



Source: SD1

Gunpowder Creek Watershed Characterization Report

Prepared for: Sanitation District No. 1 of Northern Kentucky



January 2009

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1. WATERSHED SUMMARY

Watershed characterization reports are being developed for sixteen watersheds located in Northern Kentucky that lie within Sanitation District No. 1's (SD1) service area. The purpose of the watershed characterization reports is to describe the physical and natural features, land cover, infrastructure, waterbody conditions, potential pollutant sources and other features in each watershed. This information will allow SD1 and other interested parties to develop an understanding of important features, pollutant sources and water quality in the watersheds. This information will also assist SD1 and others in goal-setting, prioritization of improvement projects, and assessment of effectiveness of these projects. The watershed characterization reports meet the system characterization element for the receiving water that is required for a combined sewer overflow (CSO) Long-Term Control Plan (LTCP). Additionally, the Consent Decree requires that the Watershed Plans include elements of a LTCP.

The Gunpowder Creek watershed is 58.2 mi² in size and is located within Boone County in the West Study Basin. This creek originates west of the Cincinnati/Northern Kentucky International Airport, and in the past, has been impacted by deicing fluids in airport runoff. Gunpowder Creek flows southwest to the Ohio River (Figure 1) and has two larger tributaries. The headwaters of this watershed are fairly developed, and more rural areas are found farther downstream.

Gunpowder Creek and its tributaries are designated for warm water aquatic habitat, primary contact recreation, secondary contact recreation and domestic water supply (at applicable points of withdrawal). Three segments of the Gunpowder Creek mainstem and one tributary appear on the 303(d) list of impaired waterbodies (KDOW, 2008). The Kentucky Division of Water plans to complete TMDLs for these segments by 2012.

Water quality data have been collected in the Gunpowder Creek watershed since 1985. A comparison of recent water quality data to applicable water quality criteria revealed pH violations and exceedances of the bacteria criteria. Violations of dissolved oxygen, temperature and pH have been historically observed at the USGS continuous monitoring station between 2001 and 2005, but more recent data from this location are still being reviewed and are not included in this assessment.

The most recent fish data reflect fair to excellent conditions in Gunpowder and South Fork Gunpowder Creeks, respectively; however macroinvertebrate samples indicate very poor conditions in an unnamed tributary draining the airport.

The most recent aquatic habitat assessments reflect fully supporting conditions on South Fork Gunpowder Creek. Habitat assessments conducted on the Gunpowder Creek mainstem reflect partially supporting to supporting but threatened conditions.

Potential pollutant sources in the watershed include SD1 and Florence sanitary sewer overflows (SSOs), KPDES permitted dischargers, septic systems and overland storm water runoff. The potential for these sources to generate fecal coliform bacteria has been assessed using a Watershed Assessment Tool (WAT!)¹. The WAT! identifies the

¹ The WAT! is still under development. All results presented here are for illustrative purposes only. The results are subject to change and should therefore not be relied on or considered definitive.

possible sources within a watershed and estimates their potential impact. It also allows SD1 to compare and rank the 16 different Northern Kentucky watersheds.

The WAT! calculated a low fecal coliform loading potential for year-round conditions for the Gunpowder Creek watershed, with overland runoff being the dominant source. The WAT! calculated a high fecal coliform loading potential for base flow conditions, with septic systems being the dominant source.

The WAT! ranking is one of several factors that should be considered when prioritizing watersheds for improvement projects. Other factors include high public interest due to past impacts from the airport, the presence of drinking water supply features, and the absence of any threatened or endangered species and any special designations for the creek or its tributaries.

Much data collection is planned or ongoing in this watershed and no additional biological, habitat or chemical monitoring is recommended for this watershed.

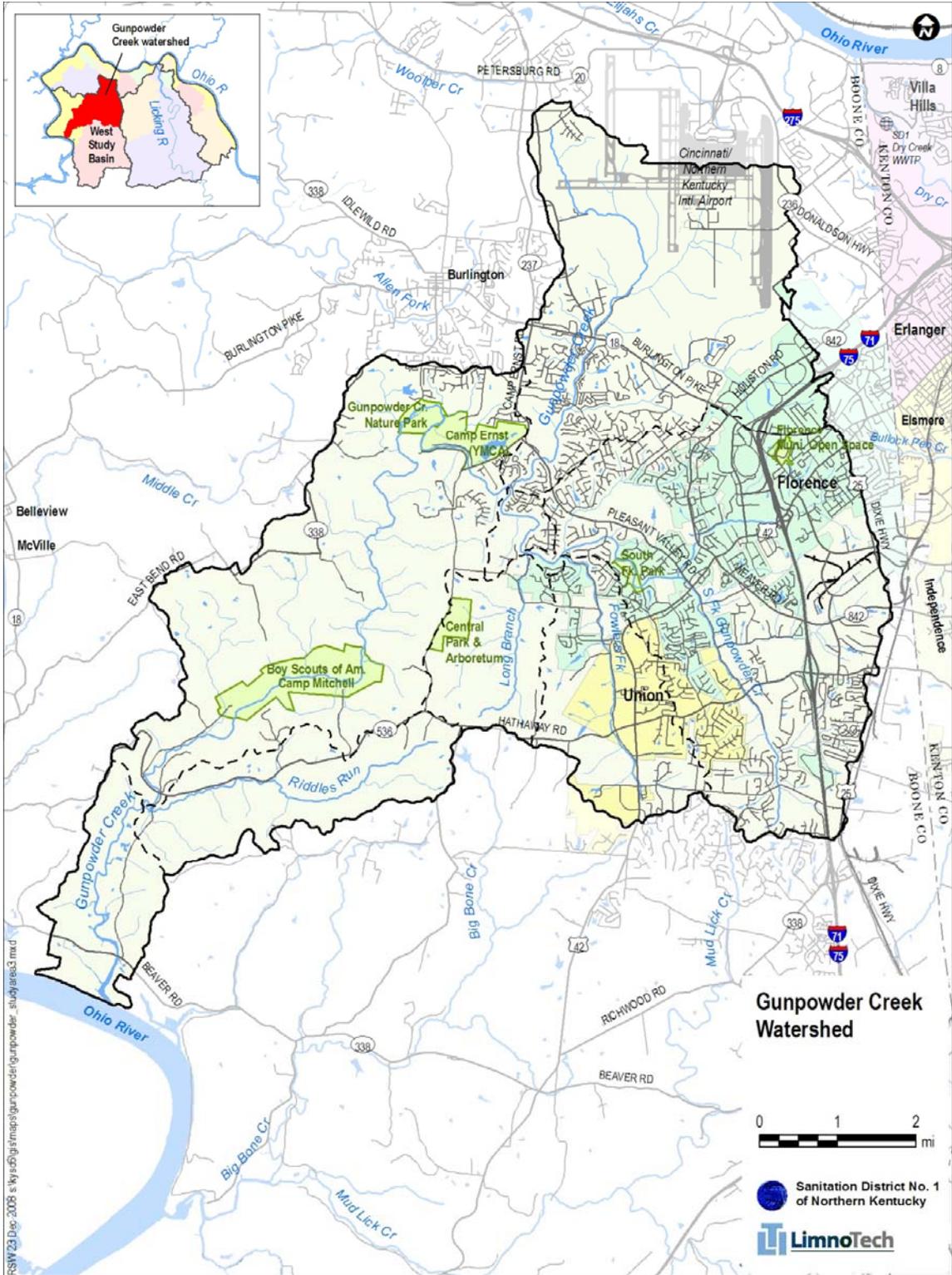


Figure 1. Gunpowder Creek Watershed

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2. WATERSHED FEATURES

Gunpowder Creek originates in eastern Boone County, with its headwaters located west of the Cincinnati/Northern Kentucky International Airport. The creek flows southwest and is joined by several tributaries before it empties into the Ohio River. The watershed for this creek is 58.2 square miles in size.

2.1 PHYSICAL AND NATURAL FEATURES

The following sections describe key features of the watershed and creek, including hydrology, geology, topography, soils, climate, and habitat. These features are important because they affect land uses, and shape the chemical, biological, and hydrological characteristics of Gunpowder Creek.

2.1.1 Hydrology

The Gunpowder Creek mainstem is 21.9 miles long and has two major tributaries. The larger of the two, the South Fork of Gunpowder Creek, drains much of the city of Florence, and itself has several significant tributaries (i.e., Fowlers Fork and Long Branch). The other tributary, Riddles Run, drains much of the southerly portion of the watershed.

One active USGS continuous monitoring station (03277075) is located on Gunpowder Creek at Camp Ernst Road. The watershed area draining to the station is 36.8 square miles², comprising approximately 63% of the Gunpowder Creek watershed. Daily discharge measurements are available at the station from April 1999 to the present³. The average flow at the station is 53 cfs, with 95% of flows less than 240 cfs. Base flows at this location have been measured at less than 2 cfs, with flows increasing by up to three orders of magnitude during a storm event. The maximum flow recorded at the USGS station is 2,140 cfs. The periods of high flow tend to be very brief and only last one to two days. In contrast, during extended periods of dry weather, flows at the station become intermittent. Between April 1999 and September 2007 there were 63 days with zero flow.

The 100-year floodplain extends almost the entire length of Gunpowder Creek and South Fork Gunpowder Creek. The Gunpowder Creek floodplain is widest, roughly 0.5 miles, between the confluence of Riddles Run and the mouth of Gunpowder Creek.

Flooding has occurred in the watershed since the early 1990s. More recently, the smaller tributaries in this watershed have been affected by flooding. Portions of the upper Gunpowder Creek watershed frequently experience flooding, though the most extensive flood zone area identified in the Boone County Comprehensive Plan is the lower East Bend Bottom, at the mouth of Gunpowder Creek (BCPC, 2005).

² This drainage area was calculated using a detailed watershed delineation developed for this project; the reported drainage area differs slightly from that reported by the USGS.

³ This analysis only uses approved data from USGS, and at the time of the analysis data was approved through 9/30/2007.

2.1.2 Geology

The Gunpowder Creek watershed is located within the Outer Bluegrass Physiographic⁴ Region, which is underlain primarily by Ordovician-age interbedded limestone and shale (Ray et al., 1994). Although most of this watershed is underlain by bedrock with a moderate potential for karst development (Paylor and Currens, 2002), rocks in this region generally contain higher percentages of shale layers and do not develop extensive karst features (Ray et al., 1994)⁵.

The mainstem of this creek cuts through the erodible shale found in the Kope formation. The rolling upland areas are underlain by the Grant Lake Limestone/Fairview and Bull Fork formations, which produce broad stream valleys. Groundwater yield varies depending on geological formation. Except near the headwaters, groundwater is generally unavailable on ridgetops. Wells in the valley bottoms can yield 100-500 gallons per day. This water is hard and may contain salt and hydrogen sulfide (Carey and Stickney, 2004).

2.1.3 Topography

The Gunpowder Creek watershed has higher relief in the east, with upland areas dissected by headwater streams. The highest elevations (965 ft) in this watershed are along a ridge that marks the eastern edge of the watershed. U.S. Highway 25 (Dixie Highway) was built along this ridge. The highest ground is at the intersection of Mt. Zion Road (Kentucky 536) and U.S. 25, between Florence and Independence. The lowest elevation in the watershed (453.6 feet at normal Ohio River pool) is located at the confluence of Gunpowder Creek with the Ohio River.

2.1.4 Soils

The nature of soils and topography in a watershed plays an important role in both the amount of runoff generated and the amount of soil erosion that can occur. Most (82%) of the soils in the Gunpowder Creek watershed are classified as hydrologic soil group C (NRCS, 2006), meaning they have slow infiltration rates when thoroughly wetted. Another 11% of the soils are classified as hydrologic soil group D meaning water movement through the soil is restricted or very restricted. Soils in this group have a high runoff potential when thoroughly wet.

Most (83%) of the soils in the watershed are ranked “highly erodible”, and 14% are ranked “fairly erodible” as indicated by an index for erodibility (NRCS, 2006). The erodibility of soils is important when soils are disturbed through activities such as land clearing for new development. Portions of this watershed are anticipated to undergo significant development in the future (Section 2.2), especially within the South Fork Gunpowder Creek subwatershed.

⁴ Physiographic regions are based on differences in geology, topography and hydrologic regime. The State of Kentucky is divided into five physiographic regions.

⁵ In areas with karst, an almost immediate connection between groundwater and surface water can exist, short-circuiting any attenuation of pollutant loads that might otherwise occur.

2.1.5 Climate

The temperatures in this area are generally lowest in January and highest in July. Precipitation averages 41.2 inches annually, with the wettest months observed between March and July. Minimum precipitation is recorded in the fall and late winter as shown in Figure 2 (NCDC, 2008).

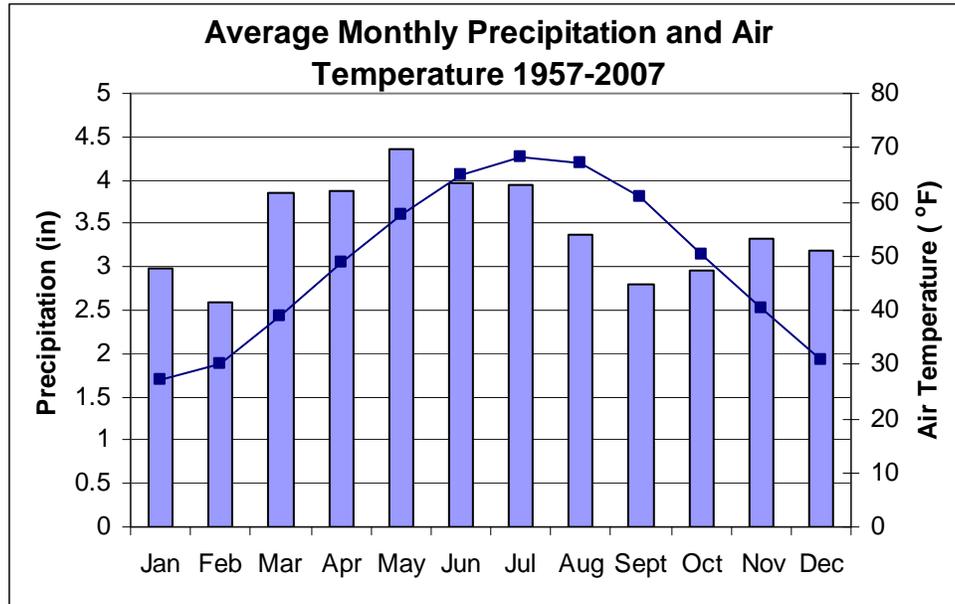


Figure 2. Average Monthly Precipitation and Air Temperature at the Cincinnati Northern Kentucky Airport (1957-2007)

2.1.6 Habitat

The Gunpowder Creek watershed lies within the Outer Bluegrass ecoregion⁶, which is characterized by sinkholes, springs, entrenched rivers and intermittent and perennial streams (Woods et al. 2002). Wetlands are not common in this ecoregion or this watershed. Streams typically have relatively high levels of suspended sediment and nutrients. Glacial outwash, which tends to be highly erodible, exists in a few areas within this ecoregion.

Pre-settlement conditions in this ecoregion consisted of open woodlands with barren openings, and vegetation was mostly oak-hickory, with some white oak, maple-oak-ash and American beech-sugar maple forests (Woods et al. 2002).

The Kentucky State Nature Preserves Commission (KSNPC) monitors the occurrence of exemplary ecological communities, which are relatively undisturbed or have recovered sufficiently from previous disturbances and have the flora and fauna that is believed to represent the ecological communities that existed in Kentucky at the time of European colonization. KSNPC identified calcareous sub-xeric forest and riparian forest as being

⁶ Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources (Woods et al., 2002).

present in this watershed; these communities are rare examples of intact communities of this type in Kentucky (KSNPC, 2007).

Aquatic habitats in the Gunpowder Creek watershed have been altered from their historical state by agricultural, urban and suburban developments (Section 2.2.1).

In 2007, portions of Gunpowder Creek were observed to have cobble substrate, variable aquatic habitat types (pools, riffles and runs) and clear water during low flows (Figure 3 and 4). Figure 3 also shows stream widening.

Habitat assessments⁷ have been conducted at five sites in the watershed (Table 1). Rankings ranged from “partially supporting” indicating that available habitat can only partially support a diverse and productive ecosystem, to “fully supporting”.



Figure 3. Unnamed Tributary to Gunpowder Creek at RM 17.1

⁷ This assessment was conducted using EPA-established protocols. KDOW rated several components of physical habitat within the stream such as epifaunal substrate, embeddedness, sediment deposition, channel flow status, bank stability and riparian vegetation zone width, among others.



Source: LimnoTech

Figure 4. Gunpowder Creek at Limaburg Road, RM 17.9

Table 1. Aquatic Habitat and Biological Sampling

Stream	River Mile	Monitoring ^a					
		Habitat		Macroinvertebrates		Fish	
		Year(s)	Ranking	Year(s)	Ranking	Year(s)	Result
Gunpowder Ck.	14.1					1977	Poor
Gunpowder Ck.	15.1			1999	Fair		
Gunpowder Ck.	16.1	1999, 2004	Partially supporting; Supporting, but threatened			1999, 2004	Fair
Gunpowder Ck.	18.9	2004	Partially supporting				
Gunpowder Ck.	19.5			1995	Poor		
S. Fork Gunpowder Ck.	1					1977	Very Poor
S. Fork Gunpowder Ck.	1.9	1999, 2004	Partially supporting; Fully supporting			1999, 2004	Poor; Excellent
S. Fork Gunpowder Ck.	4.3	1999	Partially supporting			1977	Poor
Unnamed trib to Gunpowder Ck. at RM 19.4	0.1			1995	Very poor		
Unnamed trib to Gunpowder Ck. at RM 18.9	0.1	2004	Partially supporting	1995, 2004	Very poor		

^aWhen sampled more than once and rankings vary, both rankings are listed

2.2 LAND COVER CHARACTERISTICS

Land cover and land use play an important role in the quantity and quality of runoff into receiving waters. Current and future land cover in the Gunpowder Creek watershed are described below.

2.2.1 Current Land Cover

The Kentucky Division of Geographic Information, Commonwealth Office of Technology provided a GIS dataset showing 2005 Kentucky land cover. This dataset was updated and improved to approximate 2007 land cover conditions (Figure 5) using a variety of other datasets that represent current impervious conditions (roads, parking lots, buildings), open space lands (including parks), and surface waters.

Development in the watershed is concentrated near the headwaters of Gunpowder Creek and in eastern portion of the South Fork Gunpowder Creek watershed. These more heavily developed areas include the Cincinnati/Northern Kentucky International Airport and the incorporated communities of Florence and Union. The downstream portions are much more rural and development is primarily observed along roads and within smaller communities.

Four large parks were identified in the Gunpowder Creek watershed along. The existing parks are Central Park and Arboretum, Gunpowder Creek Nature Park, South Fork Park and a municipal park. These are shown in Figure 1, along with a private YMCA camp, Camp Ernst. In addition, a new park has been recently funded through the Kentucky Heritage Land Conservation Fund and this park will be located adjacent to Gunpowder Creek, approximately 0.75 miles downstream of the Gunpowder Creek Nature Park (Boone County Parks and Recreation, 2007).

Currently, 46% of the Gunpowder Creek watershed is developed and 12% is covered with impervious surfaces. Forest and pasture/hay comprise most of the rural land cover.

2.2.1.a Animal operations

There are no permitted concentrated animal feeding operations (CAFOs) or animal feeding operations (AFOs) in the watershed (Kentucky Geographic Network, 2008, 2008a).

A tour of the watershed and a review of information obtained from the Conservation District in 2007 (Campbell and Kenton County Conservation District, 2007) confirmed that beef cattle are present in the South Fork Gunpowder Creek watershed. Information obtained from the Census of Agriculture and the Boone County Agricultural Extension Service (Boone County Agricultural Extension Service, 2008) indicates there may be over 1,800 cattle and over 900 horses in this watershed.

2.2.1.b Septic Systems

SD1 estimates that approximately 7% of all parcels in the Gunpowder Creek watershed are serviced by septic systems (Figure 13). These properties are found in the highest densities in the South Fork Gunpowder Creek watershed. Properties potentially serviced by septic systems are also found in the Gunpowder Creek watershed downstream of the South Fork Gunpowder Creek confluence.

The Northern Kentucky Health Department does not currently have estimates of septic system failure rates in Boone County. Anecdotal reports from Health Department inspectors suggest that 10% of the septic systems in Northern Kentucky may be operating improperly due to incorrect installation, lack of maintenance or age of the system (NKHD, 2008).

In addition, one septic “hot spot” area was identified as having problems in the South Fork Gunpowder Creek subwatershed. This is an area in an older subdivision that either has very small lots that have unrepairable failing systems, or has systems that have been repaired to the extent practicable on the site, but are not fully functional (NKHD, 2008a). Sampling in the vicinity of this area is discussed in Section 4.3.3.

2.2.2 Future Conditions

Portions of the Gunpowder Creek watershed are developing at a rapid pace. Most of the new development is focused near the headwaters of Gunpowder and South Fork Gunpowder Creeks. Modest growth is expected in the western, more downstream portions of the watershed, with development generally following roads and/or ridges. This development is expected to take the form of non-subdivision single family residences and small, low density subdivisions (Boone County Planning Commission, 2005).

Several reconstruction projects are planned for KY 237 and one for South Airfield Road. Additional projects in the watershed include road widening of KY 1829 and US 42 (Kentucky Transportation Cabinet, 2006). These projects are all located in the eastern portion of the watershed.

2.2.2.a Future land cover

Future land cover was developed by modifying 2007 land cover to reflect potential future conditions (roughly 2030) obtained from SD1 and the Northern Kentucky Area Planning Commission (NKAPC). It is predicted that development will primarily replace pasture and forest lands (Figure 6). Developed lands are predicted to increase from 46% to 60% and impervious surfaces in the watershed are predicted to increase from 12% to 16%.

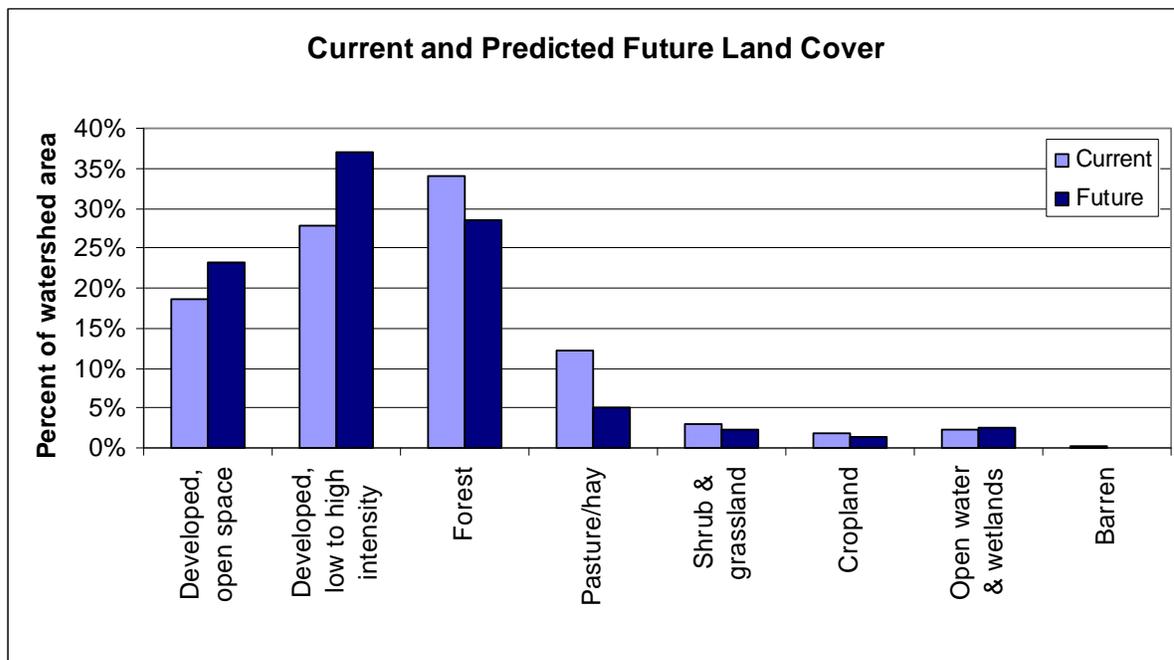


Figure 6. Current and Predicted Future Land Cover

2.3 INFRASTRUCTURE FEATURES

This section summarizes infrastructure features for the Gunpowder Creek watershed⁸. Approximately 39% of the Gunpowder Creek watershed is located within SD1's sanitary sewer service area. This area contains approximately 164.2 miles of separate sewer lines.

Approximately 17% of the Gunpowder Creek watershed is located within the City of Florence's sanitary sewer service area, which is outside SD1's service area. An additional 89 miles of separate sanitary sewers are located within Florence.

There is no combined sewer system area in this watershed.

Approximately 51% of the Gunpowder Creek watershed lies within SD1's storm water service area. Within the service area, the storm water system is comprised of approximately 354.3 miles of streams and channels and approximately 103.1 miles of pipes.

Approximately 14% of the watershed is located in the Florence storm water service area, which is outside SD1's service area. This area contains approximately 95.7 miles of streams and channels; the extent of the piped storm water system has not been mapped.

The extent of the sanitary sewer and storm water service areas in this watershed, for SD1 and Florence are shown in Figure 7.

⁸ SD1 is undertaking a characterization and assessment of the sewer system, and overflows identified herein are subject to change. Information on the sanitary and storm water system in Section 2.3 was queried from SD1's geodatabase accessed on November 21, 2008.

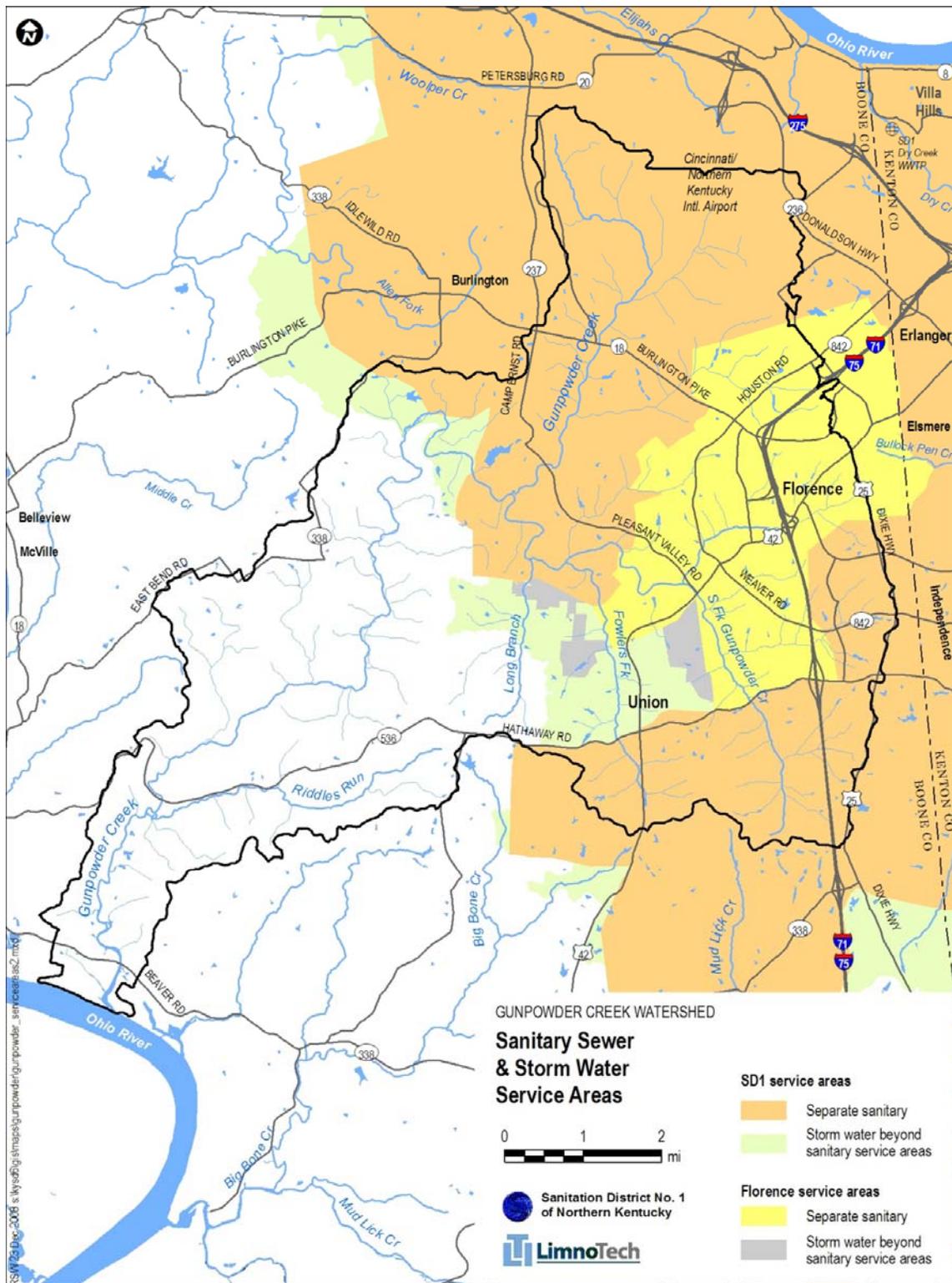


Figure 7. Sanitary Sewer and Storm Water Service Areas

2.3.1 Point Sources and Infrastructure

The occurrence of KPDES-permitted discharges, sewer overflows and storm water discharges are discussed below.

2.3.1.a KPDES dischargers

There are 25 KPDES-permitted dischargers in the Gunpowder Creek watershed. Eighteen of these permits are for sanitary wastewater and the majority (15) of these are covered under general permits for residences. There are also seven KPDES-permitted storm water discharges, six of which are covered under individual permits. One of these discharges combines storm water runoff and concrete mixer truck washout.

Based on a review of recent effluent monitoring data (January 2007 to June 2008), it was observed that twelve of the permitted dischargers have violated permit limits for at least one of the following parameters: oil and grease, chloride, chromium (IV), TSS, dissolved oxygen, fecal coliform, *E. coli*, pH, and total ammonia. KDOW requires effluent monitoring for the residential general permits (monitoring is required twice a year); however, data were not available for seven of these facilities in this watershed. KDOW estimates that as a general group, residential dischargers fail at a rate that is believed to be higher than 10% (KDOW, 2007).

Permitted dischargers are presented in Table 2.

Table 2. Permitted Dischargers

Receiving Water	KPDES ID	Facility Name	Permit Type	Outfall	Outfall Description	Currently Permitted? ^a	Permit Violations
Riddles Run	KYG400411	Residence	Minor	0011	Sanitary wastewater Type B	Y	None
Riddles Run	KYG400468	Residence	Minor	0011	Sanitary wastewater Type B	Y	NA
Riddles Run	KYG400689	Residence	Minor	0011	Sanitary wastewater Type B	Y	NA
Riddles Run	KYG401493	Residence	Minor	0011	Sanitary wastewater Type B	Y	NA
Gunpowder Creek	KYG400125	Residence	Minor	0011	Sanitary wastewater Type B	Y	NA
Gunpowder Creek	KYG400418	Residence	Minor	0011	Sanitary wastewater Type B	Y	NA
Gunpowder Creek	KYG400592	Residence	Minor	0011	Sanitary wastewater Type B	Y	NA
Gunpowder Creek	KYG401437	Residence	Minor	0011	Sanitary wastewater Type B	Y	Total ammonia
Gunpowder Creek	KYG401704	Residence	Minor	0011	Sanitary wastewater Type B	Y	Dissolved oxygen, total ammonia
Long Branch	KYG400248	Residence	Minor	0011	Sanitary wastewater Type B	Y	NA
Fowler Fork	KY0058564	Union BP	Minor	0012	Sanitary wastewater	Y	None
Fowler Fork	KY0075621	Union Baptist Church	Minor	001G	Sanitary wastewater	Y	Dissolved oxygen, E. coli, pH, total ammonia, TSS
Fowler Fork	KY0100862	TNT Roofing Products Inc	Minor	0012	Sanitary wastewater	Y	Fecal coliform
Fowler Fork	KYG400075	Residence	Minor	0011	Sanitary wastewater Type B	Y	None
Fowler Fork	KYG400452	Residence	Minor	0011	Sanitary wastewater Type B	Y	None
South Fork Gunpowder Creek	KY0021431	Florence Travel Center	Minor	001A	Storm water runoff	Y	TSS
South Fork Gunpowder Creek	KY0031631	Richwood Motel & MHP	Minor	0012	Sanitary wastewater	N ^b	NA
South Fork Gunpowder Creek	KY0096296	Moraine Materials Co	Minor	00A1	Storm water runoff	N	NA
				00B1	Concrete mixer truck washout	N	NA

Table 2. Permitted Dischargers - Continued

Receiving Water	KPDES ID	Facility Name	Permit Type	Outfall	Outfall Description	Currently Permitted? ^a	Permit Violations
South Fork Gunpowder Creek	KY0097411	Aristech Acrylics LLC	Minor	0011	Storm water runoff	Y	Total chromium 6+
South Fork Gunpowder Creek	KYG400031	Residence	Minor	0011	Sanitary wastewater Type B	Y	None
South Fork Gunpowder Creek	KYG400036	Residence	Minor	0011	Sanitary wastewater Type B	Y	None
South Fork Gunpowder Creek	KYG400088	Residence	Minor	0011	Sanitary wastewater Type B	Y	Total ammonia, total suspended solids
South Fork Gunpowder Creek	KY0101591	BP Oil Co Richwood Bulk Plant	Minor	0011	Storm water runoff	Y	None
Gunpowder Creek	KY0082864	Cincinnati/N Ky Intl Airport	Minor	002A	SBR internal outfall to 004	Y	None
				004A	Storm water to Gunpowder Creek	Y	Dissolved oxygen, oil and grease, pH
Gunpowder Creek	KY0082678	Cinn/Northern KY Intl Airport	Minor	001A	Storm water runoff	Y	TSS
Gunpowder Creek	KY0106640	Boone Ready Mix Inc	Minor	0021	Concrete mix rinse water and storm water	Y	pH, TSS
Gunpowder Creek	KYG500096	KTC Boone Co Maint Garage	Minor	SW10	Storm water runoff	Y	Chloride, oil and grease, pH
				SW20	Storm water runoff	Y	NA

^a Discharge is permitted as of June 2008

^b Discharge permit inactive as of June 2008 due to connection to SD1's sanitary sewers.

NA = no data available

In addition to the permittees above, the City of Florence holds a permit, KYP000015, for three locations where wastewater is transferred from their collection system to SD1's.

2.3.1.b Sewer overflows

There are no combined sewer overflows (CSOs) in the Gunpowder Creek watershed.

Sanitary sewer overflow (SSO) locations are listed in Table 3. One SD1 SSO is located in the central portion of the Gunpowder Creek watershed. In addition, seven SD1 pump stations (PS) have been categorized as having limited wet weather capacity. These are listed in Table 3, along with model predicted overflows.

According to the City of Florence Sanitary Sewer Overflow Plan, there is one SSO that is an individual manhole overflow and four that are at pump stations (Rosetta, Pheasant Run, Fowler Creek, and Blackstone) (City of Florence, 2007).

2.3.1.c Storm water discharges

SD1's storm water service area includes the central and northern portions of this watershed. Storm water outfalls are scattered widely throughout the central portion of this area.

In addition to storm water outfalls, there are approximately 56 suspected illicit activity points (SIAs) in the central portion of this watershed (eight of these are located in the City of Florence, which is not served by SD1). SIAs are locations where there was possible evidence of illicit discharges during SD1's storm water mapping project (2001-2002). These locations are being further investigated to determine if they are recurring.

Other portions of this watershed are located outside of SD1's storm water service area, so outfalls and other illicit discharges may be located in these areas, but were not inventoried by SD1.

Table 3. Sanitary Sewer Overflow Points

Manhole ID ^c	Direct Discharge to Waterbody	Typical Year Spill Frequency (No.) ^{a, b}	Typical Year Volume (MG) ^{a, b}
2380001	Gunpowder Creek	4	0.37
2280PS2 (Kentucky Aire PS)	Tributary to South Fork Gunpowder Creek	8	1.11
2420PS6 (South Hampton PS)	South Fork Gunpowder Creek	4	0.06
2280PS1 (Highland Acres PS)	Tributary to South Fork Gunpowder Creek	0	0
2420PS3 (Union PS)	Fowlers Fork	0	0
1030PS1 (Gammon Calmet PS)	Tributary to South Fork Gunpowder Creek	0	0
2380PS1 (Gunpowder PS)	Gunpowder Creek	0	0
1030PS2 (Levi PS)	Tributary to South Fork Gunpowder Creek	0	0
FL-SSO-004 (Florence, Vivian Drive)	Utterback Creek, tributary to South Fork Gunpowder Creek	3	0.03
FL-SSO-001 (Florence, Rosetta PS)	Utterback Creek, tributary to South Fork Gunpowder Creek	6	1.7
FL-SSO-002 (Florence, Pheasant Run PS)	Unnamed tributary to South Fork Gunpowder Creek	3	0.03
FL-SSO-003 (Florence, Fowler Creek PS)	South Fork Gunpowder Creek	20	5.2
FL-SSO-005 (Florence, Blackstone PS)	Unnamed tributary to South Fork Gunpowder Creek	0	0

^a The results presented were generated by models based on SD1's current understanding of the collection system infrastructure. These models are predictive tools and are based on numerous variables and assumptions on the characteristics of the collection system, and may differ from actual measured field conditions. These models are subject to change based on improved knowledge of the system, improvements to the system, and changes in land use and development. These results are subject to change and should therefore not be relied on or considered definitive.

^b The 2006 results obtained from City of Florence Sanitary Sewer Overflow Plan (City of Florence, 2007), are presented for the Florence SSOs.

^c Florence SSOs are identified by SSO number instead of Manhole ID

2.3.2 Recently Completed Infrastructure Projects

SD1 has completed five sewer assessment projects in this watershed. These projects extended sewer lines, providing properties in the area the opportunity to connect to sewer service. These are described below.

- Dublin Drive Sewer Assessment Project. Completed in 2004, this project provided sewer access for 31 properties in the Fowlers Fork subwatershed.

- Sycamore Sewer Assessment Project. Completed in 2005, this project provided sewer access for 40 properties in the Fowlers Fork subwatershed.
- Duncan Drive Sewer Assessment Project. Completed in 2005, this project provided access for 35 properties in the South Fork Gunpowder Creek subwatershed.
- Highland Sewer Assessment Project. Completed in 2005, this project provided access for 108 properties in the South Fork Gunpowder Creek subwatershed.
- Boone Aire Sewer Assessment Project. Completed in 2001, this project provided sewer access for 49 properties in the South Fork Gunpowder Creek subwatershed.

In addition, SD1 recently completed the American Sign Pump Station Rehabilitation, eliminating the American Sign Pump Station bypass. This project involved replacing a high maintenance pump station with a new pump station sized to provide additional wet weather capacity. Backup power will also be provided via an on-site generator.

2.3.3 Ongoing or Planned Infrastructure Improvement Projects

SD1 has a number of ongoing and planned projects for the Gunpowder Creek watershed including six projects associated with the Western Regional Water Reclamation Facility (WRWRF). These projects will convey flows from the current Lakeview and Taylorsport pump station service areas, which both currently have overflows in their systems. The diverted flow will be conveyed and stored within a new 8.5 foot diameter tunnel to the new WRWRF. These projects are:

- Sunnybrook Sewer
- Frogtown Interceptor Sewer
- South Fork Gunpowder Interceptor Sewer and Rosetta Sewer
- Union Sewer (North and South)
- Gunpowder Interceptor Sewer
- Western Regional Conveyance System

Two additional projects in the Gunpowder Creek watershed include:

- Blackstone Pump Station Removal. The elimination of this station will occur when the Western Regional Water Reclamation Facility goes online. This project will help to attenuate the flow throughout the gravity portion, which will address surcharging in the system.
- Pump Station Backup Power Program. As part of systemwide improvements, SD1 is planning to install backup generators at 11 pump stations within the Gunpowder Creek watershed. The installation of generators at these locations will help eliminate overflows as a result of power failure at the following pump stations: Cinnamon Ridge, Dublin Green No. 2, Hampton Ridge, Jonathan, Kentucky Aire, Levi, Orchard Estates, Saturn, South Hampton, Sycamore and Youell Rd.

The anticipated start and completion dates, the total cost of the project and goals of each project are detailed in Table 4.

Table 4. Ongoing or Planned Infrastructure Improvement Projects

Capital Improvement Project Title	Goal	Anticipated Start Date	Anticipated Completion Date	Project Total
Western Regional - Sunnybrook Sewer	Convey flows from the current Lakeview service area to the WRWRF via the Narrows Rd PS and eliminates the Gammon Calmet PS overflow	2008	2013	\$7,692,000
Western Regional - Frogtown Interceptor Sewer (from Sunnybrook Dr. to Frogtown Rd.)	Convey flows from the South Hampton and Hempsteade PS drainage basins to the WRWRF and eliminate PS overflows	2010	2013	\$6,968,000
Western Regional - South Fork Gunpowder Interceptor Sewer and Rosetta Sewer	Eliminate Fowler Creek and Rosetta pump station bypasses and the Vivian SSO and convey flows to the WRWRF	2008	2013	\$17,858,000
Western Regional - Union Sewer (North and South)	Eliminate Union PS bypass and convey flows to the WRWRF	2007	2009	\$7,575,000
Western Regional - Gunpowder Interceptor Sewer	Eliminate the SSO 2380001 and convey all of the tributary drainage area to WRWRF	2008	2009	\$14,608,000
Western Regional Conveyance System	Provide conveyance and storage prior to WRWRF	2008	2013	\$117,900,000
Blackstone Pump Station Removal	Eliminate the overflow at Blackstone PS	2009	2010	\$310,000
Pump Station Backup Power Program	Ensure that all pump stations have backup power or other appropriate measures for addressing power outages	2008	2015	\$1,397,000

The implementation of all of the current and future projects will eliminate:

- Two SSOs (SSO 2380001 and Florence Vivian SSO), and
- Eight pump station bypasses (South Hampton, Hempsteade, Gammon Calmet, American Sign, Union, Rosetta (Florence), Fowler Creek (Florence) and Blackstone (Florence)).

The construction of these projects will also facilitate future projects to eliminate overflows at the Kentucky Aire, Highland Acres and Pheasant Run pump stations.

2.4 SENSITIVE AREAS

The federal CSO Control Policy (USEPA, 1994) states EPA's expectation that a permittee's Long-Term Control Plan (LTCP) give the highest priority to controlling CSOs in sensitive areas. The CSO Control Policy indicates that sensitive areas include:

- Waters designated as Outstanding National Resource Waters (ONRW);
- Waters with threatened or endangered species and their habitat;
- Waters with primary contact recreation, such as bathing beaches;
- Public drinking water intakes and their designated protected areas;
- National Marine Sanctuaries (NMS); and
- Shellfish beds.

These six criteria were evaluated individually. None of the waterbodies in the Gunpowder Creek watershed have been designated as Outstanding National Resource Waters (401 KAR 10:030) and there are no National Marine Sanctuaries in the watershed (NOAA, 2008). Additionally, there are no known threatened or endangered species or commercial shellfish beds within the Gunpowder Creek watershed nor is shellfish harvest for consumption by private individuals known to occur. Therefore these criteria were determined not to be relevant to the identification of sensitive waters in the Gunpowder Creek watershed. The remaining two criteria are discussed below. The discussion of species of concern in this watershed (section 2.4.1) is also included only for potential relevance for ranking watersheds.

2.4.1 Threatened & Endangered Species or Their Designated Critical Habitat

The Kentucky State Nature Preserves Commission (KSNPC) did not identify any threatened or endangered species in this watershed, but did identify five species of concern (Table 5; KSNPC, 2005). Two of these, the eastern hellbender and the northern leopard frog, inhabit aquatic or wetland areas. The eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*) is a large salamander that inhabits fast-flowing, shallow waters with good water quality and is particularly sensitive to low levels of dissolved oxygen (Figure 8; Mayasich et al., 2003). The causes of the eastern hellbender's population decline include habitat degradation and loss, water quality declines, and impoundments (Mayasich et al., 2003). The northern leopard frog inhabits various habitats including slowly flowing areas in creeks and rivers, springs, the nearshore area of lakes, bogs, fens, herbaceous wetlands, riparian areas and grasslands (NatureServe, 2007). Threats to the northern leopard frog include habitat loss, commercial overexploitation and competition with introduced species (NatureServe, 2007).



Figure 8. An Adult and Juvenile Eastern Hellbender

The other three species of concern depend on upland habitats such as woodlands and grasslands: the savannah sparrow, the side-oats grama and the redback salamander.

Table 5. Species of Concern in the Gunpowder Creek Watershed

Taxonomic Group	Common name	Scientific name	Status ^a	Last Observed	Habitat(s)	Identified Threats
Vascular Plants	Side-oats Grama	<i>Bouteloua curtipendula</i>	State - Special Concern	1977	Rocky hillsides and grasslands	N/A
Amphibians	Northern Leopard Frog	<i>Rana pipiens</i>	State - Special Concern	1934	Ponds, wetlands, grasslands	Habitat loss, non-native species, commercial overexploitation
	Eastern Hellbender	<i>Cryptobranchus alleganiensis alleganiensis</i>	Federal - SOMC State - Special Concern	Early 1990s	Shallow swift streams with high water quality ^b	Habitat loss/ degradation, water quality declines and impoundments
	Redback Salamander	<i>Plethodon cinereus</i>	State - Special Concern	1992	Woodlands ^c	Habitat loss/degradation
Breeding Birds	Savannah Sparrow	<i>Passerculus sandwichensis</i>	State - Special Concern	1999	Grassy fields ^d	N/A

^aSOMC = Species of Management Concern, a federal designation; Source KSNPC, 2007.

^bSource: Mayasich et al. 2003

^cNature Serve 2007

^dRobbins et al. 1983

2.4.2 Primary Contact Recreation Waters

Kentucky does not have a tiered approach for primary contact recreation (PCR). This means that the State has designated that all PCR waters should be suitable for full body contact recreation during the recreation season of May 1 through October 31 (401 KAR 10:001E). However, the State water quality standards do not define full body contact recreation, so the bacteria criteria that have been developed are based on the presumption that people will ingest the water and could therefore become ill if the water was sufficiently contaminated with bacteria.

Gunpowder Creek and its tributaries are designated for PCR. Public surveys regarding swimming activity are unavailable, however, it was determined that within Camp Ernst, swimming occurs in Camp Ernst Lake and wading occurs in Gunpowder Creek (Camp Ernst staff, 2007). Additional data will be gathered about uses of the creek.

2.4.3 Public Drinking Water Intakes or their Designated Protection Areas

There are no public drinking water intakes from surface waters located within the Gunpowder Creek watershed. The nearest public drinking water intake from surface waters is located on the Ohio River near Louisville, Kentucky.

Source Water Assessment and Protection (SWAPP) zones for the Ohio River intakes are determined by the Ohio River Valley Water Sanitation Commission (ORSANCO). SWAPP zones are not used in a regulatory sense, but are delineated to identify potential contaminants upstream of the water intakes and are used to support identification of sources potentially impacting the intakes. ORSANCO has determined that this entire watershed lies within SWAPP Zone 2, reflecting the fact that this watershed is more than 25 miles upstream of the Louisville intake (Figure 9).

There are two active public water supply wells in this watershed. Kentucky's Wellhead Protection Plan program requires public water suppliers that rely on ground water to develop a wellhead protection plan (WHPP) for their source water. The recharge area (wellhead protection area) of these wells is delineated as part of the WHPP using geologic and hydrologic data (<http://www.water.ky.gov/gw/gwprotection/wellhead/>). The wellhead protection areas are shown in Figure 9, along with other drinking water supply features.

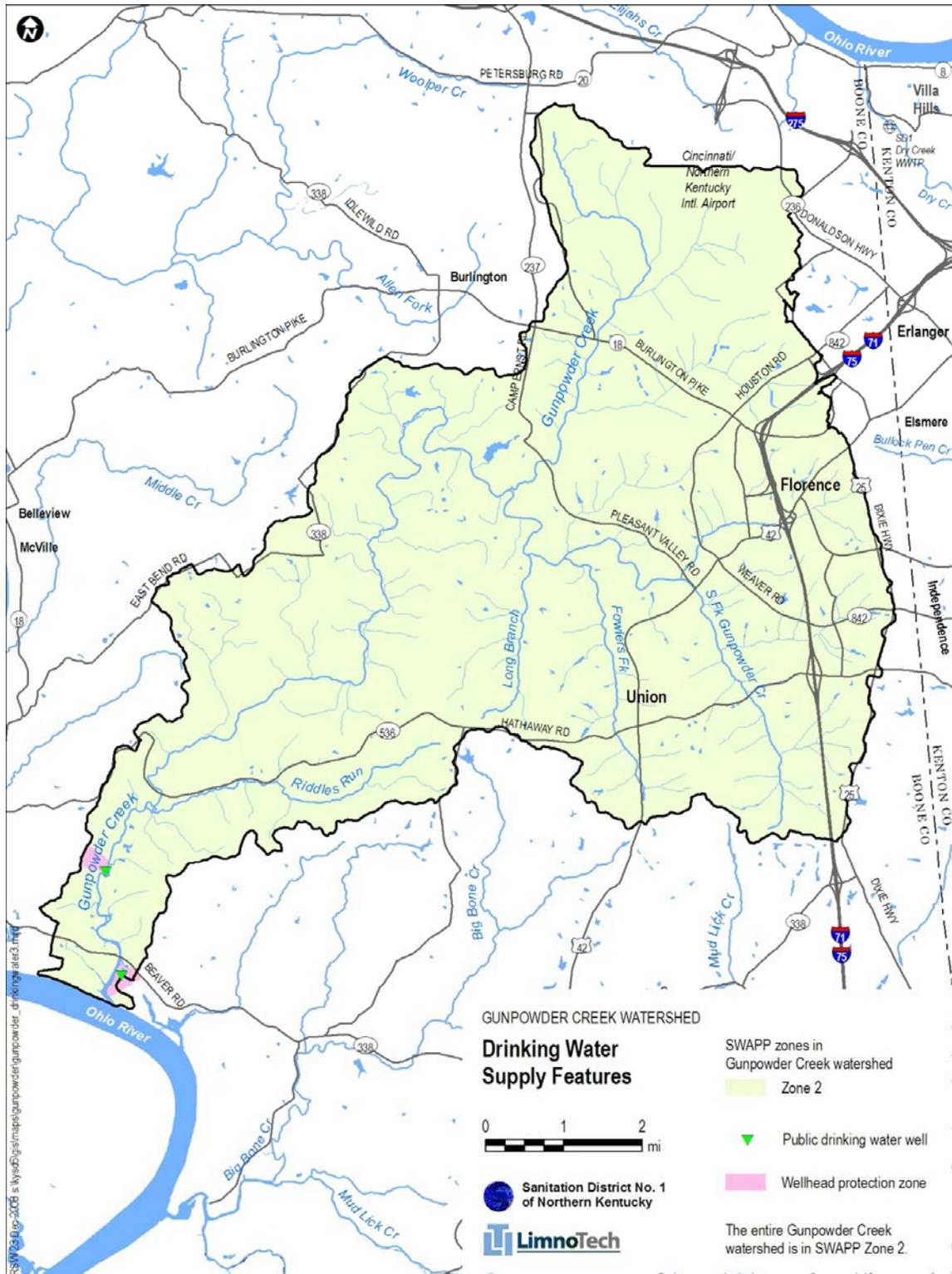


Figure 9. Drinking Water Supply Features

2.5 PUBLIC INTEREST/WATERSHED GROUP ACTIVITIES

Public interest in this watershed is high, as gauged through interest in the Total Maximum Daily Load (TMDL) for the Cincinnati/Northern Kentucky International airport, past sampling in the watershed, and interest in implementing watershed improvement projects and forming a linear park system.

In 1998, the Kentucky Division of Water developed a TMDL for Gunpowder Creek due to impacts from deicing fluid runoff from the Cincinnati/Northern Kentucky International airport. These impacts included high concentrations of biochemical oxygen demand (BOD) and nuisance growths of *Sphaerotilus* (KDOW, 1998). The TMDL specified allowable loads of oxygen-demanding substances (ammonia and biochemical oxygen demand). The TMDL also outlined implementation actions to ensure that deicing fluids do not continue to create water quality problems in the creek. The airport agreed to more than \$50 million in pollution controls, which included the installation of a recycling system for deicing fluids. Additionally, the state of Kentucky issued a more stringent discharge permit, including monitoring requirements to determine compliance, designed to eliminate the impairment of Gunpowder Creek.

Additional impairments identified by KDOW (KDOW, 2008), and planned TMDLs are discussed in Section 4.2.1.

In addition to the interest KDOW has shown in improving water quality in Gunpowder Creek, local groups including the Sierra Club, and the Northern Kentucky Water Sentinels (a program of the Sierra Club) and the Northern Kentucky Fly Fishers have also shown significant interest in Gunpowder Creek. These groups, along with Licking River Watershed Watch, have conducted monitoring in the creek and rallied residents to become involved in their goal of improving water quality in the creek.

Stream and riparian buffer restoration is being conducted by the Center for Applied Ecology at Northern Kentucky University (CAE) at the City of Florence Golf Course (World of Sports) in 2007 and 2008. The stream to be restored is an unnamed perennial tributary of Gunpowder Creek and the restoration will involve removal of an impoundment and restoration of the stream channel. Project maintenance and monitoring will be conducted at least annually over a period of 5 years after construction.

The Conservation District has recently expressed interest in pursuing a 319(h) grant for the Gunpowder creek watershed. It also indicated that there is interest in developing a linear park system along Gunpowder Creek, downstream of the Gunpowder Creek Nature Park (Campbell, Kenton and Boone County Conservation District, 2007a). Within the Comprehensive Plan (BCPC, 2005) it is recommended that the South Fork/Gunpowder Creek tributary valleys be used for recreation purposes, including the provision of a greenway system along the creek corridors as adjoining areas are developed. As discussed in section 2.2.1, Boone County was recently awarded funds to purchase park land surrounding a portion of Gunpowder Creek. This land will be kept as a natural area and is located downstream of the existing Gunpowder Creek Nature Park and Camp Ernst. The Boone County Greenways Plan is under development but was not available at the time of this report. This plan may contain additional information on proposed greenways in this watershed.

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3. WATERBODY USES

This section describes designated uses for Gunpowder Creek and its tributaries, as well as current uses.

3.1 DESIGNATED USES

Gunpowder Creek and its tributaries are designated for warm water aquatic habitat, primary contact recreation, secondary contact recreation and domestic water supply, applicable at existing points of public water supply withdrawal (401 KAR 10:026). These uses are defined below.

- **Warm water aquatic habitat** means any surface water and associated substrate capable of supporting indigenous warm water aquatic life.
- **Primary contact recreation** waters means those waters suitable for full body contact recreation during the recreation season of May 1 through October 31.
- **Secondary contact recreation** waters means those waters that are suitable for partial body contact recreation, with minimal threat to public health due to water quality.
- **Domestic water supply** means surface waters that with conventional domestic water supply treatment are suitable for human consumption through a public water system as defined in 401 KAR 8:010, culinary purposes, or for use in any food or beverage processing industry; and meet state and federal regulations under the Safe Drinking Water Act, as amended, 42 U.S.C. 300f - 300j.

3.2 CURRENT USES

An assessment of available information found the following:

- The most recent (2004) fish data reflect fair to excellent biology in Gunpowder and South Fork Gunpowder Creeks, respectively. Macroinvertebrate samples indicate very poor conditions in an unnamed tributary draining the airport.
- The most recent (2004) aquatic habitat assessments reflect fully supporting conditions on South Fork Gunpowder Creek and partially supporting to supporting, but threatened conditions in Gunpowder Creek.
- A statewide fish consumption advisory was issued on April 11, 2000 due to low levels of organic mercury found in fish taken from Kentucky waters (KDOW, 2007a).
- There are currently no swimming advisories for Gunpowder Creek (KDOW, 2007b). Based on personal communication with Camp Ernst staff, it was learned that swimming occurs in the Camp Ernst Lake and wading occurs in Gunpowder Creek.
- One fishing access site was found in the watershed. It is on Camp Ernst Lake, which is stocked with fish (<http://kygeonet.ky.gov/kdfwr/viewer.htm>). There is also a boat ramp at a marina on the lower Gunpowder along KY 338.
- Gunpowder Creek is identified by the Kentucky Department of Fish and Wildlife Resources as a smallmouth bass stream, based on fish populations (Ross, undated).

- Gunpowder Creek from Camp Ernst Road to Dale Williamson Road has been rated as a class II+ section by American Whitewater and several websites describe this stretch of the river from the viewpoint of boat paddlers.
- There are no surface drinking water intakes in the watershed.
- There are two active public water supply groundwater wells in this watershed, and both are located in the downstream portion of the watershed (KDOW, 2008b; KDOW, 2007c).

4. WATERBODY CONDITIONS

This section describes monitoring programs and observed water quality and biological conditions in this watershed.

4.1 303(d) STATUS AND POLLUTANTS OF CONCERN

Three segments of Gunpowder Creek and two segments of South Fork Gunpowder Creek are listed on Kentucky's 2008 303(d) list of impaired waters (Table 6; KDOW, 2008) due to nonsupport or partial support of the warm water aquatic habitat (WAH) use and nonsupport of the primary contact recreation (PCR) use.

Table 6. 303(d)-listed Waterbodies

Waterbody Segment	Designated Uses (Use support)	Pollutants	Suspected Sources
Gunpowder Ck. RM 0.0 – 15.0	WAH (Not Supporting)	Sedimentation/siltation	Site Clearance (Land development or redevelopment)
Gunpowder Ck. RM 15.4 – 17.1	WAH (Not Supporting)	Sedimentation/siltation; Nutrient/Eutrophication biological indicators Organic enrichment (sewage) biological indicators	Agriculture, Unspecified urban storm water, Streambank modifications/destabilization, Site clearance (land development or redevelopment), Loss of riparian habitat, Highway/road/bridge runoff (non-construction related)
Gunpowder Ck. RM 18.9 – 21.6	WAH (Partially Supporting)	Unknown	Unspecified urban storm water
South Fork Gunpowder Ck. RM 0.0 – 2.0	WAH (Not Supporting)	Sedimentation/siltation Turbidity Nutrient/Eutrophication biological indicators Organic enrichment (sewage) biological indicators	Agriculture, Package plant or other permitted small flows discharges, Post-development erosion and sedimentation, Site clearance (land development or redevelopment)
South Fork Gunpowder Ck. RM 4.1 – 6.8	PCR (Not Supporting)	Fecal coliform	Source unknown

KDOW plans to initiate TMDLs for these 303(d)-listed segments in 2008. Sediment TMDLs will be developed once additional sediment data are collected, if needed. The TMDLs for nutrients and organic enrichment will not be initiated until nutrient criteria are promulgated by the state. The preliminary schedule for TMDL development is for approved TMDLs to be completed in 2012 (KDOW, 2008a).

4.2 MONITORING PROGRAMS

Water quality data have been collected in this watershed by KDOW, Licking River Watershed Watch (LRWW), Northern Kentucky University (NKU), the Conservation District, USGS and SD1. Data currently compiled by SD1 from known monitoring programs are presented in Table 7, however, only data which have been fully analyzed are discussed in section 4.3 Water Quality Data Analysis. Available data exists for the main stem of Gunpowder Creek, South Fork Gunpowder Creek, Riddles Run, Utterback Creek, Fowler Fork, Long Branch, as well as unnamed tributaries to Gunpowder Creek. Data not included in this report will be reviewed and included in subsequent updates. .

4.2.1 Future Sampling

SD1 plans to continue monitoring this watershed during base flow conditions with at least one survey per year. The five sampling locations are: Gunpowder Creek (RMs 4.0, 14.7 and 17.9) and South Fork Gunpowder Creek (RM 2.6 and 5.3). Typical analyses will include bacteria, nutrients, solids, oxygen-demanding constituents and physical parameters.

SD1 is planning to collect wet weather data in the Gunpowder Creek watershed in 2010 at the five locations described above. Attempts will be made to collect data during three events. Samples may be analyzed for bacteria, nutrients, solids, oxygen-demanding constituents, metals and physical parameters. Within each event, samples will be collected near hour 0, 2, 4, 6, 12, 24, 36 and 48 hours of the start of the storm, though these intervals are dependent on the storm characteristics and may be changed if necessary.

Biological monitoring is also planned for this watershed in 2010 at the baseline locations. This will include habitat surveys along with fish and macroinvertebrate population assessments.

Additionally, surveys to assess the degree of stream hydromodification are currently underway. Additional sampling in the Gunpowder Creek watershed is also planned by the Cincinnati/Northern Kentucky International Airport and the USGS (at the existing station). These programs are described briefly below.

The airport conducts biological monitoring as a requirement of their KPDES permit. For monitoring, their consultant will conduct macroinvertebrate and fish (number and species) monitoring (personal communication, airport environmental coordinator). In the Gunpowder Creek watershed, monitoring is conducted at a station on Gunpowder Creek at RM 18.8. These data are provided to KDOW.

The USGS will continue to operate the stage gage, and measure flow and water quality (physical parameters) at station 03277075. This station is operated and funded via a cooperative agreement between USGS and SD1.

Table 7. Summary of Water Quality Monitoring Data

Entity	Dates	Parameters Sampled	Sampling Locations ^b	Number of Samples
NKU	1998	Alkalinity, bromide, chloride, fluoride, hardness, conductivity, sulfate, TOC, TSS, nutrients, metals	S. Fork Gunpowder Cr. RM 6.0	1 sample (10/11/1998)
NKU	1998	Fecal coliform, E. coli, DO, pH, temperature	S. Fork Gunpowder Cr. RM 6.0	1 sample (7/14/1998)
NKU	1998	2,4-D, Dichlorophenoxyacetic acid, Alachlor, Atrazine, Chlorpyrifos-methyl, Metolachlor	S. Fork Gunpowder Cr. RM 6.0	1 sample (5/17/1998)
NKU	2001	Fecal coliform, E. coli, DO, pH, temperature	Gunpowder Cr. RM 4.0, 7.8	1 sample (8/25/2001)
NKU	2002	Atrazine, DO, pH, temperature	Gunpowder Cr. RM 4.0, 5.0, 7.8; Riddles Run RM 0.2	1 sample May 2002
NKU	2003	Fecal coliform, alkalinity, boron, chloride, hardness, DO, pH, conductivity, silicon, sulfate, TSS, nutrients, metals	Gunpowder Cr. RM 1.0, 4.0, 14.0, 16.1; Riddles Run RM 0.2	1 sample Sept. 2003
NKU	2003	Fecal coliform	Gunpowder Cr. RM 1.0, 4.0, 14.0, 16.1; S. Fork Gunpowder Cr. RM 5.2; Utterback Cr. RM 0.7	1 sample (7/10/2003)
LRWW	2002	Fecal coliform	Gunpowder Cr. RM 4.0, 5.0, 7.8; Riddles Run RM 0.2	1 sample (7/12/2002)
LRWW	2003	Fecal coliform	Gunpowder Cr. RM 1.0, 4.0, 14.0, 16.1; Riddles Run RM 0.2	1 sample (5/14/2003)
LRWW	2004	Fecal coliform, E. coli	Gunpowder Cr. RM 1.0, 4.0, 14.0, 16.1, 17.4	3 samples (May, July, Sept)
Conservation District	2004-2006	Fecal coliform, E. coli, DO, pH, conductivity, temperature	S. Fork Gunpowder Cr. RM 5.2; Utterback Cr. RM 0.7	2 samples per year (May, July)

Table 7. Summary of Water Quality Monitoring Data - Continued

Entity	Dates	Parameters Sampled	Sampling Locations	Number of Samples
SD1	2006	Fecal coliform, E. coli, DO, pH, conductivity, turbidity, temperature	Gunpowder Cr. RM 4.0, 14.7; S. Fork Gunpowder Cr. RM 2.6; Unnamed Trib. RM 0.1	2 samples from baseline survey (9/27/2006 & 10/16/2006)
SD1	2007	Fecal coliform, E. coli, carbonaceous biological oxygen demand (5-day), DO, pH, conductivity, TSS, temperature, turbidity, nutrients	Gunpowder Cr. RM 4.0, 14.7, 17.9; S. Fork Gunpowder Cr. RM 2.6, 5.3	1 sample (8/1/2007 except Gunpowder Cr. RM 4.0 was taken on 7/31/2007))
SD1	2008 ^a	Fecal coliform, E. coli, carbonaceous biological oxygen demand (5-day), DO, pH, conductivity, TSS, temperature, turbidity, nutrients	Gunpowder Cr. RM 4.0, 14.7, 17.9; S. Fork Gunpowder Cr. RM 2.6, 5.3	1 sample (10/22/2008)
KDOW	2006, 2007	DO, pH, conductivity, temperature	Gunpowder Cr. RM 15.5, 17.1, 18.9, 21.4; S. Fork Gunpowder Cr. RM 0.1, 2.6, 4.3, 6.7; Fowler Fork RM 0.4; Long Br. RM 0.3; Utterback Cr. RM 0.1; Unnamed Tribs. RM 0, 0.1, 0.2, 1.6	2 samples (Nov. 2006 & Jan. 2007)
KDOW	1999, 2004	DO, pH, conductivity, temperature	Gunpowder Cr. RM 16.1; S. Fork Gunpowder Cr. RM 1.9	2 samples (Aug. of 1999 & 2004)
KDOW	1985	Fecal coliform, Fecal strep	Gunpowder Cr. RM 14.7	2 samples (3/5/1985 & 7/9/1985)
KDOW	1995	Fecal coliform	Gunpowder Cr. RM 16.1, 17.9, 21.6	1 sample (7/13/1995)
KDOW	1994-1996	Ethylene glycol, BOD, DO, pH, temperature, TOC, TSS, nutrients	Gunpowder Cr. RM 19.5; Unnamed Trib. RM 0.1, 0.9, 1.6	6 samples for RM 19.5, 7 samples for RM 0.1, 8 samples for RM 0.9, 2 samples for RM 1.6
KDOW	2006-2007	E. coli, carbonaceous biological oxygen demand (5-day), DO, DO % Sat, pH, conductivity, TOC, TSS, temperature, turbidity, nutrients	Gunpowder Cr. RM 15.5, 17.1, 18.9, 21.4; S. Fork Gunpowder Cr. RM 0.1, 2.6, 4.3, 6.0, 6.7; Fowler Fork RM 0.4; Long Br. RM 0.3; Utterback Cr. RM 0.1; Unnamed Tribs. RM 0, 0.1, 0.2, 1.6	Approximately 13 samples over a one year period from Nov. 2006 to Nov. 2007
USGS	1999-present ^a	Gage height, discharge, precipitation, DO, DO % sat, DO equilibrium, pH, conductivity, turbidity, temperature	Gunpowder Cr. RM 14.7 (Station No. 03277075)	15-minute intervals

^aData not analyzed in Section 4.3, including USGS data collected after WY 2005

^b RM = River mile

4.3 WATER QUALITY DATA ANALYSIS

Historical water quality data (1985-2005) have been analyzed to identify past water quality problems in this watershed. Bacteria, dissolved oxygen, temperature, pH and unionized ammonia exceedances have been observed. All of the temperature and pH violations, as well as the majority of the dissolved oxygen violations were observed at the continuous USGS station.

Recent data (2006-2007) have been analyzed in more detail to describe current stream conditions, because these data better reflect the effect of existing sources on instream water quality. Recent data reflect pH violations and exceedances of the bacteria criteria. The recent data analysis does not include the continuous USGS measurements or recent data collected by the Conservation District. These data are still being reviewed and will be included in the next update of this report.

4.3.1 Historical Data

Both discrete measurements and the continuous water quality data were analyzed to identify historical water quality problems. Historical exceedances of fecal coliform and *E. coli* were observed at many locations along Gunpowder Creek and South Fork Gunpowder Creek, as well as a location on Riddles Run. Dissolved oxygen violations were observed on an unnamed tributary and at the USGS station. Temperature and pH violations were identified through a review continuous data at the USGS station (WY 2001- WY 2005) (CEG, 2007). A single unionized ammonia violation was observed on an unnamed tributary.

A summary of historical water quality problems is presented in Tables 8, 9 and 10, for those parameters that exceeded their applicable criteria. Measurements for parameters or locations not shown met the respective water quality criteria.

Table 8. Historical Bacteria Exceedances

Stream	River Mile	Parameters exceeding criteria			
		Fecal coliform bacteria		<i>E. coli</i> bacteria	
		# samples	% of samples exceeding criteria ^a	# samples	% of samples exceeding criteria ^a
Gunpowder Creek	1.0	5	40%	1	100%
Gunpowder Creek	4.0	8	75%	3	67%
Gunpowder Creek	5.0	1	100%	---	n/a
Gunpowder Creek	7.8	2	100%	1	100%
Gunpowder Creek	14.0	6	33%	2	50%
Gunpowder Creek	14.7	1	100%	3	0%
Gunpowder Creek	16.1	6	100%	1	100%
Gunpowder Creek	17.4	1	100%	1	100%
Gunpowder Creek	21.6	1	100%	---	n/a
Riddles Run	0.2	3	67%	---	n/a
South Fork Gunpowder Creek	0.7	4	75%	2	50%
South Fork Gunpowder Creek	5.2	4	75%	2	50%

^a There are no instances where 5 samples were collected from a single location within a 30-day period. Therefore the comparison to the geometric mean portion of the fecal coliform and *E. coli* criteria, which requires a minimum of 5 samples taken during a 30-day period, is not possible. Comparisons were, however, made to the part of the criteria that reads, "Content shall not exceed 400 colonies/100 ml in 20 percent or more of all samples taken during a 30-day period for fecal coliform or 240 colonies/100ml for *E. coli*." Even this comparison is conservative as the criterion is meant to be applied to a dataset of 5 or more samples collected over a 30-day period.

n/a = not applicable

Table 9. Historical Dissolved Oxygen Violations

Stream	River Mile	Parameters violating criteria	
		Dissolved Oxygen	
		# measurements	% of measurements in violation ^a
Unnamed Tributary to Gunpowder Creek at River Mile 18.9	0.1	4	25%

^a The dissolved oxygen criterion is 4 mg/l.

Dissolved oxygen concentrations less than 4 mg/l have also been observed in water years 2001, 2003, 2004, and 2005 between February and September and were distributed across flow regimes. Acute dissolved oxygen violations at higher flows suggest either a source of

oxygen demand a significant distance upstream, or a local source of considerable volume (CEG, 2007).

Infrequent temperature violations have been observed at the USGS station during the summer. One temperature measurement violated the temperature criterion in WY 2001, and two measurements exceeded the criterion in WY 2005. The 2001 violation occurred during a period of lower flow (< 3 cfs).

pH violations at the USGS station (RM 14.7) due to a change more than 1 su in a 24-hour period have been observed in all five of the water years (2001-2005) examined. pH violations of the 9.0 su criteria have also been observed in WY 2001, 2002, 2004, and 2005. Most of the rapid pH changes observed in the data occurred coincident with increased flow, following a period of lower instream flows. Two periods of rapid pH change (July 2003 and August 2004) coincided with a period when diurnal dissolved oxygen concentrations varied by over 6 mg/l.

A single violation of the unionized ammonia criteria was observed in the historical data (Table 10).

Table 10. Historical Unionized Ammonia Violations

Stream	River Mile	Parameters violating criteria	
		Unionized ammonia ^a	
		# samples	% of samples in violation
Unnamed tributary entering Gunpowder Creek at RM 19.4	0.1	2	50%

^a The unionized ammonia criteria is 0.05 mg/l

4.3.2 Recent Data

More recent water quality data were available for many locations along Gunpowder Creek and several tributaries. Fecal coliform has been measured at six locations, E. coli has been measured at 10 locations, and pH has been measured at 23 locations. A summary of recent issues are presented in Tables 11 and 12 for those parameters that exceeded applicable criteria. Measurements for parameters not shown met the respective water quality criteria. Recent data collected at the USGS station and by the Conservation District are still being reviewed and will be included in the next update of this report.

Table 11. Recent Bacteria Exceedances

Stream	River Mile	Parameters exceeding criteria			
		Fecal coliform bacteria		<i>E. coli</i> bacteria	
		# samples	% of samples exceeding criteria ^a	# samples	% of samples exceeding criteria ^a
South Fork Gunpowder Creek	2.6	3	33%	3	33%
South Fork Gunpowder Creek	4.3	---	n/a	8	75%
South Fork Gunpowder Creek	5.3	1	100%	1	100%
Unnamed Tributary to South Fork Gunpowder Creek at RM 5.3	0.0	---	n/a	7	100%
South Fork Gunpowder Creek	6.0	---	n/a	8	63%
South Fork Gunpowder Creek	6.7	---	n/a	6	83%

^a There are no instances where 5 samples were collected from a single location within a 30-day period. Therefore the comparison to the geometric mean portion of the fecal coliform and *E. coli* criteria, which requires a minimum of 5 samples taken during a 30-day period, is not possible. Comparisons were, however, made to the part of the criteria that reads, "Content shall not exceed 400 colonies/100 ml in 20 percent or more of all samples taken during a 30-day period for fecal coliform or 240 colonies/100ml for *E. coli*." Even this comparison is conservative as the criterion is meant to be applied to a dataset of 5 or more samples collected over a 30-day period.

n/a = not applicable

Table 12. Recent pH Violations

Stream	River Mile	Parameters violating criteria	
		pH	
		# measurements	% of measurements in violation ^a
Unnamed Tributary to South Fork Gunpowder Creek at RM 5.3	0.0	10	10%

^a The pH criteria are between 6.0 and 9.0 SU.

A discussion of recent water quality violations follows below by parameter.

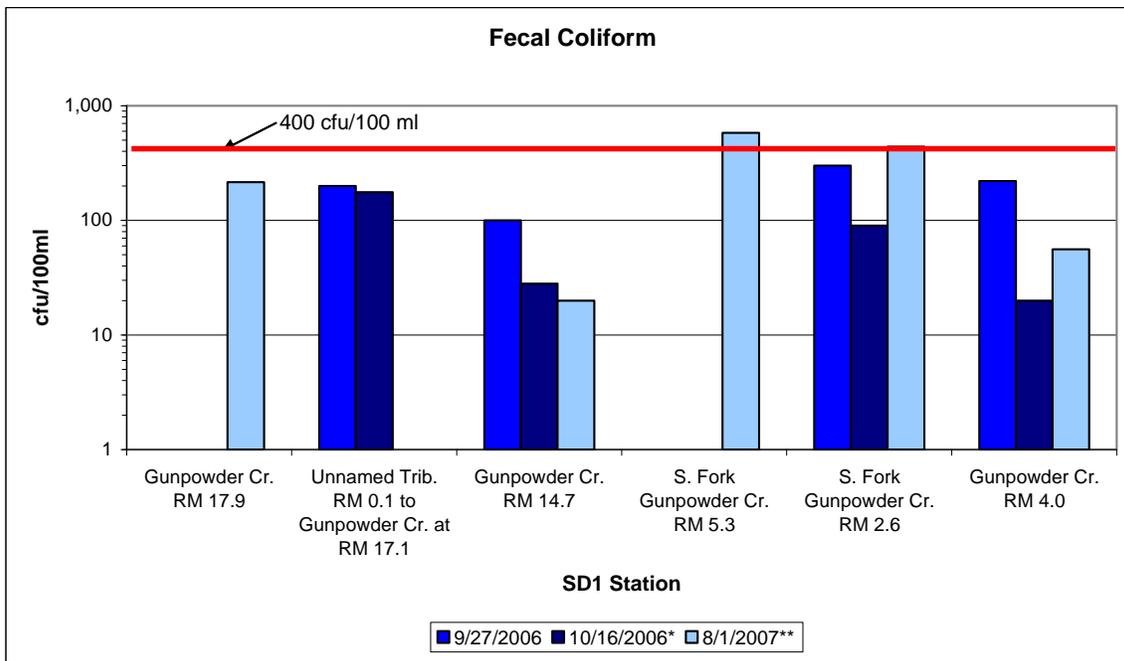
4.3.2.a Bacteria

Both the fecal coliform and *E. coli* samples from Gunpowder Creek and South Fork Gunpowder Creek exceeded the applicable criterion. Exceedances of fecal coliform have also been observed in Riddles Run. Bacteria measurements are discussed below.

Fecal coliform data are available for base flow and storm flow conditions. As shown in Figure 10, base flow exceedances of the fecal coliform criteria were only observed in South Fork Gunpowder Creek. For SD1's data, the maximum base flow fecal coliform

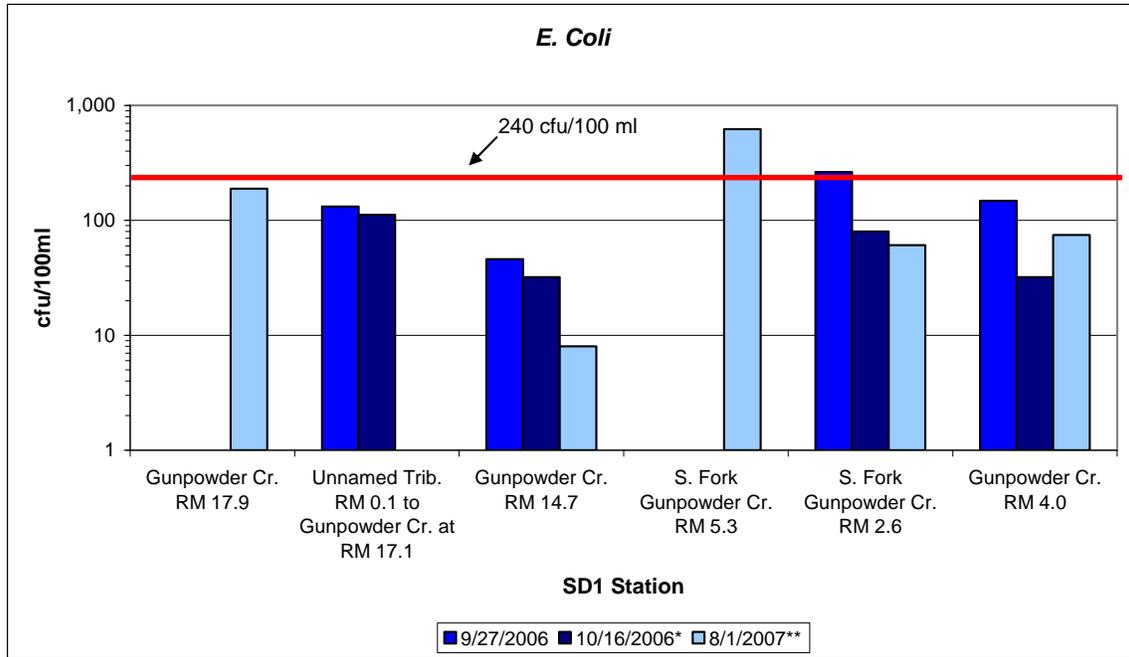
concentration of 580 cfu/100 ml was recorded in South Fork Gunpowder Creek at RM 5.3. A similar pattern was observed for *E. coli*, as shown in Figure 11, with the highest *E. coli* concentration, 621 cfu/100 ml, at South Fork Gunpowder Creek RM 5.3. Figure 12 shows the results of a recent KDOW survey that examined base and storm flow concentrations in South Fork Gunpowder Creek.

Bacteria results presented in a draft Sherwood Lakes Stream Survey Summary Report show elevated dry weather concentrations for two unnamed tributaries draining Squire Street and Crescent Street. Dry weather fecal coliform concentrations at these two sites range between 500 and 2100 cfu/100 ml. Wet weather fecal coliform concentrations at these two sites range between 2,800 and 22,000 cfu/100 ml. These sampling stations are located upstream of South Fork Gunpowder Creek RM 5.3 (SD1, 2007).



*Unnamed trib. result is average of 2 samples on 8/1/07 ** RM 4.0 collected 7/31/08

Figure 10. 2006-07 Base Flow Fecal Coliform Concentrations Compared to 400 cfu/100 ml Criterion



*Unnamed trib. result is average of 2 samples on 8/1/07 ** RM 4.0 collected 7/31/08

Figure 11. 2006-07 Base Flow *E. Coli* Concentrations Compared to 240 cfu/100 ml Criterion

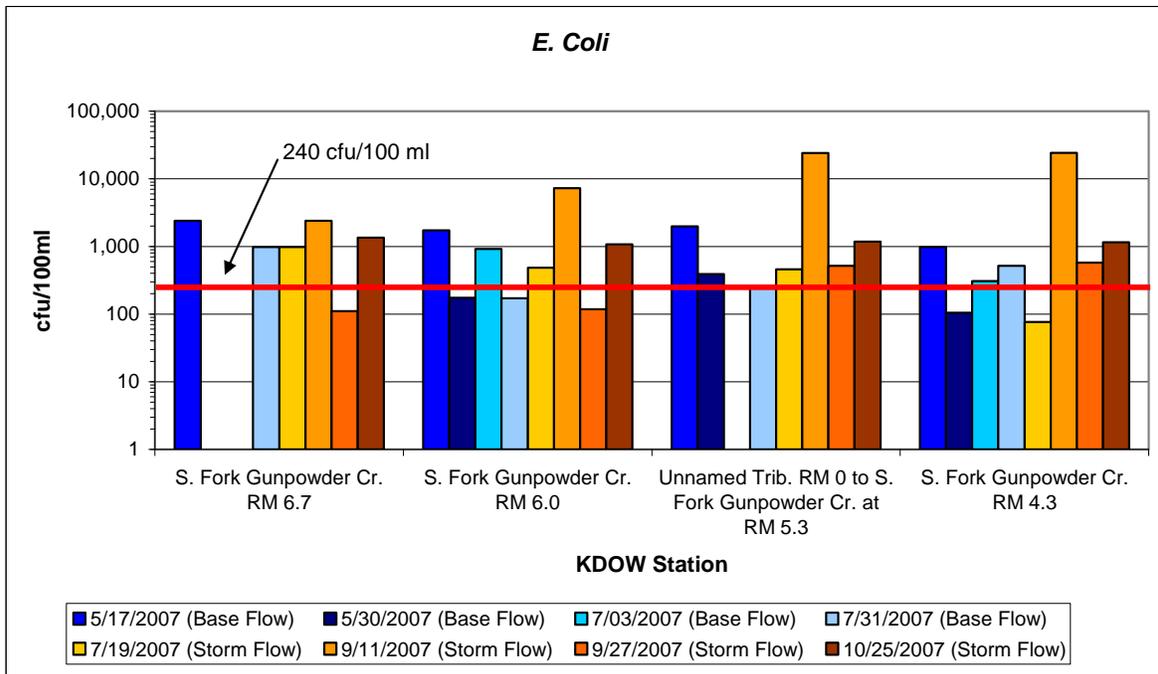


Figure 12. Base and Storm Flow *E. Coli* Concentrations Compared to 240 cfu/100 ml Criterion

4.3.2.b pH

One of the 189 recent pH measurements violated the 9 su pH criteria. A measurement of 9.1 su was observed on an Unnamed Tributary to South Fork Gunpowder Creek at RM 5.3 on May 30, 2007.

4.4 BIOLOGICAL CONDITIONS

Macroinvertebrate communities are susceptible to water quality and habitat degradation, and data from these communities are used as a tool to detect changes in habitat and water quality and assessing stream health (KDOW 2008c). Between 1999 and 2004, KDOW sampled macroinvertebrates at four sites and the MBI⁹ scores ranged from “very poor” to “fair” (Table 1).

Fish were sampled by KDOW at five sites throughout the watershed and the KIBI scores¹⁰ were found to range from very poor to excellent (Table 1).

4.5 STREAM METABOLISM

Stream metabolism can be used as a measure of ecosystem health because it responds to the complex interactions between instream conditions (physical, biological and chemical) and watershed conditions. It can be assessed by looking at the ratio of primary production (P), which is influenced by instream conditions (light and nutrient inputs), to respiration (R), which is influenced by watershed conditions (other nutrient and detritus inputs). This ratio can be calculated using continuous instream dissolved oxygen measurements, because dissolved oxygen responds to both instream and watershed inputs. Smaller ratios (e.g., P:R less than 1) suggest that stream system health is more strongly affected by watershed inputs than by instream and near stream processes.

Stream metabolism has been analyzed at the eight USGS continuous monitoring stations which deploy multi-parameter sondes. These stations are located in watersheds that have varying levels of watershed impacts; however, none are located in an unimpacted or reference watershed. For the 2000-2005 period, all eight sites have ratios that indicate the health of these streams is more strongly affected by watershed inputs than instream and near stream inputs.

For the period 2000 to 2005, Gunpowder Creek (RM 14.7) had the lowest average P/R ratio among all monitored sites, suggesting that stream metabolism at this site is more dominated by organic consumption processes than the other monitored sites. Further, fluctuations in average annual metabolism measures for the Gunpowder Creek site vary more than those observed at any other monitoring sites for the 2000-2005 period. Continued evaluation of stream metabolism at the Gunpowder Creek station will help to

⁹ The macroinvertebrate data collected by KDOW were used to calculate the Kentucky macroinvertebrate biotic index (MBI). The MBI compiles attributes of the macroinvertebrate community such as taxa richness, pollution tolerant species and pollution intolerant species. Additional metrics are added depending on the stream size and/or ecoregion.

¹⁰ The data from this survey were used to calculate the Kentucky Index of Biotic Integrity (KIBI), a multimetric index using fish as an indicator of stream health. The KIBI compiles attributes of the fish community such as taxa richness and abundance, pollution tolerance/ intolerance, feeding and reproductive needs, and presence or absence of native species in order to provide a numerical value and corresponding narrative classification for streams.

understand the natural variability of metabolism and the potential of changes within this watershed impacting the production/respiration balance at this site.

5. SOURCE ANALYSIS

This section summarizes potential pollutant sources in the Gunpowder Creek watershed in order to provide information related to recent observed impairments. Conclusions are based on the watershed characterization and available water quality data.

5.1 WATERSHED SOURCE ANALYSIS

Exceedances of both base flow and storm flow bacteria criterion were observed in South Fork Gunpowder Creek. One pH violation was also observed in the South Fork Gunpowder Creek subwatershed. The recent data for the mainstem of Gunpowder Creek were only available during base flow conditions and no violations were observed. Potential sources were identified within the Gunpowder Creek watershed, based on the watershed characterization information discussed previously. These sources are summarized in Table 13 and their location is shown in Figure 13. There are no CSOs in this watershed.

Table 13. Summary of Potential Sources

	Gunpowder Creek Upstream of South Fork Gunpowder Creek	South Fork Gunpowder Creek	Gunpowder Creek downstream of South Fork Gunpowder Creek
<i>Recent observed impairment =></i>	<i>303(d): Sedimentation, nutrients, organic enrichment^a</i>	<i>Bacteria^b, pH 303(d): Sedimentation, turbidity, nutrients, organic enrichment^c</i>	<i>303(d): Sedimentation^{d, e, f}</i>
SSOs ^g		1 (Florence)	1 (SD1)
SSOs-pump station ^g		6 (SD1) and 4 (Florence)	1 (SD1)
Septic systems	Many	Many One "hotspot" neighborhood	Few
KPDES sanitary outfalls ^h		9	9
KPDES storm water/other outfalls	5	3	
Livestock		Beef cattle	Cattle and horses likely
Storm water runoff	Urban	Urban	Rural
<i>Watershed improvements</i>	<i>Stream & riparian buffer restoration at City of Florence Golf Course</i>	<i>One SD1 SSO at a pump station (American Sign) has recently been eliminated. Additionally, a total of 9 SSOs are planned for elimination. These include:</i> <ul style="list-style-type: none"> <i>• 5 SD1 SSOs at pump stations</i> <i>• 1 Florence SSO and 3 Florence SSOs at pump stations</i> 	<i>1 SD1 SSO planned for elimination Interest in developing a linear park system downstream of Gunpowder Creek Nature Park.</i>
<i>TMDL development planned by KDOW. Preliminary schedule is for approved TMDL to be completed by 2012.</i>			

^a The following sources were identified as potentially contributing to the warm water aquatic habitat impairment: site clearance, agriculture, urban storm water, streambank modifications/destabilization, loss of riparian habitat, highway/road/bridge runoff (KDOW, 2008).

^b The following sources were identified as potentially contributing to the primary contact recreation impairment: source unknown (KDOW, 2008).

^c The following sources were identified as potentially contributing to the warm water aquatic habitat impairment: agriculture, package plant or other permitted small flows discharges, post development erosion and sedimentation, site clearance (KDOW, 2008).

^d The following source was identified as potentially contributing to the warm water aquatic habitat impairment: site clearance (KDOW, 2008).

^e DO, pH and temperature violations have historically been observed at the USGS station, but recent data have not been reviewed.

^f Flooding has also been identified as a problem.

^g SD1 is undertaking a characterization and assessment of the sewer system, and sources are subject to change.

^h Excludes permitted CSOs.

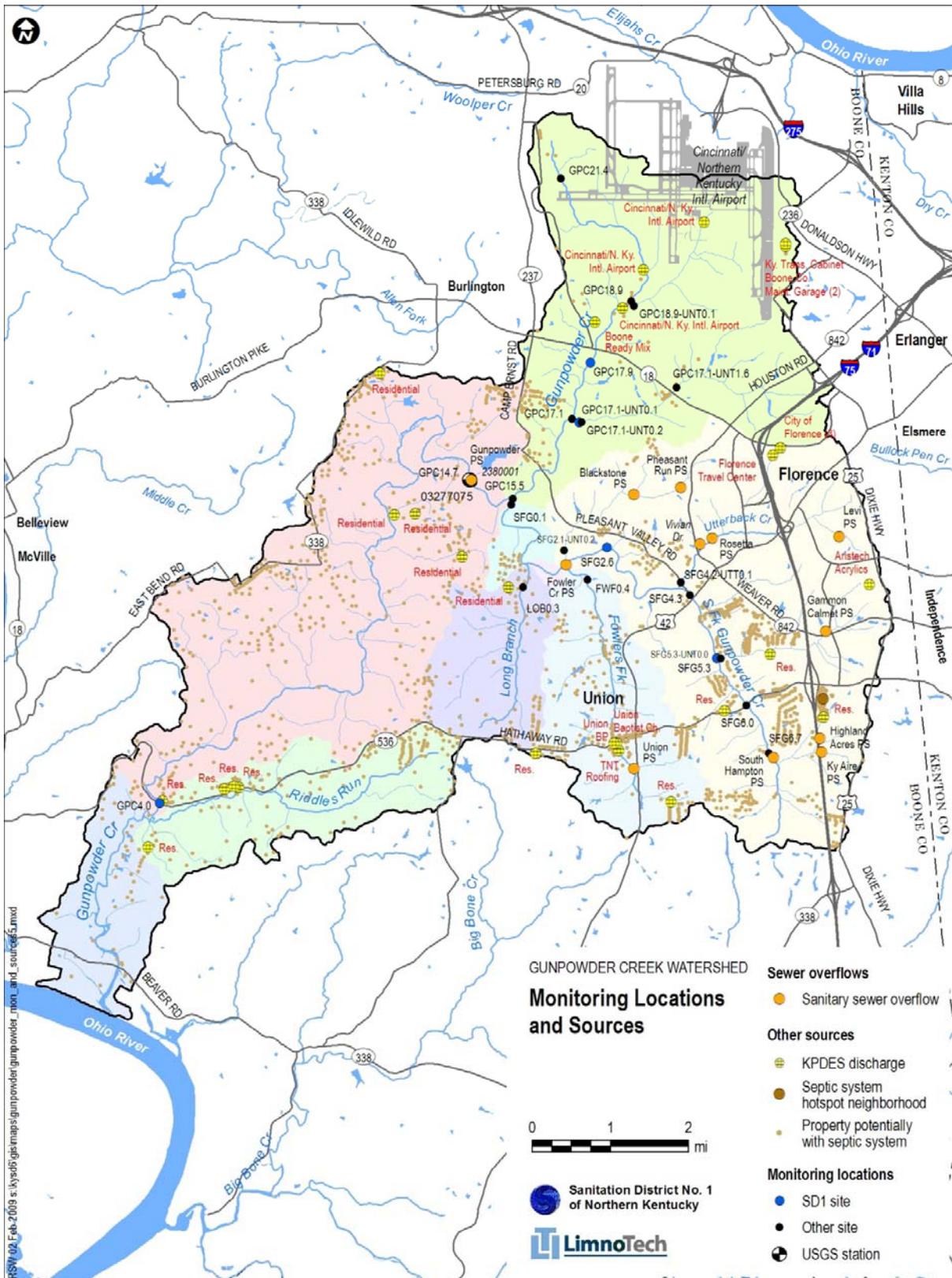


Figure 13. Monitoring Locations and Sources

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6. RANKING

6.1 RESULTS

The WAT! is a tool that assesses the potential for point and nonpoint sources to generate fecal coliform, total solids and total phosphorus pollutant loads. WAT! was developed for these three pollutants because data to support modeling were readily available and they are representative indicators of potential water quality conditions. Calibration of the WAT! tool for total solids and total phosphorus is planned, and results should be available in future reports. Results for fecal coliform are discussed below.

This analysis was conducted for each of the sixteen watersheds located within SD1's study area. In addition to assessing pollutant loading potential by source, the WAT! also assesses pollutant loading potential by watershed, which allows for ranking and comparisons among the sixteen watersheds.

WAT! results¹¹ indicate that under year-round conditions, the Gunpowder Creek watershed has a low ranking (analogous to load) for fecal coliform, relative to the sixteen identified watersheds in SD1's jurisdictional area.

In addition to WAT! results, other factors such as such as presence of public drinking water features, presence of aquatic-dependent threatened and endangered (T&E) species, special designations, and public interest may affect watershed prioritization. These and other ranking considerations are summarized in Table 14.

Table 14. Watershed Ranking Considerations

CSO (#)	SSO (#)	Public Drinking Water	Aquatic-dependent T&E Species ^a (#)	Public interest/	Special designation	WAT Rank, year-round conditions ^b
						Bacteria
0	13	SWAPP Zone 2 (due to Louisville intake) 2 groundwater wells	0	High	None	14 of 16

^a There are no threatened or endangered (T&E) species in this watershed. There are two aquatic-dependent State species of special concern, one is also a species of management concern (Federal designation). There are also three terrestrial species of special concern in this watershed.

^b The WAT! is still under development. All results presented here are for illustrative purposes only. The results are subject to change and should therefore not be relied on or considered definitive.

6.2 SCREENING TO DETERMINE IF ADDITIONAL DATA ARE NEEDED

Gunpowder Creek has been sampled since 1994, and in recent years, has been sampled fairly intensively for flow, water quality, biology and habitat. SD1 plans to conduct chemical and biological monitoring, and habitat assessment at multiple locations in this watershed. Two of the locations SD1 plans to sample in the future (South Fork

¹¹ WAT is still under development. All results presented here are for illustrative purposes only. The results are subject to change and should therefore not be relied on or considered definitive.

Gunpowder Creek at RM 2.6 and 5.3) have been recently sampled by KDOW for their 2006-2007 sampling program, providing an opportunity to compare results over time at these locations.

6.2.1 Data Gap Analysis

Sufficient water quality data exist or are planned for collection to characterize current condition in this watershed.

Wet weather event-based sampling is scheduled for 2010. This monitoring will better characterize the contribution of wet weather sources and overall stream health.

6.3 SOURCE PRIORITIZATION

The sources identified through the process of watershed characterization have been quantified using the WAT!. WAT! has been applied for a five-year period (1992-1996 climatological conditions), to quantify fecal coliform contributions by source. Together the characterization and WAT! results help inform source prioritization for improvement or elimination.

6.3.1 WAT! Results

The relative fecal coliform load generated by source is shown in Figure 14. These WAT! results incorporate predicted sewer overflow volumes from infrastructure model simulations for 1992-1996 climatological conditions¹². CSOs were not a factor in the WAT! results, as none occur in the watershed, however, flow estimates are available for nine of the SSOs.

Under year-round conditions, the largest source of fecal coliform is storm water runoff. Septic systems are not a significant contributor to the total annual bacteria load; however, during base flow conditions they are estimated to contribute the majority of the fecal coliform load.

¹² The results presented were generated by models based on SD1's current understanding of the collection system infrastructure. These models are predictive tools and are based on numerous variables and assumptions on the characteristics of the collection system, and may differ from actual measured field conditions. These models are subject to change based on improved knowledge of the system, improvements to the system, and changes in land use and development. These results are subject to change and should therefore not be relied on or considered definitive.

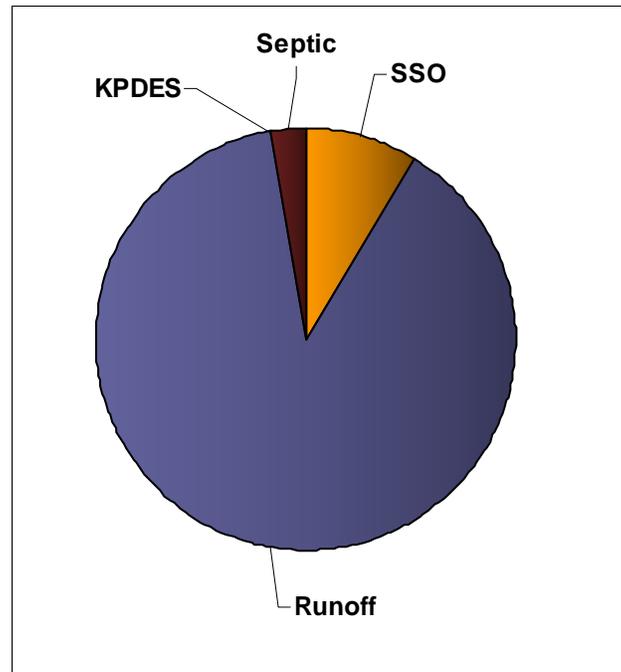


Figure 14. Initial Year-Round WAT! Results for Fecal Coliform

WAT! is still under development. All results presented here are for illustrative purposes only. The results are subject to change and should therefore not be relied on or considered definitive.

WAT! results should be considered preliminary as ongoing work may affect the WAT! source analysis and rankings. Work is currently ongoing to refine the bacteria contribution from septic systems.

6.4 WATERSHED RANKING

The WAT! produced a ranking, by watershed for sixteen watersheds, based on their potential to generate fecal coliform over a 1-year period. The water quality impact score (analogous to load) for each of the sixteen watersheds was used as a ranking metric. Additional detail on the ranking is available in the WAT! documentation.

The WAT! produces rankings of the watersheds for both base flow and year-round conditions. By separating base flow conditions, the impacts of dry weather sources on stream conditions can be differentiated from the combined impact of dry and wet weather sources. The ranking of the Gunpowder Creek watershed during year-round and base flow conditions is provided in Table 15.

Table 15. WAT! Watershed Rankings

	Rank for Year-Round Conditions ^{a,b}	Rank for Base flow Conditions ^{a,b}
Fecal coliform	14	3

^a Rank ranges from 1 to 16. A rank of 1 indicates a high water quality impact score, which is analogous to load. The lowest rank possible is 16.

^b WAT is still under development. All results presented here are for illustrative purposes only. The results are subject to change and should therefore not be relied on or considered definitive.

The WAT! analysis for both total solids and total phosphorus will be presented in future reports upon completion of the WAT! calibration. Future monitoring programs will further populate and refine WAT! results and rankings, aiding in characterization of potential sources.

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