Executive Summary

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EXECUTIVE SUMMARY

Purpose

On April 18, 2007, the Consent Decree negotiated between Sanitation District No. 1 (SD1), the U.S. Environmental Protection Agency, and the Kentucky Energy and Environment Cabinet became effective. The purpose of the Consent Decree was to establish a structure for developing and implementing plans to address SD1's combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs). Such overflows can degrade the quality of streams and rivers and are regulated through the federal Clean Water Act. SD1's Consent Decree is unique because it incorporates a watershed-based approach in the planning process that allows for the consideration of pollution sources beyond sewer overflows.

As required in the Consent Decree, SD1 has prepared Watershed Plans describing projects for addressing overflows and other water quality issues to be implemented over the next five years as well as a preliminary overall plan (i.e., full system solution) for achieving the goals of the Consent Decree. Updated Watershed Plans will be submitted at five-year intervals. The deadline for full implementation of these Plans is December 31, 2025. Through this decree, SD1 will be managing the largest program of water quality improvement in Northern Kentucky's history.

Background

Like many urban regions of the United States and Europe, the wastewater collection system of Northern Kentucky is comprised of both combined sewers and separate sanitary sewers. Combined sewers carry sewage and storm water runoff and are typically found in the older areas of cities such as Covington, Newport, and Bellevue. During dry weather conditions, flow in SD1's combined sewer system is mostly comprised of sewage from homes and businesses and is conveyed to the Dry Creek Wastewater Treatment Plant. At the plant, wastewater is treated to remove pollutants before being discharged to the Ohio River.

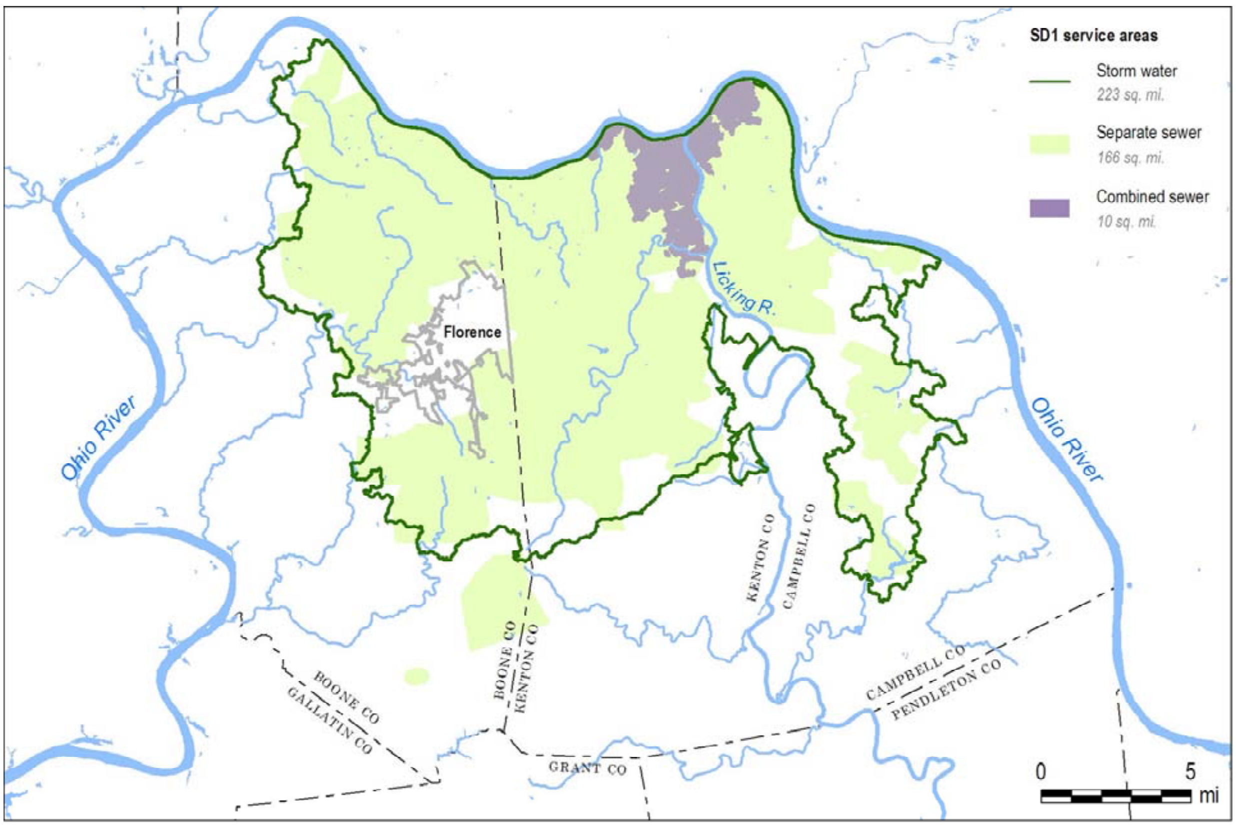
During wet weather conditions, the capacity of the combined sewer system can be exceeded due to storm water runoff. As a result, excess flow is discharged from the system at CSO outfalls. The SD1 combined sewer system has 97 of these outfalls, the majority of which are located along the Ohio River, Licking River, Banklick Creek, and Taylor Creek. In more recently developed areas, a separate sanitary sewer system has been constructed to carry sanitary sewage and a separate storm water sewer network has been constructed to carry runoff. In properly functioning sanitary sewers, there is sufficient flow capacity in the system to convey all sewage to a treatment facility. In practice, separate sanitary sewers can be subject to additional flow during wet weather conditions. Increased wet weather flow in sanitary sewers can be caused by:

- Rain water inflow to the system from improper connections such as roof downspouts, driveway drains, etc.
- Rain water and ground water infiltration into aging manholes, pipes, and private laterals.

This increased wet weather flow can create SSOs. SSOs can also result from the loss of flow capacity in the system (pipe blockages or collapse) or malfunctions at pump stations. There are 126 confirmed SSO points in the SD1 sanitary sewer system.

SD1's sanitary sewer service area encompasses 176 square miles of Campbell, Kenton and Boone Counties. The majority of this area is served by separate sanitary sewers as shown on Figure ES.1.

Figure ES.1 SD1 Service Area Overview



In addition to CSOs and SSOs, there are other pollution sources that can impact the quality of Northern Kentucky's waterways. These sources include polluted runoff (urban and agricultural land use), failing septic systems, and industrial point sources. The overall health of a waterway can also be affected by factors such as increased peak flows when land is converted from natural conditions to more developed uses, the loss of riparian buffers along stream corridors, and the loss of wetlands.

History of SD1

SD1 was established in 1946 by the Division of Sanitary Engineering of the Kentucky Department of Health pursuant to an amendment of Chapter 220 of the Kentucky Revised Statutes. This amendment gave SD1 the authority for the management, collection, transmission and treatment of wastewater. In 1954, SD1 completed the construction of Northern Kentucky's first wastewater treatment plant in the City of Bromley. In 1979, SD1 completed the construction of new interceptor sewers, associated pump stations, and the Dry Creek Wastewater Treatment Plant. To meet the needs of an expanding population, SD1 completed a major expansion of the Dry Creek plant in 1993.

Until 1995, a vast majority of the wastewater collection system of the Northern Kentucky region was owned, operated, and maintained by the different political jurisdictions of the region. In 1995, SD1 assumed ownership of this infrastructure for 28 municipalities and portions of three counties. By 1999, two more cities, Independence and Alexandria, had transferred their sewer system ownership and maintenance to SD1. At present, the Cities of Florence and Walton are the only jurisdictions in the region to retain ownership of their sewer systems. This consolidation process significantly increased the amount of infrastructure owned and maintained by SD1, as shown in Table ES.1.

Table ES.1 SD1 Infrastructure Inventory

	Before 1995	Current
Miles of sewer lines	128	1,600
Sanitary Pump Stations	16	129[1]
Catch Basins in Combined Sewer Area	0	3,302
Flood Pump Stations	0	15

Note:
[1] An additional thirteen (13) sanitary pump stations are operated by SD1 under contract.

At the time of this consolidation, it was recognized that there were a significant number of sewer overflows and other problems in the system. For example, the area served by the City of Alexandria's sewer system had been placed under a building moratorium in 1996 because of overflows at the Alexandria Wastewater Treatment Plant. The consolidation of the system represented an opportunity to address long-standing problems and improve sanitary sewer service for Northern Kentucky. Because the system is a complex network of pipes, pump stations, and treatment facilities, the previous structure of local control often hindered attempts to address sewer overflows. For example, excessive wet weather inflow into the sanitary sewer system of one jurisdiction could often lead to overflows in a downstream community.

As a regional utility, SD1 was able to direct resources to areas with the most pressing needs. For example, the Eastern Regional Water Reclamation Facility was constructed under SD1 management and replaced the failing Alexandria treatment plant in 2007. The benefits of this project were the elimination of approximately 8 million gallons of sewer overflow volume in a typical year and a lifting of the building moratorium. SD1's long-range planning abilities also facilitated the transition to an expanded system as development occurred in Northern Kentucky. This was particularly important in high-growth areas such as Boone County, which doubled in population between 1990 (57,589) and 2008 (115,231).

In 2003, SD1 became the regional authority, as a co-permittee with local jurisdictions, for the Phase II storm water regulations promulgated by the U.S. Environmental Protection Agency. This was another step forward in improved water quality management for the region and provided many of the same benefits as the sanitary sewer consolidation, since streams and rivers typically flow across jurisdictional boundaries, and polluted runoff originating in one city may impact downstream areas. SD1 is currently in the process of establishing formal ownership and responsibility for much of Northern Kentucky's public storm sewer infrastructure.

Watershed-based Approach

SD1's Consent Decree is the country's first enforcement action that allows a community to use the watershed management approach to more efficiently and cost-effectively meet federal Clean Water Act requirements for addressing CSOs and SSOs. This approach is based on the fact that sewer overflows are not the sole source of impairment for Northern Kentucky's streams and rivers. Traditionally, most Consent Decrees focus solely on CSOs and SSOs, with an emphasis on gray infrastructure solutions. SD1's watershed approach identifies the characteristics of individual watersheds and considers CSOs and SSOs along with other sources impacting the waterways (such as runoff and dry weather sources). Additionally the iterative structure allows time to investigate new technologies and update the full system generalized plan using information gained from the implementation of projects during the first five years. SD1's watershed approach:

- Recognizes other pollutant sources and their relative impacts and puts CSOs and SSOs into context with those sources;
- Provides a process to address and control highest regional priorities first to offset controls on CSOs;
- Uses an integrated approach of controls that will address both wet and dry weather sources of pollution and lead to a greater improvement in water quality and public health;
- Provides additional benefits to the community such as air quality, wildlife habitat, urban beautification, and economic development; and
- Directs funds to projects that provide the greatest benefits.

SD1 has studied what other utilities across the country have implemented and spent to comply with their CSO and SSO Consent Decrees, which have often not achieved significant improvements in the attainment of water quality standards. These utilities have, at times, been forced to continue to spend money beyond a cost-effective level of control that did not result in additional water quality improvement because the other sources of pollution were left unaddressed. This type of silo approach to water quality improvement is neither efficient nor cost-effective, particularly in today's challenging economic climate.

Many sewer overflow programs have been developed that relied exclusively on gray infrastructure such as storage tanks, conveyance pipes, and high-rate treatment facilities. While gray infrastructure has its place in any sewer improvement program, there are situations where alternative strategies are the more cost-effective and beneficial solution. SD1 believes that the best approach is to implement an integrated watershed-based approach using more efficient and cost-effective means to reduce pollutant levels, and doing so in a manner that still conforms to the CSO Control Policy as set out in the Consent Decree and is consistent with the goal of eliminating SSOs.

The watershed-based approach in SD1's Consent Decree allows for the consideration of alternative control strategies such as green infrastructure or watershed controls, as a means to offset or delay traditional overflow controls.

- **Watershed controls:** are systems and practices that can reduce pollution from sources other than sewer overflows, such as storm water runoff. Watershed control projects could include regional retention facilities, wetlands or riparian buffers.
- **Green infrastructure:** is generally defined as systems and practices that mimic the natural water cycle. When trees and vegetation are replaced with impervious surfaces, this cycle is impacted by a reduction in infiltration and evapotranspiration and an increase in runoff. Examples of green infrastructure include green roofs, reforestation, tree boxes, rain gardens, vegetated swales, rain water harvesting, and permeable pavements.

Green infrastructure and watershed controls also provide additional community benefits, such as improved air quality, wildlife habitat, urban beautification, or economic development. The inclusion of these benefits into a comprehensive, capital-intensive, water quality improvement program represents a new approach for public utilities and regulators. There is a growing expectation among the public that these techniques for water quality management should be included in the planning process.

SD1 will be responsible for managing most of the capital funding to be used towards water quality improvements in Northern Kentucky for the foreseeable future. Past experience has shown that wastewater and storm water systems can be managed more efficiently when a single organization has the ability to consider the overall system. A watershed-based approach is a logical extension of the sanitary and storm sewer system consolidation. While SD1 does not have authority to regulate all pollutant sources in Northern Kentucky, the role as a regional utility does provide the best opportunity for the development of plans that can focus resources towards the most critical areas of need. Through the development of the Watershed Plans, SD1 will seek mechanisms to implement controls that extend beyond current authorities.

Characterization

To support the Watershed Plans and conform to the CSO Control Policy, it was necessary for SD1 to accurately characterize the sanitary sewer system, the watersheds of Northern Kentucky, and opportunities for alternative controls.

Sewer System

The sewer system characterization involved a combination of system mapping, rainfall monitoring, water quality sampling of CSO, SSO, and storm water outfalls, and hydraulic modeling of the system. The hydraulic modeling task involved the development of a detailed computer model of the sewer system. This model was used to calculate overflow characteristics (volume, duration, and activation frequency) and provide input to the water quality models. The hydraulic model was calibrated and validated using a combination of historical data and 12 months of data collected from approximately 250 flow monitors and 45 rain gauges in 2007 and 2008. The results were further validated by comparing model calculated overflow points to field investigations. The result was a state of the art hydraulic model that provides the best available representation of how SD1's sewer system operates in dry and wet weather conditions. This tool allows SD1 to have confidence in the calculated overflow volumes from the sewer system.

In accordance with standard guidelines, the hydraulic model was used to simulate "typical year" conditions. The rainfall record from 1970 was selected as the most representative of typical conditions based on review of 50 years of rainfall data from the Cincinnati-Northern Kentucky International Airport. In the process of developing a full system solution concept and evaluating potential projects, other rainfall conditions such as the 1-year and 5-year design storms and other extended typical periods of rainfall were also used in certain analyses. The calculated overflow volumes for typical year conditions are shown in Table ES.2.

Table ES.2 CSOs and SSOs by Basin for a Typical Year (1970)

Basin	Number of CSOs	Total CSO Volume (Million Gallons)	Number of Confirmed SSOs	Total SSO Volume (Million Gallons) [1]
North	26	796.2	45	7.5
Central	39	790.2	51	158.6
East	32	286.4	21	73.4
West	0	0	9	2.6
Total	97	1,872.8	126	242.1

Note:
[1] Includes the model-calculated volume from model-predicted overflow locations, as well as the volume prior to the Eastern Regional sewer system improvements.

Watersheds

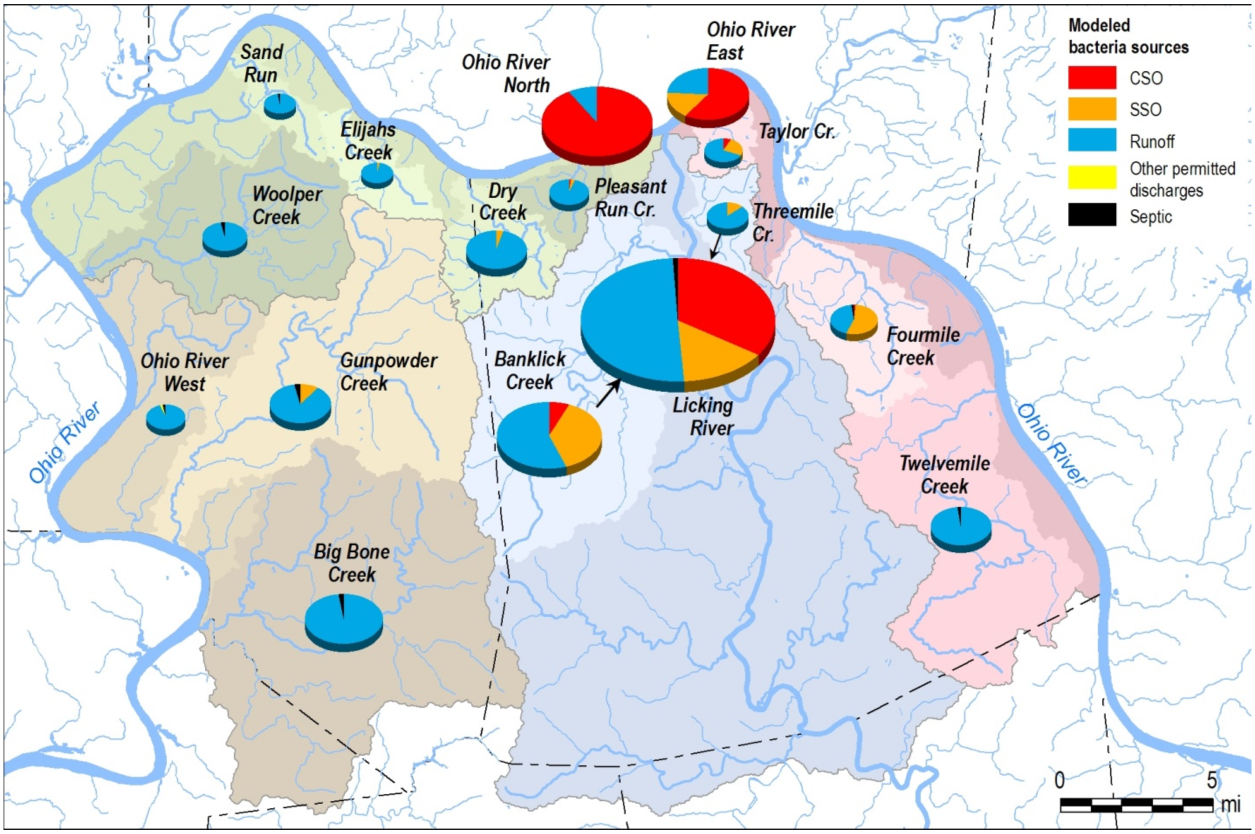
SD1's planning process involved a more thorough characterization of watersheds than is normally achieved through traditional sewer overflow control programs. This characterization involved both field data collection and water quality model development for Northern Kentucky's waterways to assess their current condition and response to overflows and other sources of pollution. Watershed characterization is particularly important in Northern Kentucky because of the wide variability in the size and quality of its watersheds. For example, the total watershed area of the Ohio River at its confluence with the Licking River is approximately 71,250 square miles, as compared to Taylor Creek which has a total watershed area of 4.2 square miles.

SD1's watershed characterization effort was based on a division of the entire three-county Northern Kentucky region into sixteen watersheds. SD1 compiled a variety of data from different sources, including current land use, zoning, and identified pollution sources other than sewer overflows. Initiated in 2006, SD1 continues to collect instream data from all sixteen watersheds, including water quality, flow, biologic and habitat data. While a variety of water quality data were collected, fecal coliform bacteria was the focus of the watershed characterization efforts. The selection of fecal coliform as the primary indicator of water quality in the Watershed Plans is based on several factors. First, fecal coliform bacteria represent a public health risk because they are an indicator of pathogenic substances. Secondly, SSOs and CSOs are known sources of fecal coliform bacteria pollution to waterways. Most importantly, water quality standards for fecal coliform bacteria established by the Kentucky Division of Water and the Ohio River Valley Water Sanitation Commission were in place at the beginning of the watershed characterization work. Earlier studies have also indicated elevated fecal coliform densities throughout Northern Kentucky watersheds.

The most relevant fecal coliform water quality criteria with respect to the Watershed Plans are the 30-day maximum and the 30-day geometric mean, during the recreational season (May 1 to October 31). For the Ohio River, the 30-day maximum level is 400 colony forming units per 100 milliliters for 90% of the days within a 30-day period. The same level applies to all other waterways, but must be met for 80% of days. The 30-day geometric mean for all waterways is 200 colony forming units per 100 milliliters. In general, the 30-day maximum criterion is more stringent than the geometric mean for Northern Kentucky waterways.

SD1 developed a Watershed Assessment Tool that utilized the results of the watershed and sewer characterization work. The Watershed Assessment Tool was developed for the entire three-county area and is used to calculate annual fecal coliform bacteria loads. These results were used to guide the development of detailed water quality models, evaluate watershed control opportunities, and provide a relative assessment of different controls. Figure ES.2 provides a summary of the bacteria load results from the Watershed Assessment Tool for each of the sixteen modeled watersheds; the size of each pie chart in the figure is relative to the total bacteria load from its corresponding watershed (i.e., the Licking River watershed has a greater total load than Taylor Creek).

Figure ES.2 Watershed Assessment Tool Results – Fecal Coliform Loading

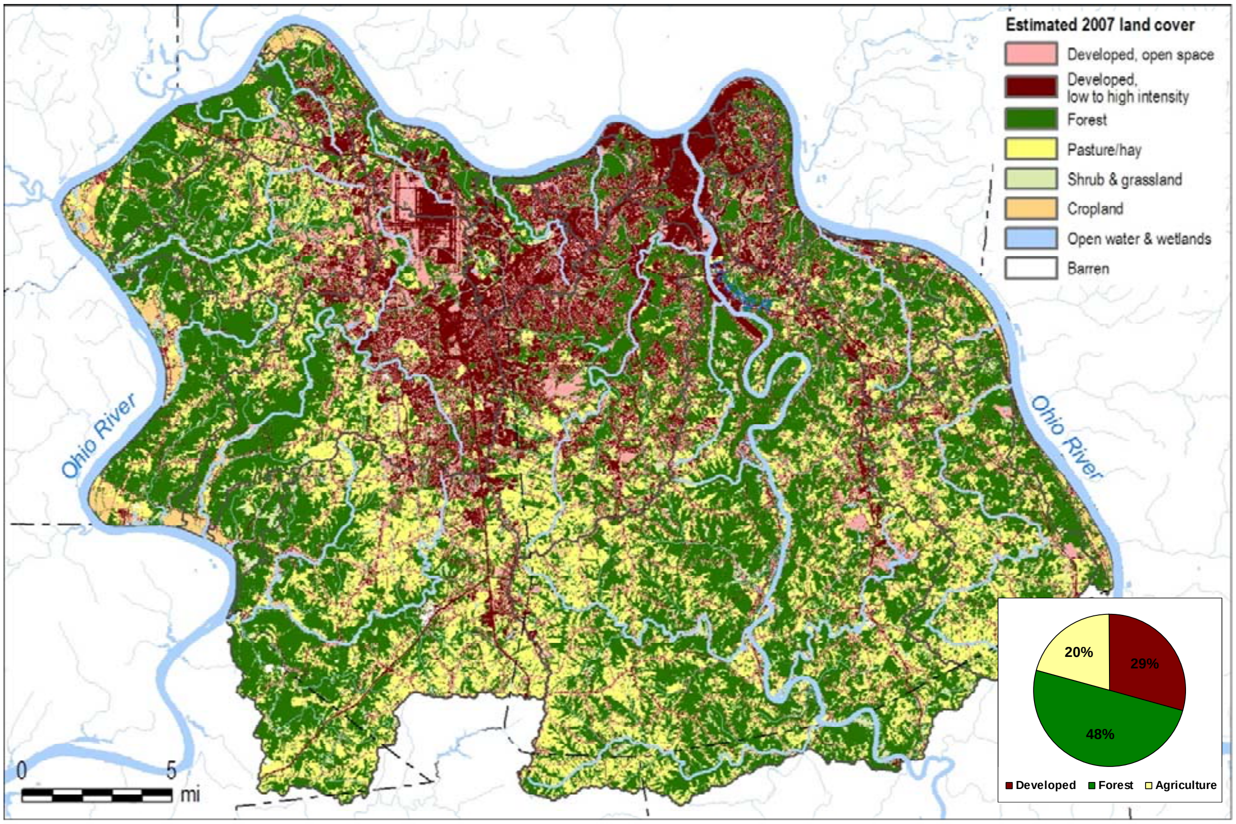


More detailed water quality models were developed for the Banklick Creek, Taylor Creek, and a combined section of the Ohio River / lower Licking River / lower Banklick Creek system. The models were developed using the instream water quality data (dry and wet weather conditions), sewer system hydraulic modeling results, storm water outfall sampling data, and other data. Each model calculates instream, hourly bacteria densities along the length of the modeled stream. These results were used to estimate the impact of different pollution sources, forecast the effect of different land development and pollutant control scenarios, and identify data gaps.

Alternative Controls

The characterization of alternative control opportunities (both green infrastructure and large-scale watershed controls) covered a majority of the SD1 service area, with a particular emphasis in the combined sewer system because of the significant CSO control benefit of runoff volume reduction from green infrastructure. This characterization included developing an inventory of natural and built systems. Natural system components included stream mapping, geology, soils, and tree canopy. Built system components in the characterization included impervious surface mapping, transportation corridors, sewer system mapping, and current/projected land use. A summary of current land cover across Northern Kentucky is shown in Figure ES.3. Land cover is useful in the characterization of alternative controls because there is often a correlation between land use and the selection of a given watershed control (i.e., stream corridors in agricultural areas may be good candidates for the restoration of riparian buffers).

Figure ES.3 Estimated 2007 Land Cover



Detailed assessments of large-scale watershed controls were generally made in the watersheds with combined sewer systems. These assessments included an analysis of the bacteria reduction benefits resulting from regional projects such as regional basins, wetlands, and riparian buffers.

The characterization of the combined sewer area indicated that approximately 38% of the total combined sewer service area (10 square miles) is covered with impervious surface. This type of characterization is useful because storm water runoff volume is closely linked to the amount of impervious surface. The distribution of that impervious surface is summarized in Table ES.3.

Table ES.3 Impervious Surface in Combined Sewer System

Surface Type	Amount of Impervious Area (square feet)	Percentage of Total Impervious Area
Rooftops	44,000,000	46%
Roadways	33,000,000	36%
Parking, driveways and sidewalks	17,000,000	18%
Total	94,000,000	38%

Full System Analysis

The CSO Control Policy states that the Environmental Protection Agency “expects the long-term CSO control plan to consider a reasonable range of alternatives,” and “the analysis of alternatives should be sufficient to make a reasonable assessment of cost and performance” (EPA, 1994). Therefore, SD1 evaluated solutions to reduce sewer overflows and improve water quality by first identifying full system solution concepts for the 2025 planning horizon. The full system solution alternatives are conceptual programs that address all overflows across the three-county study area under future build-out conditions. The evaluation relied heavily on the results of the sewer system and watershed characterization work.

For these evaluations, SD1 developed a suite of metrics to assess project benefits. These included traditional metrics to assess system performance and bacteria reductions as well as non-traditional metrics such as aquatic habitat restoration, flood mitigation, and quality of life improvements for residents. While the analysis of full system solutions is a Consent Decree requirement, the selection of controls is ultimately impacted by cost-benefit considerations and affordability. Despite the selection of a given full system solution concept at this time, ongoing evaluations and studies may show that the expected benefits from a proposed conceptual full system plan are neither realistic or cost effective and, therefore, necessitate changes in future plans. SD1’s watershed-based approach accommodates such changes in direction, when appropriate, while ensuring substantial progress toward ultimate goals.

The base condition of the full system solution analysis was a 2025 future conditions scenario that assumed no sewer overflow controls would be constructed and that future development would not include water quality treatment practices, such as storm water best management practices or low impact development practices. This scenario represents a hypothetical but important baseline, because it establishes a standard reference point for comparison of potential 2025 solutions and their associated water quality improvements. When compared to current conditions, this future scenario indicated significant deterioration of water quality in Northern Kentucky’s watersheds.

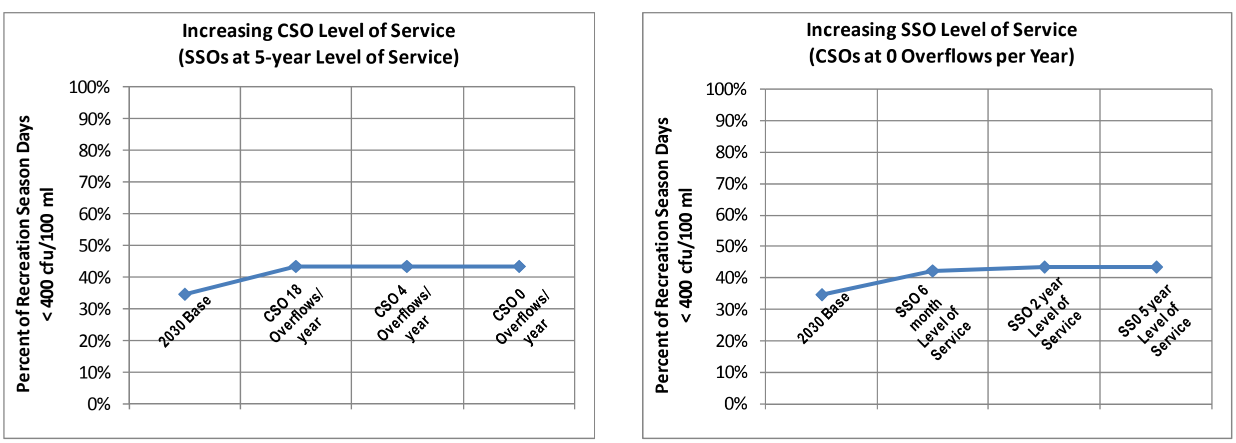
The second alternative in this full system solution analysis was based on the evaluation of gray-only controls to address CSOs and SSOs across a typical range of control levels. These gray-only concepts were developed to provide an understanding of the facilities, costs and benefits associated with the gray infrastructure needed to eliminate SSOs under different control levels and conform to the CSO Control Policy presumptive approach under future conditions. In addition, the gray-only evaluations provided the required information for the economic analysis and served as a point of reference against green infrastructure and watershed control approaches. The following technologies were included in the gray-only concept analysis:

- Primary and secondary treatment expansion
- High-rate treatment
- Deep tunnel for storage and/or conveyance
- Storage tanks
- Conveyance improvements (pump stations and piping)

Six gray-only full system solution concepts were evaluated at two levels of control. From that set, one was selected for a more thorough analysis across a broader range of controls. The selection of that alternative was based on a combination of factors, including cost, ability to implement, and alignment with community goals. The cost of the selected gray-only solution concept varied from $1.9 Billion to $3.2 Billion in 2009 dollars, depending on the level of overflow reduction. Despite this massive investment in gray infrastructure and the corresponding reductions in overflow volume, the model often indicated minimal improvements in water quality standards compliance by December 2025.

For example, the Banklick Creek water quality model showed only minor improvement in the percentage of recreation season days that would meet the corresponding fecal coliform 30-day maximum criterion. As shown in Figure ES.4, the elimination of all CSO volume increases compliance with the bacteria water quality standard by 7% (from 35% with no overflow control to 42% with the elimination of CSOs). Controlling SSOs up to a 5-year level of service increases achievement of instream water quality standards by a similar amount (from 35% with no control to 41% with elimination of SSOs). The Taylor Creek model also indicated minimal improvement in water quality standards compliance at similar levels of CSO and SSO control.

Figure ES.4 Water Quality Benefits of Increasing the Level of CSO and SSO Control in Banklick Creek



Note: cfu/100 ml stands for colony forming units per 100 milliliters.

For Banklick and Taylor Creeks, the limited value of sewer overflow control can be attributed to: (1) the overflow volume entering these streams is relatively small compared to other sources of pollution, and (2) the stream monitoring and models indicate that the water quality of both streams is severely impacted by dry weather and non-overflow wet weather sources of bacteria pollution.

The calculated water quality improvements in the Ohio River resulting from the control of SD1 overflows were also marginal, but for different reasons. While a majority of the total SD1 overflow volume flows directly into the Ohio River, SD1 overflows comprise only approximately 6% of the total annual bacteria load to the 13-mile reach of the river adjacent to Northern Kentucky. The Ohio River is subject to significant wet weather input of bacteria from sources other than SD1 overflows. These sources include CSOs and SSOs from other urban sewer utilities as well as urban and agricultural runoff, both locally and upstream. While loads from SD1 overflows can result in elevated bacteria levels in the river, the duration of these levels is short enough that water quality standards are still met more than 90% of the time along the Kentucky shore, if other sources are controlled. These results show that controlling SD1 overflow sources that discharge to the Ohio River would result in little increase in compliance with water quality standards.

SD1's analysis indicates that the Licking River is affected by both SD1 overflows and other upstream sources, depending on the stretch of river examined. This highlights the need for a watershed-based approach that addresses the multiple sources of pollution contributing to the water quality impairment of this river.

The final assessment of potential full system solution concepts was an evaluation of a combination of gray infrastructure, green infrastructure, and watershed controls. The purpose of this evaluation was to determine whether a more cost-effective solution with increased improvement to water quality could be achieved using a combination of controls as compared to gray infrastructure approaches for sewer overflow control only. This was a particularly important question to address given the extremely high-cost of a traditional gray-only full system solution and its limited benefits in water quality improvement. Watershed and green controls were simulated using a cumulative benefit approach rather than by estimating the benefits of individual best management practices or green practices.

The watershed and green controls used in this analysis represented the implementation of controls for new development, the retrofit of runoff controls into existing development, the protection and re-establishment of riparian buffers where feasible, and control of dry weather-related bacteria sources (see Table ES.4). It should be noted that cost estimates for watershed controls are inherently less accurate than gray infrastructure costs. For example, a riparian buffer program could involve easement donations (lower cost) or purchases (higher cost). The implementation of a green infrastructure program could also involve variable levels of outside funding support. Specifically, local jurisdiction funding may be available for the green street component of an urban retrofit program which would lower the SD1 program cost.

Table ES.4 Watershed / Green Infrastructure Control Analysis Results for Banklick Creek

New Development - Design Event	Existing Development – Retrofit[1]	Riparian Buffers	Dry Weather Source Control	CSO Control Level (annual overflows)	SSO Level of Service	Watershed / Green Control Costs[2] ($ Millions)
0.5 inches	20%	50 feet	0%	18	6-month	$27.8 - $86.8
1.0 inch	50%	100 feet	0%	18	6-month	$65.1 - $180.3
1.5 inches	100%	Variable buffer (EPA guidance)	90%	0	5-year	$134.2 - $406.7

[1] Retrofit program based on the control of storm water runoff up to a 1.2" storm event; implemented over a percentage of currently developed areas.

[2] Based on Banklick Creek watershed cost analysis.

Despite these cost estimating complications, the analysis of the combined control scenarios provided encouraging results. The Banklick Creek and Taylor Creek water quality models indicate that a program based on a combination of gray controls at a lower level of CSO and SSO reduction with a moderate implementation of green and watershed controls yields greater overall benefits as compared to a gray-only program at a higher level of overflow control. The value of this assessment is its prediction that green and watershed controls can provide substantial improvements in water quality relative to their cost.

The most important conclusions resulting from the full system were as follows:

- At typical levels of overflow control, the cost of a traditional gray-only program to eliminate SSOs and reduce CSOs in conformance with the CSO Control Policy by 2025 varied from $1.9 to $3.2 Billion (2009 dollars). The economic analysis, which is presented below, clearly indicates that the SD1 ratepayers do not have the ability to support an overflow control program of this scale.
- When put in context with other pollution sources, increasing levels of sewer overflow control provide diminishing returns in water quality and public health improvement. Even at high levels of overflow control, improvements in water quality associated with a traditional gray-only program were generally limited.
- The impact of overflow control was not consistent across all watersheds, depending on watershed characteristics and the other sources of pollution.
- Use of green and watershed controls can be a more cost-effective approach for providing water quality and public health improvement than a program of gray-only controls.

The results of this work provided critical input into the economic analysis task and selection of projects for the five-year improvement program.

Economic Analysis

Financing a long-term, capital intensive program without placing an unreasonable burden on ratepayers is one of SD1's biggest challenges. The timing of the Watershed Plans submission is unique, in that it is occurring in the midst of the most severe national economic crisis in generations. As a result, the financial affordability precedents from other utilities' sewer overflow control programs established in consent decree negotiations over the past 10 years may no longer be valid.

SD1 is funded through a combination of sanitary and storm water utility rates and fees; no income is available from property taxes, sales taxes, or other taxes. Sanitary sewer rates currently represent 70% of this revenue stream. The current economic situation has the potential to significantly impact SD1's financial position. For example, the recession will clearly affect the ability of some ratepayers to pay increased sewer rates. As unemployment increases, credit markets tighten, and foreclosures increase, some ratepayers will ultimately not be able to afford their sewer bills.

This situation directly impacts the ability of SD1 to maintain adequate revenue, meet its bond coverage requirements, and keep a high credit rating. SD1 is required to maintain fiscally conservative accounting by its Board of Directors. The recent history of sanitary sewer rate adjustments (average annual increases over 13% for the last 10 years) have supported a bond rating of AA or better. The minimum debt service coverage required by SD1's bond indenture is 125%; however, the Board of Directors has set a goal of 150%. With the current and projected impact of the economic crisis, there will be more pressure and scrutiny for future rate adjustments.

In addition to funding projects associated with the Consent Decree, SD1 has an obligation to operate and maintain current assets. These "Committed Projects" are asset management costs that are not discretionary, as they reflect the cost of doing business for a sewer and storm water utility. This would include projects to fix failing pipes, prevent loss of service and building backups, and minimize wet weather overflows.

Funding scenarios and affordability implications were developed for two time frames, the full Consent Decree implementation period ending in 2025 and the watershed planning cycle for the next five years.

Full System Solution

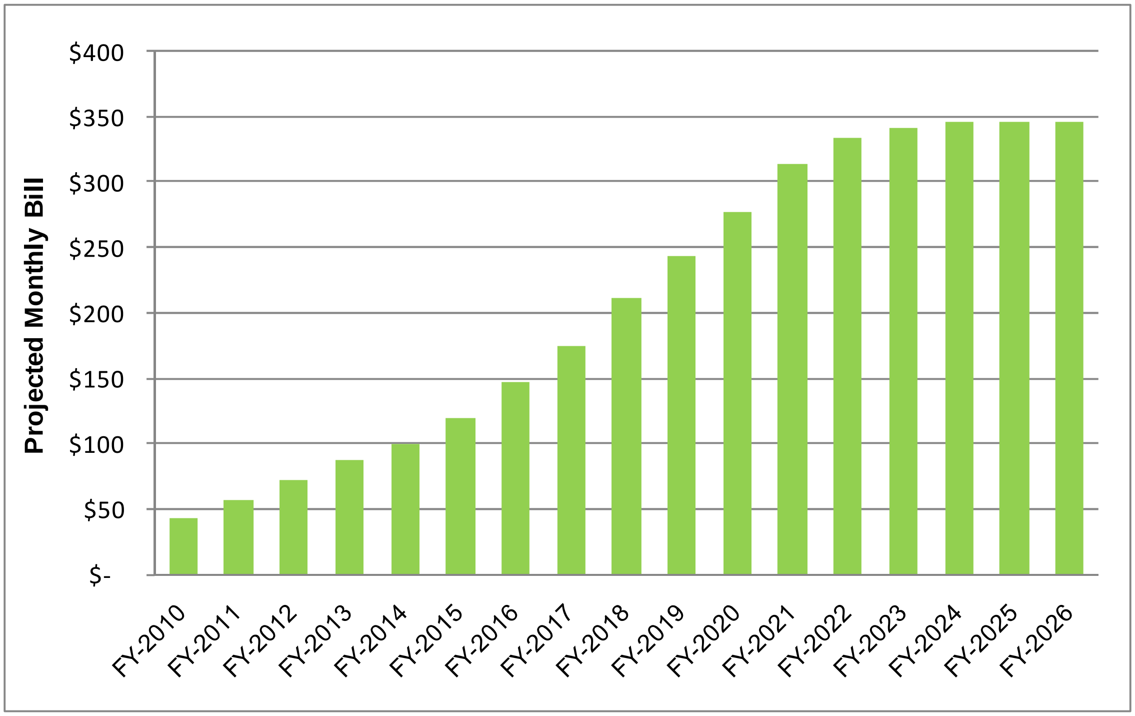
For the 2025 scenario, SD1 used the Financial Capability Assessment approach that is typically included in long-term control plans for CSO control. The improvement scenario for this analysis was a full system solution based on a CSO control level of 4 activations in a typical year and SSO elimination based upon a level of service of no more than one overflow every 2 years.

Per the Financial Capability Assessment, this program equates to an annual cost per household of $2,114. The corresponding Residential Indicator is 3.6%, based on a median household income of $58,400 (entire SD1 service area). Given that the sewer overflow consent decree programs developed by most other urban utilities can be achieved at costs with a residential indicator of less than 2%, this analysis indicates that

SD1's program is clearly in the "High Financial Impact" category. When assessed in terms of Northern Kentucky's lower-income communities, the financial impact is even greater. The seven lowest income communities (representing approximately 40 percent of the households in SD1's service area) have a median household income of $38,900. For these households, the Residential Indicator is 5.4%.

In addition to the Residential Indicator analysis, SD1 estimated the future rate increases that would be needed to support this full system solution. To assess the year-by-year impacts of the program, a conceptual schedule was developed to represent a construction sequence with final completion by 2025. This capital spending schedule was then incorporated into SD1's financial tools to estimate future rate requirements, as shown in Figure ES.5.

Figure ES.5 Residential Sewer Rates for the Full System Solution Concept – Future Projections (Future Dollars)



An average residential monthly sewer bill over $340 in 2024 represents an increase of 850% over 2010 rates ($40 per month). Even when allowing for future income growth, which is particularly difficult to predict in today's economic climate, these rate projections represent staggering increases that are unaffordable for SD1's ratepayers. The need for developing a watershed-based program that is cost effective, maximizes improvements to water quality and public health, and is supported by the public is clear.

Five-year Watershed Plan Horizon

The five-year cycle of the Watershed Plans also requires its own economic analysis. Because this analysis is not based on a full system solution or the full duration of the Consent Decree, the traditional affordability metrics such as the Residential Indicator are not directly applicable. Rather, SD1 used the estimated rate increase scenarios as the controlling indicator for determining an affordable five-year program.

As noted previously, SD1 has obligations both to the Committed Projects (asset management efforts) as well as the completion of the Initial Watershed Projects. These combined programs represent approximately $380 Million in capital spending over the five-year period of fiscal years 2010 to 2014. Future rate increases, beyond the recently approved 15% increases for fiscal years 2010 and 2011, needed to support the $380 Million spending projections were estimated at 12.5% for fiscal year 2012 and 10% in fiscal years 2013 and 2014. With this rate projection, the average residential bill would increase from $40 per month in fiscal year 2010 to $61 per month in fiscal year 2014.

SD1's objective for the next five years is to complete the Initial Watershed Projects, continue working the Committed Projects, and implement the System-wide and Basin Projects that have been identified through the watershed planning process. Taking into consideration all available information on the current economic crisis and the ability of ratepayers to fund these improvements, the maximum acceptable rate increases over this five-year period is 15% annually. SD1's financial tools indicate that this rate adjustment schedule will support $459 Million in System-wide and Basin Projects, Committed Projects, and Initial Watershed Project obligations over the period of fiscal years 2010 through 2014. These System-wide and Basin Projects are presented in more detail below.

Five-Year Improvement Program

Improvements to be made over the next five years include the completion of the Initial Watershed Projects, continued work on asset management, and the implementation of System-wide and Basin Projects that have been identified through the watershed planning process. All of these will provide significant improvements in CSO reduction, SSO elimination, public health, and the resulting water quality of Northern Kentucky's waterways. The funding of these projects will also require an aggressive schedule of 15% annual rate adjustments through fiscal year 2014. In addition, SD1 will evaluate, pursue, and seek commitments to ensure the successful implementation of green infrastructure in its overall full system plan. These commitments will be included in updates to the five-year Watershed Plans and will serve as a model for future green infrastructure projects and programs.

Initial Watershed Projects

A total of 52 different Initial Watershed Projects are listed in Exhibit D of the Consent Decree. These projects can be broadly categorized into three groups, as shown in Table ES.5. The benefits associated with these projects include SSO elimination, CSO elimination, overflow volume reduction, increased treatment capacity, and increased conveyance capacity.

Table ES.5 Five-year Improvement Program: Initial Watershed Projects

Project Name	Benefit	Spending through 2009 ($ Millions)	2010-2014 Budget ($ Millions)
Western Regional (11 projects)	New water reclamation facility, conveyance improvements, SSO elimination	$46	$255
Eastern Regional (10 projects)	New water reclamation facility, conveyance improvements, SSO elimination	$75	$2
Pump Station and Sewer Improvements, Sewer Separation, Illicit Discharge Removal, and Overflow Studies (31 projects)	SSO elimination, CSO elimination, overflow volume reduction, increased conveyance capacity	$37	$0 (all projects completed)
	Total	$158	$257

The Eastern Regional and Western Regional project groups represent the largest portion of the Initial Watershed Project set. The Eastern Regional projects were needed to eliminate the sewer overflows and resolve the 1996 sanction that led to a building moratorium in the Alexandria area; those projects are nearly complete at this time. The Western Regional projects include the construction of the new Western Regional Water Reclamation Facility and significant sewer construction throughout the area tributary to that facility. The largest of these sewer projects is the $141 Million conveyance tunnel project. The Western Regional projects will serve as a cornerstone in the ultimate solution to SD1's sewer overflow problems. These projects allow for the diversion of wastewater flow away from stressed areas of the SD1 system such as the Dry Creek Wastewater Treatment Plant and Lakeview Pump Station, thereby eliminating sewer overflows and providing additional capacity to accommodate future growth.

Committed Projects

In addition to funding projects associated with the first Watershed Plans, SD1 has an obligation to operate and maintain current assets and meet its other obligations. These Committed Projects represent a total of approximately $124 Million in spending over the period of fiscal year 2010 through 2014. As shown in Table ES-6, these projects include high priority sewer repairs and replacements, a number of Consent Decree required programs, improvements at pump stations and treatment facilities, and capital purchases.

Table ES.6 Five-year Improvement Program: Committed Projects

Project Name	Benefit	2010-2014 Budget ($ Million)
High-priority Sewer Projects	Critical sewer rehabilitation / replacement; Projects include Van Deren, Highland Pike, Wayman's Branch	$5.0
Nine Minimum Control Program	Element of Nine Minimum Controls Program, Consent Decree requirement	$1.4
River's Edge Inline Storage and Solids & Floatables Project	CSO volume reduction, Solids and Floatables Controls at 2 CSO outfalls	$6.0
Capacity, Management, Operations, and Maintenance Program	Consent Decree requirement; Projects include Pump Station Back-up Power, South Park Industrial Pump Station Overflow Elimination	$22.1
Consent Decree Planning, Implementation, Management	Necessary to ensure effective implementation of overall Consent Decree program	$10.4
Improvements at Dry Creek Wastewater Treatment Plant	System maintenance, increased treatment capacity	$16.9
Pump Station Projects	Pump station asset management and elimination	$5.9
Ongoing Sewer Rehabilitation / Repair Projects	Rehabilitation / replacement based on Continuous Sewer Assessment Program and Cities' opportunities; SSO elimination	$34.5
Storm Sewer Rehabilitation / Repair Projects	Storm water asset management	$17.6
Capital Purchases (vehicles, construction equipment, etc.)	Equipment	$4.0
	Total	$123.8

System-wide Projects and Basin-Specific Projects

As required in the Consent Decree, SD1 has developed Watershed Plans for improvement projects to be implemented over the next five years. Information that was needed for the development of these Plans included the results of the system characterization, the full system analysis, and the economic analysis. In addition, public participation was also a critical component in the watershed planning process.

SD1 solicited public input through a variety of channels. Those included a widely-publicized and well-attended Watershed Summit meeting in 2007, the formation of a 53-member Watershed Community Council that met regularly over the last 18 months, and the development and distribution of a survey to assess the community's support of the Consent Decree program. Through that process, a set of criteria were established that guided the selection of projects for the Watershed Plans. Those criteria included:

- Reduction of sanitary sewage entering waterways
- Reduction of polluted runoff
- Public health benefits
- Maintenance of critical, aging infrastructure
- Cost

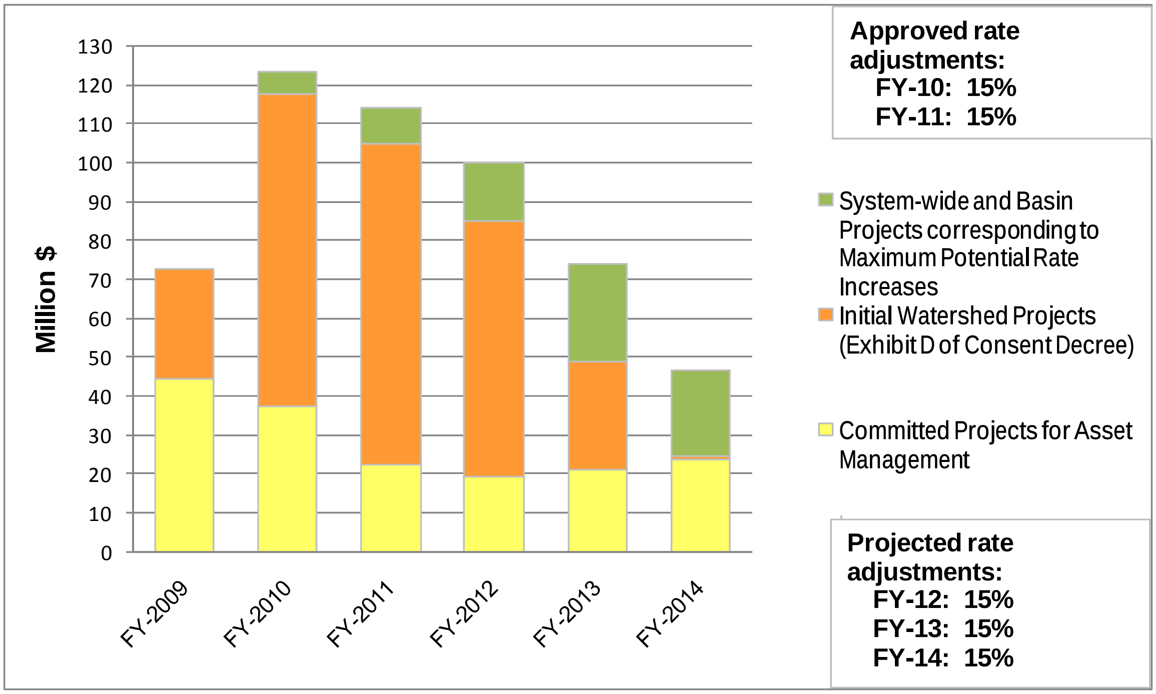
The selected set of Consent Decree compliance projects for these Watershed Plans includes both System-wide and Basin Projects. As shown in Table ES.7, these projects also include a combination of gray infrastructure, green infrastructure, and watershed control approaches.

Table ES.7 Five-year Improvement Program: System-wide and Basin Projects

Project Name	Benefit	2010-2014 Budget ($ Millions)
System-wide		
River Water Intrusion Mitigation	CSO reduction	$5.0
Priority Inflow and Infiltration Source Identification and Removal	SSO reduction/elimination	$6.0
Green Programs (downspout disconnection, rain barrels, rain gardens, green roofs, urban reforestation)	Runoff reduction, CSO reduction, Improve water quality, green space	$2.0
Green Demonstration Projects (green street, green school, partnering on development, innovative technology testing)	Runoff reduction, CSO reduction, improve water quality, green space	$4.6
	System-wide Project Total	$17.6
Central Basin		
Lakeview Pumps Replacement	Increase pump station capacity and reliability	$5.4
Church Street (Gray, Green, and Watershed controls)	CSO reduction, storm water runoff, green space	$3.8
Vernon Lane –Public & Private Source Inflow and Infiltration Removal	SSO elimination	$3.8
Watershed Controls Pilot Projects - Wetlands and Retention Facilities	Improve dry and wet weather water quality	$3.6
Ripple Creek Pump Station Removal	SSO elimination	$0.9
	Central Basin Project Total	$17.5
East Basin		
Ash Street Pump Station and Forcemain	CSO elimination (Sensitive area); SSO reduction	$19.7
Green Demonstration Projects – Taylor Creek Retention	Improve water quality; flood control	$0.5
	East Basin Project Total	$20.2
North Basin		
Allen Fork Pump Station Overflow Elimination	SSO elimination	$8.3
Lakeside Park – Public Sewer Rehabilitation and Private Source Removal	SSO elimination	$5.8
Willow Run Dynamic Control	CSO reduction	$1.3
Willow Run Direct Entry Point Bar Racks	Reduce debris entry and reduce blockages	$0.06
Kentucky Transportation Cabinet Basin – Green Infrastructure Retrofit	CSO reduction, inform future green infrastructure	$1.5
	North Basin Project Total	$17.0
West Basin		
Highland Acres Pump Station Removal	SSO elimination	$1.65
Kentucky Aire Pump Station Removal	SSO elimination	$4.0
	West Basin Project Total	$5.7
	System-wide and Basin Projects Total	$78.0

The total capital spending associated with all project work over the next five years is approximately $459 Million. The distribution of spending over that period is weighted towards Initial Watershed Projects in the first few years with a transition to the System-wide and Basin Projects towards the end, as shown in Figure ES-6.

Figure ES.6 Capital Spending and Rate Adjustment Schedule



Overflow Reduction Benefits

The overflow reduction benefit resulting from the projects described in the five-year improvement program is substantial, with an overall 28% reduction in typical year sewer overflow volume. Based on hydraulic model results, the CSO volume for a typical year will be reduced by 493 million gallons, representing a 26% decrease from current conditions. The annual SSO volume, including both confirmed and model-predicted overflow locations, for a typical year is reduced by 108 million gallons, representing a 44% decrease. The overflow reduction is associated with the projects presented in Table ES.8.

Table ES.8 Five-year Program: Overflow Reduction for Selected Projects

Project	Overflow Reduction (millions of gallons)	
	CSO	SSO
Western Regional	-	59.7
Eastern Regional	-	8.0
River Water Intrusion Mitigation	281	7.5
Church Street	35	-
Ash Street Pump Station	2.4	21.6
Vernon Lane Infiltration/Inflow Reduction	-	3.8
Ripple Creek Pump Station Removal	-	0.3
Lakeside Park Improvements	-	0.4
Additional System Improvements o Static Inline Storage o Bromley Wet Well Modifications o Willow Run Dynamic Control o Kentucky Transportation Cabinet Basin Retrofits o Taylor Creek Improvements	174.6	6.5
Selected Project Totals	493	107.8

Lakeview Pump Station

Since SD1 entered into the Consent Decree, significant improvements have been completed at the Lakeview Pump Station and additional improvements will be completed within the next five years. As a result of those projects, the annual overflow volume from the Lakeview bypass will be reduced by more than 90% in a typical year. Water quality sampling shows that this reduction in overflow results in approximately 10 additional days of achievement of instream water quality standards, annually. As SD1 evaluated control alternatives for the remaining overflow at the bypass, it was estimated that higher levels of control to eliminate the 1 million gallons of remaining annual overflow volume will produce no additional days of achievement of instream water quality standards for the Banklick Creek.

The cost to construct a storage tank or install interim high rate treatment that would eliminate or treat the remaining overflow volume ranged between $15 Million to $27 Million. In addition, this investment would only address the overflow at the pump station and would do nothing to improve the condition of the water quality in the upper two-thirds of the watershed. Model results have shown that far greater water quality, community, and public health benefits can be achieved by directing resources toward the improvement of dry weather conditions in Banklick Creek. SD1 is proposing that that the solution to address the overflow at Lakeview be focused on the overall water quality issues within the Banklick Creek watershed. The proposed solution includes six components:

- Replace existing pumps at the Lakeview Pump Station to maximize and provide reliable peak pumping capacity
- Redirect a portion of the Lakeview tributary area to the new Western Regional Water Reclamation Facility and reduce the annual calculated overflow from 10.6 to 1 million gallons (under construction)
- Conduct investigations and target cost-effective inflow and infiltration removal in the area remaining tributary to Lakeview to reduce wet weather flows and target upstream SSOs at locations with a higher risk for public exposure
- Implement a Source Identification Program to detect sources of pollution (dry and wet weather-related) determined to exist through monitoring and modeling efforts
- Construct a wetland system in Banklick Creek to reduce dry weather bacteria levels and improve overall water quality in the downstream system
- Construct instream retention facilities to provide water quantity and water quality benefits associated with precipitation/runoff events (wet weather conditions)

This combination of controls represents a cost-effective solution that provides greater water quality, public health, and community benefits than a more costly investment to contain or treat the remaining 1 million gallons of overflow from the Lakeview Pump Station. In addition, by delaying action at Lakeview with respect to the remaining overflow volume, SD1 will be able to reallocate $20 Million over the next five years to the Ash Street Pump Station project in Silver Grove which will provide approximately 24 million gallons of annual overflow reduction in a part of the system where the overflow has greater potential for public health impacts.

This approach represents a change from the language of Exhibit E in the Consent Decree which specifies a completion date of December 31, 2013 for the construction of remedial measures at the Lakeview Pump Station to eliminate the bypass. However, the proposed solution described above supports the position that this modified approach will provide substantially greater improvements to water quality and public health. Therefore, the Watershed Plan provides for a delay in the December 31, 2013 Consent Decree deadline to eliminate the bypass at the Lakeview PS SD1 will monitor the effectiveness of the proposed controls and evaluate the need for further overflow elimination at Lakeview in future Watershed Plans.

Conclusion

SD1's Consent Decree is unique in that it incorporates a watershed-based approach that allows for the extensive characterization of area watersheds to put CSO and SSO controls into context with other sources of pollution. This approach provides an alternative to traditional regulatory practices which target specific sources through individual pollution control programs. By taking a watershed-based approach, SD1 will make use of a wider variety of data to assess the relative impact of different pollutant sources on the receiving waterways.

This approach also prevents the pitfall of directing funds towards increasingly higher levels of CSO and SSO control when those improvements do not provide corresponding improvements in water quality. Traditionally, most consent decrees focus solely on CSOs and SSOs, with an emphasis on gray infrastructure solutions. SD1's watershed approach identifies the characteristics of individual watersheds and considers CSOs and SSOs along with other pollution sources impacting the waterways (such as runoff and dry weather sources). The iterative structure of SD1's Watershed Plans allows time to investigate new technologies and adjust the approach so that solutions for updated Plans will be developed using information gained from the implementation of projects during the first five years. This includes the pursuit of green infrastructure approaches that are more cost effective than traditional gray infrastructure, including mechanisms to ensure the implementation of such controls.

The U.S. Environmental Protection Agency acknowledges that "[for] some receiving water reaches within a watershed, CSOs could well be less significant contributors to nonattainment than storm water or upstream sources. In such cases, a large expenditure on CSO control could result in negligible improvement in water quality" (EPA, 1995b). Much of the work performed by SD1 thus far supports this statement. The proposed full system plan of a combination of gray and green infrastructure along with watershed controls is shown to be more cost effective at meeting the long-term goals of the Consent Decree.

The SD1 Consent Decree, developed in partnership with state and federal regulatory agencies, represents a paradigm shift in wet weather control programs. The watershed approach is one of the U.S. Environmental Protection Agency's "Four Pillars" for sustaining water infrastructure (EPA, 2006). Under the watershed approach, priorities and solutions that provide the largest overall environmental impact are developed based on current information considering watershed-based, cost-effective alternatives as well as traditional gray-only infrastructure solutions. This process recognizes the need to consider environmental progress, make wise use of public resources, and direct funds towards the most significant problems first.

SD1's Watershed Plans are focused on prioritizing those projects that maximize the return on investment, protect public health, and improve water quality. This approach also allows SD1 to compare gray-only controls against integrated sets of gray, green, and watershed solutions and calculate the estimated cost savings and greater net environmental benefit of the integrated solutions. The watershed approach provides SD1 with the opportunity to learn from experience and allows the information gained on project effectiveness to be factored into the next round of decision-making and project selection. The overall effectiveness of this new approach will require additional work for post-construction monitoring and results confirmation, which is why the Consent Decree requires the development and submittal of updated Watershed Plans every five years. This iterative cycle provides all stakeholders with an opportunity to review performance and benefits and make appropriate adjustments to program goals moving forward. The 28% in overflow reduction associated with this first Watershed Pan is indicative of the fact that that substantial progress is being made towards the ultimate goals of the Consent Decree.

As a pioneer in this approach, SD1 will need to work closely with the regulatory agencies and local stakeholders to coordinate and maintain considerable flexibility throughout the duration of the Consent Decree. For example, this could mean that, in certain situations, it is sensible to accept a lower level of overflow control than traditional programs, in exchange for greater improvement in water quality through investments in a combination of controls that address other dry weather and wet weather-related sources. Likewise, directing resources toward other sources of pollution may provide a more substantial improvement in water quality. The planning of such projects will require assurances by SD1 that they can be implemented as well as the willingness of regulators to accept offsets or delays in typical overflow controls.

Given the adaptive nature of this approach, the total cost of the SD1 program and a comprehensive schedule with which controls are implemented over the full duration of the Consent Decree cannot be precisely defined at this time. However, through these five-year cycles, SD1 will measure progress and ensure that funds are directed into control programs that meet regulatory mandates, maximize improvements in water quality and public health, and meet the expectations of the public.