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Ohio River East 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) 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, pollution 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 East 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 East watershed is almost entirely located within Campbell County and contains numerous small tributaries that drain to the Ohio River. Land cover in this watershed is predominantly forest, but developed lands are also common in the northern portion of this watershed.

There are no active flow gages in this watershed, so it is not possible to characterize tributary flows. However, local topography is steep in places and runoff is expected to be rapid in these locations. Some very low, flat areas also exist near the Ohio River shoreline.

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. Tenmile Creek appears on the 303(d) list as partially supporting the warm water aquatic habitat use (KDOW, 2008). Available biological and habitat data are consistent with this listing indicating fair biological conditions and a habitat that is not supporting a diverse and productive ecosystem. pH violations have been recently observed during base flow conditions.

Potential pollutant sources in the Ohio River East watershed include CSOs, sanitary sewer overflows (SSOs), other KPDES-permitted dischargers, livestock, septic systems, and urban and rural storm water runoff.

The potential for these sources to generate fecal coliform bacteria loads has been assessed using a Watershed Assessment Tool (WAT!).[1] This tool assesses the potential sources within a watershed and estimates their potential impact. It also allows SD1 to compare and rank the sixteen different Northern Kentucky watersheds.

[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.

The WAT! calculated a high fecal coliform loading potential for year-round conditions for this watershed and a low loading potential for base flow conditions. This analysis identified CSOs as the 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 primary bacteria source for the small tributaries. The dominant source under base flow conditions is predicted to be septic systems.

The WAT! ranking is one of several factors that should be considered when prioritizing watersheds for improvement projects. Other factors include high public interest in this watershed due to the opening of the Eastern Regional Water Reclamation Facility in the nearby Twelvemile Creek watershed, two endangered aquatic-dependent species, the presence of public groundwater drinking water intakes, and the location of this watershed off-shore from and upstream of three surface drinking water intakes on the Ohio River.

Next steps for this watershed may include investigation of sources and additional biological and habitat assessments to benchmark current conditions. Because improvement projects are planned to reduce collection system overflows in this watershed, next steps might include the application of the Ohio River and the WAT! to better understand the appropriate level of control for the watershed.

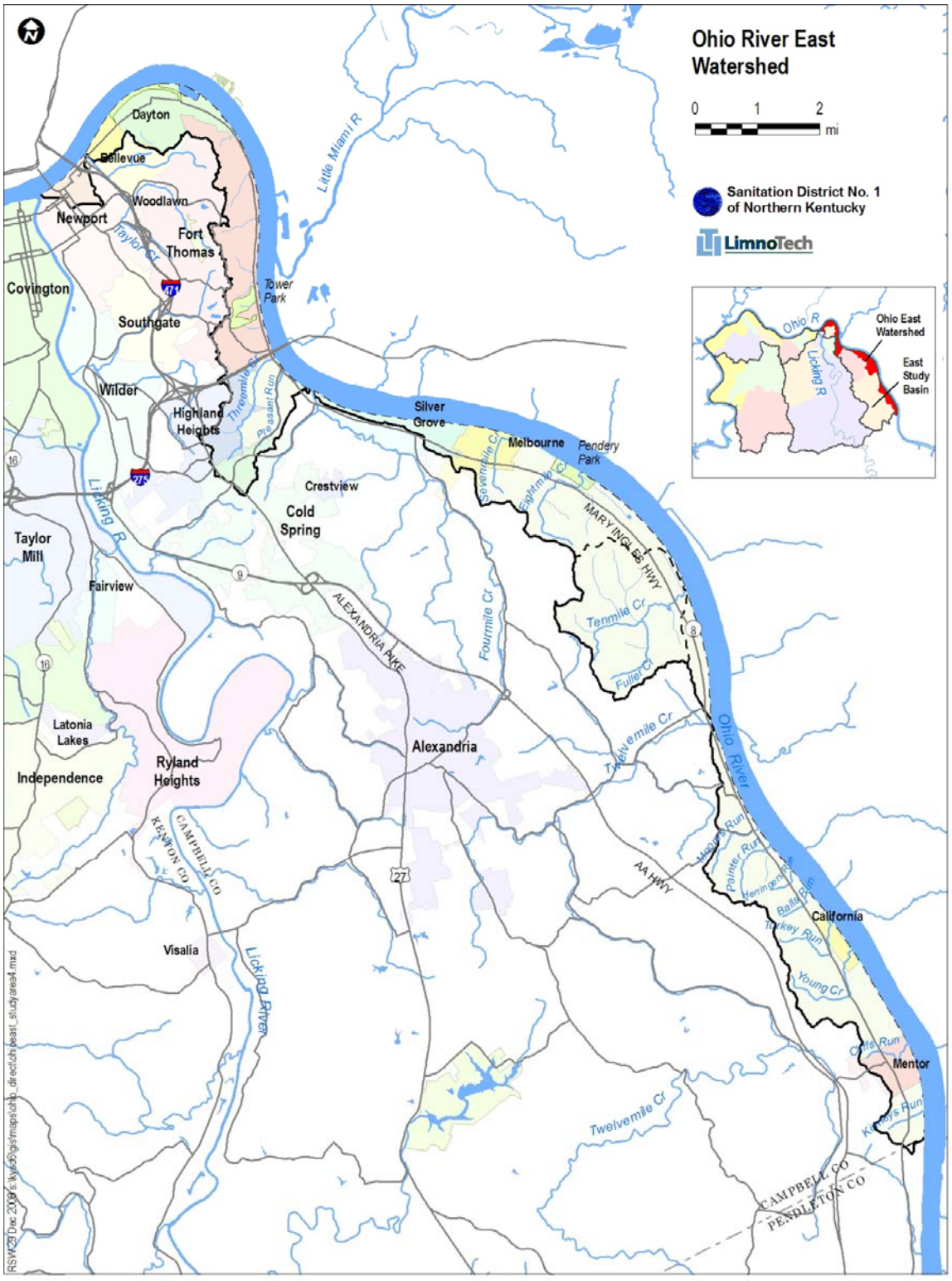

Figure 1. Ohio River East Watershed

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2. WATERSHED FEATURES

The 20-square mile Ohio River East watershed is located primarily within Campbell County (a very small portion is located in Pendleton County). It includes one monitored tributary (Tenmile Creek) as well as several small direct tributaries to the Ohio River between Ohio River RM 443.8 (Pendleton/Campbell county line) and RM 470.2 (Licking River mouth).

2.1 PHYSICAL AND NATURAL FEATURES

The following sections describe key features of the watershed and creeks, 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 East tributaries.

2.1.1 Hydrology

The streams in this watershed are all fairly small, with lengths of named streams ranging from 0.8 to 2.6 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 Ohio River East 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 creeks.

2.1.2 Geology

This watershed is located in the Outer Bluegrass Physiographic[2] Region, which is underlain primarily by Ordovician-age interbedded limestone and shale (Ray et. al., 1994). Although a few areas in this watershed are 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].

Many of the smaller tributaries to the Ohio River traverse the erodible shale of the Kope formation. Groundwater is generally much less available on hilltops and hillsides. Wells in the valley bottoms generally yield 100-500 gallons per day; however, water is hard and may contain salt and hydrogen sulfide (Carey and Stickney, 2005). Tenmile Creek is primarily underlain by glacial sediments, which have a high groundwater yield. 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 iron may be high.

[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 exists, 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. Slopes near the shore of the Ohio River, especially on the inside edge of Ohio River bends, can be quite flat.

Within this watershed, the higher elevations are found along ridge lines that separate the Ohio River corridor from the interior watersheds. The highest elevations in this watershed (884.1 feet) are found along Washington Trace Road, between Alexandria and California, KY, and in Cold Spring, along Alexandria Pike, south of the I-471/I-275 interchange. The lowest elevations in the watershed (453.6 feet at normal Ohio River pool) occur at the Ohio River shoreline.

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.

Most (83%) of the soils in the Ohio River East 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" (37%) or "fairly erodible" (50%) 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 2 (NCDC, 2008).

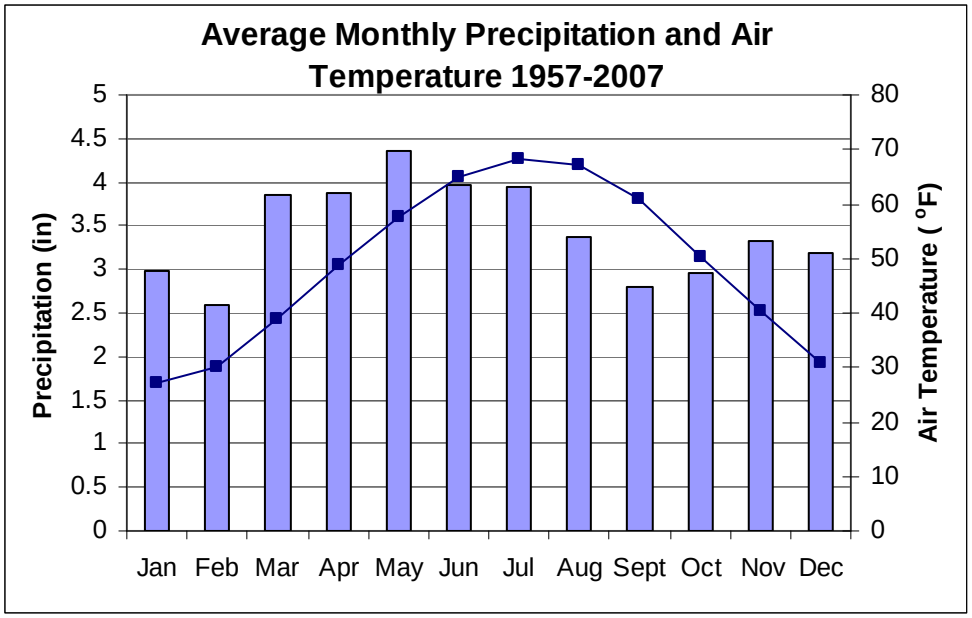

Figure 2. Average Monthly Precipitation and Air Temperature at the Cincinnati Northern Kentucky Airport (1957-2007)

2.1.6 Habitat

The northern part of this watershed lies within the Outer Bluegrass ecoregion[4], which is characterized as having sinkholes, springs, entrenched rivers and intermittent and perennial streams (Woods et al., 2002). Wetlands are not common in this ecoregion and comprise approximately 1% of the area of this watershed. Streams generally have relatively high levels of suspended sediment and nutrients. Glacial outwash, which tends to be highly erodible, exists in a few areas within the Outer Bluegrass ecoregion.

Areas in this watershed that are south of the Twelvemile Creek mouth lie within the Hills of the Bluegrass ecoregion, which has slender ridges and hills leading down into narrow valleys. Streams have steep gradients and are generally lower in nutrients than those in the Outer Bluegrass ecoregion, but may suffer higher erosion rates (Woods et al., 2002). Stream bank erosion has been observed in Tenmile Creek, within the Hills of Bluegrass ecoregion (Figure 3).

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

Figure 3. Tenmile Creek at Mary Ingles Highway

Pre-settlement conditions in this watershed 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.

One habitat assessment was conducted by KDOW on Tenmile Creek in 2003, the results of which indicate that this stream does not support a diverse and productive ecosystem[5] (Table 1).

Table 1. Aquatic Habitat and Biological Sampling

Stream	RM	Habitat		Fish	
		Date	Ranking	Date	Ranking
Tenmile Creek	1.4	2003	Not supporting	2003	Fair

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 this 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 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 and most of the development is concentrated in the north. Developed lands comprise 34% of this watershed, and roughly

[5] This assessment was conducted using EPA-established protocols and rating 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.

8% of the watershed is impervious. Incorporated areas in this watershed include Bellevue, California, Cold Spring, Dayton, Fort Thomas, Highland Heights, Melbourne, Mentor, Newport and Silver Grove. Land cover to the south is more rural in nature, but pockets of development are found near Silver Grove, Melbourne, California and Mentor. Parks identified in this watershed include: Gill Lynn Park, Tower Park, Morscher Park Sports Complex, and Pendery Sports Park.

2.2.1.a Animal operations

There are no permitted concentrated animal feeding operations (CAFOs) in this watershed, however, there is one animal feeding operation (AFO) in the Tenmile Creek subwatershed, which is a small farm with 10 animals (beef/swine) (Kentucky Geographic Network, 2008, 2008a). A tour of the watershed and a review of information obtained from the Conservation District (BCKCD, 2007) confirmed that beef cattle and horse operations exist in the Tenmile Creek subwatershed and elsewhere in this watershed.

2.2.1.b Septic Systems

SD1 estimates approximately 6% of all parcels in this watershed are potentially serviced by septic systems. These systems are located south of Melbourne, and outside SD1's sanitary service area.

The Northern Kentucky Health Department does not currently have estimates for septic system failure rates in Campbell County. 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. Furthermore, the Health Department has indicated that, based on slope, soil, and substrate characteristics, septic systems installed in Campbell County are prone to more frequent failures than those located in Boone or Kenton Counties (NKHD, 2008).

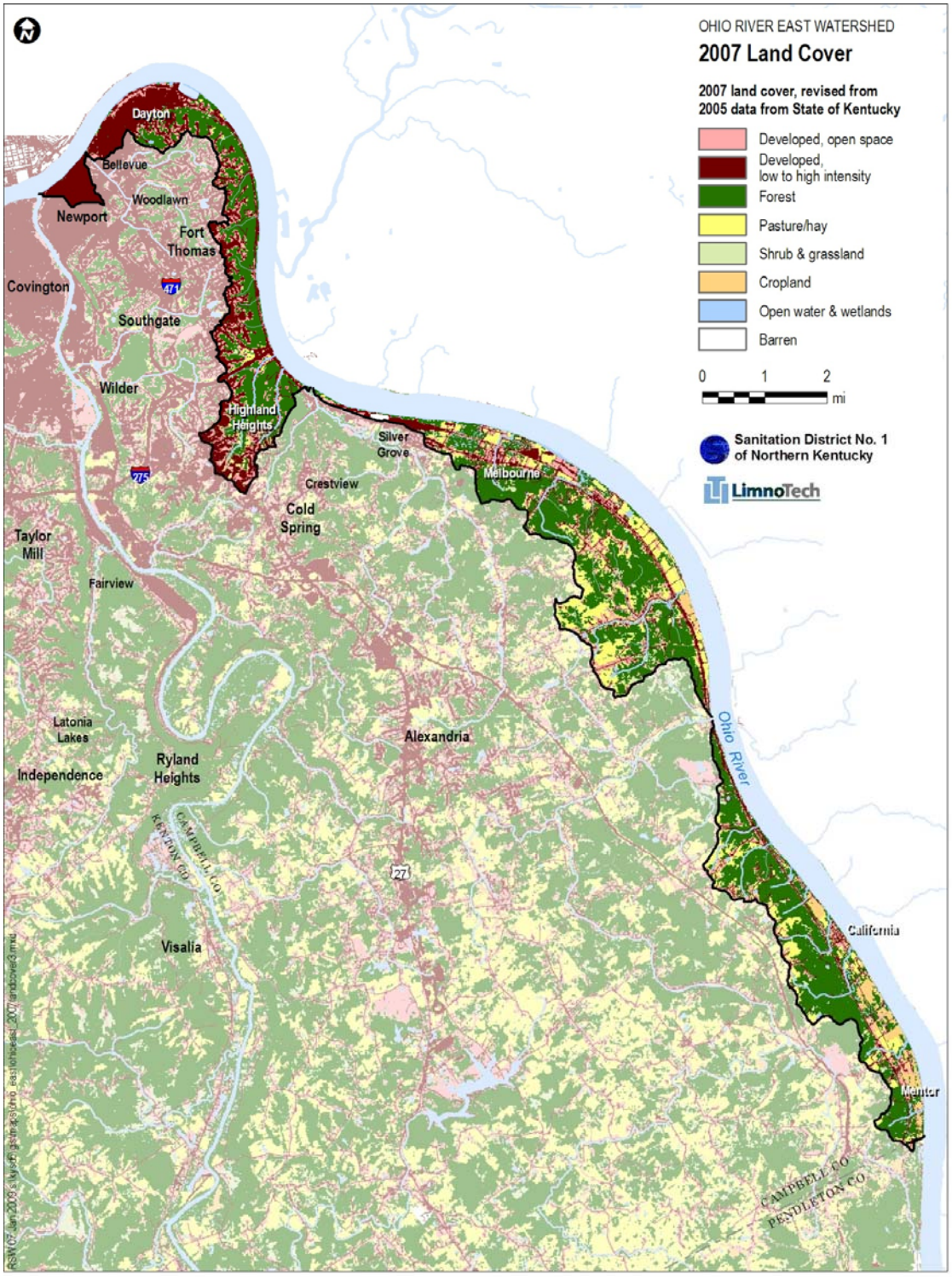

Figure 4. 2007 Land Cover

2.2.2 Future Conditions

Adjacent portions of Southern Campbell County has been under a construction moratorium due to a lack of sewage treatment capacity. This moratorium was partially lifted in May 2008, with the opening of the Eastern Regional Water Reclamation Facility in the Twelvemile watershed. Development is anticipated to increase in these adjacent areas, though it is not anticipated to impact the Ohio River East 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 forest and pasture lands. The majority of new development is forecast to follow major roads to the south and occur in the vicinity of small towns (e.g., Silver Grove, Melbourne, California and Mentor).

In the future, developed lands are predicted to comprise 42% of the watershed, replacing forest and pasture/hay (Figure 5). The amount of impervious surfaces is predicted to increase from 8% currently to 10%.

Local interest in protecting farmland, if consistent with the results of a recent survey (AFT, 2005), might alter forecast future development patterns for this watershed. This survey found that, "65% of the farmland owners in Campbell County want their land to stay in agricultural production for the foreseeable future (approx. 20-30 years). Approximately 32% would like to keep their land in agriculture even after they no longer own it, and 21% are willing to explore options for protecting their land for the future."

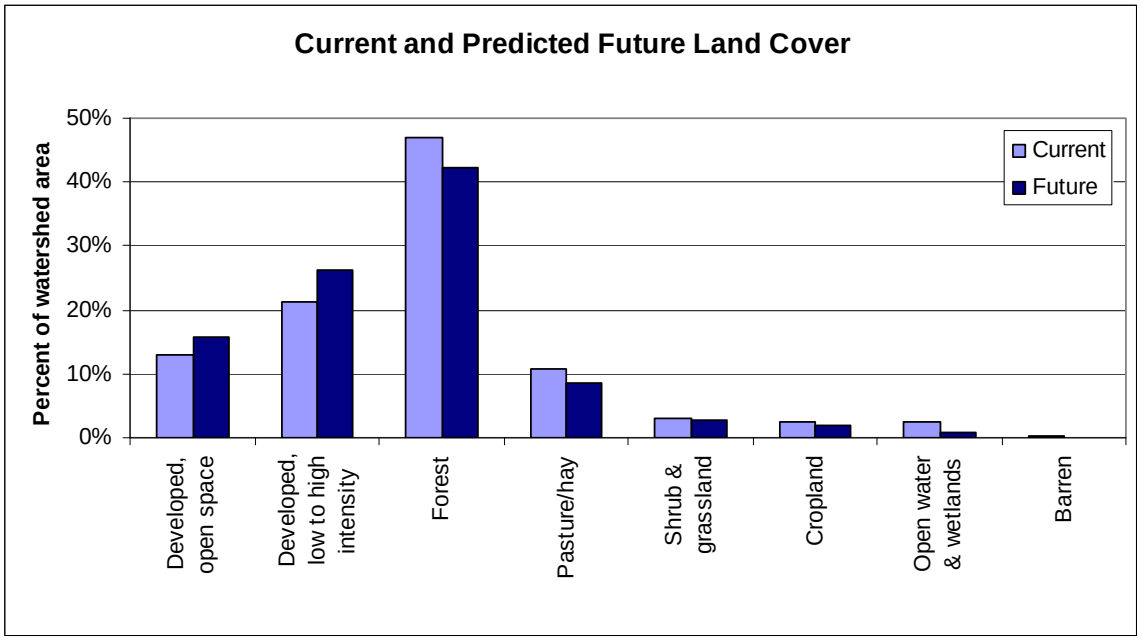

Figure 5. Current and Predicted Future Land Cover

2.3 INFRASTRUCTURE FEATURES

This section summarizes SD1's infrastructure features within the Ohio River East watershed[6]. Approximately 24% of this watershed is within SD1's separate sanitary system area. This sanitary sewer infrastructure is primarily located north of Melbourne and includes approximately 58.4 miles of separate sanitary sewer lines.

Approximately 8% of this watershed is within SD1's combined sanitary system and includes approximately 43.5 miles of combined sanitary sewer lines.

Approximately 41% of this watershed lies within SD1's storm water service area. Within this service area, the storm water system is comprised of approximately 71.5 miles of streams and channels and approximately 25.3 miles of pipes.

The sanitary sewer, combined sewer and storm water service area 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.

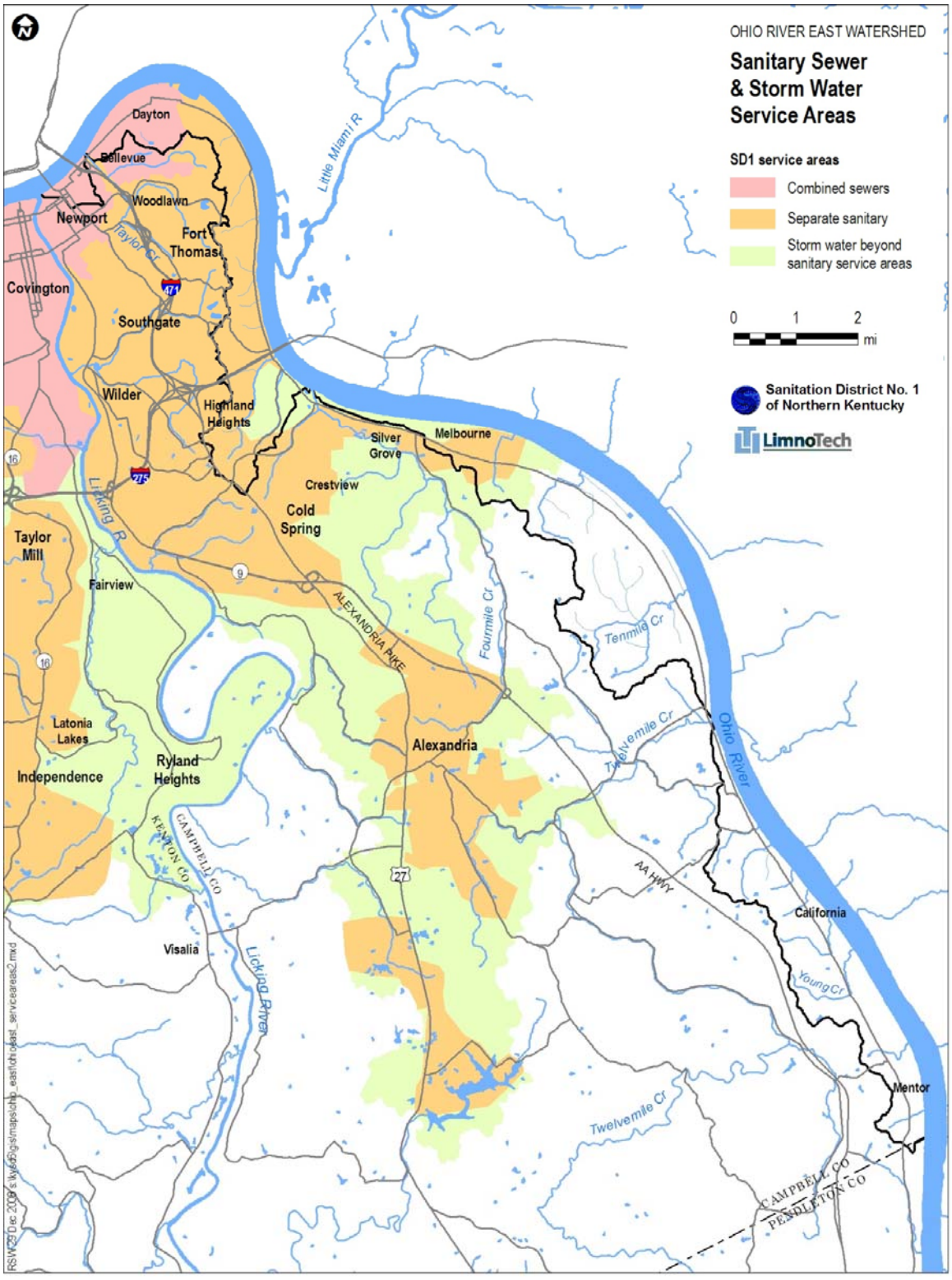

Figure 6. Sanitary Sewer, Combined Sewer and Storm Water Service Areas

2.3.1 Point Sources and Infrastructure

The occurrence of KPDES-permitted dischargers, sewer overflows and storm water discharges is described below.

2.3.1.a KPDES dischargers

There are 26 KPDES-permitted dischargers in this watershed. All of these permits are for sanitary wastewater, and the majority (22) of these are covered under general permits for residences. One of the permittees also has a storm water discharge.

Based on a review of recent effluent monitoring data (January 2007 to June 2008), it was observed that nine of the permitted dischargers have violated permit limits for at least one of the following parameters: fecal coliform, 5-day biochemical oxygen demand (BOD_5), dissolved oxygen, total ammonia, total suspended solids (TSS), pH, and total chlorine. KDOW requires effluent monitoring for the residential general permits (monitoring is required twice per year); however, data were not available for 11 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).

Permitted dischargers are presented in Table 2. Permitted CSOs are not included in this tally and are discussed separately.

Table 2. Permitted Dischargers

Receiving Water	KPDES ID	Facility Name	Outfall	Permit Type	Outfall Description	Permit Violations
Pleasant Run Creek	KYG400953	Residence	0011	Minor	Sanitary wastewater Type B	None
Pleasant Run Creek	KYG401864	Residence	0011	Minor	Sanitary wastewater Type B	NA
Pleasant Run Creek	KYG401429	Residence	0011	Minor	Sanitary wastewater Type B	BOD_5, dissolved oxygen, fecal coliform, total ammonia, TSS
Eightmile Creek	KYG400298	Residence	0011	Minor	Sanitary wastewater Type B	None
Eightmile Creek	KYG400404	Residence	0011	Minor	Sanitary wastewater Type B	None
Eightmile Creek	KYG402037	Residence	0011	Minor	Sanitary wastewater Type B	NA
Eightmile Creek	KYG400133	Residence	0011	Minor	Sanitary wastewater Type B	None
Eightmile Creek	KYG400116	Residence	0011	Minor	Sanitary wastewater Type B	NA
Sevenmile Creek	KY0088749	Prestress Serv of Melbourne	0011	Minor	Sanitary wastewater	Total ammonia
			0021	Minor	Storm water runoff	TSS
Tenmile Creek	KYG400287	Residence	0011	Minor	Sanitary wastewater Type B	BOD_5, total ammonia, TSS
Tenmile Creek	KYG400439	Residence	0011	Minor	Sanitary wastewater Type B	NA
Tenmile Creek	KYG400380	Residence	0011	Minor	Sanitary wastewater Type B	NA
Tenmile Creek	KYG401545	Residence	0011	Minor	Sanitary wastewater Type B	NA
Tenmile Creek	KYG401673	Residence	0011	Minor	Sanitary wastewater Type B	BOD_5, total ammonia, TSS
Tenmile Creek	KYG400396	Residence	0011	Minor	Sanitary wastewater Type B	None
Cliffs Run	KY0090603	Spangler Apts	0011	Minor	Sanitary wastewater	Dissolved oxygen, fecal coliform, pH, total ammonia, TSS
Herringers Run	KYG401499	Residence	0011	Minor	Sanitary wastewater Type B	NA
Herringers Run	KYG400324	Residence	0011	Minor	Sanitary wastewater Type B	NA
Kinneys Run	KYG401490	Residence	0011	Minor	Sanitary wastewater Type B	Fecal coliform
Moores Run	KYG401723	Residence	0011	Minor	Sanitary wastewater Type B	None
Painter Run	KY0093254	Holly Hill Childrens Home	0011	Minor	Sanitary wastewater	Total chlorine, total ammonia
Painter Run	KYG400326	Residence	0011	Minor	Sanitary wastewater Type B	Fecal coliform, TSS
Painter Run	KYG400276	Residence	0011	Minor	Sanitary wastewater Type B	NA
Turkey Run	KYG401938	Residence	0011	Minor	Sanitary wastewater Type B	NA
Young Creek	KYG400464	Residence	0011	Minor	Sanitary wastewater Type B	NA
Young Creek	KY0027707	AJ Jolly School	0012	Minor	Sanitary wastewater	NA

NA indicates monitoring data not available

2.3.1.b Sewer overflows and bypasses

There are 22 combined sewer overflows (CSOs) in the Ohio River East watershed (Table 3), four of which are "to be permitted". Eight of the CSOs discharge to the smaller tributaries, the remaining fourteen discharge directly to the Ohio River mainstem.

Table 3. Combined Sewer Overflow Points

Manhole ID	Common Name	Direct Discharge to Ohio River?	Typical Year Spill Frequency (No.)[a]	Typical Year Volume (MG)[a]
0030031	Carmel Manor	No	0	0
0200069	Government Sewer	No	26	0.25
0330100	Tower Hill	No	6	0.15
0340050	Lester Ln.	No	20	0.48
0340051	Manor Lane	No	31	1.0
0570089	McKinney St.	Yes	62	49.99
0570090	Main St.	Yes	56	36.3
0600094	Foote Ave.	Yes	26	1.64
0600096[b]	O'Fallon St.	Yes	8	0.14
0600097	Ward Ave.	Yes	36	4.54
0600104[b]	Diversion 0600037	Yes	3	0.12
0610071	Taylor Ave.	Yes	68	14.11
0610072	Washington Ave.	Yes	25	0.63
0620075	Patchen St.	Yes	59	9.95
0620077	Lafayette Ave.	Yes	25	0.32
0630061	Riverside Drive	Yes	2	0.09
0640090	Diversion 0640081	Yes	62	128.8
0650090	Taylor Bottoms	No	29	3.53
0770096	Saratoga St.	Yes	65	6.55
0790084	Columbia St.	Yes	74	14.3
0010228[b]	NA	No	NA	NA
0360079[b]	Anchor Inn	No	46	1.52

[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.

NA indicates model results are not available

There are seven sanitary sewer overflows (SSOs) in the Ohio River East watershed. One of these SSOs occurs at the Highland Heights pump station (PS) which has an active constructed bypass with a history of overflows. The Winters Lane 2 pump station has had overflows due to wet weather. Both the Highland Heights and Winters Lane No. 2 pump stations are being addressed through ongoing Watershed Planning and pump station back-up power activities. SSOs are listed in Table 4.

The Harrison Harbor pump station is also located in this watershed and is identified in Exhibit E of the Consent Decree (pump station list for pump station plan). Through recent detailed flow monitoring and historical data review, it was determined that the Harrison Harbor pump station is not subject to excess flow during wet weather and has no constructed bypasses.

Table 4. Sanitary Sewer Overflow Points

MH ID	Direct Discharge to Waterbody	Typical Year Spill Frequency (No.)[a]	Typical Year Volume (MG)[a]
0060002	Ohio River tributary	4	0.03
0060001	Ohio River Tributary	6	0.34
0050022	No[b]	8	0.36
0300008	No[b]	NA	NA
Highland Heights PS	No[b]	46	16.8
Winters Lane 2 PS	No[b]	NA	NA
Harrison Harbor PS	No[b]	NA	NA

[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] Greater than 50 feet from a waterbody

NA indicates model results are not available

2.3.1.c Storm water discharges

SD1's storm water service area within the Ohio River East watershed covers all areas between Melbourne and Bellevue. Storm water outfalls are distributed fairly evenly throughout this area, but are not found within the combined sewer area.

Additionally, there are approximately 25 suspected illicit activity points (SIAs), which are generally located north of the Fourmile confluence with the Ohio River. 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.

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. One storm water outfall covered by an individual KPDES permit is discussed in Section 2.3.1.a.

2.3.2 Recently Completed Infrastructure Projects

The Highland Heights Pump Station Study, completed in 2006, evaluated the redirection of flows from parts of the separate sewer and combined sewer systems to areas of the system with available capacity. This project identified potential solutions to bring CSOs in the area into compliance with the 1994 CSO policy and reduced the activity of the downstream CSOs. This project also identified potential solutions to at least three known SSOs and several suspected SSOs.

2.3.3 Ongoing or Planned Infrastructure Improvement Projects

The River's Edge Interceptor Replacement project is a large infrastructure improvement project in this watershed (Table 5) and includes:

- Approximately 8,000 linear feet of the existing Ohio River Interceptor in the Dayton area are currently being replaced with a new 84-inch pipe that will serve to provide in-line storage for the Main Street and McKinney Street CSOs.
- New diversion structures will be built to facilitate the use of the in-line storage as well as to provide some solids and floatable control and grit capture.
- Tideflex check valves are being installed at Main and McKinney to prevent Ohio River water from entering the outfalls during high river levels.

As part of the Consent Decree, SD1 is required to provide backup power to all pump stations. In conjunction with the pump station backup power plan, the wet weather flows into the Winters Lane 2 pump station will also be addressed. Finally, the ongoing watershed planning effort will help address other wet-weather related overflows in this basin including the Highland Heights pump station.

Table 5. Ongoing or Planned Infrastructure Improvement Projects

Capital Improvement Project Title	Goals	Anticipated Start Date	Anticipated Completion Date	Project Total
River's Edge Interceptor Replacement	8,000 LF of 84-inch pipe to provide 2.2 million gallons of in-line storage	Already started	2009	Approximately $12,000,000

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 nine species (Table 6; KSNPC, 2007, KSNPC, 2007a), two of which are aquatic-dependent species that are endangered. These are the pink mucket and sheepnose mussels.

The pink mucket is identified as endangered on both the federal and state lists. The sheepnose mussel is a state endangered species and a candidate for the federal list. Habitat degradation due to water quality and quantity changes is cited as the leading factor in freshwater mussel decline, however they are also threatened by overharvest and aspects of poor land management, channelization and damming, exotic species and pollution from chemical pesticides and herbicides (Cummings and Mayer, 1992; KDOW, 1998; Sietman, 2003; NatureServe, 2007). The primary water quality issues responsible for freshwater mussel decline are siltation, increased water temperatures and point and non-point source pollution (NatureServe, 2007).

Six species in this watershed are listed by the state as species of special concern. These include one mussel species (longsolid mussel), three fish species (burbot, black buffalo and spottail shiner), two amphibian species (redback salamander and northern leopard frog) and one plant species (Virginia mallow).

The longsolid mussel prefers the sandy and gravel areas of medium sized to large rivers (Cicerello and Schuster, 2003). Threats to this mussel are similar to those previously described.

The burbot (figure 7) more commonly inhabits the deep and cold portions of lakes and large rivers, but may move into shallower areas at night to feed (NatureServe). Declining numbers are thought to be related to the introduction of exotic species, water pollution and dams. The black buffalo typically inhabits the pool and backwater areas of small to large rivers. Low numbers may be due to introduced species, habitat loss and water quality declines. The spottail shiner is usually associated with the rocky, sandy, shallow areas of large rivers. Impacts to spottail shiner populations are similar to those described for the black buffalo.

Figure 7. The Burbot, *Lota lota*

The northern leopard frog inhabits 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 this frog include habitat loss, commercial overexploitation, and competition with introduced species (NatureServe, 2007). The redback salamander, a woodland species, may be threatened by localized habitat loss, mainly due to timber harvest and habitat degradation (NatureServe)

Virginia mallow is a vascular plant found in the loose, sandy soils associated with riverine floodplains. Threats to the species include changes in hydrologic conditions, overstory removal, stream alteration and increased erosion (KSNPC, 2006).

Table 6. Endangered Species and Species of Concern

Taxonomic Group	Common name	Scientific name	Status[f]	Last Observed	Habitat(s)	Identified Threats
Freshwater Mussels						
	Longsolid	*Fusconaia subrotunda*	State - Special Concern	1987	Gravel of large rivers[a]	Water quality declines, stream modifications and exotic species
	Pink Mucket	*Lampsilis abrupta*	Federal - Endangered State - Endangered	1989	Gravel or sand in large rivers and tributaries[a]	Water quality declines, stream modifications and exotic species
	Sheepnose	*Plethobasus cyphyus*	Federal - Candidate State - Endangered	1987	Gravel or mixed sand and gravel in medium to large rivers[a]	Water quality declines, stream modifications and exotic species
Fishes						
	Burbot	*Lota lota*	State - Special Concern	1993	Stony riffles and undercut banks in large streams and rivers[b]	Non-native species introductions, water pollution[b] and dams[c]
	Black Buffalo	*Ictiobus niger*	State - Special Concern	1991	Silty backwaters[b]	Non-native species introductions, water pollution[b]
	Spottail Shiner	*Notropis hudsonius*	State - Special Concern	1991	Large rivers and streams[b], sandy or rocky shallows without vegetation[d]	Non-native species introductions, water pollution[b]
Amphibians						
	Northern Leopard Frog	*Rana pipiens*	State - Special Concern	1998	Ponds, wetlands, grasslands	Habitat loss, non-native species, commercial overexploitation
	Redback Salamander	*Plethodon cinereus*	State - Special Concern	1983	Woodlands[c]	Habitat loss/degradation
Vascular plants						
	Virginia Mallow	*Sida hermaphrodita*	State - Special Concern	1998	Riverine floodplains[e]	Changes in hydrologic conditions, overstory removal, stream/wetland alteration, increased erosion[e]

[a] Source: Cummings and Mayer, 1992.
[b] Source: Hubbs and Lagler, 2007.
[c] Source: NatureServe, 2007.
[d] Source: Lee et al., 1980.
[e] Source: KSNPC, 2006.
[f] Source: KSNPC, 2007, 2007a

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 in 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. Three public drinking water intakes are located in the Ohio River, off-shore from this watershed. These intakes are operated by the Northern Kentucky Water District and Greater Cincinnati Water Works.

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 portions of this watershed are located within SWAPP Zones 1 and 2, reflecting the distance of the watershed from the three Ohio River intakes.

There are two active public water supply wells in this watershed, both at the same St. Anne Covenant location. 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 8, along with other drinking water supply features.

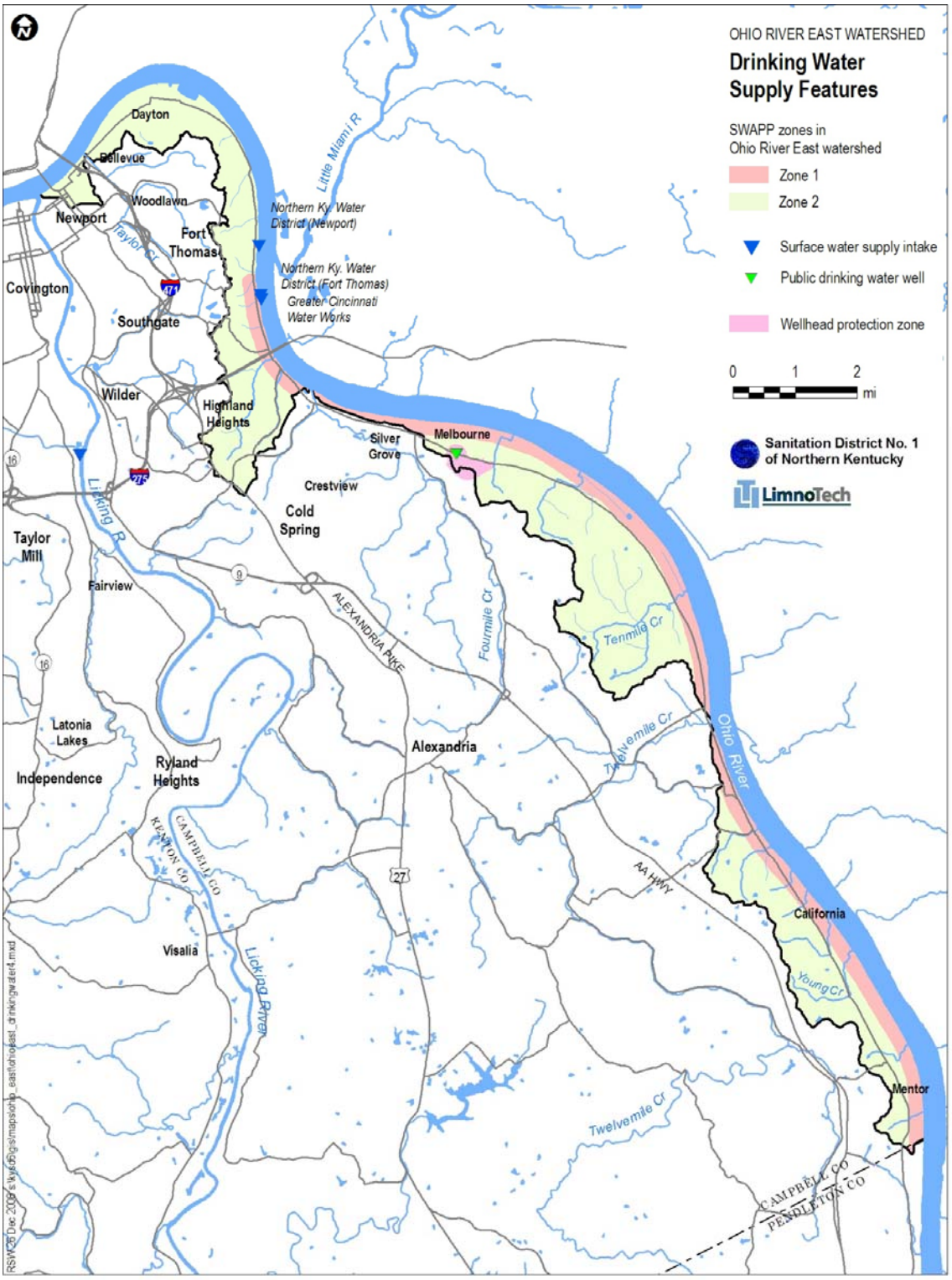

Figure 8. Drinking Water Supply Features

2.5 PUBLIC INTEREST/WATERSHED GROUP ACTIVITIES

Interest in this watershed is high due to the recent opening of the nearby Eastern Regional Water Reclamation Facility in the Twelvemile Creek watershed, which has drawn attention to sources upstream of the three Ohio River water intakes. 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.southbankpartners.com/home.asp; http://www.covingtonky.com/index.asp?fn=news&id=1180).

Another indicator of interest in this watershed is expressed through the sampling conducted by KDOW and SD1.

The Campbell County Conservancy, a conservation-oriented organization, is active in the county working to conserve green space and preserve land that has unique or significant natural, historical or scenic value in order to enhance the quality of life for current and future generations. It is not known, however, if this organization is active in this watershed (http://www.campbellcounty.ky.gov/boards/conservancy.htm.

3. WATERBODY USES

This section describes designated and current uses for streams 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 KAR10:026). 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.

3.2 CURRENT USES

An assessment of available information found that within the Ohio River East watershed:

- A 2003 assessment of Tenmile Creek indicated aquatic habitat could not support a diverse and productive ecosystem, and fish data indicated fair biological conditions.
- 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 in the Cabinet for Health and Family Services 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 and two fishing access sites to the Ohio River are located in this watershed (http://kygeonet.ky.gov/kdfwr/viewer.htm).
- There are no surface water intakes in this watershed, however there are three surface water intakes on the Ohio River located just offshore from this watershed.
- There are two active public water supply groundwater wells in this watershed (KDOW, 2008a; KDOW, 2007c).

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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

Tenmile Creek is listed on Kentucky's 2008 303(d) list of impaired waters (Table 7; KDOW, 2008).

Table 7. 303(d) Listing

Waterbody Segment	Designated Uses (Use support)	Pollutants	Suspected Sources
Tenmile Creek into Ohio R. (RM 0.05 – 1.15)	Warm water aquatic habitat (Partially Supporting)	Sedimentation/siltation Nutrient/eutrophication biological indicators	Site clearance (land development or redevelopment), Livestock (grazing or feeding operations), and Crop production (crop land or dry land)

TMDLs have not yet been initiated for these impairments (KDOW, 2008). The TMDLs for nutrients and organic enrichment will not be initiated until after nutrient criteria are promulgated by the state.

4.2 MONITORING PROGRAMS

Water quality data have been collected in this watershed by KDOW and SD1. Data currently compiled by SD1 from known monitoring programs are presented in Table 8; however, only data which have been fully analyzed are discussed in Section 4.3 Water Quality Data Analysis. Available data exists for the mainstem of Tenmile Creek.

Data not included in this report will be reviewed and included in subsequent updates.

Table 8. Summary of Water Quality Monitoring Data

Entity	Dates	Parameters Sampled	Sampling Locations[b]	Number of Samples
KDOW	2003	DO, pH, conductivity, temperature	Tenmile Cr. RM 1.4	1 sample (8/12/2003)
SD1	2006	Fecal coliform, E. coli, DO, pH, conductivity, turbidity, temperature	Tenmile Cr. RM 1.3	2 samples from baseline survey (10/9/2006 & 10/24/2006)
SD1	2007	Fecal coliform, E. coli, DO, pH, conductivity, turbidity, temperature, nutrients, solids, CBOD	Tenmile Cr. RM 1.3	1 sample from baseline survey (5/1/2007)
SD1	2008[a]	Fecal coliform, E. coli, DO, pH, conductivity, turbidity, temperature, nutrients, solids, CBOD	Tenmile Cr. RM 1.3	1 sample from baseline survey (10/14/2008)

[a] Data not analyzed in Section 4.3

[b] RM = River mile

4.2.1 Future Sampling

SD1 plans to continue monitoring this watershed during base flow conditions with at least one survey per year. The sampling location is Tenmile Creek at RM 1.3. Typical analyses will include bacteria, nutrients, solids, oxygen-demanding constituents and physical parameters. Additionally, surveys to assess the degree of stream hydromodification are also planned by SD1.

Outfall sampling was initiated in 2007 to better characterize water quality and loadings from CSOs, SSOs and storm water runoff. Three 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.

4.3 WATER QUALITY DATA ANALYSIS

Water quality data have been collected in Tenmile Creek in 2003, 2006 and 2007 by SD1 and KDOW. The 2003 data showed no violations of the applicable water quality criteria. A comparison of recent (2006-2007) water quality data to applicable water quality criteria revealed violations of the pH criteria.

4.3.1 Recent Data

Recent water quality data were available for Tenmile Creek at RM 1.3, and were collected during base flow conditions. The single parameter that violated applicable criteria is presented in Table 9. Measurements for parameters not shown met water quality criteria. A discussion of the pH violation follows Table 9.

Table 9. Recent pH Violations

Stream	River Mile	Parameters violating criteria	
		pH	
		# measurements	% of measurements in violation[a]
Tenmile Creek	1.3	3	33%

[a] The pH criteria are between 6.0 and 9.0 SU.

4.3.1.a pH

The maximum pH criteria of 9 su was exceeded in one of the three base flow measurements from Tenmile Creek at River Mile 1.3. The measurement exceeding the standard (9.64 su) was collected on October 24, 2006. There were no pH measurements less than the minimum criteria of 6 su.

4.4 BIOLOGICAL CONDITIONS

In 2003, KDOW surveyed the fish population at one site in Tenmile Creek. The KIBI score[7] calculated for Tenmile Creek indicated "fair" conditions.

[7] 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.

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5. SOURCE ANALYSIS

This section summarizes potential pollutant sources in the Ohio River East watershed based on the watershed characterization and recent water quality data.

5.1 WATERSHED SOURCE ANALYSIS

Potential sources within this watershed were identified based on the watershed characterization information discussed previously. These sources are summarized in Table 10 and their locations are shown in Figure 9. Sources in the Tenmile Creek subwatershed are presented separately because this creek was identified as having the recent pH violation. Although the recent pH violation was observed during base flow conditions, all potential sources are included in this summary.

Table 10. Summary of Potential Sources

	Direct drainage south of Tenmile Creek	Tenmile Creek[b]	Direct drainage north of Tenmile Creek
Recent observed impairment =>		*pH*	
CSOs[a]			22 (14 are direct to Ohio R.)
SSOs[a]			4
SSOs - pump stations			3
Septic systems	Many	Many	
KPDES sanitary outfalls[c]	9	6	11
KPDES storm water/other outfalls			1
Storm water runoff	Rural	Rural	Rural and urban
AFO		1	
Watershed improvements			Planed work will improve storage for 2 CSOs and will help address SSOs at 2 pump stations. The third pump station was determined not to overflow.

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

[b] Site clearance, livestock and crop production are identified as potential sources contributing to the impaired aquatic habitat use in this watershed (KDOW, 2008).

[c] Excludes permitted CSOs.

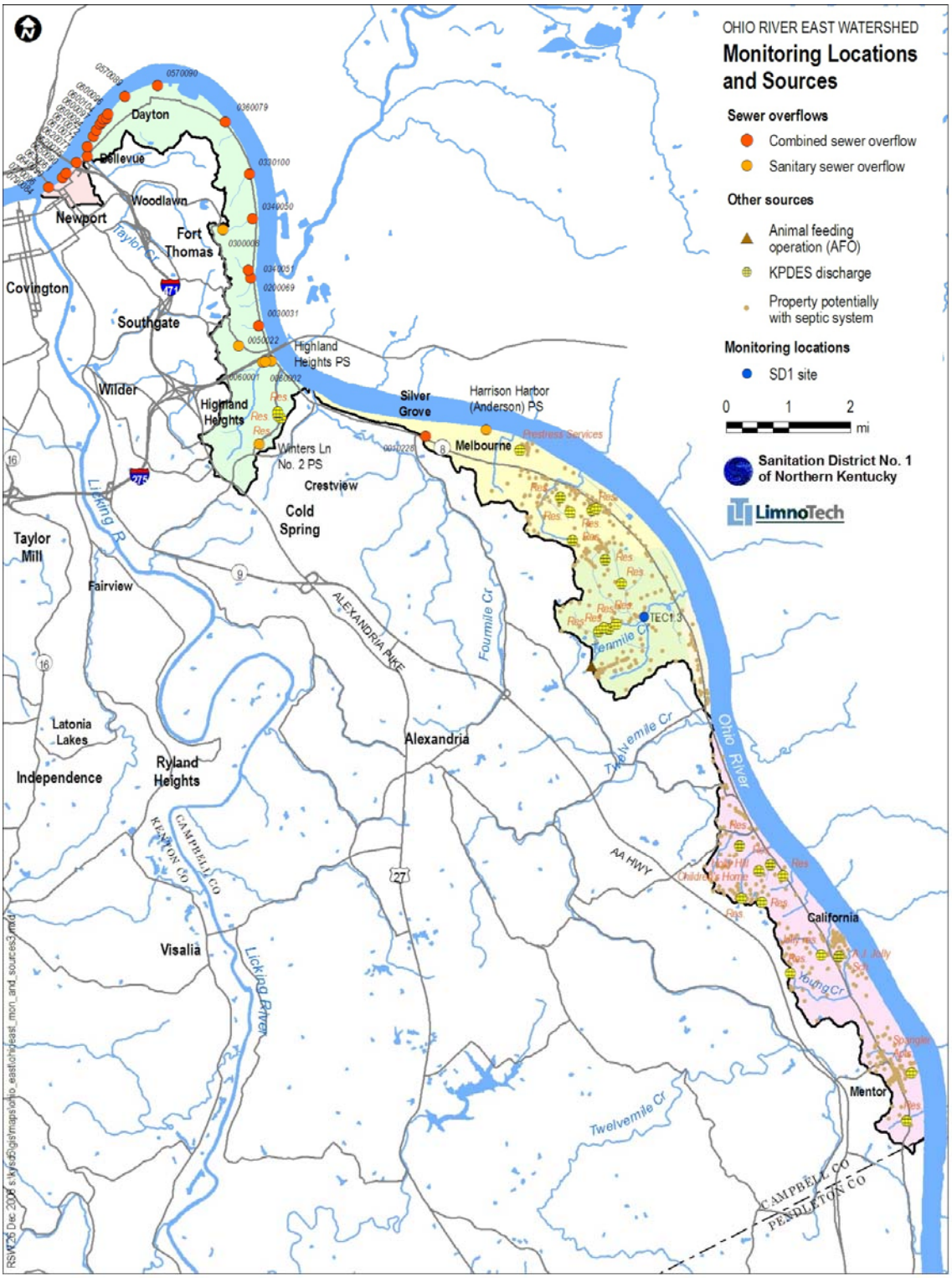

Figure 9. Monitoring Locations and Sources

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[8] indicate that under year-round conditions, the Ohio River East 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 (#)[a]	Special Designation	Public interest	WAT! Rank, year-round conditions[b]
						Bacteria
22 (14 are direct to Ohio R.)	7	SWAPP Zone 1 and 2 for 3 intakes located in the Ohio River, offshore from this watershed. 2 groundwater wells	2	None	High	3 of 16

[a]Six additional aquatic species are State species of special concern. One terrestrial species is a State species of special concern. T&E = Threatened and/or endangered.

[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

The Ohio River East watershed contains many small streams that drain to the Ohio River; however, Tenmile Creek is the only stream that has been sampled. Annual base flow

[8] 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.

sampling is planned for this creek. No habitat or biological sampling is currently planned.

6.2.1 Data Gap Analysis

The cause of the recent pH violation is not known. A site visit to the Tenmile Creek watershed may help to identify potential sources and observe whether excessive algae growth is occurring, as algae may contribute to pH violations. A habitat and biological assessment of Tenmile Creek would help to determine whether conditions have changed since 2003.

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 10, 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[9]. Flow estimates are available for twenty of the CSOs and three of the SSOs in this watershed.

Under year-round conditions, the largest source of fecal coliform is CSOs (Figure 10). 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 11 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 East tributaries is storm water runoff.

[9] 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.

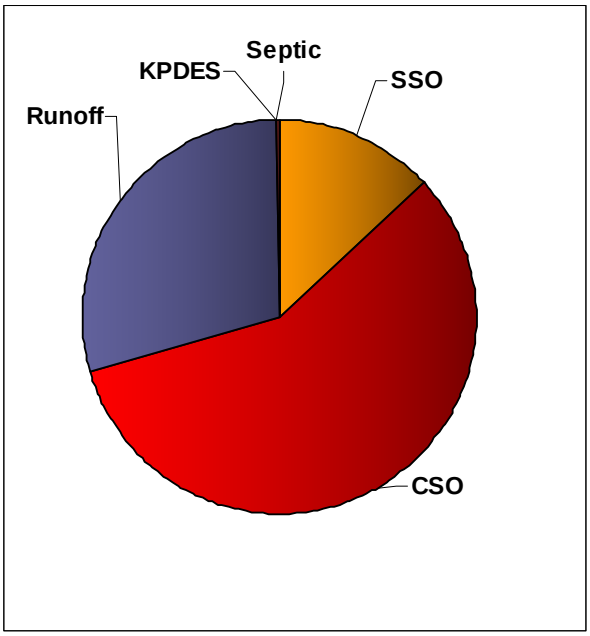

Figure 10. Initial Year-Round WAT! Results for Fecal Coliform (Includes Ohio River CSOs)

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.

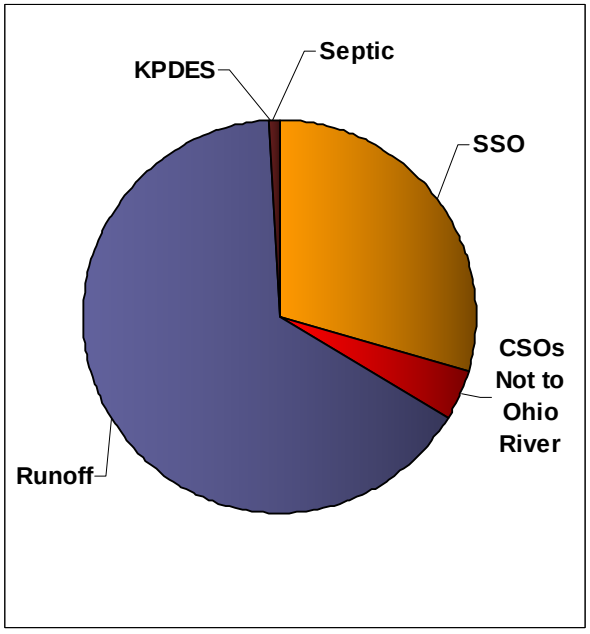

Figure 11. Initial Year-Round WAT! Results for Fecal Coliform (Excludes Ohio River CSOs)

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 East watershed during year-round and base flow conditions is provided in Table 12.

Table 12. WAT! Watershed Rankings

	Ohio River East Rank for Year-Round Conditions[a,b]	Ohio River East Rank for Base Flow Conditions[a,b]
Fecal coliform	3	10

[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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