Red Bird River Watershed Restoration Project
Draft Watershed Plan

April 2016

Statement of Acknowledgment:

The project originated in 2011 from a collaborative effort in Knoxville, Tennessee between the U.S. Forest Service and partners. The group focused a lot of energy addressing potential watershed-based restoration efforts in the Southern Appalachian Region. In the very beginning, Clay and Leslie community leaders and residents asked that the focus be on improving water quality and tourism opportunities in and around the Red Bird River. This led to the Forest Service contracting with Kentucky Waterways Alliance to lead and author the watershed restoration plan using their model that has been successful in other communities. Consultant Lynn Garrison, born and raised in Clay and Leslie Counties, contributed expertise in project facilitation and brought much knowledge of the local community to the effort. The Forest Service also contracted with PRIDE to deliver environmental education programs and organize river cleanup efforts.

Many thanks to the participants and volunteers who came from all over the Commonwealth to participate in the community meetings and cleanups. A special thanks to Clay County Judge Joe Asher and Solid Waste Coordinator Chris Reid, Leslie County Judge Executive James Sizemore and Solid Waste Coordinator Angie Muncie, Kentucky Division of Forestry, Kentucky Department of Fish and Wildlife Resources, Kentucky Division of Water, Big Creek Elementary School, Big Creek Mission, Red Bird Mission, Natural Resource Conservation Service, Farm Service Agency, Rural Development, US EPA, Office of Surface Mining, ARRI, Heartwood, MACED, Cumberland Valley RC&D, and the many individuals representing private and community interests across the Region; too numerous to name in fear of leaving out someone. This plan will be the conduit for securing grant funding, volunteer efforts and other means to implement the actions across the Red Bird River Watershed for years to come. It could not have been completed without your assistance. Thank You!

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Chapter 1: Getting Started

1.1 Introduction

The Red Bird Restoration Project has one important purpose - to improve the ecology of Red Bird River area. A major component of this broad mission is to bring the community together to write a watershed plan - or a blueprint for better water quality in the Red Bird River. A watershed plan is a tool that we can use to learn more about our waterway, the land around it, and what is happening on the land that is affecting the waterway. A watershed plan focuses on identifying sources of pollution in the watershed and making recommendations for how best to improve and protect natural and historic resources and water quality in the Red Bird River. The plan is a collaborative effort with an emphasis on protecting the areas that are healthy and vibrant for generations to come.

1.2 The Watershed

The Red Bird River begins in northeastern Bell County, forms the boundary between Clay and Leslie counties, and eventually comes to a confluence with Goose Creek at Oneida to form the South Fork of the Kentucky River. This watershed plan focuses on the Red Bird River Watershed (HUC 05100203010), which means it focuses on the river itself, and the land around it in Clay, Leslie, and Bell Counties (Figure 1.1). The total watershed area is 195.5 square miles and a total of 354 river miles.

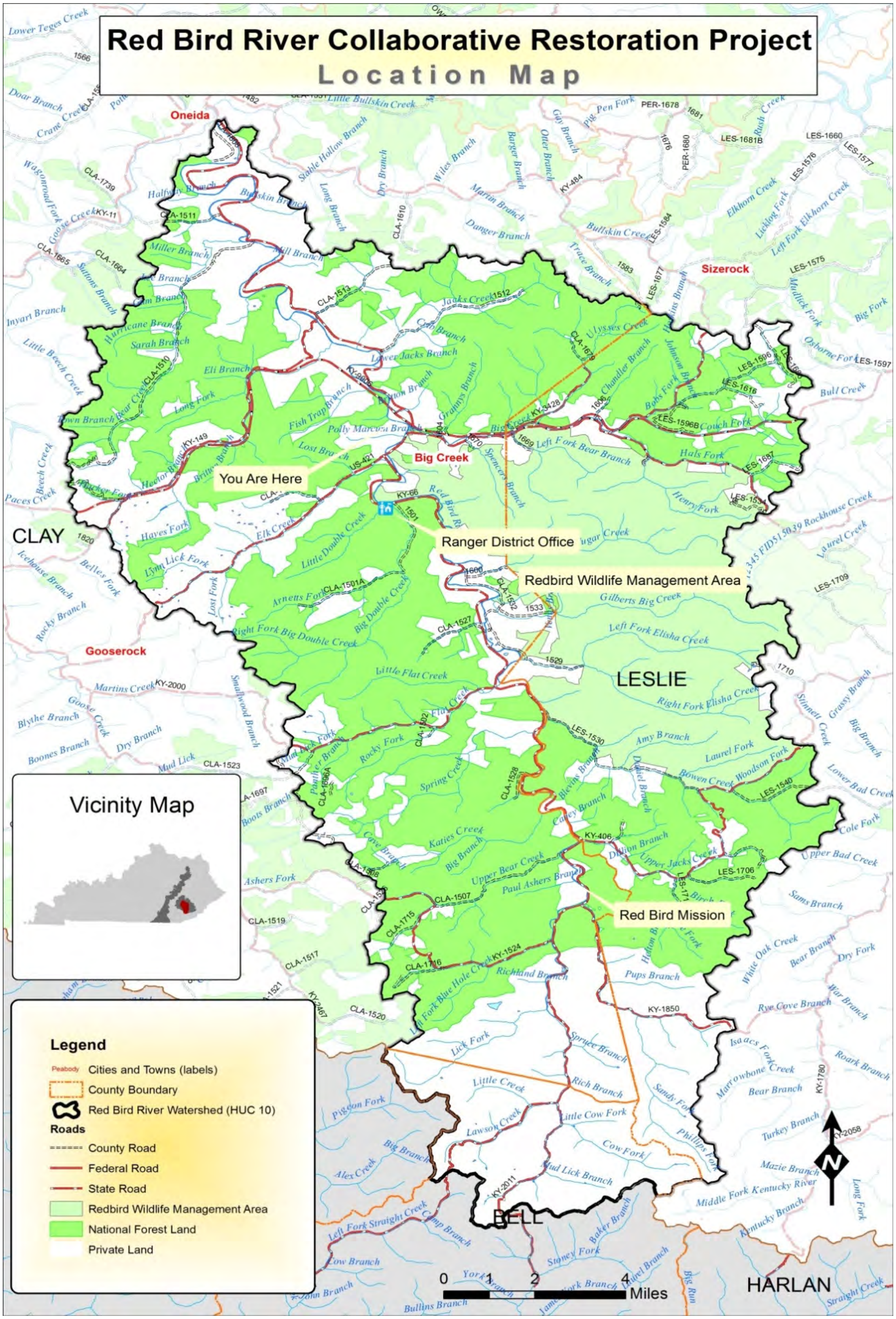

Figure 1.1: Red Bird River Watershed in southeastern Kentucky.

The ultimate goal of this project is to improve water quality in the Red Bird River and its tributaries. Watershed planning is an interactive and iterative process that involves organizations, groups, and community members coming together to develop a tool (a watershed plan) to help meet this goal. A watershed plan can be used to inform the public on local water resource issues, to improve water quality by implementing recommended Best Management Practices (BMPs), and as a basis for applying for future funding.

What is a watershed plan, and why does the Red Bird River need one?
Watershed planning is a comprehensive, collaborative way to plan for the protection and improvement of the water quality in a given body of water. It makes sense to look at all the things affecting the Red Bird River, for example, instead of just the water itself. Watershed planning involves gathering local stakeholders to share their knowledge, concerns, and ideas in developing the plan. It is a great way to protect the streams in good condition, take care of a stream with pollution issues, and outreach to the local community about water resource issues. The knowledge gathered from stakeholders, water quality sampling data, background research, and proposed BMPs to combat pollution or protect resources all go into the plan.

The Red Bird River is mostly in really good condition. However, bacteria in some areas threaten public health and overall water quality. The river is listed as “partially impaired” in the Kentucky 2010 Integrated Report to Congress (KDOW, 2010) for primary contact recreation (swimming or wading). This means that there is too much bacteria in the creek for the water to be safe for contact. Agricultural practices were identified as the suspected source of the problem. As part of this planning process, we will address this issue, find out what is happening, and propose ways we can work together to remedy the problem.

1.3 A brief history of this project

The Redbird River Restoration Project is an outgrowth of the collaborative meeting in Knoxville in June 2010 where partners and stakeholders worked with Forest Service staff to identify a common focus and need for restoration efforts on the watershed in the Redbird district. The initial idea was to accomplish some on-the-ground work and initiate a longer-term collaborative plan for watershed restoration with community partners. From the standpoint of the Daniel Boone National Forest, this work was envisioned as part of the regional efforts toward Southern Appalachian Forest Restoration and the agency-wide Watershed Condition Assessments and Restoration initiative. Some of the partners from Kentucky who attended the Knoxville workshop included John Gassett, Julian Campbell, Scott Shouse, David Ledford, and Lynn Garrison. Some informal discussions with partners continued after the Knoxville workshop, but more focused efforts are now underway to develop a plan for watershed restoration and establish a multi-partner collaborative group to move forward.

1.4 Project Stakeholders and Concerns

Because watershed planning is inclusive and intended for community use, it needs to include all the people that may be affected by the plan and who have a stake in the plan. The community members and organizational personnel in attendance at the first two watershed meetings created the following lists of stakeholders to be included and concerns about the project:

<u>Local stakeholders</u>
Corporate land owners
Private land owners and local residents
State and federal agencies
County commissioners
Magistrates and Judge Executives
Coal companies
Students
Kiwanis
NRCS
State Dept. of Ag
4-H
Community Service groups
Local Farm Bureau Reps.
Chamber
Business owners
Church groups
Wildlife NGOs
KOWA

<u>Chapter One Stakeholder Concerns</u>
Swim and wade in water safely
Drinking water
Not enough landowners involved
Fishing and hunting
Recreation uses
Garbage needs to be picked up first
Army Corps water restrictions
Public Relations

Watershed planning is an iterative process. These lists were made at watershed team meetings. As this plan develops, it will be possible to edit these lists and this chapter.

Red Bird River Watershed

Chapter 2: Watershed Inventory

Introduction 2.1

The Red Bird River is over 34 miles long and runs through the southeastern Kentucky counties of Bell, Clay, and Leslie. The river is part of the Kentucky River Basin, forming the South Fork of the Kentucky River at its confluence with Goose Creek at Oneida, KY. The watershed area includes the communities of Big Creek, Spring Creek, Queensdale, and Beverly, Kentucky.

For much of its course, the Red Bird runs through the Daniel Boone National Forest's Redbird District (Figure 2.1). It also encompasses the 24,014 acre Redbird Wildlife Management Area. The river is an Outstanding State Resource Water and home to some of the most beautiful land in the state of Kentucky.

The Red Bird River is also an impaired waterway with some pollution issues. This chapter describes the watershed, including its impairment status, the land uses surrounding it, and existing water quality data. It also covers local town and population demographics and natural and physical information including hydrology, soils, and geology.

2.2 The Watershed

The Red Bird River Watershed, from the headwaters in Bell County to the mouth at Oneida, is 195 square miles and 125,180 acres. It flows for 349 linear miles of stream. Its hydrologic unit code is 0510020302. This 10-digit code is part of the Hydrologic Unit (HUC) system which is a standardized watershed classification system developed by the US Geologic Survey (USGS). HUCs are watershed boundaries organized by size. Other watersheds comparable in size will also have a 10-digit number; it's like an address for the watershed. Bigger watersheds have smaller HUC numbers. The Red Bird River Watershed is part of the larger Kentucky River Basin.

Project Overview

Chapter 1 presents an introduction to the project, including stakeholders and stakeholder concerns. Chapter 2 covers information that was available on the Red Bird River Watershed prior to this project. These information and data have been gathered from a variety of sources in order to create an understanding of the watershed. Chapter 3 covers new water quality data that were collected specifically for this plan.

Chapter 4 includes the results from the water quality sampling as well as prioritization of areas for treatment based on the results. Water quality issues may be remediated using a variety of different BMPs, which are outlined in Chapter 5. Chapters 6 discusses which BMPs are chosen for specific water quality problems, based on feasibility, in defined areas within the watershed and how. Chapter 7 outlines the plans for BMP implementation and continued monitoring.

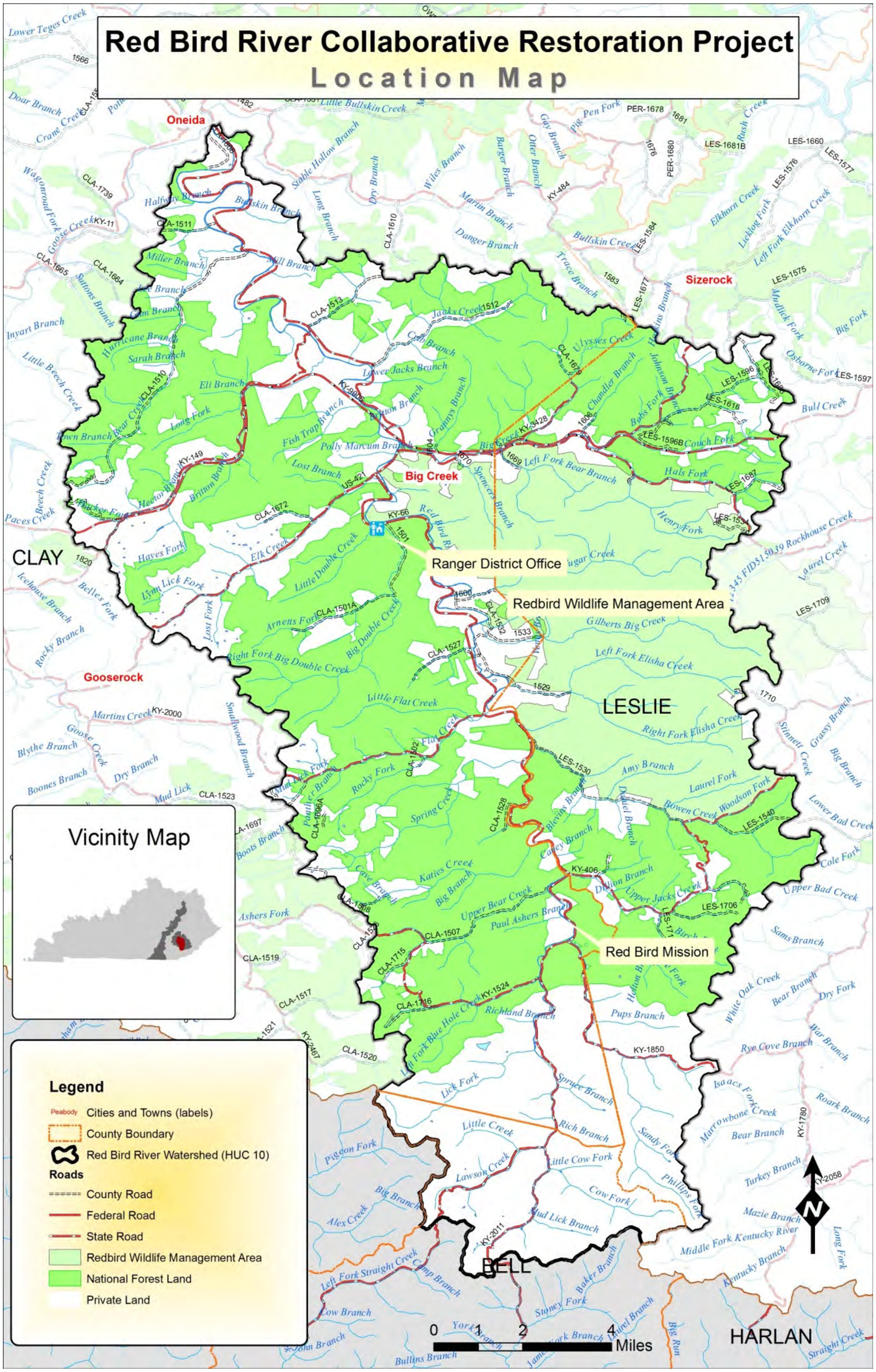

Figure 2.1: The land ownership in Red Bird River Watershed in southeastern Kentucky.

2.3 Water Resources

Hydrology

Hydrology is the study of water on the Earth and how that water is distributed and how it affects the Earth's surface. The Red Bird River begins its course in Bell County and flows north through the steep terrain of southeastern Kentucky until it meets Goose Creek near Oneida to form the South Fork of the Kentucky River (Figure 2.2).

Stream flow and precipitation

Stream flow (or discharge) measures the amount of water traveling through a stream in cubic feet per second (cfs). One could also think of this as a measurement of how much water is in a stream at one time. Knowing the stream flow can be a useful tool. Precipitation is directly linked to stream flow. Pollutants in the water are also affected by stream flow in that they can be more concentrated or more diluted depending on how much water is in the stream. High flows also have the potential to pick up more pollutants and transport them to downstream locations. The USGS has gaging stations that record these data year-round on many streams throughout the country. There is one USGS gaging station (03281040) on the river in Big Creek.

In the Red Bird River Watershed, precipitation is distributed throughout the year with autumn receiving the lowest average amount. Mean annual precipitation averages 49 inches. The greatest average monthly precipitation occurs in March (5.3 inches) followed by July (4.9 inches); the least occurs in October (3.4 inches). A portion of the precipitation occurs as snow, sleet, or freezing rain. Snowfall averages 15 to 17 inches per year.

Ridges are narrow and winding. Side slopes average 40-50 percent slope, but may exceed 65 percent in the most entrenched valleys. Rock outcrops are occasionally encountered. Valleys are narrow and V-shaped, with long slopes. Small cliffs are infrequently encountered in the most entrenched valleys. Fourth and fifth order streams have well-developed alluvial bottoms.

The Red Bird River Watershed has a moderate number of small to medium sized intermittent and perennial streams and rivers. Larger streams have moderately broad, flat valleys with well-developed floodplains. Gradients are moderately high. Drainage patterns are dendritic. Dissection is moderately high throughout the Red Bird watershed with an average of 17.8 miles of ephemeral, intermittent and perennial streams per square mile.

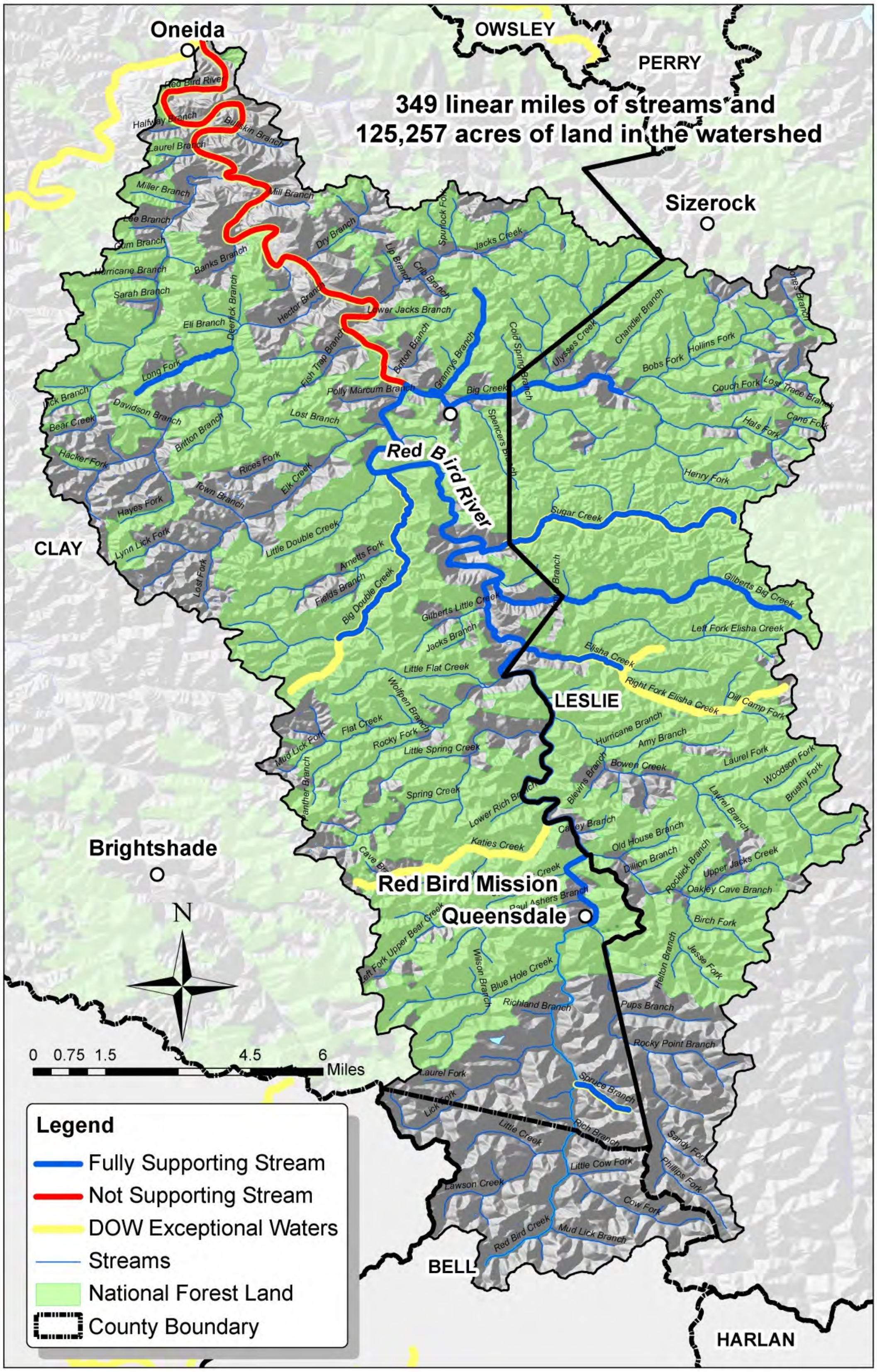

Figure 2.2: Streams and impairment status within the Red Bird River Watershed.

Stream flow varies in a pattern similar to the seasonal variation in rainfall, and varies from stream to stream based on drainage basin size and other physical characteristics. Stream flow generally increases during November through January as precipitation increases and evapotranspiration decreases. Increasing precipitation in the form of rain or snow augments flows through the winter months. Spring thunderstorms help to maintain a relatively high runoff through May. The steep valley slopes of the upper basins promote rapid runoff and flash flooding, while the flatter slopes of the lower basins promote slower runoff and the flooding covers larger areas for longer periods of time. The low-flow season generally begins in June and extends through late October, although early summer thunderstorms often produce some of the largest flood events (Figure 2.3). At the mouth of the Red Bird River, 100-year flood flows are approximately 32,720 cubic feet per second.

Low-flow frequency is often expressed as the lowest average for a given number of consecutive days for a given recurrence interval. In the 195 square mile Red Bird Watershed, the 7-day, 10 year recurrence interval flow is 0.5 cubic feet per second and the mean annual streamflow near the mouth for 2011 was 272.3 cfs (KY Watershed Viewer 2012).

Hydrology

Flooding is a natural phenomenon that occurs regularly with any waterway. A healthy riparian zone (the vegetative buffer along waterways) and an undeveloped floodplain can help decrease the severity of flooding. As an area becomes more developed with fewer trees, shrubs, and grasses and more impervious surfaces (like roads and buildings), the more frequent severe flooding may be. Flooding in the Red Bird River Watershed is not a big problem in typical years outside of flash flooding after big storms. The high percentage of forest and otherwise undeveloped land helps decrease the occurrence of severe flooding.

Two of the largest floods in the Red Bird River Watershed were in 1947 and 1957. The heaviest damage occurred in built up areas where a higher percentage of homes were built in the flood plain than homes in less developed areas. Figure 2.3 shows the Ranger Station in the Peabody area in 1940, before the 1947 flood. Figure 2.4 shows the same area during the 1947 flood.

Figure 2.3: Photo of the Ranger Station in Peabody in 1940 (USFS 2012).


Figure 2.4: The June 28, 1947 Red Bird River flood as seen from the USFS office in Peabody, KY.

In addition to the unusually heavy rain fall, a convergence of other events that diminished the area of forest cover and reduced forest health across the landscape may have contributed to the severity of flooding in the 1947 and 1957 floods. These factors include:

1. By the mid-1930s more than 50% of American Chestnut trees in the watershed had succumbed to chestnut blight. By 1940, essentially all were dead. With the loss of chestnut, mast hogs turned to other plants and did extensive damage to the herbaceous plants. Wildlife, people, and livestock lost a major, dependable food supply and a significant source of income. This was a major disturbance event for the forests.
2. Logging began when early settlers started to use trees to construct homes, build fences, and heat homes. Native Americans and settlers cleared land for farming. Early settlers started cutting logs to sell to companies outside the area around 1870 and continued until large out-of-state companies gained control of most of the land and timber.
3. Considerably more land was being cultivated and grazed in 1947 and 1957 than today. Up until 1950, domestic livestock was allowed to graze in the forest. The 1945 Census of Agriculture indicated that more than 16,000 hogs and pigs fed in the forests and pastures of Clay and Leslie counties. In addition, there were 9,250 cattle and 4,050 mules and horses. The 1945 Census of Agriculture showed 128,589 acres of cropland compared to only 15,020 in 2007. The number of livestock units (excluding chickens, ducks, and geese) was 19,921 in 1945 and 3,632 in 2007. The overall effect of this situation was less ground cover and potentially compacted soils on steep slopes. Both of these would have contributed to increased and faster rainfall runoff coming off of the slopes.

This information was compiled by Lynn Garrison from noted sources. Additional information and personal accounts of flooding in the Red Bird area can be found in the Appendix A.

Groundwater-surface water interaction

Surface water features (streams, lakes, reservoirs, wetlands, and estuaries) interact with groundwater. These interactions are important to consider because a streams can get water from, or lose water to, the groundwater system. This exchange of water can have an impact on the water quality and quantity of waterways. Withdrawal of water from streams can deplete groundwater or conversely, removal of groundwater can deplete water in streams, lakes, or wetlands. Similarly, pollution of surface water can cause degradation of groundwater quality, and pollution of groundwater can degrade surface water. Effective watershed planning requires a clear understanding of the linkages between groundwater and surface water as it applies to any given setting (USGS 2012). Groundwater systems do not necessarily share the same watershed boundaries of surface waterways.

In many places in Kentucky, there are karst features. “Karst” is a term used to describe features of limestone deposits that have become eroded by surface and/or groundwater. Features of karst topography include caves, sinkholes, and underground streams. A major karst area can be found along the crest of Pine Mountain in southeast Kentucky. Limestone from beneath the coal fields was thrust to the surface through geologic processes. This section dissects Bell County, but is south of the Red Bird River Watershed (Currens 2002).

Regulatory Status of Waterways

The Red Bird River and many of its tributaries have been assessed by the Kentucky Division of Water (KDOW). The Red Bird River is an impaired waterway. It is also an Outstanding State Resource Water (OSRW). The Red Bird River can be both an OSRW and an impaired waterway because the Clean Water Act has a provision, in the anti-degradation section of the water quality standards, that allows for waterways with a special status like an OSRW to maintain Tier 2 protections even though water quality standards are not being met for one of its designated uses. This is so the river does not become more degraded. The Red Bird is impaired because it has too much fecal coliform. This means that the impaired section of the river is not safe for primary contact (like swimming), but that same section of the river could still be good habitat for aquatic organisms. Table 2.1 illustrates assessment information.

Designated Uses

KDOW assigns designated uses to each assessed waterway. For each use, certain chemical, biological, or descriptive ("narrative") criteria apply to protect the stream so that its uses can safely continue. The criteria are used to determine whether a stream is "impaired," and thus needs a watershed-based plan or Total Maximum Daily Load (TMDL) study. If a waterway does not meet water quality standards for its designated use, then it is considered impaired.

According to KDOW, all unassessed waters in Kentucky are labeled as "High Quality" waters. Waterways may have the following designated uses:

- primary contact recreation (PCR) like swimming or wading
- secondary contact recreation (SCR) like fishing or boating
- warm water aquatic habitat (WAH)
- cold water aquatic habitat (CAH)
- domestic water supply (WS)
- Outstanding State Resource Water (OSRW)

Impairment Status

Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop a Total Maximum Daily Load, or TMDL, for these waters. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards (US EPA 2012).

Table 2.1: Red Bird River Watershed Assessment Information (KDOW 2012).

Waterbody & Segment	Total Size	County	WAH/CAH	PCR	SCR	Fish Cons.	DWS	Assess Date	Designated Uses	Assessment Category	Causes	Sources
Big Creek 0.0 to 4.3	4.3 Miles	Clay	2-FS	3	3	3	3	12/19/1999	CAH, FC, PCR, SCR	2		
Big Double Creek 0.0 to 4.4	4.4 Miles	Clay	2-FS	3	3	3	3	1/1/2004	WAH, FC, PCR, SCR	2		
Big Middle Fork Elisha Creek 0.0 to 1.5	1.5 Miles	Clay	2-FS	3	3	3	3	1/1/2005	WAH, FC, PCR, SCR	2		
Bowen Creek 0.0 to 1.5	1.5 Miles	Leslie	5-PS	3	3	3	3	11/19/2009	WAH, FC, PCR, SCR	5	463 – impairment unknown	140 – source unknown
Elisha Creek 0.8 to 1.8	1 Miles	Leslie	2-FS	3	3	3	3	3/4/2005	WAH, FC, PCR, SCR	2		
Hector Branch 0.0 to 5.5	5.5 Miles	Clay	5-PS	3	3	3	3	11/25/2009	WAH, FC, PCR, SCR	5	463 – impairment unknown	140 – source unknown
Left Fork Big Double Creek 0.0 to 1.5	1.5 Miles	Clay	2-FS	3	3	3	3	3/22/2005	WAH, FC, PCR, SCR	2		
Left Fork Elisha Creek 0.0 to 3.9	3.9 Miles	Leslie	2-FS	3	3	3	3	3/22/2005	WAH, FC, PCR, SCR	2		
Little Middle Fork Elisha Creek 0.0 to 0.75	0.75 Miles	Leslie	2-FS	3	3	3	3	3/22/2005	WAH, FC, PCR, SCR	2		
Red Bird River 0.0 to 15.3	15.3 Miles	Clay	2-FS	5-PS	2-FS	3	3	1/5/2010	WAH, FC, PCR, SCR	5	400 – fecal coliform	156 – ag.
Spruce Branch 0.0 to 1.8	1.8 Miles	Clay	2-FS	3	3	3	3	3/1/2003	WAH, FC, PCR, SCR	2		
Upper Jacks Creek 0.0 to 2.2	2.2 Miles	Clay	5-PS	3	3	3	3	12/3/2009	WAH, FC, PCR, SCR	5	463 – impairment unknown	140 – source unknown
Katie's Creek 0.0 to 4.05	4.05 Miles	Clay	2-FS	3	3	3	3	11/25/2009	WAH, FC, PCR, SCR	2		

*Reporting categories assigned to surface waters during the assessment process: Category 1 - Attaining all designated uses. Category 2 - Attaining some designated uses; insufficient or no data available to determine if the remaining uses are attained. Category 3 - Insufficient or no data and information are available to determine if any designated use is attained or impaired. Category 4 - Impaired or threatened for one or more designated uses but does not require development of a TMDL: A. TMDL has been completed. B. Pollution control requirements are reasonably expected to result in attainment of water quality standard in near future. C. Impairment is not caused by a pollutant. Category 5 - Impaired or threatened for one or more designated uses by a pollutant(s), and requires a TMDL.

Impaired waterways are recorded in an official report created by KDOW every two years, the *Integrated Report to Congress on the Condition of Water Resources in Kentucky* (2010 Integrated Report) (NOTE: 2010 was the most current status when the report was written. More current data are available and watershed BMP activities will be adjusted where applicable). It reports on the quality of water in the assessed streams, lakes, and reservoirs of all major river basins of the state and includes the 303(d) list of impaired waterways. The list of impaired waters requiring a TMDL is called the 303(d) list and can be found in Volume 2 of the Integrated Report. The report is public information and may be accessed online or by contacting the Kentucky Division of Water offices at (502) 564-3410.
Each two year cycle focuses on a different river basin in Kentucky, but the report includes information on all the impaired waterways in the state.

The Red Bird River is listed as impaired in the 303(d) List of the 2010 Integrated Report to Congress and requires a TMDL:

- Red Bird River, river miles 0.0 to 15.3, Clay County
  Into Kentucky River Segment Length: 15.3
  Impaired Use(s): Primary Contact Recreation Water (Partial Support)
  Pollutant(s): Fecal Coliform
  Suspected Sources: Agriculture

Three direct tributaries to the Red Bird River are also impaired and require a TMDL:

- Bowen Creek, river miles 0.0 to 1.5, Leslie County
  Into Red Bird River Segment Length: 1.5
  Impaired Use(s): Warm Water Aquatic Habitat (Partial Support)
  Pollutant(s): Cause Unknown
  Suspected Sources: Source Unknown

- Hector Branch, river miles 0.0 to 5.5, Clay County
  Into Red Bird River Segment Length: 5.5
  Impaired Use(s): Warm Water Aquatic Habitat (Partial Support)
  Pollutant(s): Cause Unknown
  Suspected Sources: Source Unknown

- Upper Jacks Creek, river miles 0.0 to 2.2, Clay County
  Into Red Bird River Segment Length: 2.2
  Impaired Use(s): Warm Water Aquatic Habitat (Partial Support)
  Pollutant(s): Cause Unknown
  Suspected Sources: Source Unknown

Special Use Waters

Kentucky identifies certain Special Use Waters, which receive greater protection than other waterways. Special Use designations are made because of some exceptional quality of the water that needs protection or maintenance of current water quality. There are occurrences of the following Special Use Waters designations in the project area (Table 2.2):

- *Cold-water Aquatic Habitat* - are those surface waters and associated substrate that will support indigenous aquatic life or self-sustaining or reproducing trout populations on a year-round basis (401 KAR 10:031, Section 4).

- *Exceptional Waters* - refers to certain waterbodies whose quality exceeds that necessary to support propagation of fish, shellfish and wildlife and recreation in and on the water. Waters placed in this category are reference reach waters, Kentucky Wild Rivers, some outstanding state resource waters and waters with "excellent" fish or macroinvertebrate communities (401 KAR 10:030 Section 1).

- *Reference Reach Water* - are a representative subpopulation of the least-impacted streams within a bioregion. These streams serve as chemical, physical, and biological models from which to determine the degree of impairment (physical, chemical or biological) to similar stream systems in each representative bioregion. These are not necessarily pristine streams, but represent those least-disturbed conditions that are attainable in each bioregion.

- *Outstanding State Resource Water* - are surface waters designated by the Energy and Environment Cabinet pursuant to 401 KAR 10:031, Section 8, and include unique waters of the Commonwealth, including those with federally threatened or endangered species.

There are no occurrences of the other Special Use Waters designations of State Wild River, State Wild and Scenic River, National Wild and Scenic River, or Federal Wild River in the Red Bird River Watershed.

Table 2.2: Red Bird River Watershed Special Use Waters (KDOW 2012).

Waterway name	Counties	River miles or Segment	Cold Water Aquatic Habitat	Exceptional Water	Reference Reach Water	Outstanding State Resource Water
Big Creek	Clay	4.3 Miles	Y			
Big Double Creek	Clay	Mouth to Confluence 6.5 River Miles		Y	Y	Y
Left Fork of Big Double Creek	Clay	Mouth to Headwaters 1.5 River Mile		Y	Y	Y
Spruce Branch of Red Bird River	Clay	Mouth to Headwaters 1 River Mile		Y	Y	Y
Elisha Creek	Leslie	Land use change (residential) to confluence of Right Fork and Middle Fork Elisha Creek 1 River Mile		Y	Y	Y
Red Bird River	Clay	Mouth to Big Creek 15.3 River Miles		Y		Y
Sugar Creek of Red Bird River	Leslie	4.8 River Miles		Y	Y	
Right Fork of Elisha Creek of Red Bird River	Leslie	Mouth to Headwaters 3.2 River Miles		Y		Y

Monitoring

Watershed Watch

The Kentucky River Watershed Watch is a volunteer organization that monitors water quality and health of local streams in the Kentucky River Basin. It is part of the statewide group Watershed Watch in Kentucky that has volunteers working across the state. Volunteers are trained to analyze physical water characteristics in the field, and how to collect, store, and transport water samples for laboratory analyses. Each volunteer chooses a sampling location that is easily accessible to them and re-visits it for each sampling event. Sampling for each event occurs during the same weekend at all sites within the Kentucky River Basin. This allows the data to be examined historically for a site, as well as throughout the length of a stream, or across the entire basin at relatively the same point in time. There are currently no Kentucky River Watershed Watch sample sites located in the Red Bird River Watershed.

Geomorphology

Soil erosion is considered the biggest water quality issue in much of the country, and Kentucky is no exception. When soil is moved by water and then deposited in another location (a process called soil deposition) or remains in the waterways (a process called sedimentation) it can create habitat problems for aquatic organisms and is the cause of many stream impairments. A lot of sediment in a waterway makes it difficult for aquatic organisms to breathe and function normally. Geomorphology is the study of erosion, sediment (soil) transport, and sediment deposition and how these processes shape the surface of the earth. These processes are often set in motion by human activity on the land, such as: development, livestock grazing, land clearing, timber harvest, mining, mineral extraction, and road construction.

In a study conducted by the University of Louisville's Stream Institute on the geomorphology of Kentucky's streams, the Eastern Kentucky Coalfields section includes a sample site on the Red Bird River near the mouth of Big Creek. The study determined that the Red Bird River at Big Creek is an E4 Rosgen Stream Type (Vesely 2008). This means that the river is in relatively good condition.

2.4 Natural Features

Geology and topography

Prior to the formation of the southern Appalachian Mountains, this area was a shallow inland sea, much like the Gulf of Mexico today, and rich tree-fern forests covered the swampy ground. Over time, the accumulation of dead plants, animals, and sediments created the limestone, coal, sandstone, and siltstone layers we can and cannot see today on the landscape and underground. These layers are known as "strata" and the entire profile is termed the "stratigraphic column." The geology of the project study area is sedimentary in nature; that is, it formed by the accumulation of the above materials in thick horizontal strata.

Shale, siltstone, sandstone, coal, limestone, and conglomerate are the most common rock types found in the area. Most of the rock in the area was formed during the lower and middle Pennsylvanian Period, or roughly 318 to 308 million years ago, and is known as the Breathitt Formation (Figure 2.5). This geologic formation is around 600 feet thick and contains 40 known separate coal beds. The Fire Clay coal bed reaches its maximum thickness, 70 inches, in the headwaters of the project study area.

The final uplift of the Appalachian Mountains, known as the Allegheny Orogeny, occurred about 300 million years ago, and served to lift up the Cumberland Plateau out of the shallow sea. Shortly thereafter the Pine Mountain overthrust occurred, which tilted the land of the Cumberland Plateau slightly downward to the NW from the high point of Pine Mountain. This began a period of intense erosion as the streams wore down through the less resistant rock strata and created the steep slopes, deep gorges, and hollows that make up the current landscape (Figure 2.6). The current topography is rugged and steep, with long slopes and few rock outcrops.

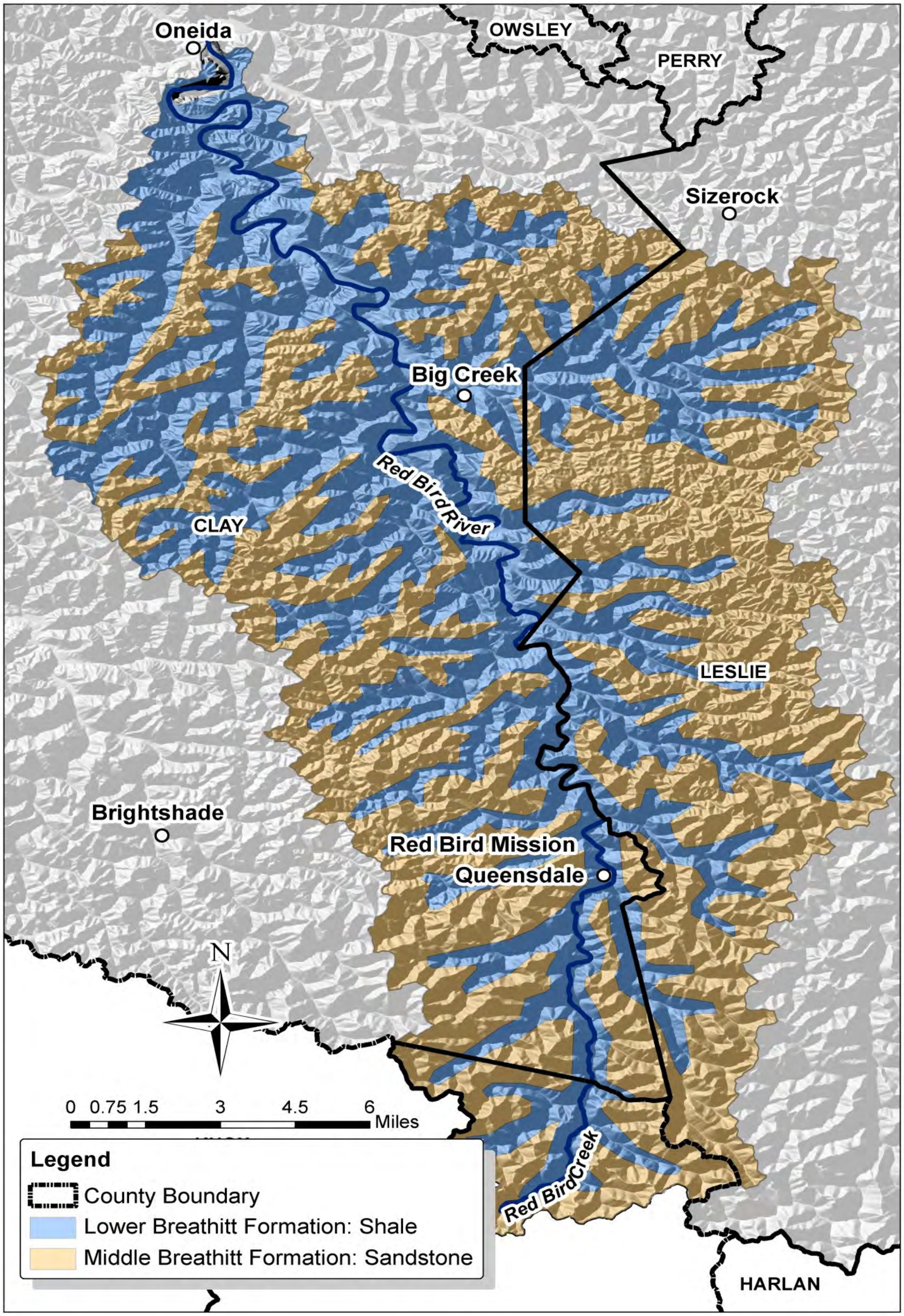

Figure 2.5: Geology of the Red Bird River Watershed (USFS 2012).

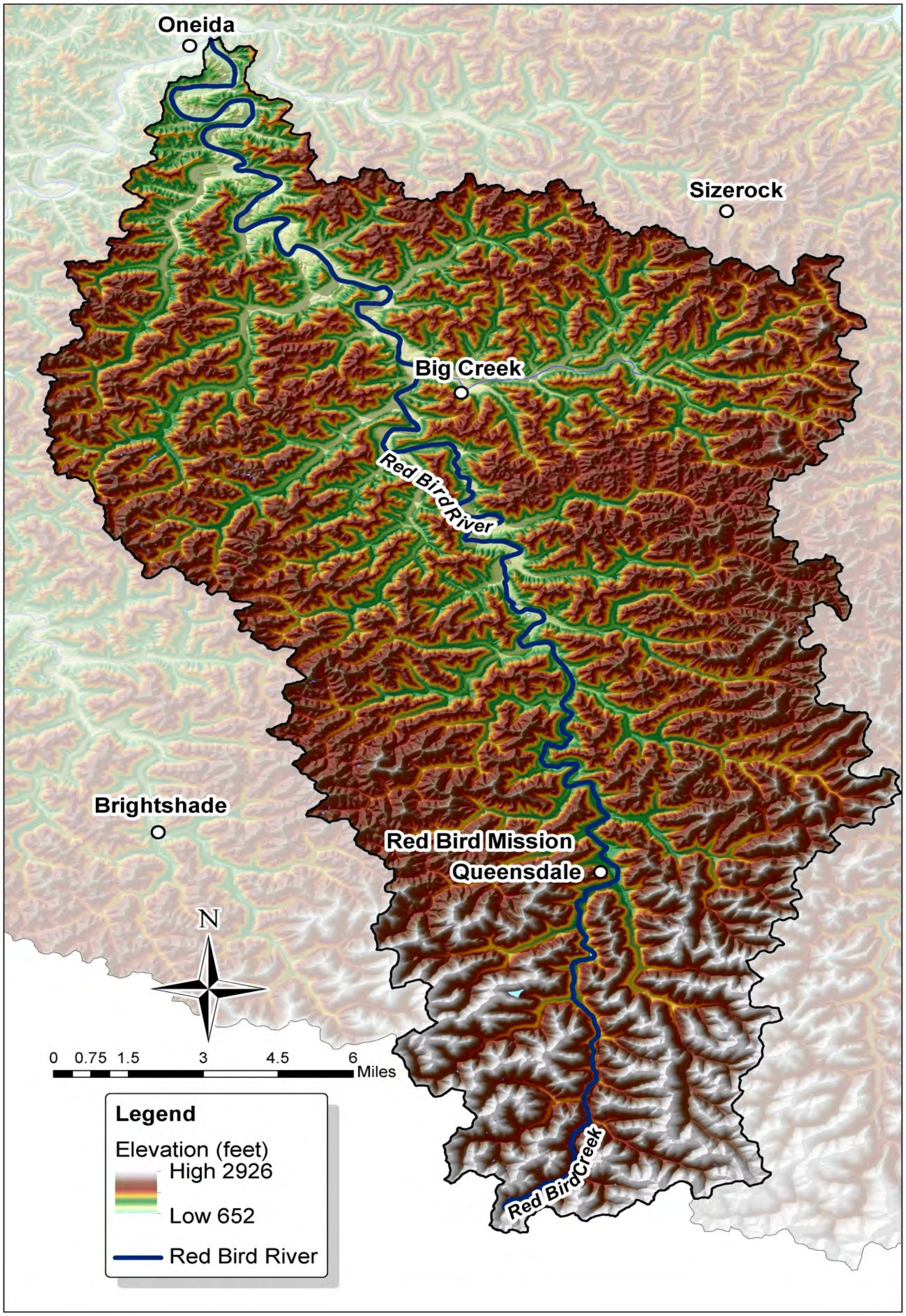

Figure 2.6: Topography of the Red Bird River Watershed (USFS 2012).

Soils

In general, soils are a combination of sand, silt, and clay-sized particles. The ratio of these three particles has a large influence on the characteristics of the soil, such as productivity, strength, and erodibility. Most of the soils in the project study area may be classified as silt loams, which are thought to be the most productive soils for the growth of vegetation. However, other factors, such as rock content, slope steepness, and aspect, will have a large influence on how the soil is used. Additionally, soil can be classified based on where it originated. Residual soils are those that form in place directly over the parent material; they are often found on the tops of ridges and in valley bottoms. Colluvial soils form elsewhere and are moved by gravity to another place on the landscape, such as a mountain sideslope or fan. Alluvial soils form elsewhere and are moved by water to another place on the landscape. Often, the soils in and around a stream are alluvial.

While soils provide many benefits, they can also be a problem for water quality. Sediment is the most common pollutant in our waters, and it comes from soils eroding off of the landscape and entering the water. Sediment can carry agricultural and urban pollutants with it as well.

In the project study area the soil series vary by where they occur on the landscape (Figure 2.7). On the ridgetops one may find the Gilpin and DeKalb soil series, which are silt and sandy loams, respectively. Both are residual soils weathered in place from shale, siltstone, and sandstone parent material. They are shallow to bedrock (less than 3' thick), rocky, and drain excessively well. Because of this, the soils do not hold much water for plant uptake, and this is reflected in the vegetation of the ridgetops: pines, laurels, red maples, and dry oaks.

The sideslopes of the project area are covered by various soil associations dominated by the Shelocta soil series, a silt loam. This is a deep soil, reaching depths of 5 feet, that drains well. It is a residual soil that has weathered from underlying shale, siltstone, and sandstone. The one limiting attribute of this soil is the slope, which averages 25%. However, despite the slope, this soil is good for the growth of hardwood trees and associated vegetation.

The river and stream bottoms of the study area are covered with mostly alluviual soils, such as the Craigsville, Pope, and Grigsby series. These are deep sandy loams and loams that are well-drained, have moderate to moderately rapid permeability, and occur on low gradient slopes.

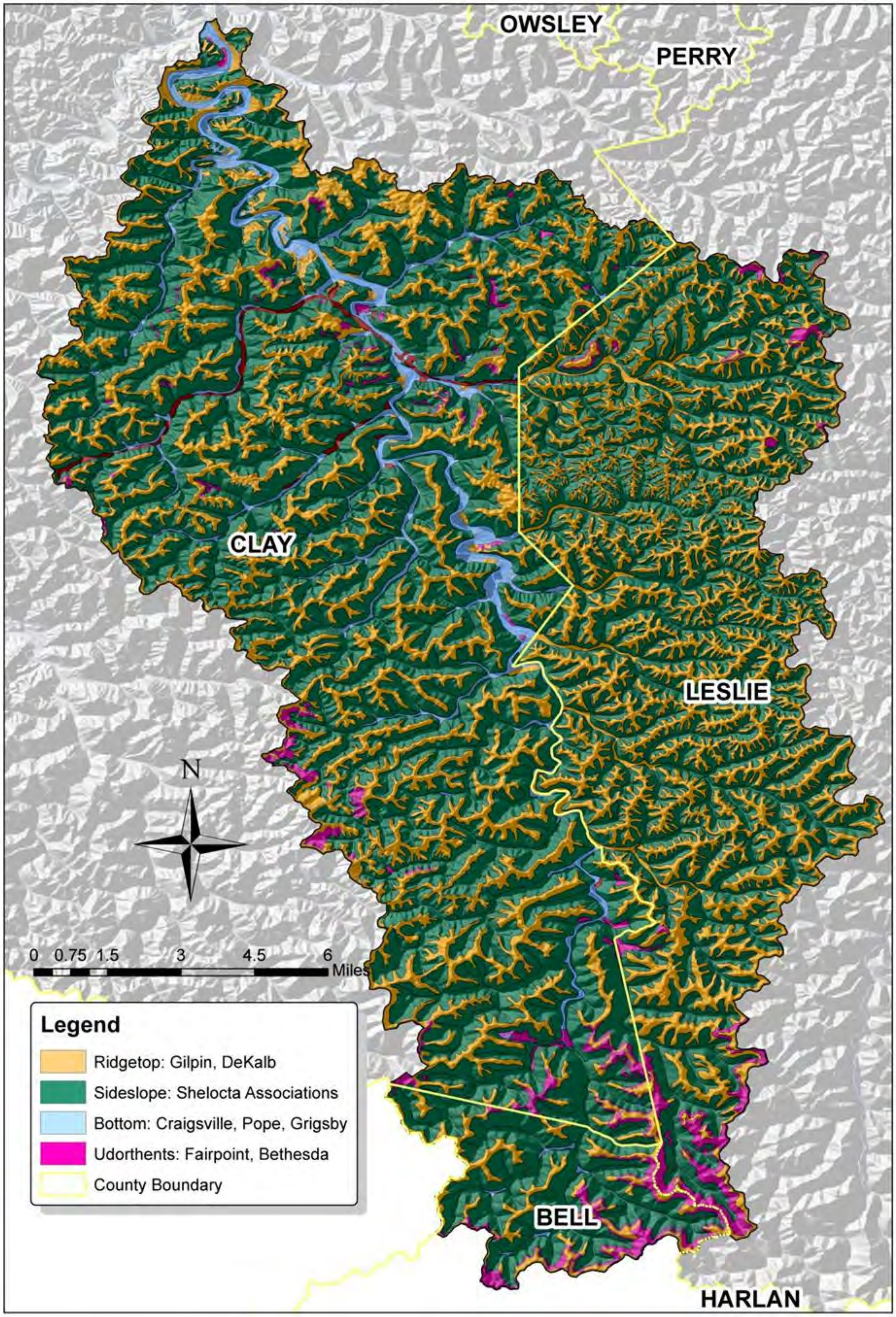

Figure 2.7: Soils of the Red Bird River Watershed (USFS 2012).

The project area lies within the Eastern Kentucky Coal Fields, and coal extraction is a common land use practice in the watershed. Recent updates to the soil survey have included the classification of residual soils left after a mined area is reclaimed. These are known as "Udorthents," and include the Fairpoint and Bethesda soil series. They are formed from acid bedrock that has been blasted to the surface to uncover coal seams. Found where mountaintops have been removed or in valley fills, these soils are classified as gravelly and shaley clay loams and are well-drained, but have moderately slow permeability from excessive compaction. Grass and exotic herbaceous vegetation grow on these soils.

Ecoregion

According to the EPA's Ecoregion map of Kentucky, the Red Bird River Watershed lies mostly within the Central Appalachians Dissected Appalachian Plateau, referred to as section "69d" (Figure 2.8).

The following description is from the Ecoregions of Kentucky Map:

> 69d- The **Dissected Appalachian Plateau** ecoregion is composed of narrow ridges, deep coves, and narrow valleys and is mostly forested. Cool, high gradient streams with cobble and boulder substrates and extensive riffles are common. Ecoregion 69d is more rugged, more extensively forested, and has higher stream gradients than the Cumberland Plateau (68a) and the Ohio/Kentucky Carboniferous Plateau (70f). Forest composition is controlled by aspect, slope position, degree of topographic shading, and past usage and, thus, is highly variable. Ecoregion 69d is underlain by flat-lying Pennsylvanian shale, siltstone, sandstone, and coal. Surface and underground coal mining, logging, and both gas and oil production are common and have degraded surface waters. Acidic drainage and sedimentation from coal mines have decreased the biological productivity of many streams and, in some reaches, all but the most tolerant aquatic biota have been eliminated. However, gradual improvement in the control of acidic mine drainage is occurring. Nutrient levels in streams are very low and are a reflection of the ecoregion's low population density, limited agriculture, and non-carbonate rocks (Woods, A.J., Omernik, J.M., Martin, W.H., Pond, G.J., Andrews, W.M., Call, S.M, Comstock, J.A., and Taylor, D.D., 2002, Ecoregions of Kentucky (color poster with map, descriptive text, summary tables, and photographs): Reston, VA., U.S. Geological Survey (map scale 1:1,000,000).

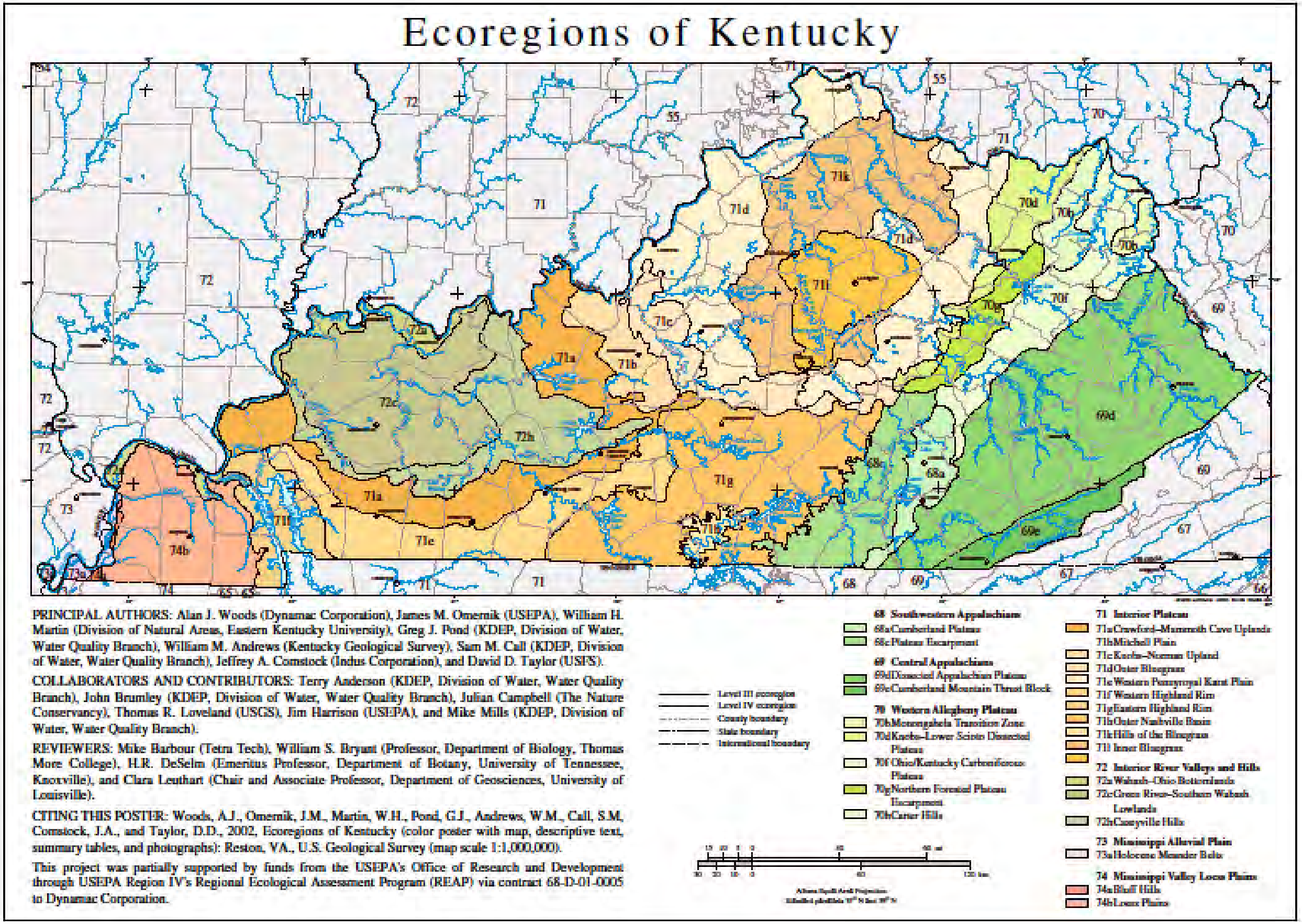

Figure 2.8: Ecoregion Map of Kentucky http://www.epa.gov/wed/pages/ecoregions/ky_eco.htm .

2.5 Streamside Vegetation

There is a great diversity of vegetation in the Red Bird River Watershed. In fact, the area holds remnants of one of the most diverse forest types in the world: the mixed mesophytic. The word *mesophytic* means moderately moist – mesophytic plants are those that thrive in a moderately moist environment. E. Lucy Braun was a botanist from Cincinnati, and in the early 1900's, she set out to describe the forest types of the eastern United States before the virgin timber was harvested. What she found in this area was unlike anything she had seen: towering hardwood and conifer trees, a lush midstory of mid-sized trees, and a vibrant and thick understory of herbs, forbs, wildflowers, and grasses. The forest here was and continues to be a hotspot of diverse and unique vegetative species.

In general, on the ridgetops and high shoulder slopes, where water and nutrients are limiting and the exposure is open, one may find pitch, shortleaf, and Virginia pines mixed in with a dry oak community that includes scarlet, black, chestnut, and white oaks as well as various hickories. Other woody species common to this community include blackgum, sourwood, sassafras, mountain laurel, and blueberry. These communities also may be found on the sideslopes, especially on warmer south-facing slopes.

In the protected coves and valleys where the water and soil accumulate, one may find the mixed mesophytic remnants. Whereas many forests have a handful of dominant trees, the mixed mesophytic forest type can have up to 25 different dominant species and is unusually rich in resources and diversity. There are three characteristics of the mixed mesophytic: three distinct strata of vegetation (overstory, midstory, and understory), deep and well-drained soils, and very high diversity of species in all three strata. The overstory can contain yellow-poplar, cucumber, sugar maple, yellow buckeye, American basswood, bigleaf magnolia, eastern hemlock, American beech, red maple, northern red oak, black cherry, and white oak, among other species. In the midstory one may encounter dogwood, American holly, blackgum, sassafras, sourwood, rhododendron, bigleaf and umbrella magnolias, and pawpaw. The understory, especially in the spring, is a carpet of wildflowers that may include Jack in the Pulpit, Dutchman's Britches, violets, orchids, wild ginger, trilliums, ground pine, ground cedar, Pippsissewa, Rattlesnake plantain, wild geranium, wintermint, partridge berry, trailing arbutus, and many others.

Along the streams and rivers vegetation again changes to reflect the different conditions. One will likely find sycamore, eastern hemlock, red maple, yellow buckeye, witch hazel, rhododendron, river birch, sweet birch, black willow, and cane, among others in these riparian environments.

2.6 Plants and Animals

Rare and endangered species

The flora and fauna (plants and animals) of the Red Bird River Watershed are diverse. According to the Kentucky State Nature Preserves Commission (2012), there are a number of endangered, threatened, or sensitive plant and animal species in the watershed (Table 2.3). These species can be used as indicators of the health of a stream (Humphries et. al, 2006). Table 2.5 is a specially prepared list of the endangered, threatened, and sensitive plants and animals in the Red Bird River Watershed (not by county).

Three species for which occurrences have been recorded in the Red Bird River Watershed are listed as endangered by USFWS. These are: snuffbox (freshwater mussel), gray bat, and Indiana bat. Occurrences have also been recorded for one Candidate species, Kentucky Arrow Darter. The best populations of the Kentucky Arrow Darter are in the Red Bird Watershed.

The term "endangered species" means any species which is in danger of extinction throughout all or a significant portion of its range. A Candidate species is a species for which USFWS or National Oceanic and Atmospheric Administration has on file sufficient information on biological vulnerability and threats to support a proposal to list as endangered or threatened. Approved *Candidate Conservation Agreements* or *Candidate Conservation Agreements with Assurances* may be used for Candidate species to implement actions that remove or reduce threats to the covered species, so that listing may not be necessary. Most of the following information on endangered species was collated from the U.S. Fish and Wildlife Service Endangered Species (USFWS) home page at www.fws.gov/endangered.

- **Snuffbox Mussel (*Epioblasma triquetra*)**

In February 2012, USFWS added the snuffbox to the list of endangered species giving the species full protection under the Endangered Species Act.

The snuffbox is a small- to medium-sized freshwater mussel with a yellow, green, or brown shell interrupted with green rays, blotches or chevron-shaped lines. Males can grow up to 2.8 inches, with females reaching only up to 1.8 inches. It is a biological indicator of stream health because it cannot tolerate pollution or excessive siltation. It is one of the first species to disappear from a system when habitat changes occur.

Range and Habitat. Historically the snuffbox was widespread, occurring in 210 streams and lakes in 18 states and Ontario, Canada. The population has been reduced to 79 streams and lakes in 14 states and Ontario, representing a 62 percent range-wide decline. The snuffbox is currently found in Alabama, Arkansas, Illinois, Indiana, Kentucky, Michigan, Minnesota, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, Wisconsin, and Ontario, Canada. Most populations are small and geographically isolated from one another, further increasing their risk of extinction. The Red Bird River population of snuffbox mussels is listed as marginal. This small population occurs sporadically in the lower 20 river miles of the river and viability is unknown.

The snuffbox is usually found in small- to medium-sized creeks, inhabiting areas with a swift current, although it is also found in Lake Erie and some larger rivers. It occurs in swift currents of riffles and shoals and wave-washed shores of lakes over gravel and sand with occasional cobble and boulders. Adults often burrow deep in sand, gravel or cobble substrates, except when they are spawning or the females are attempting to attract host fish.

Why Endangered. Dams, pollution, sedimentation, nonnative species,

- **Gray Bat (*Myotis grisescens*)**

The gray bat was listed as an endangered species by USFWS in 1976. The scientific name, *Myotis*, means mouse ear and refers to the small, mouse-like ears of the bats in this group.

Gray bats are distinguished from other bats by the unicolored fur on their back. They weigh 7-16 grams. The bat's wing membrane connects to its ankle instead of at the toe, where it is connected in other species of *Myotis.*

The gray bat eats flying and emerging aquatic insects, foraging over riparian areas and bodies of water at night and helps keep nocturnal flying insect populations at natural levels.

Habitat. With rare exceptions, gray bats live in caves year-round. During the winter gray bats hibernate in deep, vertical caves. In the summer, they roost in caves which are scattered along rivers. Most of these caves are in areas of limestone karst areas in the southeastern United States.

Why Endangered. Human disturbance, habitat loss or degradation, cave commercialization or improper gating.

- **Indiana Bat (*Myotis sodalis*)**

The Indiana bat was first listed as "endanger of extinction" in 1967 under the Endangered Species Protection Act of 1966 prior to passage of the Endangered Species Act of 1973. It is now listed under the current Endangered Species Act of 1973.

The Indiana bat is a small bat, less than 2 inches in length, with dark gray to brownish black fur. It has a pinkish nose, small hind feet with sparse, short hairs that do not extend beyond the toes, and a calcar (the spur extending from the ankle) that has a slight keel.

The Indiana bat is an insectivore, feeding primarily on insects, and is, along with other insect eating bats, the only major predator of nocturnal flying insects. Predators of bats include foxes, barn owls, and domesticated cats.

Range and Habitat. The Indiana bat is found throughout much of the eastern United States. Indiana bats hibernate during winter in caves or, occasionally, in abandoned mines. They require cool, humid caves with stable temperatures, under 50° F but above freezing. Very few caves within the range of the species have these conditions. Bats must store energy in the form of fat before hibernating. If bats are disturbed or cave temperatures increase, more energy is needed and hibernating bats may starve. After hibernation, Indiana bats migrate to their summer habitat in wooded areas where they usually roost under loose tree bark on dead or dying trees

Why Endangered. Human disturbance, cave commercialization and improper gating, summer habitat loss or degradation, pesticides and environmental contaminants.

- **Candidate Species Kentucky Arrow Darter (*Etheostoma* spilotum)**

Most of the following information on the Kentucky arrow darter is from Dr. Michael Floyd's presentation to the Red Bird River Watershed Collaborative Meeting on January 24, 2013. Some material was added from the review of Candidate Species in the *Federal Register* published on November 22, 2013.

The Kentucky Arrow Darter is endemic to Kentucky. Some of the best populations are in the Red Bird River Watershed. The fish is a rather large, slender (total length is about 4.6 inches), brightly colored darter that is restricted to the upper Kentucky River basin in eastern Kentucky (Figure 2.9).

Habitat. The species preferred habitat consists of pools or transitional areas between riffles and pools (runs and glides) in moderate-to-high-gradient streams with bedrock, boulder, and cobble substrates. Kentucky arrow darters feed on a variety of aquatic invertebrates, but adults feed predominantly on larval mayflies.

Status. Status surveys from 2007-2010 by the Kentucky Department of Fish and Wildlife Resources (KDFWR), Kentucky State Nature Preserves Commission (KSNPC), and USFWS revealed that the species has declined across its range. During these surveys, the species was observed at only 33 of 68 historical streams and 45 of 100 historical sites.

Threats. The species habitat and range have been severely degraded and limited by water pollution from surface coal mining and gas-exploration activities, removal of riparian vegetation, stream channelization, increased siltation associated with poor mining, logging, and agricultural practices, and deforestation of watersheds. The threats are severe because they are widespread across the species range. The threats are imminent because the effects are manifested immediately and will continue for the foreseeable future. Elevated specific conductance and sedimentation appeared to be major limiting factors for the species. The best remaining populations were observed in the Red Bird River Watershed (Clay and Leslie counties), Robinson Forest (Breathitt and Knott counties), and several direct tributaries of the North Fork Kentucky River (Breathitt and Lee counties).

Figure 2.9: KY Arrow Darter (USFWS 2013).

Invasive species

Invasive species can be plants or animals and can disturb natural habitats, limiting biodiversity and food sources. They can be costly to remove once well established. Like most regions of Kentucky, the Red Bird area has been invaded by invasive, exotic plant species. Invasive plants are those that grow in large clumps and exclude or inhibit the growth of other plants. They are species that would not naturally occur in the area, but have been introduced (on purpose or by accident) from elsewhere. Native plant and animal species can be invasive, but it is more often the case that the invasive species are also exotic species. There are also exotic bird species, like the house sparrow, that live in Kentucky, but these are not covered here. The following is a partial list of the invasive, exotic plant species in the Red Bird River Watershed:

- Vine honey suckle (*Lonicera japonica*)
- Kudzu (*Pueraria lobata*)
- Winter creeper (*Euonymus fortunei*)
- Japanese knotweed (*Polygonum cuspidatum*)
- Privet (*Ligustrum vulgare*)
- Japanese Stiltgrass (*Microstegium vimineum*)
- Multiflora rose (*Rosa multiflora*)
- Chinese yam (*Dioscorea oppositifolia*)

Table 2.3: Endangered and Threatened Species of the Red Bird River Watershed (KY State Nature Preserves Commission 2012).

Taxonomic Group	Scientific name	Common name	Statuses	Ranks	# of Occurrences E	H	F	X	U
Vascular Plants	*Chrysosplenium americanum*	American Golden-saxifrage	T /	G5 / S2?	1	0	0	0	0
Vascular Plants	*Juglans cinerea*	White Walnut	T / SOMC	G4 / S2S3	1	0	0	0	0
Vascular Plants	*Lycopodium clavatum*	Running Pine	E /	G5 / S1?	1	0	0	0	0
Vascular Plants	*Podostemum ceratophyllum*	Threadfoot	S /	G5 / S3	2	0	0	0	0
Vascular Plants	*Prenanthes crepidinea*	Nodding Rattlesnake-root	S /	G4 / S3	4	0	0	0	0
Vascular Plants	*Silphium wasiotense*	Appalachian Rosinweed	S / SOMC	G3 / S3	18	0	0	0	0
Vascular Plants	*Solidago curtisii*	Curtis' Goldenrod	S /	G4G5 / S3	1	0	0	0	0
Vascular Plants	*Thermopsis mollis*	Soft-haired Thermopsis	E /	G3G4 / S1	3	0	0	0	0
Gastropods	*Anguispira rugoderma*	Pine Mountain Tigersnail	E /	G2 / S2	9	0	0	0	0
Gastropods	*Mesomphix rugeli*	Wrinkled Button	T /	G4 / S2	3	0	0	0	0
Freshwater Mussels	*Epioblasma triquetra*	Snuffbox	E / LE STWG	G3 / S1	4	0	3	0	0
Freshwater Mussels	*Villosa lienosa*	Little Spectaclecase	S / STWG	G5 / S3S4	2	2	1	0	0
Crustaceans	*Cambarus parvoculus*	Mountain Midget Crayfish	T / STWG	G5 / S2	8	0	0	0	0
Insects	*Calephelis borealis*	Northern Metalmark	T /	G3G4 / S2	0	1	0	0	0
Fishes	*Etheostoma sagitta spilotum*	Kentucky Arrow Darter	T / C STWG	G3G4T3 / S2S3	13	4	0	0	0
Fishes	*Percina macrocephala*	Longhead Darter	E / SOMC STWG	G3 / S1	0	2	0	0	0
Reptiles	*Eumeces anthracinus*	Coal Skink	T / STWG	G5 / S2	1	0	0	0	0
Mammals	*Corynorhinus rafinesquii*	Rafinesque's Big-eared Bat	S / SOMC STWG	G3G4 / S3	3	0	0	0	0
Mammals	*Myotis grisescens*	Gray Myotis	T / LE STWG	G3 / S2	1	0	0	0	0
Mammals	*Myotis leibii*	Eastern Small-footed Myotis	T / SOMC STWG	G3 / S2	2	0	0	0	0
Mammals	*Myotis sodalis*	Indiana Bat	E / LE STWG	G2 / S1S2	1	0	0	0	0
Mammals	*Spilogale putorius*	Eastern Spotted Skunk	S / STWG	G5 / S2S3	1	0	0	0	0
Communities	*Appalachian sub-xeric forest*		N /	GNR / S5	1	0	0	0	0
					80	**9**	**4**	**0**	**0**

Note: This list is current as of August 2012. T= threatened; E = endangered; SOMC = species of management concern; LE STWG = listed endangered state and tribal wildlife grant; C = candidate; N = no protection status; S= special concern; X= extinct; U= unknown

2.7 Human Influences and Impacts

Water Use and Supply

In Kentucky, the water withdrawal program administered by KDOW regulates all withdrawals of water greater than 10,000 gallons per day from any surface, spring, or groundwater source with the exception of: water required for domestic purposes, agricultural withdrawals, including irrigation, steam-powered generated plants regulated by the Kentucky Public Service Commission, or injection underground as part of operation for the production of oil and gas. As of the writing of this chapter (September 15, 2012), according to the Water Quantity Section of KDOW, there are no permitted water withdrawals in the Red Bird River Watershed. This means that large quantities of water are not being extracted from the Red Bird River. It is important to understand the amount of water flowing in a stream because the flow impacts many aspects of the stream itself including water quality, habitat, flooding, and many others.

Source Water Protection Plans

Source Water Protection Plans are required by the Safe Drinking Water Act to assess the quantity of water used in a public water system and to formulate protection plans for the source waters used by these systems. According to KDOW, Watershed Management Branch, there are no public drinking water sources in the Red Bird Watershed, and no formal Source Water Protection Plans have been developed. A Source Water Protection prescription area has been developed by the Daniel Boone National Forest (DBNF), but the Red Bird River Watershed is not included in it.

Wellhead Protection Plans

Wellhead Protection Plans are used to assist communities that rely on groundwater as their public water source. According to the Wellhead Protection Program of KDOW, there are no Wellhead Protection plans in the Red Bird Watershed because all public water sources in the area use surface water.

Groundwater Protection Plans

Groundwater Protection Plans (GPPs) are required for anyone engaged in activities that have the potential to pollute groundwater. Activities that would require a GPP include pesticide application or storage for commercial purposes, installation or operation of on-site sewage disposal systems, storing or handling of road oils, or any mining activity. According to the Groundwater Section of KDOW, there are no GPPs in the Red Bird Watershed. However, there may be facilities in the watershed area that need a GPP. For more information on what types of facilities require GPPs or guidance on how to write a plan, visit the Groundwater Section of the

KDOW website. It is part of this watershed-based plan to implement education and awareness campaigns on the need for groundwater protection and active GPPs.

Past or Current Watershed-based Plans

While no formal watershed plans have been completed, the Daniel Boone National Forest has completed two watershed assessments in the area to determine resource conditions and develop projects based on the goals and objectives described in the 2004 *Land and resource Management Plan for the Daniel Boone National Forest.*

Permitted Water Withdrawal

There are no permitted water withdrawals of any type in the watershed project area. The city of Manchester draws its water from Goose Creek, outside of the Red Bird River Watershed. There are most likely private water wells at homes, but these do not require a permit.

<u>Sewer and Septic Systems</u>

The Red Bird River Watershed does not include a sewer system. Most homes and businesses most likely rely on septic or other onsite wastewater systems which could include a small package treatment plant, a lagoon, or a constructed wetland. Figure 2.10 displays the wastewater infrastructure present in the Red Bird River Watershed. The cities of Manchester and Hyden are outside of the watershed area.

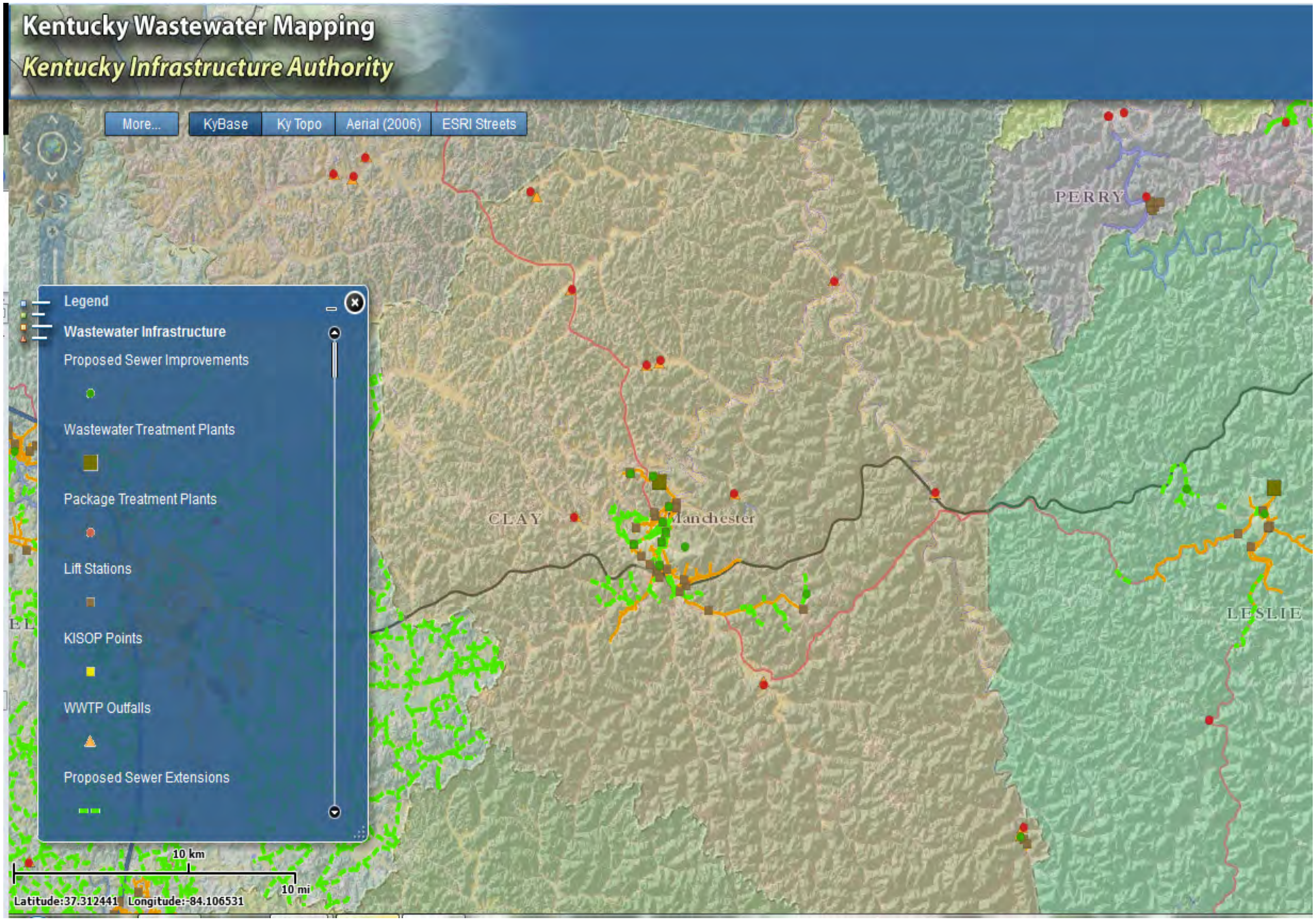

Figure 2.10: Wastewater Infrastructure in the Red Bird River Watershed (KY Infrastructure Authority 2012).

Point Sources and Permitted Discharges

Point source pollution is pollution that has a known source, or discharge point. Examples of point sources could include industrial and wastewater plants that discharge directly from a pipe into a stream. For the most part, this watershed-based plan is concerned with nonpoint sources of pollution. However, it is necessary to understand all sources of pollution in a watershed to isolate nonpoint sources from point sources of pollution and to calculate accurate pollutant loads.

In Kentucky, most point sources are required to have a permit through the Kentucky Pollutant Discharge Elimination System or KPDES. These permits allow specified levels of certain substances into the waterway. Discharge data from permitted facilities in the state are public information and available through from the facility itself, a Freedom of Information Act request to the KY Division of Water, or online sources like EPA's Enforcement & Compliance History Online (or ECHO) website (http://www.epa-echo.gov/echo/compliance_report_water_icp.html). Most facilities are required to file a monthly or quarterly report that details the contents of the water being discharged from their facilities called a Discharge Monitoring Report. The facility's discharge permit should specifically state the limits of the pollutant allowable.

According to KDOW, the following entities have KPDES permits in the project area:

1. KY0026000 – Red Bird Mission Medical Clinic
2. KY0082091 – Big Creek Elementary School
3. KY0088587 – Red Bird Mission High School and Elementary School
4. KY010631 – Goose Creek Mining, LLC
5. KYG046117 – Straight Creek Coal Mining, Inc.
6. KYG045498 – Chas Coal
7. KYG045437 – Chas Coal
8. KYG046251 – Chas Coal
9. KYG042858 – Chas Coal
10. KYG045333 – Xinergy Corp
11. KYG046339 – Nally and Hamilton Enterprises, Inc
12. KYG046772 – Xinergy Corp
13. KYG045750 – Xinergy Corp
14. KYG046619 – Jadco Enterprises, Inc
15. KYG045636 – Shamrock Coal Co., Inc
16. KYG046152 – Joshua Wagners
17. KYG046633 – Ikerd Mining
18. KYG046740 – Clay Laurel Mining, Inc
19. KYG046788 – Rayovac Energy, LLC
20. KYR10F534 – Industrial Park Access Road

Permits for Red Bird Mission Medical Clinic, Big Creek Elementary School, and Red Bird Mission High and Elementary Schools deal with discharge from onsite wastewater systems (Table 2.4). The rest of the permits listed are coal mining operation permits. Each mine operation typically includes multiple discharge points.

Table 2.4: Non-coal Permitted Facilities in the Red Bird River Watershed.

Facility Name	Permit Number	Expiration Date	Permit/Facility Description	# Effluent Exceedances (3 yrs)
Red Bird Mission Medical Clinic	KY0026000	5/31/2017	Medical facility	6 Chlorine
Big Creek Elementary School	KY0082091	1/31/2018	Package Treatment Plant for onsite sewage	4 *E. coli* and Nitrogen
Red Bird Mission High and Elementary Schools	KY0088587	3/31/2018	Package Treatment Plant for onsite sewage	9 Chlorine, Ammonia, *E. coli*, and Total Suspended Solids

Mining Data

Within the Red Bird Watershed, there are surface and underground coal mines that were mined before laws were enacted, mines that have been mined and reclaimed, mines that are actively mining, and sites that have surface and underground coal mining permit applications pending to be issued (Figure 2.11). Before surface or underground coal mining can occur, mine operators must obtain a coal mining permit from the Kentucky Department of Natural Resources, Division of Mine Permits (KYDNR/DOP). Surface and underground coal mine applications receive extensive engineering and environmental review by KYDNR/DOP before permits are issued and coal mining is allowed to begin. The issued permit contains volumes of pre-mining geologic, hydrologic, and agricultural data that interpret the probable hydrologic consequences the mine will have on the area and how the environmental impacts from the mining operation will be minimized. The permit also contains certified engineering designs for all structures that will be built to achieve minimizing those impacts. All mining operations must also obtain a KPDES permit that sets water quality parameters and discharge limits for the site (see page 34 for list of permitted discharges). Water sampling must occur at each discharge point bi-monthly and reported to the Kentucky Division of Mine Reclamation quarterly. Each mine usually has several discharge points. Permit specific discharge data can be found on the KYDMP/DOP website at http://minepermits.ky.gov/Pages/default.aspx. The web site also provides access to the Surface Mining Information System (SMIS) that enables the viewer to track pending coal mining applications, enforcement actions on permitted sites, mine ownership, post mining land use and other pertinent information about mine sites.

The appendix contains a list of active, permitted surface and underground coal mines. The list also indicates the status of the mine and acreage permitted and disturbed to date. The permit number can be used to inquire information from the KYDNR/DOP SMIS data base.

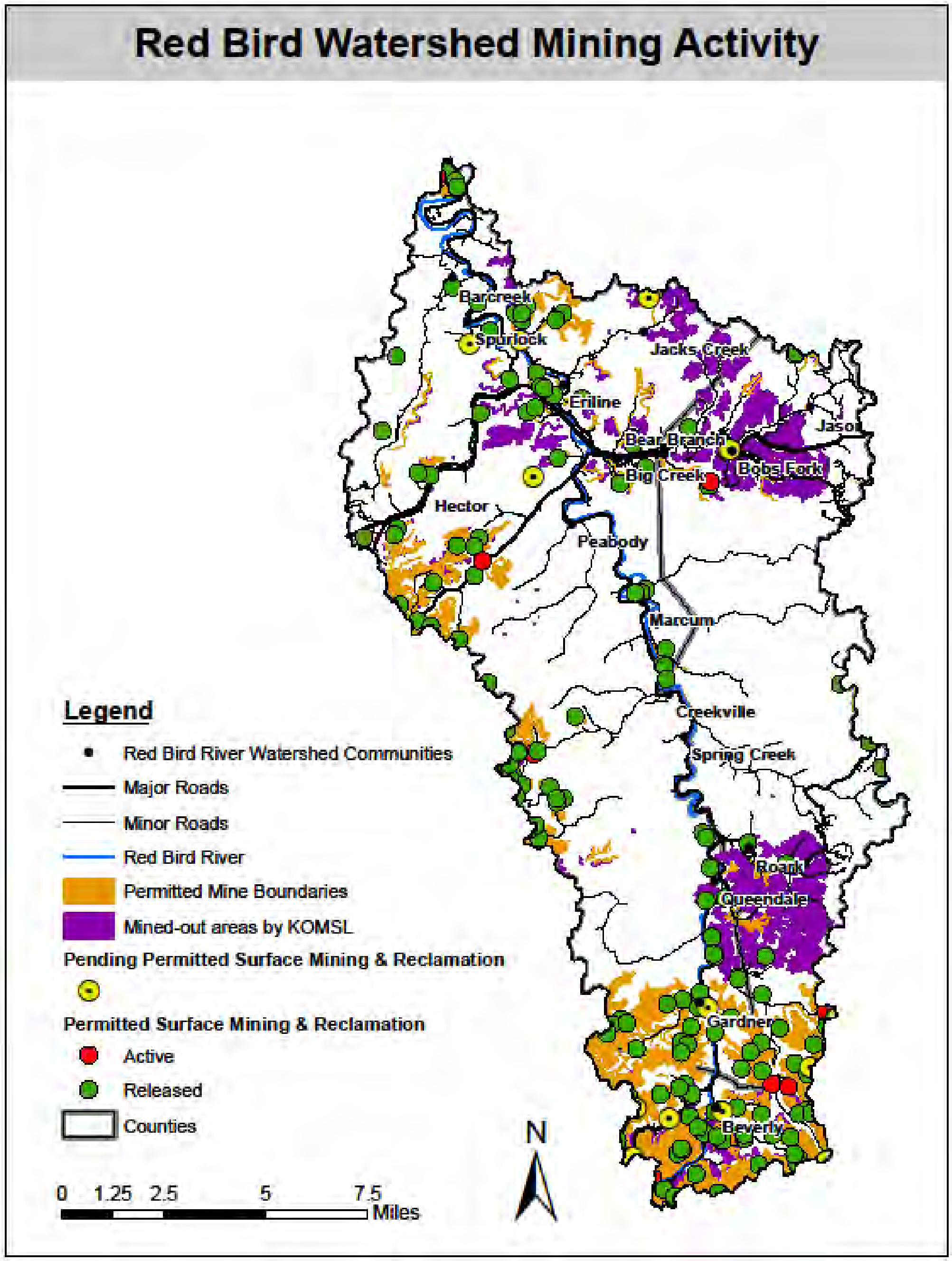

Figure 2.11: Coal mining activity in the Red Bird River Watershed (KYGeonet and OSM 2012).

Resource Use

The way resources are used in a watershed can have significant impacts on the water quality of the surrounding waterways. Watershed planning endeavors to understand these impacts, both positive, negative, or neutral, and take appropriate steps protect or restore the waterways in light of these impacts. To this end, sources of pollution are sought out in the watershed. A 'source' is not a particular household or business, but rather an area of the watershed where pollution seems to originate. For example, if a creek downstream of a shopping mall has high levels of chloride, the watershed planning team would think about the mall and surrounding land uses as potential sources of chloride. Then a best management practice could be recommended to mitigate the pollution. In this case, it may be concluded that stormwater runoff is allowing chloride from salt treatments to the mall parking lot to enter the creek. Stormwater best management practices, like a rain garden to absorb stormwater runoff, may then be recommended.

The Red Bird River Watershed is highly forested with little commercial development or impervious surface. Figure 2.12 illustrates various land uses in the watershed. Most of the impervious surfaces shown on the map are roads. The Daniel Boone National Forest and the Red Bird Wildlife Management Area (Figure 2.13) are among the biggest uses for in the watershed. Hunting, fishing, timber harvest, hiking, OHV use, and other recreation activities happen on these lands. There is also coal mining and natural gas and oil extraction sites (see Figure 2.14).

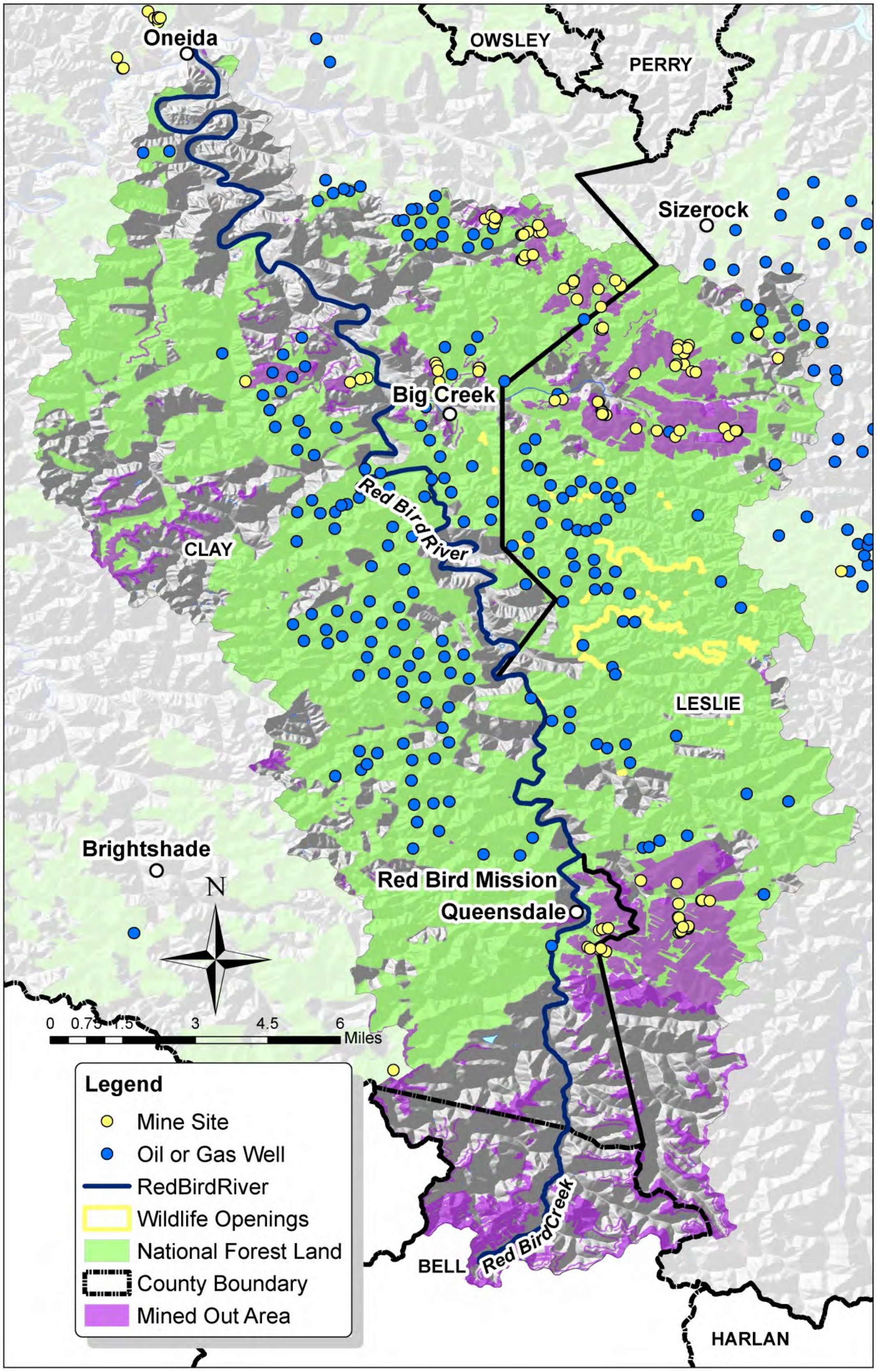

Figure 2.12: Resource use in the Red Bird River Watershed (USFS 2012).

Wildlife Management Areas

There are two wildlife management areas located within the watershed (Figure 2.13). One of them, the Redbird Wildlife Management Area, accounts for a large portion of the watershed. The other, the Elk Forest Wildlife Management Area, is a small portion of the southern tip of the watershed. Information taken directly from each area's website is included here. For more information, contact the Management area directly.

Redbird Wildlife Management Area Overview
Location & Size: Clay & Leslie counties, 24,014 acres
Elevation minimum 842 feet, maximum 1881 feet.
Area Habitat mostly forest: open land 5%, forest 95%, wetland 0%, open water 0%.

Directions & Description: 7 miles west of Hyden. Hilly to steep with gentle slopes in bottomlands and on ridge tops; mostly forested with approximately 100 acres of openings and 25 miles of improved hiking trails. No developed facilities. Mobility impaired access to permit holders on designated area, which is currently the Redbird Crest Trail. Within Daniel Boone National Forest. Owned by U.S. Forest Service.

Elk Forest Wildlife Management Area
Location & Size: Clay, Bell, Knox, & Leslie counties, 16,204 acres
Elevation minimum 1040 feet, maximum 2440 feet.
Area Habitat mostly forest: open land 15%, forest 85%, wetland 0%, open water 0%.

Directions & Description: The area lies between KY 66 and U.S. 421 south of Hal Rogers Parkway in the area where Clay, Bell and Leslie counties meet. The area is a mixture of mature hardwoods and reclaimed coal mining land. The strip benches and other remains of mining on portions of Elk Forest WMA should make the property an easier place to hunt compared to the topography of the surrounding area.

The area is open to regulated hunting for deer, turkey and small game. There are few viable fishing opportunities on the area. Be sure to follow all signage as some areas are off-limits to the public. The majority of this area is located in Elk Hunt Unit 6d, with additional portions located in EHU 6a, EHU 6b, and EHU 6c.

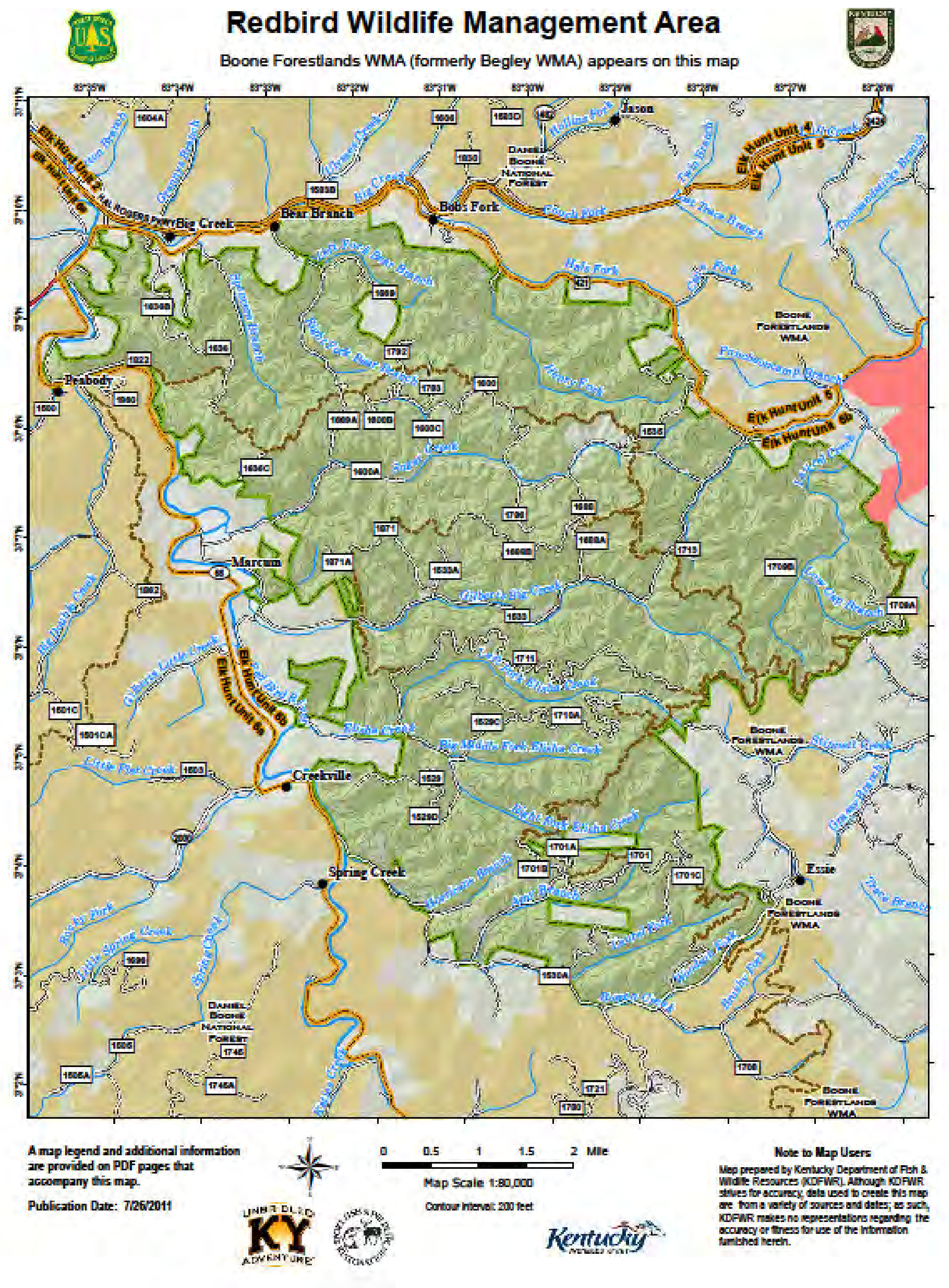

Figure 2.13: The Redbird Wildlife Management Area Map (KY State 2012).

There are other land uses in the watershed that impact water quality including timber harvesting, oil and gas wells, and coal mining.

<u>Timber Harvest</u>

From previous sections in this chapter, it is clear that the Red Bird River Watershed is a rugged landscape covered in hardwood timber. This was not always the case. The two primary natural resources of the area, timber and coal, have largely dictated the forest cover and land use of the area in modern times.

In general, recorded timber harvesting in the region began with the arrival of the first European settlers who used trees to construct homes, build fences, and heat homes. Native Americans and early European settlers also cleared land for agriculture. Both of these groups encountered vast tracts of forests that were full of huge trees; one account states that mature forests covered 95% of the state of Kentucky at the time of European settlement (Taylor 1958). Commercial interest occurred as early as the 1830's, when vast tracts of timber were harvested to fuel the iron ore industry (Jones 2005).

In the Red Bird River Watershed, European settlers started cutting logs to sell to companies outside of the area in about 1870 and continued until large out-of-state companies gained control of most of the land and timber. The most intense wave of timber harvesting occurred in the period of 1880 – 1914 (Clark 1984). In 1907 alone, 913 million board feet of timber were harvested in Kentucky (Taylor 1958). By 1920, almost all of the vast hardwood forests of Kentucky had been harvested and abandoned by industry, leaving behind degraded and barren landscapes. For example, Fordson Coal Company (a subsidiary of Ford Motor Company) held significant timber reserves in the watershed until approximately 1950. They conducted extensive harvests of virgin timber, especially white oak, to use in the wood components of automobiles, such as the spokes, running boards, and interiors. Both on federal and private lands, much of the timber was high-graded, a practice where only the best timber is harvested from a stand. This method of harvest is undesirable, largely because the remaining timber is inferior in form, volume, and health. High-grading leaves no savings account to ensure future forest productivity mainly because the trees left to reproduce are substandard.

Currently, the Red Bird River Watershed boundary encompasses approximately 125,180 acres of land, of which 77,560 acres (62%) is national forest system land managed by the Daniel Boone National Forest. Timber harvesting on federal land has been on-going since the formation of the Redbird Ranger District in 1962. Ford held significant forest reserves in the area until 1950, at which time the forest started recovering to the hardwood stands we see today. Timber harvesting still occurs, just at a much smaller scale comparatively. Most of the forests are now second and third generation, and hardwood timber quality is very good in this watershed. The extreme, narrow, and winding terrain creates many niches for favorable hardwood growth of many species, but it also presents the biggest obstacle to harvesting. There likely are small isolated pockets of old growth timber with considerable volume spread throughout the watershed, but no way to access it for harvest due to the rugged terrain and steep slopes.

Timber harvesting across the Daniel Boone National Forest hit a peak in 1997, and has since decreased dramatically due to various reasons. While some may hold a negative opinion of timber harvesting, it is an important management tool that provides for the current and future health of the forest. It is very similar to weeding a garden in that a desired condition is worked towards by eliminating the undesirable. In this case the desired condition is a forest with species, health, and volume that mimics historical values.

In the past four years on federal land in the Red Bird River Watershed, there have been two commercial timber harvests from 384 acres. The Elk Timber Sale was in the Britton Branch area of the forest, and the Bob's Fork Timber Sale was north of Hwy. 421, east of the community of Big Creek. Harvested species included chestnut oak, white oak, black oak, and scarlet oak. Two more timber sales are scheduled in the near future (2015) on federal lands in the watershed.

Oil and gas development

Oil and natural gas resources occur throughout much of western, south-central, and eastern Kentucky. Most natural gas is produced from the Devonian black shale of eastern Kentucky. As shown in Figure 2.14, the Red Bird Watershed has approximately 678 wells sites of which 541 are currently active. A majority of the active wells produce natural gas, and the mineral ownership is separate from the surface ownership. The gas wells are relatively shallow (less than 1500 feet), and fracking techniques are usually not employed. As a result, the direct water quality effects are relatively benign. However, each of these active wells is serviced by gravel or dirt roads and a pipeline. These roads are often on steep slopes and erosion control measures are not always fully implemented. Downstream sedimentation levels are elevated and aquatic habitat is affected. The Daniel Boone National Forest is currently mapping these access roads and identifying soil and water problems.

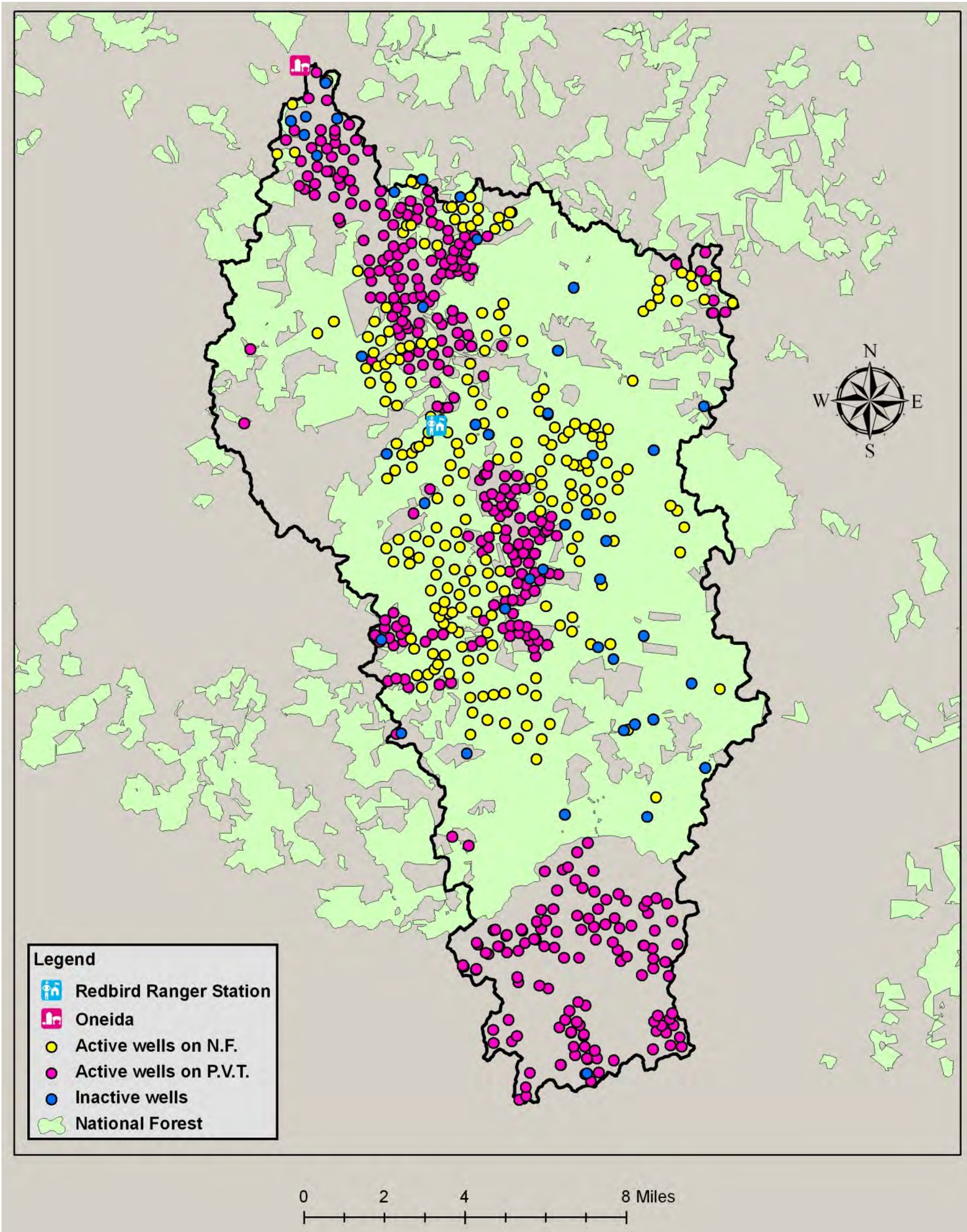

Figure 2.14: Oil and gas wells in the Red Bird River Watershed (USFS 2012).

Other Water Disturbances

401 and 404 Permits

Any person, firm, or agency (including federal, state, and local government agencies) planning to work in jurisdictional waters of the United States, or dump or place dredged or fill material in waters of the United States should contact the U.S. Army Corps of Engineers (USACE) office in your area and the Kentucky Division of Water, Water Quality Certification Section to obtain a permit. The 401 Water Quality Certification Program of the Kentucky Division of Water is the Commonwealth's review and authorization of selected federal license and permits (Kentucky Division of Water website water.ky.gov/permitting/Pages/KYWaterQualityCertProg.aspx).

Examples of federal licenses and permits subject to 401 certification include Clean Water Act 404 permits for discharge of dredged or fill material issued by the USACE, Federal Energy Regulatory Commission (FERC) hydropower licenses, and Rivers and Harbors Act 9 and 10 permits for activities that have a potential discharge in navigable waters issued by the USACE. A 401 certification from the Commonwealth of Kentucky also affirms that the discharge will not violate Kentucky's water quality standards (Kentucky Division of Water website water.ky.gov/permitting/Pages/KYWaterQualityCertProg.aspx).

Examples of activities that may require a certification from the Kentucky Division of Water, Water Quality Certification Section include:

- Placement of dredged or fill materials into waters of the state and/or wetlands
- Structural fill such as culverts and bridge supports
- Road and utility crossings
- Dredging, excavation, channel widening, or straightening
- Flooding, excavating, draining and/or filling a wetland
- Bank sloping; stabilization
- Stream channel relocation
- Water diversions
- Divert, obstruct or change the natural flow or bed of any waters of the state (e.g. debris removal, bank stabilization or culverting)
- Construct a barrier across a stream, channel, or watercourse that will create a reservoir: dams, weirs, dikes, levees or other similar structures (Kentucky Division of Water website water.ky.gov/permitting/Pages/KYWaterQualityCertProg.aspx).

A Freedom of Information Act request to the Louisville District Army Corps of Engineer for any 404 permits in the counties of Leslie, Clay, and Bell for the time period of January 1, 2007 to December 31, 2011 resulted in two permits within the project study area (Table 2.5). There were other permits issued within these counties that fell outside of watershed project area.

Table 2.5: Record of 404 permits issued within project study area from 2007 to 2012 (US Army Corps of Engineer via FOIA request by Kentucky Waterways Alliance, 2012).

Project Name	Location	DA Number	Start Date	End Date	Action Type
Elisha Creek Restoration (mitigation project)	Left Fork Elisha Creek, Leslie County	LRL-2011-404-pgj	October 5, 2011	Ongoing	Mitigation project
Chesapeake Appalachia stream bank stabilization	Hector Branch, Clay County	LRL-2010-636-jea	July 29, 2010		Stream bank mitigation, NW13

The project in Clay County was a bank stabilization project and did not require a Water Quality Certification. The project on Elisha Creek was a more involved wetland mitigation project, and it did require a Water Quality Certification.

2.8 Demographics and Social Issues

Communities of people are embedded in ecosystems in the Red Bird River Watershed and influence the composition, structure, and function of these systems. Prehistoric Native Americans were the first settlers of the area. They superimposed a cultural overprint that shaped ecosystem dynamics by a patchwork pattern of immigration and settlement, by competition for scarce or valued resources, and by geographic displacement of populations in the quest for territorial dominance.

Historical Kentucky changed due to European settlement. The American chestnut is no longer a canopy species. A fungus on chestnut nursery stock imported from Europe brought the blight to New York in 1904. It spread down the Appalachian Mountains, reaching Eastern Kentucky by 1930. It quickly killed all mature chestnut trees. Many non-native species of plants were introduced.

The Euro-Americans made their living by farming, hunting, and gathering wild plant foods. They grew the Indian crops of corn, beans, gourds, and tobacco. But they also grew Old World crops like oats, wheat, and hemp, and they tended fruit trees in orchards. Unlike Fort Ancient farmers, they kept domesticated livestock, such as cattle, sheep, mules, chickens, horses, and hogs which were allowed to forage freely on the landscape until about 1950. But they also hunted deer, raccoon, opossum, squirrel, and rabbit like the native peoples and rapidly extirpated (made locally extinct) many species such as the white-tailed deer, elk, bear, cougar, wolf, and bison.

The overall population of Bell, Clay, and Leslie counties peaked in 1950 and declined thereafter (Figure 2.15). The population of the Red Bird Watershed has had a large decline in population. The population of Clay County has been relatively stable from 1940-present. The Census

Bureau predicts that the populations of Bell, Clay, and Leslie counties will each continue to decline through 2050. By comparison, from 1950 through 2010 the population of the United States more than doubled and the population of Kentucky increased by 47%. All population data used in this section was obtained from the Census Bureau website at www.census.gov.

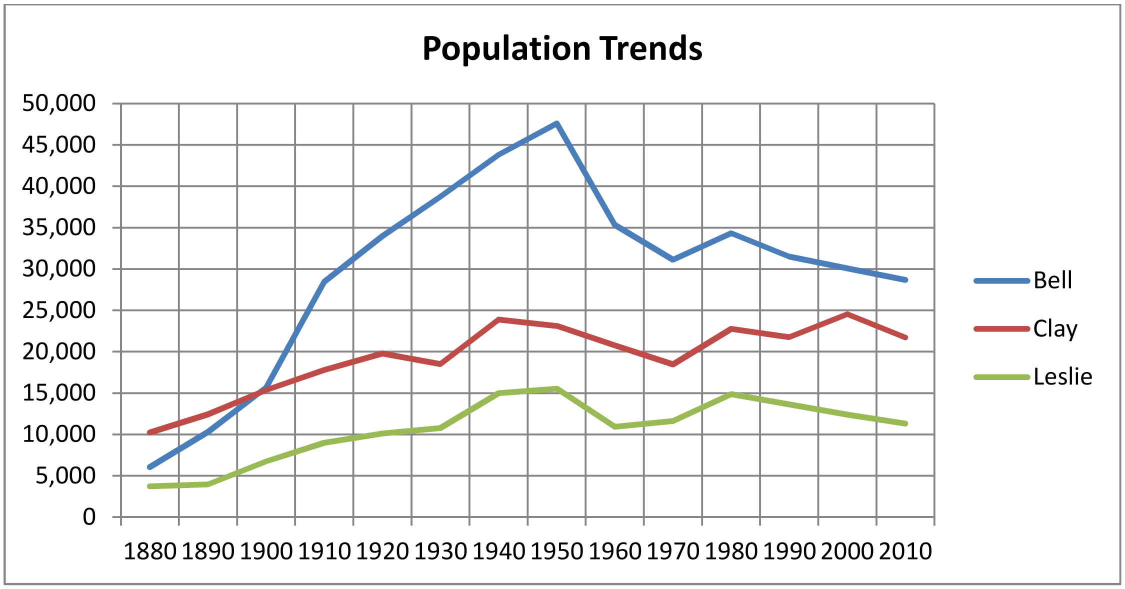

Figure 2.15: Population trends in Bell, Clay, and Leslie Counties from 1880-2010 (Census data).

White populations are a much higher percentage of the overall population in Bell, Clay and Leslie counties than Kentucky and National averages. African Americans are the largest non-white group.

The population density of each county in the area is below the Kentucky and National average (Figure 2.16). Clay and Leslie counties and the Red Bird River Watershed are far below the Kentucky and National average. However, the ecological impact is higher than would be expected since home sites often include several acres of surrounding lands that are impacted.

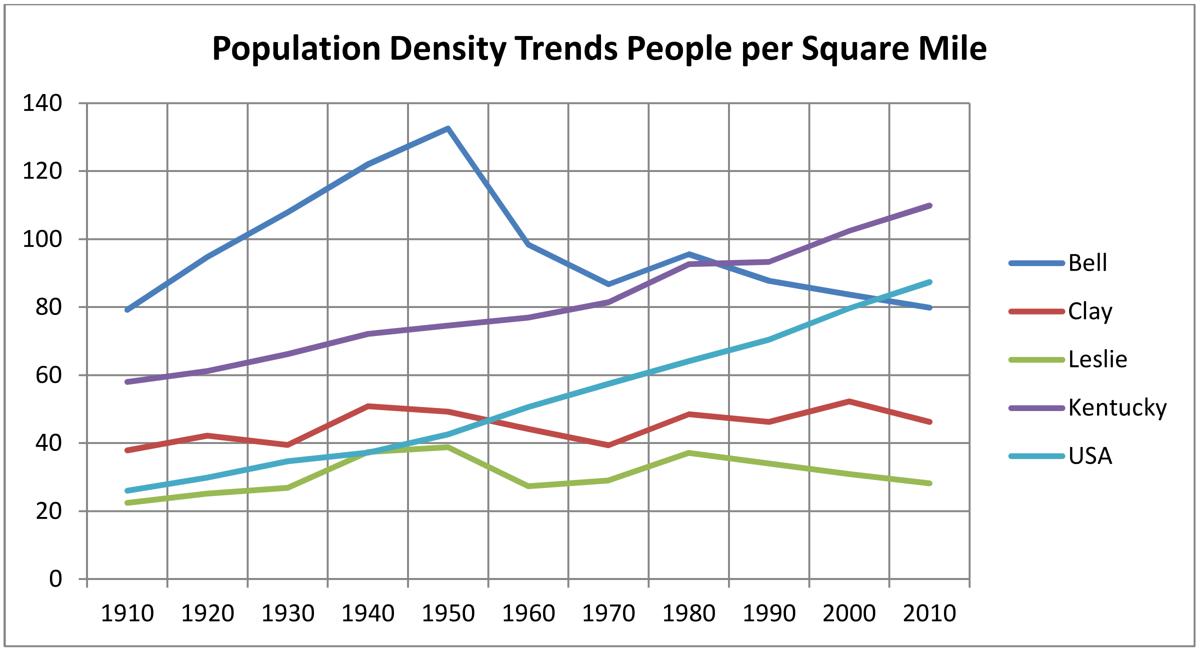

Figure 2.16: Population Density Trends, People per Square Mile (US Census).

The number of households has also declined but not as fast as the population since family size has declined. The number of persons per household, except Clay County, is similar to Kentucky and National averages. The percent of people who own their own homes is higher than Kentucky and National averages.

Government agencies were the number one source of employment in Bell, Clay, and Leslie counties in 2010. Local governments were the largest source of government employment. In Bell county 19.2% of all jobs were government jobs in 2010, in Clay County 29.6% and in Leslie County 24.1%. The number two source of employment in Bell and Clay counties was retail trade. Typically the number two source of employment in Leslie County has been mining, but the number of mining jobs fluctuates widely. Leslie County does not have any of the large box stores, and its residents often shop in surrounding counties. Consequently, the proportion of retail trade jobs is lower than Bell and Clay counties. Agriculture is a relatively minor source of employment in Bell and Leslie counties but in 2010 accounted for 5.5% of jobs in Clay County. Forestry is relatively small source of jobs in all three counties. All employment data were obtained from the Bureau of Economic Analysis website at www.bea.gov/. Data were not available for some sources in some counties due to privacy considerations.

2.9 References

Clark, T.D. 1984. The greening of the south: the recovery of land and forest. University Press of Kentucky, Lexington, KY.

Jones, R.L. 2005. Plant life of Kentucky. University Press of Kentucky, Lexington, KY.

Taylor, W.S. 1958. Kentucky's resources, their development and use. Bulletin of the Bureau of School Service, College of Education, University of Kentucky, Lexington, KY.

Red Bird River Watershed

Chapter 3: Securing Data

3.1 Introduction

The work conducted for Chapter 2 gave you a better understanding of your watershed; however, additional data and more in-depth analyses are necessary to identify pollutant sources and to target implementation projects in places where they will have the most benefit. There are two major goals of watershed planning: protect good water quality and improve poor water quality. To achieve these goals, efforts must be targeted to protect areas without problems and to restore areas with problems. To prioritize areas with problems, it is necessary to identify where pollutants impact waterways. This is done through sampling the water quality and comparing the results to known standards.

It is important to remember that this project is focused on *nonpoint source pollution*. Nonpoint source pollution originates from diffuse areas (land surface or atmosphere) with no well-defined point of origin. Pollutants are generally carried off the land and into waterways by rain or melting snow. Common nonpoint pollution sources are parking lots and roads, construction sites, agriculture, forestry, recreation, residential activities, and urban land uses.

This chapter will provide detail about where, what, and how data were collected to assess the current water quality in the Red Bird River Watershed. Those analyses and findings may be found in Chapter 4.

3.2 Water Quality Sampling

Water quality sampling is often conducted as part of a watershed planning project. Even if there are existing data, collecting new data allows for an up-to-date look at the condition of the water. Furthermore, conducting project-specific analyses can provide information about target areas or measure the effectiveness of implemented BMPs. General information about water quality parameters – what each parameter means and how it is collected – can be found in the *Watershed Planning Guidebook for Kentucky Communities*. The “Watershed Basics” section reviews watershed planning, regulatory issues, and the science behind water quality testing. It can be viewed online:
http://kwalliance.org/what-we-do/watershed-planning/watershed-guidebook/

When analyzing water quality, it is important to have a baseline standard for comparison. The following discussion details the standards and sources used for this comparative analysis. When discussing standards for this project, it is important to look at those that apply to ***warm water aquatic habitat*** (WAH) only.

The state of Kentucky has legal standards that apply to warm water aquatic habitat for some water quality parameters (KDOW 2012) (Table 3.1). Standards are either numeric or narrative. In Table 3.1 where “No numeric standard” is indicated, it means that there exists a Kentucky standard which states, “shall not be changed to the extent that the indigenous aquatic community is adversely affected” (KDOW 2012). Where “No standard” is indicated, there is no federal or Kentucky standard (numeric or narrative) in existence for that parameter.

There are other parameters for which there are no federal or Kentucky standards (numeric or narrative) such as phosphorus, sulfate, and specific conductance. Since extreme levels of these parameters are known to adversely affect aquatic life, the Kentucky Division of Water (KDOW) created a set of “benchmarks.” The following excerpt is from the benchmark reports (KDOW 2013a and 2013b):

> Nutrient benchmark recommendations provided by the KDOW represent the best information available to the agency at this time. The goal is to provide estimates of typical in-stream concentrations below which it is unlikely that nutrients would be a cause of aquatic life impairments. As such, benchmarks are useful in identifying sub-basins with potential nutrient issues when setting priorities for further monitoring or for developing strategies for load reductions. It is important to note that benchmarks for data screening and prioritization presented here do not necessarily represent targets for water quality. The numbers are intended to represent typical in-stream values in the region for streams with relatively low levels of impacts. Values above (or below in some cases) these benchmarks are not necessarily a cause for concern, but a pattern of higher numbers (or lower in some cases) may help to identify potential stressors to aquatic life or unusual conditions in the watershed.
>
> In making these recommendations, the agency considered regional and watershed-specific nutrient expectations, regional-scale patterns in biological effects, and relevant published literature. These benchmarks may be different than targets to be used ultimately as management endpoints; watershed-specific characteristics, practical considerations, and insight gained from early phase monitoring might suggest alternate values for that purpose. The Watershed Group may wish to discuss with KDOW alternative benchmarks and/or targets based on more detailed local information or consultation with experts familiar with the watershed. Also, these benchmarks should be reviewed as more information becomes available on conditions in the watershed, including any specific nutrient-related issues that may be observed in the course of monitoring.

> The project area contains segments designated as Outstanding State Resource Water, including several streams in Kentucky's wadeable streams Reference Reach network. The lower Red Bird River is an Outstanding State Resource Water that was designated based on its importance as a sport fishery, and the watershed as a whole is home to the Kentucky arrow darter, *Etheostoma spilotum*, a candidate for federal listing as an endangered species. Because of the importance in maintaining water quality to protect these uses, we have provided conservative benchmarks for data screening. (p. 1)

Some parameters do not have any federal or Kentucky standards (numeric or narrative) or benchmarks, such as calcium and magnesium. In this case, if there are no recommended criteria for the protection of aquatic life *in general*, then the EPA found no need for one to be in place, and Kentucky follows suit. Table 3.1 illustrates the parameters, standards, standard sources, uses, and benchmarks for all parameters in this analysis. Most of the standards reflect conditions needed to sustain warm water aquatic habitat (WAH). The standard for *E. coli* is based on acceptable conditions needed for primary contact recreational waters, such as those used for swimming and fishing. There is no *E. coli* standard for warm water aquatic habitat.

Links to online sources for KY Surface Water Standards and US EPA National Primary Drinking Water Contaminants may be found in the reference section at the end of this document.

Table 3.1: Parameters, standards, uses, and benchmarks used in the water quality analyses for the Red Bird River Collaborative Restoration Project.

Parameter	Standard (Source)	Standard Type	KDOW Benchmark
Temperature	31.7^{O}C (KDOW)	WAH*	
pH	>6.0 to <9.0 (KDOW)	WAH	
Dissolved Oxygen	≤4.0 mg/L (KDOW)	WAH	
Specific conductance	<119 µS/cm (KDOW)	WAH	X
Sulfate	<19.5 mg/L (KDOW)	WAH	X
Nitrate-N	<0.16 mg/L (KDOW)	WAH	X
Total P	<0.02 mg/L (KDOW)	WAH	X
Alkalinity (as $CaCO_3$)	12-54 mg/L (KDOW)	WAH	X
Total Dissolved Solids	No numeric standard	WAH	
Total Suspended Solids	No numeric standard	WAH	
Hardness (as $CaCO_3$)	No numeric standard	WAH	
Total Aluminum	<0.750 mg/L (US EPA - acute)	WAH	
Total Calcium	No standard	WAH	
Total Cadmium	** (KDOW – acute)	WAH	
Total Iron	<4 mg/L (KDOW - acute)	WAH	
Total Magnesium	No standard	WAH	
Total Manganese	No standard	WAH	
Total Lead	*** (KDOW – acute)	WAH	
E. coli	<240 colony forming units per unit (KY)	Primary contact recreational waters	

*Warm Water Aquatic Habitat

**Cadmium standard: [e (1.0166 (in hardness) – 3.924)] / 1000

***Lead standard: [e (1.273 (in hardness) – 1.460)] / 1000

3.3 Methods for Monitoring

Two types of monitoring were conducted during 2011 and 2012 within the Red Bird River Watershed:

- Water chemistry and physical properties of the river and its tributaries (hereafter referred to as "Water Quality Data") were obtained during a single sampling event.
- *Escherichia coli* (*E. coli)* data were collected by grab samples on three separate sampling events, and reflect two dry weather samplings and one wet weather sample.

Methods – Water Quality Data

Between August 29, 2011 and September 1, 2011, water quality data were collected at 36 sampling points in the Red Bird River Watershed (Figure 3.1): eight sampling points along the main stem of the Red Bird River, and 28 sampling points along tributaries entering the Red Bird River. The sampling points were pre-determined by USFS personnel and collected by a combination of Tennessee Valley Authority and USFS personnel.

At each sampling location, the following parameters were measured:

- Latitude and longitude, measured with a GPS
- pH, turbidity, temperature, dissolved oxygen, specific conductance, and oxidation/reduction potential were measured with a Hydrolab (model MS-5).
- Total alkalinity, acidity, oil and grease, total dissolved solids, total suspended solids, total hardness, aluminum, calcium, cadmium, iron, magnesium, manganese, iron, total phosphorus, bicarbonate, carbonate, nitrate, and sulfate were measured by analyzing grab samples, which were collected in pre-dosed bottles provided by Environmental Testing and Consulting, Inc. located in Memphis, TN. Grab samples were taken in the field, shipped on ice to the consultant, and analyzed for the above chemical parameters.
- Other physical measurements included flow (measured with a Global Water Flow Probe, Model FP101), wetted perimeter, and bankfull depth.

Methods – *E. coli* Data

To test for the presence and amount of *E. coli* throughout the watershed, grab samples were collected during five sampling events: February 13, 2012; May 15-16, 2012; August 13, 2012; October 10, 16-17, 2013; and May 1, 12-13, 22-28, 2014. The 2012 data had a large variance, so additional sampling was conducted in 2013 and 2014 by the KDOW.

At each sampling location, the field crew first measured specific conductance, pH, and temperature using a YSI Model MPS 556 (multi probe system). A grab sample was gathered and preserved with sodium thiosulfate (provided by Microbac). Between samples, the collection bottle (one liter poly) was triple rinsed and stored in a ziplock bag. The water samples were shipped on ice to Microbac Laboratories, Inc., in Hazard, KY and analyzed using method SM-9223B.

The samples collected during 2012 were from locations on the main stem of the Red Bird River and its tributaries (Figure 3.1). Samples collected during 2013 and 2014 were from a subset of the locations (Figure 4.26).

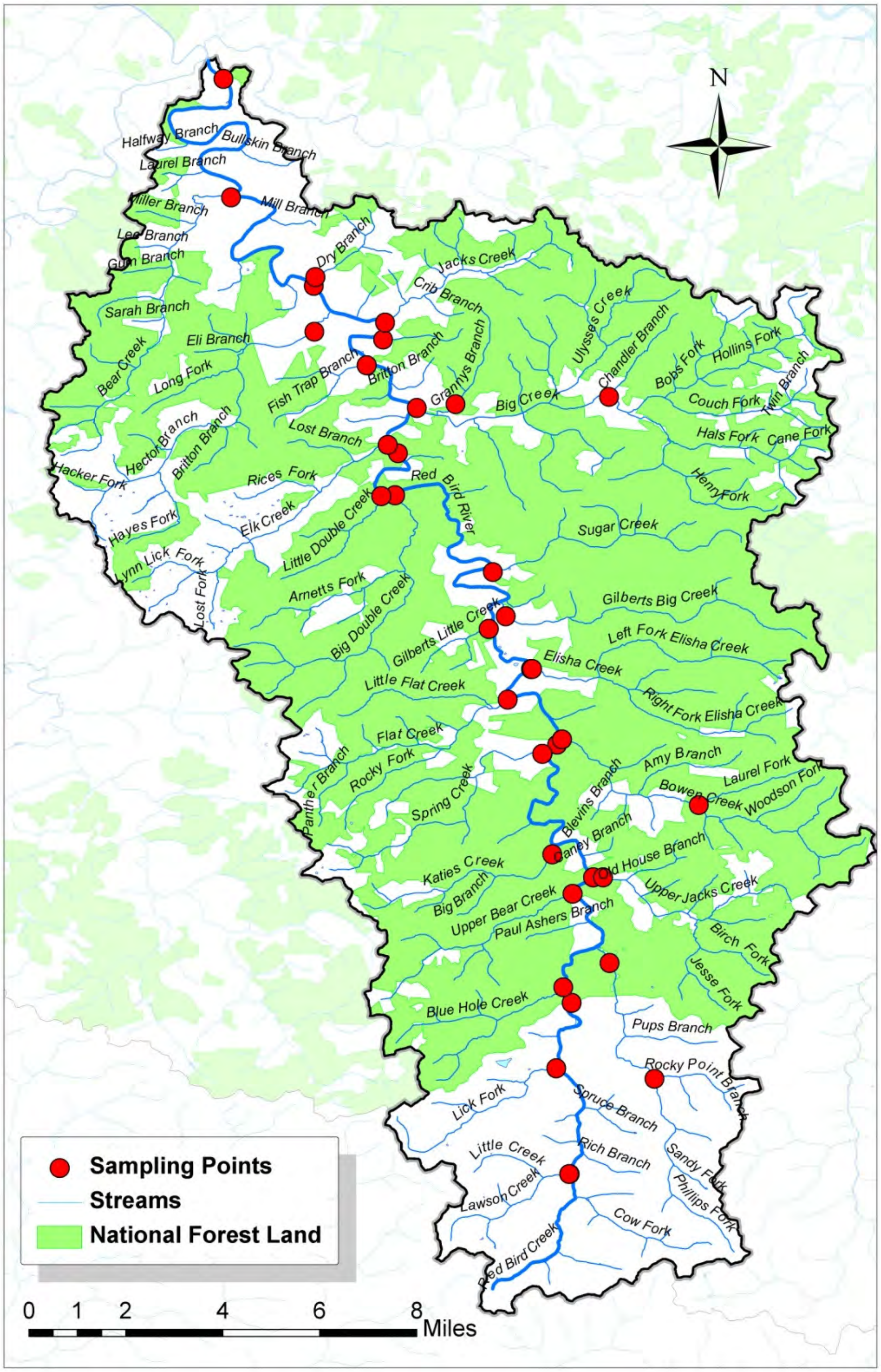

Figure 3.1: Location of the initial water quality sampling points within the Red Bird River Watershed.

3.4. References

Kentucky Division of Water (KDOW). 2012. Surface water standards. Available online at: http://www.lrc.ky.gov/kar/401/010/026.htm. Accessed 9/5/2012.

Kentucky Division of Water (KDOW). 2013a. Red Bird River Watershed Plan Benchmark Recommendations for Non-nutrient Parameters. 2 pp.

Kentucky Division of Water (KDOW). 2013b. Red Bird River Watershed Plan Benchmark Recommendations for Nutrient Parameters. 2 pp.

United States Environmental Protection Agency (US EPA). 2011. Drinking water contaminants. Available online at: http://water.epa.gov/drink/contaminants/index.cfm. Accessed 12/7/2011.

Red Bird River Watershed

Chapter 4: Analyzing Results

4.1 Introduction

Chapter 3 detailed the specifics of how the water quality data were collected and what standards we used for comparison purposes. This chapter will present and analyze the water quality data collected in the Red Bird River Watershed. It is analyzed and put into perspective by comparing it to current standards and benchmarks defined in Chapter 3.

4.2 The Goal of this Analysis

The intent of the Red Bird River Collaborative Restoration Project, as identified in public meetings, is to improve the water quality in the Red Bird River Watershed. When asked about what was important regarding the watershed in which they live, residents and stakeholders identified several issues, including:

- Safely swimming and wading in the water
- A sustainable supply of safe drinking water
- Fishing and hunting in and near the water
- Increased recreation uses
- Large amounts of garbage in the watershed

To address these issues, it was necessary to gain an understanding of the existing water quality conditions in the Red Bird River and its tributaries. This was done through water quality monitoring. This chapter will present and discuss the results of the data collected for this express purpose in the Red Bird River Watershed. The analysis will further assist in identifying locations in the watershed where implementation of Best Management Practices (BMPs) will be most feasible, efficient, and effective.

4.3 Organization of Results and Discussion

Results are organized according to the following layout:

1. **Water chemistry and physical properties data** (hereafter referred to as **“Water Quality Data**”)

    a. Main stem Samplings – 8 sampling points along the Red Bird River (Figure 4.1)

        i. A brief discussion on flow
        ii. Parameter concentration decreases from headwaters to mouth
        iii. Parameter concentration increases from headwaters to mouth
        iv. No change in the parameter concentration or stays steady from headwaters to mouth

b. Tributary Samplings- 28 sampling points located mostly at the mouths of the tributaries to the Red Bird River (Figure 4.2)
    i. Tributaries with Parameters that Did Not Exceed a Numeric Standard or Benchmark
    ii. Tributaries with Parameters that had Increased Concentrations relative to other Tributaries but with no Numeric Standard or Benchmark
    iii. Tributaries with Parameters that Did Exceed Numeric Standards or Benchmarks

c. Land use and discussion of water quality data

2. ***Escheria coli (E. coli)* data** – analyzed all data together, regardless if they were on the main stem or a tributary.

Dividing the water quality data into two groups, the main stem and the tributaries, made it possible to determine which sub-watersheds were contributing pollutants to the main stem of the Red Bird River. By doing this, the type of land use in the sub-watersheds can be analyzed to determine the source of the pollutants.

The *E. coli* data and analyses are presented as an entire group (all sampling points regardless of location) to get a broad picture of this pollutant in the watershed.

In an attempt to be concise and non-repetitive, a couple of the water quality parameters listed in Chapter 3 are not reported in this analysis. Hardness is largely composed of calcium and magnesium in this watershed, so instead of reporting three graphs that are identical, only hardness is presented. Also, specific conductance is closely related to total dissolved solids, so only specific conductance is reported in this analysis.

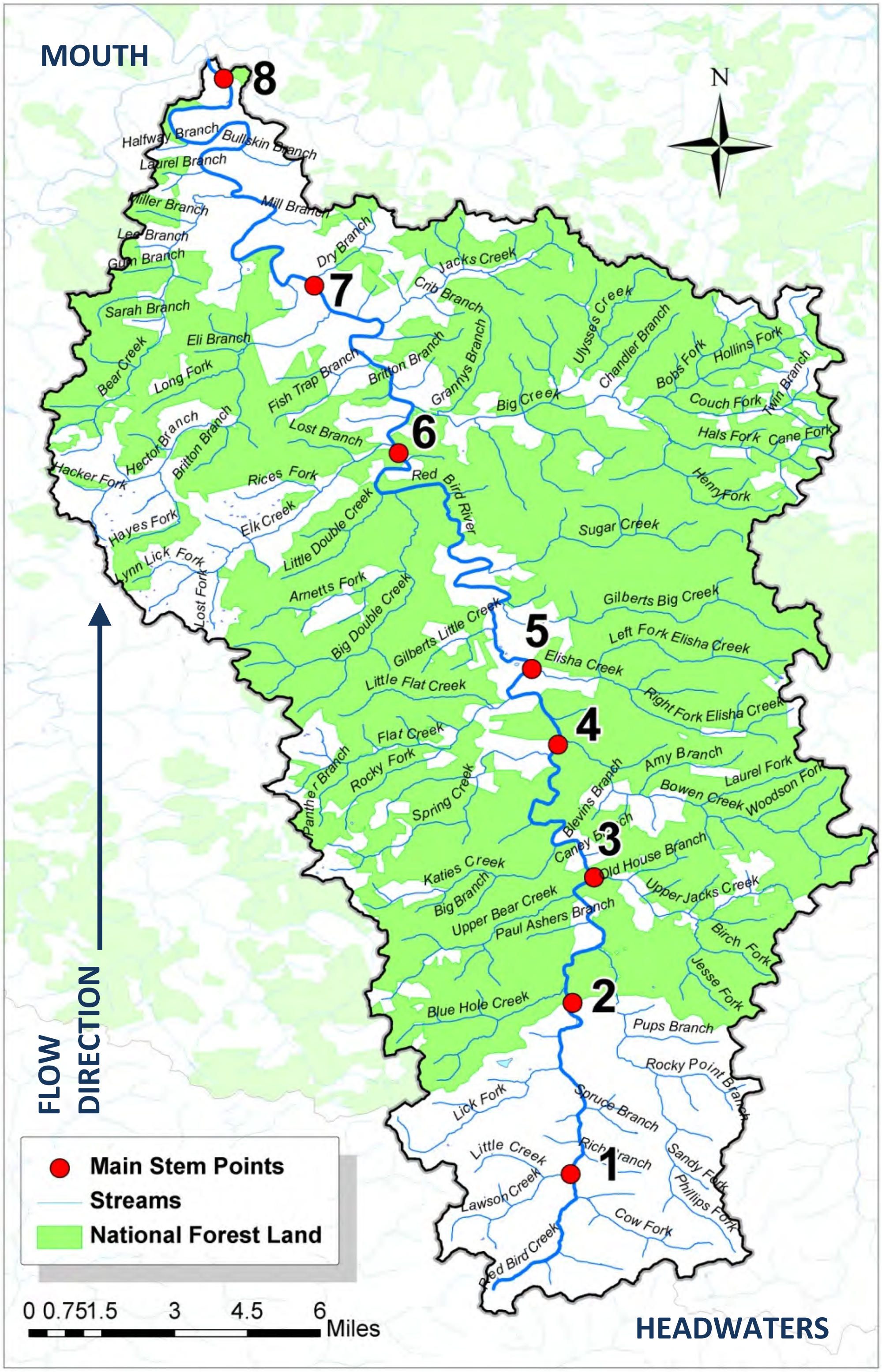

Figure 4.1: Location of the eight sampling points along the main stem of the Red Bird River.

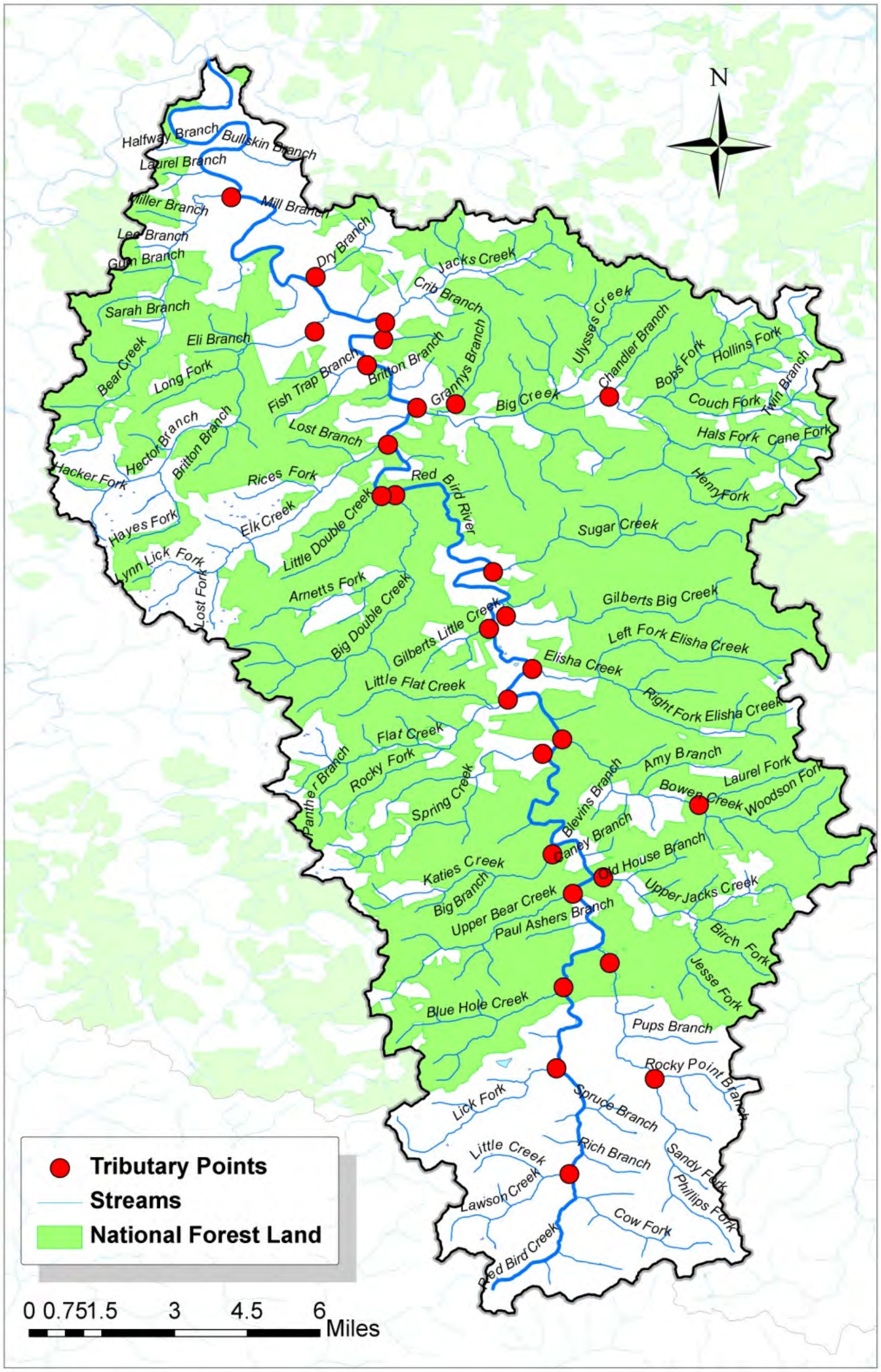

Figure 4.2: Location of the 28 tributary sampling points in the Red Bird River Watershed.

4.4 Results & Discussion – Water Quality Data

Main Stem Sampling

It is important to note that in Figures 4.1 and 4.2 the headwaters are located at the bottom of the map (sampling points 1 and 2), and the mouth of the watershed is located at sampling point 8; water flows in a northerly direction in the Red Bird River. As one travels from sampling point 1 to 8, water quantity and flow typically increases.

When graphed, chemical and physical parameters measured on the main stem exhibited one of three trends: concentration decreases from the headwaters to the mouth; concentration increases from the headwaters to the mouth; or no change in concentration from the headwaters to the mouth. A graph of each parameter is shown in its appropriate section of this report, and when the parameter exceeded a state or federal standard or a benchmark, it is indicated as a red line on the graphs shown later in this report. Since all the parameters are affected by flow, a brief discussion of flow follows.

Main stem – A Brief Discussion on Flow

At the eight sampling points along the main stem, water flow generally increased from the headwaters to the mouth of the watershed (Figure 4.2). This is a typical finding in watersheds and is caused by the increasing input of tributaries along the main stem. This often results in a "dilution effect" of water quality parameters. For example, iron could have an elevated concentration in the headwaters, but by the time it reaches the mouth of the watershed, the concentration is considerably lower and diluted. This is caused by addition of flows from tributaries over the length of the river. There can be variation in flow levels due to various factors like topography, input from tributaries, and local stream uses (Figure 4.3).

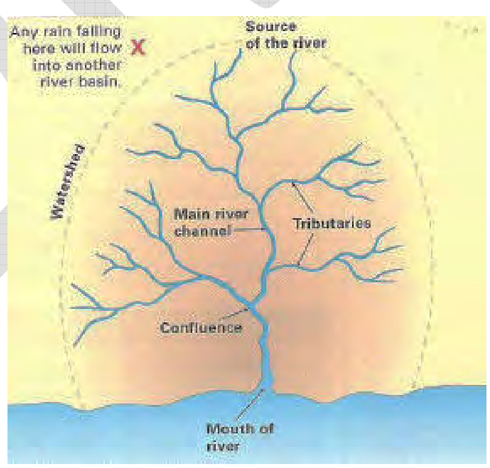

Figure 4.3: Diagram of typical in-stream flow in a riverine system.

The following figures (Figures 4.4 through 4.13) depict water quality measurements taken during the sampling event that occurred between August 29 and September 1, 2011. All water quality parameters, except *E. coli,* were sampled one time during this sampling event. The amount of the measured parameter is on the vertical axis, and the sample point/location is on the horizontal axis (see mapped location of sample points on Figures 4.1 and 4.2). Data was graphed this way so that one may compare the differences in amounts of a specific parameter, such as flow, at different locations in the watershed, from the headwaters to the mouth.

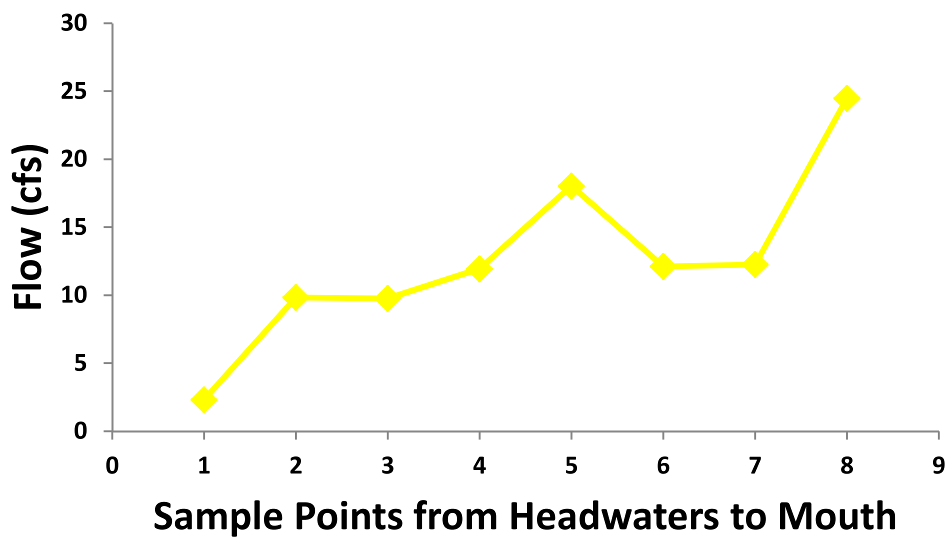

Figure 4.4: Flow, measured in cubic feet per second, in the Red Bird River from the headwaters (Sample point 1) to the mouth (Sample point 8).

Main stem – Decreases from headwaters to the mouth

When analyzed and graphed, four of the water quality parameters showed a decreasing pattern from the headwaters to the mouth of the Red Bird River (Figure 4.5):

- pH
- specific conductance
- sulfate
- hardness

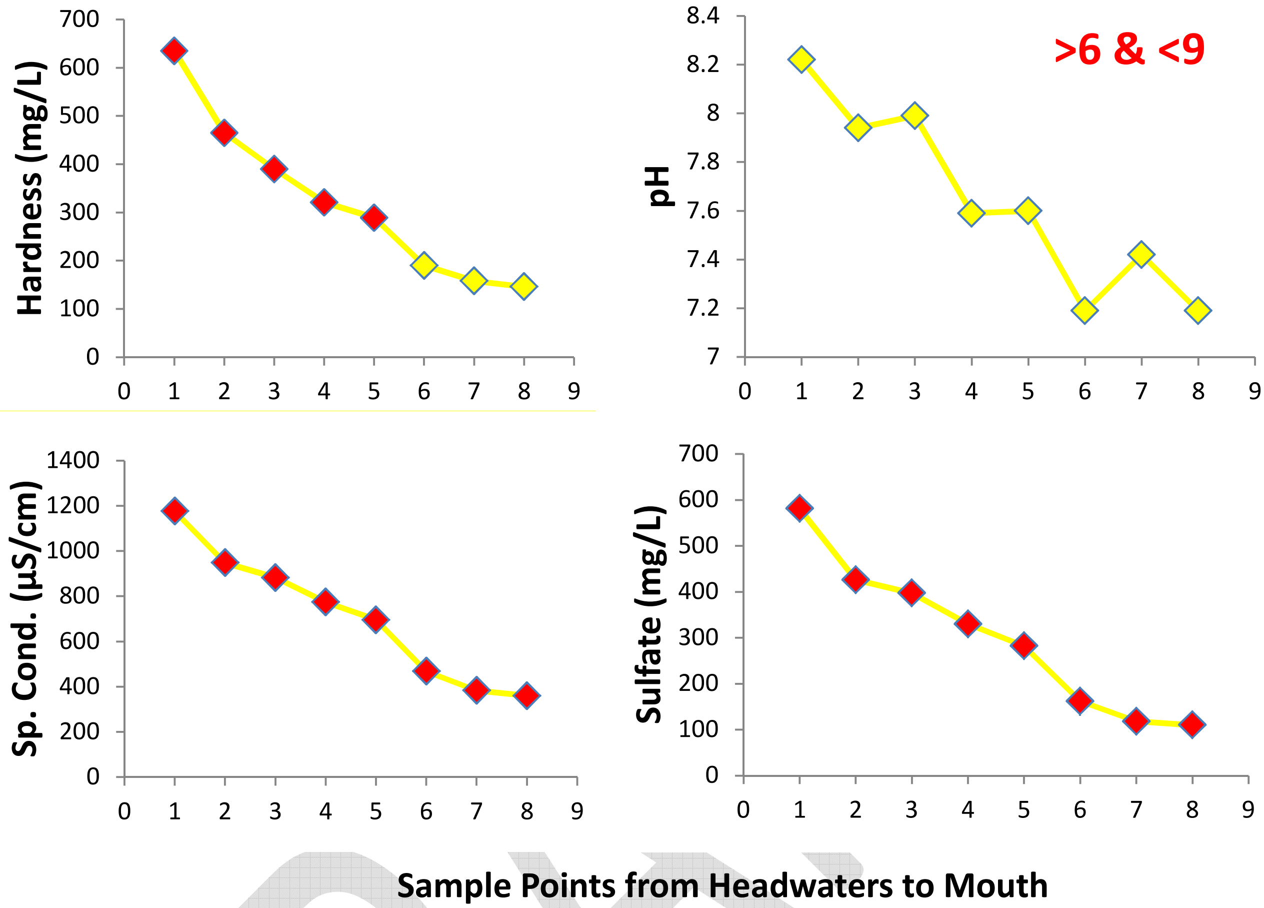

Figure 4.5: Hardness, pH, SC, and sulfate measurements at eight sample points from the headwaters to the mouth in the Red Bird River Watershed. Red lines and numbers depict the numeric standard, or maximum; hardness has none. Sampling points in red indicate an exceedance of a numeric standard. All four parameters decrease in concentration from the headwaters to the mouth of the Red Bird River.

Data indicate that pH, specific conductance, sulfate, and hardness are high in the headwaters and gradually decrease as they flow downstream. This pattern is likely due to a dilution effect.

When discussing the hardness values with KDOW personnel, they indicated that although there is no numeric standard for this parameter, values that exceed 200 mg/L are extreme compared to native conditions (pers. comm., Brooke Shireman, March 2013). As seen in Figure 4.5, there are five values that exceed this threshold, and some by 2 to 3 times. This could be influenced by the geology, which is largely shale and sandstone, but is cemented by minerals high in calcium and magnesium. Additionally, the practice of lining creek or mining outflow channels with limestone rock to reduce the acid in the mine effluent could have an influence on these elevated levels as well.

At all of the sampling points along the main stem, sulfate and specific conductance exceeded the recommended benchmark values provided by KDOW (Figure 4.5). The following map

(Figure 4.6) indicates the specific locations where sulfate and specific conductance exceeded the benchmarks along the Red Bird River. By mapping the locations where water quality parameters exceeded numeric standards, the sub-watersheds can be investigated to determine the potential source of the pollutant.

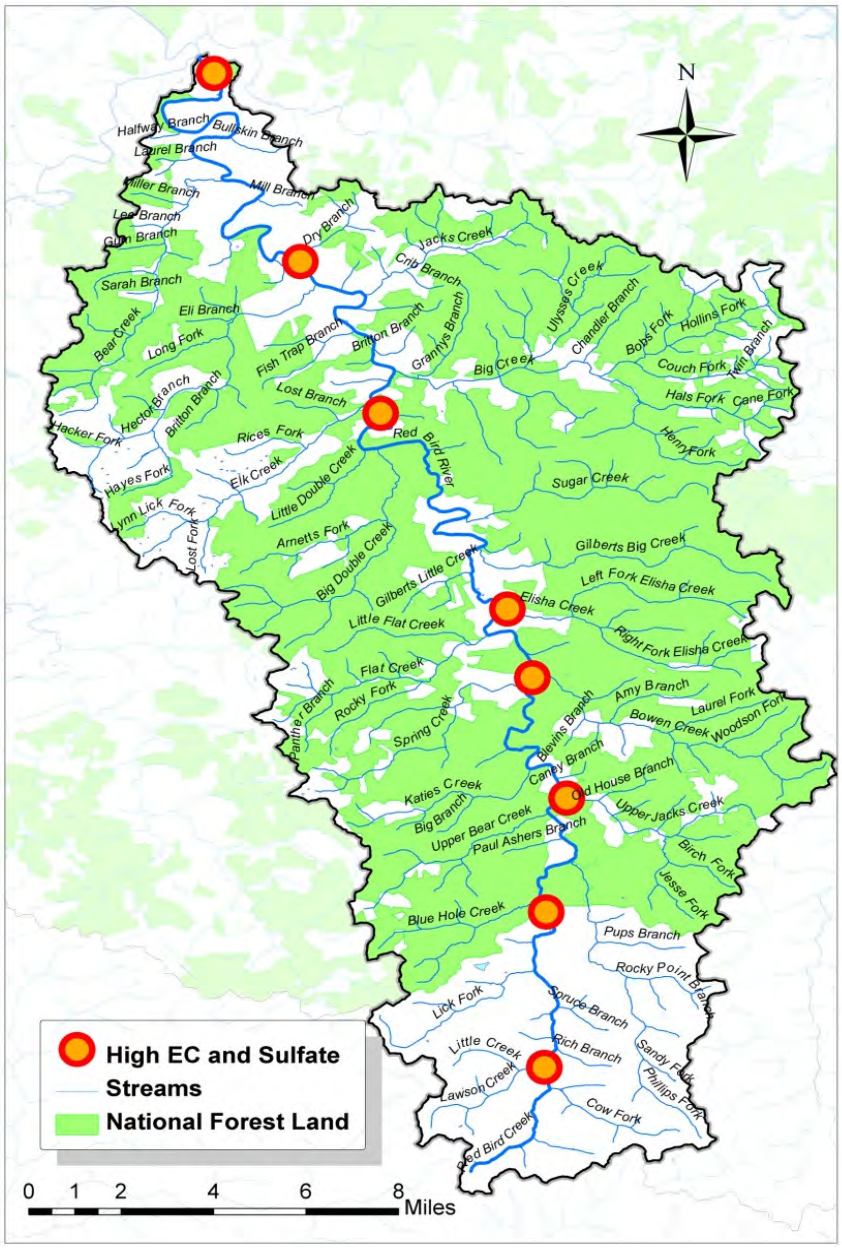

Figure 4.6: All eight sampling points on the main stem of the Red Bird River had sulfate and specific conductance concentrations that exceeded benchmarks. Hardness exceeded native conditions in the bottom five sampling points on the map.

Main stem – Increases from headwaters to the mouth

Three water quality parameters had a trend of low concentration in the headwaters with increasing concentration as the sampling points approached the mouth (Figure 4.7): Total Suspended Solids (TSS), Total Iron, and Total Manganese

None of the three parameters exceeded a numeric standard.

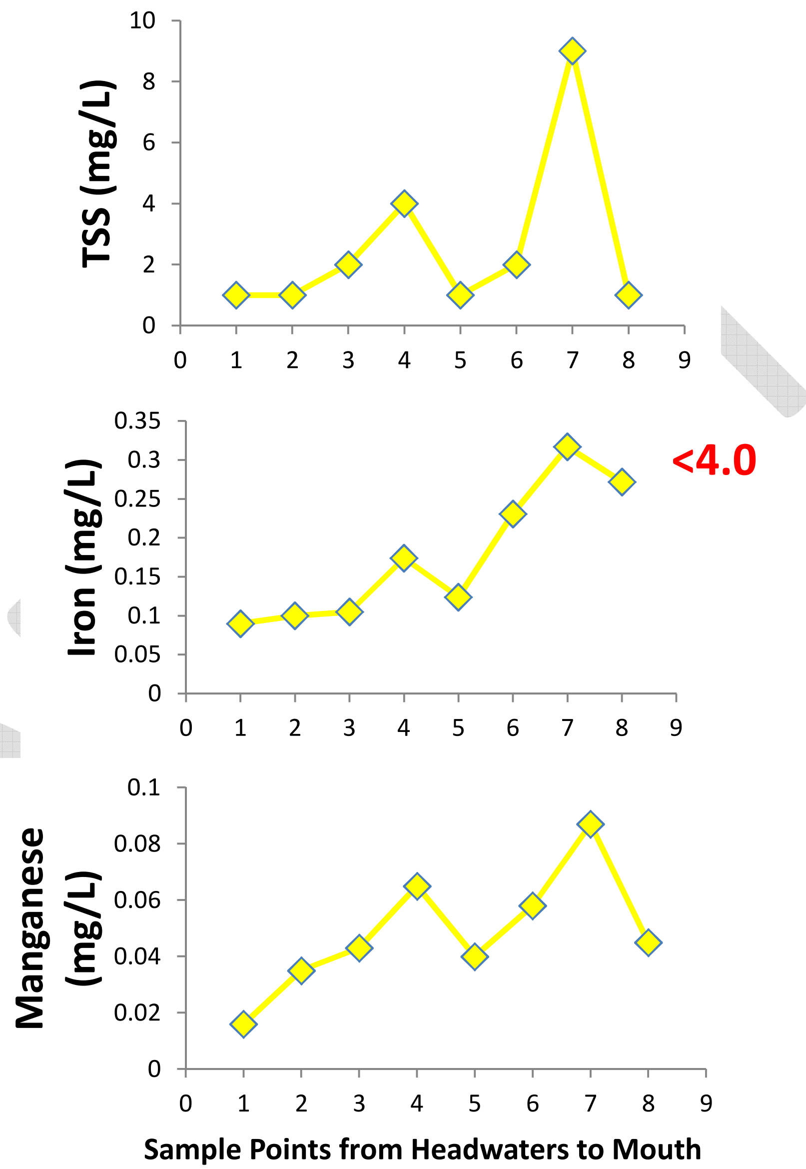

Figure 4.7: TSS, iron, and manganese measurements at eight sample points from the headwaters to the mouth in the Red Bird River Watershed. Red numbers depict the numeric standard, or maximum. All four parameters increase in concentration from the headwaters to the mouth of the Red Bird River.

Main stem – No change from headwaters to the mouth

A final group of water quality parameters stayed steady in concentration from the headwaters to the mouth on the main stem of the Red Bird River: temperature, nitrate, total aluminum, total cadmium, total lead, and total phosphorus. With regard to temperature, nitrate, total aluminum, total cadmium, and total lead, no numeric standards were violated. This group of results is overall positive, because high concentrations of metals in drinking water, especially aluminum, cadmium, and lead, can lead to serious or fatal human health issues.

Unfortunately, the KDOW benchmark for total phosphorus (0.02 mg/L) was lower than the laboratory reporting limit of our phosphorus samples (0.05 mg/L). We do not have workable total phosphorus data for this watershed plan. However, the sources of phosphorus in the Red Bird River are likely due to sewage due to the absence of farm land and fertilizer use. We do have good *E. coli* data, which serves as a proxy for phosphorus, since the two are highly correlated where sewage issues occur. Therefore, we feel the phosphorus concentrations are related to *E. coli* concentrations and if we mitigate for *E. coli*, we will concurrently mitigate for phosphorus.

Taken as a whole, the main stem analyses revealed a couple of hotspots where elevated parameter concentrations could impact the water for humans and aquatic life. The next section, which details the tributaries of the Red Bird River, helps focus attention on specific areas and land use practices that could be contributing to the water quality issues.

Tributaries

When analyzed and graphed, the results of the water quality measurements of the tributaries did not fall into easily defined trends as did the results from the main stem. Once the tributary data were graphed, it became apparent that most parameters showed a typical range of occurrence within the watershed, but also revealed "outliers," or extreme values. For example in Figure 4.8, most of the tributaries had flow that ranged between 0 to 2 cubic feet per second (from a single sampling event). However, five of the tributary sampling points (Figure 4.8, red dots) contributed higher flow amounts to the main stem.

Because this was common in all the tributary analyses, the parameter results are grouped accordingly: Tributaries with Parameters that Did Not Exceed a Numeric Standard or Benchmark, Tributaries with Parameters that had Increased Concentrations relative to other Tributaries but with no Numeric Standard or Benchmark, and Tributaries with Parameters that Did Exceeded Numeric Standards or Benchmarks. It is important to note that five tributary sampling points were dry over the sampling period and no sample was obtained. Therefore, "0" values are seen in each of the tributary graphs. These data are null values and were not included in any of the analyses.

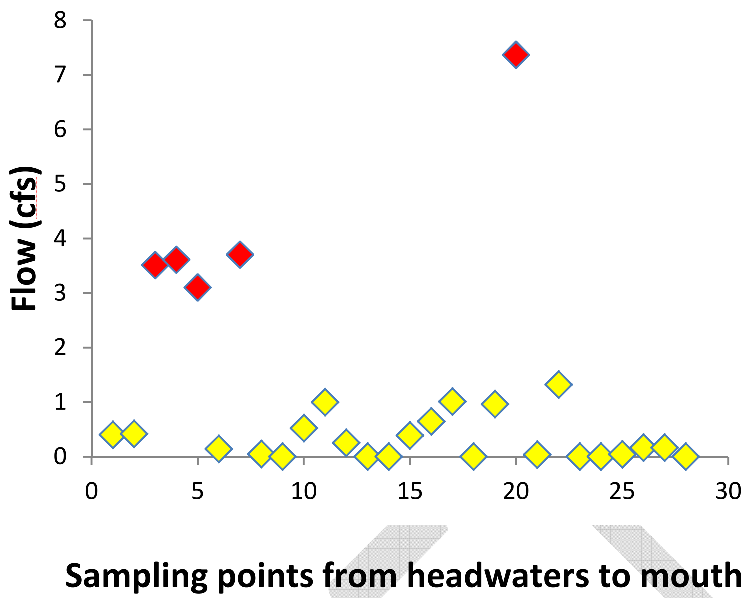

Figure 4.8: Water flow, measured in cubic feet per second during one sampling event, in the 28 tributaries of the Red Bird River as they occur from the headwaters to the mouth. Red points indicate outliers, or extreme values, when compared to the rest of the data points.

<u>Tributaries with Parameters that Did Not Exceed a Numeric Standard or Benchmark</u>

Seven water quality parameters had similar levels at all tributary sampling points:

- pH
- temperature
- total aluminum
- total cadmium
- total lead

This group of results is overall positive. Several of these parameters have numeric standards or benchmarks, but none of the project data measurements exceeded those. Although total phosphorus was measured, we do not have good data for this parameter as previously discussed.

<u>Tributaries with Parameters that had Increased Concentrations relative to other Tributaries with no Numeric Standard or Benchmark</u>

Three water quality parameters had obvious elevated concentrations when graphed, but are parameters for which there are no numeric standards or benchmarks (Figure 4.9):

- flow
- total suspended solids
- total manganese
- hardness (as CaCO3)

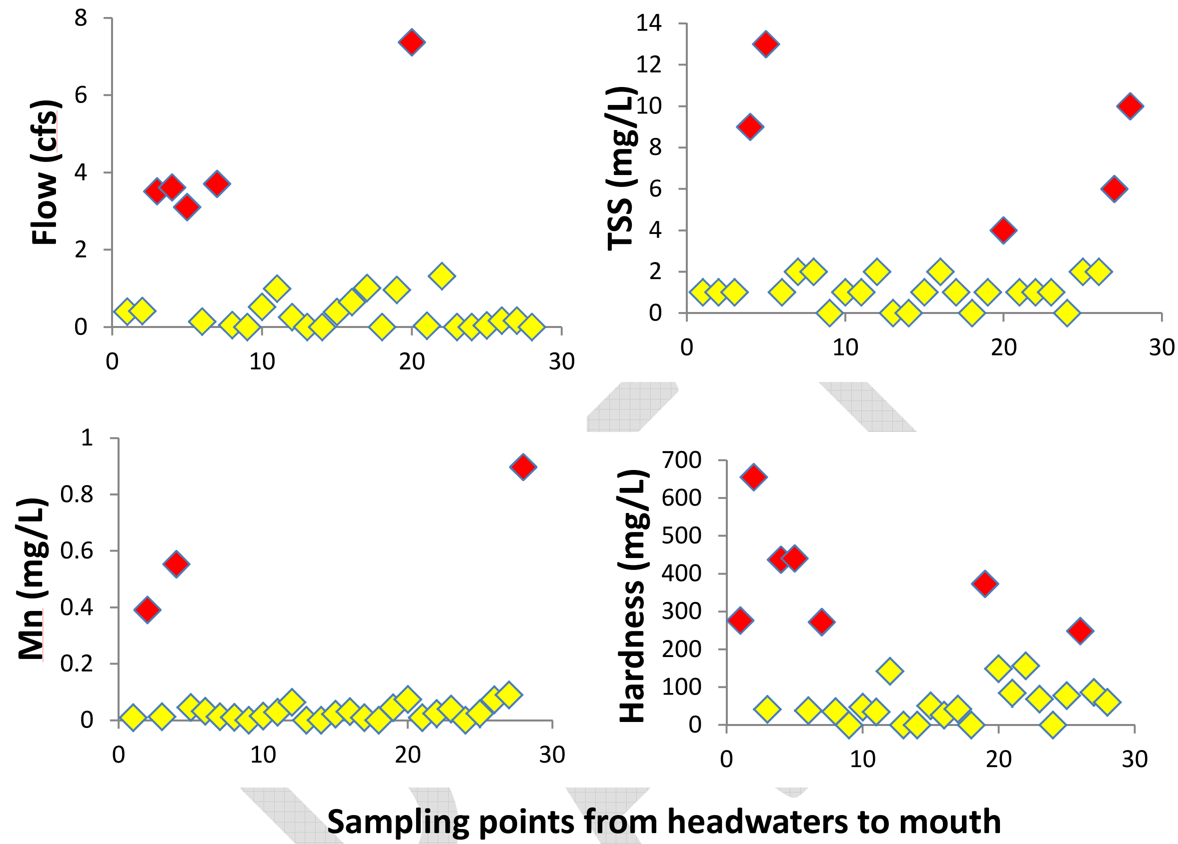

Figure 4.9: Red Bird River tributary sampling points, in order from the headwaters to the mouth, which had increased flow, total manganese, hardness, and total suspended solids. Data are from a single sampling event. Red sampling points are higher than most values and could signify potential problems at that sampling location.

To further pinpoint potential problem areas on the landscape, the following maps (Figures 4.10 through 4.13) depict the sub-watersheds in which the elevated parameter concentrations were recorded. Tributaries with red lines indicate upstream locations where the source for the elevated parameter could have originated. Not all tributaries were sampled, only at the locations indicated by the red marker. Highlighting the entire system above the sampling point only suggests where potential sources could be located and may warrant a closer look.

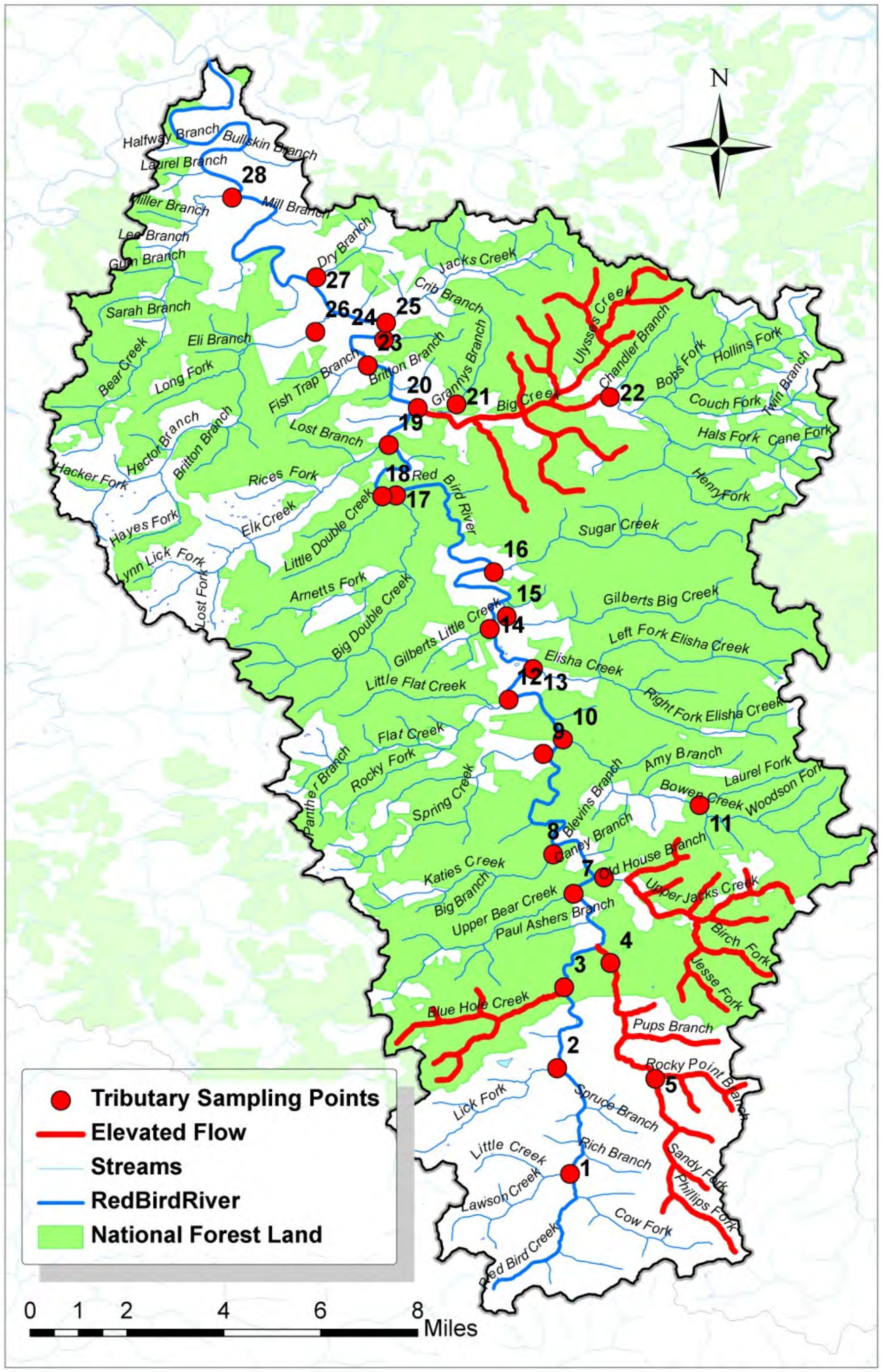

Figure 4.10: Red Bird River tributaries with higher flow relative to the other tributaries, indicated by bold red lines. Data are from are from a single sampling event.

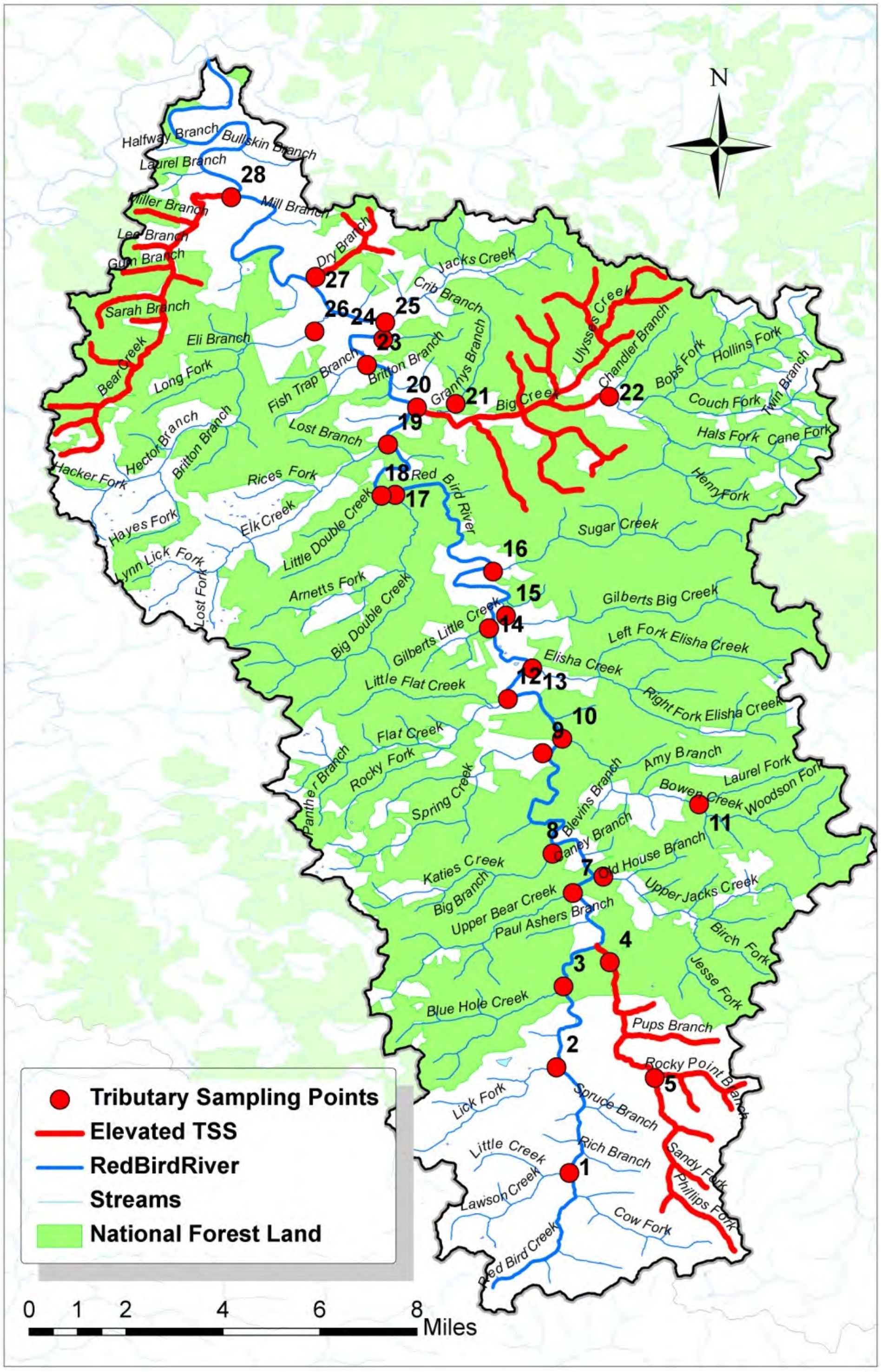

Figure 4.11: Red Bird River tributaries that had higher total suspended solids compared to the other tributaries, indicated by bold red lines. Data represents a single sampling event.

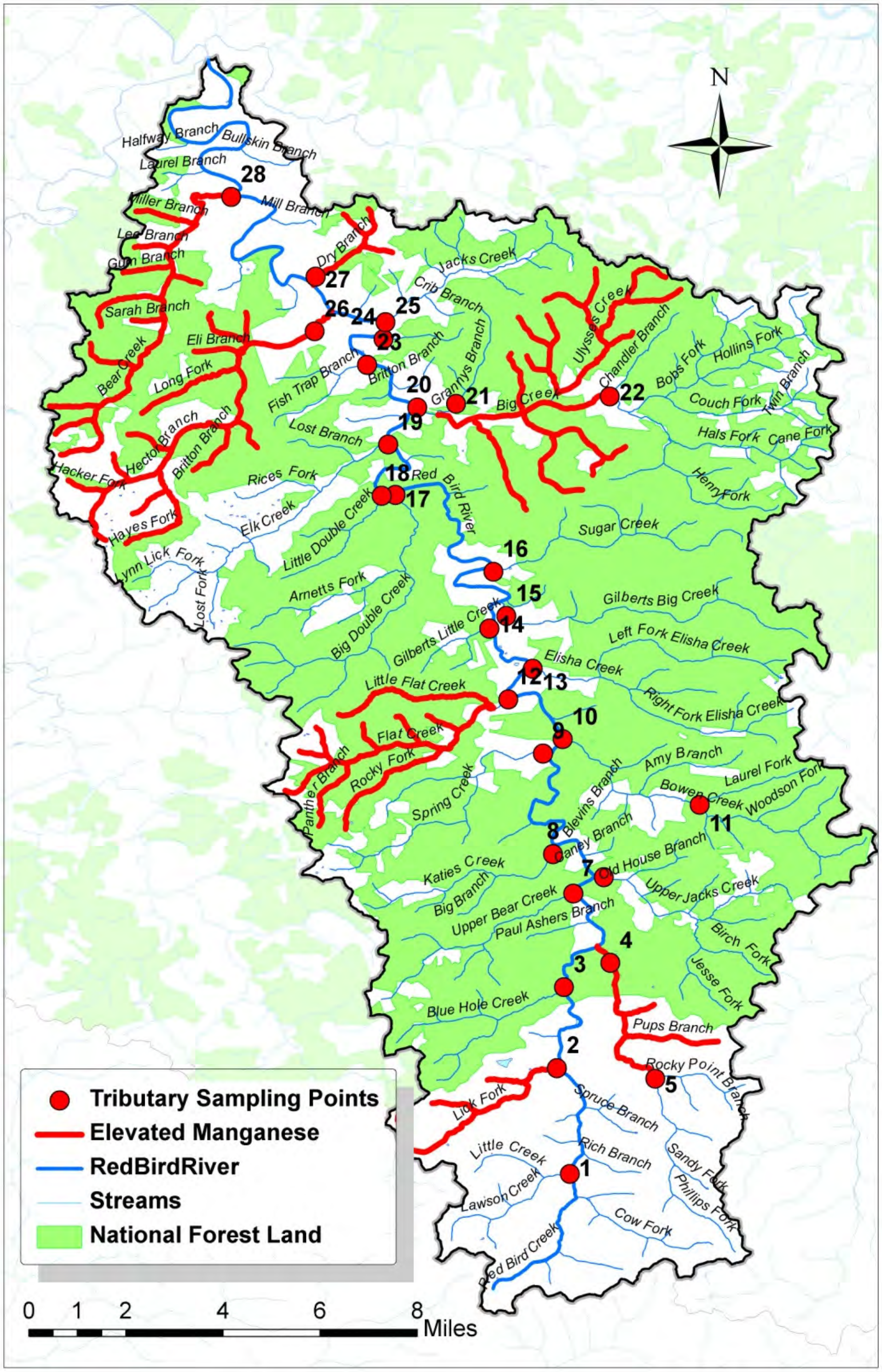

Figure 4.12: Red Bird River tributaries that had higher manganese concentrations compared to the other tributaries, indicated by bold red lines. Data represents a single sampling event.

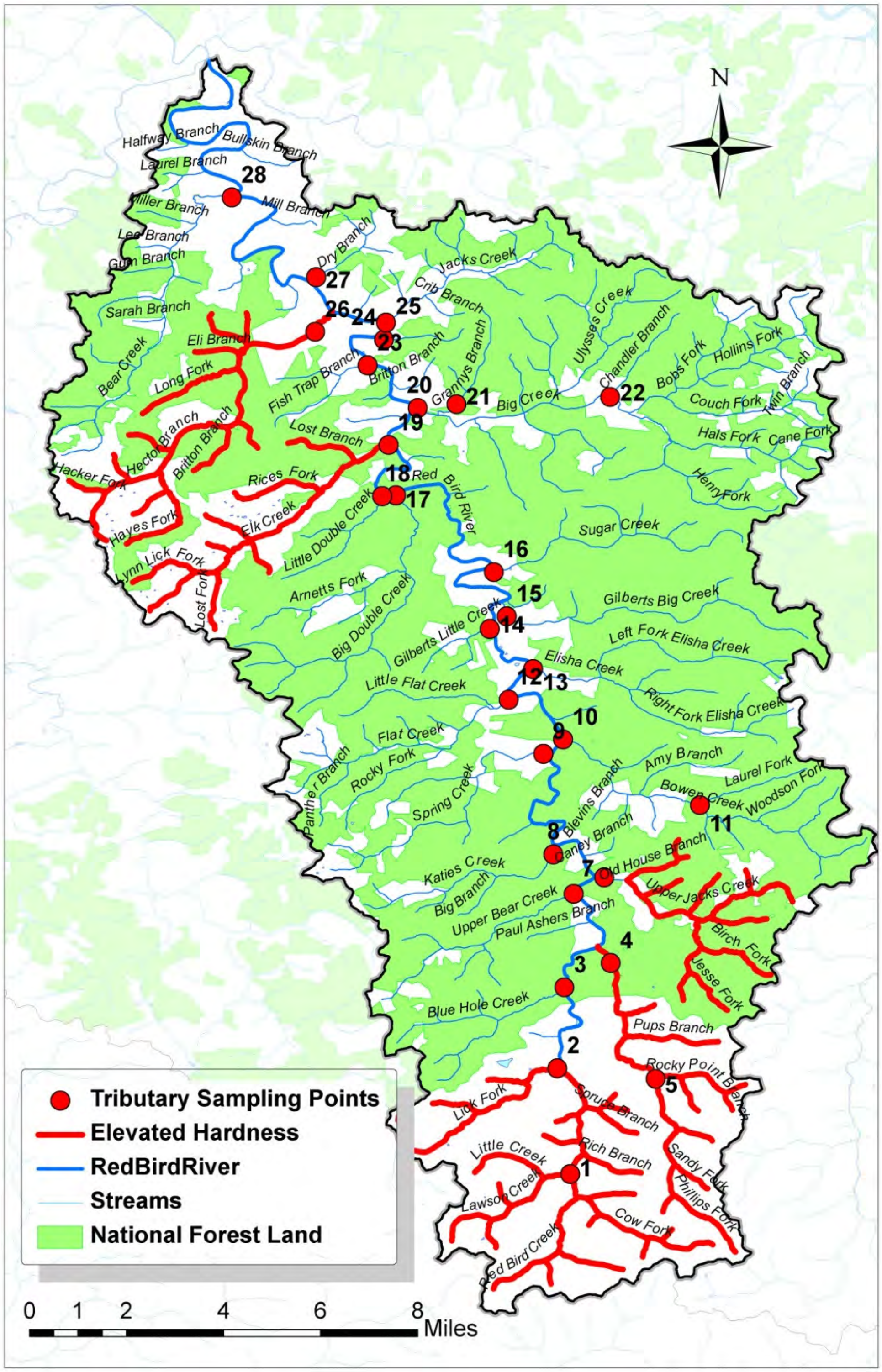

Figure 4.13: Red Bird River tributaries that had higher hardness (as CaCO3) concentrations compared to the other tributaries, indicated by bold red lines. Data represent a single sampling event.

Tributaries with Parameters that Did Exceed Numeric Standards or Benchmarks

Five water quality parameters had concentrations that exceeded numeric standards or benchmarks for warm water aquatic habitat (Figure 4.14):

- sulfate
- dissolved oxygen
- total iron
- specific conductance
- nitrate-N

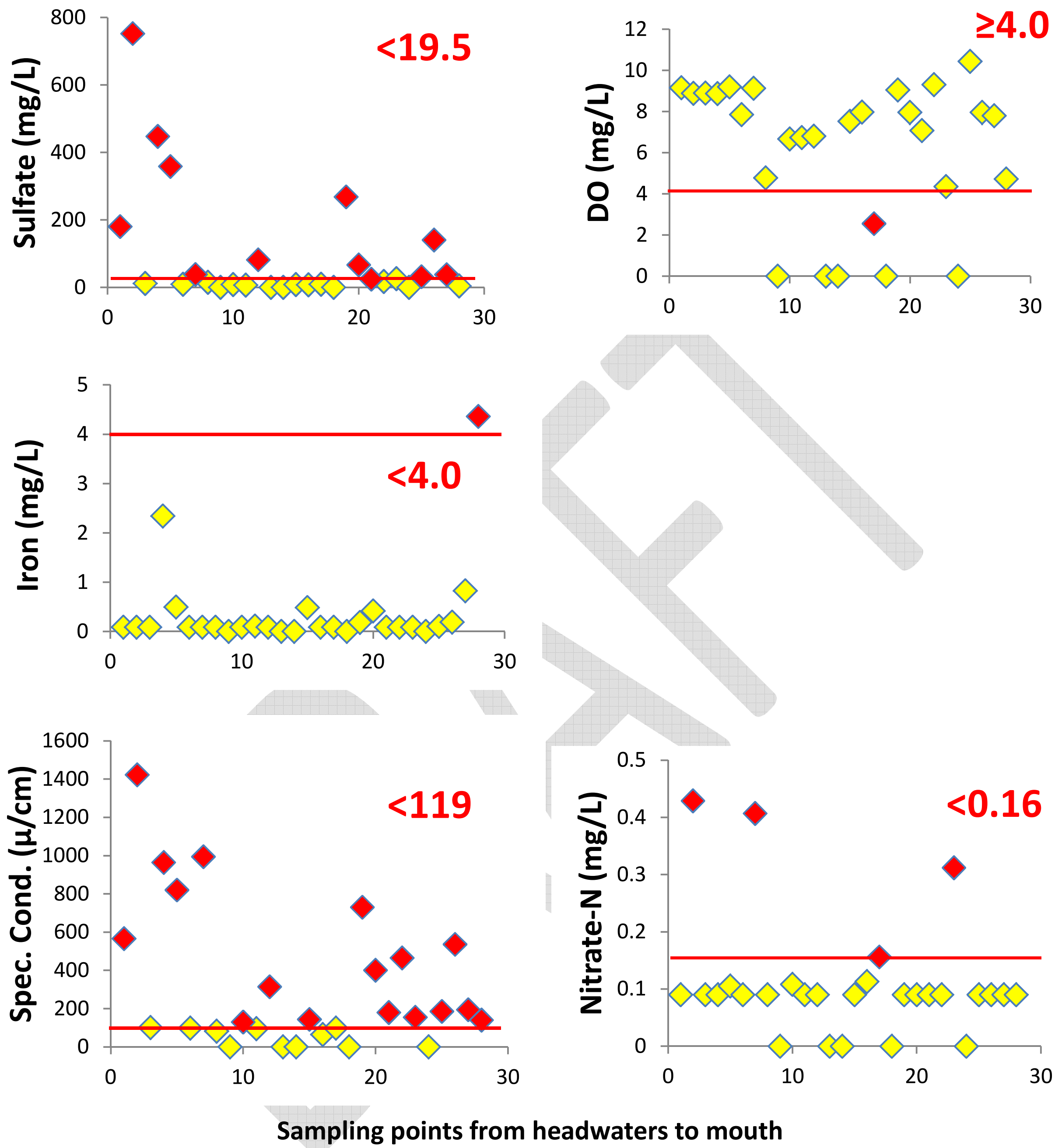

Figure 4.14: Red Bird River tributary sampling points, in order from the headwaters to the mouth, that had sulfate, dissolved oxygen, iron, specific conductance, and nitrate-N concentrations that exceeded or didn't meet numeric standards or benchmarks. Data are from a single sampling event. Red lines and numbers represent standards or benchmarks. Standards and benchmarks are represented by the red line, and sampling points that exceeded standards and benchmarks are in red.

To further identify potential problem areas on the landscape, the following maps (Figures 4.15 through 4.19) depict the sub-watersheds in which the elevated parameter concentrations were measured.

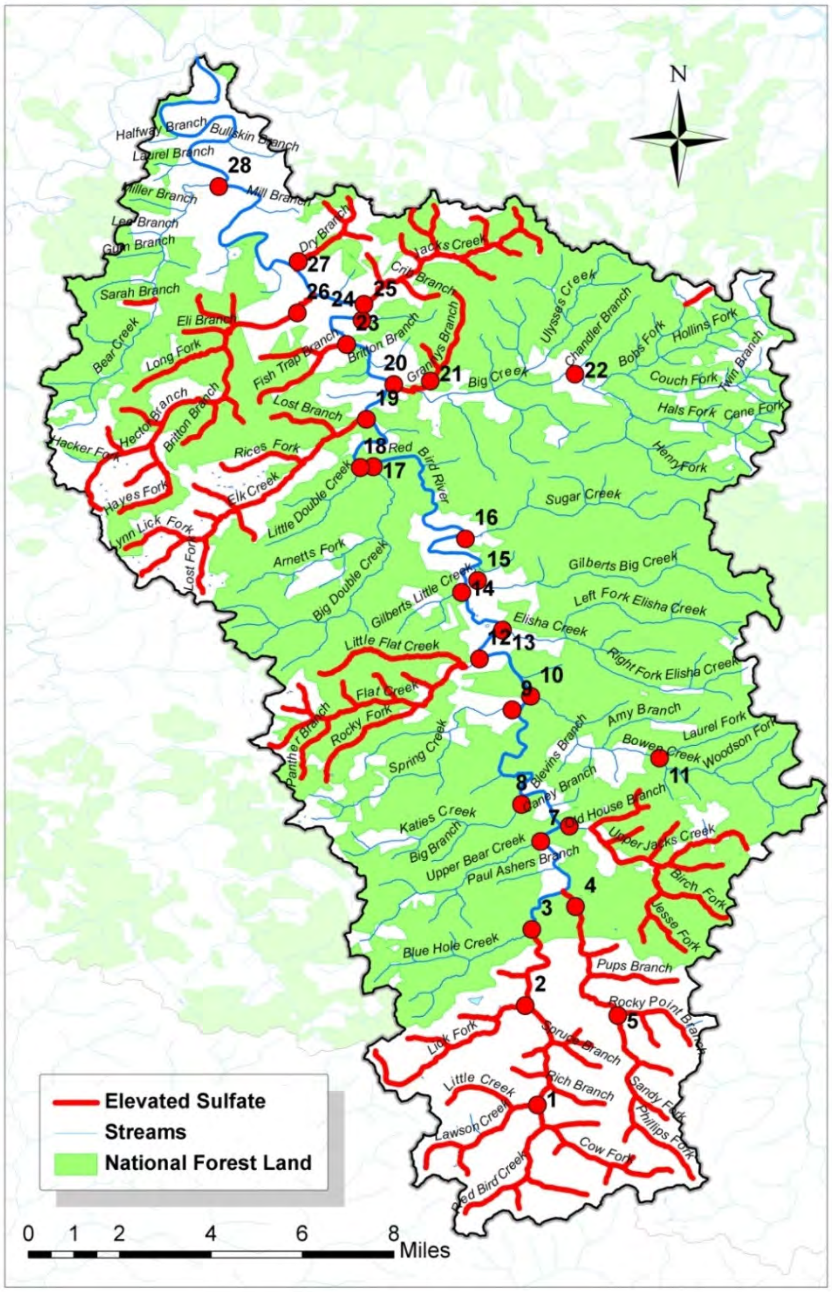

Figure 4.15: The location of Red Bird River tributaries where sulfate concentrations exceeded a standard or benchmark, indicated by bold red lines. Data represent a single sampling event.

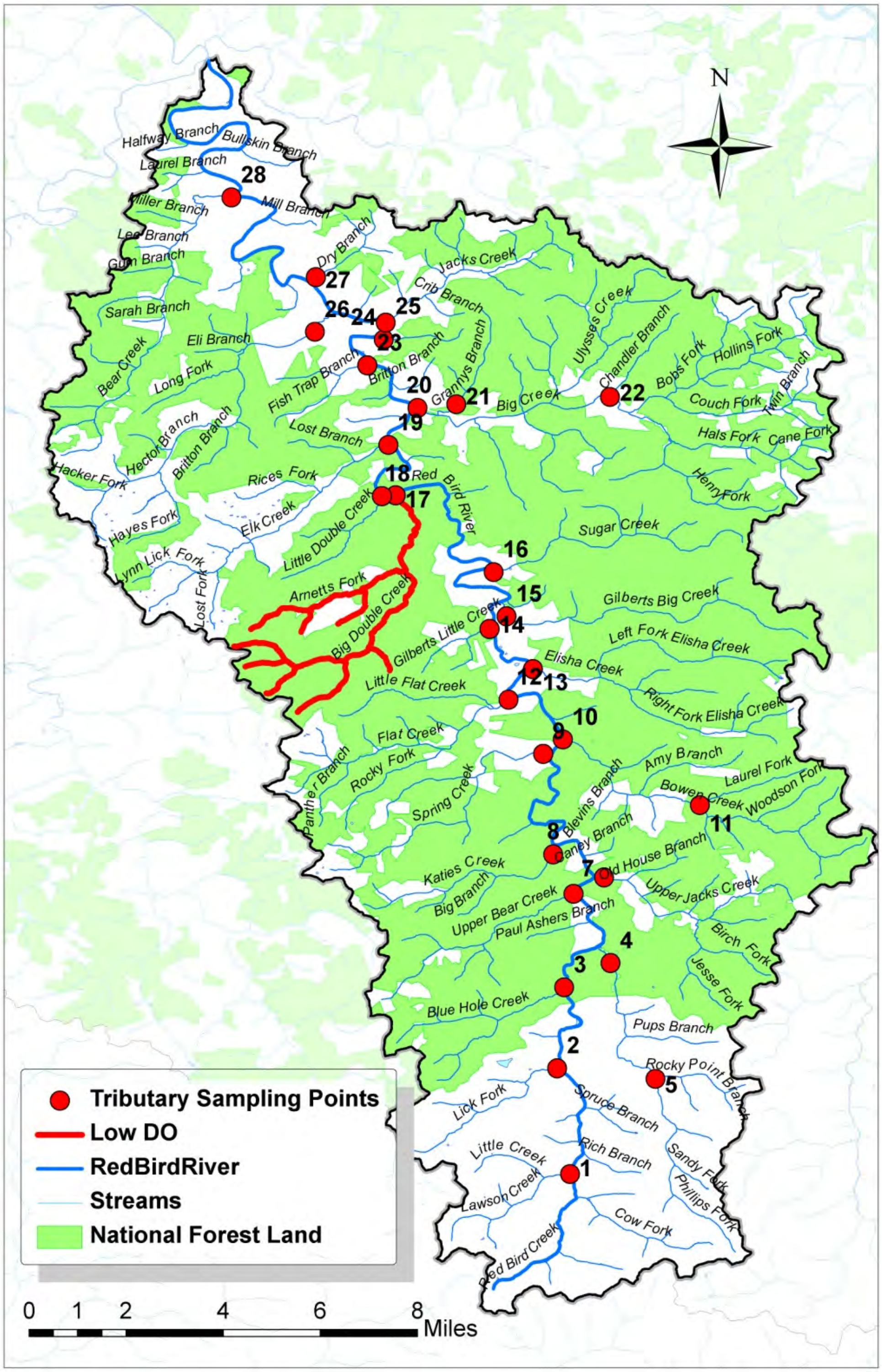

Figure 4.16: The location of Red Bird River tributaries where dissolved oxygen concentrations did not meet a standard or benchmark, indicated by bold red lines. Data represent a single sampling event.

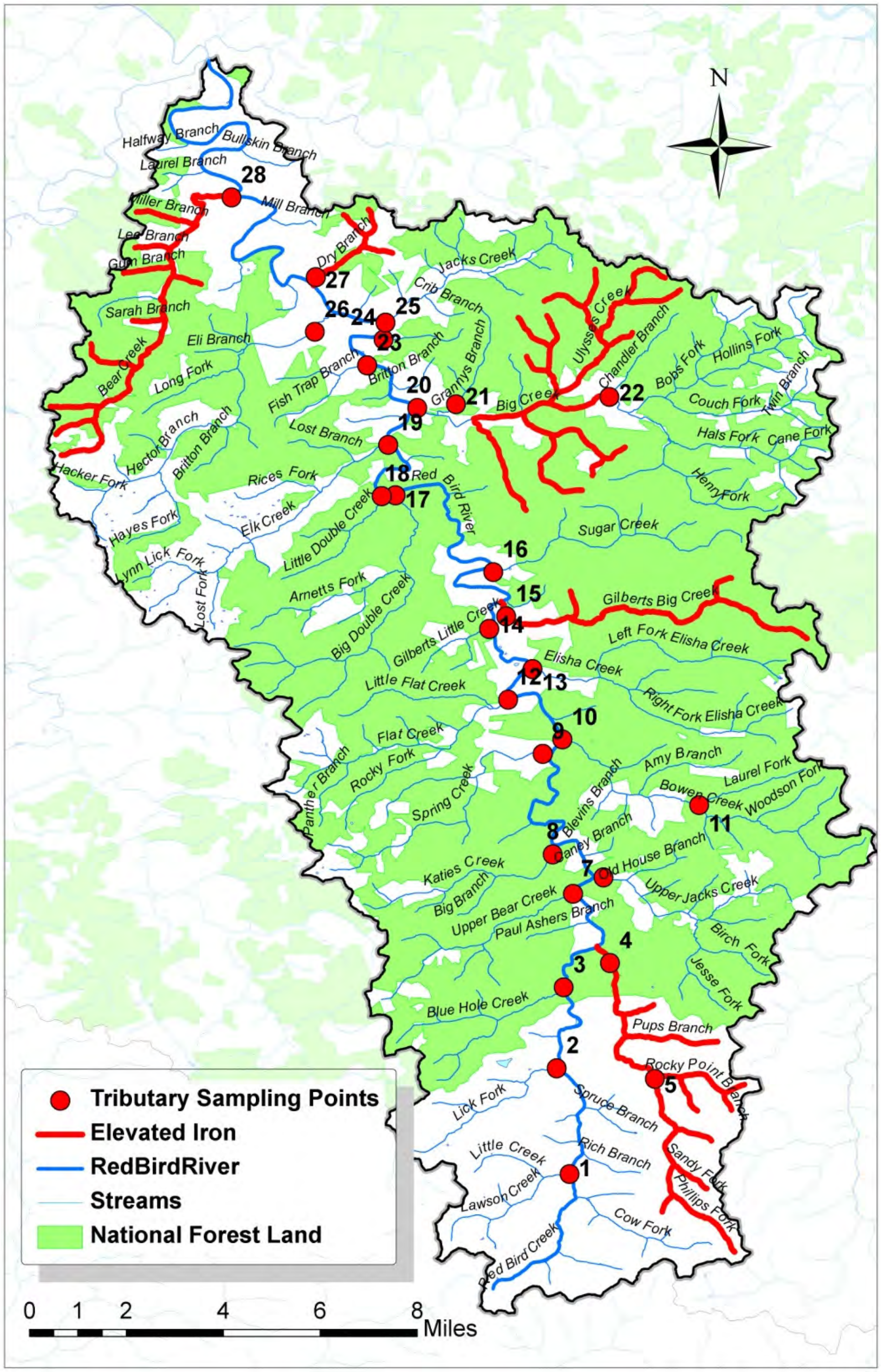

Figure 4.17: The location of Red Bird River tributaries where iron concentrations exceeded a standard or benchmark, indicated by bold red lines. Data represent a single sampling event.

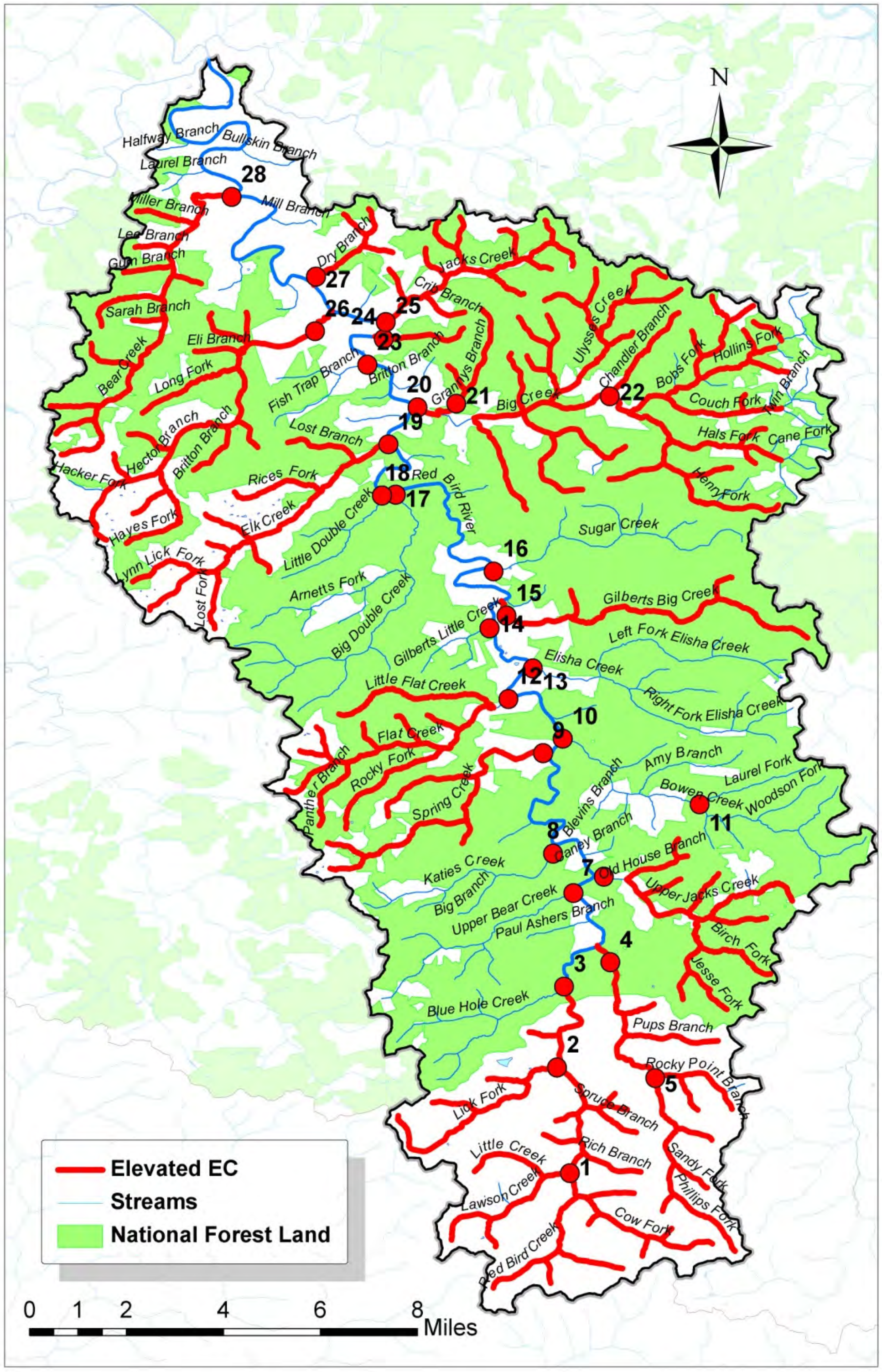

Figure 4.18: The location of Red Bird River tributaries where specific conductance exceeded a standard or benchmark, indicated by bold red lines. Data represent a single sampling event.

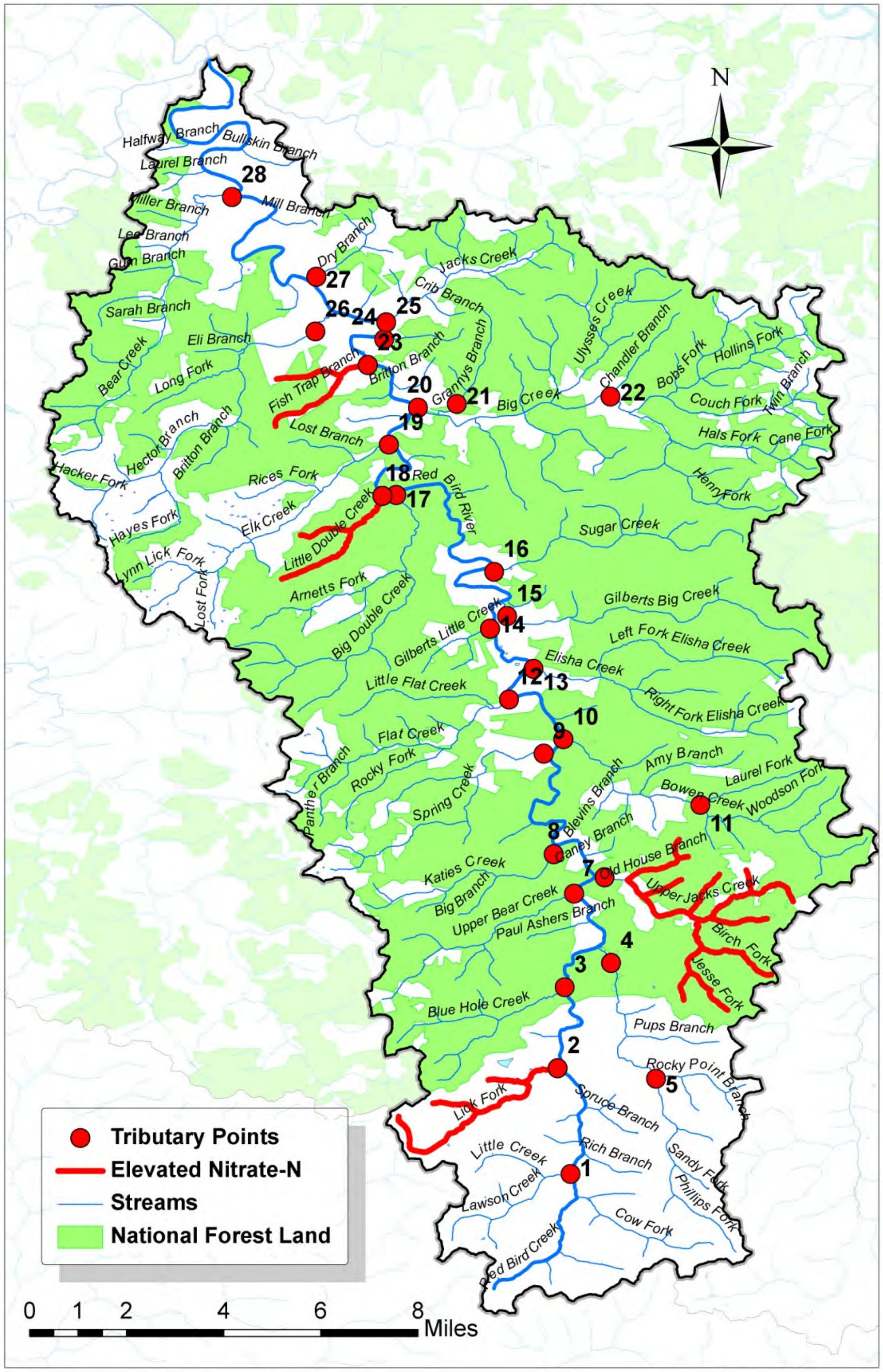

Figure 4.19: The location of Red Bird River tributaries where nitrate-N concentrations exceeded a standard or benchmark, indicated by bold red lines. Data represent a single sampling event.

4.5 Resource Utilization and Discussion of Water Quality Data

The water quality data reveal specific locations within the Red Bird River Watershed where resource utilization practices could be contributing to impaired water quality. To further investigate potential sources, Figures 4.20 and 4.21 show different types of resource utilization found in the watershed.

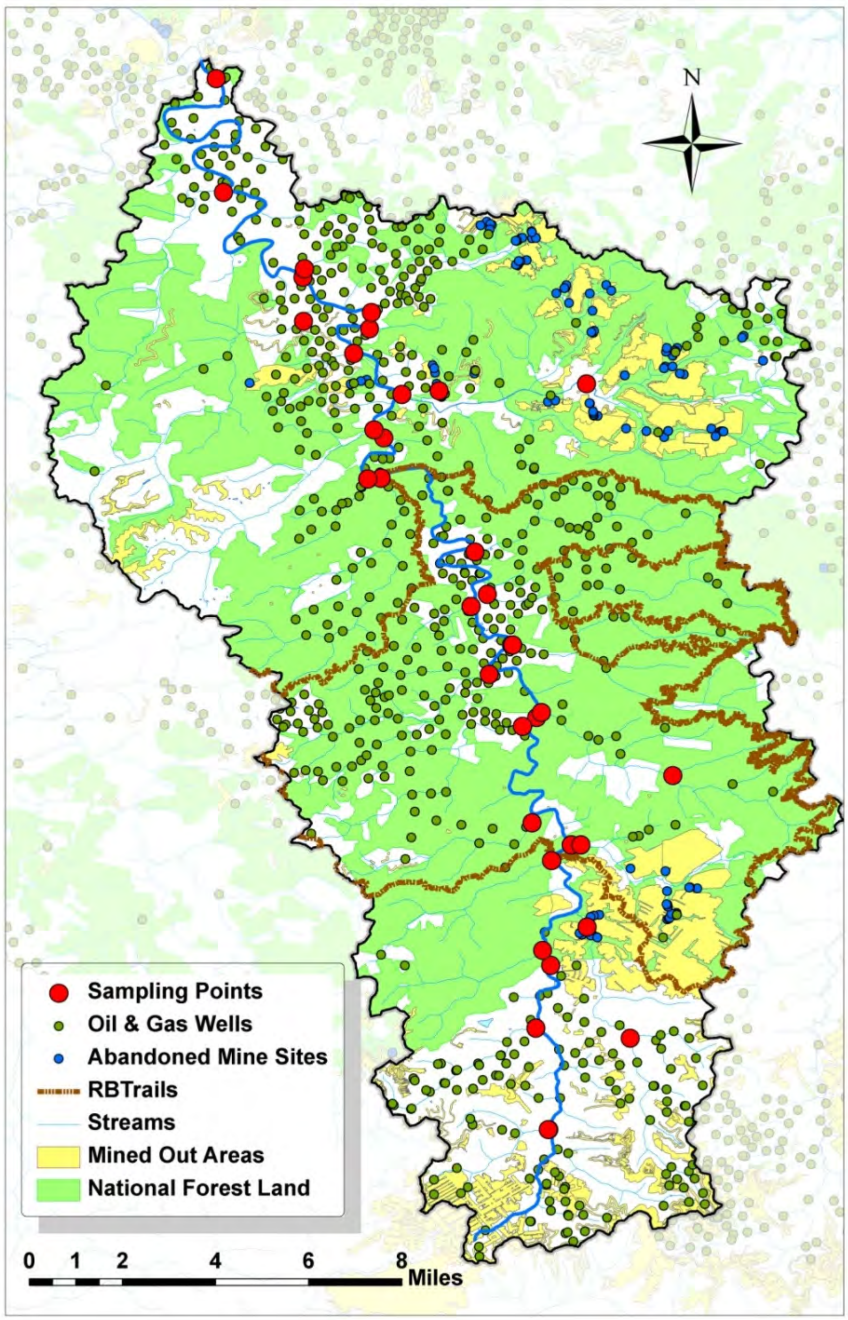

Figure 4.20: Resource utilization within the Red Bird River Watershed.

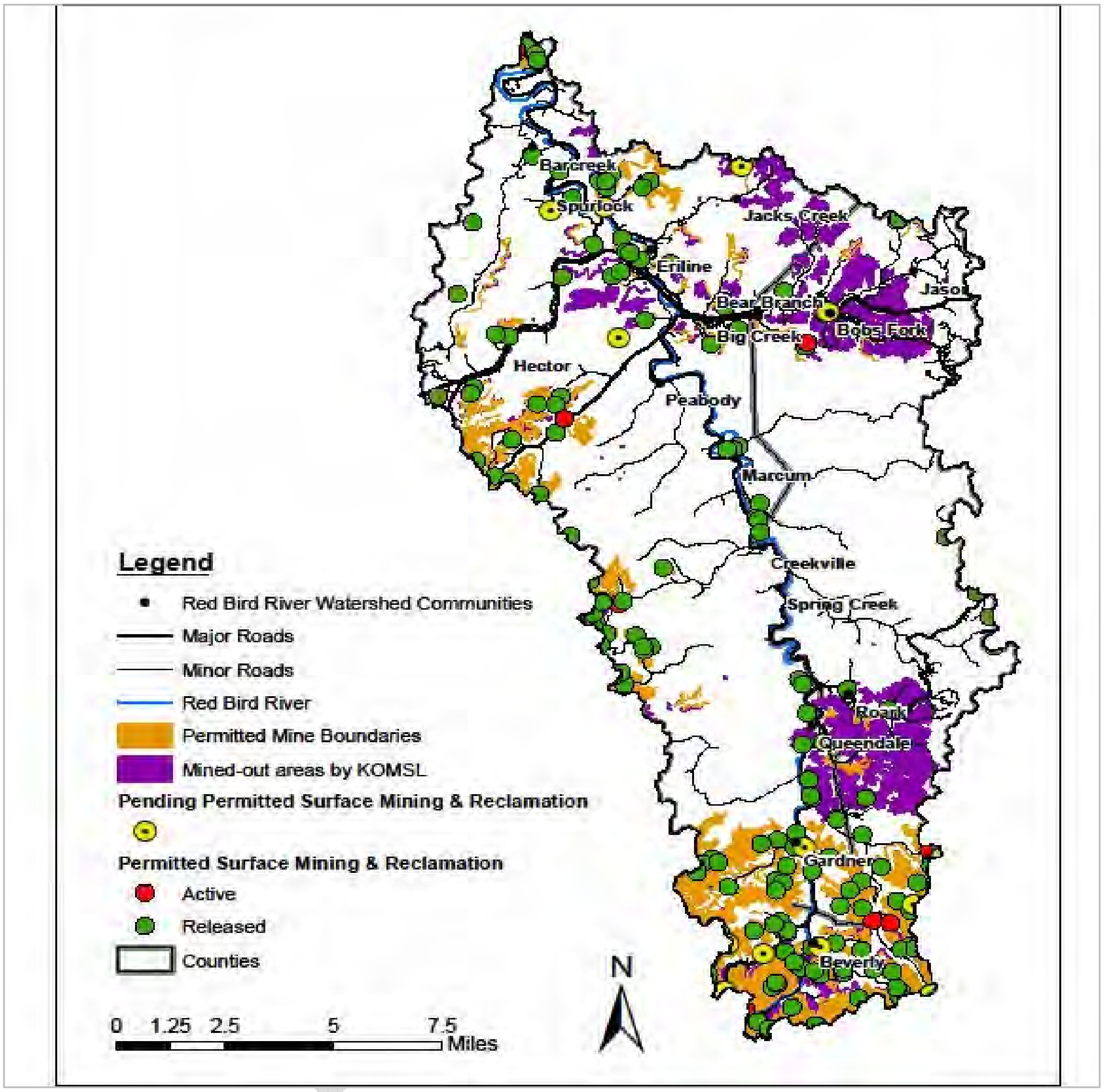

Figure 4.21: Mineral activity within the Red Bird River Watershed.

The Red Bird River Watershed's location in the mountains of eastern Kentucky limits how land can be used. For example, most homes are located along waterways because slopes are too steep. Arable land may be found in floodplains and terraces of the river. Tributary watersheds tend to be narrower with steeper slopes and less floodplain. The majority of land surface rights are National Forest System (NFS) lands under the management of the USDA Forest Service, Daniel Boone National Forest. Hiking and off-highway vehicle trails, wildlife management areas, forested lands, logging operations, and picnic areas are all found on NFS lands.

The watershed is rich in mineral resources and as a result, there is an extensive network of gas and oil wells, abandoned mine sites, mined out areas, permitted mine areas, and both active and released permitted surface mining and reclamation areas. Across large areas beneath NFS lands, mineral rights are privately owned. Figure 4.22 shows the location of elevated parameter concentrations and what kind of land use is in that area.

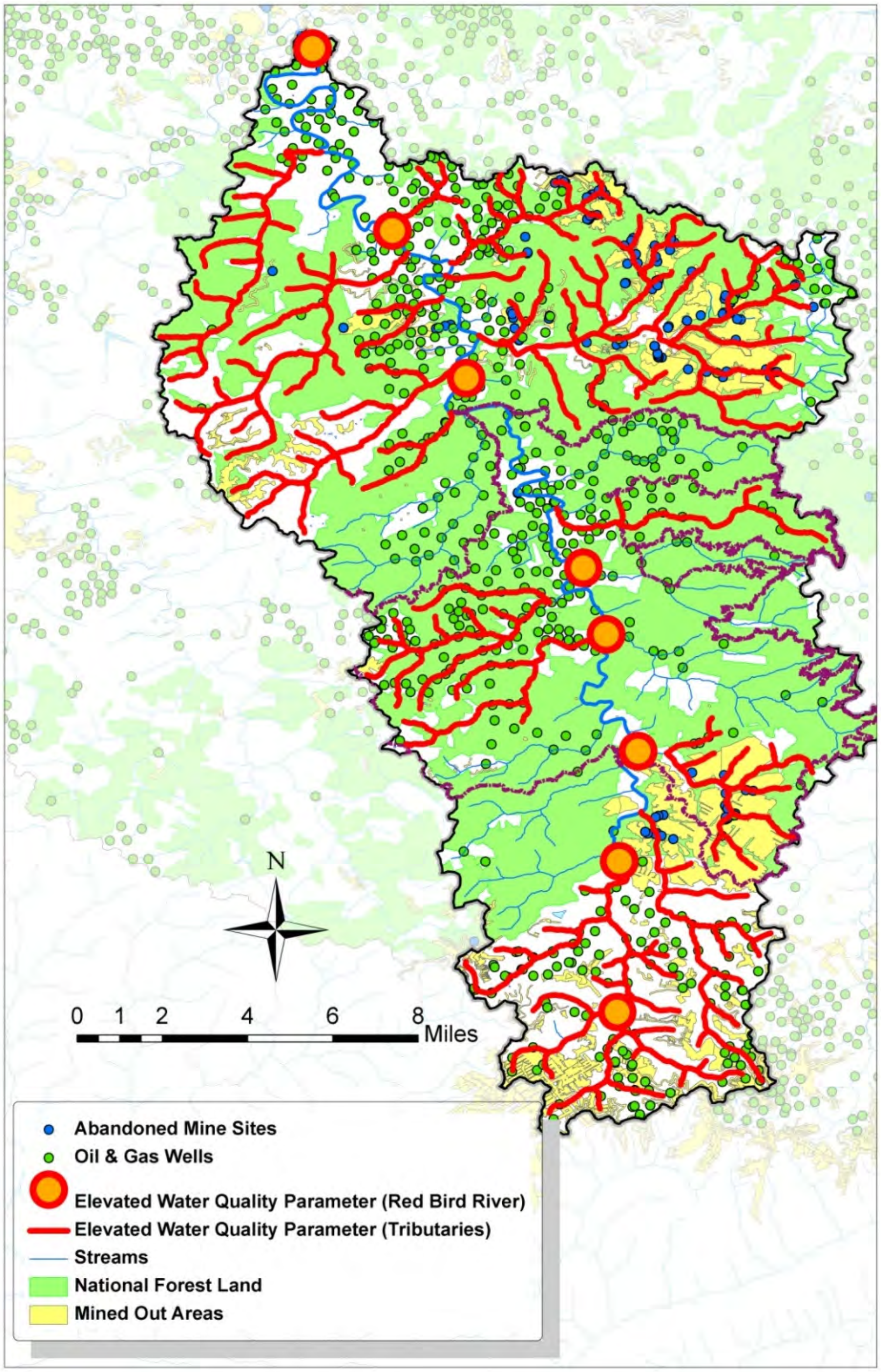

Figure 4.22: Locations of elevated sulfate, iron, manganese, specific conductance, hardness, and nitrate-N concentrations combined with resource utilization within the Red Bird River Watershed.

On the Daniel Boone National Forest, areas are managed primarily for recreation and timber. Off-road vehicles are regularly used in the watershed, and the Red Bird Crest Trail is a common destination for this user group. Additionally, timber is harvested on private and public lands in the watershed. Surface mining is not permitted on NFS lands. The combined activities of trail riding and logging could influence the amount of sediment that enters the stream. However, the effects of logging have been extensively studied, and the Forest Service uses logging techniques designed to minimize erosion and sedimentation (Swank et. al. 1986; USDA FS 2004 and 2012). Monitoring of past and ongoing timber sales, including timber haul road construction, have shown that BMPs employed during timber harvest are highly effective at minimizing soil erosion and sedimentation (Anderson and Lockaby 2011). Trails are constructed and maintained with specific standards as well (USDA FS 2011). Private logging is regulated by the Kentucky Division of Forestry.

Resource extraction has been occurring in the Red Bird River Watershed for at least 100 years. Much of the extraction has and continues to occur in the privately-owned headwaters of the Red Bird River Watershed (shown as white within the watershed boundary on Figure 4.21). The environmental effects that result from coal mining can be grouped into those that occurred prior to the 1977 passage of the Surface Mining Control and Reclamation Act (SMCRA) (hereafter referred to as "pre-law effects") and those that occurred after the passage of this law ("post-law effects"). Prior to the passage of SMCRA, there was no required reclamation of mining areas. As a result, many areas experienced severe erosion, produced acid mine drainage, and suffered landslides. These pre-law effects are still an issue, particularly in areas that were never reclaimed. They continue to be a chronic contribution to the water quality problems in the Red Bird River Watershed. These areas occur on NFS and private lands.

Since its passage, SMCRA has controlled some of the pre-law effects, but other effects have emerged or persisted, including the generation and control of acid mine drainage and the management of overburden (the soil and rock material overlying a mineral deposit; it is removed and usually pushed into piles, and is also referred to as mine waste or spoil). Pyrite is an iron sulfide mineral generally associated with coal fields in the United States (Evangelou, 1985). When pyrite is oxidized, it creates acid mine drainage, which is an acidic, iron and sulfate rich water (Pierzynski et al., 2000). High sulfur coal is common in the watershed, as are pyrite concentrations (Cole & Williams, 1981; Currens, 1981).

When the overburden is brought to the surface in order to gain access to the coal seam, it may be placed in a valley, covering the stream. This is known as valley fill. As the unweathered rocks in the overburden break down, elevated levels of metals and salts may be leached from the rock. As water percolates through the unweathered overburden, it can transport metals such as iron and manganese, sulfates, and salts into the waterways. Collectively, this weathering and leaching of salts influences the specific conductance. When sulfide-rich overburden is used to cover a site after mining has been completed, acid sulfate soils, and runoff, are likely to form (Brady and Weil, 2002).

Considering the locations of water quality problems, and knowing the current and historic land use in the watershed, it is very likely that the elevated concentrations of sulfate, specific conductance, iron, and manganese within the Red Bird River Watershed are the result of current and historic coal mining activities.

The other elevated parameters are likely a consequence of land management practices and current and historic mining activities. Mining activities can result in altered flow, as legacy underground shafts can flood and alter subsurface hydrology. Areas that were not reclaimed properly may also contribute to increased amounts of runoff, as vegetation struggles to establish on the acidic and compacted soils. Other land activities can temporarily contribute to increased flows, especially those that remove established vegetation, such as logging, trail building, forest conversion, or farming. Further, elevated hardness (composed of bases, such as calcium and magnesium) and elevated specific conductance, may be attributed to the weathering and dissolution of carbonaceous minerals in the overburden (Agouridis et al. 2012). Often, mine operators will line drainage channels with limestone to counteract the acid waters coming off of the mine. This practice can cause an elevation of calcium, magnesium, hardness, total dissolved solids, and specific conductance. Total suspended solids may be the result of eroded roads and trails, and/or from the fines that weather from overburden.

Finally, the elevated level of nitrate-N indicates a nutrient issue in the watershed, and can originate from a couple of different sources. Agricultural runoff, failing septic or straight-pipes, the accumulation of garbage in the streams, and livestock in the creek are likely the sources for the elevation of this parameter.

4.6 Results & Discussion – E. coli Data

When sampling for *E. coli,* it is important to get a range of values based on multiple sampling events for dry and wet weather events. Initially, three *E. coli* sampling events occurred in 2012: two immediately following periods of dry weather, and one immediately following a period of wet weather (Table 4.1). During periods of low flow, *E. coli* bacteria can concentrate in areas across the landscape and in the waterways, which may produce local hotspots; however, during periods of high flow, these areas all flush into the tributaries and river. This can cause a spike in the contaminant level for an entire section of waterway. It is important to sampling all locations when the flow is consistent throughout the watershed, ideally within the same day. *E. coli* samplings were taken at the same 36 locations as the water quality samplings (Figures 4.1 and 4.2). The water quality standard for *E. coli* states that it should not exceed 240 Colony Forming Units (CFU), and it is by this standard that the discussion is based. Another unit of measure for *E. coli* is the most probable number per 100 mL (MPN), used for samples processed using the IDEXX© Method. MPN and CFU are estimates of fecal coliform concentration, and while they aren't equivalent they can be used interchangeably for watershed management purposes.

Table 4.1: Initial sampling events for *E. coli* in the Red Bird River Watershed and percentage of total samples (of 36) that exceeded the water quality standard of 240 colony forming units.

Sampling Date(s)	≤240 (acceptable)	>240 (not acceptable)
8/13/12 dry event	83%	17%
5/15-16/12 wet event	36%	64%
2/27/12 dry event	100%	0%

The data revealed elevated concentrations of *E. coli* at different times throughout the Red Bird River Watershed (Figure 4.23). The first sampling event, 2/27/12, indicated that all samples met the water quality standards. Through the next two sampling events, the results were mixed. During the 5/15-16/12 sampling event, the majority of samples (64%) exceeded the water quality standard (Figure 4.23).

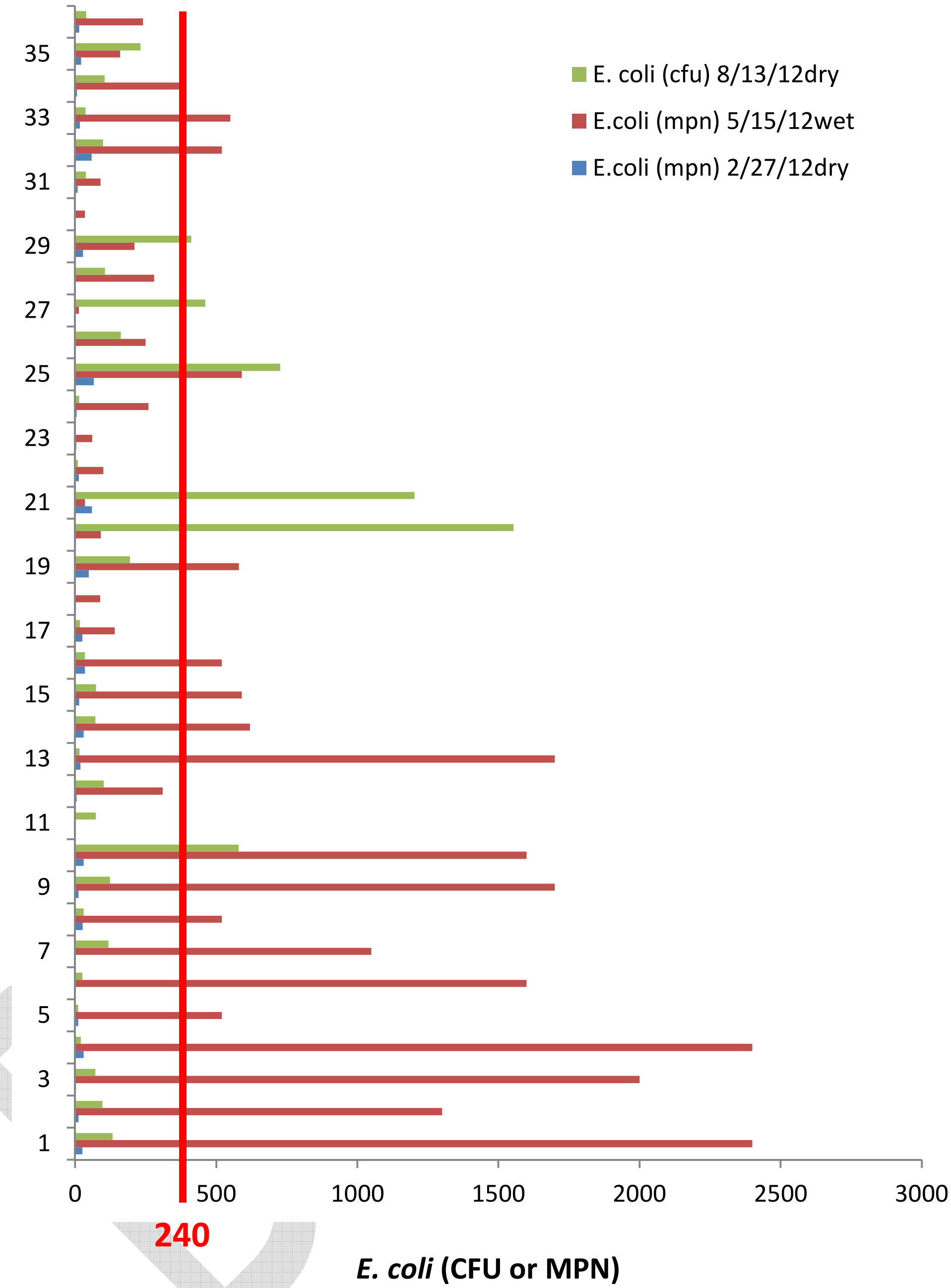

Figure 4.23: *E. coli* concentrations at all 36 sampling points on the Red Bird River, arranged spatially from the headwaters (point 1) to the mouth (point 36), for three sampling events. The water quality standard of 240 CFU is shown.

When a trend line was fitted to the samplings from 5/15-16/12, it appeared that *E. coli* concentrations were highest in the headwaters and progressively lower as the sampling points approached the mouth of the watershed (Figure 4.24).

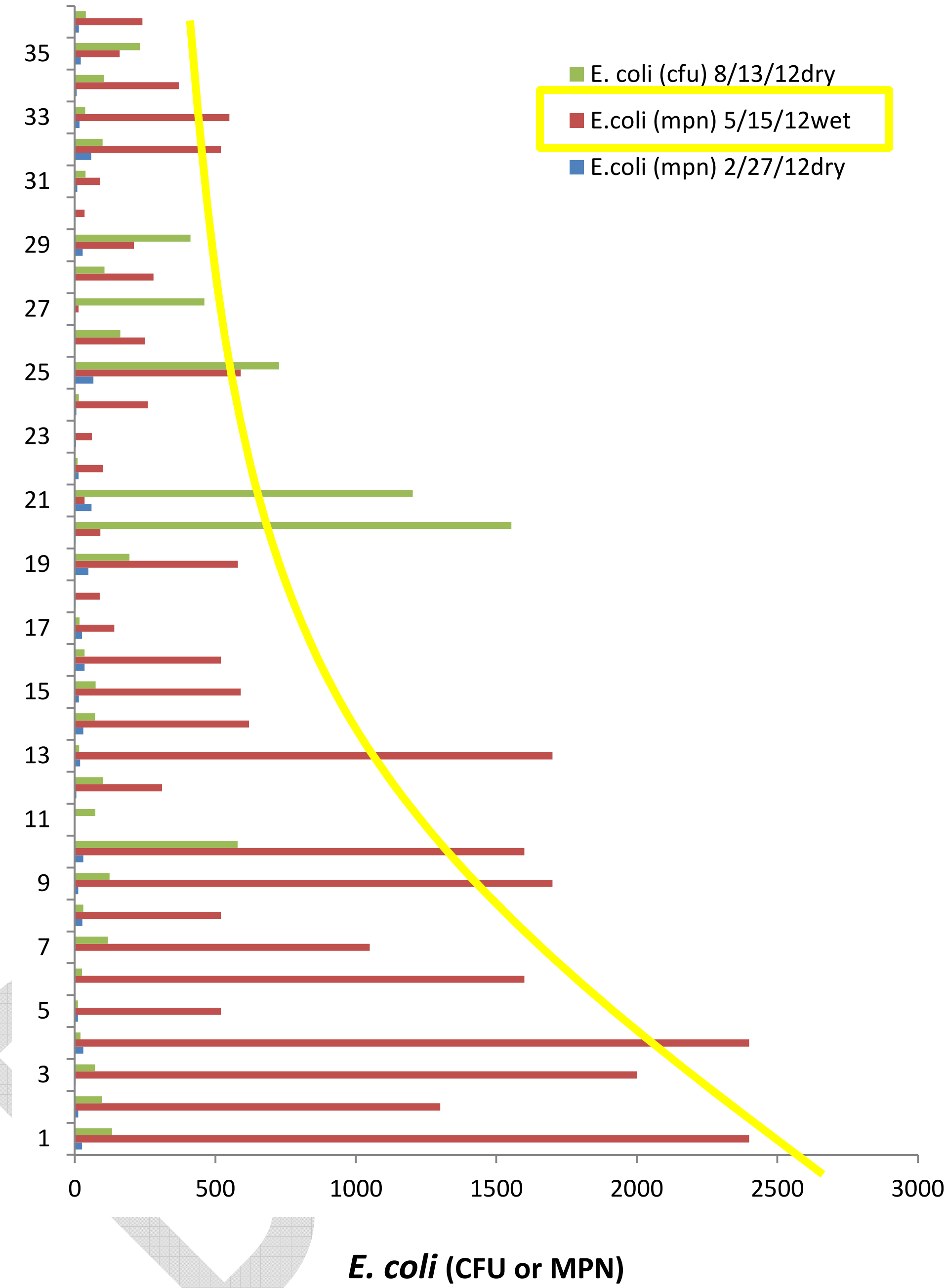

Figure 4.24: *E. coli* concentrations at 36 sampling points from the Red Bird River. The yellow line illustrates the pattern of decreasing concentration from the headwaters (point 1) to the mouth (point 36) of the Red Bird River for the 5/15-16/2012 sampling event.

While the trend is distinct in Figure 4.24, it should be interpreted with caution since the samplings were taken during a 2-day period. The first day of *E. coli* sampling (5/15) started in the headwaters and worked towards the middle of the watershed. The second day (5/16) started in the middle of the watershed and finished at the mouth. If all samplings had been gathered in the same day with comparable flows after the significant rain event, then it could be hypothesized that most of the 36 sites would have exceeded the standard of 240 CFU. The second day (lower in the watershed) may have had lower concentrations because of a day's dilution. The third sampling event, 8/13/12, revealed a spike in concentration in the middle of the watershed (Figure 4.25).

So what does this mean? The data indicate there are definite nutrient problems in the watershed, and it appears the sampling points in the middle and upper watershed are particularly problematic. The large variation in measurements indicated a need for additional sampling, which occurred in October 2013 and May 2014. Results for that sampling event are reported later in this chapter (page 35-36).

Similar to the elevated nitrate-N, *E. coli* spikes indicate a nutrient issue in the watershed and can originate from a couple of different sources. Failing septic or straight-pipes, the accumulation of garbage in the streams, and livestock in the creek are the likely the sources for the elevation of this parameter.

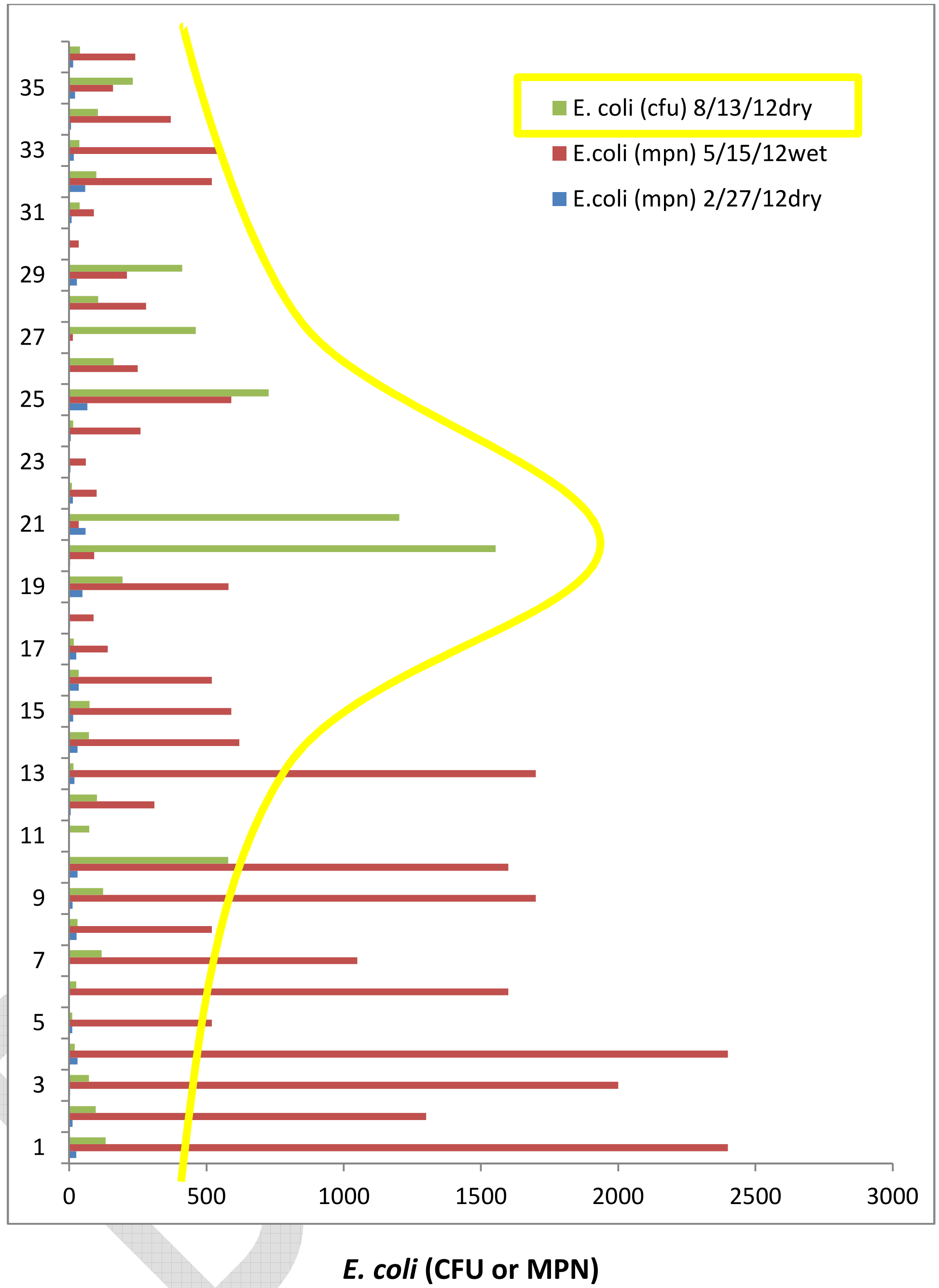

Figure 4.25: *E. coli* concentrations at 36 sampling points in the Red Bird River Watershed arranged from the headwaters (point 1) to the mouth (point 36). The sampling event of 8/13/12 is highlighted, showing a spike in concentration in the middle of the Red Bird River Watershed.

Additional E. coli Monitoring Efforts

In October of 2013, KDOW conducted *E. coli* monitoring at selected sites within the Red Bird River Watershed (Figure 4.26). This monitoring was done in accordance with a KDOW approved Quality Assurance Project Plan (Quality Assurance Project Plan: Red Bird River Water Quality

Monitoring in Support of a Watershed Based Plan, KDOW 2013). The original goal of the effort was to collect five samples within a thirty day period during the Primary Contact Recreation (PCR) Season (May – October). The results would be used to complete an assessment for the *Kentucky Integrated Report to Congress on the Condition of Water Resources in Kentucky* (Integrated Report). Due to weather conditions and the lack of a significant rain event, only three sampling events were completed. However, KDOW completed a five in thirty sampling in May 2014. The results from KDOW events along with the two events collected by Tennessee Valley Authority during the 2012 PCR Season are presented below.

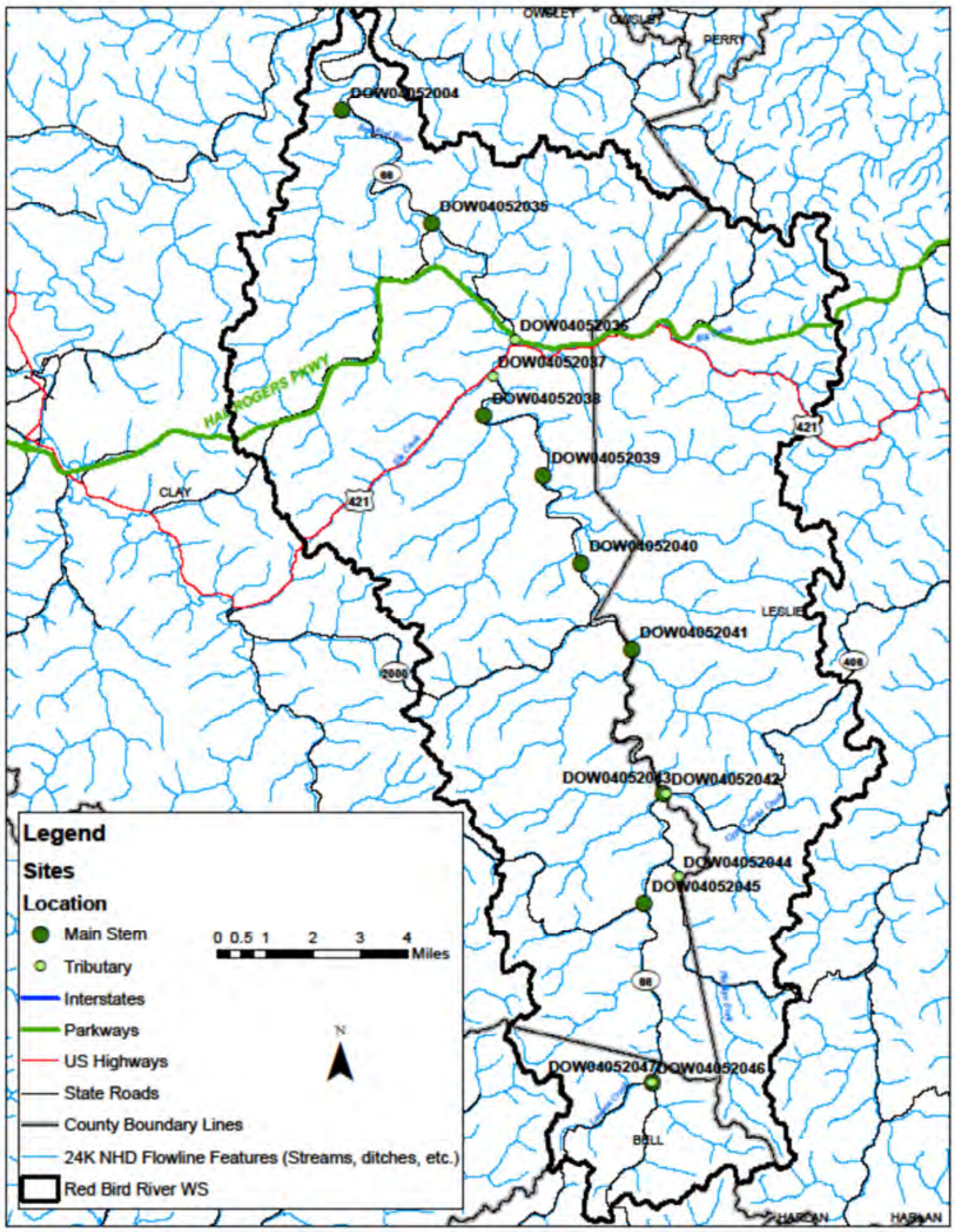

Figure 4.26: KDOW Sampling Site Locations.

Sampling Sites

Due to limited resources, KDOW selected a subset of the TVA sites for additional monitoring. All of the main stem sites were included along with sites from tributaries that were expected to have high *E. coli* concentrations and potentially failing septic systems or straight pipes. Table 4.2 displays the selected sites, the original TVA number and lat/long, and the KDOW database number (EDAS #) and lat/long. As noted, a few KDOW sites are in different locations than the original TVA sites. KDOW also added a location on the main stem that was not sampled by TVA. These location changes were due to stream accessibility and a more representative sampling design for assessment purposes regarding the Integrated Report.

The goal of the data analysis in this watershed plan is to identify potential sources of *E. coli* and prioritize subwatersheds for implementation to address these sources. The combined results from the TVA and KDOW efforts for these sites have been used for the following analysis.

Table 4.2: TVA and KDOW Sampling Site Locations in the Red Bird River.

Site Name	TVA #	Lat	Long	EDAS #	Lat	Long
Red Bird Creek	33	36.937009	-83.535262	DOW04052047	36.937009	-83.535262
Lawson Creek	32	36.937072	-83.535435	DOW04052046	36.937072	-83.535435
Red Bird Creek	1	36.992051	-83.536777	DOW04052045	36.992051	-83.536777
Phillips Fork	2	37.000012	-83.523344	DOW04052044	37.000012	-83.523344
Red Bird River	30	37.025573	-83.528289	DOW04052043	37.025573	-83.528289
***Upper Jacks Creek**	5	37.025612	-83.525326	DOW04052042	37.025857	-83.527275
*****Red Bird River**	29	37.065144	-83.539067	DOW04052041	37.069968	-83.539078
*****Red Bird River**	28	37.087723	-83.546812	DOW04052040	37.09675	-83.557701
Red Bird River	N/A	.	.	DOW04052039	37.123886	-83.571307
Red Bird River	27	37.152024	-83.586529	DOW04052038	37.1426	-83.593494
Elk Creek	16	37.154557	-83.589648	DOW04052037	37.154557	-83.589648
Big Creek	17	37.165645	-83.580881	DOW04052036	37.165645	-83.580881
Red Bird River	26	37.201972	-83.611666	DOW04052035	37.201972	-83.611666
****Red Bird River**	25	37.263803	-83.638642	DOW04052004	37.23777	-83.644884

***KDOW site and TVA site are located at different lat/longs. There are major tributaries that enter the main stem between sites.

**KDOW site and TVA site are located at different lat/longs. There are minor tributaries that enter the main stem between the sites.

*KDOW site and TVA site are located at different lat/longs. There are not tributaries that enter the main stem between the sites.

E. coli Results – Concentrations

Table 4.4 and Figure 4.27 display the results of the *E. coli* monitoring efforts from KDOW and TVA. Kentucky has a Water Quality Standard for *E. coli* during the PCR season which spans from May 1st – October 31st (401 KAR 10:031). *E. coli* shall not exceed 240 colony forming units per 100 mL in twenty percent or more of all samples taken during a thirty day period and/or shall not exceed 130 colony forming units per 100 mL as a geometric mean based on not less than five (5) samples taken during a thirty day period (Table 4.3).

Table 4.3: Kentucky Primary Contact Recreation Standard (PCR) May 1-Oct31.

Bacteria	Geometric Mean (colony forming units/100 mL)	Maximum (colony forming units/100 mL)
E. coli	**130** (from 5 samples collected within 30 days)	**240** (number not to be exceeded in more than 20% of the samples)

The values exceeding the 240 colony forming units/100mL maximum are highlighted in Table 4.4 and the 240 colony forming units/100mL maximum is indicated with the red line on Figure 4.27.

In the following sections, the unit for *E. coli* is reported as Most Probable Number (MPN). MPN is used for samples processed using the IDEXX© Method. MPN and Colony Forming Units (CFU) are estimates of fecal coliform concentration, and while not equivalent they can be used interchangeably for watershed management purposes.

Table 4.4: *E. coli* results from TVA and KDOW for the sampling period between 5/12 – 5/14 for sites within the Red Bird River Watershed. Highlighted cells indicate the sample exceeded the 240 threshold.

		5/15/12	8/13/12	10/10/13	10/16/13	10/17/13	5/1/14	5/12/14	5/13/14	5/22/14	5/28/14
EDAS #	**NAME**	**TVA *E. COLI* (MPN)**	**TVA *E. COLI* (MPN)**	**KDOW *E. COLI* (MPN)**	**KDOW *E. COLI* (MPN)**	**KDOW *E. COLI* (MPN)**	**KDOW *E. COLI* (MPN)**	**KDOW *E. COLI* (MPN)**	**KDOW *E. COLI* (MPN)**	**KDOW *E. COLI* (MPN)**	**KDOW *E. COLI* (MPN)**
DOW04052047	Red Bird Creek	2400	133	23	12	186	55	77	125	313	34
DOW04052046	Lawson Creek	1300	96	20	58	88	299	980	461	579	104
DOW04052045	Red Bird Creek	2400	20	44	52	308	135	35	219	291	31
DOW04052044	Phillips Fork	1600	26	9	387	167	28	22	9	78	57
DOW04052043	Red Bird River	1700	123	33	26	28	71	55	45	72	62
DOW04052042	Upper Jacks Creek	1600	579	68	131	173	285	130	190	727	218
DOW04052041	Red Bird River	1700	15	24	29	41	118	75	59	344	82
DOW04052040	Red Bird River	140	17	24	36	194	128	30	46	214	39
DOW04052039	Red Bird River	*	*	28	74	71	148	82	70	365	45
DOW04052038	Red Bird River	260	14	68	23	74	236	108	32	411	21
DOW04052037	Elk Creek	590	727	96	119	228	194	411	345	1414	689
DOW04052036	Big Creek	250	162	12	10	10	291	308	260	1300	687
DOW04052035	Red Bird River	550	37	49	51	72	162	260	144	1553	64
DOW04052004	Red Bird River	240	39	101	140	84	147	144	71	416	35

* TVA did not sample this site.

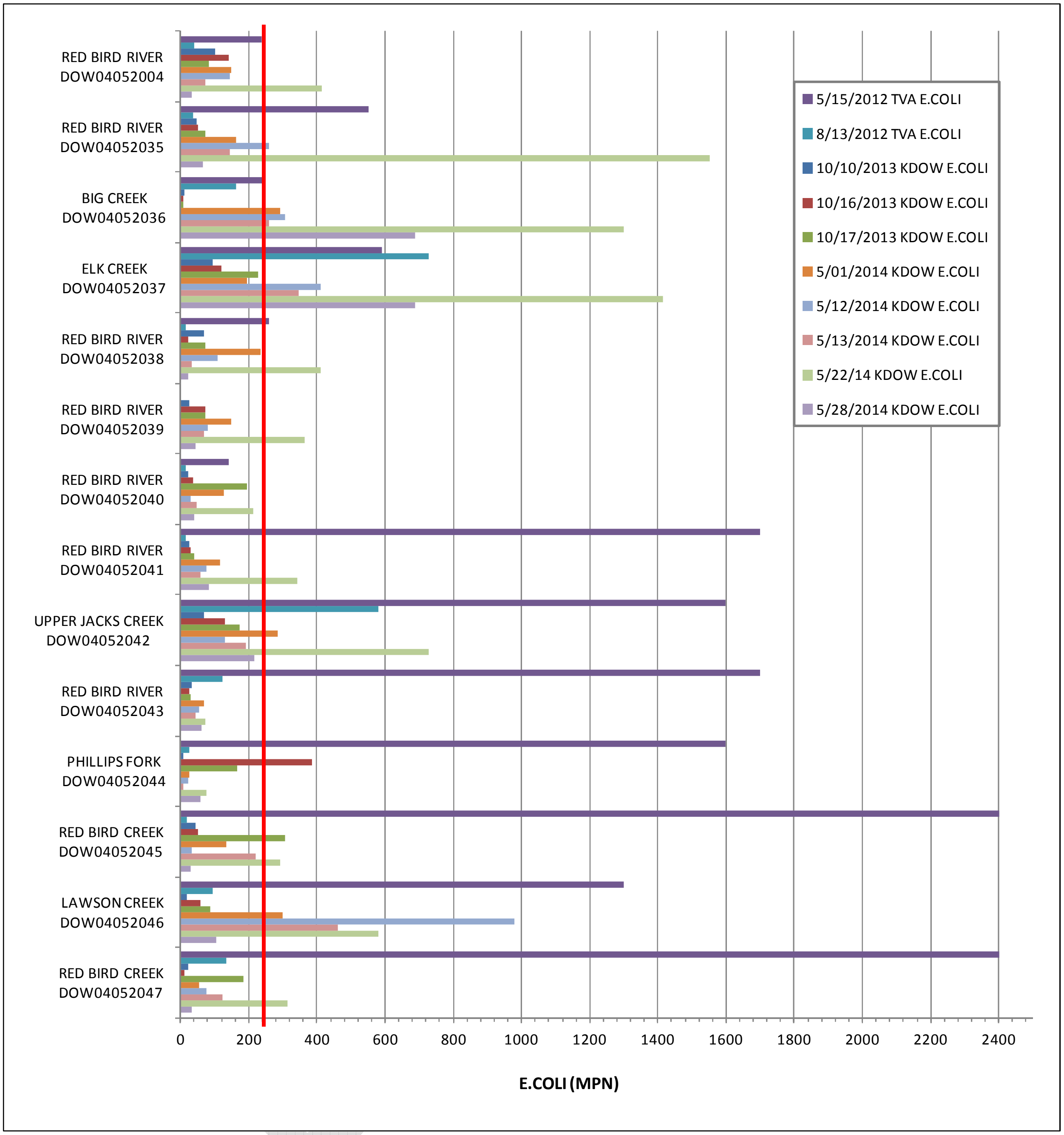

Figure 4.27: *E. coli* results from TVA and KDOW for the sampling period between 5/12-5/14 for sites within the Red Bird River Watershed.

Table 4.5 shows the Geometric Mean of the five samples collected in May 2014. The highlighted values exceed the standard of 130 colony forming units/100mL.

Table 4.5: *E. coli* results and Geometric Mean for May 2014 Samples for sites within the Red Bird River Watershed.

		5/1/14	5/12/14	5/13/14	5/22/14	5/28/14	
EDAS #	**NAME**	***E. coli* (MPN)**	***E. coli* (MPN)**	***E. coli* (MPN)**	***E. coli* (MPN)**	***E. coli* (MPN)**	**GEOMETRIC MEAN (MPN)**
DOW04052047	Red Bird Creek	55	77	125	313	34	89
DOW04052046	Lawson Creek	299	980	461	579	104	382
DOW04052045	Red Bird Creek	135	35	219	291	31	99
DOW04052044	Phillips Fork	28	22	9	78	57	30
DOW04052043	Red Bird River	71	55	45	72	62	60
DOW04052042	Upper Jacks Creek	285	130	190	727	218	257
DOW04052041	Red Bird River	118	75	59	344	82	108
DOW04052040	Red Bird River	128	30	46	214	39	68
DOW04052039	Red Bird River	148	82	70	365	45	107
DOW04052038	Red Bird River	236	108	32	411	21	93
DOW04052037	Elk Creek	194	411	345	1414	689	484
DOW04052036	Big Creek	291	308	260	1300	687	461
DOW04052035	Red Bird River	162	260	144	1553	64	227
DOW04052004	Red Bird River	147	144	71	416	35	117

Since the five samples from May 2014 were collected under a KDOW approved Quality Assurance Project Plan and meet the frequency required for assessing the results based on the 130 colony forming units/100 mL standard, the results can be used for the Integrated Report. It is possible that stream segments containing the sites with a geometric mean exceeding the standard (highlighted in yellow) will be listed as not supporting PCR in a future iteration of the Integrated Report.

Figure 4.28 shows the precipitation amount preceding the sampling events. The data are from the University of Kentucky Agricultural Weather Center and were collected at Buckhorn Lake.

Most sites show higher concentrations following rain events of an inch or more (05/15/12, 05/22/14). However, Big Creek, Elk Creek, Lawson Creek, and Upper Jacks had more than one event where the concentrations exceeded the standard following dryer conditions.

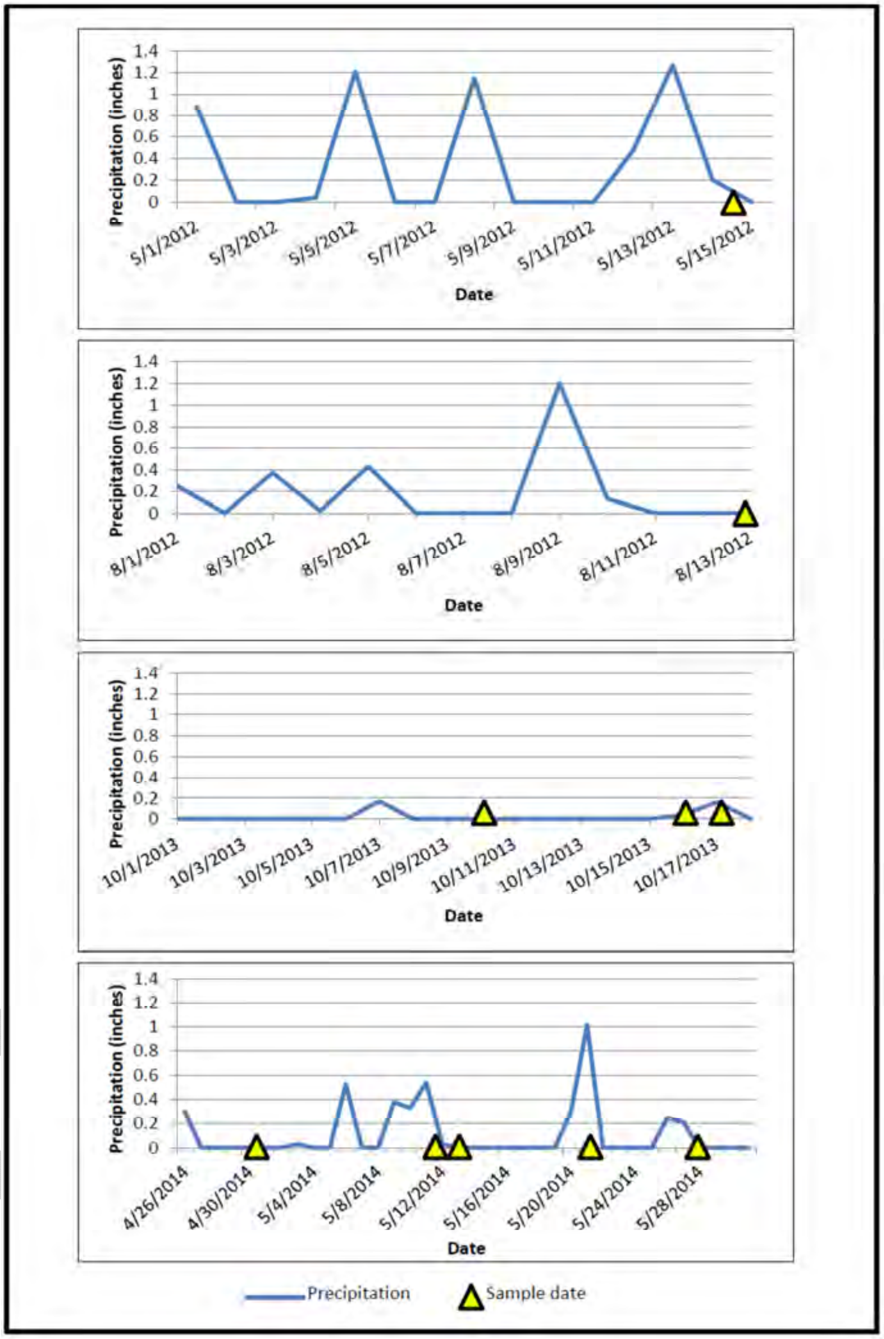

Figure 4.28: Precipitation Amounts Prior to Sampling Events.

4.7 Pollutant Loads

A pollutant load is the amount of a specific pollutant moving through a stream. The pollutant load is based upon the concentration of the pollutant and the stream flow. Loads are generally expressed in terms of weight of the pollutant and a period of time, resulting in pounds per year, for example. Pollutant loads are important in watershed planning because they allow a more balanced comparison of subwatershed. A watershed with a low concentration of a pollutant but with a lot of flow may have a higher load than a watershed that has a high pollutant concentration but only a trickle of flow. Large loads likely have significant impacts on the larger watershed as a whole.

Flow data were collected with a portion of the KDOW sampling events but were not collected for the TVA events. Due to the incomplete record of flow data, Mean Annual Flow was used for load calculations. Mean Annual Flow values were obtained from the Low Flow Mean Annual Flow GIS layer (kyvector.SDE.KY_Low_Flow_Mean_Flow). The values generated by this layer have been calculated using the equation in the USGS Water-Resources Investigations Report 02-4206 "Estimating Mean Annual Streamflow of Rural Streams in Kentucky"(Martin 2002).

Total Suspended Solids Pollutant Loads

Although there is no numeric standard for total suspended solids (TSS), KDOW has supplied a local benchmark of 5.0 mg/L for the Red Bird project. Since sediment is an on-going issue with all waterways, measures to reduce it are recommended. Table 4.6 includes loadings for TSS based on the same data used to create Figure 4.11. TSS values that were recorded as <2 were changed to a value of 2 for TSS loadings because the actual value was not recorded. Loadings were calculated with the following formula and using guidance from p. 94 of the Watershed Planning Guidebook for Kentucky Communities (Kentucky Waterways Alliance and KDOW, 2010):

Actual concentration x discharge (cfs) x conversion factor = actual load

The highlighted areas show subwatersheds that have loads exceeding the 5 mg/L benchmark and thus, need a load reduction.

***E. coli* Pollutant Loads**

Pollutant loads, target loads, percent load reductions needed to achieve the standard, and pollutant yields were calculated by Brooke Shireman, former KDOW employee, for each site sampled by TVA and KDOW (Table 4.7 and Figure 4.29). Pollutant loads, target loads, percent load reductions needed to achieve standards, and pollutant yields were calculated using the geometric mean of the 5 samples collected in May 2014 and comparing them to the 130 CFU/100mL PCR Standard (Table 4.8 and Figure 4.30). There are many reasons to look at loads and reductions needed for this subset of data. As previously noted, these data will be used in the Integrated Report to determine PCR use support of the segments sampled. The Daniel Boone National Forest has also received §319(h) Nonpoint Source funding to implement this watershed plan. It's important that this funding is used to target implementation to address sources of these potential impairments and protect subwatersheds that fully support PCR.

Table 4.6: TSS pollutant load results from TVA August-September 2011 sampling using actual TSS and mean annual flow measurements and 5 mg/L KDOW benchmark. The highlighted areas are sub-watersheds that have loads exceeding the 5 mg/L benchmark.

Site	Site Name	TSS (mg/L)	MAF (cfs)	Annual Load (lbs.)	Annual Target Load (lbs.)	Annual Load Reduction Needed (lbs.)
1	Red Bird 7	2	27.7	109065.8415	272665	-163599
2	Phillips Fork (Lower)	9	13	230337.6075	127965	102372
3	Blue Hole Creek	2	5.8	22836.891	57092.2	-34255
4	Upper Bear Creek	2	6.4	25199.328	62998.3	-37799
5	Upper Jacks Creek	2	12.2	48036.219	120091	-72054
6	Katies Creek	2	5.3	20868.1935	52170.5	-31302
7	Spring Creek	0	8	0	78747.9	-78748
8	Bowen Creek (Lower)	2	14.4	56698.488	141746	-85048
9	Flat Creek	2	11.1	43705.0845	109263	-65558
10	Elisha Creek	0	11.6	0	114184	-114184
11	Gilberts Little Creek	0	2.4	0	23624.4	-23624
12	Gilberts Big Creek	2	8.2	32286.639	80716.6	-48430
13	Sugar Creek	2	8.3	32680.3785	81700.9	-49021
14	Big Double Creek	2	12	47248.74	118122	-70873
15	Little Double Creek	0	3.1	0	30514.8	-30515
16	Elk Creek	2	11.9	46855.0005	117138	-70283
17	Big Creek (Lower)	4	38.6	303966.894	379959	-75992
18	Grannys Branch	2	1.9	7481.0505	18702.6	-11222
19	Lower Jacks Branch	0	1.2	0	11812.2	-11812
20	Fish Trap Branch	2	2.8	11024.706	27561.8	-16537
21	Hector Branch	2	15.2	59848.404	149621	-89773
22	Jacks Creek	2	7.8	30711.681	76779.2	-46068
23	Dry Branch	6	3.2	37798.992	31499.2	6299.83
24	Bear Creek	10	11.8	232306.305	116153	116153
25	Red Bird 1	2	272.2	1071758.919	2679397	-2E+06
26	Red Bird 2	9	248	4394132.82	2441185	1952948
27-	Red Bird 3	2	166	653607.57	1634019	-980411
28	Red Bird 4	2	114	448863.03	1122158	-673295
29-	Red Bird 5	4	86.7	682744.293	853430	-170686
30	Red Bird 6	2	56.9	224037.7755	560094	-336057
31	Lick Fork	2	5.8	22836.891	57092.2	-34255

32	Lawson Creek	2	5.5	21655.6725	54139.2	-32484
33	Red Bird 8	2	9.3	36617.7735	91544.4	-54927
34	Phillips Fork (Upper)	13	5.2	133083.951	51186.1	81897.8
35	Bowen Creek (Upper)	2	8.2	32286.639	80716.6	-48430
36	Big Creek (Upper)	2	20.4	80322.858	200807	-120484

Table 4.7: *E. coli* pollutant load results from TVA and KDOW using 240 CFU/100mL PCR Standard.

EDAS #	NAME	Average *E. COLI* (MPN/100mL)	MAF (ft3/s)	Annual Load (MPN/year)	Target Annual Load (MPN/year)	% Load Reduction Needed	Annual Yield (MPN/year/mi2)
DOW04052047	Red Bird Creek	550.76	9.3	4.56272E+13	1.98826E+13	56.42%	7.39502E+12
DOW04052046	Lawson Creek	312.56	5.5	1.53135E+13	1.17585E+13	23.21%	4.20701E+12
DOW04052045	Red Bird Creek	564.74	28	1.40859E+14	5.98616E+13	57.50%	7.46077E+12
DOW04052044	Phillips Fork	437.78	13.6	5.30364E+13	2.90756E+13	45.18%	6.04748E+12
DOW04052043	Red Bird River	382.08	56.9	1.93662E+14	1.21647E+14	37.19%	4.99645E+12
DOW04052042	Upper Jacks Creek	510.22	12.2	5.54493E+13	2.60825E+13	52.96%	6.6486E+12
DOW04052041	Red Bird River	361.98	101.3	3.98964E+14	2.16571E+14	33.70%	5.71009E+12
DOW04052040	Red Bird River	82.2	126.3	9.24813E+13	2.70019E+14	0.00%	1.05404E+12
DOW04052039	Red Bird River	57.733	148.2	7.62173E+13	3.16839E+14	0.00%	7.39615E+11
DOW04052038	Red Bird River	87.88	165	1.29167E+14	3.52756E+14	0.00%	1.11524E+12
DOW04052037	Elk Creek	351.94	11.9	3.73074E+13	2.54412E+13	31.81%	4.40985E+12
DOW04052036	Big Creek	88.7	38.6	3.04993E+13	8.25235E+13	0.00%	1.10465E+12
DOW04052035	Red Bird River	151.72	248	3.35176E+14	5.30203E+14	0.00%	1.89902E+12
DOW04052004	Red Bird River	120.74	268.9	2.89215E+14	5.74885E+14	0.00%	1.50273E+12

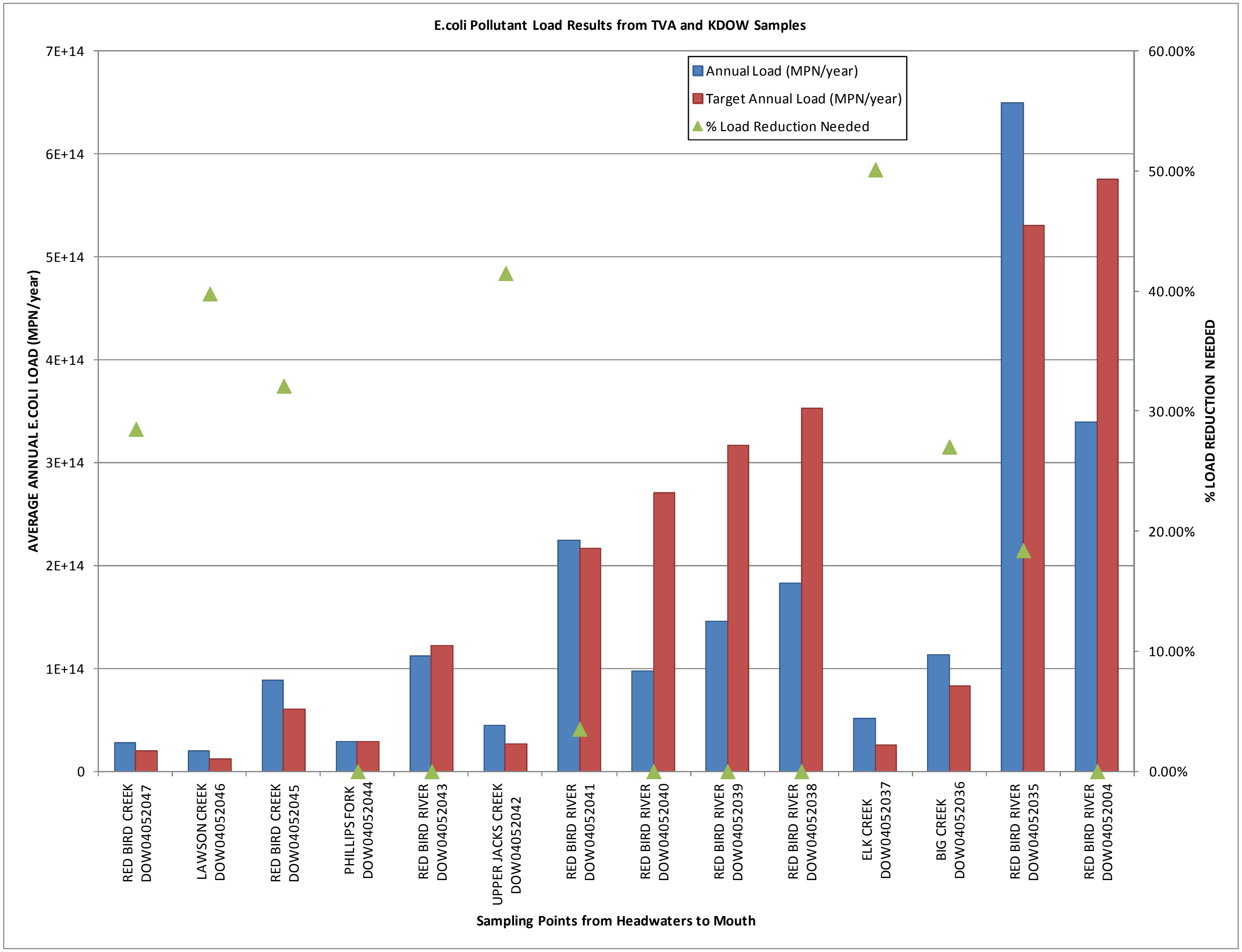

Figure 4.29: *E. coli* pollutant load results from TVA and KDOW using 240 CFU/100mL PCR Standard.

Table 4.8: *E. coli* pollutant load results from KDOW May 2014 Sampling using Geometric Mean and 130 CFU/100mL PCR Standard.

EDAS #	NAME	GEOMEAN *E. COLI* (MPN/100mL)	MAF (ft3/s)	Annual Load (MPN/year)	Target Annual Load (MPN/year)	% Load Reduction Needed	Annual Yield (MPN/year/mi2)
DOW04052047	Red Bird Creek	88.99	9.3	7.37258E+12	1.07697E+13	0.00%	1.19491E+12
DOW04052046	Lawson Creek	381.97	5.5	1.87142E+13	6.3692E+12	65.97%	5.14126E+12
DOW04052045	Red Bird Creek	98.66	28	2.46091E+13	3.2425E+13	0.00%	1.30345E+12
DOW04052044	Phillips Fork	29.60	13.6	3.58566E+12	1.57493E+13	0.00%	4.08855E+11
DOW04052043	Red Bird River	60.16	56.9	3.04921E+13	6.58923E+13	0.00%	7.8669E+11
DOW04052042	Upper Jacks Creek	256.72	12.2	2.78991E+13	1.4128E+13	49.36%	3.34522E+12
DOW04052041	Red Bird River	108.06	101.3	9.75083E+13	1.17309E+14	0.00%	1.39557E+12
DOW04052040	Red Bird River	68.23	126.3	7.67599E+13	1.4626E+14	0.00%	8.74857E+11
DOW04052039	Red Bird River	106.74	148.2	1.4091E+14	1.71621E+14	0.00%	1.36739E+12
DOW04052038	Red Bird River	92.97	165	1.36645E+14	1.91076E+14	0.00%	1.17981E+12
DOW04052037	Elk Creek	484.47	11.9	5.13562E+13	1.37806E+13	73.17%	6.07048E+12
DOW04052036	Big Creek	460.92	38.6	1.58485E+14	4.47002E+13	71.80%	5.74012E+12
DOW04052035	Red Bird River	226.92	248	5.01298E+14	2.87193E+14	42.71%	2.84022E+12
DOW04052004	Red Bird River	116.96	268.9	2.80154E+14	3.11396E+14	0.00%	1.45565E+12

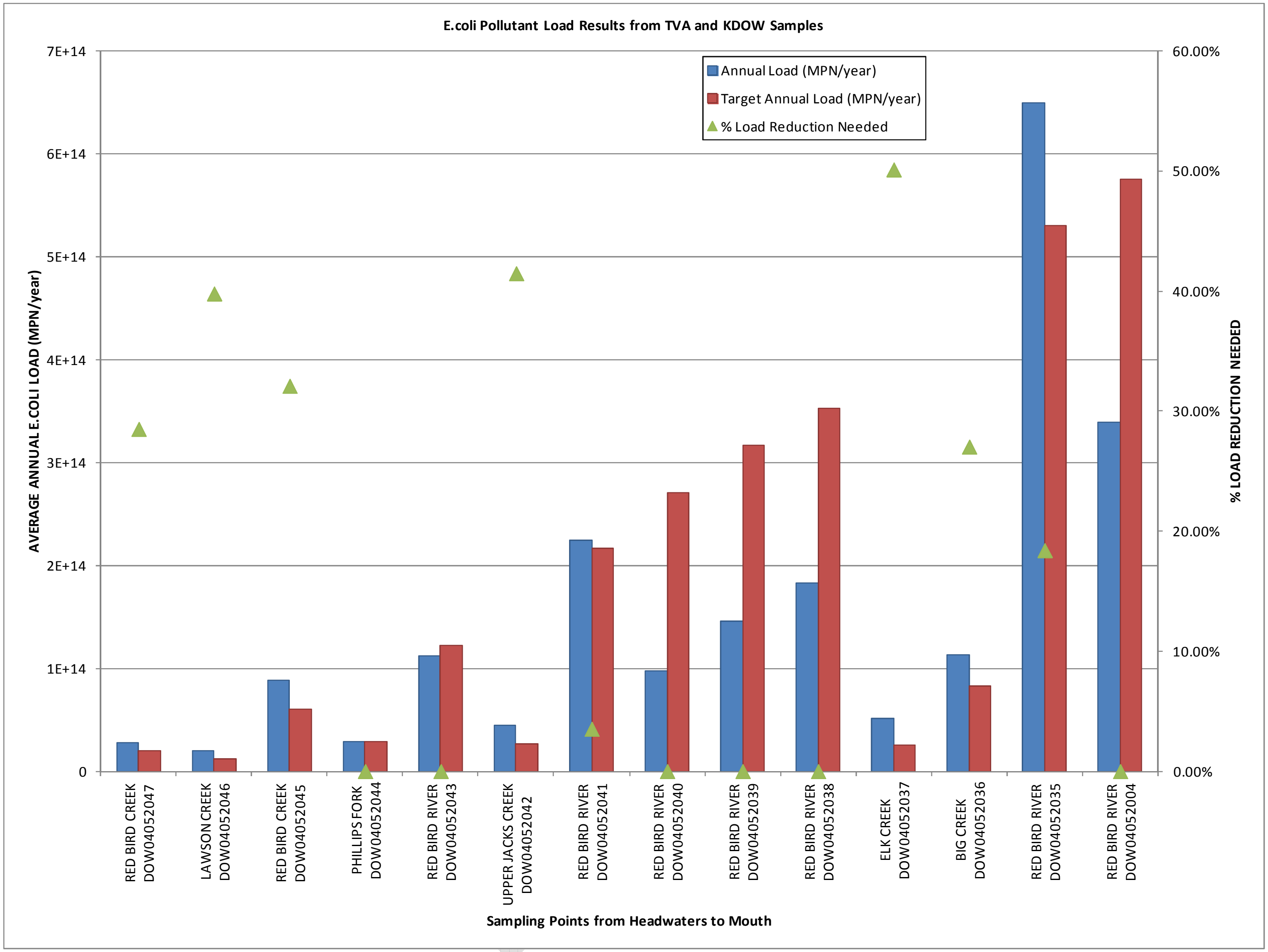

Figure 4.30: *E. coli* pollutant load results from KDOW May 2014 sampling using Geometric Mean and 130 CFU/100mL PCR Standard.

As noted previously, the goal of the analysis is to identify potential sources of *E. coli* and prioritize subwatersheds for implementation to address these sources.

Based on the complete data set, the data subset of the May 2014 events, and the number of times the *E. coli* concentration at the site exceeded the 240 CFU/100mL standard, Lawson Creek, Upper Jacks Creek, Elk Creek, Big Creek and the Red Bird River at site DOW04052035 show consistent issues with meeting the PCR standard (Table 4.9).

Table 4.9: Percent load reductions needed and concentrations exceeding 240 CFU/100mL.

EDAS #	Site Name	% Load Reduction Needed (based on 240 CFU/100 mL)	% Load Reduction Needed (based on 130 CFU/100 mL)	# of Concentrations that Exceed Standard 240 CFU/100mL
DOW04052047	Red Bird Creek	56%	0%	2
DOW04052046	Lawson Creek	23%	66%	5
DOW04052045	Red Bird Creek	58%	0%	3
DOW04052044	Phillips Fork	45%	0%	2
DOW04052043	Red Bird River	37%	0%	1
DOW04052042	Upper Jacks Creek	53%	49%	4
DOW04052041	Red Bird River	34%	0%	2
DOW04052040	Red Bird River	0%	0%	0
DOW04052039	Red Bird River	0%	0%	1
DOW04052038	Red Bird River	0%	0%	2
DOW04052037	Elk Creek	32%	73%	6
DOW04052036	Big Creek	0%	72%	6
DOW04052035	Red Bird River	0%	43%	3
DOW04052004	Red Bird River	0%	0%	2

A number of the other sites demonstrated needed load reductions based on the 240 CFU/100mL standard. However, they had a limited number of concentrations exceeding the standard. These sites indicated higher concentrations after wet weather events but did not show a pattern of elevated concentrations as seen in the sites mentioned above. The sites in this category located on the main stem (DOW04052045, DOW04052041) may have elevated levels due to high levels in tributaries such as Lawson Creek and Upper Jacks Creek. Six of the sites do not require load reductions under either of the standards. Five of these sites are located on the main stem. There are a number of high quality tributaries along these segments which may allow for some dilution of the elevated concentrations in the upper tributaries.

4.8 Priority Areas

Repeating the Goal of this Analysis (Section 4.2 of this document):

> *"The intent of the Red Bird River Collaborative Restoration Project, as identified in public meetings, is to improve the water quality in the Red Bird River Watershed."*

In order to improve the water quality, the condition of the current water quality as well as potential contaminant sources in the watershed must be understood. This information is not meant to call out potential polluters; rather, it is to identify locations in the watershed in which the cooperative implementation of BMPs will be most feasible, efficient, and effective to improve the water quality in the Red Bird River Watershed.

Based on this analysis, Lawson Creek, Upper Jacks Creek, Elk Creek, and the Big Creek subwatersheds will be the first priority for implementation to address issues associated with elevated *E. coli* levels. Each of these subwatersheds contain higher numbers of residences clustered along the stream which may be contributing to higher pollutant loads from straight pipes, failing septic systems, and inadequate septic system drain fields. The Red Bird River at site DOW04052035 does show elevated levels and needed load reductions, however this may be due to the inputs of the subwatersheds identified above. If success monitoring doesn't show an improvement in this segment after implementation takes place in the subwatersheds, then this area will be prioritized for future implementation.

Other subwatersheds and main stem segments are second priority areas for implementation to both restore and protect segments from future impairments. As noted above, future success monitoring may show improvement in these areas due to implementation in the first priority subwatersheds. It will be important to continue to assess the watershed and modify the implementation strategy (presented in the following chapters) accordingly.

TSS reductions are needed in five areas of the Red Bird River Watershed: Lower Phillips Fork, Upper Phillips Fork, Site 2 on the main stem of the Red Bird River, Dry Branch, and Bear Creek (Table 4.6). BMPs to control TSS will be implemented first on Lower Phillips Fork, Bear Creek, Sugar Creek, and Big Double Creek. Second priority will be given to Upper Phillips, and third priority will be given to Dry Branch and Site 2 on the main stem of the Red Bird River.

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Red Bird River Watershed

Chapter 5: Finding Solutions

Introduction 5.1

In watershed planning, a best management practice, or BMP, is traditionally defined as something built on the ground with documentable results in reducing pollution. The phrase is used to refer to any management practice designed to reduce pollution or improve water quality and habitat. Targeted BMP implementation is vital to successful watershed planning.

BMPS may be:

- Structural – these BMPs require construction, installation, and maintenance. They're usually BMPs that one can see such as riparian stream buffers, rain gardens, and silt fences (Figure 5.1).
- Nonstructural – these BMPs involve changes in activities or behavior of people in the watershed. Examples include education and outreach campaigns or events like watershed team meetings and river cleanups.

Figure 5.1: Riparian stream buffers and silt fences are structural BMPs that help protect water quality.

5.2 Best Management Practices for the Red Bird River Watershed

There are all kinds of BMPs to address all sorts of issues. Because everything we do on the land affects the water, most types of land use have associated best management practices. BMPs can address agricultural issues like erosion and manure management, residential issues like failing septic systems and stormwater runoff, construction issues like erosion, and many others. For this project, there should be a direct link between a specific, identified watershed issue and the proposed BMP that will help mitigate that issue.

It is important to consider education and protection practices as BMPs, too. Education can be very effective in improving local water quality as it is often our collective daily actions that impact our waterways the most. Conservation easements, riparian buffer zone establishment, ground water protection plans, source water protection plans, wellhead protection plans, and agricultural water quality plans are all pro-active actions that can protect good water quality. It is often more practical and economical to protect good water quality than to improve poor water quality.

Issues to be addressed by Recommended Best Management Practices
With the source indications from Chapter 4, knowledge gathered from community members at watershed team meetings, and background information presented in Chapter 2, we can now select BMPs to recommend for future implementation that will most effectively and efficiently address identified pollutant and habitat issues in the Red Bird River Watershed.

The main water quality issues of concern in the Red Bird River Watershed are (for more information about these water quality issues, see Chapter 4):

- watershed education and garbage issues
- bacteria (*E. coli)*
- total suspended solids
- specific conductance
- sulfate
- hardness and manganese

BMPs for education and garbage, *E. coli*, and total suspended solids are described below. Many of the BMPs recommended to address bacteria issues may also help mitigate total suspended solid issues and vice versa. BMPs for specific conductance, sulfate, and hardness and manganese are related to coal mining and are addressed in Sections 5.6.

5.3 Watershed Education and Garbage Issues BMPs

Education on watershed issues and nonpoint source pollution – General watershed and water quality education can be one of the most effective ways to improve water quality. Daily actions of watershed residents have huge impacts on waterways. Educational messages can be incorporated into other BMPs. Also, environmental education programming for schools is another way to emphasize watershed health, water quality, and habitat issues.

Education about garbage and littering issues – While everyone knows what garbage is, some people may not consider the impacts of dumping it in or near water, or they may be unaware of how widespread littering or garbage dumping is in the community. Some area residents may not know about free dump or tire amnesty days. Education can take many forms and target many audiences. Public service announcements on radio or TV, photos in the newspaper of trash dumps, storytelling or art contests, t-shirts, anti-trash campaigns led by local leaders, and many other ideas may inspire action and behavior change in individuals and communities.

Incentive programs for participating in garbage pickup – Working with local experts and leaders, establish a program to incentivize participation in existing garbage disposal programs.

Adopt a Highway program – Institute or support an existing "Adopt a Highway" program. The program model could be modified to fit the watershed community, such as "Adopt a Creek" or "Adopt a Waterfall," etc.

County or city ordinance review – A review of what regulations are currently working or not working in a community can help be a catalyst for change.

Fines or taxes – Fines and more widespread enforcement of existing anti-littering laws or fees added to property taxes to cover mandatory garbage collection may be effective.

Pay per pound or per bag trash pickup program – A type of incentive program that would pay area residents for trash picked up from designated areas.

Recycling programs – Establishing a recycling program or supporting an existing one, as needed, can help reduce the overall amount of garbage in a community. The mechanism for this would depend on the local resources available and/or grant funding secured.

Creek Cleanups – Getting together as a community to pick up trash from roads, hillsides, and waterways can help drive home the message that what we do on the land affects the water. It also helps remove solid waste from waterways.

5.4 Bacteria (*E. coli*) BMPs

Education about onsite wastewater issues – This BMP could be implemented in a variety of ways and tailored to different audiences. Educational materials about proper onsite wastewater system maintenance could be mailed to households outside of the sewer line service area, used in public service announcements, discussed at community meetings and events, and otherwise distributed.

Tiered approach based on proximity and connection to a creek or waterway. Funding could be provided by EPA 319(h) grants, East Kentucky PRIDE, and SOAR.

> *Financial assistance for septic system pump outs* – Financial assistance could be provided to help homeowners have their septic systems inspected and pumped.
>
> *Financial assistance for onsite wastewater system repair or replacement* – Financial assistance could be provided to help homeowners repair or replace their septic system or other onsite wastewater system.

Financial assistance for onsite wastewater system installation – Financial assistance could be provided to help homeowners install onsite wastewater systems to eliminate straight pipes.

Sewer line installation – Sewer lines could be extended from Manchester and/or Hyden to include the Red Bird River Watershed.

5.5 Total Suspended Solids BMPs

Education about soil erosion and siltation and sedimentation in waterways – Soil erosion and the resultant sedimentation and/or siltation of waterways can greatly reduce the quality of habitat for aquatic organisms. Education about keeping soil in place and out of the water is important for many types of land users including farmers, homeowners, land developers, recreational users, timber harvesters, and mine operators.

Riparian buffer establishment – Riparian areas are those areas directly adjacent to waterways. Establishing a buffer of plants around the waterways, also known as a filter strip or stream buffer, can help improve the health of the water in many ways. One important way a riparian buffer can help is by catching and filtering out pollutants that would otherwise flow into the water during or after a rain event. Another way is by stabilizing creek banks with plant roots. And another way is by providing shade for the water and its inhabitants. Riparian buffers can be effective on farms, suburban yards, and in towns.

Tree planting events may be organized by the U.S. Forest Service or a watershed coordinator within the community with help from other organizations, such as EKY PRIDE and Kentucky Department of Fish and Wildlife Resources. Grant funds can help pay for tree seedlings and plants. Boy Scout troops are another good resource for this type of event.

Conservation easements - A conservation easement is a voluntary agreement that allows a landowner to limit the type or amount of development on their property while retaining private ownership of it. An easement can be used to help establish healthy riparian areas, shield land from development, or protect parcels of land to maintain or improve watershed health.

Stream restoration – Historically, many of the stream channels in the Red Bird Watershed have been straightened, channelized, and pushed to one side of the valley. In the short term this may be good for small farming operations, but in the long term it usually results in severe bank erosion and a loss of fish habitat (Figure 5.2). Adding meanders back into the stream channel and reconnecting the stream to its floodplain can help this problem.

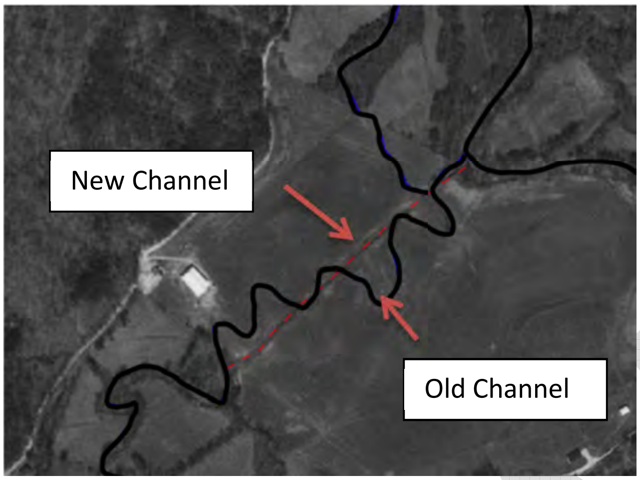


Figure 5.2: Stream channelization and the resulting bank erosion.

Trail and road maintenance – Proper care and maintenance of recreational trails and roadways can prevent erosion and sedimentation. Steep sections of roads and trails on mountainous terrain often become major sources of stream sedimentation. Frequent maintenance and installing BMPs like water bars, relief ditches, and stable stream crossings can greatly reduce the amount of dirt in our creeks. This work will be done by the Daniel Boone National Forest employees and volunteers.

Agricultural erosion prevention BMPs – Limiting livestock access to streams, filter strips, healthy pasture practices like rotational grazing, use of cover crops, and no-till farming can greatly reduce erosion, and therefore, siltation and sedimentation of waterways.

Exclusion fencing – Using fences to keep livestock from accessing the creek can help reduce the amount of manure and sediment getting in to the creek. Often, an alternative watering system is installed in a location away from the creek to provide livestock with a clean and safe water source.

Heavy use area protection – A livestock heavy use area is a sheltered concrete pad where livestock feed that helps collect much of their manure in one place to be cured for compost use later. This reduces the amount of manure and sediment washing into the creek. It also helps keep livestock hooves dry. This work is often done through the local conservation district with a cost share option.

5.6 Coal Mining BMPs

Coal mining is a significant land use in the Red Bird River Watershed. There are active mines, proposed mines, and abandoned mine sites. Specific conductance, sulfate, aluminum, iron, manganese, and other heavy metals are some of the water quality parameters of concern that are often associated with coal mining.

There are several BMPs designed for coal mined lands, but those are regulated through various mining agencies. Mining is a highly regulated activity and change must occur through legislation. This watershed plan is designed to identify issues and present local solutions for nonpoint source pollutants. The scope of coal mining is larger than this plan and regulated as a point source by federal and state agencies.

Green Forest Works is a 501(c)(3) non-profit organization that can solicit private funds and grants to restore forests on abandoned mined lands. They could be a potential funding source for reforestation projects and riparian area plantings.

The Green Forests Work for Appalachia works through the steps in this process:

1. Partner with landowners to secure access to surface mined sites.
2. The highly-compacted blasted rock is "deep ripped" by a large bulldozer with a 4 foot ripper shank to allow tree roots to establish.
3. The exotic vegetation is controlled so that tree seedlings can compete for sunlight and nutrients.
4. A wide range of community partners are engaged to plant hundreds of trees per acre on sites throughout the Appalachian range.

The full proposal and additional information can be found here:
http://arri.osmre.gov/Partnerships/green_forest_works/gfw.shtm
Their current website is: http://greenforestswork.com

5.7 Conclusion

This chapter lists the BMPs that have the potential to address the current water quality issues in the Red Bird River Watershed. These BMPs may not all be appropriate or feasible for the watershed. In Chapter 6, feasibility factors like economics, stakeholder cooperation, regulatory matters, political will, and other watershed management activities will be considered. For those BMPs that are found to be feasible, an action plan will be created to facilitate implementation down the road. It is important to keep in mind that watershed planning is iterative and that this watershed plan can be revised as new information or additional resources become available.

5.8 References

Green Forest Works for Appalachia. Available online at: http://arri.osmre.gov/Partnerships/green_forest_works/gfw.shtm. Accessed on May 14, 2013

Red Bird River Watershed

Chapter 6: Strategy for Success

6.1 Introduction

By this point in the watershed planning process, we know a lot about the water quality of the Red Bird River and the BMPs that could be used to address the issues. The intent of this chapter is to distill those BMPs down to a realistic plan to improve water quality. Each BMP is tied to reducing specific pollution issues in the Red Bird River.

6.2 Feasibility and Selected BMPs

Chapter 5 presented many BMPs that could improve the water quality and habitat of the Red Bird River. Not all of those BMPs are feasible at this time, however. Some would be impractical or too expensive or a bad fit. In selecting which ones to plan out for the future, the watershed team considered factors like stakeholder cooperation, available funding, areas of local concern, political will, watershed management activities, regulatory matters, and others.

The watershed team selected three areas on which to focus in this watershed plan:

- *E. coli* (bacteria)
- Total Suspended Solids (TSS) as a measure of sediment
- Watershed Education and Garbage

In this chapter, action items planning tables are presented for BMPs selected to address these issues. These issues, and the corresponding BMPs, were selected because the watershed team believed them to be valuable and feasible for the communities of the Red Bird River.

BMPs to address the water quality issues of specific conductance, sulfate, and hardness and manganese are not included because they are not considered feasible at this time. These parameters are most likely attributed to coal mining practices, and therefore must be addressed through those regulated practices.

6.3 EPA Potential Recovery Tool

In the process of analyzing the data collected for Red Bird, the Kentucky Division of Water recommended utilizing the EPA Potential Recovery Tool to help prioritize sub-watersheds within the larger Red Bird River Watershed. This model is a tool to help identify areas with higher potential for recovery, and thus, in theory, the best places to focus implementation efforts. The following description from the EPA website explains the Tool:

> The concept of recovery potential - the restorability of a water body - is a primary consideration in restoration programs whose main goal is to bring about recovery. Restoration research and practice have shown that many, very diverse factors affect the likelihood of restoration success, and these can be grouped on the basis of their *ecological*, *stressor*, and *social* influences on restorability (www.epa.gov).

To use the Recovery Potential Tool, three classes of indicators must be selected based on the specific sites: Ecological, Stress, and Social. Figure 6.1 illustrates the results of the model and the selected sub-watersheds.

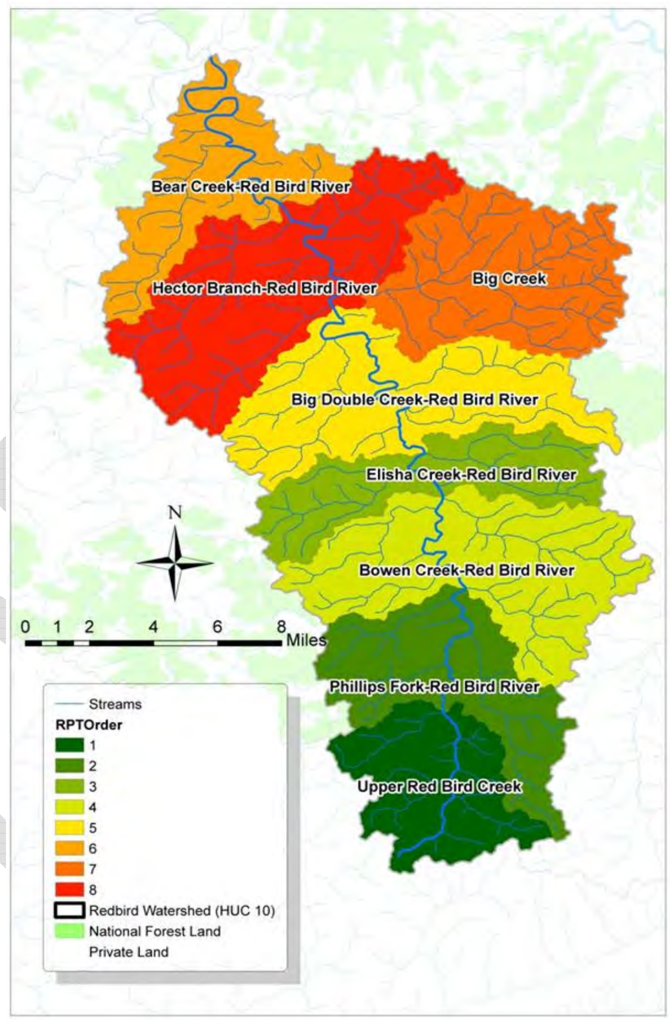


Figure 6.1: Recovery Potential Ranking for Red Bird River Sub-watersheds (USFS 2014).

6.4 Implementation Planning

Table 6.1 is an overview of water quality concerns that this planning chapter addresses. The subsequent three tables, Tables 6.2-6.4, outline BMPs recommended to mitigate *E. coli*, Total Suspended Solids (TSS), and watershed education and garbage issues. The tables that follow those are more detailed action item tables to aid future implementation in selected areas.

Table 6.1: Red Bird River Watershed Concerns and Priorities Overview.

Concerns	Source/Cause/Pollutant	Indicators	Priorities
Decrease *E. coli* levels to meet Primary Contact standards	**Residential inputs:** failed septic systems increase *E. coli* entering our waterways. **Runoff from livestock operations:** *E. coli* levels increase without proper buffer zones and creek fencing.	*E. coli* counts Nutrients Visual survey	**Reduce *E. coli* loads from failed/failing septic systems and livestock operations** **Educate home and landowners**
Decrease erosion and sediment loads in the Red Bird River Watershed	**Runoff from disturbed land:** sediment input can fill in creeks causing water to more rapidly overflow banks. Sediment loads also negatively impact water temp., nutrient concentrations, and aquatic habitat. **Removal of stream bank vegetation:** the removal of vegetation from the bank allows for sediment to easily erode.	Visual observations TSS Bank measurements Water Temperature Nutrients concentrations	**Reduce erosion from run-off associated with vegetation disturbances and construction** **Increase stream bank and riparian zone vegetation** **Stabilize stream banks** **Education**
Watershed Awareness and Garbage	Residential sources: **lack of awareness of watershed and garbage issues; lack of resources to properly deal with garbage.**	**Residential sources of pollution** **Garbage dumps**	**Watershed education for all area residents** **Easy access to garbage pickup** **Cleanup existing and prevent new dumps**

Table 6.2: Best Management Practices that may mitigate *E. coli* issues in the Red Bird River Watershed.

Water Quality Issue	Suspected Source	Best Management Practice (BMP)	Location in Watershed
E. coli	Failing septic systems	Education about wastewater system maintenance and issues	Watershed-wide
		Wastewater system pump out program	Unsewered areas of the watershed
		Wastewater system repair and replacement program	Unsewered areas of the watershed
		Expansion of sewer lines	Unsewered areas of the watershed
	Straight pipes	Wastewater system installation program	Unsewered areas of the watershed
	Agriculture (livestock)	Exclusion fencing	Pastured areas of the watershed
		Heavy use area protection	
	Wildlife	Riparian buffers	Watershed-wide

Table 6.3: Best Management Practices that may mitigate Total Suspended Solids in the Red Bird River Watershed.

Water Quality Issue	Suspected Source	Best Management Practice	Location in Watershed
Sediment as measured by Total Suspended Solids	Agriculture	Exclusion fencing	Agricultural areas of the watershed
		Heavy use areas	Agricultural areas of the watershed
		Riparian buffers	Agricultural areas of the watershed
		Cover crops	Agricultural areas of the watershed
		No-till farming	Agricultural areas of the watershed
	Construction	Silt fences Road maintenance Drainage improvements	Construction sites including roads
	Recreational Activities	Trail/road maintenance	Trails, roads, and other recreational areas
		Responsible recreation	Trails and other recreational areas
		Riparian buffers	Trails and other recreational areas
		Conservation easements	Trails and other recreational areas

Table 6.4: Best Management Practices that may ameliorate Education and Garbage issues in the Red Bird River Watershed.

Water Quality Issue	Suspected Source	Best Management Practice	Location in Watershed
Garbage (including littering, illegal garbage dumps, and historical trash dumps)	Residents	Education and Outreach on garbage issues	Watershed-wide
		County Ordinance Review to consider adding the garbage collection fee to property taxes	Watershed-wide
		Grant to supplement fee involved with garbage pickup	Watershed-wide
		Incentives for pounds collected	Watershed-wide
		Fines or community service hours for littering	Watershed-wide
		Residential recycling program School recycling program	Watershed-wide
	Historical trash dumps	Community Creek Cleanup	Old garbage dump sites
		Incentives for pounds collected	Old garbage dump sites
	Tourists	Anti-trash campaign highway signs	Watershed-wide
		Adopt a Highway program	Watershed-wide
Watershed Education	Residents	Watershed-based education on water quality and habitat issues in the Red Bird River Watershed	Watershed-wide

6.5 Priority Areas

Chapter 4 ends with a prioritization of subwatersheds for future implementation work. Various methods were used to select the priority areas including the EPA Recovery Potential Tool, pollutant loads, and spatial analysis of pollutant concentration. Local knowledge of the watershed and expected level of watershed resident participation were also deciding factors.

All parts of the Red Bird River Watershed are important. With limited funding, however, the first iteration of this watershed plan must pinpoint focus areas in order to make a demonstrable impact on water quality. Three streams have been selected for BMPs to reduce *E. coli* loads (Figure 6.2). Four streams have been selected for BMPs to reduce TSS loads (Figure 6.3). Garbage and educational BMPs are prescribed for the entire Red Bird River Watershed. Streams have been identified for BMP implementation ranked by first, second, and third priority (Figures 6.2 and 6.3).

***E. coli* BMPs**

These areas were selected for *E. coli* BMP implementation:

1. Upper Jacks Creek (in the Bowen Creek-Red Bird River HUC12 - First priority)
2. Elk Creek (in the Hector Branch-Red Bird River HUC 12 - Second priority)
3. Big Creek (in the Big Creek HUC 12 - Third priority)

TSS BMPs

These areas were selected for TSS BMP implementation:

1. Lower Phillips Fork (in the Phillips Fork-Red Bird River HUC 12 - First priority)
2. Sugar Creek (in the Big Double HUC 12 - First priority)
3. Big Double (in the Big Double-Red Bird River HUC 12 - Second priority)
4. Bear Creek (in the Bear Creek-Red Bird River HUC 12 - Third priority)

Based on the data presented in Chapter 4 (see Table 4.6), Sugar Creek and Big Double Creek do not require TSS load reductions. They are included as priority areas here because they are both in the Red Bird Crest Trail area, which has been identified by the Daniel Boone National Forest as areas in need of work to address sediment issues.

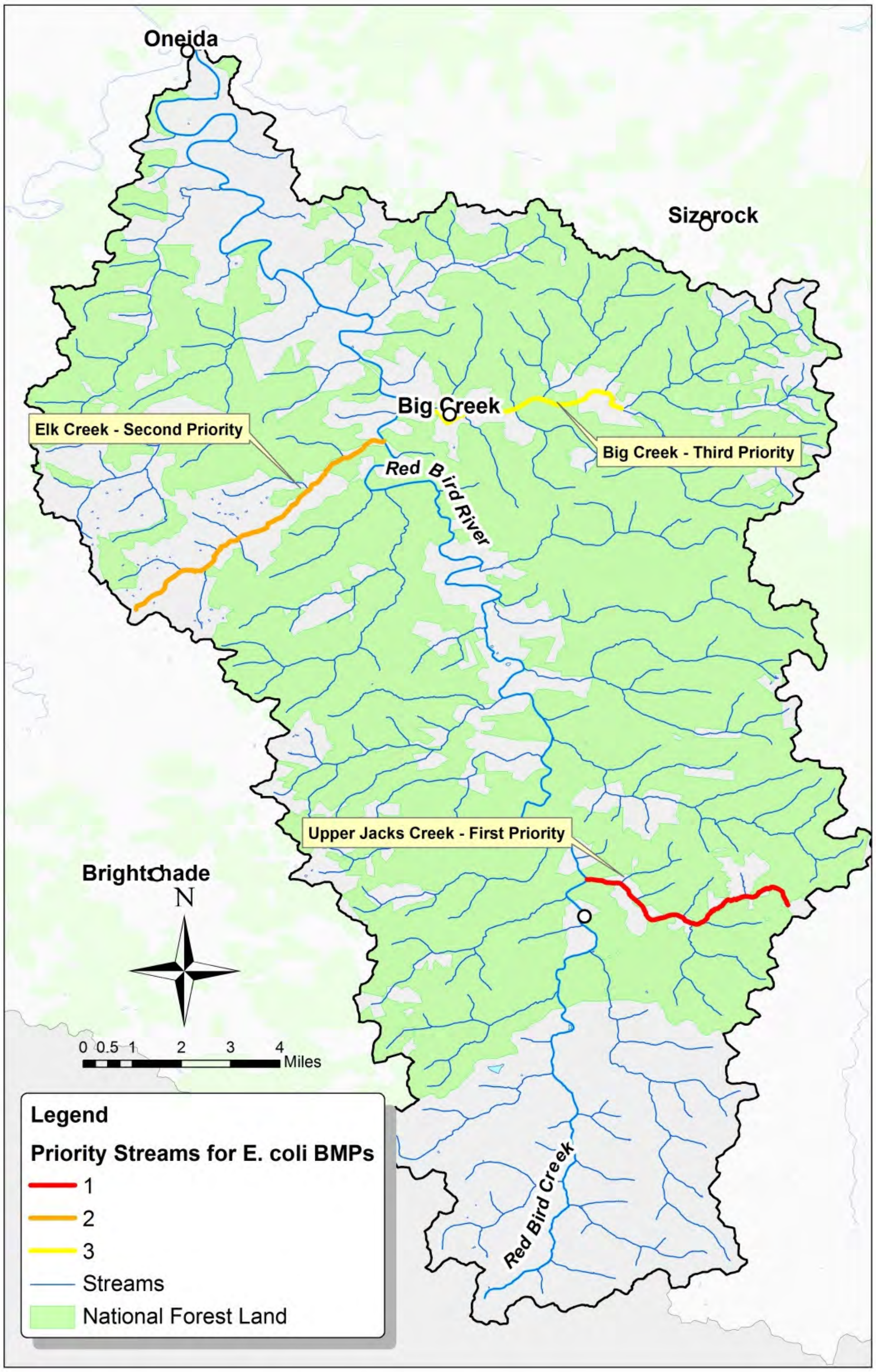


Figure 6.2: Streams in the Red Bird River Watershed chosen and prioritized for E. coli BMPs.

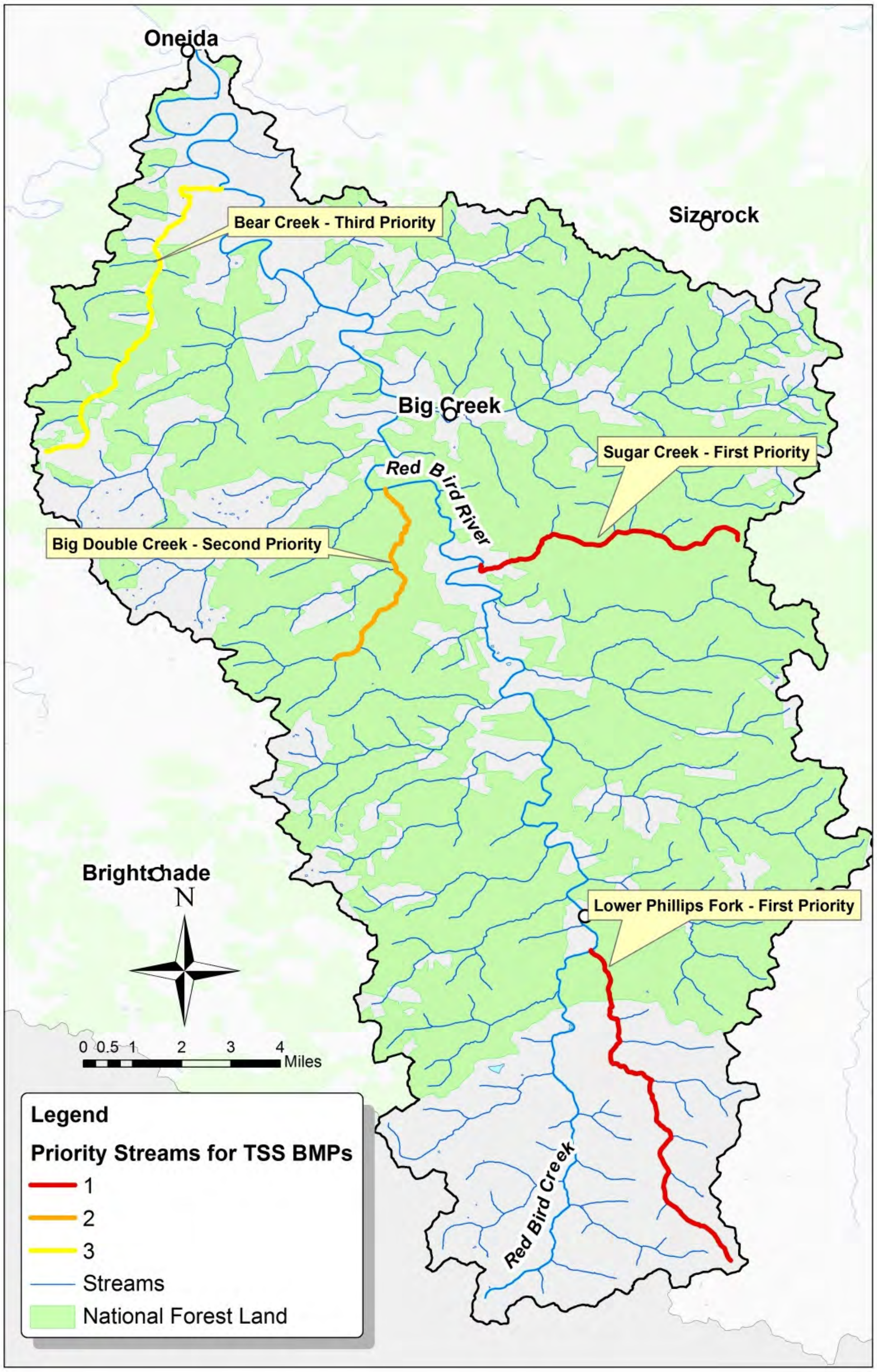


Figure 6.3: Streams in the Red Bird River Watershed chosen and prioritized for TSS BMPs.

6.6 Action Items

Tables 6.1-6.4 provide an overview of the BMPs that will help improve the water quality of the Red Bird River. The next group of tables narrows down priority subwatersheds and includes more specific information such as Action Items.

These are the steps needed to encourage, plan, install, maintain, and monitor the success of BMPs and water quality improvements. There may be multiple action items necessary to implement each one, and it will be necessary to figure out the following details:

- Responsible Party – Identify the person or organization responsible for carrying out each action item. This may be a current partner or someone outside the group.
- Technical Assistance – Identify who will be providing the specialized scientific and technical knowledge to support effective implementation of action item.
- Total Cost – Estimate the cost of the action item.
- Funding Mechanism – Identify the funding mechanism including concrete amounts already established as well as potential sources and in-kind assistance.
- Location – Identify the area in the sub-watershed where the BMP will be implemented.
- Pollutant or Parameter – BMPs may address multiple pollutants or parameters.
- Target value –The target value is the in-stream benchmark for the pollutant or measureable parameter. This was established in Chapter 4.
- Target load reduction – The target load reduction needed for the pollutant or measureable parameter was also established in Chapter 4.
- Milestones: short (less than one year), mid-term (1-3 years), long-term (3+ years), and extended (20+ years with following-up monitoring).

There may be additional information that the watershed team will add. The idea is to iron out details in advance so that once implementation begins, most of the planning work is finished.

6.7 Priority Area BMP Tables

The following tables will help plan out implementation of BMPs. Tables 6.5 through 6.9 are for *E. coli*, Tables 6.10 through 6.13 are for sediment, and Tables 6.14 through 6.16 are for garbage and education issues.

Table 6.5: Relationship of Concerns to Target Values in *E. coli* priority reduction areas of Upper Jacks, Elk, and Big Creeks.

Concerns	Priorities	Indicator	Target Value	Basis
Decrease bacteria levels to meet Primary Contact standards	Reduce bacteria loads from failed/failing septic systems Reduce bacteria loads from agricultural sources Educate home and landowners	Bacteria Count	Monthly geometric range of 130 cfu/100 mL	Water Quality Standards

For Table 6.6, Action Items were added. Action Items are organized by the associated BMP. To address each of their concerns, there are multiple BMPs, and for each BMP, there are multiple Action Items.

Table 6.6: Summary of Action items for BMPs in Upper Jacks, Elk, and Big Creeks.

Concerns	Priorities	BMP	Action Items
Decrease bacteria levels to meet Primary Contact standards	Reduce bacteria loads from failed/failing wastewater system Educate home and landowners	Repair or replace wastewater systems Enforce current laws and regulations Education	1. Work with County Health Department to provide assistance. 2. Help qualifying homeowners with grant programs. 3. Provide monitoring information with local and state agencies. 4. Work with local agencies to provide education opportunities for landowners.
	Reduce bacteria loads from agricultural sources Educate landowners and producers	Exclusion fencing Heavy use protection areas Riparian buffers Education	5. Work with NRCS and local agencies to provide assistance and find funding 6. Help qualifying landowners find existing assistance programs 7. Work with local agencies to provide education opportunities.

Pollutant Load columns have been added to Table 6.7. Tying pollutant loads to BMPs is a critical step in the watershed planning process and important to map out for each sub-watershed.

Table 6.7: *E. coli* Target Load Reductions for Upper Jacks, Elk, and Big Creeks.

BMP	Action Items	Indicator	Target Value	Target Load Reduction Needed
Upgrade Wastewater Systems	1. Work with County Health Departments to provide assistance. 2. Help qualifying homeowners with grant programs. 3. Provide monitoring information with local and state agencies.	Bacteria count	Monthly geometric range of 130 cfu/100 mL PCR Standard	Upper Jacks = 49% Elk Creek = 73% Big Creek = 72%
Education about wastewater system maintenance and issues	1. Work with County Health Departments to provide assistance. 2. Help qualifying homeowners with other grant programs. 3. Provide monitoring information with local and state agencies.	Resident participation	n/a	n/a
Install Exclusion fencing, Heavy use area protection, and Riparian Buffers	1. Work with local agencies to provide education opportunities for landowners. 2. Find funding for BMP implementation. 3. Develop a workshop to be held for landowners. 4. Secure local cost share money to do on-ground demonstration.	Bacteria count Resident participation	Monthly geometric range of 130 cfu/100 mL PCR Standard	Upper Jacks = 49% Elk Creek = 73% Big Creek = 72%

Finally, Table 6.8 shows the planning of each BMP and associated Action Item. Not all the details are known at this time, but they are important to consider. It would also be helpful to address milestone goals for short-term (less than one year), mid-term (1-3 years), long-term (3+ years), and extended (20+ years with follow-up monitoring) items.

Table 6.8: Summary of Action items details for BMPs in Upper Jacks, Elk, and Big Creeks.

BMP	Responsible Party	Technical Assistance	Cost	Funding Mechanisms
Wastewater Systems	Landowner Health Department Watershed Coordinator	Health Department East KY PRIDE	$3,000 - $10,000 per house*	East KY PRIDE
Education about wastewater system maintenance and issues	Red Bird Watershed Team Watershed Coordinator Health Department	Health Department East KY PRIDE UK Extension	n/a	319 grant
Riparian Buffers, Exclusion fencing, and Heavy use area protection	Landowners	Soil and Water Conservation Offices NRCS	$10/linear foot of stream*	Watershed team to look for future funding opportunities

*Costs are based on estimates from East Kentucky PRIDE, past experience, and local knowledge.

Table 6.9: Expected pollutant load reduction from the implementation of *E. coli* BMPs.

BMP	Indicator	Site	*E. coli* Load***	Load Reduction Needed*	# of Septic Systems Recommended	Estimated Load Reduction Expected**
Financial incentive program for septic system tank repair or replacement	Bacteria count	Upper Jacks	27.9	13.8	2	26 trillion/93%
		Elk Creek	51.3	37.6	3	39 trillion/76%
		Big Creek	158.5	113.8	9	117 trillion/74%

*units of trillion *E. coli* cfu/100 ml/yr

**based on 13 trillion *E. coli* cfu/100 ml/yr reduction for each corrected failing septic system. Literature values from US EPA, National Environmental Services Center, and AWWA Research Foundation.

***Values from Table 4.8; units of trillion *E. coli* CFU/100 ml/yr.

Table 6.10: Relationship of Concerns to Target Values in TSS priority reduction areas of Lower Phillips, Sugar, Bear, and Big Double Creeks.

Concerns	Priorities	Indicator	Target Value	Basis
Decrease the sediment loads in Red Bird River	Increase stream bank and riparian zone vegetation Stop erosion from trails and roadways Stabilize stream banks Education	TSS	5 mg/L	Reference data
		Visual Assessment	Reduction in visible signs of erosion and better trail/road conditions	Trails and roads maintenance standards
		Habitat Assessment	130	Literature values
		Biological Assessment (volunteer form)	Score of "Good"	Literature values

For Table 6.11, Action Items have been added and organized by the associated BMP.

Table 6.11: Summary of Action items for Sediment BMPs in Lower Phillips, Sugar, Bear, and Big Double Creeks.

Concerns	Priorities	BMP	Action Items
Decrease the sediment loads in Red Bird River	Increase stream bank and riparian zone vegetation Stabilize stream banks Education Decrease erosion	Vegetated buffer strips along stream channel Trail/road improvements Silt Fences, Road maintenance Drainage improvements Education	1. Secure local cost share money to do on-ground demonstration. 2. Complete an inventory of area trails and roadways contributing to TSS loads. 3. Develop outreach materials for trail user groups and landowners. 4. Work with local agencies to provide educational opportunities.
	Increase stream bank and riparian zone vegetation Stabilize stream banks Decrease erosion	Agricultural BMPs like cover crops, no-till farming, exclusion fencing, and heavy use area protection	1. Secure local cost share money to do on-ground demonstration. 2. Obtain funding for local landowners to implement. 3. Work with local agencies to increase education throughout watershed.

Table 6.12: Sediment Target Load Reductions for Lower Phillips, Sugar, Bear, and Big Double Creeks.

BMP	Action Items	Indicator	Target Value	Target Load Reduction Needed
Vegetated buffer strips along stream channel Trail improvements Silt Fences	1. Secure local cost share money to do on-ground demonstration. 2. Complete an inventory of area trails and roadways contributing to TSS loads.	TSS Trail/road condition	5.0 mg/L	Lower Phillips = 2369.7 (lbs.) Bear Creek = 2.8 (lbs.)
Education	1. Develop outreach materials for trail user groups and landowners. 2. Work with local agencies to provide educational opportunities.	Resident participation Trail/road condition	n/a	n/a
Agricultural BMPs like cover crops, no-till farming, exclusion fencing, and heavy use area protection	1. Secure local cost share money to do on-ground demonstration. 2. Obtain funding for local landowners to implement.	TSS	5.0 mg/L	Lower Phillips = 2369.7 (lbs.) Bear Creek = 2.8 (lbs.)

Table 6.13: Summary of Action items and estimated load reduction for TSS BMPs in Lower Phillips, Sugar, Bear, and Big Double Creeks.

BMP	Responsible Party	Technical Assistance	Cost	Funding Mechanisms	Estimated Load Reduction
Vegetated buffer strips along stream channel Trail/road improvements Silt Fences, Road maintenance Drainage improvements	Landowner	Fish and Wildlife KY Department of Fish and Wildlife Resources (KDFWR) Daniel Boone National Forest	\$10/linear foot of stream (estimate from past experience) \$870/ton (based on past experience within the DBNF) \$4-5/foot	319 grant NRCS cost share programs KDFWR cost share programs	50% removal of sediment
Education	Watershed Team WSC	WSC Daniel Boone National Forest	n/a	319 grant	n/a
Agricultural BMPs like cover crops, no-till farming, exclusion fencing, and heavy use area protection	Landowner	NRCS and other local agencies	fencing = \$4-5/foot	NRCS cost-share programs; Watershed team to look for future funding opportunities	50% removal of sediment

Table 6.14: Relationship of Concerns to Target Values in the Red Bird River Watershed.

Concerns	Priorities	Indicator	Target Value	Basis
Watershed Awareness and Garbage	Watershed education for all area residents Easy access to garbage pickup Cleanup existing and prevent new dumps	Garbage dumps	No garbage High level of watershed issue awareness	Observation Participation in outreach programs

For Table 6.14, Action Items were added. Action Items are organized by the associated BMP. To address each of their concerns, there are multiple BMPs, and for each BMP, there are multiple Action Items.

Table 6.15: Summary of Action items for BMPs in the Red Bird River Watershed.

Concerns	Priorities	BMP	Action Items
Watershed Awareness and Garbage	Community Education	Watershed-based education on water quality and habitat issues in the Red Bird River Watershed	1. Work with local organizations and agencies to collaborate on education and outreach events and materials.
		Education and Outreach on garbage issues	
	Easy access to garbage pickup Cleanup existing and prevent new dumps	Community Creek Cleanup	1. Work with local organizations and agencies to coordinate efforts and bolster existing programs. 2. Look for funding sources to support increased efforts. 3. Organize several cleanups on roadways and in creek areas per year. 4. Discuss local ordinances, fines, service hour programs, and other ideas with local leaders and governments. 5. Explore the feasibility of an area recycling program with local leaders, organizations, and governments.
		County Ordinance Review to consider adding the garbage collection fee to property taxes	
		Grant to supplement fee involved with garbage pickup	
		Incentives for pounds collected	
		Fines or community service hours for littering	
		Adopt a Highway program and/or Anti-trash campaign highway signs	
		Pilot recycling program	

Table 6.16: Summary of Action items for BMPs in Lower Phillips, Sugar, Bear, and Big Double Creeks.

BMP	Responsible Party	Technical Assistance	Cost	Funding Mechanisms
Watershed education on water quality and habitat issues	Red Bird River Watershed team Watershed Coordinator	KY Department of Fish and Wildlife Resources Daniel Boone NF	To be determined	319 grant
Education and Outreach on garbage issues	Red Bird River Watershed Team Watershed Coordinator	County Solid Waste Coordinators Eastern KY PRIDE	To be determined	319 grant
Community Creek Cleanup	Red Bird River Watershed Team Watershed Coordinator	County Solid Waste Coordinators Eastern KY PRIDE	$300/cleanup (past experience and E. KY PRIDE)	319 grant Small community grants
County Ordinance Review to consider adding garbage collection fee to property taxes	Red Bird River Watershed Team Watershed Coordinator	County Solid Waste Coordinators Eastern KY PRIDE	To be determined	319 grant Small community grants
Grant to supplement fee involved with garbage pickup	Red Bird River Watershed Team Watershed Coordinator	County Solid Waste Coordinators Eastern KY PRIDE	To be determined	319 grant Small community grants
Incentives for pounds collected	Red Bird River Watershed Team Watershed Coordinator	County Solid Waste Coordinators Eastern KY PRIDE	To be determined	319 grant Small community grants
Fines or community service hours for littering	Red Bird River Watershed Team Watershed Coordinator	County Solid Waste Coordinators Eastern KY PRIDE	To be determined	319 grant Small community grants
Adopt a Highway program and/or Anti-trash campaign highway signs	Red Bird River Watershed Team Watershed Coordinator	County Solid Waste Coordinators Eastern KY PRIDE	To be determined	319 community grant Small grants
Recycling program	Red Bird River Watershed Team Watershed Coordinator	County Solid Waste Coordinators Eastern KY PRIDE	To be determined	319 grant Small community grants

Red Bird River Watershed

Chapter 7: Making it Happen

7.1 Introduction

The goal of this watershed plan is to improve the water quality of the Red Bird River Watershed using the guidance of this plan. Extensive background data and local knowledge have been collected and provided here by community members, local organizations, and project partners. In order to evaluate progress on the effectiveness of the Best Management Practices implementation, ongoing work will be necessary.

Nonstructural BMPs are recommended to help raise awareness of watershed issues and to cultivate a deeper sense of stewardship of the unique qualities of the Red Bird River. Structural BMPs are recommended to install on the ground work to help address specific sources of pollution. One of the most important BMPs recommended is to hire a local Watershed Coordinator to facilitate the plan implementation. Success Monitoring of BMPs will also be required.

7.2 Organization of Implementation Effort

The Red Bird River Watershed Plan was developed by Daniel Boone National Forest staff, consultant Lynn Garrison, and Kentucky Waterways Alliance staff with assistance and input from the Kentucky Division of Water, regional resource managers, technical experts, community members from Clay and Leslie Counties, area leaders, local organizations, and other stakeholders. The plan will be implemented through the actions of the project partners, watershed landowners, residents, and local organizations, assisted and supported by public and private entities involved in natural resource management, regulatory compliance assistance, outreach, and education.

At the time of the writing of this plan, the Daniel Boone National Forest project staff has applied for a KY Division of Water 319(h) Nonpoint Source grant (FY2014) (due to scheduling conflicts, this project was resubmitted for FY2015 grant money) for watershed plan implementation in the Red Bird River Watershed. As part of the grant project, a local Watershed Coordinator would be hired to oversee the implementation of the watershed plan. The implementation would take place in cooperation with County Solid Waste Coordinators, Eastern KY PRIDE, County Health Departments, Red Bird Mission, local governments, County Soil and Waters Conservation Boards, and other project partners.

The Watershed Coordinator will be a key part of this project and its success. S/he will be housed at the Red Bird Mission, which is in the heart of the Red Bird River Watershed, and serves the surrounding communities with key services, such as healthcare, daycare, adult education, and household assistance. This person will evaluate candidates, oversee, and implement the implementation of the septic portion of the project. The Watershed Coordinator will also be in charge of the education and outreach parts of the plan, continually evaluating this process and the needs of the community. Education and outreach efforts will be geared towards promoting implementation measures identified in this plan.

The schedule for implementing NPS management measures in the Red Bird River Watershed may be found in Table 7.1. Interim milestones are included.

Table 7.1: Schedule of actions for implementing NPS management measures in the Red Bird River Watershed. Interim milestones included.

BMP Installations & Milestones	Date	
	Expected Begin*	**Expected Completion***
Submit all draft materials to NPS Program staff for review and approval.	January 2015	January 2018
Develop and submit a BMP Implementation Plan for NPS program staff approval.	January 2015	March 2015
Hire a local Watershed coordinator.	January 2015	March 2015
Continue to support local watershed planning team.	January 2015	January 2018
Conduct two watershed team meetings per year.	January 2015	January 2018
Submit an Annual Report if requested by KDOW.	September 2015	September 2017
Identify existing DBNF roads and trails in need of repair for sedimentation	February 2015	July 2017
Installation of Red Bird TSS BMPs. • Lower Phillips Fork & Sugar Creek • Big Double Creek • Bear Creek • 100% of BMPs completed	 May 2015 May 2016 May 2017	 September 2015 September 2016 September 2017 January 2018
Develop post-implementation monitoring plan with KDOW to assess effectiveness of BMP's	March 2015	July 2015
Identify households for onsite wastewater needs with Watershed Coordinator	February 2015	July 2017
Repair and/or installation of failing onsite wastewater systems in cooperation with PRIDE. • Upper Jack's Creek • Elk Creek • Big Creek • 100% of BMPs completed	 June 2015 June 2016 June 2017	 September 2015 September 2016 September 2017 January 2018

Work with E. KY PRIDE on an environmental education program in local schools (based on funding and opportunity)	January 2015	January 2018
Conduct community activities such a clean-up days.	August 2015	August 2017
Submit Final Report	September 2017	January 2018

*Expected begin and end dates subject to change based on contract date between DBNF and KDOW.

7.3 Success Monitoring

Monitoring implementation of the watershed plan would involve two separate but related activities: monitoring the implementation of activities and BMPs listed in the plan, and monitoring whether or not water quality in the Red Bird River measurably improves.

The first set of monitoring tasks, tracking activity measures, would consist of documenting the planning, execution, and outcome of the various work items listed in the watershed management plan, e.g., educational demonstrations and workshops, event participation, awareness building events, reports to local officials, and other activities. Interim progress on implementation will be documented by photo-documentation, watershed meetings, and field visits. These actions are absolutely critical for building awareness of water quality issues in the Red Bird River Watershed, increasing understanding of the technical aspects of recommended management practices, building support for BMP implementation, and providing overall support for water quality improvement.

The second set of monitoring tasks would involve documenting changes in water quality in the watershed. There will be a success monitoring plan that will address the impairments identified in Chapters 2-4. The monitoring plan will be designed by KDOW and the Daniel Boone National Forest to monitor for parameters targeted by BMPs for each area/site. Sampling will begin approximately 3 months after BMPs have been implemented for a sufficient time period. The Watershed Coordinator will document progress of implementation activities, using a digital spreadsheet, to keep track of what was done, where, when, by whom, costs, observations, and other information pertinent to the BMP and pollutant. Through the process of continuous evaluation, it will be determined if activities are addressing enough BMPs and in the right places to make a difference in the identified issues. If activities are proving less effective than anticipated, activities will be re-considered and modified.

7.4 Conclusion

Watershed planning is an iterative process. The first draft of this watershed plan was started in 2012 and completed 2014. The plan was set aside due to scheduling conflicts, and was finalized in 2016. It is expected that some of the information in the plan will need updating. Stakeholders and project partners will likely change, data will be added, land uses may change, local priorities may shift, and restoration efforts and BMPs may improve water quality and habitat conditions.

As part of the process of creating this watershed plan, ten public meetings were held in either Clay County or Leslie County, numerous road side or creek-side cleanups were held, and various other educational events have taken place. It is the sincere hope of the project partners involved that these important efforts will continue as the community works toward a cleaner, safer watershed.

Appendix A: Historic Flooding

Flooding information

Historic Floods in Red Bird River by Lynn Garrison

Floods are the number one cause of Presidential declared natural disasters for Bell, Clay, and Leslie Counties. Storms are number two.

Two of the largest floods in the Red Bird River Watershed were in 1947 and 1957. The heaviest damage occurred in built up areas where a higher percentage of homes were built in the flood plain than homes in less developed areas. Homes built along small tributaries in the early 1900s were more likely to have been built out of the flood plain. This was in part due to the practice of logging in the fall and winter to earn money for provisions. Logs were cut and moved to stream banks where they were marked with the loggers registered brand. “Splash dams” were built upstream from the logs, and when water flow was great enough to float logs, the water from the splash dams was released to increase capacity of the stream to float the logs downstream to mills. The water and logs moved with such force that they did considerable damage to vegetation along the stream. Consequently, resident loggers were not likely to build too close to stream banks. This type of logging began about 1870 in the Red Bird River Watershed and continued into the early 1900s. The rate of harvest was sustainable and provided a reliable source of income until large outside companies became interested.

Both the Oneida Baptist Institute (slightly downstream from the Red Bird project area) and the Red Bird Mission were extensively damaged in the 1947 flood. The Oneida Baptist Institute and Oneida had substantial damage in the 1957 flood. Even though the water level at the Big Creek gage was only 1.67 feet higher in the 1947 flood than in the 1957 flood, the damage throughout the Red Bird River Watershed was far greater, especially in the headwater area. The 1947 flood came in the summer, June 28, when crops were in the fields. It destroyed gardens, orchards, and crops, on which people were highly dependent, and it was too late to replant. This loss, plus the loss of many stores and roads caused a food shortage. The 1957 flood was at the end of January before any gardens or crops had been planted. Also some of the homes destroyed in the 1947 flood were rebuilt on higher ground. Both floods damaged homes, businesses, roads, bridges, utility lines, communications lines, suspension foot bridges, and fences.

John W. Bischoff, Red Bird Mission Superintendent in 1947, clearly described the enormity and dynamics of the 1947 flood in the following statement:

"About 2:00 a.m., on June 28, rain came down in sheets, and I knew we were having a cloudburst similar to the one experienced at Jack's Creek Community Center six years ago.

Then we stood there helplessly and watched the Schaeffer home go by. The sidewall broke off and we could see the furniture in the house as it swept across the tennis court and the ball diamond and crashed into the porch of the boys' dormitory. It struck so hard that the house seemed to bounce, and then whirled around the corner of the dormitory, and we have never seen it since. A few scattered articles like the bathtub and sink were found down the river a way, but the doctor's household goods were completely swept away.

Shortly after the Schaeffer house floated away, Uncle Millard's store and post office started down the Red Bird. Crashing into a huge tree it began breaking up. Pieces of homes, big trees and logs went floating by. We could hear the roar of rocks tumbling in the water, many of them weighting as much as five hundred pounds. Afterward we found that a large boulder estimated to weigh about two tons had been moved near the bridge by the water.

It was with great relief that we saw the flood beginning to fall. Stopping to think about it, we realized that we were practically blue with cold; so we changed into borrowed clothing. Our Jack's Creek Community Center was the least affected, although people living a half-mile or more away on the river lost homes, other buildings, fences, and gardens. At Beech Fork the Helton Post Office, the bridge just below the school, and several homes between our Beech Fork and Lower Beech Fork churches were taken. The Mill Creek community experienced even higher water than Red Bird; good homes being washed away, and all three stores were severely damaged. The church was washed off its foundation and lodged between the mountain and the stone parsonage constructed last year [1946]. Almost every chicken on Mill Creek was lost, and fine apple orchards were uprooted and washed away. Just across from the parsonage two men were trapped in a home which appeared doomed, so they climbed into an apple tree.

Throughout the area as far as we know only one life was lost, that of a girl on Straight Creek."

Note: Dr. Schaeffer, mentioned above, lives in Berea. He was a medical doctor at the Red Bird Mission Hospital for a number of years. I believe he is well into his 90s. He still loves to talk about the Red Bird Area.

The heaviest precipitation during the 1947 flood was in the headwaters of the Red Bird River while the heaviest precipitation during the 1957 flood was in the headwaters of the Middle Fork of the Kentucky River (up to 12.5 inches), including Greasy Creek which was being heavily logged at that time. Since there were no reliable rain gages in the area at that time the USGS measured water in buckets and other containers to estimate rain fall. The 1957 flood damaged Stinnett Settlement High School so badly it was permanently closed.

In addition to the unusually heavy rain fall, a convergence of other events that diminished the spatial extent of forests cover and reduced forests health across the landscape may have contributed to the severity of flooding in the 1947 and 1957 floods:

1. By the mid-1930s more than 50% of the American chestnut trees in the Red Bird River Watershed had succumbed to the chestnut blight and by 1940 essentially all were dead. There is only limited data on the percentage of trees in the Red Bird River Watershed that were American chestnut but two samples taken in the area by Lucy Braun showed 13.8% and 26.7% of the canopy trees were American chestnut. The watershed was compromised as the vast root systems of these often large trees were for the most part eliminated. This would reduce the capacity of the forests to absorb and release some of the rainfall slowly. The cooling effect of the forests was also diminished by the loss of such a vast network of canopy. Even though there was considerable ecological redundancy and in time the chestnuts trees were replaced with other species it took decades for the forest to recover to anything close to it historical ecological function. With the loss of chestnut, mast hogs turned to other plants and did considerable damage to the herbaceous flora. Wildlife, people, and livestock had lost a major and dependable food supply and for local people a major source of income. This was a major disturbance event for the forests.

2. Logging began with the arrival of the first settlers who used trees to construct homes, build fences, and heat their homes. Native Americans and early settlers also cleared land for agriculture. Early settlers started cutting logs to sell to companies outside of the area in about 1870 and continued this practice until large out-of-state companies gained control of most of the land and timber. Starting in the late 1800s, large companies became interested in the area and started purchasing timber and land for logging. The most intensive and extensive logging occurred from 1899 to 1916.

3. Considerably more land was being cultivated and grazed in 1947 and 1957 than today. Up until 1950, domestic livestock was allowed to forage in the forest. The 1945 Census of Agriculture indicated that more than 16,000 hogs and pigs fed in the forests and pastures of Clay and Leslie counties. Additionally, there were 9,250 cattle and 4,050 mules and horses. The 1945 Census of Agriculture showed 128,589 acres of cropland compared to only 15,020 in 2007. The number of livestock units (excluding chickens, ducks, and geese) was 19,921 in 1945 and 3,632 in 2007.

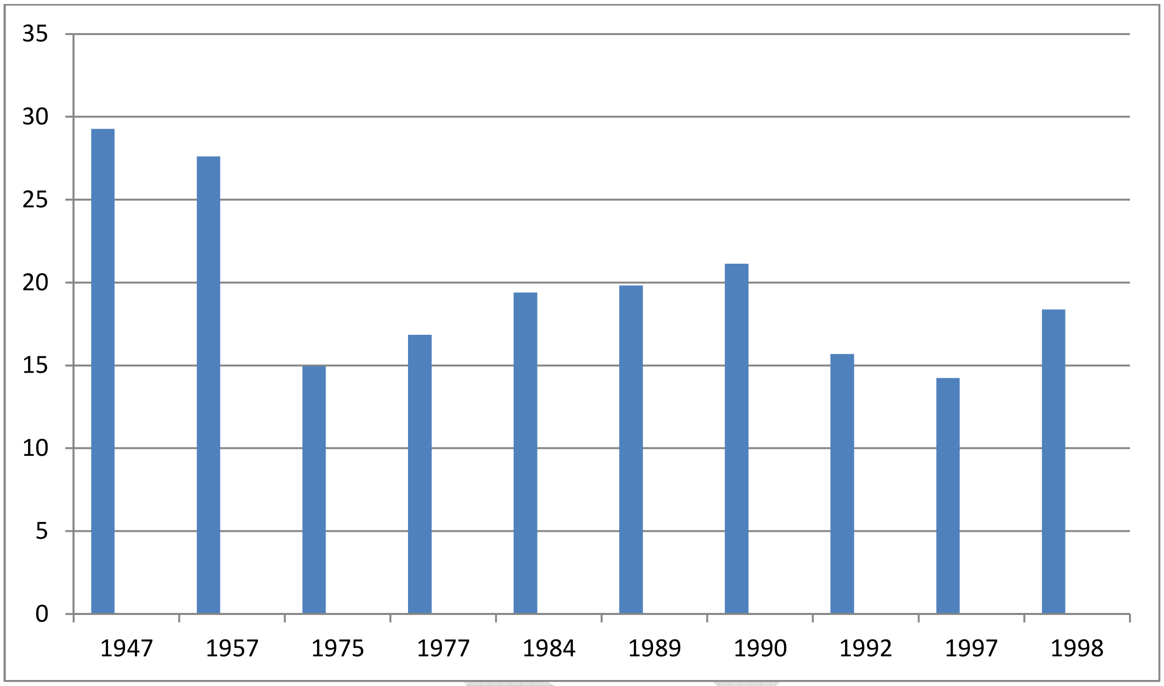
The upper Cumberland River experienced a major flood in 1977. Flooding in the Red Bird River Watershed in 1977 was minor. This was the flood that topped the flood wall in Pineville and flooded most of the town.

Following are tables and charts of highest gage heights recorded at USGS Gage 03281041 in Red Bird River just downstream from Big Creek, KY. Gage heights can help one envision the extent of flooding. Note: I believe that bankfull height is about 10 feet in most of the area near Big Creek. That is what I got by taking several points from Google Map Pro.

Gage Heights Recorded at USGS 03281040 near Big Creek, KY, 1947-2000

Calendar Year	Gage Height (feet)
1947	29.27
1957	27.60
1973, March 15	13.97
1973, November 28	13.73
1975, March 13	14.96
1976, March 29	11.85
1977, April 4	16.85
1978, January 26	13.99
1979, December 9	13.55
1980, March 21	9.77
1981, June 6	11.13
1982, January 4	10.95
1983, January 12	9.50
1984, May 7	19.40
1984, November 19	9.75
1985, November 28	11.49
1986, November 9	10.96
1988, January 20	8.84
1989, June 16	19.82
1989, October 17	21.14
1990, December 23	13.31
1991, December 2	15.68
1993, March 23	12.34
1994, February 11	13.35
1995, May 14	11.81
1996, March 6	8.22
1996, December 1	14.24
1998, April 17	18.38
1999, January 9	12.89
2000, April 4	10.28

Highest Gage Heights in feet at USGS Gage 03281040 near Big Creek, KY, 1947-2000



Red Bird River Watershed Plan

Appendix B: Mine Information

Active Mine information

Active Mines in the Red Bird River Watershed from Kentucky Division of Mine Reclamation and Enforcement SMIS

BELL COUNTY

1. Permit Number 8075210
Location:
Nearest Stream: Red Bird Creek
Nearest Intersection: KY 66/KY 2011
Nearest Community: Beverly

Permittee:
Chas Coal LLC
19485 South Highway 66
P.O. Box 98
Beverly, KY 40913 (606)596-0110
This mine has had a number of operators including: Century Operations LLC, Jadco Enterprises Inc., Redbird Company, Inc., Suburban Coal Operations LLC, 3M Energy Resources LLC

Mine type: Underground
Original Acres: 2,878.4000
Current Acres 4,676.1800
Coal Seam: Hazard #4

Post Mining land Use: Fish and wildlife 10.7800 acres
Forest Land 9.5200 acres

2. Permit Number 8070352
Chas Coal

Nearest Stream: Lawson Creek
Nearest intersection: KY 66 with KY 2011
Nearest Community: Beverly

Permittee:
Chas Coal LLC
22665 Highway 421

P.O. Box 952
Hyden, KY 41749
(606)672-4844

Representative; Clifford Berry, Jr.

Operators:
Mitco Enterprises, Inc.
Covol Fuels No 3 LLC
M&G Mining, LLC

Mine Types:
Surface Contour
Surface Auger

Original Acres: 556.1000
Current Acres: 556.1000

Coal Seams:
Hazard #7
Hazard #7R
Hazard #8

This mine includes an acid overburden and acid producing condition.
Post Mining land Use: Fish and Wildlife Habitat 151.9000 acres

CLAY COUNTY

3. Permit Number 0260141
Location:
Nearest Stream: Spring Creek
Nearest intersection: 2000 Jct & Sand Hill Rd
Nearest community: Brightshade

Permittee:
Shamrock Coal Company Incorporated
1374 Highway 192 East
London, KY 40741
(606)878-7411
Representative Name: Smith Orville

Mine type: Combination
Original Ares: 42.7500
Current Acres: 42.7500

Coal Seam: Haddix

Post mining land use: Forest Land

4. Permit Number 8260572
Jessie Bowling #1

Nearest stream: Red Bird River
Nearest intersection: KY 66/Bar Creek RD Intersection
Nearest community: Flatwoods

Permittee:
Jess Bowling
2525 Harrodsburg RD, STE 23
C/O William Duncan Bishop
Lexington, KY 40504
(859)223-7959

Operators:
J&L Drilling Inc.
Ikerd Mining, LLC

Mine Types
Surface Contour
Surface Auger
Surface Area

Original Acres: 129.4000
Current Acres: 132.7000
Coal Seams:
Hazard #4
Hazard #5A

Post mining land use: Hay or Pasture Land 107.0000 acres

5. Permit Number 8265058
Location:

KY Rt. 66/KY 1524
Nearest Stream: Laurel Fork
Nearest intersection: KY RT 66/1524
Nearest community: Beverly

Note: some data for this mine show it in Upper Cumberland Watershed and other show it in Upper Red Bird River.

Permittee:
Chas Coal LLC
19485 South HWY 66
P.O. Box 98
Beverly, KY 40913
(606)599-0506; (606)596-0110

Operators: large list including: 3M energy Resources LLC, Xinergy Corp, and Suburban Coal Operations

Mine Type: Underground
Original Acres: 382.9000
Current Acres: 522.4100

Coal Seams:
Hazard #8
Hazard # 8A

Post mining land use: Fish and Wildlife Habitat 48.7100 Aces

6. Permit Number 8260629
Flatwoods Mine
Location:
Nearest Stream: Mill Branch
Nearest intersection: KY 66/Bar Creek RD intersection
Nearest Community: Spurlock

Permittee:
Ikerd Mining LLC
719 Crane RD
Somerset, KY 42501
(606)678-5878

Mine Type:
Surface Contour

Surface Auger
Surface Area

Original Acres: 129.4000
Current Acres: 295.0700

Coal Seams:
Hazard #4
Hazard #5A

Post mining land use: Fish and Wildlife Habitat 116.5300 acres
Hay or Pasture Land 152.8400 acres

7. Permit Number 8260612
Location:
Nearest stream: Lick Fork
Nearest intersection: Rt. 66/1524
Nearest community: Gardner

Permittee:
Chas Coal LLC
19485 South HWY 66
P.O. Box 98
Beverly, KY 40913
(606)599-0506; (606)596-0110

Operators:
3M Energy Resources LLC,
Xinergy Corp LLC,
Chas Coal LLC

Mine type:
Surface Area
Surface Contour
Surface Auger

Original Acres: 790.0000
Current Acres: 1,013.8900

Post mining land use: Fish and Wildlife Habitat 473.5300 acres

8. Permit Number 8260651

Flatwoods
Nearest Stream: Dry Branch
Nearest intersection: KY 66 and Dry Branch Road
Nearest Community: Flatwoods

Permittee:
Ikerd Mining, LLC

625 Memorial Drive
P.O. Box 1056
Hazard, KY 41702
(606)439-1446; (606)439-1456

Mine Types:
Surface Area
Surface Contour

Original Acres: 286.3000
Current Acres: 398.2300

Coal Seams: Hazard 5A

Post mining land use: Fish and Wildlife Habitat 394.9300 acres
Recreation 3.3000 acres.

LESLIE COUNTY

9. Permit Number 8665087
Hazard IV Energy

Locaton:
Nearest Stream: Bear Branch
Nearest intersection: US 421 Jct with KY 66
Nearest Community: Big Creek

Permittee:
Hazard IV Energy Inc.
5812 South Highway 25,
Corbin, KY 40701
Representative name: Lorene Spurlock

Mine type: Underground
Original Acres: 48.7000
Current acres: 50.6000
Coal Seam: Fireclay

Post mining land use: Fish and Wildlife Habitat 12.6000 acres

10. Permit Number 8665139
Nearest Stream: Rocky Point Branch
Nearest intersection: 1850 & KY HWY 1780
Nearest Community: Warbranch

Permittee:
Chas Coal LLC
19485 South HWY 66
P.O. Box 98
Beverly, KY 40913
(606)599-0506; (606)596-0110

Operators:
3M Energy Resources LLC
Xinergy Corp.

Mine Types:
Underground
Surface Remining
Surface Auger

Original Acres: 1,112.2000
Current Acres: 588.8000

Post mining land use: Fish and Wildlife Habitat 17.2000 acres

Red Bird River Watershed Plan

Appendix C: Wastewater Treatment Funding Options

From: Carigan, Deven (EEC) [mailto:Deven.Carigan@ky.gov]
Sent: Tuesday, January 14, 2014 3:42 PM
To: Walker, Jon -FS
Cc: Shireman, Brooke (EEC)
Subject: Campton WWTP options

Hi, Jon. Here are the funding options available to WWTPs.

1.**SRF** (State Revolving Fund, for investments in water infrastructure). This is a loan, currently the city would qualify for at 0.75% interest rate based on MHI (median household income). The term is for 20 years, but can go up to 30 years.

You have said that the mayor said that the system can't get this loan because they cannot repay it. Anshu says that Campton has 2 loans already, 1 for wastewater and 1 for drinking water. The clean water SRF requires 10% of the funds to give in the form of principle forgiveness. The city might be able to get some principle forgiveness so the system might want to look into. They must be at or below the MHI of $33,261, and Campton's MHI is somewhere around $19k. http://www.gwadd.org/Sept_24_2012_WMC/2%20CWSRF%20Fact%20Sheet.pdf this link is from Fall 2012, so there might be updates.

2.**ARC** (Appalachian Regional Commission). They can give out a max of $500k. We would have to work with them. Someone from Campton would have to set a meeting and involve several entities interested in improving the watershed, the drinking water situation, or the wastewater situation. The goal would be to try to get as much grant money as possible to improve the lines at the WWTP. The plant itself seems to be fine, the lines are where the issues are.

3.**CBDG** (Community Block Development Grant). Implemented by DLG (Department for Local Government). Campton would qualify because it's a low income area, but these grants are pretty hard to get as the money is getting low.

The 1st option is implemented by KIA (KY Infrastructure Authority), and ARC & CBDG grants are implemented by groups that their office at KIA's offices.

4.**Rural Development**, implemented by USDA. This is a 70/30 – 70% of the money is a loan, and interest rates vary, and 30% of the money is a grant. I don't have info on the max amount.

First steps:

Any of this work will need to come from the mayor, and you will need to go through the ADD (Area Development District). Wolfe Co is in the Kentucky River ADD (KRADD). http://www.kradd.org/ Anshu Singh, with the DOW's Water Infrastructure Branch, said the contact in this ADD would be Jennifer McIntosh, and Anshu would also be glad to help with questions in these processes.

Campton will need to have an estimate of the money needed to perform the upgrade work necessary. Anshu suspected it would be in the area of $500k, going on the thought that the system didn't have more than 6-7 miles of line. She said installing liners should be an option in some parts, while replacement would be necessary in others, depending on the condition of the lines.

Some selling points that could be helpful to Campton receiving some grant money are that the drinking water system derives its water from both a reservoir and a well, and the well has been designated as a GUDI well, which is Groundwater Under the Direct Influence of surface water. The argument there is that any improvement made to surface water in this area will reduce contaminants that must be removed before the water is suitable for drinking. Having fewer contaminants to address helps keep the water facility equipment in good shape, requiring less maintenance. That seems like a good argument since Campton water has a high tech membrane system for its drinking water. I would also imagine the citizens would greatly appreciate a mayor who was instrumental in the watershed having fewer fecal bacteria in their recreational and drinking water. Additionally, if we are doing nonpoint source work in the watershed, and that is coupled with point source improvement, there is possibility for delisting the impaired stream. All of these outcomes would be very desirable in this major recreational water.

Additional info:

*I found out a bit more about the SSES (Sanitary Sewer Evaluation Study). This is a study that the WWTP would do or have done, where they would do a smoke test and/or run a camera through the lines to identify leaks and other weaknesses in the lines. Campton would use the information to assess the system, to be able to determine if the lines need to be replaced or if they can be rehabilitated using a liner. It is not necessary that they already have the SSES to apply for money; the project should be SSES followed by rehabilitation or replacement of the lines.

*Below are links for information regarding Kentucky Operator Certification requirements and trainings can be found here http://dca.ky.gov/certification/Pages/CertifiedOperator.aspx . This could be useful for the operators of both the drinking water and the wastewater treatment facilities. I have also included some links provided by Chad VonGruenigen, who recently came (back) to us from DCA (Division of Compliance Assistance).

Deven Carigan, Technical Advisor

Nonpoint Source and Basin Team Section

Watershed Management Branch

KY Division of Water

502-564-3410 x4950

fax: 502-564-9899

From: Von Gruenigen, Chad (EEC)
Sent: Friday, January 10, 2014 12:22 PM
To: Carigan, Deven (EEC)
Cc: Shireman, Brooke (EEC)
Subject: Operator Training Info

Hello,
Below is a link to Kentucky's Operator Certification Program 2014 Training Schedule.
http://dca.ky.gov/certification/Training%20Schedule/currenttrainsched.pdf

List of alternative training providers
http://dca.ky.gov/certification/Documents/AlternativeTrainingProvidersRev070113.pdf

You may also look up operator training information at the link below.
http://dep.gateway.ky.gov/eSearch/Search_License.aspx

These are two common associations that offer training:

KWWOA training events unfortunately the agendas may not have been approved as of yet.
http://www.kwwoa.org/training-registration

KRWA training events unfortunately the agendas may not have been approved as of yet.
http://www.krwa.org/training/

Thank you,

Chad Von Gruenigen
Basin Coordinator
KY Division of Water
200 Fair Oaks Lane, 4th Floor
Frankfort, Ky
(502) 564-3410 ext. 4941
chad.vongruenigen@ky.gov

Red Bird River Watershed Plan

Appendix D: Benchmark Recommendations for Nutrient Parameters

Red Bird River Watershed Plan
Benchmark Recommendations for Nutrient Parameters
Kentucky Division of Water
2/27/2013

Nutrient benchmark recommendations given here represent the best information available to the Kentucky Division of Water (KDOW) at this time. The goal is to provide estimates of typical in-stream concentrations below which it is unlikely that nutrients would be a cause of aquatic life impairments. As such, benchmarks are useful in identifying sub-basins with potential nutrient issues when setting priorities for further monitoring or for developing strategies for load reductions. In making these recommendations we considered regional and watershed-specific nutrient expectations, regional-scale patterns in biological effects, and relevant published literature. These benchmarks may be different than targets to be used ultimately as management endpoints; watershed-specific characteristics, practical considerations, and insight gained from early phase monitoring might suggest alternate values for that purpose. The Watershed Group may wish to discuss with KDOW alternative benchmarks and/or targets based on more detailed local information or consultation with experts familiar with the watershed. Also, these benchmarks should be reviewed as more information becomes available on conditions in the watershed, including any specific nutrient-related issues that may be observed in the course of monitoring.

Benchmark Screening Numbers and Summary

The project area contains segments designated as Outstanding State Resource Water, including several streams in Kentucky's wadeable streams Reference Reach network. The lower Red Bird River is an Outstanding State Resource Water that was designated based on its importance as a sport fishery, and the watershed as a whole is home to the Kentucky arrow darter, *Etheostoma spilotum*, a candidate for federal listing as an endangered species. Because of the importance in maintaining water quality to protect these uses, we have provided conservative benchmarks for data screening. A summary of candidate benchmarks follows the final set of recommendations, in order to provide supplemental information in interpreting nutrient data.

Total P mg/L	<0.02
TKN mg/L	<0.50
Nitrate+Nitrite-N mg/L	0.16
Total N mg/L	0.60

Candidate benchmarks description and summary

Ecoregional Reference Reach candidate benchmarks:

The Reference Reach network of streams represents the least-impacted conditions for aquatic life in wadeable streams in the respective ecoregions. The project area sub-watersheds lie within the

Dissected Appalachian Plateau (ecoregion 69d) of the Central Appalachians. KDOW's Reference Reach grab sample data for this ecoregion are summarized below.

	Eco-region	Number Samples	MIN	MED	75th percentile	90th percentile	MAX
TP(mg/L)	69d	19	<0.010	<0.020	<0.020	<0.020	0.037
NN-N(mg/L)	69d	23	<0.020	0.051	0.157	0.307	0.354
TKN(mg/L)	69d	22	<0.200	<0.200	<0.500	<0.500	<0.500
TN(mg/L)	69d	22	0.010-0.220	0.063-0.263	0.223-0.526	0.495-0.795	0.520-0.820

Watershed reference candidate benchmarks:

The regional reference streams reflect expectations for streams in the region as a whole. However, if there are segments within the project area (or within closely comparable watersheds) where aquatic life use and special uses are known to be fully supported, then nutrient data from those streams can produce a more specific "watershed reference", provided there is sufficient data to adequately characterize the conditions. KDOW's Ambient Water Quality Network has a station on the Red Bird River, PRI091. Aquatic life use has been assessed as fully supporting in this section, but this has based primarily on physiochemical parameters and not directly on biological community or fishery health. Still, nutrient data from this station show generally low nutrient concentrations, similar to regional reference streams.

Red Bird River, PRI091

	Number Samples	MIN	MED	75th percentile	MAX
TP(mg/L)	82	<0.010	<0.020	<0.020	0.408
NN-N(mg/L)	82	<0.010	0.114	0.177	0.516
TKN(mg/L)	78	<0.200	<0.200	<0.500	2.120

Effects-based (empirical) candidate benchmarks:

The sub-watersheds fall in the Mountains Bioregion. The benchmarks from a KDOW draft bioregional nutrient thresholds report are TP 0.025 mg/L, TN 0.650 mg/L. These numbers are Bioregion-wide estimates of biologically relevant thresholds that that may represent increased risk of nutrient impairment of aquatic life use in wadeable streams.

Literature-based candidate benchmarks

Literature guidelines for the boundary between oligotrophic and mesotrophic conditions are TP 0.025 mg/L and TN 0.700 mg/L. The boundary between mesotrophic and eutrophic conditions are given as TP 0.075 mg/L and 1.5 mg/L. Reference Reaches and watershed reference data summarized above suggest that minimally impacted streams in Ecoregion 69d are naturally oligotrophic. Maintaining an oligotrophic condition may be important in protecting native aquatic species and communities. Additionally, the oligotrophic boundary for phosphorus has been shown in numerous studies to be near a threshold for increased risk of nuisance benthic algae.

Red Bird River Watershed Plan

Appendix E: Benchmark Recommendations for Non-Nutrient Parameters

Red Bird River Watershed Plan
Benchmark Recommendations for Non-Nutrient Parameters
Kentucky Division of Water
2/27/13

Please consult water quality standards for parameters that have a numeric standard (e.g., pH, dissolved oxygen, unionized ammonia). For parameters with no numeric standard, consult the benchmark screening numbers described below. The numbers are intended as estimates of typical in-stream values in the region for streams with relatively low levels of impacts. Values above these benchmarks (above or below, in the case of alkalinity) are not necessarily cause for concern, but a pattern of higher numbers (higher or lower for alkalinity) may help to identify potential stressors to aquatic life or unusual conditions in the watershed.

It is important to note that benchmarks for data screening and prioritization presented here do not necessarily represent targets for water quality. If targets for reduction are to be developed for any of these parameters then those will need to be developed with consideration of the extent and magnitude of problems, achievability, and special goals for the project.

The project area contains segments designated as Outstanding State Resource Water, including several streams in Kentucky's wadeable streams Reference Reach network. The lower Red Bird River is an Outstanding State Resource Water that was designated based on its importance as a sport fishery, and the watershed as a whole is home to the Kentucky arrow darter, *Etheostoma spilotum*, a candidate for federal listing as an endangered species. In consideration of these special uses, screening benchmarks and targets, including those based on water quality standards, should be reviewed by experts familiar with the specific water quality requirements of any species or communities of concern.

In addition to the final recommendations, a full ecoregion summary follows to help in interpretation of monitoring results.

Benchmark Screening Numbers

Ammonia-N (mg/L)	<0.050
Sulfate (mg/L)	19.5
Specific Conductance (µS/cm)	119
Alkalinity (mg/L as $CaCO_3$)	12-54

Since TSS and Turbidity may be potentially important parameters in this project, benchmarks for these parameters should be developed in close consultation with project experts and the DOW technical advisor. Limited data are available for Reference Reach streams for TSS and Turbidity, and these samples are mainly from biology sampling visits which are conducted only during stable flow conditions during March-September. New monitoring data collected for the watershed plan and a review of relevant literature will be important in developing screening benchmarks and reduction targets for sediment-related measures in this project.

Ecoregional Reference summary

Reference Reach sample data for the Dissected Appalachian Plateau (ecoregion 69d) of the Central Appalachians are summarized below. Benchmarks were chosen based on the 75th percentile of Reference Reaches, with the exception of Alkalinity, which was given as the range between 25th and 75th percentiles.

	Eco-region	Number samples	MIN	**25th Percentile**	MED	**75th Percentile**	90th Percentile	MAX
Ammonia-N (mg/L)	69d	23	<0.025	<0.050	<0.050	<0.050	0.084	0.250
Unionized Ammonia (mg/L)	69d	7	<0.001	<0.001	<0.001	0.001	0.005	0.011
Sulfate (mg/L)	69d	20	<4.0	8.5	14.7	19.5	28.5	181.0
Specific Conductance (µS/cm)	69d	53	23	50	79	119	161	888
Alkalinity (mg/L as $CaCO_3$)	69d	15	7.9	11.7	29.2	54.1	84.0	103.0
TSS (mg/L)	69d	20	0.5	1.8	3.0	5.0	6.1	17.5
Turbidity (NTU)	69d	9	0.8	3.0	4.0	5.1	8.2	10.4

Red Bird River Watershed Plan

Appendix F: E-mail Regarding Benchmark Recommendations

Cotton, Claudia A -FS

m:	Shireman, Brooke (EEC) <Brooke.Shireman@ky.gov>
nt:	Monday, March 25, 2013 8:32 AM
To:	Cotton, Claudia A -FS
Subject:	RE: Benchmarks needed for the RBR

Use chronic values

Hi Claudia,

You can use the 240 cpu standard for E.coli. E.coli doesn't have much effect on aquatic life but it is a concern for public safety, which is important in this watershed.

In the past we have not provided benchmarks for parameters outside of those listed in the guidebook. Many of our projects that have collected additional parameters have developed their own benchmarks based on literature values or expertise in their group.

I asked Lara to provide some sources. She put together the following which includes the ranges found in some of our reference reaches. In addition to her information below, she suggested looking at minimally impacted sites that you know of in the watershed and compare those results with the others. I suggest discussing Lara's information with the others (Water Quality committee?) to determine what you think is best for Red Bird. Just make sure you include your reasoning for your choices in the narrative of the plan. This will be helpful for review and future success monitoring.

hanks,
ooke

Lara's Information

One source to look at for parameters without Kentucky WQS is EPA's National Recommended Criteria.
http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm

Keep in mind that if Kentucky has not adopted these criteria then there is a reason for that. Still, there is a lot of information referenced on this page that might help with gaining a better understanding of the parameters of concern.

You will see Aluminum here. It is important to note that most states (including us) have not adopted the recommendations for Aluminum. It is my understanding that this is due to questions about validity of the numbers and of using total recoverable rather than dissolved fractions. That being said, the EPA acute number of 750 µg/L (0.750 mg/L) could be used to screen the data to see if any sites come close. That number is intended for sites where pH is 6.5-9. If pH is lower and hardness is low (<10 mg/L?) then it is my understanding that Al toxicity increases greatly, so if that is the case then we would probably want to talk further about it. In our Reference Reach data from samples in the mountains (through 2011), 3 of 29 samples were above 0.750 mg/L, so it might be that occasionally high concentrations are expected.

The National Recommended Criteria page lists Hardness and gives no numbers, but gives a link to a narrative statement. A reading of that section might be helpful. Basically, hardness matters most with respect to how worried you are about toxicity of metals. Our data from Reference Reach samples in the mountains (155 samples, through 2011) nged from 2.0 to 271, with most samples around 30-80 mg/L.

You will not see Calcium, Magnesium, or Manganese on EPA's list. Here is a summary of the range in mountains Reference Reaches for these parameters, based on 30 samples through 2011:
Calcium 0.996-54.3 mg/L

Magnesium 0.66- 6.05 mg/L
Manganese 0.002-0.149

ould even hesitate to say that these ranges are a good estimate of what is "typical" or "background", since there are few samples for reference reaches. And again, if there are no recommended criteria then EPA has deemed that to protect aquatic life **in general** there was not a need for criteria. That being said, if there was a particular concern with a species or sensitive group (like the KY arrow darter or mussels) then someone familiar with toxicity to those groups should be consulted on additional screening numbers.

From: Cotton, Claudia A -FS [mailto:ccotton@fs.fed.us]
Sent: Thursday, March 21, 2013 4:15 PM
To: Shireman, Brooke (EEC)
Subject: Benchmarks needed for the RBR

Hi Brooke,

I need benchmarks for the RBR for the following parameters:

Total Al
Total Ca
Hardness (as CaC03)
Total Mg
Total Mn

E. coli okay with a 240 cpu standard? That is for primary contact recreation water and not aquatic habitat. There appears to be no KY E. coli standard for WAH.

As soon as I can get these I can finish Chapter 4.

Thanks,
Claudia