3	0.1	0	7.6	8	24		
756	Sandlick Creek	5/13/2016	4	0.1	3	7.8	7.4	19	**590**	R
756	Sandlick Creek	7/11/2016	3	0	0	**3.2**	7.2	18	**840**	
756	Sandlick Creek	9/9/2016	2	0	0	9	8.2	23	**970**	
763	South Elkhorn Creek	5/13/2016	4	1.5		5.2	7.7	12	390	Y
763	South Elkhorn Creek	7/7/2016	3	0.1	1	**4**	7.7	18	480	
763	South Elkhorn Creek	9/9/2016	2	0	0	5.2	7.4	19	**600**	
765	South Elkhorn Creek	5/16/2016	3	1	2	9	7.5	13	**600**	Y
765	South Elkhorn Creek	7/7/2016	3	0.5	2	6	7.5	20	**590**	
765	South Elkhorn Creek	9/12/2016	2	0.1	0	**4.5**	7.5	22	**800**	
767	Clear Creek	5/12/2016	5	>1.5	3	7.8	7.7	15	390	G
767	Clear Creek	7/9/2016		1	1	6.6	7.75	26	360	
767	Clear Creek	9/9/2016	3	0	0	6.8	8.5	23	80	
772	Unnamed Tributary	5/16/2016	3	1	0	10	8	15	410	G
772	Unnamed Tributary	7/7/2016	2	0.5		6.6	8	22	480	
772	Unnamed Tributary	9/12/2016	0							
786	Eagle Creek	9/9/2016	3	0.1	0	5.48	8.3	26.1	370	G
792	West Hickman Creek	5/14/2016	3	0.5	2	6.8	7.4	16	**640**	R
792	West Hickman Creek	7/9/2016	3	0.5	0	5.2	7.6	22.5	**520**	
792	West Hickman Creek	9/10/2016	2	0.1	1	**4.15**	7.7	22.5	**1780**	
793	McConnell Spring	5/14/2016			0	5.29	7	15.7	**710**	R
793	McConnell Spring	7/8/2016	2	0.5	0	**3**	6.5	18		
793	McConnell Spring	9/10/2016	3	0	0	**1.8**	6.5	18	**810**	
794	Town Branch	5/13/2016	4	1.5	0	8.84	7.5	14	**890**	R
794	Town Branch	7/8/2016	3	1	0	8.4	7.9	20	**1080**	
794	Town Branch	9/9/2016	1		0	7.9	7.8	20	**1160**	
796	Spring Station	7/8/2016	2	0.1	0	8.57	6.68	15.9	450	G
796	Spring Station	9/10/2016	2	0	0	7.14	7.09	18.7	398	
801	North Fork Kentucky River	9/10/2016	3	0	1	5.2	7.8	21	**800**	Y
802	Pine Creek	9/10/2016	3	0	0	**4.5**	7.8	19	**580**	Y
803	Cram Creek	9/10/2016	3	0	0	**4**	7.8	19	470	Y
810	South Elkhorn Creek	7/9/2016	2	0.5	0	6.6	7.6	23	**640**	Y
811	Steeles Branch	5/16/2016	3	0	1		8.24	15.63	376	G
811	Steeles Branch	7/8/2016	3	0.1	0					
811	Steeles Branch	9/9/2016	2	0	0					

Site ID#	Stream	Sampling Date	Flow	Rainfall (inches)	Turbidity	Dissolved Oxygen (mg/L) *	pH	Temperature (°C)	Conductivity (microsiemens/ cm)	Assessment R (red)=poor Y(yellow)=fair
815	Cane Creek	5/12/2016	4	1	1					G
820	North Fork Kentucky River	5/14/2016	4	0.5	2	8.4	7.5	14	450	
820	North Fork Kentucky River	7/9/2016	4	>1.5	3	6.4	7.5	19	380	Y
820	North Fork Kentucky River	9/10/2016	2	0	1	5.8	7.5	21	**950**	
823	Glenns Creek	7/9/2016	3	0.5	0		7.75	22		Y
823	Glenns Creek	9/12/2016	3		0	7.75	7.5	16	**690**	
827	Quicksand Creek	9/10/2016	2	0	0	7.8	7.7	23	**780**	Y
831	Lower Red River	5/12/2016	5	1	3	5.5	7	15	100	G
832	Red River	5/12/2016	5	1	3	6.25	7	15	100	G
833	Spring	9/12/2016	3		0	5	6.75		**560**	Y
848	North Fork Kentucky River	5/14/2016	4	0.5	2	7.9	7.5	12	**530**	Y
848	North Fork Kentucky River	9/10/2016	3	0	0	6.4	7.5	22	**720**	
850	Colley Creek	5/14/2016	4	0.5	1	8	7.5	12	460	Y
850	Colley Creek	9/10/2016	3	0	0	6.3	7.3	21	**640**	
861	Glenns Creek	7/9/2016	3	0.5	0		7.7	22		Y
861	Glenns Creek	9/12/2016	3		0	7.2	7.75	17	**650**	
869	Maces Creek	5/14/2016	3	0.5	1	9	7.5	6	280	
869	Maces Creek	7/11/2016	3	0.5	0					Y
869	Maces Creek	9/10/2016	2	0	0	5	8	20	**800**	
875	Right Fork Carr Creek	5/14/2016	4	0.5	1	8.8	7.5	11	**600**	
875	Right Fork Carr Creek	7/9/2016	4	>1.5	3	7.4	7.5	16	500	R
875	Right Fork Carr Creek	9/10/2016	2	0	1	6.4	7.5	20	**1200**	
891	North Elkhorn Creek	5/13/2016	4	0.5	2	7.8	7.25	17	430	
891	North Elkhorn Creek	7/9/2016	4	1.5	0	**4.6**	7.5	24		Y
891	North Elkhorn Creek	9/9/2016	3	0	1	10.4	8	25		
914	Holly Spring	5/16/2016	3	0.5		7.8	7	10.8	440	
914	Holly Spring	7/7/2016	3	1	0	7	7.5	15	**510**	Y
914	Holly Spring	9/9/2016	2	0	0	7.2	7	18	**560**	
915	Wolf Run	5/16/2016	3	1		10	8.5	12	**530**	
915	Wolf Run	7/7/2016	2	1	0	9.2	8.5	20	**650**	Y
915	Wolf Run	9/9/2016	2	0	0	6.6	8.5	23	**700**	
918	Muddy Creek	5/14/2016	4	1	2	7.6	7.9		320	
918	Muddy Creek	7/9/2016	4	>1.5	3	6.6	7.6	22.6	260	Y
918	Muddy Creek	9/10/2016	1	0	0	**2.9**	7.8	22	370	
921	Otter Creek	5/14/2016	4	1.5	2	6.2	7.6	10	490	G
942	Lower Howard Creek	5/14/2016	3	1	1	8	7.5	15	**540**	Y
943	Quicksand Creek	9/10/2016	2	0	0	7	7.4	23	**730**	Y
944	South Fork Quicksand Creek	9/10/2016	2	0	0	7.8	7.9	22	**880**	Y
954	Spring	7/9/2016		0.5	0		6.5	14		Y
954	Spring	9/12/2016	3	0	0	7.2	6.5	14	**670**	
955	Elk Lick Creek	7/8/2016	3		0	8	7.8	19	**780**	Y
955	Elk Lick Creek	9/12/2016	2	0.1	0	8.2	7.8	17	**690**	
978	Muddy Creek	5/14/2016	4	1.5	3	8	8.2		320	
978	Muddy Creek	7/9/2016	4	>1.5	3	6.8	7.5	22.6	250	G
978	Muddy Creek	9/10/2016	2	0	0		7.5	22.5	350	
982	Lanes Run	5/16/2016	4	0.1	0	9.2	8	14.5	**620**	
982	Lanes Run	7/9/2016	3	0.5	0	**4.5**	7.5	24	**570**	Y
982	Lanes Run	9/12/2016	2	0.1	0	6.4	7.5	22.5	**610**	
983	North Elkhorn Creek	5/14/2016	3		1	8	**4**	13.5	490	Y
983	North Elkhorn Creek	9/10/2016	2	0	0	7.5	7	16.5	**700**	
984	Twin Creek	5/12/2016	5	1	3	6	7.5	17	230	Y

Site ID#	Stream	Sampling Date	Flow	Rainfall (inches)	Turbidity	Dissolved Oxygen (mg/L) *	pH	Temperature (°C)	Conductivity (microsiemens/ cm)	Assessment R (red)=poor Y(yellow)=fair G(green)=good
990	Unnamed Tributary	5/14/2016	4	1.5	3	8.8	7.8		**550**	Y
990	Unnamed Tributary	9/10/2016	1	0	0	**3.2**	7.5	21.5	**570**	
1014	Elkhorn Creek	7/9/2016	3	0.1	2	5.9	7.9	24	**520**	Y
1014	Elkhorn Creek	9/9/2016	2	0	1	5.1	7.5	25	**510**	
1018	Penitentiary Branch	5/13/2016	4	1	1		7.5	14	**650**	Y
1023	Town Branch	5/16/2016	3	0	0	7	7.5	5	**880**	Y
1028	Wolf Run	5/16/2016	3	0	1			14		Y
1028	Wolf Run	8/7/2016	2	0.5	0	5.5	7.8	20.5		
1028	Wolf Run	9/10/2016				6.6	7	24	**770**	
1030	McKecknie Creek	5/13/2016	4	>1.5	2	8.1	7.5	15		Y
1030	McKecknie Creek	9/9/2016	1	0	1		7	19	**610**	
1048	Shannon Run	5/13/2016	4	1.5	2					G
1048	Shannon Run	7/11/2016	4	1	1	8.9	7.5	5	470	
1048	Shannon Run	9/10/2016	3	0	1	6.8	7	19	490	
1087	Unnamed Tributary	5/14/2016	3	0.5	0	7.6	7.6	14.5	**730**	R
1087	Unnamed Tributary	7/9/2016	2	0.5	2	6.7	7.8	19.5	**960**	
1087	Unnamed Tributary	9/10/2016	2	0.1	3	5.7	7.9	20.5	**1020**	
1124	Marble Creek	5/14/2016	4	1.5	0	8.4	7.4	16	460	G
1124	Marble Creek	7/9/2016	3	1	0	7.8	7.5	22	410	
1124	Marble Creek	9/10/2016	1	0	0	6.4	8	21	450	
1128	Cardinal Run	5/14/2016	4	1	2	8	7.5	15	**620**	Y
1128	Cardinal Run	7/9/2016	3	0.5	1	6.2	7.5	20	**620**	
1128	Cardinal Run	9/10/2016	2	0.1	0	**4.6**	7.5	22	**640**	
1129	Cardinal Run	5/14/2016	3	1	0	6.1	7.3	13	**560**	Y
1129	Cardinal Run	7/9/2016	3	0.5	0	5.4	7.5	15	**590**	
1129	Cardinal Run	9/10/2016	3	0	0	5.6	8	18	**570**	
1132	Wolf Run	5/14/2016	3	1	0	8	7.5	14.5	**600**	Y
1132	Wolf Run	7/9/2016	3	0.5	0	7.2	7.5	23	460	
1132	Wolf Run	9/10/2016	2	0.1	0	6.2	7.5	22	**590**	
1133	Wolf Run	5/13/2016	2	0.5	0	7.6	7.25	19	**660**	Y
1133	Wolf Run	7/8/2016	2	0.5	0	7.39	7.4	22.5	**710**	
1133	Wolf Run	9/10/2016	2	0	1	**3.4**	7.5	22	380	
1134	Spring Branch	5/14/2016	4	0.1	0	7.5	7.1	14		G
1134	Spring Branch	7/9/2016	3	0.1	0	7.6	7.8	17.5		
1134	Spring Branch	9/9/2016	2	0	0					
1135	Wolf Run	7/9/2016	2	0.1	0	6.2	7.5	19.5		G
1135	Wolf Run	9/9/2016	2	0	0					
1137	Vaughns Branch	5/14/2016	4	1	0	8.4	7.5	14.5	**710**	Y
1137	Vaughns Branch	7/9/2016	2	0.5	1	6.4	7.5	23	480	
1137	Vaughns Branch	9/10/2016	2	0.1	0	5.6	7.5	22	**740**	
1138	Vaughns Branch	5/16/2016	2	1	0	11.8	7.5	10	450	Y
1138	Vaughns Branch	7/7/2016	2	1	0	6.8	7.5	21	**540**	
1138	Vaughns Branch	9/9/2016	1	0	0	5.8	7.5	25	**580**	
1139	Vaughns Branch	5/16/2016	2	0.1	1	7.4	7.25	11.6	**740**	Y
1139	Vaughns Branch	7/8/2016	2	0.1	0					
1139	Vaughns Branch	9/12/2016	2	0.1	2	**3.4**	7	19	**680**	
1143	Dry Fork	5/13/2016	4	0.1	1	9.6	7.5	21	**600**	R
1143	Dry Fork	7/11/2016	3	0	0	5	7	20		
1143	Dry Fork	9/9/2016	3	0	0	9.2	8	22	**1200**	
1151	Cram Creek	9/10/2016	3	0	0	6.9	7	19	**520**	Y

Site ID#	Stream	Sampling Date	Flow	Rainfall (inches)	Turbidity	Dissolved Oxygen (mg/L) *	pH	Temperature (°C)	Conductivity (microsiemens/ cm)	Assessment R (red)=poor Y(yellow)=fair G(green)=good
1152	Cram Creek	9/10/2016	3	0	0	5.6	7.4	19	380	G
1174	Royal Springs	5/13/2016	4	0.5	1	6	7.5	15	470	G
1174	Royal Springs	7/9/2016		1.5						
1174	Royal Springs	9/9/2016	2	0	0	6.6	7	24		
1184	Spring Branch	5/16/2016	3	0	0		7.4	16.17	**584**	Y
1184	Spring Branch	7/8/2016	2	0.1	0					
1185	North Fork Kentucky River	5/14/2016	4	0.5	2	7.7	7.5	13	**540**	Y
1185	North Fork Kentucky River	9/10/2016	3	0	0	6.4	7.5	21	**750**	
1191	Kentucky River	9/10/2016	3	0.1	0	10	7.5	27	**570**	Y
1195	Lees Branch	5/13/2016	4	>1.5	0	6.4	7.5	16	350	Y
1195	Lees Branch	7/8/2016	1	0.1	0	**2.71**	6.51	22	423	
1195	Lees Branch	9/10/2016	1	0	0	**4.26**	7.25	25	393	
1199	Vaughns Branch	5/16/2016	1	0	0		**9.5**	15	**1290**	R
1199	Vaughns Branch	7/11/2016	3	0	0	7	8	21	**1050**	
1199	Vaughns Branch	9/12/2016	0	0.1	0					
1209	Sandlick Creek	5/13/2016	3	0.1	0	9.8	**4.6**	19	**1110**	R
1221	Cane Run	5/13/2016	4	0.5	1	8.9	8	18	450	G
1221	Cane Run	7/9/2016	3	1.5	0	10	8	23		
1221	Cane Run	9/9/2016	2	0		8	7.75	23		
1242	Dry Fork	5/13/2016	4	0.1	1	10	7.5	22	**1090**	R
1243	Long Branch	5/13/2016	4	0.1	0	9.8	**4.5**	23	**1660**	R
1243	Long Branch	7/11/2016	3	0	0	7	**4.5**	20		
1243	Long Branch	9/9/2016	2	0	0	7.2	**4**	26	**1440**	
1270	Unnamed Tributary	5/13/2016	4	>1.5	2	8.1	7	15	440	G
1270	Unnamed Tributary	7/8/2016	3	1	1	6	7	20	400	
1270	Unnamed Tributary	9/9/2016	2	0	0	5.1	7.5	19.5	440	
1271	Herrington Lake	5/13/2016	4	1.5	1	11	8.2	20	260	G
1271	Herrington Lake	9/10/2016	3	0.1	1	7.5	8.2	28	300	
1274	Elk Lick Creek	7/8/2016	3	0.1	0		7.8	21	**530**	Y
1274	Elk Lick Creek	9/12/2016	2	0.1	0	8.2	7.8	18	**850**	
1275	Unnamed Tributary	7/9/2016	2	0.5	0	6.4	7.7	22	**810**	Y
1276	West Hickman Creek	7/9/2016	3	0.5	1	5.4	7.2	22.5	480	Y
1276	West Hickman Creek	9/10/2016	2	0.1	0	5.2	7.5	22	**740**	
1278	Kentucky River	7/9/2016	4	>1.5	3	7.4	7.8	23	430	Y
1278	Kentucky River	9/12/2016	2	0	1		7.9	17	**550**	
1287	Kentucky River	5/13/2016	5	>1.5	3	8	7.5		260	Y
1287	Kentucky River	7/9/2016	4	1.5	3	7	7.5	25	410	
1287	Kentucky River	9/9/2016	2	0.1	1	5.8	8	28	**570**	
1301	North Elkhorn Creek	5/16/2016	4	0.1	1	7.4	7.8	12	460	R
1301	North Elkhorn Creek	7/9/2016	3	0.1	1	**4.4**	7.8	22	**560**	
1301	North Elkhorn Creek	9/10/2016	2	0	1	**4.2**	8	21	**560**	
1307	Jessamine Creek	5/16/2016	3	0	0		7.8	13	480	Y
1307	Jessamine Creek	7/9/2016	2	0.5	0	6.6	7.5	24	**540**	
1307	Jessamine Creek	9/9/2016	2	0	0	**3.6**	7.5	24	**590**	
1314	Wolf Run	5/13/2016		0.5	0	9.6	7.5	16	**550**	Y
1314	Wolf Run	7/8/2016	3	0.5	0	7.2	7.5	21	**660**	
1314	Wolf Run	9/9/2016	2							
2924	Tates Creek	9/10/2016	1	0	0	2.1	6.9	20.5	67	G
2954	St. Asaph's Creek	5/13/2016	4	>1.5	1	8.1	6.5	14	240	G
2954	St. Asaph's Creek	7/8/2016	3	1	0	7.6	6.5	18	280	
2954	St. Asaph's Creek	9/9/2016	2	0	0	5.8	6.5	17	330	

Site ID#	Stream	Sampling Date	Flow	Rainfall (inches)	Turbidity	Dissolved Oxygen (mg/L) *	pH	Temperature (°C)	Conductivity (microsiemens/ cm)	Assessment R (red)=poor Y(yellow)=fair G(green)=good
2970	Prestons Cave Spring	5/14/2016	3		1	6.65	7	15.8	**750**	
2970	Prestons Cave Spring	7/8/2016	3	0.1	0					Y
2970	Prestons Cave Spring	9/10/2016	3	0	0	5.4	6.8	18	**800**	
3005	McConnell Branch	5/16/2016	2	0	1	6.8	7	10	**730**	
3005	McConnell Branch	7/11/2016	1	0	2	**2.7**	7	20	**700**	Y
3005	McConnell Branch	9/12/2016	0	0.1						
3006	Lower Howard Creek	5/14/2016	3	1	1	8	7.5	15	**540**	y
3010	Town Branch	5/13/2016	4	1	0	8.4	7.4	14	**810**	
3010	Town Branch	7/8/2016	3	1	0	12	7.5	22	**1090**	R
3010	Town Branch	9/9/2016	1	0	0	9	7.5	20	**1160**	
3013	Shannon Run	5/13/2016	4	1.5	2					
3013	Shannon Run	7/11/2016	4	1	1	9	7.5	5	480	G
3013	Shannon Run	9/10/2016	3	0	1	6.7	7	20	490	
3059	Gardenside Branch	5/14/2016	3	1	0	6.7	7	12	490	
3059	Gardenside Branch	7/9/2016	3	0.5	0	5.9	7	18	**570**	R
3059	Gardenside Branch	9/10/2016	1	0	0	**1.9**	7.5	20	**680**	
3060	Vaughns Branch	5/13/2016	3	1	0	7.3	8	18	**677**	
3060	Vaughns Branch	7/8/2016	3	0.1	0					Y
3060	Vaughns Branch	9/12/2016	2	0.1	0	5.9	7.9	18	**600**	
3085	St Clair Spring	5/16/2016	1	0	1	6.5	6.9	15		G
3128	Unnamed Tributary	7/8/2016	3	0.1	0	**4**	8	22	**630**	R
3128	Unnamed Tributary	9/9/2016	2	0	0	**4.2**	8	22	**730**	
3137	Wolf Run	5/14/2016	3		1	8	8	17	**860**	
3137	Wolf Run	7/8/2016	2	0.1	0					R
3137	Wolf Run	9/12/2016	2	0.1	0	5.7	7.25	19	**1120**	
3172	Tates Creek	9/10/2016	3	0	0	5.8	6.9	22	**625**	Y
3180	Spring	5/13/2016	4	1	0		8	15	410	Y
3180	Spring	7/7/2016	4	0.5	0	6.8	7.5	18	**690**	
3203	Evans Branch	7/8/2016	3	0.1	0		7.8	19	**1150**	Y
3203	Evans Branch	9/12/2016	2	0.1	0	7.6	7.5	17.5	**560**	
3211	Silver Creek	9/10/2016	3	0	0	5	8.5	22	450	G
3214	Glenns Creek	5/14/2016	4	0.1	1		7.8	15	**520**	
3214	Glenns Creek	7/9/2016	4	0.1	0	5	8.4	26	**610**	Y
3214	Glenns Creek	9/9/2016	2	0	0	3	8.2	23	**680**	
3216	Unnamed Tributary	5/16/2016	3	0	0	5	8	10	**770**	R
3216	Unnamed Tributary	9/9/2016	2	0	1	**3.6**	7.75	22	**620**	
3222	Unnamed Tributary	5/15/2016	3	0.1	1	9.4	7.25	10	110	G
3222	Unnamed Tributary	7/9/2016	4	>1.5	1	7.8	7	18	110	
3223	Unnamed Tributary	5/15/2016	3	0.1	1	9.6	7	10	70	G
3223	Unnamed Tributary	7/9/2016	4	>1.5	1	7.8	7	20	80	
3224	Middle Fork Lower Devil Creek	5/15/2016	3	0.1	1	9.8	7.25	10	80	G
3224	Middle Fork Lower Devil Creek	7/9/2016	4	>1.5	1	7.8	7	20	90	
3225	Middle Fork Lower Devil Creek	5/15/2016	3	0.1	1	9.6	7.3	10	130	G
3225	Middle Fork Lower Devil Creek	7/9/2016	4	>1.5	1	7.8	7.5	20	180	
3227	Whittleton Branch	7/9/2016	3	1.5	0	7	7.5	17	160	G
3227	Whittleton Branch	9/12/2016	2	0.1	0		4.5	18.5	150	
3230	South Elkhorn Creek	5/14/2016	4	1	1	8.3	7.5	15	490	Y
3230	South Elkhorn Creek	9/9/2016	2	0.1	1	4.8	7.6	24	**710**	
3252	South Elkhorn Creek	5/13/2016		1.5		6.4	7.5	11	270	
3252	South Elkhorn Creek	7/7/2016	3	0.1	0	6.4	7.5	15	320	Y
3252	South Elkhorn Creek	9/9/2016	2	0	0	**4**	7.7	18	500	
3271	North Fork Kentucky River	9/10/2016	3	0	0	10	7.1	14	**1060**	R
3282	Elkhorn Creek	5/16/2016	3	0	2	8	8	13	480	G
3282	Elkhorn Creek	9/9/2016	3	0	0					

Site ID#	Stream	Sampling Date	Flow	Rainfall (inches)	Turbidity	Dissolved Oxygen (mg/L) *	pH	Temperature (°C)	Conductivity (microsiemens/ cm)	Assessment R (red)=poor Y(yellow)=fair G(green)=good
3283	Lower Howard Creek	5/14/2016	3	0.1	0	5.5	7.5	13	**710**	R
3283	Lower Howard Creek	7/9/2016	4	>1.5	0	7.8	7.5	20	**660**	
3283	Lower Howard Creek	9/9/2016	1	0	0		8	20	**1320**	
3298	Red Lick Creek	9/9/2016	2		2	5.2	7.4	25	350	G
3299	Locust Branch	9/9/2016	2	0	0	7	7.8	21	420	G
3300	Ross Creek	7/9/2016	4		1	6	7.5	18	190	G
3300	Ross Creek	9/9/2016	1	0	0	10	7.5	18	270	
3343	Buck Lick Branch	7/9/2016	4	1.5	1	10	8	18	260	
3343	Buck Lick Branch	9/9/2016	2	0		5	7.5	18	330	G
3349	Waterside Lake	9/9/2016	1	0	1	7.5	7.5	28	330	G
3350	Town Creek	5/16/2016	3	0	0		7.3	13		Y
3350	Town Creek	7/9/2016	3	0.5	0	7.2	7.4	19	**650**	
3350	Town Creek	9/9/2016	2	0	0	**3.4**	7.3	23	**540**	
3353	Fairchild Branch	5/13/2016	4	0.1	0	5	7.9	25	**540**	Y
3363	Silver Creek	9/12/2016	2	0	0		8.5	17	480	G
3366	Hill & Dale Kids Creek	5/14/2016	4		1	8	7.5	15	240	Y
3366	Hill & Dale Kids Creek	7/8/2016	2	0.5	0	8.15	7.1	23.7	**630**	
3366	Hill & Dale Kids Creek	9/10/2016	0	0						
3369	Kentucky River	5/16/2016	4	1	3	8.68	7.74	17.2	310	G
3369	Kentucky River	9/8/2016	3	0	0	7.44	8.65	28.3	350	
3370	Notch Lick	5/12/2016	3	1	1	8	8.2	15	**610**	R
3370	Notch Lick	9/9/2016	1		1	**2.8**	7.6	22	**650**	
3371	Locust Creek	5/12/2016	3	1	2	7.4	8.3	16	**550**	Y
3371	Locust Creek	9/9/2016	1		0	9	7.8	23	**540**	
3373	Kentucky River	5/16/2016	4	1	3	8.6	7.89	17.2	330	G
3373	Kentucky River	9/8/2016	3	0	0	6.13	8.39	27.1	340	
3390	Wildcat Chase	5/16/2016	3	0.1	1	9	7.7	13	**1000**	R
3390	Wildcat Chase	7/8/2016	3	0.5	0	7	7.6	23	**930**	
3390	Wildcat Chase	9/9/2016	2	0	1	7.4	7.7	21	**970**	
3397	Middle Fork Kentucky River	7/8/2016	3	1	2	7	7.5	21	200	Y
3397	Middle Fork Kentucky River	9/9/2016	2	0	0	6.5	8	24	**730**	
3398	Rockhouse Creek	7/8/2016	3	1	2	7	7.5	20	150	G
3398	Rockhouse Creek	9/9/2016	2	0	0	6.5	7.5	23	440	
3400	Bull Creek	9/9/2016	1	0	0	8.5	7.4	19	350	G
3401	Cutshin Creek	7/8/2016	3	1	0	7	7.5	23	**540**	R
3401	Cutshin Creek	9/9/2016	2	0	0	6	8	25	**1410**	
3402	Middle Fork Kentucky River	7/8/2016		>1.5	1	7	7	17	50	G
3402	Middle Fork Kentucky River	9/9/2016	2	0	0	7	7	18	220	
3403	Middle Fork Kentucky River	7/8/2016	4	>1.5	1	9	7	18	320	Y
3403	Middle Fork Kentucky River	9/9/2016	2	0	0	7	7.5	19	**730**	
3405	Beech Fork	7/8/2016	4	>1.5	1	7.5	7.6	18	410	R
3405	Beech Fork	9/9/2016	2	0	0	8	7.4	16	**1100**	
3407	Ohio River	9/9/2016	3	0.1	1	**4.2**	7.8	25	450	Y
3410	South Elkhorn Creek	5/16/2016	4	0	2	7.4	7.8	14	500	G
3410	South Elkhorn Creek	9/10/2016	2	0.1	0	5	8	24	470	
3434	Unnamed Tributary	7/9/2016	4	1.5	1	8	7.5	18	260	G
3434	Unnamed Tributary	9/9/2016		0	0	8.25	7.3	20	320	
3436	Brushy Fork	5/14/2016	4	0.5	1	9	7.3	14	250	G
3436	Brushy Fork	7/9/2016	4	>1.5	1	7.6	7.5	22	290	
3437	Owsley Fork	5/14/2016	4	0.5	1	9.6	8.6	12	350	G
3437	Owsley Fork	7/9/2016	5	>1.5	1	8.2	8.5	22	330	

Site ID#	Stream	Sampling Date	Flow	Rainfall (inches)	Turbidity	Dissolved Oxygen (mg/L) *	pH	Temperature (°C)	Conductivity (microsiemens/cm)	Assessment R (red)=poor Y(yellow)=fair G(green)=good
3449	Elkhorn Creek	9/9/2016	2	0	1	7.8	8	24	**530**	Y
3451	Crooked Creek	9/9/2016	2		0	5.9	7.4	26	390	G
3471	Unnamed Tributary	7/9/2016	3	0.5	0	6.7	7.5	22	**820**	Y
3472	Town Branch	5/12/2016	3	>1.5	0	8.6	7.5	18		G
3473	Isaac Creek	9/10/2016	2	0	0	6	7.5	18	250	G
3476	Boone Creek	5/14/2016	4		2					Y
3476	Boone Creek	9/10/2016	2	0.1	0	10	7.2	21	**510**	
3477	Dix River	5/14/2016	4		2					G
3477	Dix River	9/10/2016	2	0.1	3	8	7.8	24	350	
3478	Town Branch	5/13/2016	3	1	2	6.25	7	18.5	**850**	R
3478	Town Branch	7/8/2016	2	0.1	1	5.2	7.75	19	**1010**	
3478	Town Branch	9/9/2016	2	0	1	6.6	7.5	21.5	**1030**	
3479	Stewart Creek	5/12/2016	4	>1.5	1	9.2	7.3	14	150	G
3479	Stewart Creek	7/9/2016	4	>1.5	2	8	7.5	16	200	
3479	Stewart Creek	9/9/2016	2	0	0	8	7.5	20	260	
3481	Sandlick Creek	5/14/2016	3	0.1	0	9.1	7.3	13	**730**	Y
3482	Creeches Creek	5/16/2016	3	0.5	0	9.4	6.8	11	80	G
3482	Creeches Creek	7/11/2016	3	0	0	7.2	7.2	20	90	
3482	Creeches Creek	9/10/2016	2	0.1	0	6.8	7.25	20	110	
3485	Wadward Creek	5/12/2016	4	>1.5	1	9.6	7.3	14	150	G
3485	Wadward Creek	7/9/2016	4	>1.5	2	8.4	7.5	17	180	
3485	Wadward Creek	9/9/2016	2	0	0	7	7.5	21	280	
3486	Woodward Creek	5/12/2016	4	>1.5	1	8.8	7.3	13	150	G
3486	Woodward Creek	7/9/2016	4	>1.5	2	8.4	7.5	17	180	
3486	Woodward Creek	9/9/2016	2	0	0	8	7.5	19	260	
3487	Cave Creek	5/14/2016	4	1	2	8.2	7.4	17	**590**	R
3487	Cave Creek	9/9/2016	2	0.1	0	6.2	7.6	23	**1110**	
3515	St. Asaph's Creek	7/8/2016	3	1	1	8.4	7	17	260	G
3515	St. Asaph's Creek	9/9/2016	2	0	0	7	8.2	18	410	
3516	St. Asaph's Creek	7/8/2016	3	1	1	7	7	17	260	G
3516	St. Asaph's Creek	9/9/2016	2	0	0	8.1	8	19	410	
3517	St. Asaph's Creek	7/8/2016	3	1	1	7.6	8	18	240	G
3517	St. Asaph's Creek	9/9/2016	2	0	0	5.4	8	21	260	
3520	Crystal Creek	7/9/2016	4	>1.5	2	7	6.75	20	80	G
3520	Crystal Creek	9/10/2016	2	0	0	5.5	7	22	400	
3522	North Fork Kentucky River	7/9/2016	4	>1.5	3	14	7	21	160	Y
3522	North Fork Kentucky River	9/10/2016	3	0	0	12.4	8	26	**1230**	
3531	Big Branch	7/9/2016	4	>1.5	3	7	6.4	17.8	80	G
3531	Big Branch	9/10/2016	1	0	0	6.8	6.8		150	
3532	Double Cabin Creek	7/9/2016	4	>1.5	3	6.8	6.4	18	90	G
3532	Double Cabin Creek	9/10/2016	2	0	0	6.6	6.8		280	
3548	Millers Creek	9/10/2016	3	0.1	2	5	7.2	25	350	G
3549	Shaker Creek	9/12/2016	2	0.1	0	8.8	8	16.9	500	G
3550	Shaker Creek	9/12/2016	2	0.1	0	9	8	18.5	500	G
3551	Shawnee Run	9/12/2016	2	0.1	0	9	8	18	480	G
3564	Sturgeon Creek	9/10/2016	2	0	1	**4.4**	7	23	210	Y

Flow Rate:	
0	Dry
1	Ponded
2	Low
3	Normal
4	Bank Full
5	Flood

Table 3

2016 KRWW Pathogen Sampling Results

Site ID#	Stream Name	Location	County	May E. coli Results (CFU/100 ml)	July E. coli Results (CFU/100 ml)	September E. coli Results (CFU/100 ml)	Average E. coli 1-3 samples (CFU/100 ml)
Primary Contact (Swimming) Standard for E. coli = 240 cfu/100 ml or Most Probable Number (MPN)							
741	Lees Branch	150 yds downstream of Stephens St	Woodford	238	2628	135	**1,000**
744	Cane Run	0.2 mi upstream of 460 bridge	Scott	1100	794	563	**819**
753	Clarks Run	Just upstream of Goggin Ln bridge	Boyle	-	-	241	**241**
755	North Elkhorn Creek	at Great Crossings	Scott	1017	216	63	**432**
756	Sandlick Creek	Near mouth at Caudilltown	Letcher	180	590	30	**267**
763	South Elkhorn Creek	Upstream of US60, near airport	Fayette	1274	980	120	**791**
765	South Elkhorn Creek	0.5 mi upstream of KY341	Scott	104	691	110	**302**
767	Clear Creek	0.5 mi downstream of Hifner bridge	Woodford	12033	244	20	**4,099**
772	Unnamed Tributary	behind 124 Creekside Dr, Ironworks Estates	Scott	82	959	-	**521**
786	Eagle Creek	Boat ramp Eagle Creek Resort	Carroll	-	-	7	7
792	West Hickman Creek	Behind Tates Creek Center	Fayette	414	908	218	**513**
793	McConnells Spring	McConnell Spring (WR-M2)	Fayette	259	1246	84	**530**
794	Town Branch	Jimmy Campbell Lane bridge	Fayette	2282	520	3609	**2,137**
796	Spring Station	At spring on Beals Run	Woodford	-	1248	75	**662**
801	N Fk Kentucky River	Mayking at Old Regular Baptist	Letcher	-	-	120	120
802	Pine Creek	Near mouth at Mayking Baptist	Letcher	-	-	10	10
803	Cram Creek	at mouth of Cram Cr and Pert Fk	Letcher	-	-	790	**790**
810	South Elkhorn Creek	US68 Harrodsburg Road bridge	Fayette	-	988	-	**988**
811	Steeles Branch	Redd Rd bridge, off Frankfork Pk	Fayette	556	197	833	**529**
815	Cane Creek	Gordon proprerty on Menifee/Powell line	Menifee	41	-	-	41
820	N Fk Kentucky River	Boat ramp at Perry County Park	Perry	830	6490	80	**2,467**
823	Glenns Creek	Jct of Steele Rd and McCracken at Glenn's Cr Baptist Church	Woodford	-	2172	830	**1,501**
827	Quicksand Creek	Below Hwy 15 bridge	Breathitt	-	-	173	173
831	Lower Red River	Twin Creek	Estill	2909	-	-	**2,909**
832	Red River	Below Route 15 bridge in Clay City	Powell	3873	-	-	**3,873**
833	Spring	Graddy Spring on Greenwood Farm	Woodford	-	-	20	20
848	N Fk Kentucky River	Below Crafts Colley at jct with Letcher HS drainage	Letcher	1080	-	860	**970**
850	Colley Creek	Mouth, beside Ermine post office	Letcher	730	-	230	**480**
861	Glenns Creek	On Hwy 1659, approx .7 mi from Hwy 1964 in Millville	Woodford	-	446	161	**304**
869	Maces Creek	Next to Viper Elem outdoor classroom, under bridge	Perry	420	420	640	**493**
875	Right Fork Carr Creek	Downstream from Vicco, Hwy 15 pullover, below Acup Creek	Perry	560	660	690	**637**
891	North Elkhorn Creek	Hwy 25	Scott	2046	233	<10	**1,140**
914	Hollly Spring	Across from Gardenside Park tennis court (WR-H1)	Fayette	52	305	121	159
915	Wolf Run	At Gardenside Park above foot bridge (WR-S5)	Fayette	420	3873	2282	**2,192**
918	Muddy Creek	10 m downstream of bridge at outflow of Army Depot	Madison	496	2142	62	**900**
921	Otter Creek	750' upstream from where Beaver Drive meets Otter Cr	Madison	3877	-	-	**3,877**
942	Lower Howard Creek	Bridge upstream of Old Stone Church	Clark	1010	-	-	**1,010**
943	Quicksand Creek	Approximately 100 meters above confluence with South Fork of Quicksand Creek.	Breathitt	-	-	121	121
944	South Fork Quicksand Creek	Approximately 250 meters above confluence with main branch of Quicksand creek.	Breathitt	-	-	73	73

Site ID#	Stream Name	Location	County	May E. coli Results (CFU/100 ml)	July E. coli Results (CFU/100 ml)	September E. coli Results (CFU/100 ml)	Average E. coli 1-3 samples (CFU/100 ml)
Primary Contact (Swimming) Standard for E. coli = 240 cfu/100 ml or Most Probable Number (MPN)							
954	Spring	Welcome Hall	Woodford	-	268	14136	**7,202**
955	Elk Lick Creek	Just below falls branch at Nature Sanctuary	Fayette	-	132	156	144
978	Muddy Creek	Hwy 52	Madison	201	5172	168	**1,847**
982	Lanes Run	Jst upstream of gage station on Hwy 460	Scott	75	75	20	57
983	North Elkhorn Creek	On private farm on Russell Cave Rd	Fayette	1014	-	241	**628**
984	Twin Creek	0.25 mi above confluence of Twin Cr and Red River	Estill	1421	-	-	**1,421**
990	Unnamed Tributary	Behind 134 Norton Drive	Madison	1296	-	789	**1,043**
1014	Elkhorn Creek	Below Fish Hatchery	Franklin	-	124	62	93
1018	Penitentiary Branch	US127 N and Thornhill bypass	Franklin	579	-	-	**579**
1023	Town Branch	South Forbes Lane at stockyards	Fayette	6131	-	-	**6,131**
1028	Wolf Run	Old Frankfort Pike (USGS site)	Fayette	399	650	1043	**697**
1030	McKecknie Creek	Sutton Lane bridge crossing	Garrard	2046	-	10462	**6,254**
1048	Shannon Run	Bridge on Briarwood St in Sycamore Estates.	Woodford	921	482	733	**712**
1087	Unnamed Tributary	Behind Meadowbrook golf course, UT to West Hickman	Fayette	1500	1050	908	**1,153**
1124	Marble Creek	Just off Marble Creek Ln	Jessamine	119	169	2247	**845**
1128	Cardinal Run	WR-C1 At Devonport Dr. Crossing	Fayette	399	865	2723	**1,329**
1129	Cardinal Run	WR-C2 Below Chinquapin Ln Bridge off Parker's Mill Rd.	Fayette	798	573	586	**652**
1132	Wolf Run	WR-S1 Village Drive and Cambridge Drive upstream of Vaughns Branch	Fayette	959	1314	1046	**1,106**
1133	Wolf Run	WR-S10 Lafayette Parkway at Rosemont	Fayette	836	583	144	**521**
1134	Spring Branch	WR-S8 Springs Branch at end of Faircrest Drive	Fayette	336	820	175	**444**
1135	Wolf Run	WR-S9 Wolf Run upstream of Springs Branch at end of Faircrest Drive	Fayette	657	4611	3448	**2,905**
1137	Vaughn's Branch	WR-V1 25 feet upstream of mouth at Valley Park	Fayette	1725	3076	201	**1,667**
1138	Vaughn's Branch	WR-V2 Park at end of Tazwell Drive	Fayette	987	6488	1234	**2,903**
1139	Vaughn's Branch	WR-V3 25 ft upstream of Nicholsasville Rd at Intersection with Alumni Drive	Fayette	556	1086	780	**807**
1143	Dry Fork	mouth of Dry Fork 20 ft above garage	Letcher	1160	< 10	80	**620**
1151	Left Fk Cram Creek	Jct of Cram Cr Rd/Great Oak Rd	Letcher	-	-	2600	**2,600**
1152	Right Fk Cram Creek	Jct of Cram Cr Rd/Great Oak Rd	Letcher	-	-	150	150
1174	Royal Springs	intersection of West Main and South Water Street.	Scott	1664	-	155	**910**
1184	Spring Branch	WR-S85 upstream of Sheridan Drive Culvert.	Fayette	581	1467	-	**1,024**
1185	N Fk Kentucky River	Above confluence with Crafts Colley	Letcher	580	-	460	**520**
1191	Kentucky River	Cummins Ferry Rd marina	Mercer	-	-	31	31
1195	Lees Branch	In front of Midway University	Woodford	291	906	1616	**938**
1199	Vaughn's Branch	Behind Lexington Clinic Surgery Center at Golf Course Fence	Fayette	738	2755	-	**1,747**
1209	Sandlick Creek	Acid Mine Drainage across from Rainbow Drive, sampled just above culvert at confluence of two streams	Letcher	<10	-	-	10
1221	Cane Run	jct of Coleman Lane and Hwy 25.	Scott	2987	496	341	**1,275**
1242	Dry Fork	Acid Mine Drainage entering Dry Fork near Horns on Little Dry Fork Rd (aka Crown)	Letcher	10	-	-	10

Site ID#	Stream Name	Location	County	May E. coli Results (CFU/100 ml)	July E. coli Results (CFU/100 ml)	September E. coli Results (CFU/100 ml)	Average E. coli 1-3 samples (CFU/100 ml)
Primary Contact (Swimming) Standard for E. coli = 240 cfu/100 ml or Most Probable Number (MPN)							
1243	Long Branch	near mouth just above Hwy 931 N culvert by Refuse Dr. below strip job and old refuse pile	Letcher	10	< 10	260	135
1270	Unnamed Tributary	creek behind 919 Lancaster street	Lincoln	2987	586	556	**1,376**
1271	Herrington Lake	dock at 668 Mallard Cove	Mercer	10	-	10	10
1274	Elk Lick Creek	upstream from Quarry Branch	Fayette	-	75	52	64
1275	Unnamed Tributary	near the corner of Wilson Downing Road and Belleau Wood Drive.Trib to West Hickman	Fayette	-	2046	-	**2,046**
1276	West Hickman Creek	behind 790 Jairus Drive in Veterans Park	Fayette	-	624	63	**344**
1278	Kentucky River	main stem at Munday's Landing at mile 109.5.	Woodford	-	1428	< 10	**1,428**
1287	Kentucky River	Boat ramp upstream of the bridge at US 68 on the Mercer/Jessamine line	Mercer	2359	2310	393	**1,687**
1301	North Elkhorn Creek	White Oak Road bridge over Elkhorn and south of Stamping Ground in Scott Co	Scott	240	336	359	**312**
1307	Jessamine Creek	Short Shun crossing	Jessamine	305	813	1658	**925**
1314	Wolf Run	at Roanoke Drive and Greenway	Fayette	9208	3076	465	**4,250**
2924	Tates Creek	At outflow of St. Andres Pond	Madison	-	-	10	10
2954	St. Asaph's Creek	200 yards northeast of Buffalo Spring in Stanford	Lincoln	2909	1500	31	**1,480**
2970	Preston's Cave Spring	resurgence near Puerta Del Cielo Assembly of God Church at 1935 Dunkirk Dr	Fayette	216	884	408	**503**
3005	McConnells Spring	Ditch line off Red Mile Road south of Horseman's Lane	Fayette	331	3448	-	**1,890**
3006	Lower Howard Creek	Upstream of suspected pipe	Clark	309	-	-	**309**
3010	Town Branch	266 yds from Jimmie Campbell bridge	Fayette	1616	644	3873	**2,044**
3013	Shannon Run	Sycamore subdivision- Lavy Lot as it leaves Sycamore Estates	Woodford	1733	1024	279	**1,012**
3059	Gardenside Branch	downstream of Darien Drive Culvert at head of Cross Keys Park	Fayette	1904	2489	1455	**1,949**
3060	Vaughn's Branch	end of parking lot behind Harrodsburg Road fire station	Fayette	794	2909	1793	**1,832**
3085	St. Clair Spring	From Spurr Road turn onto Greendale Road and the site is 100 yards down before the railway crossing	Fayette	243	-	-	**243**
3128	Unnamed Tributary	UT to South Elkhorn Cr. at Spring Dale Baptist Church,1380 Higbee Mill Rd	Fayette	-	410	122	**266**
3137	Wolf Run	behind the parking lot at 2134 Nicholasville Road	Fayette	988	471	528	**662**
3172	Tates Creek	Near entrance to Baldwin Farms near Crutcher Pk Rd	Madison	-	-	213	213
3180	Spring	Penitentiary Branch Cove Spring at Cove Spring park	Franklin	320	202	-	**261**
3203	Evans Branch	just upstream from confluence with Elk Lick Creek	Fayette	-	121	20	71
3211	Silver Creek	At 1016 crossing bridge in Berea	Madison	-	-	155	155
3214	Glenns Creek	at the Millville Community Center	Woodford	402	576	86	**355**
3216	Unnamed Tributary	UT to West Hickman. Waterford subdivision, 180 yards east south east from the wier at the lower end of the large Waterford pond	Fayette	262	-	1046	**654**
3222	Unnamed Tributary	Muir Valley Calvin Hollow	Wolfe	41	189	-	115
3223	Unnamed Tributary	Muir Valley behind Rogers Elementary	Wolfe	98	168	-	133

Site ID#	Stream Name	Location	County	May E. coli Results (CFU/100 ml)	July E. coli Results (CFU/100 ml)	September E. coli Results (CFU/100 ml)	Average E. coli 1-3 samples (CFU/100 ml)
Primary Contact (Swimming) Standard for E. coli = 240 cfu/100 ml or Most Probable Number (MPN)							
3224	Unnamed Tributary	Muir Valley downstream of beaver dams	Wolfe	122	216	-	169
3225	Middle Fk Lower Devil Cree	Muir Valley headwaters	Wolfe	185	108	-	147
3227	Whittleton Branch	Just beyond Natural Bridge Park boundary off Hwy 11	Powell	-	10	< 10	5
3230	South Elkhorn Creek	40 ft. downstream of the old Ft. Harrodsburg Road stone bridge across from Ramsey's restaurant. At the intersection of Bowman's Mill and Old Harrodsburg Road	Fayette	836	-	199	**518**
3252	South Elkhorn Creek	Clays Crossing subdivision	Jessamine	583	1300	161	**681**
3271	N Fk Kentucky River	4.3 mi from Hwy 15/Hwy 1110 jct, below bridge	Breathitt	-	-	20	20
3282	Elkhorn Creek	Just below where Sulphur Lick feeds into Elkhorn Creek in Peaks Mill	Franklin	346	-	75	211
3283	Lower Howard Creek	Behind 207 Hampton Avenue	Clark	1126	2613	41	**1,260**
3298	Red Lick Creek	Jct of Red Lick Rd and Station Camp Rd	Estill	-	-	98	98
3299	Locust Branch	In Locust Branch on Hwy 594	Estill	-	-	164	164
3300	Ross Creek	Off Hwy 851 at Sturgeon Branch and Ross Creek	Lee	-	498	10	**254**
3343	Buck Lick Branch	Below spring, 100 yds off Little Ross Creek Rd	Lee	-	323	98	211
3349	Waterslide Lake	Behind residence at 4868 Waterside Lake	Lee	-	-	41	41
3350	Town Creek	Where East Main and Campground Lane meet at the AdventureServe Campground	Jessamine	464	933	256	**551**
3353	Fairchild Branch	At mouth of Sandlick Creek	Letcher	460	-	-	**460**
3363	Silver Creek	Just upstream of Stevnson Trail bridge, at confluence of Silver Cr and Brushy Fk	Madison	-	-	146	146
3366	Hill & Dale Kids Creek	In front of Kentucky Chocolates on Southland Dr	Fayette	3436	1968		**2,702**
3369	Kentucky River	100 yards downstream of WWTP discharge	Carroll	142	-	2	72
3370	Notch Lick	506 Notch Lick Road in Carrollton	Carroll	285	-	67	176
3371	Locust Creek	Confluence of East & West Prongs of Locust Creek	Carroll	457	-	15	236
3373	Kentucky River	100 yards upstream of mouth of Eagle Creek	Owen	228	-	4	116
3390	Wildcat Chase	Behind Plymouth Rock Court	Fayette	2098	1076	1529	**1,568**
3393	Middle Fk Kentucky River	Turn left onto Dryhill Road, go 6.84 miles to Hwy 3425, turn right onto bridge. Turn right at end of bridge. Drive 0.2 mile. Sampling will take place on the right under the parkway bridge	Leslie	1722	-	-	**1,722**
3397	Middle Fk Kentucky River	Turn left onto KY 257 (Dryhill Road). Turn right into Hyden City Park parking lot.	Leslie	-	813	295	**554**
3398	Rockhouse Creek	Behind Leslie County courthouse	Leslie	-	605	1014	**810**
3400	Bull Creek	Driveway on Bull Creek Rd (KY 3424)	Leslie	-	-	52	52
3401	Cutshin Creek	KY HWY 80/KY HWY 1807 in Wooton	Leslie	2064	528	148	**913**
3402	Middle Fk Kentucky River	Travel 421 S for 10.7 miles, turn right onto Middle Fork Road (KY 1780). Sampling at intersection.	Leslie	3076	218	< 10	**1,647**

Site ID#	Stream Name	Location	County	May E. coli Results (CFU/100 ml)	July E. coli Results (CFU/100 ml)	September E. coli Results (CFU/100 ml)	Average E. coli 1-3 samples (CFU/100 ml)
Primary Contact (Swimming) Standard for E. coli = 240 cfu/100 ml or Most Probable Number (MPN)							
3403	Middle Fk Kentucky River	Travel 421S for 10.7 mi, turn right onto Middle Fork Rd (KY 1780). Travel 7.5 mi turning right onto KY 1850. Sampling will be at bridge intersection.	Leslie	1860	160	262	**761**
3405	Beech Fork	Travel Highway 421 South for approx. 13 miles. Turn right into Driveway at 7235 Highway 421. Location behind home	Leslie	-	259	173	216
3407	Ohio River	Boat ramp at 5th St, Carrolloton	Carroll	-	-	48	48
3410	South Elkhorn Creek	Hwy 1685 in southeast corner of Franklin Co. 0.44 mi on Hwy 1685 (Bedford Rd) and 0.1 mi before Vansant Rd	Franklin	148	-	246	197
3434	Unnamed Tributary	720 Little Ross Creek Road	Estill	-	429	2143	**1,286**
3436	Brushy Fork	Upstream of Brushy Fork Park on Ky 595	Madison	450	1439	-	**945**
3437	Owley Fork	Headwaters of Owsley Fork Reservoir	Jackson	74	441	-	**258**
3449	Elkhorn Creek	Behind Canoe Kentucky	Franklin	-	-	121	121
3451	Crooked Creek	At 115 Winkler Cemetery Rd, Irvine	Estill	-	-	262	**262**
3471	Unnamed Tributary	Behind residence at 4501 Mandeville Way. UT to West Hickman Creek	Fayette	-	8664	-	**8,664**
3472	Town Branch	By the Oliver Lewis bridge	Fayette	24196	-	-	**24,196**
3473	Isaac Creek	Pine Mountain Settlement School	Harlan	-	-	600	**600**
3476	Boone Creek	On Paper Mill Road	Garrard	2224	-	74	**1,149**
3477	Dix River	On Paper Mill Road	Garrard	1624	-	109	**867**
3478	Town Branch	Downstream of Break Room Tavern	Fayette	9208	1274	4884	**5,122**
3479	Stewart Creek	On sampler's property	Estill	74	139	31	81
3481	Sandlick Creek	Approx 100 ft south of bridge on Sparrow Dr.	Letcher	1990	-	-	**1,990**
3482	Creeches Creek	LOCATION NEEDED	Wolfe	20	41	41	34
3485	Woodward Creek	In front of sampler's home. 421 Patsy Road, Irvine	Estill	51	146	20	72
3486	Woodward Creek	Upstream of site 3485	Estill	85	135	10	77
3487	Cave Creek	Harrods Hill subdivision just before it crosses Malone Drive into Beaumont subdivision	Fayette	2142	-	880	**1,511**
3515	St. Asaph's Creek	Behind 313 West Main Street, Stanford	Lincoln	-	1086	282	**684**
3516	St. Asaph's Creek	Behind 213 East Main Street, Stanford	Lincoln	-	1723	171	**947**
3517	St. Asaph's Creek	Behind 909 East Main Street. Near confluence to Logan's Creek	Lincoln	-	1211	399	**805**
3520	Crystal Creek	Behind the Senior Center, 137 East Main Street, Beattyville	Lee	-	226	63	145
3522	N Fk Kentucky River	Where Lee, Breathitt and Wofle counties come together	Lee	-	1968	10	**989**
3531	Big Branch	Big Branch Saint Helens	Lee	-	2098	20	**1,059**
3532	Double Cabin Creek	On Highway 52	Lee	-	1723	20	**872**
3548	Millers Creek	Just off Hwy 52 in Ravenna	Estill	-	-	160	160
3549	Shaker Creek	Downstream from confluence of 2 tribs, near spring along Pelly Trail	Mercer	-	-	173	173
3550	Shaker Creek	Directly downstream of Fulling Mill waterfall on Shawnee Run Trail	Mercer	-	-	52	52
3551	Shawnee Run	Directly downstream of confluence of Shawnee Run and Shaker Creek, at end of Chinn-Poe Trail	Mercer	-	-	122	122
3564	Sturgeon Creek		Lee	-	-	31	31

Table 4
2016 KRWW Chemical Sampling Results

Site ID#	Sampling Date	Stream	County	Chloride	Conductivity	Turbidity	Sulfate	Assessment
Method Detection Limit (MDL)				1.0 mg/L	1 mS/cm	0.1 NTU	5.00 mg/L	
Water Quality Standard/ Benchmark				Drinking Water Supply=250 Acute Aquatic Life=1,200 Chronic Aquatic Life= 600	Aquatic Life Benchmark= 500 microsiemens / cm*	No Std. Available	Drinking Water Supply= 250 mg/L	R (red) = poor Y (yellow) = fair G (green) = good
741	9/10/2016	Lees Branch	Woodford	14	481	3.59	15.4	G
744	9/9/2016	Cane Run	Scott	40.7	**577**	4.06	32.2	Y
753	9/9/2016	Clarks Run	Boyle	52	**585**	1.85	31.1	Y
755	9/9/2016	North Elkhorn Creek	Scott	50.9	**527**	3.93	36.6	Y
756	9/9/2016	**Sandlick Creek**	**Letcher**	3.09	**2648**	4.18	**1717**	R
763	9/9/2016	South Elkhorn Creek	Fayette	42.4	**569**	3	56.7	Y
765	9/12/2016	South Elkhorn Creek	Scott	81.9	**709**	1.9	75.4	Y
767	9/9/2016	Clear Creek	Woodford	10.4	416	1.84	13.1	G
786	9/9/2016	Eagle Creek	Carroll	18	332	6.2	52.9	G
792	9/10/2016	**West Hickman Creek**	**Fayette**	**398**	**1584**	2.41	46.3	R
793	9/10/2016	McConnells Spring	Fayette	98.8	**772**	2.65	62.5	Y
794	9/9/2016	**Town Branch**	**Fayette**	161	**1018**	0.96	103	R
796	9/10/2016	Spring Station	Woodford	21.5	471	2.73	15.2	G
801	9/10/2016	**N Fk Kentucky River**	**Letcher**	12.2	**851**	2.06	**286**	R
802	9/10/2016	Pine Creek	Letcher	16.2	**612**	0.8	160	Y
803	9/10/2016	Cram Creek	Letcher	7.76	**505**	0.89	72.7	Y
811	9/9/2016	Steeles Branch	Fayette	28.3	438	3.66	21.2	G
820	9/10/2016	**N Fk Kentucky River**	**Perry**	21.8	**894**	5.51	**323**	R
823	9/12/2016	Glenns Creek	Woodford	76.2	**632**	2.28	49	Y
827	9/10/2016	Quicksand Creek	Breathitt	4.8	**663**	4.79	226	Y
833	9/12/2016	Spring	Woodford	4.24	**517**	1.66	14.6	Y
848	9/10/2016	**N Fk Kentucky River**	**Letcher**	14	**800**	2.92	**260**	R
850	9/10/2016	**Colley Creek**	**Letcher**	20.5	**709**	2.09	**294**	R
861	9/12/2016	Glenns Creek	Woodford	64	**589**	2.66	52.2	Y
869	9/10/2016	**Maces Creek**	**Perry**	18.4	**734**	3.09	**272**	R
875	9/10/2016	**Right Fork Carr Creek**	**Perry**	9.07	**1143**	3.12	**539**	R
891	9/9/2016	North Elkhorn Creek	Scott	49.3	**521**	3.73	47.3	Y
914	9/9/2016	Hollly Spring	Fayette	61.3	**589**	0.51	25.5	Y
915	9/9/2016	Wolf Run	Fayette	80	**649**	0.65	66.9	Y
918	9/10/2016	Muddy Creek	Madison	22.8	425	3.64	10.6	G
943	9/10/2016	Quicksand Creek	Breathitt	5.41	**619**	7.87	232	Y
944	9/10/2016	uth Fork Quicksand Cre	Breathitt	3.07	**826**	1.62	215	Y
954	9/12/2016	Spring	Woodford	21.7	**642**	12.3	44.6	Y
955	9/12/2016	Elk Lick Creek	Fayette	32.4	**592**	0.35	79	Y
978	9/10/2016	Muddy Creek	Madison	15.3	354	3.91	10.8	G
982	9/12/2016	Lanes Run	Scott	41.4	**545**	0.74	39.6	Y
983	9/10/2016	North Elkhorn Creek	Fayette	45.3	**610**	1.54	36.3	Y
990	9/10/2016	Unnamed Tributary	Madison	28.7	**583**	39	31.1	Y
1014	9/9/2016	Elkhorn Creek	Franklin	58.9	**599**	6.84	46.9	Y
1028	9/10/2016	Wolf Run	Fayette	90.2	**744**	1.75	55.5	Y

Site ID#	Sampling Date	Stream	County	Chloride	Conductivity	Turbidity	Sulfate	Assessment
1030	9/9/2016	McKecknie Creek	Garrard	14.3	**554**	42.2	29	Y
1048	9/10/2016	Shannon Run	Woodford	18.1	462	1.35	20.5	G
1087	9/10/2016	Unnamed Tributary	Fayette	123	**886**	11.8	88.7	Y
1124	9/10/2016	Marble Creek	Jessamine	6.51	410	0.85	10.6	G
1128	9/10/2016	Cardinal Run	Fayette	56.9	**581**	1.82	33.6	Y
1129	9/10/2016	Cardinal Run	Fayette	49.5	**595**	0.7	27.9	Y
1132	9/10/2016	Wolf Run	Fayette	66.5	**539**	0.53	42.6	Y
1133	9/10/2016	Wolf Run	Fayette	51.3	**611**	0.79	56.2	Y
1134	9/9/2016	Spring Branch	Fayette	58.3	500	0.96	53.4	G
1135	9/9/2016	Wolf Run	Fayette	91.7	**593**	1.07	76.9	Y
1137	9/10/2016	Vaughn's Branch	Fayette	72.5	**671**	0.76	43.3	Y
1138	9/9/2016	Vaughn's Branch	Fayette	51.1	**523**	1.46	18.2	Y
1139	9/12/2016	Vaughn's Branch	Fayette	76.8	**621**	11.1	86.4	Y
1143	9/9/2016	**Dry Fork**	**Letcher**	12.7	**1201**	4.53	**350**	R
1151	9/10/2016	Left Fk Cram Creek	Letcher	5.86	**617**	0.5	71.1	Y
1152	9/10/2016	Right Fk Cram Creek	Letcher	10.7	438	1.2	67.6	G
1174	9/9/2016	Royal Springs	Scott	60.4	**716**	1.38	63.8	Y
1185	9/10/2016	**N Fk Kentucky River**	**Letcher**	14.2	**896**	2.36	**261**	R
1191	9/10/2016	Kentucky River	Mercer	9.28	**509**	15.8	133	G
1195	9/10/2016	Lees Branch	Woodford	14	494	5.14	7.83	G
1221	9/9/2016	Cane Run	Scott	37.1	**670**	2.31	32.5	Y
1243	9/9/2016	**Long Branch**	**Letcher**	10.1	**1427**	1.26	**467**	R
1270	9/9/2016	Unnamed Tributary	Lincoln	7.26	425	2.3	< than MDL	G
1271	9/10/2016	Herrington Lake	Mercer	10.4	322	2.35	55.3	G
1274	9/12/2016	Elk Lick Creek	Fayette	55.6	**840**	0.49	129	Y
1276	9/10/2016	West Hickman Creek	Fayette	78.1	**655**	1.23	41.6	Y
1278	9/12/2016	Kentucky River	Woodford	10.5	**553**	8.94	153	Y
1287	9/9/2016	Kentucky River	Mercer	10.1	**554**	5.75	152	Y
1301	9/10/2016	North Elkhorn Creek	Scott	43	**565**	9.41	32.5	Y
1307	9/9/2016	Jessamine Creek	Jessamine	21	**582**	2.39	49.5	Y
1314	9/9/2016	Wolf Run	Fayette	63.8	**682**	1.31	52.7	Y
2924	9/10/2016	Tates Creek	Madison	45	**572**	3.7	35.4	Y
2954	9/9/2016	St. Asaph's Creek	Lincoln	9.45	325	1.23	9.14	G
2970	9/10/2016	Preston's Cave Spring	Fayette	91.3	**843**	1.07	50.5	Y
3010	9/9/2016	**Town Branch**	**Fayette**	169	**1196**	0.64	110	R
3013	9/10/2016	Shannon Run	Woodford	19.7	**517**	3.23	20.3	Y
3059	9/10/2016	Gardenside Branch	Fayette	51.8	**740**	0.69	42.3	Y
3060	9/12/2016	Vaughn's Branch	Fayette	80.9	**743**	1.29	77.6	Y
3128	9/9/2016	Unnamed Tributary	Fayette	58.5	**715**	1	47.8	Y
3137	9/12/2016	**Wolf Run**	**Fayette**	211	**1181**	0.36	69.1	R
3172	9/10/2016	Tates Creek	Madison	31.2	**609**	0.82	81.8	Y
3203	9/12/2016	Evans Branch	Fayette	12.4	**538**	1.9	36.8	Y
3211	9/10/2016	Silver Creek	Madison	29.8	439	5.52	63.9	G
3214	9/9/2016	Glenns Creek	Woodford	69.7	**688**	4.11	45.5	Y
3216	9/9/2016	Unnamed Tributary	Fayette	53.5	**655**	1.14	71.1	Y
3227	9/12/2016	Whittleton Branch	Powell	3.96	141	0.67	5.37	G
3230	9/9/2016	South Elkhorn Creek	Fayette	53.9	**716**	0.8	51.2	Y
3252	9/9/2016	South Elkhorn Creek	Jessamine	15.2	**515**	1.56	15.8	Y
3271	9/10/2016	**N Fk Kentucky River**	**Breathitt**	15.9	**1110**	6.57	**413**	R
3283	9/9/2016	**Lower Howard Creek**	**Clark**	**251**	**1452**	1.35	51.6	R
3298	9/9/2016	Red Lick Creek	Estill	7.42	338	11	25.1	G

Site ID#	Sampling Date	Stream	County	Chloride	Conductivity	Turbidity	Sulfate	Assessment
3299	9/9/2016	Locust Branch	Estill	19.4	384	1.3	46.7	G
3300	9/9/2016	Ross Creek	Lee	2.05	334	0.84	17.2	G
3343	9/9/2016	Buck Lick Branch	Lee	4.85	372	1.92	12.3	G
3349	9/9/2016	Waterslide Lake	Lee	29.7	307	12.4	13.8	G
3350	9/9/2016	Town Creek	Jessamine	21.6	**530**	1.07	70.2	Y
3363	9/12/2016	Silver Creek	Madison	27.1	469	1.25	47.8	G
3369	9/8/2016	Kentucky River	Carroll	13.5	333	4.18	49.1	G
3373	9/8/2016	Kentucky River	Owen	11.9	333	4.66	51.1	G
3370	9/9/2016	Notch Lick	Carroll	19.1	**656**	0.5	35.1	Y
3371	9/9/2016	Locust Creek	Carroll	16	**526**	0.34	34.3	Y
3390	9/9/2016	**Wildcat Chase**	**Fayette**	125	**995**	4.75	27.7	R
3397	9/9/2016	**Middle Fk Kentucky Rive**	**Leslie**	10.9	**871**	3.07	**258**	R
3398	9/9/2016	Rockhouse Creek	Leslie	12.5	**530**	2.12	110	Y
3400	9/9/2016	Bull Creek	Leslie	22.5	389	1.99	35.4	G
3401	9/9/2016	**Cutshin Creek**	**Leslie**	10.1	**1854**	1.36	**882**	R
3402	9/9/2016	Middle Fk Kentucky Rive	Leslie	2.83	212	0.94	19.4	G
3403	9/9/2016	**Middle Fk Kentucky Rive**	**Leslie**	1.49	**946**	0.87	**399**	R
3405	9/9/2016	**Beech Fork**	**Leslie**	18.7	**1216**	1.57	207	R
3407	9/9/2016	Ohio River	Carroll	50.2	482	14.7	57.2	G
3410	9/10/2016	South Elkhorn Creek	Franklin	86.4	**771**	4.33	61.9	Y
3434	9/9/2016	Unnamed Tributary	Estill	6.24	368	4.09	7.83	G
3449	9/9/2016	Elkhorn Creek	Franklin	62.2	**666**	3.69	48	Y
3451	9/9/2016	Crooked Creek	Estill	5.38	357	3.84	40.9	G
3473	9/10/2016	Isaac Creek	Harlan	10.5	234	2.47	13.1	G
3476	9/10/2016	Boone Creek	Garrard	16.2	**504**	0.66	22.1	Y
3477	9/10/2016	Dix River	Garrard	9.49	332	6.74	18.1	G
3478	9/9/2016	**Town Branch**	**Fayette**	132	**1007**	3.43	77.6	R
3479	9/9/2016	Stewart Creek	Estill	10.1	323	0.8	5.69	G
3482	9/10/2016	Creeches Creek	Wolfe	3.76	108	1.71	7.44	G
3485	9/9/2016	Woodward Creek	Estill	8.05	356	0.53	5.59	G
3486	9/9/2016	Woodward Creek	Estill	8.67	328	0.82	5.33	G
3487	9/9/2016	**Cave Creek**	**Fayette**	172	**1219**	3.05	86.6	R
3515	9/9/2016	St. Asaph's Creek	Lincoln	10.6	398	1.35	10.9	G
3516	9/9/2016	St. Asaph's Creek	Lincoln	11.5	396	1.16	11.6	G
3517	9/9/2016	St. Asaph's Creek	Lincoln	12.1	414	1.1	12.7	G
3520	9/10/2016	Crystal Creek	Lee	18.7	386	0.44	84.7	G
3522	9/10/2016	**N Fk Kentucky River**	**Lee**	12.5	**1222**	2.96	**495**	R
3531	9/10/2016	Big Branch	Lee	8.95	152	8.61	7.51	G
3532	9/10/2016	Double Cabin Creek	Lee	9.82	288	3.19	6.83	G
3549	9/12/2016	Shaker Creek	Mercer	10.5	**520**	0.87	16.1	Y
3550	9/12/2016	Shaker Creek	Mercer	11.3	**505**	1.02	17.6	Y
3551	9/12/2016	Shawnee Run	Mercer	9.97	**504**	0.61	15.9	Y
3564	9/10/2016	Sturgeon Creek	Lee	3.29	202	5.62	30.9	G

Table 5

2016 KRWW Nutrient Sampling Results

Site ID#	Sampling Date	Stream	County	Nitrate (NO_3)	Total Nitrogen	Total Recoverable Phosphorus	Assessment
Method Detection Limit (MDL)				0.1 mg/L	0.6 mg/L	0.03 mg/L	
Water Quality Standard/ Benchmark				Drinking Water Supply = 10 mg/L*	Aquatic Life Support = 3.0 mg/L**	Aquatic Life Support = 0.3 mg/L**	**R (red) = poor Y (yellow) = fair G (green) = good**
741	9/10/2016	Lees Branch	Woodford	4.91	1.45	**0.47**	Y
744	9/9/2016	Cane Run	Scott	3.72	1.51	**0.32**	Y
753	9/9/2016	**Clarks Run**	**Boyle**	**48**	**11.5**	**0.3**	R
755	9/9/2016	North Elkhorn Creek	Scott	5.29	2.03	**0.47**	Y
756	9/9/2016	Sandlick Creek	Letcher	0.53	0.92	0.05	G
763	9/9/2016	South Elkhorn Creek	Fayette	5.06	1.38	**0.39**	Y
765	9/12/2016	**South Elkhorn Creek**	**Scott**	**48**	**11.6**	**1.22**	R
767	9/9/2016	Clear Creek	Woodford	0.66	< than MDL	0.26	G
786	9/9/2016	Eagle Creek	Carroll	2.57	1.14	0.14	G
792	9/10/2016	West Hickman Creek	Fayette	Not Analyzed	1.93	0.26	G
793	9/10/2016	McConnells Spring	Fayette	9.77	2.3	**0.37**	Y
794	9/9/2016	**Town Branch**	**Fayette**	**12.1**	**3.41**	0.26	R
796	9/10/2016	**Spring Station**	**Woodford**	**12.2**	**3.19**	**0.36**	R
801	9/10/2016	N Fk Kentucky River	Letcher	1.54	0.72	< than MDL	G
802	9/10/2016	Pine Creek	Letcher	1.06	< than MDL	< than MDL	G
803	9/10/2016	Cram Creek	Letcher	1	< than MDL	< than MDL	G
811	9/9/2016	Steeles Branch	Fayette	7.83	2.54	**0.41**	Y
820	9/10/2016	N Fk Kentucky River	Perry	0.19	< than MDL	0.06	G
823	9/12/2016	**Glenns Creek**	**Woodford**	**30.1**	**7.08**	**1.27**	R
827	9/10/2016	Quicksand Creek	Breathitt	< than MDL	< than MDL	< than MDL	G
833	9/12/2016	**Spring**	**Woodford**	**13.5**	**3.29**	**0.5**	R
848	9/10/2016	N Fk Kentucky River	Letcher	1.38	0.62	< than MDL	G
850	9/10/2016	Colley Creek	Letcher	0.25	< than MDL	< than MDL	G
861	9/12/2016	**Glenns Creek**	**Woodford**	**21.3**	**5.39**	**1.07**	R
869	9/10/2016	Maces Creek	Perry	0.28	< than MDL	< than MDL	G
875	9/10/2016	Right Fork Carr Creek	Perry	0.93	0.87	< than MDL	G
891	9/9/2016	North Elkhorn Creek	Scott	6.08	2.74	0.18	G
914	9/9/2016	**Hollly Spring**	**Fayette**	**15.6**	**3.78**	**0.43**	R
915	9/9/2016	Wolf Run	Fayette	6.73	1.79	**0.31**	G
918	9/10/2016	Muddy Creek	Madison	< than MDL	< than MDL	0.07	G
943	9/10/2016	Quicksand Creek	Breathitt	< than MDL	1.67	< than MDL	G
944	9/10/2016	Creek	Breathitt	< than MDL	< than MDL	< than MDL	G
954	9/12/2016	**Spring**	**Woodford**	**24.1**	**5.97**	**0.64**	R
955	9/12/2016	Elk Lick Creek	Fayette	2.6	1	**0.34**	G
978	9/10/2016	Muddy Creek	Madison	0.11	0.7	< than MDL	G
982	9/12/2016	Lanes Run	Scott	1.12	0.74	0.26	G
983	9/10/2016	North Elkhorn Creek	Fayette	**11.4**	2.95	0.26	Y
990	9/10/2016	Unnamed Tributary	Madison	1.26	1.2	**0.35**	Y
1014	9/9/2016	**Elkhorn Creek**	**Franklin**	**11.3**	**3.48**	**0.52**	R
1028	9/10/2016	Wolf Run	Fayette	6.01	1.93	**0.31**	G

Site ID#	Sampling Date	Stream	County	Nitrate (NO_3)	Total Nitrogen	Total Recoverable Phosphorus	Assessment
1030	9/9/2016	**McKecknie Creek**	**Garrard**	**25.8**	**8.33**	**1.24**	R
1048	9/10/2016	**Shannon Run**	**Woodford**	**22.7**	**5.45**	0.25	R
1087	9/10/2016	Unnamed Tributary	Fayette	3	1.31	**2.16**	Y
1124	9/10/2016	Marble Creek	Jessamine	1.23	0.73	0.28	G
1128	9/10/2016	Cardinal Run	Fayette	3.14	1.1	**0.35**	Y
1129	9/10/2016	Cardinal Run	Fayette	**11**	2.81	**0.43**	Y
1132	9/10/2016	Wolf Run	Fayette	2.72	1.17	**0.32**	G
1133	9/10/2016	Wolf Run	Fayette	5.11	1.39	0.19	G
1134	9/9/2016	**Spring Branch**	**Fayette**	**10.3**	2.75	**0.35**	R
1135	9/9/2016	Wolf Run	Fayette	2.33	1.11	**0.34**	Y
1137	9/10/2016	Vaughn's Branch	Fayette	1.24	0.66	**0.37**	Y
1138	9/9/2016	Vaughn's Branch	Fayette	0.41	< than MDL	**0.51**	Y
1139	9/12/2016	Vaughn's Branch	Fayette	0.19	1.22	0.25	G
1143	9/9/2016	Dry Fork	Letcher	0.88	< than MDL	< than MDL	G
1151	9/10/2016	Left Fk Cram Creek	Letcher	0.86	< than MDL	< than MDL	G
1152	9/10/2016	Right Fk Cram Creek	Letcher	0.81	< than MDL	< than MDL	G
1174	9/9/2016	Royal Springs	Scott	7.92	2.12	0.28	G
1185	9/10/2016	N Fk Kentucky River	Letcher	1.57	0.91	< than MDL	G
1191	9/10/2016	Kentucky River	Mercer	1.02	0.78	0.12	G
1195	9/10/2016	Lees Branch	Woodford	4.18	1.3	**0.46**	Y
1221	9/9/2016	**Cane Run**	**Scott**	**18.5**	**5.23**	**0.64**	R
1243	9/9/2016	Long Branch	Letcher	1.42	0.77	< than MDL	G
1270	9/9/2016	Unnamed Tributary	Lincoln	0.65	0.71	0.2	G
1271	9/10/2016	Herrington Lake	Mercer	0.63	0.65	< than MDL	G
1274	9/12/2016	Elk Lick Creek	Fayette	2.07	0.78	**0.32**	G
1276	9/10/2016	West Hickman Creek	Fayette	1.75	0.61	0.25	G
1278	9/12/2016	Kentucky River	Woodford	0.44	0.61	0.06	G
1287	9/9/2016	Kentucky River	Mercer	0.47	< than MDL	< than MDL	G
1301	9/10/2016	North Elkhorn Creek	Scott	2.58	1.4	**0.39**	Y
1307	9/9/2016	Jessamine Creek	Jessamine	1.24	1.11	0.25	G
1314	9/9/2016	Wolf Run	Fayette	3.57	1.51	**0.32**	Y
2924	9/10/2016	Tates Creek	Madison	< than MDL	0.9	0.09	G
2954	9/9/2016	**St. Asaph's Creek**	**Lincoln**	**31.2**	**7.34**	< than MDL	R
2970	9/10/2016	Preston's Cave Spring	Fayette	9.5	2.6	**0.32**	Y
3010	9/9/2016	**Town Branch**	**Fayette**	**13.3**	**3.32**	0.22	R
3013	9/10/2016	**Shannon Run**	**Woodford**	**19.6**	**4.74**	**0.31**	R
3059	9/10/2016	Gardenside Branch	Fayette	6.04	1.68	**0.38**	Y
3060	9/12/2016	Vaughn's Branch	Fayette	1.94	0.93	0.29	G
3128	9/9/2016	Unnamed Tributary	Fayette	4.21	1.22	**0.33**	Y
3137	9/12/2016	Wolf Run	Fayette	4.97	1.52	0.1	G
3172	9/10/2016	Tates Creek	Madison	0.26	< than MDL	0.1	G
3203	9/12/2016	Evans Branch	Fayette	2.98	0.96	**0.35**	Y
3211	9/10/2016	Silver Creek	Madison	0.11	0.74	< than MDL	G
3214	9/9/2016	**Glenns Creek**	**Woodford**	**27.3**	**6.35**	**1.03**	R
3216	9/9/2016	Unnamed Tributary	Fayette	2.41	1.25	**0.48**	Y
3227	9/12/2016	Whittleton Branch	Powell	0.57	< than MDL	< than MDL	G
3230	9/9/2016	South Elkhorn Creek	Fayette	3.63	1.08	**0.31**	G
3252	9/9/2016	South Elkhorn Creek	Jessamine	1.52	1.11	0.26	G
3271	9/10/2016	N Fk Kentucky River	Breathitt	< than MDL	0.91	< than MDL	G

Site ID#	Sampling Date	Stream	County	Nitrate (NO_3)	Total Nitrogen	Total Recoverable Phosphorus	Assessment
3283	9/9/2016	Lower Howard Creek	Clark	0.39	< than MDL	< than MDL	G
3298	9/9/2016	Red Lick Creek	Estill	0.13	< than MDL	< than MDL	G
3299	9/9/2016	Locust Branch	Estill	< than MDL	< than MDL	< than MDL	G
3300	9/9/2016	Ross Creek	Lee	1.58	< than MDL	< than MDL	G
3343	9/9/2016	Buck Lick Branch	Lee	0.5	< than MDL	< than MDL	G
3349	9/9/2016	Waterslide Lake	Lee	< than MDL	1.66	0.24	G
3350	9/9/2016	Town Creek	Jessamine	3.72	1.02	0.26	G
3363	9/12/2016	Silver Creek	Madison	< than MDL	< than MDL	< than MDL	G
3369	9/8/2016	Kentucky River	Carroll	2.03	1.14	0.14	G
3373	9/8/2016	Kentucky River	Owen	3.55	1.2	0.14	G
3370	9/9/2016	Notch Lick	Carroll	0.44	< than MDL	0.17	G
3371	9/9/2016	Locust Creek	Carroll	0.39	< than MDL	0.06	G
3390	9/9/2016	Wildcat Chase	Fayette	3.67	1.54	**0.58**	Y
3397	9/9/2016	Middle Fk Kentucky River	Leslie	0.11	< than MDL	< than MDL	G
3398	9/9/2016	Rockhouse Creek	Leslie	0.54	< than MDL	< than MDL	G
3400	9/9/2016	Bull Creek	Leslie	0.11	< than MDL	< than MDL	G
3401	9/9/2016	Cutshin Creek	Leslie	0.78	< than MDL	< than MDL	G
3402	9/9/2016	Middle Fk Kentucky River	Leslie	1.24	< than MDL	< than MDL	G
3403	9/9/2016	Middle Fk Kentucky River	Leslie	0.25	< than MDL	< than MDL	G
3405	9/9/2016	Beech Fork	Leslie	1.7	< than MDL	< than MDL	G
3407	9/9/2016	Ohio River	Carroll	5.29	1.75	0.11	G
3410	9/10/2016	**South Elkhorn Creek**	**Franklin**	**32.9**	**8**	**1.07**	R
3434	9/9/2016	Unnamed Tributary	Estill	0.39	< than MDL	< than MDL	G
3449	9/9/2016	**Elkhorn Creek**	**Franklin**	**12.3**	**3.4**	**0.54**	R
3451	9/9/2016	Crooked Creek	Estill	0.13	< than MDL	< than MDL	G
3473	9/10/2016	Isaac Creek	Harlan	0.87	< than MDL	< than MDL	G
3476	9/10/2016	Boone Creek	Garrard	0.46	< than MDL	0.14	G
3477	9/10/2016	Dix River	Garrard	3.22	1.07	0.13	G
3478	9/9/2016	Town Branch	Fayette	9.89	2.78	**0.38**	Y
3479	9/9/2016	Stewart Creek	Estill	1	< than MDL	< than MDL	G
3482	9/10/2016	Creeches Creek	Wolfe	0.21	< than MDL	< than MDL	G
3485	9/9/2016	Woodward Creek	Estill	0.13	< than MDL	< than MDL	G
3486	9/9/2016	Woodward Creek	Estill	0.2	< than MDL	< than MDL	G
3487	9/9/2016	Cave Creek	Fayette	5.43	1.31	0.29	G
3515	9/9/2016	**St. Asaph's Creek**	**Lincoln**	**25**	**5.44**	0.06	R
3516	9/9/2016	**St. Asaph's Creek**	**Lincoln**	**23.9**	**5.34**	0.06	R
3517	9/9/2016	**St. Asaph's Creek**	**Lincoln**	**19.8**	4.63	0.06	R
3520	9/10/2016	Crystal Creek	Lee	0.45	< than MDL	< than MDL	G
3522	9/10/2016	N Fk Kentucky River	Lee	< than MDL	< than MDL	< than MDL	G
3531	9/10/2016	Big Branch	Lee	8.97	1.89	< than MDL	G
3532	9/10/2016	Double Cabin Creek	Lee	0.13	< than MDL	< than MDL	G
3549	9/12/2016	Shaker Creek	Mercer	5.37	1.4	**0.39**	Y
3550	9/12/2016	Shaker Creek	Mercer	4.97	1.3	**0.37**	Y
3551	9/12/2016	Shawnee Run	Mercer	3.45	0.84	**0.38**	Y
3564	9/10/2016	Sturgeon Creek	Lee	0.12	< than MDL	< than MDL	G

Table 6

2016 KRWW Metal Sampling Results

Site ID#	Stream	County	Sampling Date	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium
Method Detection Limit (MDL)				0.061 mg/L	0.012 mg/L	0.014 mg/L	0.003 mg/L	0.001 mg/L	0.008 mg/L	0.001 mg/L
Water Quality Standard/ Benchmark (mg/L) *AL=Aquatic Life Standard (Acute/Short-term and Chronic/Long-term) DWS=Drinking Water Supply Standard*				**0.75 (AL-acute)** *EPA recommended*	**0.0056 (DWS)**	**0.010 (DWS); 0.34 (AL-acute); 0.15 (AL - chronic)**	**1.0 (DWS)**	**0.004 (DWS)**	**N/A**	**0.005 (DWS); 0.0021 (AL-acute); 0.00027 (AL-chronic)**
801	N Fk Kentucky River	Letcher	9/10/2016	0.14	**None detected.**	**None detected.**	0.07	**None detected.**	0.04	**None detected.**
811	Steeles Branch	Fayette	9/9/2016	0.19			0.03		0.02	
820	N Fk Kentucky River	Perry	9/10/2016	0.31			0.07		0.04	
827	Quicksand Creek	Breathitt	9/10/2016	0.17			0.05		0.02	
848	N Fk Kentucky River	Letcher	9/10/2016	0.1			0.07		0.04	
850	Colley Creek	Letcher	9/10/2016	0.08			0.07		0.03	
875	Right Fk Carr Creek	Perry	9/10/2016	0.21			0.05		0.03	
944	S Fk Quicksand Creek	Breathitt	9/10/2016	0.09			0.06		0.02	
1139	Vaughn's Branch	Fayette	9/12/2016	0.73			0.05		0.04	
1143	Dry Fork	Letcher	9/9/2016	< than MDL			0.02		0.05	
1152	Right Fk Cram Creek	Letcher	9/10/2016	0.07			0.07		0.03	
1185	N Fk Kentucky River	Letcher	9/10/2016	0.1			0.07		0.04	
3230	S Elkhorn Creek	Fayette	9/9/2016	< than MDL			0.04		0.04	
3371	Locust Creek	Carroll	9/9/2016	< than MDL			0.03		0.06	
3398	Rockhouse Creek	Leslie	9/9/2016	< than MDL			0.07		0.03	
3401	Cutshin Creek	Leslie	9/9/2016	0.09			0.05		0.04	
3451	Crooked Creek	Estill	9/9/2016	0.41			0.03		0.03	
3473	Isaac Creek	Harlan	9/10/2016	0.07			0.04		0.01	
3476	Boone Crrek	Garrard	9/10/2016	0.1			0.04		0.03	
3479	Stewart Creek	Estill	9/9/2016	0.07			0.26		0.016	
3515	St. Asaph's Creek	Lincoln	9/9/2016	0.07			0.05		0.03	
3520	Crystal Creek	Lee	9/10/2016	< than MDL			0.04		0.06	
3532	Double Cabin Creek	Lee	9/10/2016	< than MDL			0.03		0.02	
3548	Millers Creek	Estill	9/10/2016	0.16			0.25		0.03	

NOTES:

1) Highest values for each parameter are shaded.

2) Bolded values exceed a water quality standard or benchmark.

2016 KRWW Metal Sampling Results

Site ID#	Calcium	Chromium	Cobalt	Copper	Gold	Iron	Lead	Lithium	Magnesium
MDL	0.002 mg/L	0.024 mg/L	0.001 mg/L	0.005 mg/L	0.034 mg/L	0.002 mg/L	0.010 mg/L	0.001 mg/L	0.001 mg/L
Water Quality Standards	**N/A**	**0.1 (DWS); 1.8 (AL - acute); 0.086 (AL-chronic)**	**N/A**	**1.3 (DWS); 0.014 (AL-acute); 0.0093 (AL-chronic)**	**N/A**	**0.3 (DWS); 4 (AL-acute); 1 (AL-chronic)**	**0.015 (DWS); 0.082 (AL-acute); 0.0032 (AL-chronic)**	**N/A**	**N/A**
801	80.7	**None detected.**	< than MDL	**None detected.**	**None detected.**	0.27	**None detected.**	0.03	46.5
811	75.1		< than MDL			0.19		0.001	6.77
820	77		< than MDL			**0.47**		0.02	45.5
827	62.6		< than MDL			**0.39**		0.008	57.5
848	77		< than MDL			0.25		0.03	42.8
850	70.4		< than MDL			0.25		0.03	37.1
875	112		< than MDL			**0.32**		0.02	90.8
944	64.9		< than MDL			0.19		0.01	81.9
1139	72.4		< than MDL			**0.75**		0.004	13.7
1143	69.3		< than MDL			**0.7**		0.06	29.1
1152	60.8		< than MDL			0.11		0.005	12.3
1185	78.3		< than MDL			0.27		0.03	43.2
3230	107		< than MDL			0.07		< than MDL	10.2
3371	74.3		< than MDL			0.01		0.002	18.6
3398	53.5		< than MDL			0.24		0.008	16.2
3401	170		< than MDL			0.08		0.03	149
3451	51.3		0.002			**0.64**		0.003	10.3
3473	26		< than MDL			**0.49**		0.002	8.33
3476	76.3		< than MDL			0.1		< than MDL	10.9
3479	56.5		< than MDL			0.04		0.003	3.82
3515	46.6		< than MDL			0.07		0.003	17.9
3520	37.6		< than MDL			0.1		0.005	13
3532	42.6		< than MDL			0.6		0.002	5.21
3548	54.3		< than MDL			**1.03**		0.004	5.8

2016 KRWW Metal Sampling Results

Site ID#	Manganese	Nickel	Phosphorus	Potassium	Selenium	Silicon	Silver	Sodium	Strontium	Sulfur
MDL	0.001 mg/L	0.002 mg/L	0.009 mg/L	0.191 mg/L	0.011 mg/L	0.009 mg/L	0.003 mg/L	0.058 mg/L	0.010 mg/L	0.014 mg/L
Water Quality Standards	**N/A**	**0.61 (DWS); 0.47 (AL-acute); 0.052 (AL-chronic)**	**N/A**	**N/A**	**0.17 (DWS); 0.258 (AL-acute)**	**N/A**	**0.0038 (AL-acute)**	**N/A**	**N/A**	**N/A**
801	0.04	< than MDL	0.04	7.81	**None detected.**	3	**None detected.**	56.1	1.97	97.3
811	0.05	< than MDL	0.43	5.73		3.86		15.8	0.12	7.73
820	0.11	0.002	0.06	7.82		1.86		69.7	1.29	112
827	0.13	< than MDL	0.01	7.37		2.34		7.9	0.38	77.7
848	0.05	< than MDL	0.03	7.26		2.9		50.8	1.75	90.6
850	0.09	0.002	0.03	6.17		4.78		36.4	1.22	102
875	0.11	< than MDL	0.01	8.88		2.8		51.8	1.62	196
944	0.06	< than MDL	< than MDL	9.01		2.32		6.36	0.41	74.3
1139	0.5	< than MDL	0.3	5.02		3.44		43	0.25	28.1
1143	0.29	< than MDL	< than MDL	7.97		5.22		185	2.23	123
1152	0.01	0.005	0.009	3.85		4.91		12.2	0.35	23.6
1185	0.07	< than MDL	0.03	7.19		2.9		51.8	1.79	91.7
3230	0.04	< than MDL	0.32	3.69		3.46		28.4	0.2	16.5
3371	0.016	< than MDL	0.06	3.65		3.95		9.75	0.15	11.8
3398	0.05	< than MDL	0.01	4.46		2.59		23.3	0.54	38.5
3401	0.03	< than MDL	0.01	9.99		4.08		56.4	1.61	343
3451	0.24	0.006	0.01	4.31		8.15		5.57	0.1	13.9
3473	0.06	< than MDL	< than MDL	3.48		2.27		7.3	0.09	4.55
3476	0.03	< than MDL	0.15	5.31		2.12		9.65	0.14	7.59
3479	0.007	< than MDL	< than MDL	2.41		3.46		6.61	0.2	1.55
3515	0.01	< than MDL	0.06	3.61		4.17		4.03	0.07	3.59
3520	0.16	< than MDL	< than MDL	4.23		3.55		14.9	0.25	28.7
3532	0.66	< than MDL	< than MDL	4.49		4.42		6.54	0.09	1.99
3548	0.34	< than MDL	< than MDL	2.89		3.1		21.8	0.58	1.46

2016 KRWW Metal Sampling Results

Site ID#	Thallium	Tin	Vanadium	Zinc	Assessment
MDL	0.041 mg/L	0.012 mg/L	0.008 mg/L	0.002 mg/L	
Water Quality Standards	**0.00024 (DWS)**	**N/A**	N/A	**7.4 (DWS); 0.12 (acute/ chronic AL)**	**R (red) = poor Y (yellow) = fair G (green) = good**
801	**None detected.**	**None detected.**	**None detected.**	< than MDL	G
811				< than MDL	G
820				< than MDL	G
827				< than MDL	G
848				< than MDL	G
850				0.008	G
875				< than MDL	G
944				< than MDL	G
1139				0.007	G
1143				< than MDL	G
1152				0.003	G
1185				0.02	G
3230				< than MDL	G
3371				< than MDL	G
3398				< than MDL	G
3401				< than MDL	G
3451				0.002	G
3473				< than MDL	G
3476				< than MDL	G
3479				< than MDL	G
3515				< than MDL	G
3520				< than MDL	G
3532				0.002	G
3548				< than MDL	Y

APPENDIX C: METAL SAMPLING PARAMETERS

Antimony is a USEPA priority pollutant that can be toxic to plants and animals. In addition to the natural occurrence of antimony in bedrock and streambed sediments in the Knobs Region of the Kentucky River Basin, antimony salts are used in the fireworks, rubber, textile, ceramic, glass, and paint industries.
The proposed maximum contaminant level (MCL) in finished drinking water for antimony ranges from 5 to 10 micrograms per liter.

Arsenic occurs naturally in rocks and soil, water, air and plants and animals. It can be further released into the environment through natural activities, such as volcanic action, erosion of rocks, and forest fires, or through human actions. Approximately 90 percent of industrial arsenic in the U.S. is currently used as a wood preservative, but arsenic is also used in paints, dyes, metals, drugs, soaps and semi-conductors. High arsenic levels can also come from certain fertilizers and animal feeding operations. Industry practices, such as copper smelting, mining and coal burning also contribute to arsenic in our environment. Arsenic levels tend to be higher in ground water than in surface water (lakes and rivers). Levels also tend to be higher in the western United States.

Barium is a yellowish-white alkaline earth metal. It combines with water to produce barium hydroxide and is found in nature as barites ($BaSO_4$), witherite ($BaCO_3$), and other ores. Barium and its salts are often used in metallurgical industries for special alloys, in paints, and concrete. Because of the insolubility of most of its compounds, it is not considered to be an ecological threat.

Beryllium is an uncommon alkaline-earth element that is recognized as a USEPA priority pollutant and potential carcinogen. The USEPA has proposed a MCL of 1.0 micrograms per liter for beryllium, and Kentucky has adopted the USEPA lowest-observed effect levels (LOEL) for protection of aquatic life, which are 130 micrograms/liter (1.3 mg/L) and 5.3 micrograms/liter (0.053 mg/L) for acute and chronic toxicity, respectively. In addition, Kentucky water-quality criteria establish a beryllium criterion of 0.117 micrograms per liter for the protection of human health from the consumption of fish tissue. The criterion is based upon an acceptable risk level of no more than one additional cancer case in a population of 1 million people.

Cadmium s a non-essential element and it diminishes plant growth. It is considered a potential carcinogen. It also has been shown to cause toxic effects to the kidneys, bone defects, high blood pressure, and reproductive effects. Cadmium is widely distributed in the environment at low concentrations. It can be found in fairly high concentrations in sewage sludge. Primary industrial uses for cadmium are plating, battery manufacture, pigments, and plastics.

Chromium is ubiquitous in the environment, occurring naturally in the air, water, rocks and soil. It is used in stainless steel, electroplating of chrome, dyes, leather tanning and wood preservatives. It occurs in several forms, or oxidation states. The two most common are chromium VI and chromium III. The form depends on pH. Natural sources of water contain very low concentrations of chromium. It is a micronutrient (or essential trace element). High doses of chromium VI have been associated with birth defects and cancer; however, chromium III is not associated with these effects. Plants and animals do not bioaccumulate chromium; therefore, the potential impact of high chromium levels in the environment is acute toxicity to plants and animals. In animals and humans this toxicity may be expressed as skin lesions or rashes and kidney and liver damage.

Copper is a USEPA priority pollutant that is a micronutrient for the growth of plants and animals, but even small concentrations of copper in surface water can be toxic to aquatic life. Copper sulfate is frequently used to control nuisance growths of algae in water supply reservoirs. The toxicity of copper is a function of the total hardness of the water, because copper ions are complexed by anions that contribute to water hardness. Although detectable concentrations of copper in water are not known to have an adverse effect on humans, the MCL for copper has been established at 1,000 micrograms/liter, which corresponds with the taste threshold concentration for this element (National Academy of Sciences National Academy of Engineering, 1972). [USGS]

Iron is the fourth most abundant element, by weight, in the earth's crust. Natural waters contain variable amounts of iron depending on the geological area and other chemical components of the waterway. Iron in groundwater is normally present in the ferrous or bivalent form (Fe^{2+}), which is soluble. It is easily oxidized to ferric iron (Fe^{3+}) or insoluble iron upon exposure to air. This precipitate is orange-colored and often turns streams orange. Iron is a trace element required by both plants and animals. It is a vital part of the oxygen transport mechanism in the blood (hemoglobin) of all vertebrate and some invertebrate animals. Ferrous Fe^{2+} and ferric Fe^{3+} irons are the primary forms of concern in the aquatic environment. Other forms may be in either organic or inorganic wastewater streams. The ferrous form can persist in water void of dissolved oxygen and usually originates from groundwater or mines that are pumped or drained. Iron in domestic water supply systems stains laundry and porcelain. It appears to be more of a nuisance than a potential health hazard. Taste thresholds of iron in water are 0.1 mg/L for ferrous iron and 0.2 mg/L for ferric iron, giving a bitter taste or an astringent taste. Water to be used in industrial processes should contain less than 0.2 mg/L iron. Black or brown swamp waters may contain iron concentrations of several mg/L in the presence or absence of dissolved oxygen, but this iron form has little effect on aquatic life.

Lead is primarily found in nature as the mineral galena (lead sulfide). It also occurs as carbonate, as sulfate and in several other forms. The solubility of these minerals and also of lead oxides and other inorganic salts is low. Major modern day uses of lead are for batteries, pigments, and other metal products. In the past, lead was used as an additive in gasoline and became dispersed throughout the environment in the air, soils, and waters as a result of automobile exhaust emissions. For years, this was the primary source of lead in the environment. However, since the replacement of leaded gasoline with unleaded gasoline in the mid-1980's, lead from that source has virtually disappeared. Mining, smelting, and other industrial emissions and combustion sources and solid waste incinerators are now the primary sources of lead. Another source of lead is paint chips and dust from buildings built before 1978 and from bridges and other metal structures.

Nickel is a USEPA priority pollutant that can adversely affect humans and aquatic organisms. Nickel is an important industrial metal that is used extensively in stainless steel. Substantial amounts of nickel can be contributed to the environment by waste disposal (Hem, 1989) and atmospheric emissions. Nickel ions are toxic, particularly to plant life, and can exhibit synergism when present with other metallic ions (National Academy of Sciences National Academy of Engineering, 1972). [USGS]

Selenium is a nonmetallic trace element that is listed as a primary pollutant by the USEPA. Selenium is an essential micronutrient for plants and animals, but can be toxic in excessive amounts. Selenium is a relatively rare element, and concentrations of selenium in natural waters seldom exceed 1.0 microgram/liter (Hem, 1989). Sources of selenium in the Kentucky River Basin include sedimentary rocks and fly ash from coal-fired power plants that operate in Kentucky.

Silver is a USEPA priority pollutant that is extensively used for photography and various industrial and commercial purposes. Although average concentrations of silver in natural waters are small (0.3 micrograms/liter), elevated silver concentrations can be acutely or chronically toxic to aquatic organisms, and sublethal amounts can bioaccumulate in fish and invertebrate organisms (Hem, 1989). [USGS]

Thallium is a USEPA priority pollutant that can be toxic to humans and aquatic life. Thallium salts are used as poison for rats and other rodents, as well as in dyes, pigments in fireworks, and optical glass (National Academy of Sciences National Academy of Engineering, 1972).

Zinc is found naturally in many rock-forming minerals. Because of its use in the vulcanization of rubber, it is generally found at higher levels near highways. It also may be present in industrial discharges. It is used to galvanize steel, and is found in batteries, plastics, wood preservatives, antiseptics, and in rat and mouse poison (zinc phosphide). Zinc is an essential element in the diet. It is not considered very toxic to humans or other organisms.