Source: SD1

Ohio River North Tributaries Watershed Characterization Report

Prepared for: Sanitation District No. 1 of Northern Kentucky

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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's) service area. The purpose of these 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 the 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.

This report characterizes the potential impacts on direct Ohio River tributaries that are located in the North Study Basin (Figure 1). Impacts on the Ohio River mainstem will be addressed through application of a detailed water quality model in future work. This report focuses only on a group of smaller tributaries that discharge to the Ohio River, and not the Ohio River mainstem.

The Ohio River North watershed is 31.8 mi^2 in size and is located within Boone and Kenton counties. The watershed is predominantly forested with highly developed areas concentrated in the east, between Covington and Bromley.

The Kentucky Division of Water (KDOW) has designated the Ohio River tributaries for warm water aquatic habitat, primary contact recreation, secondary contact recreation and domestic water supply, at applicable points of withdrawal. Garrison Creek and Second Creek are designated as exceptional waters and reference reach streams (401 KAR 10:030). KDOW has also proposed these two creeks as candidates for outstanding state resource water designation (401 KAR 10reg:030) in the drafted amendments to the Kentucky Administrative Regulations anticipated in February 2009.

No waters within this watershed have been identified as impaired by KDOW (KDOW, 2008). Recent habitat assessments reflect fully supporting conditions, but biological data indicate variable conditions. Recent water quality data reveal elevated fecal coliform and violations of dissolved oxygen in this watershed.

Potential pollutant sources in this watershed include CSOs, other KPDES-permitted dischargers, septic systems and storm water runoff. The potential for these sources to generate fecal coliform bacteria loads has been assessed using a Watershed Assessment Tool (WAT!).[1] The WAT! identifies potential sources within a watershed and estimates their possible impact. It also allows SD1 to compare and rank the sixteen different Northern Kentucky watersheds.

The WAT! calculated a very high fecal coliform loading potential for year-round conditions for this watershed (first of sixteen). This analysis identified CSOs as the

[1] 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.

primary source of fecal coliform, although a majority of these CSOs discharge directly to the Ohio River mainstem and not to the numerous smaller tributaries that are the focus of this report. The WAT! analysis was repeated without the Ohio River CSOs, and revealed that overland storm water runoff is the largest year-round source of fecal coliform to the small tributaries in this watershed. For base flow conditions, this watershed has a higher than average loading potential for bacteria and septic systems were identified as the primary source.

The WAT! ranking is one of several factors that should be considered when prioritizing watersheds for improvement projects. Other factors include moderate public interest based on past monitoring and interest in developing a bike trail, the identification of two aquatic-dependent threatened and endangered species, the presence of public drinking water wells in the watershed, and the designation of Second Creek and Garrison Creek as exceptional waters and reference reach streams, and candidates for OSRW designation.

Next steps for this watershed may include additional biological and habitat assessments to monitor the condition of the exceptional waters and identification of the Garrison Creek dry weather bacteria sources. Because improvement projects are planned to reduce collection system overflows in this watershed, next steps might include the application of the Ohio River model and the WAT! to better understand the appropriate level of control for the watershed.

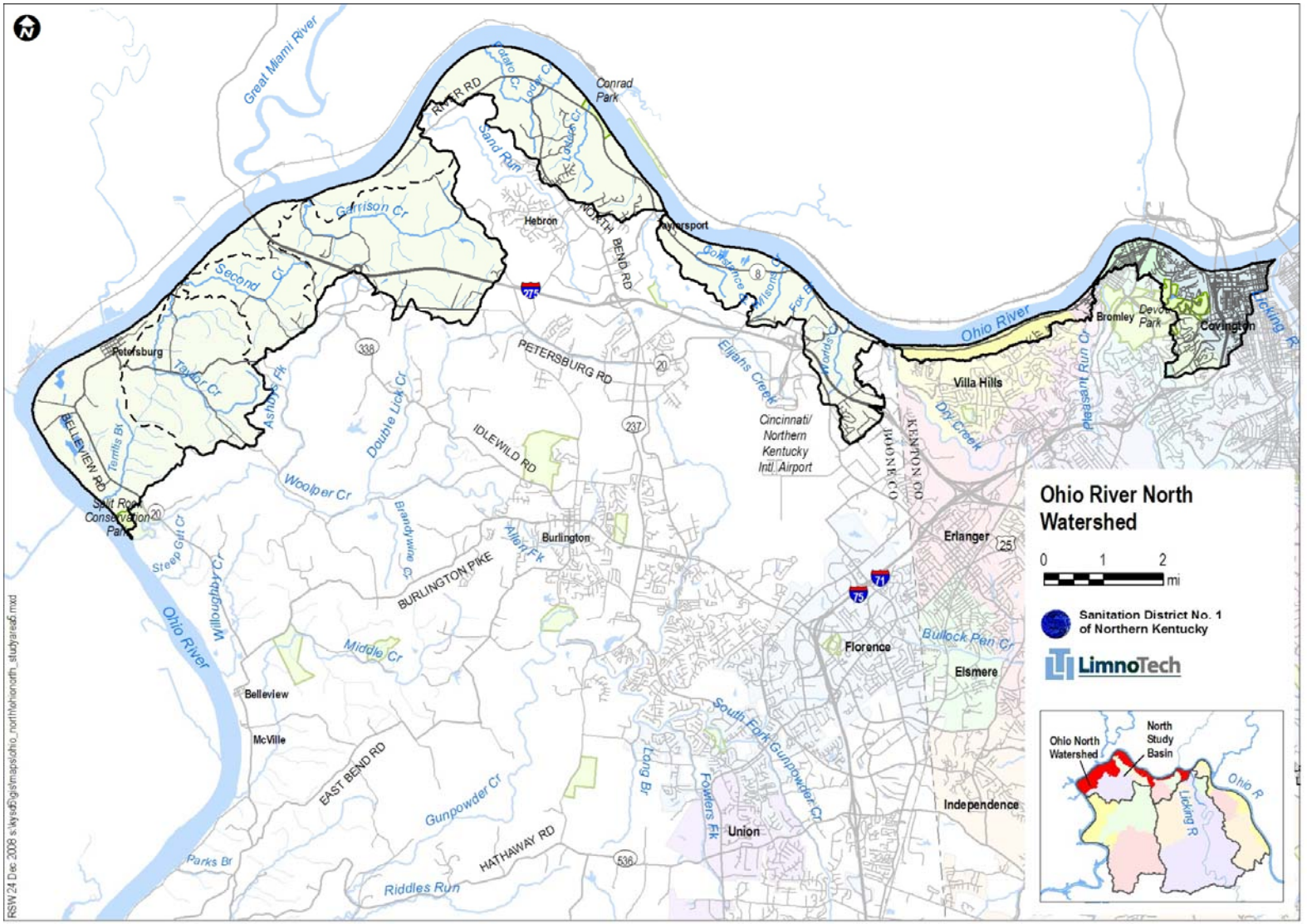

Figure 1. Ohio River North Watershed

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2. WATERSHED FEATURES

The Ohio River North tributaries are located within Boone and Kenton Counties, and include three monitored tributaries, Garrison Creek, Second Creek and Taylor Creek, as well as several small direct tributaries to the Ohio River between Ohio River RM 470.2 and RM 499.8.

2.1 PHYSICAL AND NATURAL FEATURES

The following sections describe key features of the watershed and streams, including hydrology, geology, topography, soils, climate, and habitat. These features are important because they affect land uses, and shape the chemical, biological, and hydrologic characteristics of the Ohio River North tributaries.

2.1.1 Hydrology

The streams in this watershed are all fairly small, with lengths of named streams ranging from 0.4 to 4.9 miles. There are no active USGS continuous monitoring stations on any of these streams.

Backwater effects from the Ohio River are expected near the mouth of some tributaries due to the construction of a series of dams on the Ohio River, which increased the Ohio River stage roughly 17 feet, submerging the mouths of many tributaries. The extent of the backwater effects on these tributaries is dependent upon elevation differences and on the Ohio River stage.

The 100-year floodplain typically extends less than one-half mile upstream of the mouth of these streams. An exception is Taylor Creek, which has a 100-year floodplain that extends over a mile upstream of its mouth.

2.1.2 Geology

This watershed is located in the Outer Bluegrass Physiographic[2] Region, which is underlain primarily by limestone and shale. Although roughly half of this area 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)[3].

Garrison Creek, Second Creek and Taylor Creek traverse the erodible shale of the Kope Formation. Alluvium and glacial deposits are found near the Ohio River and consist of coarse sand and gravel beds. Groundwater yield in these areas is high, and quality is good, although it may have a high iron content. Groundwater is generally much less available on hilltops and hillsides. Wells in the valley bottoms can yield 100-500 gallons per day; however, water is hard and may contain salt and hydrogen sulfide (Carey and Stickney, 2004, Carey and Stickney, 2005).

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

[3] 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.

2.1.3 Topography

The land near the Ohio River is characterized by rolling hills with some steep slopes (Figure 2). Slopes near the shore of the Ohio River, especially on the inside edge of Ohio River bends, can be quite flat.

The highest elevation (932.2 feet) in this watershed is found near Donaldson Highway at the Cincinnati Northern Kentucky International Airport. The lowest elevations in this watershed (453.6 feet at normal Ohio River pool) occur at the Ohio River shoreline.

Figure 2. The Ohio River at Newport, KY

2.1.4 Soils

The nature of soils and topography in a watershed play an important role in both the amount of runoff generated and the amount of soil erosion that can occur.

More than half (59%) of the soils in this watershed are classified as hydrologic soil group C (NRCS, 2006), meaning they have slow infiltration rates when thoroughly wetted.

Nearly all of the soils in this watershed are ranked as either "highly erodible" (63%) or "fairly erodible" (22%) 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. Future development is discussed in Section 2.2.2.

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 3 (NCDC, 2008).

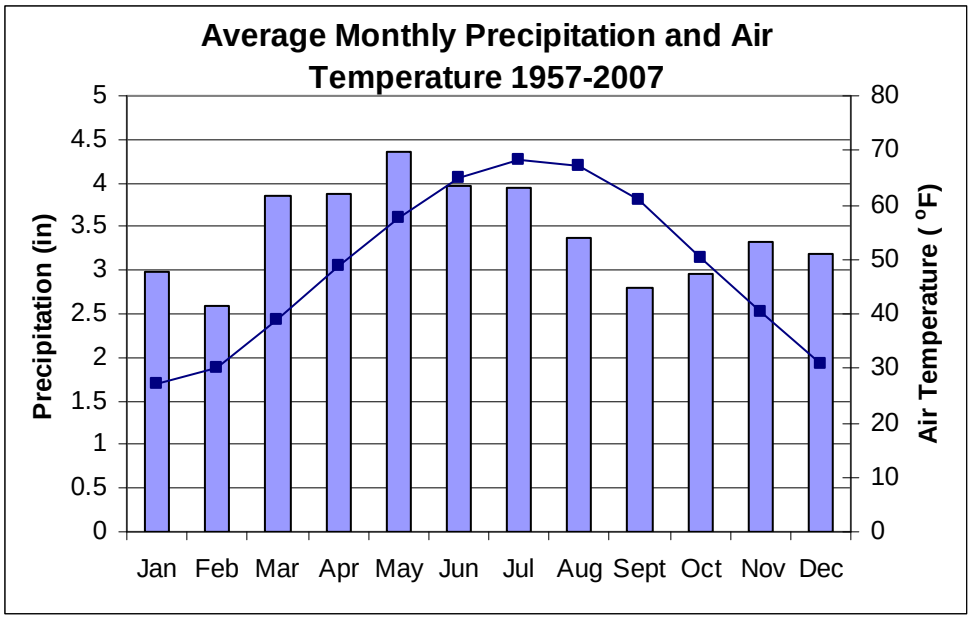

Figure 3. Average Monthly Precipitation and Air Temperature at the Cincinnati Northern Kentucky Airport (1957-2007)

2.1.6 Habitat

This watershed lies within the Outer Bluegrass ecoregion[4], which is characterized by sinkholes, springs, entrenched rivers and intermittent and perennial streams (Woods et al. 2002). Wetlands are not common in this ecoregion, and comprise less than 1% of 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 in this ecoregion. A visit to the area revealed erosion problems in many of the streams.

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). As described in Section 2.2.1, natural habitats have been altered from pre-settlement conditions.

Habitat assessments have been conducted at multiple locations on Second Creek and Garrison Creek[5]. These creeks have variable aquatic habitats (Table 1), although the most recent data indicate fully supporting conditions.

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

[5] 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.

Table 1. Aquatic Habitat and Biological Sampling

Stream	River Mile	Habitat		Macroinvertebrates[a]		Diatoms		Fish	
		Date	Ranking	Date	Ranking	Date	Result	Date	Ranking
Second Creek	0.6	2003	Supporting but threatened	2003, 2004	Good	2003	Poor	2004	Fair
	0.8	2004	Fully Supporting	2004	Excellent				
Garrison Creek	1.3			1993, 1994	Fair				
	1.7	2000	Partially supporting	2000	Excellent	2000	Good		
	2.1	2004	Fully Supporting	2004	Fair	2004	Poor	2004	Poor

[a] The two sites where macroinvertebrates have been sampled twice showed consistent results.

2.2 LAND COVER CHARACTERISTICS

Land cover and land use play an important role in the quantity and quality of runoff into receiving waters, and 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 4) using a variety of other datasets that represent current impervious conditions (roads, parking lots, buildings), open space lands (including parks), and surface waters.

The dominant land cover in this watershed is forest. Highly developed areas are found in the eastern portion of this watershed, primarily concentrated between the mouth of the Licking River and the community of Bromley. Pockets of development are also found north of the Cincinnati Northern Kentucky International Airport and I-275. Incorporated areas in this watershed include Bromley, Covington, Fort Wright, Ludlow, Park Hills and Villa Hills. Roughly 25% of this watershed is developed and 7% is impervious. Major parks in this watershed include: Giles Conrad Park, Treasure Lake Park, and portions of Devou Park and Split Rock Conservation Park along with several smaller parks throughout developed areas.

2.2.1.a Animal operations

A tour of the watershed and a review of information obtained from the Conservation District (Kenton County Conservation District, 2007) confirmed that beef cattle and horses are present in this watershed. There are no permitted concentrated animal feeding operations (CAFOs) or animal feeding operations (AFOs) in this watershed (Kentucky Geographic Network, 2008, 2008a).

2.2.1.b Septic Systems

SD1 estimates approximately 13% of all parcels in this watershed are potentially serviced by septic systems. These systems are located west of Bromley.

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

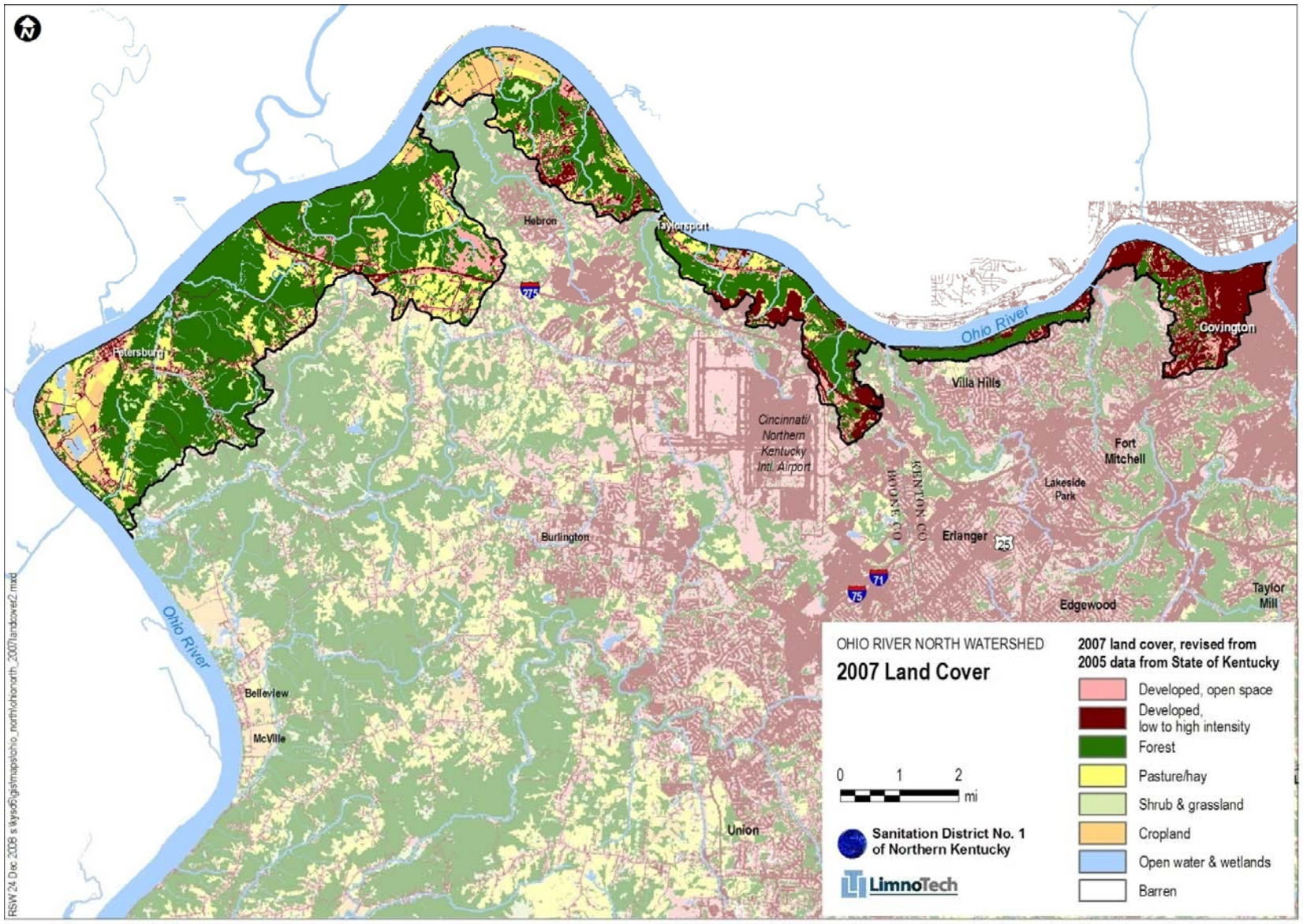

Figure 4. 2007 Land Cover

2.2.2 Future Conditions

Portions of this watershed may become highly developed under ultimate build-out conditions. In the nearby Sand Run and Elijahs Creek watersheds, new construction is already occurring. One transportation project is planned to reconstruct and widen KY 237 (North Bend Road) between I-275 to KY-8 (Kentucky Transportation Cabinet, 2006). Because new development tends to follow existing roads, this project could facilitate development in this area.

The Boone County Comprehensive Plan (BCPC, 2005) identifies two areas in this watershed as being natural areas that should be considered under the Boone County Parks and Recreation Master Plan Study. These areas are intact, and include the forested slopes along the Ohio River, along with the Indian mound areas in Petersburg. Also included is a recommendation to expand the park in Petersburg.

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). Development is predicted to extend northward and westward into this watershed from Florence, generally following existing roads, and replacing land that is currently forest and pasture. The highest density of new development is predicted to be in the east, decreasing to the west. Some small pockets of more intense development are predicted to appear along the Ohio River. In the future, forest and developed lands are predicted to be the dominant land cover (Figure 5). Developed lands are predicted to comprise roughly 35% of the watershed and the amount of impervious surfaces is predicted to increase from 7% currently to 10%.

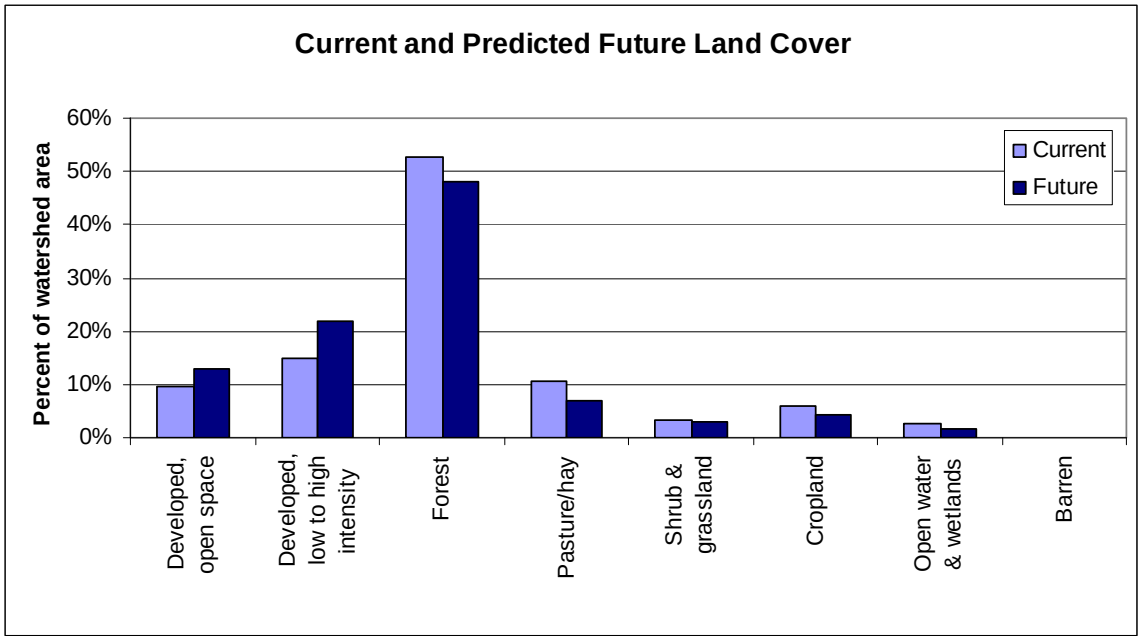

Figure 5. Current and Predicted Future Land Cover

2.3 INFRASTRUCTURE FEATURES

This section summarizes SD1's infrastructure features for the Ohio River North watershed[6]. Approximately 22% of this watershed is within SD1's separate sanitary system. Within the separate sanitary system, there are approximately 26.7 miles of separate sanitary sewer lines.

Approximately 9% of this watershed is within SD1's combined sanitary system area. Within the combined system, there are approximately 64.2 miles of combined sewer lines.

Approximately 35% of this watershed lies within SD1's storm water service area. With in the service area, the storm water system is comprised of approximately 95.5 miles of streams and channels and approximately 25.5 miles of pipes.

The extent of the separate sanitary, combined sanitary system and the storm water system in this watershed is shown in Figure 6.

[6] 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.

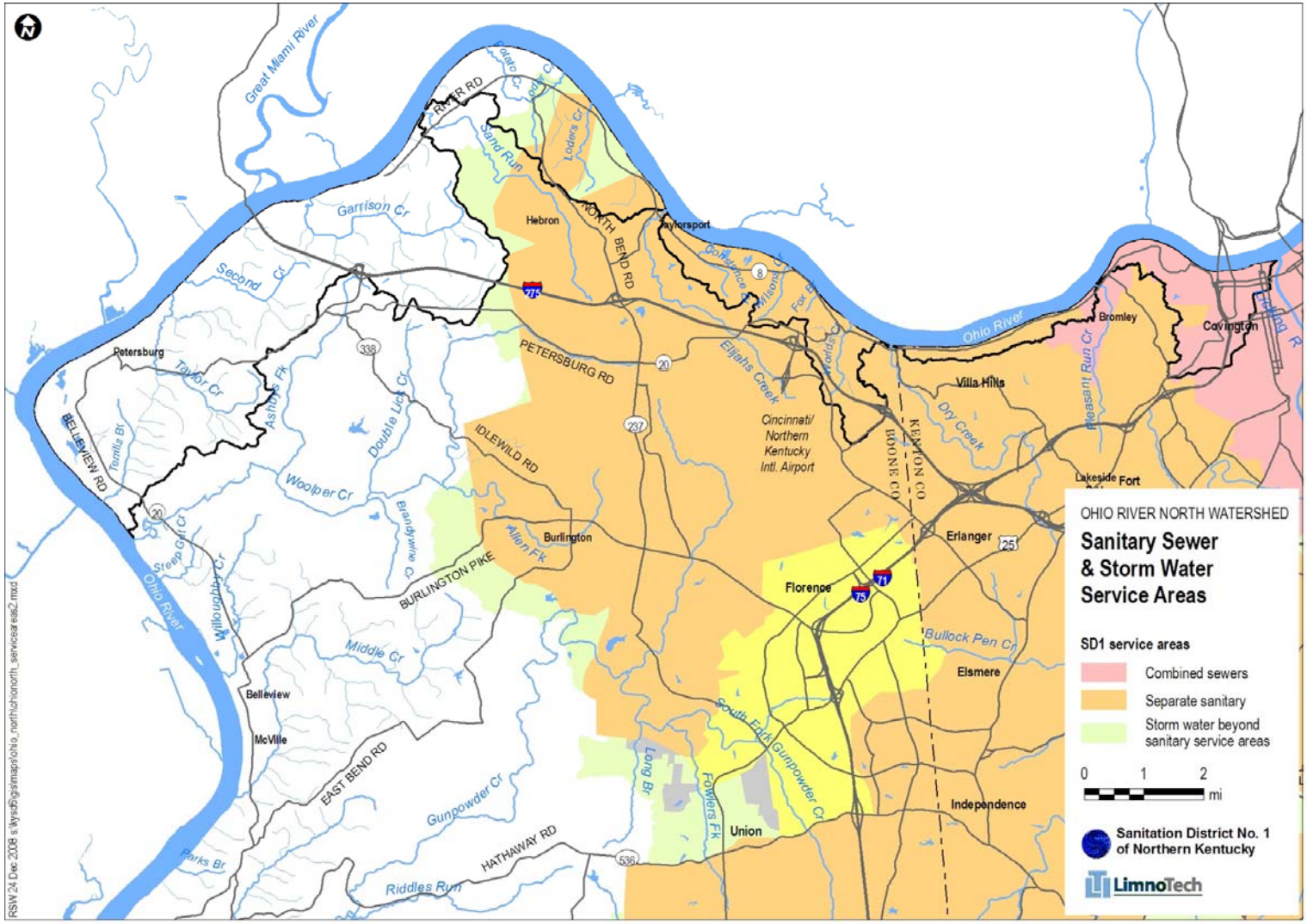

Figure 6. Sanitary Sewer, Combined Sewer and Storm Water Service Areas

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 twelve KPDES-permitted dischargers with a total of sixteen permitted outfalls in the Ohio River North watershed. Nine of the permittees discharge sanitary wastewater, and the majority (6) of these are covered under general permits for residences. These discharges and others are presented in Table 2. Permitted CSOs are not included in this tally and are discussed separately.

Based on a review of recent effluent monitoring data (January 2007 to June 2008), it was observed that three of the permitted dischargers have violated permit limits for at least one of the following parameters: fecal coliform, total suspended solids (TSS), pH, and 5-day biochemical oxygen demand (BOD_5). KDOW requires effluent monitoring for the residential general permits (monitoring is required twice per year); however, data were not available for four of these facilities in this watershed. KDOW estimates that, residential dischargers, as a general group, fail at a rate that is believed to be higher than 10% (KDOW, 2007).

2.3.1.b Sewer overflows

There are 24 combined sewer overflows (CSOs) in this watershed (Table 3), five of which are "to be permitted". Twenty of the CSOs discharge directly to the Ohio River and four discharge to tributary waterways. There are no sanitary sewer overflows (SSOs) in this watershed.

Table 2. Permitted Dischargers

Receiving Water	KPDES ID	Facility Name	Outfall	Permit Type	Outfall Description	Permit Violations
Second Creek	KYG400419	Residence	0011	Minor	Sanitary wastewater Type B	NA
Second Creek	KYG400473	Residence	0011	Minor	Sanitary wastewater Type B	NA
Second Creek	KYG401102	Residence	0011	Minor	Sanitary wastewater Type B	NA
Garrison Creek	KY0100021	Tradition Golf Club Inc	0011	Minor	Sanitary wastewater	Fecal coliform, TSS
Garrison Creek	KYG400541	Residence	0011	Minor	Sanitary wastewater Type B	None
Garrison Creek	KYG400548	Residence	0011	Minor	Sanitary wastewater Type B	None
Ohio River	KYG840059	Northern Ky Aggregates	0011	Minor	Controlled discharge	NA
Ohio River	KY0094072	Rivershore Farms Subd	0011	Minor	Sanitary wastewater	pH, TSS
Ohio River	KY0099694	Mcginnis Inc Hebron Div	0011	Minor	Washwater from dry cargo clean	NA
			0012	Minor	Washwater from dry cargo clean	NA
Ohio River	KYG402000	Residence	0011	Minor	Sanitary wastewater Type B	NA
Ohio River	KYG840092	Taylorsport Sand Co Inc	0011	Minor	Controlled discharge	None
Ohio River	KY0063274	Transmontaigne Prod Serv Inc	001A	Minor	Storm water runoff	None
			002A	Minor	Storm water runoff	None
			003A	Minor	Sanitary wastewater	BOD5, fecal coliform, TSS
			003B	Minor	Strm wtr runoff/sanitary wwtr	NA

NA = no data available

Table 3. Combined Sewer Overflow Points

Manhole ID	Common Name	Direct Discharge to Ohio River?	Typical Year Spill Frequency (No.)[a,.c]	Typical Year Volume (MG)[a,c]
1320112[b]	Dixie Hwy/S. Arlington	No	0	0
1350155	Park Hills/Dixie Hwy.	No	4	0.13
1380132[b]	Amsterdam/ Parkvale	No	3	0.25
1380146[b]	Amsterdam/ Arlington	No	2	0.01
1440204	Scott St.	Yes	1	<0.01
1440205	Greenup St.	Yes	19	0.62
1440206	Garrard St.	Yes	33	3.38
1440209	2nd St. at Russell	Yes	92	56.39
1440212	2nd St. at Madison and Madison Ave.	Yes	54	5.98
1470089	Philadelphia St.	Yes	6	0.44
1470093	Bakewell, Main St. and Johnson St.	Yes	58	43.68
1480185[b]	Wright St.	Yes	29	1.85
1480187	Willow Run	Yes	72	684.77
1490132	Parkway at Highway	Yes	37	17.92
1490172	Swain Ct.	Yes	0	0
1500131	Altamont St.	Yes	53	9.08
1710114	Kenner St.	Yes	12	0.76
1710116	Adela St.	Yes	56	29.30
1710119	Butler St.	Yes	35	18.28
1710121	Carneal St.	Yes	23	11.55
1710124	Ash St.	Yes	34	6.00
1720109	Lagoon St.	Yes	40	23.67
1730261[b]		Yes	NA	NA
1730263	Rohman St.	Yes	39	2.40

[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] These are "to be permitted" CSOs, i.e., SD1 has (or will) identified these locations for KPDES permitting.

[c] NA indicates model data is not available

2.3.1.c Storm water discharges

SD1's storm water service area within this watershed extends west to Loder Creek. Portions of this watershed (e.g., Covington) are within the combined sewer area and do not have storm water outfalls.

In addition to the storm water outfalls, there are also nine suspected illicit activity points (SIAs) in the watershed, between the mouth of Pleasant Run Creek and Elijahs Creek. SIAs are locations where there was possible evidence of illicit activity during SD1's storm water mapping project (2001-2002). These locations are being further investigated to determine if they are recurring. Much of this watershed is 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.

Storm water outfalls covered by individual KPDES permits have been discussed previously in section 2.3.1.a.

2.3.2 Recently Completed Infrastructure Projects

SD1 has recently implemented several infrastructure projects in the Ohio River North watershed as part of the Consent Decree compliance efforts:

- Pilot Solids and Floatables Control Program. Several CSOs tributary to the Ohio River are included in this program.
- Phase III of the Large Diameter Sewer Assessment Program. This investigation program helps identify opportunities to increase capacity and/or reduce rainfall-dependent infiltration and inflow, thereby reducing wet-weather overflows.
- Sonar inspection of interceptors in the combined sewer area. SD1 completed a sonar inspection of the Ohio and Licking River Interceptors (almost 79,000 feet of sewer) in 2007. This investigation program helped identify opportunities to increase capacity in the combined sewer system, minimizing CSO discharges to receiving waters.

Finally, the Parlor Grove sewer assessment project was completed in 2004 and involved extending sewer lines, giving 27 properties the opportunity to connect to sewer service.

2.3.3 Ongoing or Planned Infrastructure Improvement Projects

SD1 has several ongoing or planned infrastructure projects for this watershed:

- The Grit Chamber Project involves constructing two grit chambers to capture grit and other debris within the main sewer interceptors along the Ohio and Licking Rivers to maximize flows in the collection system and to the Dry Creek Wastewater Treatment Plant. One of the two grit chambers has already been installed just upstream from the Bromley Pump Station and is working effectively to capture grit and other debris for removal and to maximize flow to the Pump Station and treatment plant.
- The Bromley Pump Station evaluation project involves investigating the feasibility of lowering the wet well settings for the pumps. This will maintain lower hydraulic grade lines in the Ohio River Interceptor during dry weather.

With this adjustment, flow to the pump station and treatment plant will be maximized during wet weather, and collection system storage will be increased during smaller wet-weather events.

- Pump Station Backup Power Program. This program will minimize the risk of pump station overflow by ensuring that the thirteen stations in this watershed have backup power in place by no later than December 31, 2015 (note that the five major pump stations in the watershed, including Bromley, already have backup power installed).
- The combined sewer interceptor cleaning program under SD1's Continuous Sewer Assessment Program (CSAP). This program will minimize the risk of overflows by ensuring the entire pipe cross section is available to convey flow. This program will clean the interceptor sewers on a regular schedule starting in 2009.
- Several early-action Nine Minimum Control implementation projects, including in-line storage controls at the Willow Run and Parkway/Highway CSOs, and additional simple solids and floatable controls. Final decisions on these projects are being developed as part of the ongoing watershed planning effort.

Project information is provided in Table 4.

Table 4. Planned Infrastructure Improvement Projects

Capital Improvement Project Title	Goals	Anticipated Start Date	Anticipated Completion Date	Project Total
Grit Chamber Projects – Ohio River North	Increase capacity of the combined sewer system to store and convey flows to treatment; reduce solids discharge through CSOs.	2006	2010	$4,000,000
Bromley Pump Station Evaluation Project	Increase capacity of the combined sewer system to store and convey flows to treatment	2008	2008	NA – Adjustment of wet well settings involves minimal cost.
Pump Station Backup Power Program	Ensure that all pump stations have backup power or other appropriate measures for addressing power outages	2008	2015	$1,016,000
Interceptor Cleaning Program	Maintain full capacity in combined sewer interceptor system	2009	Ongoing as part of CSAP	To be determined
NMC Activities – In-line Storage and Simple Solids and Floatables Controls	Reduce CSO volumes and solids and floatables discharges	2008	2009	To be determined

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 waters have been designated by the State of Kentucky as Outstanding National Resource Waters (401 KAR 10:030), and no National Marine Sanctuaries have been designated within the project study area (NOAA, 2008). There are no known commercial shellfish beds within the Ohio River study area nor is shellfish harvest for consumption by private individuals known to occur. Therefore these three criteria were determined not to be relevant to the identification of sensitive waters in this watershed. The remaining three criteria are discussed below.

2.4.1 Threatened & Endangered Species or Their Designated Critical Habitat

Threatened and endangered species, species of concern and their designated critical habitat within this watershed were identified by contacting the Kentucky State Nature Preserves Commission (KSNPC). KSNPC identified seven species (Table 5; KSNPC, 2007, 2007a), two of which (running buffalo clover and lake sturgeon) are designated as either federal or state threatened and/or endangered species.

Running buffalo clover is a small herbaceous plant (Figure 7) that inhabits streambanks and upland areas, and erosion is noted as the biggest threat (KSNPC, 2006). Other factors contributing to population declines are loss of bison populations, non-native plants, and overall habitat loss (USFWS, 2003).

Figure 7. Running Buffalo Clover, *Trifolium stoloniferum*

The lake sturgeon is a large fish (up to 300 pounds at maturity) that inhabits nearshore areas in cold or cool rivers and lakes. It is a bottom feeder that spawns in riffles in early spring (Hubbs and Lagler, 2007), and is sensitive to altered hydrologic regimes, sedimentation, overexploitation and pollution (NatureServe, 2007).

Three aquatic-dependent species in this watershed have been identified as species of concern: the burbot, the eastern hellbender and the waterplantain spearwort. The burbot (Figure 8) inhabits riffles and undercut banks and is thought to be declining due to introduced species, water pollution and dams.

Figure 8. The Burbot, *Lota lota*

The eastern hellbender, a large salamander (Figure 9) inhabits fast-flowing, shallow waters with good water quality and is particularly sensitive to low levels of dissolved oxygen (Mayasich et al., 2003). The causes of eastern hellbender's population decline include habitat degradation and loss, water quality declines and impoundments (Mayasich et al., 2003). It was last observed in this watershed in 1904.

Figure 9. The Eastern Hellbender, *Cryptobranchus alleganiensis alleganiensis*

Waterplantain spearwort is an herbaceous perennial plant that inhabits wetland areas. Threats to this plant include riparian and stream alteration and changes in hydrologic conditions (KSNPC, 2006).

Two identified species (redback salamander and bank swallow) are not aquatic or dependent on aquatic habitats, but are dependent on upland habitats such as woodlands, grasslands and bluffs (KSNPC, 2007, 2007a).

Table 5. Endangered Species, Threatened Species and Species of Concern

Taxonomic Group	Common name	Scientific name	Status[a]	Last Observed	Habitat(s)	Identified Threats
Fishes						
	Lake Sturgeon	*Acipenser fulvescens*	Federal - SOMC State - Endangered	N/A	Nearshore in cold to cool rivers[b]	Altered hydrology, sedimentation, overexploitation and urban pollution[c]
	Burbot	*Lota lota*	State - Special Concern	1960	Stony riffles and undercut banks in large streams and rivers[b]	Non-native species introductions, water pollution[b] and dams[c]
Amphibians						
	Eastern hellbender	*Cryptobranchus alleganiensis alleganiensis*	Federal - SOMC State - Special Concern	1904	Shallow swift streams with high water quality[d]	Habitat loss/degradation, water quality declines and impoundments
	Redback Salamander	*Plethodon cinereus*	State - Special Concern	1983	Woodlands[c]	Habitat loss/degradation
Vascular Plants						
	Running Buffalo Clover	*Trifolium stoloniferum*	Federal - Endangered State - Threatened	2004	Riparian areas, upland areas[e]	Habitat loss, non-native species, bison decline
	Waterplantain Spearwort	*Ranunculus ambigens*	State - Special Concern	1977	Sloughs, swamps and pond margins[e]	Changes in hydrologic conditions, overstory removal, stream/wetland alteration, increased erosion[e]
Breeding Birds						
	Bank Swallow	*Riparia riparia*	State - Special Concern	1984	Steep riverbanks[f]	Rip-rapping of natural streams; human disturbance and channelization and stream bank modifications for flood control and bank stabilization[g]

[a] SOMC = Species of Management Concern, a federal designation.

[b] Source: Hubbs and Lagler, 2007.

[c] Source: NatureServe, 2007.

[d] Source: Mayasich et al., 2003.

[e] Source: KSNPC, 2006.

[f] Source: Robbins et al., 1983.

[g] NatureServe, 2008

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.

The tributaries to the Ohio River within this watershed are designated for PCR. Although swimming is known to occur in the Ohio River, it is not clear whether or not swimming activity occurs in the tributaries, as public surveys on swimming in the area are unavailable. No public swimming beaches were identified in the watershed. Additional data will be gathered about uses of the creeks in this watershed.

2.4.3 Public Drinking Water Intakes or their Designated Protection Areas

There are no public drinking water intakes from surface waters in this 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 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 10).

There are 4 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 10, along with other drinking water supply features.

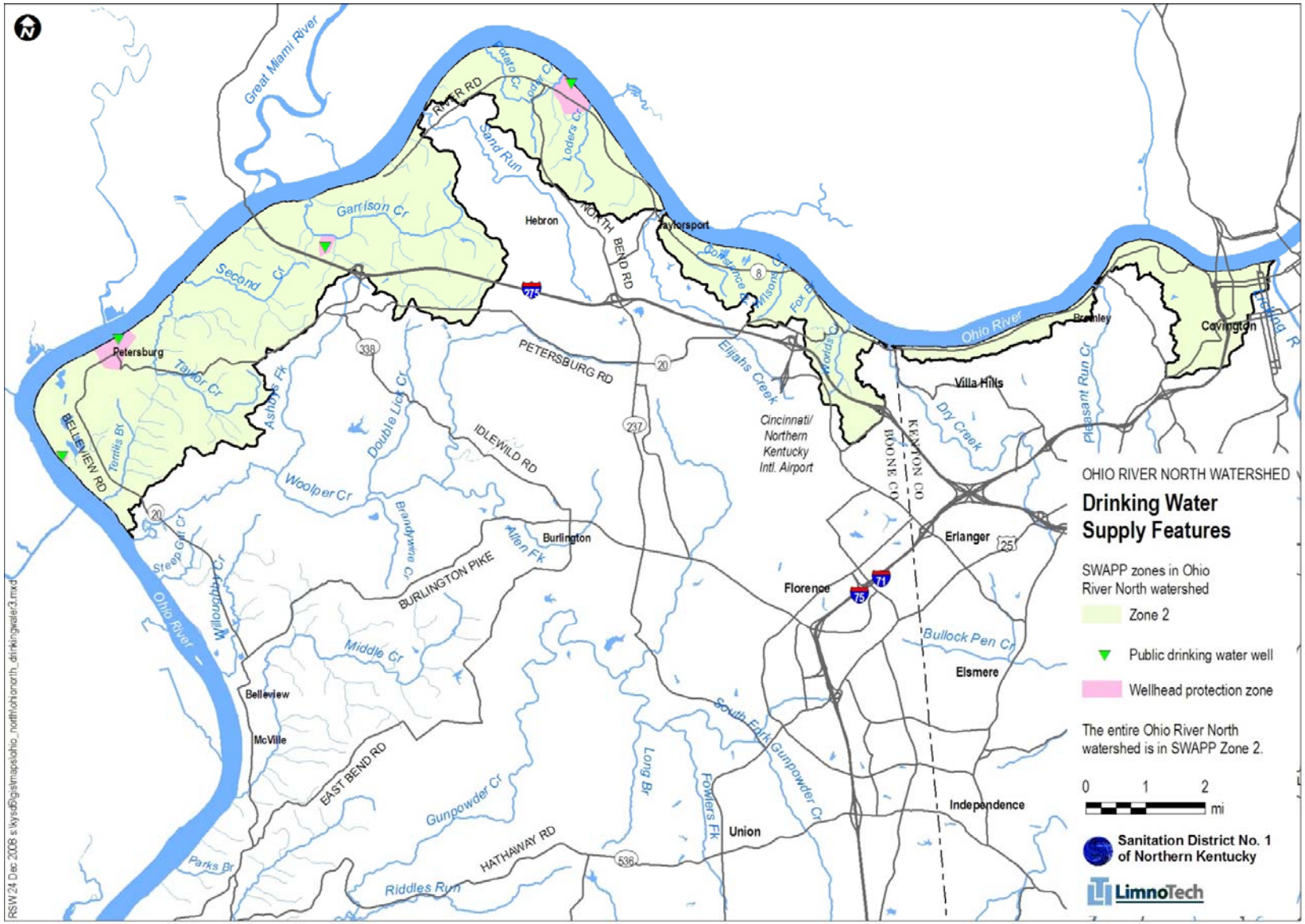

Figure 10. Drinking Water Supply Features

2.5 PUBLIC INTEREST/WATERSHED GROUP ACTIVITIES

Interest in this watershed is considered moderate and is gauged through sampling and interest in developing a biking trail. The Kentucky Division of Water (KDOW), Northern Kentucky University (NKU), Licking River Watershed Watch (LRWW), Conservation District and SD1 have all conducted sampling in this watershed at various frequencies.

Furthermore, there is recent interest in developing a four mile walking and biking trail (Riverfront Commons Trail Project) connecting Covington to Bellevue. This trail would pass through both the Ohio River East and Ohio River North watersheds, and would involve development of a 10-foot wide path along the Ohio River (http://www.covingtonky.com/index.asp?fn=news&id=1180; http://www.southbankpartners.com/home.asp). Some improvements described in the Devou Park Master Plan (approved July 2008) are within this watershed, although many are in the adjacent Pleasant Run Creek watershed (http://www.covingtonky.com/index.asp?page=devou_master_plan_final). Public interest in this park appears to be high.

The Boone County Greenways Plan is also under development and may contain additional information on proposed greenways in this watershed; however, the plan was not available at the time of this report.

Three conservation-oriented organizations, the Conservation District, the Kenton Conservancy and the Boone County Conservancy, are active in Boone and Kenton Counties but their involvement in this watershed has not been confirmed. The Conservation District works closely with the Natural Resource Conservation Service (NRCS) and the Kentucky Cabinet for Environmental and Public Protection to protect soil, water and other natural resources. The Kenton Conservancy is working to form partnerships with all stakeholders in the community and has as its mission the preservation of lands of natural, cultural, recreational, and historical significance for the people of Kenton County (http://www.kentonconservancy.org/). The Boone County Conservancy is an organization dedicated to the creation of parks and protection of land with unique or significant recreational, natural, scenic, historical or cultural value. This group is working with professors at Thomas More College and Northern Kentucky University to identify unique or significant natural areas in Boone County and will work to protect areas through voluntary acquisition of land and interests in land, in partnership with the many constituencies in the community (http://www.theblooneconservancy.org).

3. WATERBODY USES

This section describes designated and current uses in this watershed.

3.1 DESIGNATED USES

The tributaries in this watershed 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 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.

Garrison Creek and Second Creek have also been categorized as exceptional waters and are waterbodies defined in the cabinet's reference reach network (401 KAR 10:030). Furthermore, these two creeks are identified as candidates for outstanding state resource water designation (401 KAR 10reg:030) in the drafted amendments to the Kentucky Administrative Regulations anticipated in February 2009.

- **Exceptional waters** means a surface water categorized as exceptional by the cabinet pursuant to 401 KAR 10:030.
- **Outstanding state resource waters** means a surface water categorized by the cabinet as an outstanding national resource water pursuant to 401 KAR 10:031.

3.2 CURRENT USES

Available information on current uses within the watershed is summarized below.

- A 2004 assessment in Garrison Creek indicated habitat could support a diverse and productive ecosystem.
- A 2004 assessment of biological condition in Garrison Creek produced a fair ranking based on macroinvertebrate data, and poor based on fish and diatom data.
- A 2003 assessment of Second Creek (RM 0.6) found supporting, but threatened habitat. A year later, habitat was ranked as fully supporting at RM 0.8.
- A 2004 assessment of biological conditions in Second Creek indicated good to excellent based on macroinvertebrate data, poor based on diatom data, and fair based on fish data.

- 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 waterbodies in this watershed. However, KDOW and the Division of Public Health Protection and Safety recommend against swimming or other full-body contact with surface waters immediately following heavy rainfall events, especially in dense residential, urban and livestock production areas (KDOW, 2007b).
- Fishing is permitted on the Ohio River mainstem and six Ohio River access sites are located in this watershed. Two of these access sites are marinas (www.fw.ky.gov). Fishing also occurs at Prisoner's Lake in Devou Park.
- There are no surface drinking water intakes in this watershed.
- There are four active public water supply groundwater wells in this watershed (KDOW, 2008a; KDOW, 2007c).

4. WATERBODY CONDITIONS

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

4.1 303(d) STATUS AND POLLUTANTS OF CONCERN

None of the waterbodies in this watershed are listed on Kentucky's 2008 303(d) list of impaired waters (KDOW, 2008).

4.2 MONITORING PROGRAMS

Water quality data have been collected in this watershed by KDOW, Licking River Watershed Watch (LRWW), Northern Kentucky University (NKU), Conservation District and SD1. Data currently compiled by SD1 from known monitoring programs are presented in Table 6; however, only data which have been fully analyzed are discussed in Section 4.3 Water Quality Data Analysis. Water quality data exist for Garrison Creek, Second Creek and Taylor 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 three sampling locations are: Garrison Creek RM 1.7, Second Creek RM 1.6 and Taylor Creek RM 0.5. Typical analyses will include bacteria, nutrients, solids, oxygen-demanding constituents and physical parameters.

Additionally, habitat and biological conditions will be monitored at stations in Garrison and Second Creeks. Surveys to assess the degree of stream hydromodification are also planned by SD1 in these watersheds.

Outfall sampling was initiated in 2007 to better characterize water quality and loadings from CSOs, SSOs and storm water runoff. Two CSO outfalls are being sampled in this watershed and analyzed for bacteria, nutrients, solids, metals and oxygen-demanding constituents. This sampling program plan is anticipated to continue until ten events are monitored.

Table 6. Summary of Water Quality Monitoring Data

Entity	Dates	Parameters Sampled	Sampling Locations[b]	Number of Samples
NKU	2003	Fecal coliform, boron, chloride, hardness, conductivity, silicon, sulfate, TSS, temperature, nutrients, metals	Garrison Cr. RM 1.3, 4.2	1 sample (9/6/2003)
NKU	2003	Fecal coliform	Garrison Cr. RM 4.2	1 sample (7/10/2003)
LRWW	2003, 2004	Fecal coliform	Garrison Cr. RM 1.3, 4.2	3 samples for RM 1.3 (5/14/2003, 7/10/2003, & 5/22/2004) 1 sample for RM 4.2 (5/14/2003)
Conservation District	2004-2006	Fecal coliform, E. coli, alkalinity, chloride, DO, pH, conductivity, temperature, sulfate, TSS, nutrients	Garrison Cr. RM 1.3, 4.2	6 samples for RM 1.3 (July and Sept for 2004 and 2005; May and July for 2006); 5 samples for RM 4.2 (May, July, and Sept for 2004; May and July for 2006)
KDOW	2004	Alkalinity, chloride, hardness, DO, pH, conductivity, TOC, TSS, temperature, sulfate, nutrients	Second Cr. RM 0.8	1 sample (4/21/2004)
KDOW	2003, 2004, 2006	Alkalinity, chloride, fluoride, hardness, DO, pH, conductivity, TOC, TSS, TDS, temperature, sulfate, nutrients	Garrison Cr. RM 1.7, 2.1; Second Cr. RM 0.6	1 sample for Garrison Cr. RM 1.7 (7/10/2006), 2 samples for Garrison Cr. RM 2.1 (3/24/2004 & 5/1/2006), 2 samples for Second Cr. (4/15/2003 & 4/7/2004)
SD1	2006	Fecal coliform, E. coli, DO, pH, conductivity, turbidity, temperature	Garrison Cr. RM 1.7; Second Cr. RM 1.6; Taylor Cr. RM 0.5	2 samples from baseline survey (10/3/2006 & 10/23/2006)
SD1	2007	Fecal coliform, E. coli, carbonaceous biological oxygen demand (5-day), DO, pH, conductivity, TSS, temperature, turbidity, nutrients	Garrison Cr. RM 1.7; Second Cr. RM 1.6; Taylor Cr. RM 0.5	1 sample (8/14/2007)
SD1	2008[a]	Fecal coliform, E. coli, carbonaceous biological oxygen demand (5-day), DO, pH, conductivity, TSS, temperature, turbidity, nutrients	Garrison Cr. RM 1.7; Second Cr. RM 1.6; Taylor Cr. RM 0.5	1 sample (8/28/2008)

[a] Data not analyzed in Section 4.3

[b] RM = River mile

4.3 WATER QUALITY DATA ANALYSIS

Historical data (2003-2005) have been analyzed to identify past water quality problems in this watershed. Recent data (2006-present) 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. The recent data analysis does not include the 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

Historical data reveal past bacteria exceedances at two locations in Garrison Creek (Table 7). Measurements for locations not shown met water quality criteria.

Table 7. Historical Bacteria Exceedances

Stream	River Mile	Parameters exceeding criteria			
		Fecal coliform bacteria		*E. coli* bacteria	
		# samples	% of samples exceeding criteria[a]	# samples	% of samples exceeding criteria[a]
Garrison Creek	1.3	8	63%	4	50%
Garrison Creek	4.2	6	83%	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.

4.3.2 Recent Data

More recent water quality data were available for Garrison Creek (RM 1.7), Second Creek (RM 1.6), and Taylor Creek (RM 0.5). These three locations were sampled for both fecal coliform (8 samples total) and dissolved oxygen (8 samples total). Elevated bacteria were not observed in Second Creek or Taylor Creek, nor were dissolved oxygen violations observed in Second Creek.

Locations with recent water quality issues are presented in Tables 8 and 9. Measurements for parameters and locations not shown met water quality criteria.

Table 8. Recent Bacteria Exceedances

Stream	River Mile	Parameter exceeding criteria	
		Fecal coliform bacteria	
		# samples	% of samples exceeding criteria[a]
Garrison Creek	1.7	3	33%

[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 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." Even this comparison, however, is conservative, as the criterion is meant to be applied to a dataset of 5 or more samples collected over a 30-day period.

Table 9. Recent Dissolved Oxygen Violations

Stream	River Mile	Parameter violating criteria	
		Dissolved oxygen	
		# measurements	% of measurements in violation[a]
Garrison Creek	1.7	3	33%
Taylor Creek	0.5	2	50%

[a] The dissolved oxygen criterion is 4 mg/l.

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

4.3.2.a Bacteria

SD1 collected bacteria samples in this watershed during base flow conditions in 2006 and 2007. The fecal coliform criteria (400cfu/100ml) was exceeded in one sample (492 cfu/100ml) collected from Garrison Creek (Figure 11). No exceedances of *E. coli* criteria (200cfu/100ml) were observed. The maximum *E. coli* concentration, 172 cfu/100 ml was recorded in Garrison Creek.

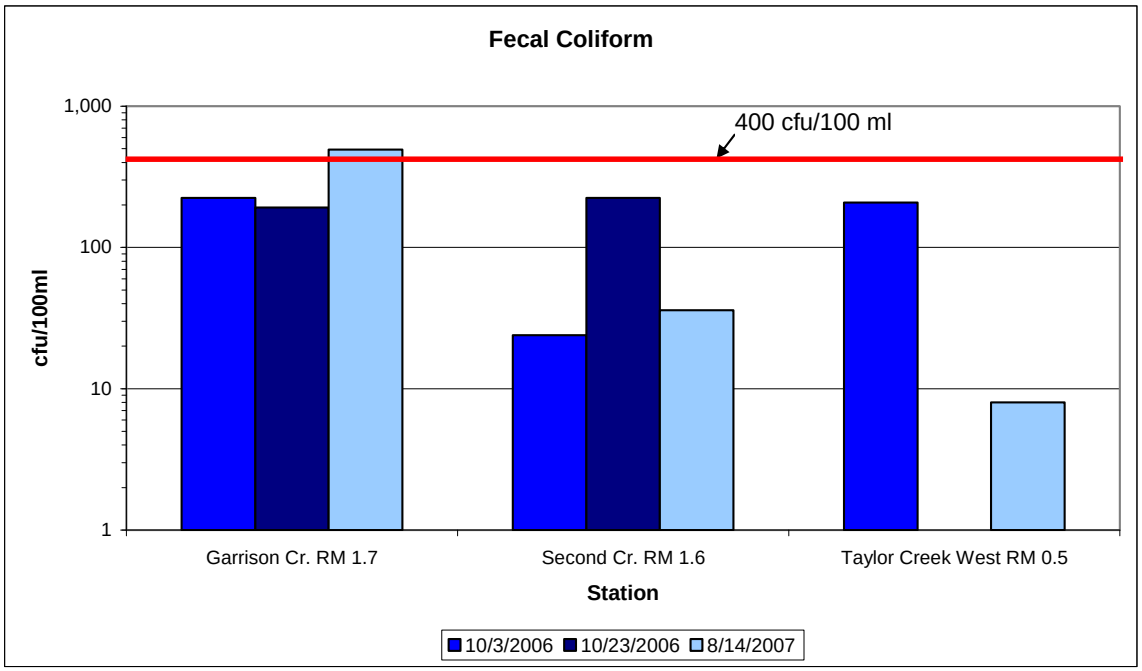

Figure 11. 2006-2007 Base Flow Fecal Coliform Results Compared to 400 cfu/100 ml Criterion

4.3.2.b Dissolved oxygen

Dissolved oxygen measurements violated the applicable water quality criterion (4 mg/l) in one sample from Garrison Creek (3.9mg/l) and one sample from Taylor Creek (2.7mg/l). Both violations were recorded on August 14, 2007.

4.4 BIOLOGICAL CONDITIONS

Biological conditions in the study area have been assessed in Second and Garrison Creeks. The data from these studies reveal variable conditions (Table 1).

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 2008b). KDOW sampled macroinvertebrates at two sites in Second Creek and at three sites on Garrison Creek (Table 1). The MBI scores[7] calculated for Second Creek ranged from good to excellent (2003 and 2004 data). The MBI scores calculated for Garrison Creek ranged from fair to excellent based on data collected at three different locations in four different years.

Benthic algae are useful biological indicators of water quality because they are sensitive to changes in water quality and are the primary producers within aquatic ecosystems. Diatoms are benthic algae that are useful indicators of biological integrity because at least a few can be found under almost any condition, and they are identifiable to species (KDOW, 2008b). In 2003, diatom communities were surveyed in Second Creek (RM

[7] 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.

0.6) and received a rating of "poor". Diatom communities in Garrison Creek were rated as "good" (2000) and "poor" (2004) at RM 1.7 and 2.1, respectively.

In 2004, KDOW sampled the fish population at one site on Second Creek and one site on Garrison Creek. The calculated KIBI scores[8] indicated "fair" conditions for the Second Creek site and "poor" conditions for the Garrison Creek site.

[8] The data from the fish surveys 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.

5. SOURCE ANALYSIS

This section summarizes potential pollutant sources in the Ohio River North watershed to provide information related to recent (2006-2007) observed impairments. Conclusions are based on the watershed characterization and recent water quality data.

5.1 WATERSHED SOURCE ANALYSIS

Sources within this watershed are summarized in Table 10 and shown in Figure 12. Sources in the Garrison Creek and Taylor Creek subwatersheds are presented separately because these creeks are identified as having recent water quality violations. Although all of the recent violations were observed during base flow conditions, all potential sources are included in this summary.

Table 10. Summary of Potential Sources

	Direct drainage east of Garrison Creek	Garrison Creek	Taylor Creek	Direct drainage west of Garrison Creek
Recent observed impairment =>		*Bacteria, dissolved oxygen*	*Dissolved oxygen*	
CSO[a]	24 (20 are direct to Ohio)			
Septic systems	Many	Many		Many
KPDES –sanitary outfalls[b]	4	3		3
KPDES –storm water/other outfalls[b]	6			1
Livestock	Reported to exist in the Ohio North Tributaries watershed, but subwatershed location is unknown.			
Storm water runoff	Urban	Rural	Rural	Rural
Watershed improvements	Grit Chamber Project, Bromley PS Evaluation, Pump Station Backup Power Program, Nine Minimum Control implementation projects and Combined Sewer Interceptor Cleaning Program are planned to increase the capacity of the combined sewer system and reduce CSO volume. Devou Park improvements and Riverfront Commons bike trail are in planning stages.			

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

[b] Excludes permitted CSOs.

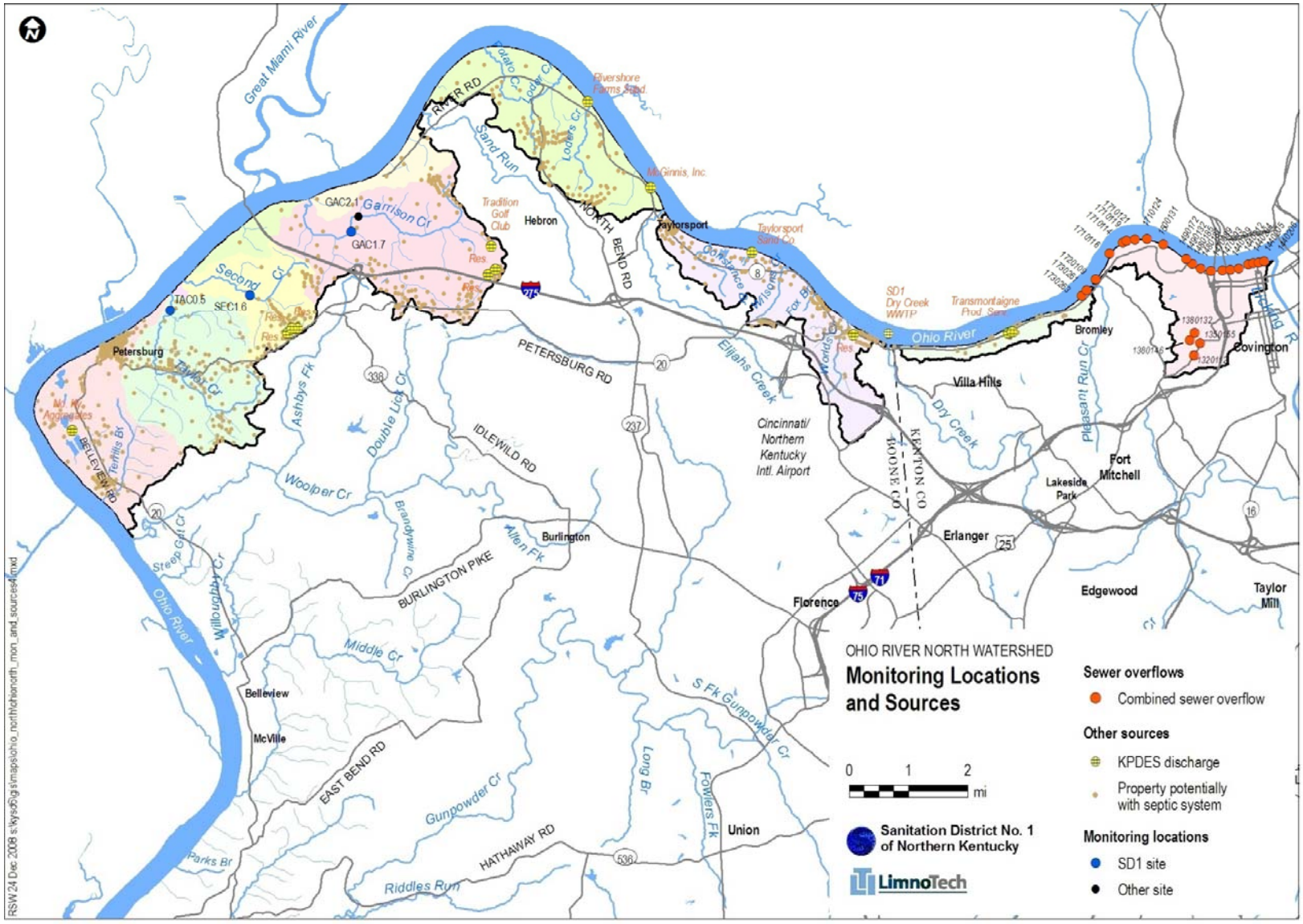

Figure 12. Monitoring Locations and Sources

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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! results[9] indicate that under year-round conditions, the Ohio River North watershed has a very high rank (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 the 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 11.

Table 11. Watershed Ranking Considerations

# CSOs	# SSOs	Public Drinking Water	# Aquatic-dependent T&E Species[b]	Special designation	Public Interest	WAT! Rank, Year-Round Conditions[a]
						Bacteria
24 (20 are direct to the Ohio R.)	0	Zone 2 (due to Louisville intake) 4 groundwater wells	2	Garrison Cr. and Second Cr. are exceptional waters & reference reach streams	Moderate	1 of 16

[a] 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.

[b] Four additional species are aquatic-dependent State species of special concern and/or Federal species of management concern. There are two terrestrial State species of special concern in this watershed.

6.2 SCREENING TO DETERMINE IF ADDITIONAL DATA ARE NEEDED

The three largest streams in this watershed have been monitored for water quality. Two of these, Garrison Creek and Second Creek, have also been assessed for habitat and biological condition. Flows have not been measured in any streams in this watershed.

[9] 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 State considers Garrison and Second Creeks to be exceptional waters and reference reach streams. Recent biological data indicate conditions in these streams may have deteriorated.

6.2.1 Data Gap Analysis

No additional chemical monitoring is recommended for this watershed, beyond that already planned. Additional biological and habitat assessments, beyond those currently planned, may be considered for Garrison and Second Creek to monitor the condition of these streams. A site visit to the Garrison Creek watershed may be useful to identify dry weather bacteria sources.

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 13, for all sources located within this watershed including CSOs that discharge directly to the Ohio River. These WAT! results incorporate predicted sewer overflow volumes from infrastructure model simulations for 1992-1996 climatological conditions[10]. Flow estimates are available for twenty-one of the CSOs in this watershed. SSOs are not a factor in the WAT! results as none occur in this watershed.

Under year-round conditions, the largest source of fecal coliform is CSOs (Figure 13). 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.

WAT! does not distinguish internally between CSOs that discharge to tributaries and those that discharge directly to the Ohio River; however, WAT! results can be processed to distinguish between total watershed load and tributary load.

Figure 14 shows the relative fecal coliform load generated, by source, for all sources that discharge to tributaries within this watershed. CSOs that discharge directly to the Ohio River are excluded from this figure. Under year-round conditions, the largest source of fecal coliform to the Ohio North tributaries is storm water runoff.

[10] 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.

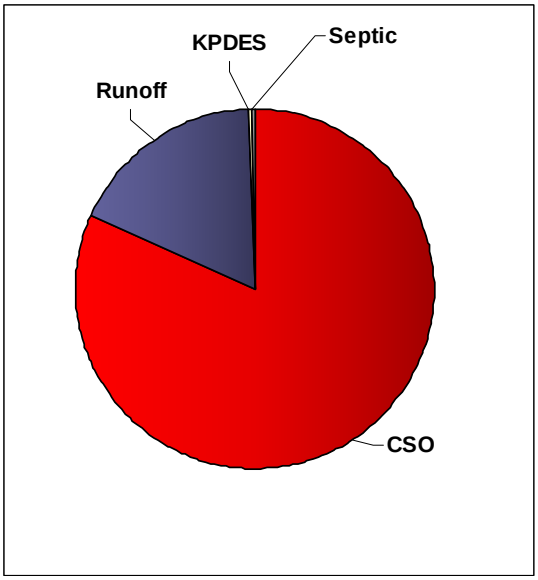

Figure 13. Initial Year-Round WAT! Results for Fecal Coliform (Includes Ohio River CSOs)

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.

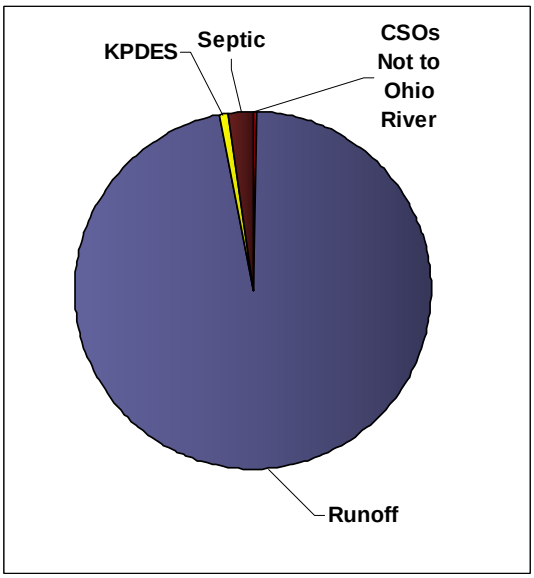

Figure 14. Initial Year-Round WAT! Results for Fecal Coliform (Excludes Ohio River CSOs)

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 RANK

The WAT! produced a ranking for the sixteen watersheds based on their potential to generate fecal coliform loads over a 1-year period. The water quality impact score (analogous to load) for each watershed was used as the 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 Ohio River North watershed during year-round and base flow conditions is provided in Table 12.

Table 12. WAT! Watershed Rankings

	Rank for Year-Round Conditions[a,b]	Rank for Base flow Conditions[a,b]
Fecal coliform	1	4

[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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