MSD

Louisville and Jefferson County
Metropolitan Sewer District

Interim CSO Long Term Control Plan

September 15, 2006

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MSD

Louisville and Jefferson County
Metropolitan Sewer District

SECTION 1

SECTION 1: INTRODUCTION

1.1 OVERVIEW AND PURPOSE

1.1.1 Introduction

On August 12, 2005 the Louisville and Jefferson County Metropolitan Sewer District (MSD) entered into a Consent Decree with the United States Environmental Protection Agency (EPA) and the Commonwealth of Kentucky to address wet weather flows within the separate and combined sewer systems. The objective of this Consent Decree is to further the objectives of the Clean Water Act; eliminate unauthorized discharges from MSD's sanitary sewer system (SSS), combined sewer system (CSS), wastewater treatment plants (WWTPs); and to address discharges from MSD's CSO locations identified in the Kentucky Pollutant Discharge Elimination System (KPDES) for the Morris Forman Wastewater Treatment Plant (MFWTP). The Consent Decree outlines the compliance program and schedules for achieving specific objectives, one of which is the submittal of this document, the Interim CSO Long Term Control Plan (LTCP).

MSD completed and submitted, to the Kentucky Environmental and Public Protection Cabinet, Department for Environmental Protection's Division of Water (DOW), a CSO LTCP for the Beargrass Creek area in 1996 and completed and submitted a CSO LTCP for the Ohio River area in 1997. These plans were in compliance with the EPA CSO Guidance Policy of April 1994. They presented the current plan to address CSOs within the MSD service area. Upon submittal of these plans, MSD appropriately initiated implementation of the CSO LTCP.

This document is the Interim CSO Long Term Control Plan, which is a modification of the 1996 and 1997 CSO LTCP. It includes a summary of the notable work completed to date, which demonstrates MSD's efforts for compliance. It also describes the manner in which MSD will undertake the development of the CSO LTCP Update, which is to be submitted on December 31, 2008.

1.1.2 CSO EPA Guidance Overview

The CSO Control Policy published on April 19, 1994 provides guidance to permittees with CSOs, NPDES authorities and State water quality standards authorities on coordinating the planning, selection and implementation of CSO controls that meet the requirements of the Clean Water Act. The policy contains provisions for developing appropriate, site specific NPDES permit requirements for all combined sewer systems that overflow as a result of wet weather events and allows for public involvement during the decision-making process.

Four key principles of the policy ensure that combined sewer overflow controls are cost effective and meet the requirements of the Clean Water Act. These principles are as follows:

- Provide clear levels of control that would meet appropriate health and environmental objectives;
- Provide sufficient flexibility to municipalities, especially financially disadvantaged communities, to consider the site specific nature of combined sewer overflows and to determine the most cost-effective means of reducing pollutants and meeting Clean Water Act objectives and requirements;
- Allow a phased approach for implementation of combined sewer overflow controls considering a community's financial capability; and

- Review and revise, as appropriate, water quality standards and their implementation procedures when developing combined sewer overflow control plans to reflect the site specific wet weather impacts of combined sewer overflows.

The policy establishes two main objectives for permittees; implementation of nine minimum controls (NMCs) and development and implementation of a LTCP. The implementation and status of the NMCs is detailed in a separate report titled NMC Compliance Report, dated June 3, 2006.

The CSO Control Policy directs the permittee to develop and implement a LTCP based on characterization, monitoring and modeling of the combined sewer system. The plan should consider the site-specific nature of CSOs and should employ a public participation process involving the rate payers, industrial users, persons residing downstream of combined sewer overflows and other interested parties. The plan should also give highest priority to controlling overflows in sensitive areas. As listed in the CSO Control Policy, the minimum elements of the CSO LTCP are the following:

1. Characterization, Monitoring, and Modeling of the Combined Sewer System
2. Public Participation
3. Consideration of Sensitive Areas
4. Evaluation of Alternatives
5. Cost/Performance Considerations
6. Operational Plan
7. Maximizing Treatment at the Existing POTW Treatment Plant

As part of the CSO alternatives development and evaluation, a review of the current and proposed water quality standards is to be conducted to define the levels of pollutant load reductions that will be required to meet water quality standards, and thus set the performance expectations for the CSO controls. General indications of past water quality studies throughout the United States are that CSOs are only one of several sources that can significantly affect the pollutant concentrations in the receiving waters. Control of just CSOs may not be sufficient to achieve the standards nor restore the water bodies to their designated uses.

1.1.3 MSD CSO Long Term Control Planning

Louisville MSD initiated its CSO abatement program in 1991, and has continued to evolve and expand the resources it dedicates to developing a comprehensive understanding of the CSS and its approach to reducing CSOs. A significant amount of work has been conducted since 1991 including characterization of the system, development of hydraulic computer models, compliance with the NMCs, and implementation of various CSO LTCP elements. Figure 1-1 illustrates some of the major activity that has taken place in the last fifteen years and has provided a foundation for the development of this Interim CSO LTCP and will be beneficial to the completion of the CSO LTCP Update in 2008.

MSD's initial efforts of CSO abatement occurred well before the final CSO Control Policy was issued in 1994. Model development and flow monitoring took place during the early 1990s to help MSD better understand how the CSS functioned during periods of wet weather. In addition, preliminary CSO controls were investigated by evaluating potential CSS best

management practices (BMPs). During the mid and late 1990s, BMPs and NMCs were implemented as means of providing reductions in the frequency of occurrence and magnitude (volume) of CSO discharges, at relatively low capital cost.

From the year 1998 until the present, MSD has devoted additional resources to more capital intensive projects such as real time control (RTC), pumping station improvements and upgrades, sewer separation, construction of storage basins, construction of solids and floatables facilities, and the elimination of several CSOs. These projects are outlined in Section 8. Completion of projects such as these demonstrate the significant impact MSD's CSO initiative in the 1990s has had on the overall progress of the CSO abatement program and poise MSD for successful completion.

A significant undertaking that has become the foundation for the current CSO LTCP is the Real Time Control (RTC) Program. The objectives for this ongoing program is a better use of existing in-line storage capacity of large conduits for a cost effective reduction of combined sewer overflows within both the Beargrass Creek and Ohio River basins. The combined sewage flow is stored within the existing pipes and conveyed to the Morris Forman Wastewater Treatment Plant (MFWTP) after the wet weather event, when treatment capacity is available. It is an application of advanced technology that is both global and predictive, which means that the decision making system will use available information monitored on the sewer network, and predicted by the Radar Rainfall Data System (RRDS), to determine the best flow management strategy. The initial phase includes the set up of a centralized decision making system (Csoft), a radar rainfall data system to predict weather 2 hours in advance, and remote automated control of five sites within the CSS.

Two key planning projects currently underway which will assist the CSO LTCP planning process for 2008 have been in progress for several years. These projects are the ORSANCO water quality study, that included a preliminary analysis of the bacterial impacts of CSO on the Ohio River; and the Beargrass Creek TMDL project using the Water Quality Tool (WQT) to determine total maximum daily load allocations for bacteria. Both of these projects will play important roles in the development of the final CSO LTCP.

1.1.4 Interim CSO LTCP Overview

The Interim CSO LTCP contains 11 sections. The Sections are as follows:

- Section 1: Introduction
- Section 2: Characterization, Monitoring, and Modeling
- Section 3: Public Participation
- Section 4: Maximization of Treatment and Flow to MFWTP
- Section 5: Consideration of Sensitive Areas
- Section 6: Consideration of Control Strategies
- Section 7: Evaluation of Draft Strategies
- Section 8: CSO LTCP Implementation through June 2005
- Section 9: Current Operational Plan
- Section 10: Current Post-Construction compliance Monitoring Program
- Section 11: Interim CSO LTCP - Process Forward

Sections 1 through 10 provide an update of the previously submitted draft LTCP. These Sections describe the past history of MSD's CSO control efforts and demonstrate MSD's efforts to date to achieve compliance with the following goals:

- Ensure that if CSOs occur, they are only as a result of wet weather (including activities to address those discharges resulting from compliance with the requirements of the United States Army Corps of Engineers (USACE) Ohio River Flood Protection System Pumping Operations Manual dated 1954 and revised 1988);
- Bring all wet weather CSO discharges points into compliance with the technology-based and water quality-based requirement of the Clean Water Act;
- Minimize the impacts of CSOs on water quality, aquatic life and human health; and
- Bring stakeholders into the planning, prioritization and selection of project process.

Additionally, as required by the Consent Decree, Section 11 of the Interim CSO LTCP describes the manner in which MSD plans to undertake the development of the CSO LTCP Update, including the following elements:

- The results of characterization, monitoring, modeling activities, and design parameters as the basis for selection and design of effective CSO controls;
- The results of an evaluation of WWTP peak flow treatment capacity for WWTP that will receive additional flow-based on any LTCP project;
- A report on the public participation process;
- Identification of how the final LTCP addresses sensitive areas as the highest priority for controlling overflows;
- A report on the cost analyses of the alternatives considered;
- Operational plan revisions to include agreed upon long-term controls;
- Maximization of treatment at MSD's existing wastewater treatment plants for wet weather flows;
- Identification of and an implementation schedule for the selected CSO controls; and
- A post-construction compliance monitoring program adequate to verify compliance with water quality-based CWA requirements and ascertain the effectiveness of CSO controls.

Section 11 discusses the planning approach for performing the work to move forward to completion of the CSO LTCP Update to be submitted in 2008.

1.2 MSD HISTORIC OVERVIEW

1.2.1 Late 1800s-1950

The sewerage system owned, operated, and maintained by the Louisville and Jefferson County Metropolitan Sewer District has evolved for almost a century and a half into an extensive network of both sanitary and combined sewers, diversion structures, mechanical regulators and other flow control devices, and pump stations.

In 1805, at Louisville's request, the state legislature passed the "Hog and Pond Law" which aimed to ban free-roaming pigs from the muddy dirt streets and to drain the water from the stagnant ponds. These stagnant ponds provided an ideal habitat for disease-carrying mosquitoes, microscopic parasites and bacteria. In 1822, a malaria epidemic occurred in which

1/4 of the population was stricken and 140 died. As a result of the epidemic, the Jefferson Pond Drainage Company was formed in 1823. The company began a major drainage effort to dig ditches and remove most of the ponds by the end of the decade. For decades to come, the drainage ditches and local streams would serve as the City's sewer system.

Sometime prior to 1850, Louisville's first underground sewers were built. They were constructed of cut stone and brick. The first sewer was likely the Second Street sewer, from Jefferson Street north to Beargrass Creek, which entered the river at 4th Street at the time. The early sewers were generally built on a piecemeal basis according to immediate needs and the funds available rather than in accordance with a comprehensive long-term plan. The sewers appear to have been intended mainly for the purpose of stormwater disposal and usually flowed toward the Ohio River or nearest surface drain.

By 1860, the underground sewer system was less than 2 miles long. During that year, the Louisville Water Company began operations that involved pumping water from the river to the downtown area. Because of the public water system operations in this decade, it became common practice to construct laterals to convey wastes directly from the houses into the sewers.

By the end of the century, the sewer system had grown to more than 99 miles. However, problems continued because the underground sewers still led directly to the ditches, the streams, and the river. Beargrass Creek was polluted with wastes from slaughterhouses and from the increasing number of sewer lines that dumped their loads into it. The City was building up to 4 miles of new sewers per year, but construction lagged far behind the need.

In 1906, the first Commissioners of Sewerage was established to direct the planning and construction of Louisville's sewer system. The Commission was authorized by acts of the General Assembly of the Commonwealth of Kentucky and approved by the Governor. The work of the Commissioners was funded through a $4,000,000 bond issue approved by the voters of the City and included provisions for satisfying long-term service area growth both inside and outside the City boundary line that existed at that time. The City pledged to pay back the bond using future tax revenue.

Over the next 7 years, the Commissioners of Sewerage oversaw the design and construction of about 54 miles of major sewer lines. The work included the City's first interceptor sewers, designed to intercept the sewer lines leading to Beargrass Creek and to carry the water directly to the Ohio River. It also included the first stretches of concrete channel for Beargrass Creek. The Commissioners existed until 1913.

The money was depleted in 1915, the year after World War I began. Sewer construction lagged again, falling further behind the need. In 1919, a year after the war ended, Louisville's voters approved another $2,000,000 bond issue for new sewers, and the second Commissioners of Sewerage was established to oversee the work. The group designed and built dozens of miles of major new sewers, funded through additional bond issues, through the boom years of the 1920s and the Depression years of the 1930s. As the Depression continued, the Commissioners also managed sewer and drainage work performed under federal public works programs.

The work initiated or managed by the Commissioners included miles of interceptor sewers that diverted raw sewage from Beargrass Creek directly to the Ohio, miles of relief sewers to handle the excess water from overloaded older sewer lines, and the huge Southwestern Outfall, stretching from South Louisville to the Ohio River near Paddy's Run. The Commissioners' work also included construction of miles of concrete channel, which replaced the natural course of Beargrass Creek, increasing its capacity to carry stormwater to the Ohio River.

Another project was the City's first sewage pump station. The Letterle pump station was built to serve the low-lying point area between the old course of Beargrass Creek and the river. The river level in downtown Louisville had been raised 8' when the Ohio River dam was rebuilt in the 1920s, permanently flooding some of the old sewers and causing the water to stagnate. The station, completed in 1939, pumped the wastewater from the point area into the Beargrass Creek interceptor. The station has been retired.

The money from the bond issues ran out as World War II began. Civilian construction was curtailed because of the war effort. The Commissioners planned to go out of business in 1942, and issued their final report that year. In the report, the Commission recognized the pollution problems that resulted from the existing system and recommended a location for a treatment plant (The Fort Southworth WWTP later renamed the Morris Forman WWTP) as well as the construction of the Ohio River Interceptor and other such lines to convey flow from the numerous outlets to the plant.

In 1946, the state legislature enacted a statute, KRS Chapter 076.00, enabling the formation of Metropolitan Sewer Districts. After enactment of this statute, a City ordinance was adopted to establish a new sewer district. The Louisville and Jefferson County Metropolitan Sewer District (MSD) was formed to take over the operation and maintenance of the sewers constructed by the City, County, and the Commissions and to continue the planning, design, and construction activities necessary to accommodate service area growth.

In early December 1946, the Board of Aldermen hired consulting engineers to prepare a plan for organizing the MSD staff and to develop a construction program and a schedule of rates and charges. The Board decided that the rates to be charged would be user fees which were based on the amount of water discharged into the sewers. The user fees were based on the consumption shown on the Louisville Water Company's water bills. The water company collected the sewer fee along with the water bill, turning the proceeds over to MSD. The Board added volume discounts for large users and also added a 33 1/3% discount for users who paid their bills promptly.

At this time, $17,000,000 in outstanding sewer bonds existed, which the new sewer district did not take over from the City of Louisville. City taxpayers' money was used to pay off these bonds for years to come. On July 1, 1947, the new sewer charges went into effect, and soon attracted opposition. As a result of several court battles settled in early 1948, higher rates outside the City were approved.

The new sewer district awarded its first construction contract in April 1947, for $3,237.50, for a sewer on Algonquin Parkway east of Beech Street. Work then began on other much-needed projects. By the end of June 1947, $26,000 worth of construction and long-delayed maintenance had been completed. Repair work was started on the Beargrass Creek channels. Sewers were extended in several neighborhoods in southern and western Louisville. Work was started on the Snead's Branch relief drain, a large line in the Shelby Street area from Eastern Parkway to Kentucky Street.

In May 1948 the Board adopted its first long-range construction plan, called the "10-year program." It detailed roughly $20,000,000 in projects, including $8,500,000 for the City's first treatment plant and its necessary interceptor sewers. The second largest project included extensive work in the Upper Dry Run area in southern Louisville, estimated at $3,300,000, and the third largest was completion of the Snead's Branch relief drain, at a total cost of about $1,600,000.

Altogether, there were 45 projects, mostly around the edges of the City. To help pay for the projects, the Board authorized its first bond issue. The total was $8,000,000, of which $4,000,000 were sold in the summer of 1949.

As MSD was going to work, another major local project was underway. On March 20, 1947, construction began on the floodwall. The project included a series of wastewater and stormwater pumping stations that became a part of MSD's system. The federal government paid for design and construction, City and County governments paid for the land, and the USACE did the design and construction work. As each section of the floodwall system was completed, it was turned over to Louisville and Jefferson County for operation and maintenance.

In 1948, the eight states in the Ohio River Valley joined the federal government in an interstate compact to clean up the river, which had become a 981-mile open sewer for untreated municipal and industrial wastes. The new Ohio River Valley Water Sanitation Commission (ORSANCO) went to work immediately. In September, the Kentucky Department of Health informed MSD that, under the interstate compact, MSD would be required to build a sewage treatment plant and stop discharging untreated wastewater into the Ohio River.

1.2.2 The 1950s

Early in 1950, MSD began acquiring land for the new treatment plant. It was the site of Fort Southworth, a Civil War fortification just outside the City limits at Algonquin and South Western parkways that had never been completed.

Construction work started at the plant in 1956. As design work continued, the cost estimates increased to $12,000,000. The construction of the new plant was financed by the City of Louisville and MSD each borrowing half the total cost. That year, MSD had its first rate increase in over a decade. Two years later, construction started at the Southwestern Outfall pumping station, which pumped wastewater from the system's largest sewer line to the new plant. And in 1958, MSD's first treatment plant went into operation. The pumping station was completed the next year.

In early 1959, shortly after the treatment plant went into operation, an assessment of MSD's accomplishments was done. In its first dozen years, MSD had built 195 miles of new sewers, at a cost of $33,000,000. Most of the tasks detailed in the 10-year plan of 1948 had been accomplished, but at far more than the original estimate of $20,000,000. And MSD still faced tasks that cost an estimated $41,000,000, which was more than the total needs estimated just before the agency was created.

In February 1959, the Board hired an executive consultant, who had overseen a part of the construction of the floodwall as head of the USACE Louisville District and had guided the sewer district through some of its toughest political and financial challenges. At that time, MSD's challenges still included sanitary sewers, drainage, and financing.

Suburban expansion was booming in the 1950s. MSD had the authority to serve the entire County, but it was still struggling with the challenge of serving the unsewered. A compromise was reached in the early 1950s in which the Board of Health would allow individual septic tanks where the land could accommodate them, and require small, "package" sewage treatment plants where septic tanks wouldn't work well. The board emphasized that both of these measures would be considered "temporary," and would be replaced by MSD service when MSD sewers became available.

Drainage became a more complex problem in the mid-1950s when MSD decided to stop building combined sewers. The decision was based on in part economics because sanitary-

only sewer lines cost much less than combined sewers, and could be financed by the fees and rates paid by the property owners being served. Additionally, it was becoming evident that combining stormwater and wastewater created difficult problems throughout the system. Untreated sewage was dumping into the streams when heavy rains overloaded the sewer lines, and partially treated wastewater had to be dumped into the streams and the river when heavy rains overloaded the treatment plants. The ORSANCO pact, signed by Kentucky in the 1950s, committed the state to stopping the practice of discharging untreated wastewater.

Because of the lack of adequate financing, limited stormwater drainage work was performed in the City. Drainage problems outside the City limits increased tremendously as farms became suburbs. In the mid-1950s, Jefferson County contracted with MSD to manage its drainage program and agreed to pay all the costs.

As the drainage problems became more critical and complex, sanitary sewer problems were also worsening. In 1959, the Board of Health banned new septic tanks in the area drained by the Middle Fork of Beargrass Creek, the prime suburban development area between Taylorsville and Shelbyville Roads east of Cherokee Park and St. Matthews. Soon afterward, it banned new septic tanks in a large area of southwest Jefferson County. Polluted water from septic tanks was creating a health hazard in ditches and streams. For the first time, it was mandatory that all new developments in these areas have sewers.

1.2.3 The 1960s

In October 1961, a plan was proposed that would merge MSD and the Louisville Water Company. The merged agency would be given countywide responsibility for water, sewers and drainage. The plan was sent to the 1962 legislature where it was battled and was eventually defeated.

In 1962, Jefferson Fiscal Court agreed to pay $200,000 for a plan for extending sanitary sewer service throughout the urbanized areas of the County by the year 2010. The study took 2 years and included extensive research into the current and future conditions throughout the County, including anticipated growth. The master plan divided the County into six study areas: North County, Middle Fork of Beargrass Creek, South Fork of Beargrass Creek, Pond Creek, West County and Floyds Fork. It recommended two major new treatment plants: North County, between the Louisville Water Company water tower and Beargrass Creek, and West County, along Lower River Road. It recommended smaller treatment plants to provide service as land developed in the Floyds Fork watershed. The cost estimate was $279,000,000.

A law passed by the 1964 legislature allowed for the formation of sewer construction sub-districts. The money for construction would be raised by selling bonds, which would be paid off by the income from assessments on the properties served. For the next 6 years, the sub-district system was used to expand sewers to several suburban areas of Jefferson County. Financing was also available through new federal clean water programs. Beginning in 1965, the federal government began a program that would pay up to 30 percent of the cost of installing suburban sewer lines.

1.2.3.1 The Environmental Era

Early in 1965, the Ohio River Valley Water Sanitation Commission (ORSANCO), which was created shortly after World War II, cited MSD for its efforts to help clean up the Ohio River, stating that MSD had helped make the river's waters the cleanest it had been in modern times.

The Fort Southworth Wastewater Treatment Plant was removing about 65 percent of the solids from the water discharged into the river, which exceeded the 45 percent required under the state regulations of the time.

Concern for the environment was intensifying during this time. Congress was finishing its first Water Quality Act, which went into effect later that year. This Act soon established standards for much cleaner discharges into the Ohio River. This was supplemented by the Clean Water Restoration Act of 1966, which provided federal matching funds for constructing sewage treatment plants.

In 1966, Kentucky and Indiana water pollution officials declared "Four Freedoms" for the Ohio River under the Water Quality Act of 1965: "Freedom from flotsam; freedom from poison; freedom from stench; freedom from sludge." These freedoms were accompanied by stringent new wastewater standards that brought protests from most of the major local industries.

To meet the proposed standards, the Fort Southworth plant had to add secondary treatment facilities, at an estimated cost of $10,000,000 to $20,000,000. In September 1967, MSD announced plans to build the secondary treatment facilities. By late 1972, the total cost of the unfinished project was estimated at about $62,000,000, $34,000,000 of which would be paid by the federal government.

1.2.3.2 Countywide Expansion

Action on the 1964 master plan for countywide sewers lagged because of a continuing lack of money. Because of the cost of constructing the Fort Southworth secondary treatment facilities, MSD did not have the money for large-scale construction of trunk sewers and other plants.

However, a 1968 state law made it possible for MSD to expand by assessing property owners a share of the costs of providing them with new sewers. This eliminated the need to form sewer sub-districts, which was a very cumbersome process.

In 1968, MSD began installing sewer lines in Avondale and Brookhaven, the last major areas of the City of Louisville without sewers. In 1970, MSD dissolved the Middletown sewer sub-district and converted the expansion into an assessment project. The projects were completed within 2 years.

1.2.3.3 Urban Renewal

Urban renewal brought massive changes to the downtown area in the late 1960s, including the first major effort to separate the City's sanitary and storm sewers. In late 1968, the combined cost of the street and sewer improvements in the urban renewal area was estimated at $18,000,000, most of which was paid by the federal government. Local governments were responsible for the remainder of the cost.

Urban Renewal and highway (I-71, I-65, I-64) construction in Louisville and Jefferson County were demolishing buildings, reducing the number of MSD customers as well as MSD's income. Urban Renewal soon demanded expensive sewer improvements, including a requirement to separate the sanitary and stormwater lines. Suburban development was booming, and MSD did not have the resources to keep up. When MSD eventually found the resources to expand, the proliferating small treatment plants had to be acquired and closed.

1.2.3.4 Industrial Waste

One of the pressing problems facing MSD in 1965 was the industrial waste being discharged into the sewers. For generations, many Louisville businesses and industries had been dumping and flushing their waste down the drain. It mingled in the sewer lines before emerging in Beargrass Creek or the Ohio River. Once it reached the creek or river, identifying its source was almost impossible.

With the opening of the Fort Southworth treatment plant and the wastewater pump stations that fed it, the problem became more troublesome. Industrial waste could damage the system, clog the equipment, and poison the treatment process. It included waste as diverse as acids and oils, rags and metal shavings, pieces of plastic and wood, and blood and animal parts.

First, MSD adopted new regulations to limit industrial waste in 1960, but without enforcement success was limited. At the Buchanan Street pumping station, waste from meat packing plants and laundries clogged the screens that were designed to keep large items out of the pumps. This created the possibility of CSO every few hours when the station had to be shut own to clean the screens. Although the Chamber of Commerce urged all industries to comply with the new standards in 1962, chemical waste from industries continued to corrode equipment and electrical wiring at various pumping stations.

In 1967, a sewer surcharge based on the amount of solids and grease in industrial waste was adopted by MSD. Plants with a lot of waste could reduce their surcharges by pre-treating their water to remove waste before discharging it to the sewers. This gave plants a financial incentive to pretreat their water to remove waste before discharging it to the sewers.

1.2.3.5 Drainage

In 1965, the federal government authorized the USACE to study flooding and flood prevention measures along Beargrass Creek. The study took years to complete and documented the problems of allowing development in the floodplain. In 1966, Jefferson County completed a 5-year, $3,000,000 project to improve the drainage ditches and creeks in the Pond Creek basin. The work eased flooding problems, but they were not eliminated. Heavy rains struck again in 1970, causing widespread local flooding problems. In Camp Taylor, sewers overflowed onto the ground, spreading their mixture of sewage and stormwater. This frequent problem was the result of insufficient funding of drainage out in the county.

1.2.4 1970s

Secondary treatment, sewer expansion and urban renewal were all coming at great cost during the 1960s. In January 1970, the aldermen approved MSD's first rate increase in a decade, which was about 40 percent for the average residential customer. The cost of living had increased nearly 30 percent since the last increase. Additional increases went into effect in 1971 and 1972. Over the 3 years, residential rates increased a total of 263 percent from 1969-1972, resulting in a typical residential user cost of $4.40/month. The increases gave MSD the income it needed to pay off the bonds it issued for major sanitary sewer improvements.

The Hite Creek plant opened in late 1970 to serve the Ford truck assembly plant and its surrounding suburbs. It was a state-of-the-art treatment plant that not only won several design and operation awards in its early years, and has continued to win awards through the 1990s. It was intended to (and does) provide outstanding wastewater treatment for a growing suburban area.

On July 1, 1972, not long after work began on secondary treatment facilities at the Fort Southworth plant, Morris Forman, age 75, retired as executive director of MSD. That summer, the treatment plant was re-named in his honor.

1.2.4.1 The Morris Forman Wastewater Treatment Plant

Construction of the secondary treatment works at the Morris Forman plant began in May 1972 and was finished by July 1976. The first major operating problem was the $7,000,000 incinerator for burning sludge, the processed solid material that had been removed from the wastewater. When the incinerator was fired up the first time it sent a terrible stench over western Louisville and the downtown area. The proper air pollution control steps were not taken before the test, and despite repeated modifications, the incinerators could not meet emissions standards. The rapidly rising costs of fuel caught up with the project, and it became more economical to dispose of the sludge in a landfill.

There were performance issues with other parts of the new facility as well. As the federal deadline passed for meeting secondary treatment standards, only 62 percent of the wastewater was getting the full secondary treatment. Then critical pumps failed during high water on the Ohio River, and the secondary treatment facility had to be shut down.

More than 2 years later, in December 1980, MSD and EPA reached an agreement on modifications and repairs at the plant. The plant went into full operation in early 1980, but could not meet federal standards. Finally, with additional repairs and modifications, in the summer of 1985, the plant met the federal secondary treatment standards for the first time.

1.2.4.2 The Countywide Sewer Plan

The countywide sewer plan had been stalled since 1964. The delay was the result of a lack of financing for the large treatment plants and their trunk sewer networks and lack of agreement about who would pay. Septic tanks continued to be built where the health department would allow them, and developers set up a multitude of small treatment systems where septic tanks were forbidden. By mid-1972, there were more than 300 small treatment plants in Jefferson County.

The Federal Water Pollution Control Act of 1972 (FWPCA) set a goal of making all of the nation's waterways safe for fishing and swimming by 1983. To achieve this goal, aggressive new standards were set for sewage treatment plants: They had to meet the "best practicable" technology by 1977 and the "best available" technology by 1983. They also had to obtain permits to operate by mid-1975.

The new standards, coupled with the problems with small plants and septic tanks, renewed interest in the countywide sewer plan. By early 1973, revisions were underway. The cost estimate was $654,000,000, including the separation of storm and sanitary sewer systems in Louisville. Under the clean-water program, the federal government would pay up to 75 percent of the cost.

MSD and the EPA agree upon the revised North County and West County plans in 1974. Both plans provided that MSD would take over small treatment plants and collection systems as MSD's trunk lines reached them. Work was scheduled to begin first on the West County plan, including a new treatment plant to serve most of the area south of Louisville and Shively and west of Okolona.

By early 1976, the combined cost estimate for the West County and North County plans was nearly $428,000,000. In June 1977 Jefferson Fiscal Court approved a $23,000,000 bond issue

to help finance the West County plant and trunk sewers serving the areas near Fairdale and Okolona. In July, MSD officially initiated the West County/Pond Creek plan.

The expansion plan came to a halt when the Southwest Homeowners Association organized to fight sewer expansion, claiming septic tanks worked well and sewers were not needed. The organization demanded that the EPA prepare an environmental impact statement for the project. The EPA responded with an environmental impact statement which was issued in 1982, stating that residential septic tanks worked well in the southwest, so sewers were not necessary except for businesses and industries. This finding conflicted with health department reports that domestic groundwater was polluted by bacteria and nitrates from the septic tanks. Nine years after the 1974 plan was adopted, there had been little progress toward building the countywide sewer system.

1.2.4.3 Drainage

One major advance during the 1970s was the construction of the dry bed flood control basin on the south fork of Beargrass Creek near Houston Acres. It kept heavy rains from aggravating the already serious flooding problems in the downstream suburbs and the City of Louisville.

In 1978, a consulting firm hired by MSD recommended that the City be responsible for maintaining and improving the drainage system. It recommended that the money be raised through a variety of sources, such as a drainage service charge, property taxes, and/or occupational taxes. The report also said that MSD would spend $2,300,000 in its income from sewer fees to maintain and operate the City's drainage system in 1978 and about $600,000 in money from County government to maintain the County's system. And it estimated that the cost of needed drainage improvements in the City would be $63,000,000.

City government took no action to provide financing for drainage services. But in 1979, it went to court to ask that MSD be declared solely responsible for drainage in the City.

1.2.4.4 Finances

Rising inflation in the mid-1970s affected the entire nation, and rapidly reduced the buying power of MSD's rate increases of the early 1970s. At the same time, federal clean water rules were requiring costly improvement programs.

In October, 1979, it was decided that MSD would be allowed to increase its rates whenever the money it had available to repay its bonds fell below 110 percent of the amount that would be required to make the payments. The Board of Aldermen and Fiscal Court would have to give their approval only if the total amount of the rate increases would top more than 7 percent in any 1-year period.

1.2.4.5 The Hexa-Octa Incident

On March 17, 1977, employees at the MFWTP noticed a strong, chemical odor that made them sick. It took more than a week to identify the substance: a mixture of hexachloropentadiene and octachlorocyclopentene, quickly abbreviated to "hexa" and "octa." They were highly toxic chemicals used in pesticides. The contaminated treatment plant was shut down on March 29th, discharging upwards of 100 MG of untreated wastewater into the river each day.

The US Army sent teams wearing protective gear entered the sewers to find the source of the chemicals. The FBI joined the investigation. And on June 7th, a federal grand jury charged

Donald E. Distler, president of Kentucky Liquid Recycling, and two of his employees with dumping toxic chemicals into the sewers. The chemicals, the courts later found, were wastes that had been sent to Distler's company for disposal. Distler's company had dumped them in a manhole in western Louisville.

The treatment plant was shut down for nearly 3 months while the contaminated material was removed. It took another 2 years to remove the contaminated material from the sewer lines and river. In January, 1983, the companies that had originated the waste, Velsicol Chemical Corp. of Chicago and Chem-Dyne Corp. of Hamilton, Ohio, agreed to pay MSD $1,900,000 for the medical costs of employees and the costs of cleaning up the sewers and the treatment plant.

1.2.5 1980 TO MID-1990s

1.2.5.1 Industrial Issues

Industrial waste had been a problem for generations, and there were many small spills and discharges that damaged the sewers, disturbed the treatment process and polluted the streams. In the early 1980s, the Environmental Protection Agency declared that industries had to obtain permits to discharge wastewater into sewers, and the permits limited the amounts of a wide range of substances that would be allowed in their wastewater. When MSD launched this program in 1981, 46 out of 148 companies failed to comply.

Gasoline, acids, solvents, ammonia, ingredients for plastic, and a wide assortment of chemicals were being spilled onto the ground, onto the streets, and into the sewers and streams. No single agency was in charge of dealing with them and there was no enforcement authority to deal with them.

In February 1981, a series of sewer explosions occurred as a result of thousands of gallons of a highly flammable solvent, hexane, that had spilled into the sewer lines from the Ralston-Purina soybean processing plant. More than 2 miles of Louisville streets were pockmarked with craters where manholes had been. Several blocks of Hill Street had fallen into the collapsed, 12' diameter sewer line. No one was hurt seriously, but homes and businesses were extensively damaged and some families had to be evacuated. It took 20 months to repair the sewer lines, and another several months to finish the work on the streets.

Ralston-Purina pleaded guilty of four counts of violating federal environmental laws, and paid a fine of $62,500. In February 1984, the company agreed to pay MSD more than $18,000,000 in damages. Many millions more were paid to other government agencies and private individuals who suffered damage.

In September 1984, MSD prepared a detailed report on industrial waste suggesting a complete overhaul of the system for reporting and dealing with spills, along with requirements that businesses and industries using hazardous materials prepare detailed plans for spill cleanup and containment. In February 1985, the task force completed work on a hazardous materials ordinance, which took effect that November. It was also one of the nation's first comprehensive local government chemical spill prevention programs. MSD was the agency designated to administer and enforce it.

1.2.5.2 The Southwestern Louisville Flood (1983)

Most of the southern portion of the City of Louisville is drained by the huge Southwestern Outfall, built by the Commissioners of Sewerage. It is a combined sewer, and it originally

emptied directly into the Ohio River. In 1960, a pump station was completed at Bells Lane to pump the wastewater from the outfall to the new treatment plant. The metal gates at the pump station were designed to be open during heavy local rains, to allow water from the overloaded combined sewer system to overflow by gravity into the river.

During the intense thunderstorm of May 1, 1983, the gates failed to open. A large neighborhood in southwestern Louisville was flooded, to depths of as much as 10'. About 400 families were driven from their homes. MSD blamed a power failure and equipment malfunctions for the problem. Two days later the MSD board appropriated $3,000,000 to help the flood victims, appointed a team to investigate the incident, and delayed action on a proposed rate increase. City government appointed its own team to investigate.

Ten days after the flood, Jack Wilburn announced he was stepping aside as MSD's Executive Director, saying he hoped his resignation would help the agency solve its problems and regain public confidence. He recommended a nationwide search to find his replacement.

At this time, MSD began taking the first steps toward regaining public confidence. It had scheduled a series of briefings for public officials and the news media on the problems facing the agency. By fall, members of the board and MSD's technical staff attended neighborhood meetings to discuss problems and programs with the public. In November, MSD began a series of public forums on major problems and issues, including aging combined sewers, cave-ins, sewer expansion needs, the ineffective MFWTP, and stormwater drainage.

In the meantime, the first steps were taken on two of the major challenges facing MSD. In June 1983, the Board approved a program of repairs and modifications at the MFWTP. That same month, Jefferson Fiscal Court approved a $138,000 revision of the outdated 1974 sewer expansion study.

1.2.5.3 The Drainage Program

In May 1986, the MSD Board approved a $991,000 study of countywide drainage needs. In June, the Board approved the basic countywide plan, and formal actions creating the new program were completed in December.

The program began in January 1987, but with opposition. Several groups went to court to challenge the new drainage fee. During the time of the court cases, MSD was able to complete nearly $2,500,000 in small, neighborhood drainage projects. By early 1991, MSD had identified more than 100 areas that would need major construction projects to deal with their drainage problems. The income from the drainage fee would finance a larger maintenance program and allowed construction of dozens of smaller drainage projects to serve individual streets and neighborhoods. The challenge delayed the $25,000,000 bond issue and the 52 major projects it was designed to finance. The challenge finally ended in June 1989, when the Kentucky Court of Appeals ruled in favor of the program.

As the drainage program neared the end of its fifth year, MSD did not have enough income to finance the growing list of needed improvements. In late 1991 the MSD Board began discussing an increase in the drainage fee. In January 1992, the Strategic Planning and Financing Committee, which originally had recommended that MSD take over the drainage program, was reconvened to study the situation.

In May 1992, MSD announced that the money from the $25,000,000 bond issue would run out after only 40 of the original 52 projects were completed. Then MSD prepared a revised list of needed drainage projects, detailing more than 170, including the 12 that had been deferred. It

proposed a 5-year schedule for completing them, using more than $40,000,000 in new bonds to be repaid from an increase in the drainage fee. In December 1992, the increase went into effect.

In January 1993, MSD approved a revised list of more than 200 drainage projects to be completed within the following 5 years. $48,000,000 in bonds were issued to finance planning and construction. The 5-year program was detailed in a loose-leaf handbook that was distributed to all elected officials in Louisville and Jefferson County and was made available to the public for examination at MSD's offices.

1.2.5.4 Flood Study Areas

Over the years, the USACE had done several studies of flooding in the community, including the study after the 1937 flood. In the mid-1970s, a special study of the Beargrass Creek basin recommended a dry-bed reservoir on the South Fork near Houston Acres to relieve flooding downstream. Jefferson County built this reservoir as part of a major drainage program in the late 1970s. The reservoir would hold water during heavy rains, then release it slowly afterward.

In 1989, a new study of the Pond Creek basin was authorized. MSD joined with the USACE in conducting it. In 1994, the study proposed $16,400,000 in flood-control work, and in 1996, Congress appropriated the first $1,500,000 to start detailed design.

A feasibility study of the South Fork of Beargrass Creek was started in 1994. The South Fork still had many problems during heavy rains, despite the improvements brought by the dry-bed reservoir. This was the first preliminary step in an area served by combined storm and sanitary sewers and drained by several small streams.

1.2.5.5 The Floodwall

In 1988, the USACE completed the southwestern Jefferson County floodwall, which was a major extension of the floodwall of the 1950s. They turned it over to MSD for operation and maintenance.

In 1991, MSD agreed to extend the floodwall in downtown Louisville to protect the Presbyterian Church headquarters. The extension and the associated pumping station cost nearly $3,000,000. When the extension was completed, the floodwall was 29 miles long, protecting about 110 square miles from the type of flooding that devastated the community in 1937. It included 16 pumping stations, designed to pump stormwater from the community into the river when the river level is high.

1.2.5.6 The Flood Plain Ordinance

Many of the community's drainage and local flooding problems stemmed from 2 centuries of uncontrolled and poorly controlled development. Over the years, efforts had been made to correct the situation through planning and zoning rules, with mixed success. In Jefferson County, Fiscal Court turned to MSD to recommend an ordinance and to administer the local program. The ordinance was passed in 1991. Using the LOJIC computerized mapping and information system, MSD refined the maps the federal agency had prepared. And in 1994, the community became the first in the nation to develop its own flood insurance rate maps under the federal program. MSD's actions also qualified the community for lower flood insurance rates.

1.2.5.7 The August 1992 Flood

On August 8, 1992, nearly 6" of rain fell on parts of Louisville in 3 hours. The old combined sanitary and storm sewer system was overwhelmed. Water flooded basements, gushed up through manholes, flooded streets and yards, and flooded the first floors of houses in a southern Louisville neighborhood. In one area near the old Hazelwood Hospital grounds, the combined sewer system was dramatically overloaded. Stormwater mixed with wastewater flooded the streets and entered the first-floor living areas of 18 homes.

The MSD Board voted the following year to offer floodproofing these homes at MSD's expense. In the summer of 1994, the Board voted to make floodproofing one of the options MSD would consider in any appropriate drainage improvement plan.

The construction of a large floodwater detention basin north of Hazelwood Hospital was approved. The basin would store the excess water which backed up from sewers during heavy storms, then release it slowly into the main sewer line when the danger of flooding had passed. While major detention basins had been required in new developments in the past, and had been planned and built along streams in relatively undeveloped areas, this was the first to be built in an older neighborhood at MSD's expense.

Under previous MSD policy, property owners had been responsible for preventing water from backing up through the sewers into their basements. Under a new program, which would be offered at first in neighborhoods with the most frequent basement backups, MSD would pay for the installation of backup prevention devices.

1.2.5.8 The Floods Of 1997

Shortly after MSD began its second half-century of service, the community was stricken by the heaviest local rainstorm on record. Eight to 12" of rain fell over Louisville over a period of 33 hours beginning on February 28. Nearly all of the floodplains along local streams had been filled and many had overflowed. In the former swamplands south of Louisville, streets and entire neighborhoods were flooded. Thousands of homes suffered flood damage. Throughout MSD's service area, sewer lines were overwhelmed and water backed up into the basements of thousands of buildings.

As the storms moved slowly eastward through Kentucky and Ohio, the Ohio River rose rapidly. MSD crews went to work along the floodwall system, installing 24 of the 45 street closures and activating all 16 pumping stations. On Friday, March 7th, the river reached its seventh-highest level on record, 15.76' above flood stage in downtown Louisville which was 26.6' higher than normal. It was the first time that the flood protection system had worked almost perfectly in a crisis because of MSD's maintenance and training programs.

1.2.5.9 Strategic Planning and Finance

In January 1984, MSD named a Strategic Planning and Finance Committee, made up of citizens and elected officials representing all areas of the community affected or potentially affected by MSD. The committee was charged to study MSD's activities and challenges and to make detailed recommendations for future programs.

While the Strategic Planning and Finance Committee was beginning its studies, MSD pushed vital projects ahead. First, MSD and the Environmental Protection Agency reached an agreement on the long-delayed West County sewer expansion program. The proposed

treatment plant's capacity was reduced to 15 MGD, which was 1/3 of the originally proposed capacity. The initial emphasis was placed on serving the Pond Creek area, where small plants and septic tanks had polluted the streams so badly that plans for a recreational lake had been delayed indefinitely. New sewers were not mandated in the southwestern neighborhoods served by septic tanks.

At the same time, MSD and the EPA agreed that the North County plan was out of date, and work on its revision began. Next, MSD and the EPA agreed on a $12,500,000 program to upgrade the MFWTP to meet federal water pollution standards.

In mid-1983, MSD had hired an executive search firm to seek and screen candidates for the Executive Director's position. On May 1, 1984, Gordon R. Garner became MSD's new executive director. At age 37, he was the youngest person ever to head MSD.

Construction of the new West County plant began in the fall of 1984. It was completed in just over 2 years and within its original budget of $22,000,000. While construction began, state and federal regulators were increasing the pressure on the small plants in the Pond Creek area. That summer, the Okolona system agreed to an MSD takeover, which took effect in January 1985. The wastewater was pumped to the MFWTP until the West County plant was completed.

In late 1984, MSD outlined its plans to take over and eliminate small treatment plants. Shortly afterward, the County Health Department released a study showing that all major streams in Jefferson County were unsafe for swimming. It blamed small treatment plants and septic tank systems. The DOW gave the owners of 14 small plants in the West County area until April 1985 to shut down. At least half were violating their permits and some had never bothered to obtain permits.

In mid-1985, the Strategic Planning and Finance Committee recommended that MSD take the lead in providing countywide drainage service, as well as sewer service. However, the City still owed MSD $1,250,000 for drainage work completed in the 1970s, on the City's promise to pay for the work once it had found a way to finance its drainage program. As a gesture of good will, MSD's Board decided to let the matter rest while negotiations over a countywide drainage program continued. The drainage proposal was returned to MSD's Strategic Planning and Finance Committee to work out the details of how the program should be financed.

By October 1985, most of the committee's initial work had been completed. The recommendations of the committee were to continue expanding the sanitary sewer system with the goal of eliminating septic tanks and small treatment plants, provide more flexible financing plans for homeowners getting new sewers, including financial assistance for those with low incomes, repair the older sewer lines in the system, set up an ongoing inspection and maintenance program for all sewer lines, and take the lead in establishing a coordinated, countywide drainage program.

On December 23rd, the MSD Board approved the Strategic Planning and Finance Committee's recommendations, which became a blueprint for action for the next 15 years.

The stormwater fee increase of 1992 was the last large rate increase sought in MSD's first half-century. In 1994, a series of small yearly increases in the wastewater rates began; at the same time, the rate schedules for commercial and industrial customers were adjusted gradually so that each class of customers would pay its proportionate share of the cost of treating the wastewater.

In 1996, the MSD Board approved a 5-year budget strategy that called for keeping the stormwater and wastewater rate increases at 5 percent or less each year, while cutting labor costs 2 percent a year through staff reductions and holding increases in operating costs to 3 percent or less each year. The strategy also called for investing an average of $65,000,000 per year in plant, lines, and drainage and flood protection.

1.2.5.10 Operational Challenges

The 1990s became the busiest period in MSD's history. As the decade began, the $25,000,000 in drainage bonds were sold, and construction started on major drainage improvements. Construction also started on the North County sanitary sewer expansion plan, with work on the force mains and the lines needed to eliminate the Muddy Fork treatment plant.

June 1990 also brought a spectacular collapse of the old brick sewer line at Preston and Broadway. It closed the busy downtown intersection for more than 4 weeks.

MSD's annual reports of the early 1990s focused on the major challenges in the years ahead. They were updated descriptions of the challenges MSD had been facing for the past 4 decades: sanitary sewer expansion, sewage treatment, and drainage improvement. Programs were now in place to address all of the issues.

Major federal funding of local sewer projects had virtually ended. In the future, money came from local sources, including the money needed to meet increasing federal clean-water standards. A major exception would be USACE involvement in flood control studies and programs along local streams, including Pond Creek and Beargrass Creek.

Beginning in the spring of 1991, an intensive field reconnaissance of the combined sewer system was conducted. The work involved inspection of the major pump stations and each CSO point. A review of construction drawings for the major combined sewers and pump station was conducted concurrent with the field survey. A hard copy inventory of each combined sewer overflow point was compiled including a written description of intended operation, location, overflow type and elevation, and a detailed drawing.

One of the major challenges facing MSD through the years has been correcting problems with old sewer lines. The problems fall into three basic categories: deterioration, improper connections, and outdated technology or design features. Deterioration, as the name implies, is the aging of the assets. Improper connections are storm water drainage pipes purposefully attached to sanitary sewer lines. Outdated technology is best exemplified by the transition of combined sewer systems from a "good" thing in the early years to a "bad" thing today.

In the late 1980s, MSD stepped up its inflow and infiltration program, surveying neighborhoods where backups were common to try to determine the sources of stormwater entering sanitary sewers. In areas where the problems were especially severe, special equipment was used to seal the cracks in the sewers or reline the pipes. Several major old sewers were rehabilitated by sliplining, which involved inserting a plastic lining inside the old pipes. Another method involved inserting a special fabric sock into the lines, inflating it so that it hugs the walls, then impregnating it with plastic resin. A detailed discussion of rehabilitation techniques can be found in Section 8 of this report. The increased I/I program reduced infiltration substantially, but infiltration through customers' leaky lines and inflow from customers' improper connections often remained a problem.

The antiquated design features that create the worst problems are designed overflows into streams and the Ohio River - from both combined storm and sanitary sewers and sanitary-only sewers. The federal clean water program began to target combined sewer overflows in the late 1980s. In 1988, MSD began an engineering survey of its 670 miles of combined sewers, detailing the locations and functions of 121 overflows. In 1997, MSD estimated it could cost $1,100,000,000 to eliminate and replace the combined sewers. Efforts were underway to identify ways to reduce or eliminate the pollution from the overflows without replacing all the lines.

Two projects in the mid-1990s were designed to approach the problem in different ways. In an eastern Louisville neighborhood overlooking Cherokee Park, MSD separated the storm and sanitary sewer systems to eliminate a relatively small overflow that emptied into Beargrass Creek inside the park. And several miles away, MSD planned a special pretreatment plant to remove the solid waste from the water flowing from a large overflow across Newburg Road from Bellarmine College.

1.2.5.11 Sanitary Sewer Expansion

While the drainage program was being developed and the West County treatment plant was under construction, MSD took several major steps to make sanitary sewer expansion more attractive to prospective customers. In 1985, the Board approved two new policies. First, a guaranteed maximum assessment would be the maximum a property owner would be charged for a share of the costs for building new lines to provide sewer service. If the project cost more than anticipated, MSD would pay the difference. If it cost less, the property owners would share in the savings. Second, a financial assistance plan provided several ways to ease the burden on low-income and elderly customers. The details would vary depending on the customer's circumstances. In early 1986, the Board approved a new policy in which all property owners were able to vote on a proposed sewer project in their area.

Working with the Environmental Protection Agency, MSD revised and updated the sewer expansion plans separately, and in stages. The North County Action Plan, where residents were eager to do away with septic tanks and small treatment plants, was revised in 1985 and 1986. Plans for the treatment plant near Beargrass Creek were dropped. Instead, the wastewater was pumped through two high-pressure sewer lines near the Ohio River to the downtown area and transported through trunk sewer lines to the MFWTP. The first construction contracts were awarded in 1990.

The West County Action Plan was divided into two subsections: the Pond Creek plan and the Mill Creek plan. The West County treatment plant was completed in November 1986 and began treating wastewater that had been pumped to the MFWTP. In the Pond Creek area, where small plants and septic tanks had created massive stream pollution problems, trunk sewer lines were being extended from the West County plant network. In the Mill Creek area, where opposition to sewers had been greatest, most planning and construction work was halted.

The Floyds Fork area was still mostly rural in the mid-1980s, but urbanization was increasing in the northern fringes. The first sub-regional treatment plant was the Cedar Creek plant, which was designed in 1989.

Several court decisions affirmed that MSD had the authority to take over small plant systems when MSD lines reached them. In the 18 months ending in October 1986, MSD had entered agreements to buy 43 small plants serving 26,000 customers - about 57 percent of those who

had been served by small plants. By the end of 1987, more than 10 small plants had been eliminated. The MSD-owned small plants continued to operate until the trunk sewers could reach them.

The largest acquisition, in September 1990, was the Jeffersontown system, serving more than 3,800 customers. The plant, originally slated to be eliminated under the early West County/Pond Creek plan, was saved and upgraded in the early 1990s, becoming one of the sub-regional plants in the Floyds Fork watershed.

In the North County area, MSD had completed more than $26,000,000 in construction and had eliminated 29 small treatment plants by the end of 1996. In addition, more than 3,000 property owners in neighborhoods formerly served by septic tanks received MSD sewer service, at a total cost of about $18,000,000. In the Pond Creek area, more than $16,000,000 in projects had been completed, eliminating 12 small treatment plants by the end of 1996. Future work was planned to eliminate more than a dozen more small plants, and to provide sewers to more than 1,800 homes on septic tanks.

In southwestern Jefferson County, challenges to the old West County plan had delayed sewer expansion for nearly 2 decades. This delay may have increased the number of customer requests in the area due to failing and inadequate septic systems. By the end of 1996, more than two dozen major sewer projects were being planned and or constructed along both sides of Dixie Highway. Eventually, the projects would serve more than 8,000 customers.

After taking over the Jeffersontown plant and sewer system in 1990 MSD began upgrading the plant to meet new environmental standards. The next major expansion was the construction of the Cedar Creek plant south of the Fern Creek neighborhood. The plant was completed in the summer of 1995, and work had begun on its network of major sewer lines. The plant eventually eliminated nine small treatment plants and many septic tank systems.

In the Floyds Fork area, plans were underway to build smaller sub-regional plants to serve the new residential and commercial areas. At the end of 1996, the Floyds Fork plant and its network of major lines in eastern Jefferson County was ready to be constructed. The plant site, on the east side of Floyds Fork north of Interstate 64, included a large natural park area to be managed by Jefferson County. The plant eliminated several small treatment plants.

The Middle Fork of Beargrass Creek, which extends through Cherokee Park and eastward to Anchorage, reached a major milestone in 1994. Its last small treatment plant, at Foxboro Manor, was closed.

The early 1990s brought MSD's first concrete moves to provide service in adjacent counties. Relatively small areas just across the County line were served, where septic tanks and poorly functioning sewers affected streams that flowed into Jefferson County.

In mid-1996, an agreement was reached for MSD to provide service to the City of Crestwood in Oldham County. In this agreement, Crestwood was to build a sewer system, and contract with MSD for operation and maintenance. The wastewater was to be treated at MSD's Hite Creek plant.

Also in mid-1996, MSD approved an amendment to the Pond Creek action plan to include areas served by 12 small treatment plants in Bullitt County. A study aimed at eliminating these plants through MSD's expansion program completed in 1998.

1.2.5.12 Treatment

The MFWTP reached a milestone in the summer of 1985. For the first time since secondary treatment began, it met the federal guidelines for water discharged into the Ohio River for 3 months in a row. In June 1986, it met federal guidelines for a year for the first time.

Improvements continued at the plant under a plan approved by the EPA through the rest of the 1980s and 1990s. While the monthly standards were sometimes exceeded, especially in wet weather, performance continued to improve.

Over the years, more than 175 wastewater treatment plants have been closed through MSD's sanitary sewer expansion program. Their sizes range from the large Okolona and Shively plants to small plants designed to serve individual residences and businesses. In addition, the expansion program has eliminated over 40,000 individual septic tank systems.

Problems with the MFWTP continued to challenge MSD in the 1990s. While the plant met federal and state standards most of the time, it still exceeded pollution limits too often, especially in wet weather, when stormwater boosted the flow beyond the plant's 105 MGD capacity. In addition, odor problems affected nearby neighborhoods.

In 1991, an outside engineering firm recommended millions of dollars of additions and improvements to meet federal pollution standards and reduce odors. In December 1994, a $13,200,000 pair of bio-roughing towers, which help digest organic waste in the water, went into operation, and the plant's performance improved. A year later, one of the towers collapsed, and the other was shut down as a precaution. Work on rebuilding the towers' interiors started in 1998. Other innovative improvements were designed for the plant in the mid-1990s.

By the mid-1990s, the West County Plant was approaching its capacity as its service area expanded. In 1994, it was added to the MFWTP's action plan for the '90s, because the two plants together were designed to handle most of the community's wastewater.

1.2.5.13 Environmental Activities

MSD greatly expanded its environmental activities in the 1980s and 1990s. Recycling and energy conservation were early priorities as well as environmental education. Workshops for teachers were set up, and special educational programs were scheduled in elementary and high schools. Summer internship programs provided high school students and their teachers with opportunities to gain experience in activities aimed at helping improve the water quality in the community's streams.

Community activities included co-sponsoring the annual Ohio River Sweep, the community's own Beargrass Creek Sweep and the Household Hazardous Materials Collection program. MSD also initiated the Greenways Program, which is developing natural areas along the community's waterways to help protect the quality of water, provide cover for wildlife, and provide pathways where citizens can enjoy nature. To support these programs, MSD added several aquatic biologists, a landscape architect and a soils bioengineering specialist to its team of engineers.

1.2.5.14 Reorganizing For The Future

By the early 1990s, MSD's activities and staff had outgrown the downtown headquarters building constructed in the late 1960s. In 1993, the Board approved buying a larger office

building, located 1 block west, and renovating it for a new headquarters. After nearly 2 years of work, including improvements that made it one of the nation's charter Energy Star Showcase buildings for energy efficiency, MSD occupied its new headquarters in December 1995, consolidating functions that had been located in several different buildings.

At the same time, MSD began moving to a multidisciplinary teamwork approach to management, and negotiated a 5-year contract with unionized employees that included programs to improve labor-management relations. And in 1996, MSD began reorganizing many of its activities by watershed, coordinating all of its efforts that affect the quality of the water in a stream.

1.2.6 Into The New Millennium – 1998-Present

1.2.6.1 The Mill Creek Area Expansion

The Mill Creek Expansion project continued, carrying over from 1985 when the MSD Board approved a plan to build 42 miles of sewer throughout southwest Jefferson County. The plan connected the remaining neighborhoods in the Mill Creek area to the MSD wastewater collection and treatment system. MSD's Mill Creek expansion has provided sanitary sewer service to 25,000 additional properties that were previously served by septic tanks. The expansion plan approved by MSD's Board included 18 neighborhoods and approximately 3,500 new customers. It has been a significant water quality improvement, treating waste from over 25,000 properties that were virtually untreated, removing the septic tanks and conveying the waste to MFWTP.

1.2.6.2 Innovative Plan to Reduce Odor at Morris Forman Wastewater Treatment Plant

In April 2000, MSD's Board approved a $64,600,000 construction project, the largest contract in MSD's history, to design and build a new solids handling process at its MFWTP. This new process to dry and recycle biosolids allowed MSD to disconnect the old solids drying process, Zimpro, that had been the cause of much of the plant's odor. The new process uses centrifuges to remove water and high-heat dryers that virtually disinfect biosolids. The resulting dried biosolids are in small pellets ranging from 1 mm - 4 mm in diameter with 95% of the liquid content removed. In FY 2004, MSD received the necessary approvals to market and distribute its dried biosolid pellets. The pellets were given the name of Louisville Green and are being sold as a usable soil-enhancing product. Until 2004, all of the biosolids produced by MSD were hauled to a landfill for disposal at an annual cost of $600,000. During the period March 2005 through September 2005, MSD diverted 10,800 tons of biosolids from landfill disposal resulting in a savings in excess of $248,000. During 2005, MSD proceeded with its plan to more aggressively market this product. Louisville Green is now being sold to farmers, golf courses, and topsoil/compost producers. In addition, customers can now buy this long-lasting organic fertilizer in 40-lb bags from local hardware stores.

1.2.6.3 Floyds Fork Wastewater Treatment Facility

Construction was completed in 2001 on the $15,000,000, 3.25 MGD Floyds Fork Wastewater Treatment Plant, serving the County's fastest-growing residential and commercial corridor - U.S.60/I-64. As the trunk lines are constructed, the existing small neighborhood wastewater plants in watershed are removed from service. The treatment facility is the first municipally

owned design/build wastewater treatment facility in Kentucky. Treatment components include influent pumping, screening, grit removal, oxidation ditch/biological treatment, biological/chemical nutrient removal, clarification, tertiary filtration, ultraviolet disinfection, post-aeration, and aerated biosolids holdings.

1.2.6.4 New Leadership

In 2002 Gordon R. Garner retired from a public-service career that spanned 4 decades and concluded with 18 years as MSD's executive director. As MSD's Chief Executive, Mr. Garner presided over a period of unprecedented growth, environmental awareness and profound organization change. Under his direction MSD: Expanded sewer service countrywide and added three major wastewater treatment plants, eliminating more than 300 neighborhood plants and thousands of septic tanks; created countrywide drainage and flood protection programs; and led development of the Louisville/Jefferson County Information Consortium's (LOJIC) regional computer mapping and geographic information system.

In January 2003, H.J. "Bud" Schardein, Jr. became MSD's fifth executive director. Like Morris Forman and Jack Wilburn before him, Schardein had worked much of this career at MSD before being selected for its top position. Schardein's philosophy is that MSD should concentrate on its basic mission: *to provide quality wasterwater and stormwater facilities for the people of our community*. Its basic mission is defined by these core businesses that our customers pay us to provide:

- **Sanitary Sewer Service**
  Providing a system that conveys and treats wastewater from homes and businesses that helps keep our steams and rivers clean.
- **Stormwater Drainage Service**
  Handling rainfall with an efficient system that also is affordable.
- **Flood Protection**
  Maintaining the 29 miles of floodwall and earthen levee, along with 16 flood pumping stations along the Ohio River, is essential for the protection of our community.
- **Regulatory Functions**
  Making sure that companies and developments comply with rules like pretreatment of wastes, erosion and sediment control and proper design of stormwater facilities.
- **Environmental Leadership**
  Employing construction practices that are environmentally friendly, while providing water quality education programs for all age groups, shows that MSD is committed to protecting the community for future generations.

1.2.6.5 Installation of Electronic Rainfall gauges

During 2001, MSD continued the installation of a network of 45 rain gauges throughout Jefferson County. Currently, eleven of the gauges have been connected to MSD's Wastewater Operations radio telemetry system. The telemetry system is used by MSD to get real-time data from its various pumping stations and treatment plants. MSD's system of pipe networks and drainage facilities are very sensitive to rainfall. Since Jefferson County is so large (390 sq. miles), it can be raining in one area and dry in another. Rainfall data is obtained from a "tipping bucket type rain gauge." It gets that name because rainfall that hits the top of the gauge is funneled down to a small opening where it empties into a small "bucket" that will tip and empty

when 0.01" of rain is collected. This tipping action is measured by the electronics in the rain gauge which is transmitted over phone lines or a very high frequency radio signal to a central receiving station at MSD. The amount of rain (tips) is accumulated and every 5 minutes the data is stored in MSD's database for an accurate history of the rainstorm. This data is shared via the Internet with MSD's customers and local radio and television stations.

1.2.6.6 Central Maintenance Facility

In September 2002, MSD opened its new Central Maintenance Facility (CMF). The facility houses some 300 Maintenance, Industrial Compliance and Monitoring, Fleet, and Administrative personnel. The new facility consolidated employees and equipment from two separate locations along with some personnel that were relocated from MSD's main headquarters.

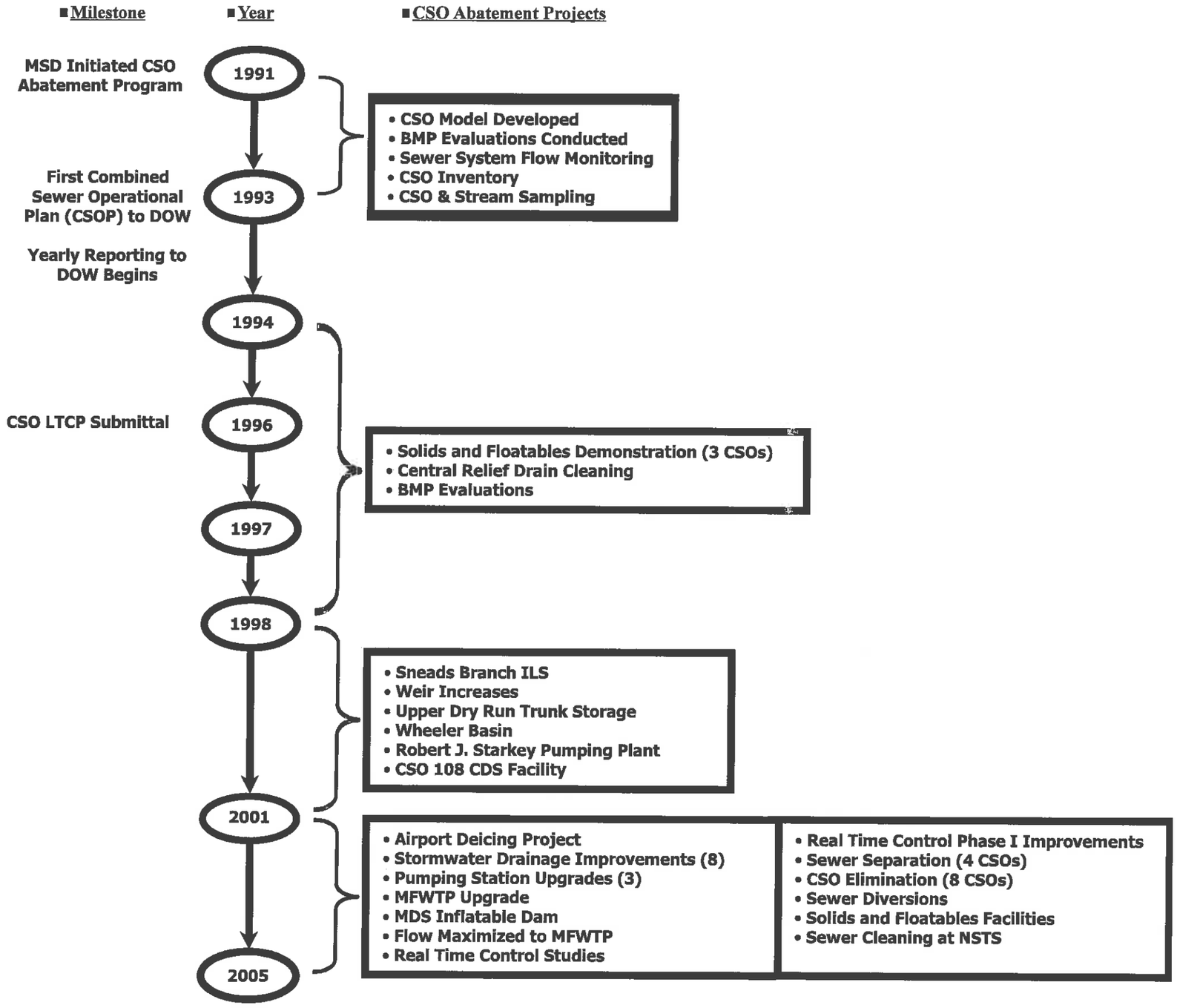
1.2.6.7 Project D.R.I.

On January 27, 2003, a $67,000,000, 2-1/2-year plan to tackle Louisville's most pressing drainage problems. The plan, dubbed Project D.R.I. (Drainage Response Initiative), identified 380 of the worst drainage problems in the Louisville Metro area. As of July 2005, approximately 89% of the planned drainage improvement projects have been completed or started. As a result of the tremendous success of the first phase of Project D.R.I., a second phase was initiated. Approximately $55,000,000 has been allocated for this phase.

The bulk of the funding for the project will came from nearly $47,000,000 collected by MSD in drainage fees from residents and businesses. An additional $20,000,000 will be funded from MSD's Drainage Maintenance Program. These funds will be used to address specific maintenance concerns in each of the 26 Metro Council districts ranging from silted drainage ditches to broken storm sewers that need repair.

Over the past 15 years, MSD has invested over $150,000,000 in drainage and flood protection projects. Most of this work focused on major channel improvements and flood storage basins. In addition, a significant amount of neighborhood drainage work has been completed.

FIGURE 1-1
MSD's CSO PROGRAM



MSD
Louisville and Jefferson County
Metropolitan Sewer District

MSD

Louisville and Jefferson County
Metropolitan Sewer District

SECTION 2

SECTION 2: CHARACTERIZATION, MONITORING, AND MODELING

2.1 INTRODUCTION

The purpose of the combined sewer system (CSS) characterization, monitoring, and modeling is to better understand the response of the system to various wet weather events, the characteristics of the overflows, and the water quality impacts that result from combined sewer overflows CSOs. This information is then used to develop a CSO control plan adequate to meet the Clean Water Act (CWA) requirements.

The major elements of a sewer system characterization are listed below with the description from the EPA Guidance: Combined Sewer Overflows Guidance for Long-Term Control Plan (EPA 832-B-95-002). Each of the major elements are also described with more detail in subsequent sections of this report.

- Rainfall Records - "permittee should evaluate flow variations in the receiving water body to correlate between CSOs and receiving water condition"
- Combined Sewer System Characterization - "permittee should evaluate the nature and extent of its sewer system through evaluation of available sewer system record, field inspection and other activities..."
- Monitoring - "monitoring program that measures the frequency, duration, flow rate, volume and pollutant concentration of CSO discharges and assesses the impact of the CSOs on the receiving waters." This includes the following: number of CSOs, location of CSOs, frequency of CSOs, volume of CSOs, concentration and mass of pollutants discharged at CSOs, impacts of the CSOs on the receiving waters and their designated uses, and mathematical modeling.

The characterization of MSD's CSS was performed as outlined above, through review of existing information, field investigation, monitoring, and mathematical modeling on the sewer system.

2.2 OVERVIEW OF CSO SEWERSHEDS: BEARGRASS; OHIO RIVER NORTH; OHIO RIVER WEST REGIONS

2.2.1 Overview of CSO System

The sewer system owned, operated and maintained by MSD has evolved for almost a century and a half into an extensive network of both sanitary and combined sewers, diversion structures, mechanical regulators and other flow control devices, wastewater treatment plants, and pump stations. The expanse of the overall separate sanitary sewer service area and the limit of the older combined sewer area are exhibited in Figure 2-1.

The combined sewer area encompasses 25,000 acres (39 sq. miles) which is about one-third of the Morris Forman Wastewater Treatment Plant (MFWTP) service area and serves about 324,000 people. MSD has subdivided the combined sewer area into three regions for study and evaluation purposes. A detailed description of the combined sewer system within each region is provided in the following sections. See Figure 2-2.

2.2.1.1 Flow of the System

In the combined sewer system, dry weather flows are conveyed to the MFWTP to remove pollutants before discharging to the Ohio River. During wet weather conditions, when capacity of the combined sewer system is exceeded, the excess flow, a mixture of sewage and stormwater runoff, is discharged to the South Fork Beargrass Creek, Middle Fork Beargrass Creek, and the Ohio River. The typical system constrictions are presented schematically and graphically in Figures 2-3, 2-4, 2-5, and 2-6.

The combined sewer system receives about 25% of the total sanitary flow conveyed to the MFWTP from the separate sewer system. A detailed description of the flow to the MFWTP is provided in Section 4.

2.2.1.2 Number and Location of CSOs

There are a total of 113 active CSOs within the MSD service area. Figure 2-7 presents the distribution of CSO locations within each area.

2.2.1.3 Volume/Flow Estimates

The existing mathematical computer model was utilized to project the average annual hydraulic volume within the combined sewer system. The results are presented in Figure 2-8 according to the contribution of the Average Annual Overflow Volume (AAOV) per region and AAOV as percentage of receiving stream flow (see Table 2-1).

In order to project annual hydraulic load, the following information was used:

- The calibrated computer simulation model described in Section 2.5
- Typical rainfall year information and AAOV calculation methods described in Section 2.4.
- Three USGS Stream Flow gauges were used to estimate the volume of stream flow on Beargrass Creek and Ohio River: USGS 03292500 SFBGC at Louisville, USGS 03293000 MFBCG at Old Cannons Lane, and USGS 03294500 Ohio River at Louisville.

TABLE 2-1

FLOW AS PERCENTAGE OF STREAM FLOW

CSO Regions	Volume of Stream Flow MG/YR	Volume of CSOs MG/YR	% of CSOs %
Beargrass Creek	27,989	945	3.376%
Ohio River North	65,838,307	1,092	0.002%
Ohio River West	65,838,307	1,919	0.003%

2.2.2 Beargrass Creek Region Overview (formerly Region 1)

The combined sewer collection and conveyance system in the Beargrass Creek Region consist of those sewers contributing dry and wet weather flow to the Robert J. Starkey Pumping Plant, including the interceptors along the South and Middle Forks of Beargrass Creek, the Northeastern Sanitary Trunk, and related collector sewers. See Figure 2-9. Much of the interceptor network in this region has limited wet weather conveyance capacities. Although

nearly all wastewater flows generated in Beargrass Creek Region are tributary to the Robert J. Starkey Pumping Plant, two exceptions exist:

- Those flows spilling into the Beargrass Interceptor Relief Sewer that are subsequently pumped over to the Southwestern Outfall service area via the Nightingale Pump Station, and
- Flows diverted from the Beargrass Interceptor to the Southeastern Interceptor and Northern Ditch Interceptor systems, via the Southeastern Diversion, upstream of the combined sewer area.

At this time, fifty-six (56) CSOs are located in the Beargrass Creek Region, with many discharge outlets located along much of the lengths of South and Middle Fork of Beargrass Creek. The slope of the interceptors serving these areas is marginal and requires a relatively high water surface elevation to maintain flow in the sewers even under dry weather conditions.

2.2.2.1 Beargrass Creek Region Major Interceptors/ Relief Sewer and Drains

The major interceptors included in the Beargrass Creek Region are designed to route sanitary flow and allotted quantities of diluted stormwater to the MFWTP via either the Robert J. Starkey Pumping Plant or Nightingale Pump Station. A description of the combined sewer system within the Beargrass Creek Region is presented below.

- **Beargrass Interceptor**

  The Beargrass Interceptor was originally constructed beginning in the early 1900s and has been reconstructed many times over the years. The line varies in size, shape and grade from a 6'-6" x 6'-1-1/2" basket-handle sewer with a 0.05% slope near its outlet end to a 36" circular sewer with a 0.073% slope just south of the Watterson Expressway. Estimated full flow capacities range between 74.4 MGD and 11.2 MGD, respectively.

- **Beargrass Interceptor Relief Sewer**

  The Beargrass Interceptor Relief (BGIR) Sewer was constructed in the 1960s and 1970s to relieve the surcharged Beargrass Interceptor. The interceptor is located on the north side of the South Fork of Beargrass Creek, whereas the relief sewer is located on the south side of the creek between the Watterson Expressway and Nightingale Road. Most of the sewers tributary to the Beargrass Interceptor from the south were connected to the relief sewer during its construction. The Beargrass Interceptor Relief Sewer is a 48" circular sewer with a varying grade. Based on a minimum slope of 0.037% and a maximum slope of 0.12%, estimated full flow capacities range from 16.5 MGD in the upstream sections to 31.1 MGD in the downstream sections.

- **Middle Fork Trunk Sewer**

  The Middle Fork Trunk Sewer serves the Middle Fork Basin of Beargrass Creek, is circular in shape and varies in size and grade throughout its length. At its outlet end, the 60" pipe on a slope of 0.095% has an estimated full flow capacity of 49.4 MGD. Typical daily dry weather flow in the Middle Fork Trunk Sewer is about 16 MGD.

- **Northeastern Interceptor**

  The Northeastern Interceptor was originally a branch of the Beargrass Interceptor and is actually two sewers constructed in an over-under configuration. The upper Northeastern Sanitary Trunk Sewer (NSTS) was designed to collect sanitary flow from the northeastern portion of the city and convey it westward to the Beargrass Interceptor for discharge into the Ohio River. The lower Northeastern Storm Drain was designed to convey stormwater

eastward for discharge into Beargrass Creek. After construction of these sewers, several sanitary sewers were erroneously connected to the Northeastern Storm Drain. Later, the construction of the McAlpine lock and dam raised the normal pool of the Ohio River from elevation 412.00 to 420.00. This submerged the Northeastern Storm Drain over most of its length and resulted in very low velocities which allowed septic conditions to develop in the sewer during dry weather periods. The Letterle PS (formerly the Point Pump Station) was constructed to alleviate this condition by intercepting the Northeastern Storm Drain and discharging flow into the NSTS. During high flow periods, the pump station was designed to discharge the combined flow directly into Beargrass Creek. The Northeastern Sanitary Trunk Sewer is a 5'-7-1/2" x 4'-0" basket-handle sewer with a 0.05% slope. The estimated flow capacity is 31.9 MGD. The Northeastern Storm Drain is a rectangular sewer of varying width and height. At the downstream end, the 6'-0" x 4'-9" Storm Drain is on a grade of 0.105% and provides an estimated full flow capacity of 78.3 MGD.

The Letterle PS Elimination project involved totally eliminating the Letterle PS. The storm drain (lower sewer) carried primarily storm flow but contained some sanitary sewage due to improperly connected private service connections (PSCs). The project included removing all sanitary connections to the lower sewer and allowing it to carry storm water only to the Beargrass Creek. The Letterle Pump Station has been abandoned and the CSO 145 outfall was eliminated and converted into a storm water outfall.

- **Snead's Branch Relief Drain**

  Beginning around 1950, the Snead's Branch Relief Drain was constructed to relieve flooding from the overloaded sewers in the area along Shelby Street near the South Fork of Beargrass Creek. This drain relieves combined sewers using side overflow weirs at eleven (11) locations, and also receives stormwater discharges from catch basins along its route. The drain discharges directly to the South Fork of Beargrass Creek and carries stormwater and the overflows of the combined sewers it relieves. An inflatable dam was constructed in 2001 at the outlet to store overflow for pumping into the Beargrass Interceptor Sewer. At the outlet end, the 11'-0" semi-elliptical drain line has a slope of 0.125% with an estimated full flow capacity of 473 MGD.

2.2.2.2 Beargrass Creek Region Major Pump Stations

- Robert J. Starkey Pumping Plant - Combination Sanitary/Flood Protection Stations

  The Buchanan Street Pump Station, renamed the Robert J. Starkey Pumping Plant in 2005, located on the east corner of Buchanan and Franklin Streets, was constructed by the Corps of Engineers in the 1950s as part of Louisville's flood control system. It functions as a wastewater pumping facility during non-flood conditions. The Beargrass Interceptor, Middle Fork Trunk, and the Northeastern Interceptor converge just outside of the pump station. A common 6' x 8' rectangular sewer conveys all flow into the pump station. The pump station was originally equipped with four pumps rated at 31 MGD each for a total of 124 MGD. Recently the pumping plant has been upgraded and is now equipped with four pumps rated at 35 MGD each for a total of 140 MGD. Flow in excess of station capacity is discharged via gravity to the Ohio River through two overflow points. When River stage elevations prevent the discharge of overflow by gravity, the pump station switches to flood pumping and discharges to the Ohio River. A schematic of the pump station and influent sewers is shown on Figure 2-10.

- **Nightingale Pump Station - Combined Sewer Pump Station**

  The Nightingale Pump Station, which is located at the end of Nightingale Road on the west side of the South Fork of Beargrass Creek, was designed to convey flow in the Beargrass Interceptor Relief Sewer through the Manning Road-Cardinal Drive Sewer and into the Upper Dry Run Trunk and eventually to the Southwestern Outfall. A schematic of the pump station and influent sewers is shown on Figure 2-11. The pump station was built in conjunction with the Beargrass Interceptor relief sewer to prevent overflows on the Beargrass Interceptor during high flow conditions. The Nightingale Pump Station is equipped with three (3) 16" pumps rated at 8,750 GPM each for a total capacity of 26,250 GPM or about 37 MGD.

2.2.2.3 Beargrass Creek Region Combined Sewer Overflows

The following is a list of CSOs located within the Beargrass Creek Region. This listing is presented in order of the approximate geographical locations of the CSOs along each fork. A sample of an inventory sheet for a CSO is shown in Figure 2-12.

South Fork (39 CSOs)

CSO 082 - Old Middle Fork Trunk at Beargrass Creek

CSO 153 - Cooper Street

CSO 121 - Regulator No.18, Green Street

CSO 141 - Baxter Avenue Sanitary

CSO 120 - Phoenix Hill Sewer

CSO 119 - Brent Street Sewer

CSO 118 - Regulator No. 15, East Broadway

CSO 083 - Brent Street at Broadway

CSO 084 - Brent Street at Beargrass Creek

CSO 117 - Regulator No. 11, Dry Run

CSO 179 - Kentucky Street Sewer Overflow

CSO 149 - Dry Run Diversion

CSO 146 - Snead's Branch Sanitary Sewer Diversion

CSO 147 - Swan Street Diversion (Swan Street north of Beargrass Creek)

CSO 091 - Schiller Avenue

CSO 092 - St. Catherine at Beargrass Creek

CSO 152 - Regulator No. 7, Southeastern Beargrass Creek

CSO 113 - Ellison Avenue Sewer

CSO 151 - Regulator No. 5, Castlewood

CSO 148 - Eastern Parkway Diversion

CSO 111 - Emerson Street Sewer

CSO 110 - Regulator No. 2, Goss Avenue

CSO 097 - Cantonment Siphon No. 2

CSO 106 - Royal-Neff

CSO 137 - Calvary Cemetery

CSO 109 - Regulator No. 2, Deer Park

CSO 108 - Regulator No. 1, Newburg Road

CSO 018 - Nightingale PS

CSO 082 is located west of Beargrass Creek at the confluence of the middle and south forks. The CSO is located on the 39" Middle Fork Trunk Sewer just upstream from the junction with the Beargrass Interceptor and just downstream of a siphon under the creek. A 12" high-level overflow sewer diverts high flows to Beargrass Creek. A flapgate prevents backflow from the creek into the overflow sewer. A COPA Cyclone screen was installed for the solids and floatables control.

CSO NO.	082
CSO Name.	BGI at BGC
Location	BGC @ OMFT
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0.59
Overflow Frequency (NO/YR)	12
Avg. Overflow Duration (HRS)	1.25
Percentage of Entire System(AAOV)	0.02%

CSO 153 is located near Lexington Road and Cooper Street. The CSO is located at an abandoned regulator on a 36" sewer flowing northwest from Cooper Street at Beargrass Creek. An 8" low flow sewer conveys low flows through the abandoned regulator chamber and under Beargrass Creek to the Beargrass Interceptor. Overflows continue through the 36" sewer to Beargrass Creek.

CSO NO.	153
CSO Name.	Cooper Street
Location	Lexington & Cooper
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	7.15
Overflow Frequency (NO/YR)	53
Avg. Overflow Duration (HRS)	3.37
Percentage of Entire System(AAOV)	0.20%

CSO 121 is located under the railroad viaduct on Lexington Road west of Beargrass Creek. The CSO is located on a 36" sewer flowing east on Liberty Street at Beargrass Creek. A 12" wide x 6" deep slot cut into the invert of the 36" sewer and a small dam downstream of the slot directs low flows through a 12" side outlet sewer to an abandoned regulator chamber and a 12" sewer to the 5'-2" x 4'-11" basket handle Beargrass Interceptor. Overflows that top the dam continues through the 36" sewer to Beargrass Creek. In October 1997, this dam was raised 6" as part of a NMC measure to increase the retention of wet weather flows from this catchment area.

CSO NO.	121
CSO Name.	Reg. No. 18-Green St.
Location	Lexington Road W. of BGC
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	3.2
Overflow Frequency (NO/YR)	23
Avg. Overflow Duration (HRS)	1.39
Percentage of Entire System(AAOV)	0.09%

CSO 141 is located on Baxter Avenue south of Beargrass Creek. The CSO is located on an 18" sewer flowing southwest along Beargrass Creek to CSO 120. The actual orifice opening is elliptical shaped due to the 15" drop intercepting the 18" sewer invert at an angle. The overflows exit the manhole through a 24" sewer to Beargrass Creek.

CSO NO.	141
CSO Name.	Baxter Ave.
Location	Baxter Ave. & BGC
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0
Overflow Frequency (NO/YR)	0
Avg. Overflow Duration (HRS)	0
Percentage of Entire System(AAOV)	0.00%

CSO 120 is located on the East Side of Beargrass Creek on Lexington Road. The CSO is located on a 24" sewer flowing from Lexington road, west of Baxter Avenue. The overflow manhole collects flows from a 15" sewer carrying low flows from CSO 141 and a 24" sewer. A small dam diverts low flows through an 8" sewer to an abandoned regulator chamber where flows are carried under Beargrass Creek to the 5'-2" x 4'-11" basket handle Beargrass Interceptor. Overflows that top the dam continue through the 24" sewer to Beargrass Creek. In March 1997, this dam was raised 6" as part of a NMC measure to increase the retention of wet weather flows from this catchment area.

CSO NO.	120
CSO Name.	Phoenix Hill Sewer
Location	E of BGC & S of Baxter
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	4.35
Overflow Frequency (NO/YR)	24
Avg. Overflow Duration (HRS)	1.5
Percentage of Entire System(AAOV)	0.12%

CSO 119 is located north of Broadway between the east side of Beargrass Creek and Campbell Street. The CSO is located on a 18" sewer downstream of CSOs 083 and 084. The 18" sewer enters a siphon chamber that has a 15" high-level overflow sewer. A 16" siphon conveys low flow west under Beargrass Creek through an abandoned regulator chamber to the Beargrass Interceptor. High flows in the inlet chamber of the siphon overflow through the high level sewer to Beargrass Creek. A COPA Cyclone screen was installed or the solids and floatables control.

CSO NO.	119
CSO Name.	Brent Street Sewer
Location	BGC N of Broadway
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	2.35
Overflow Frequency (NO/YR)	27
Avg. Overflow Duration (HRS)	1.62
Percentage of Entire System(AAOV)	0.07%

CSO 118 is located on Broadway west of Beargrass Creek. The CSO is located on an 8' circular sewer east of Broadway at Beargrass Creek. A 3' wide 6" deep slot cut in the invert of the 8' Broadway sewer diverts low flows through a 3' x 2'-3" side outlet rectangular sewer and a 16" x 34-1/4" regulated opening to a gate chamber. Flows exit the gate chamber through a 2'-6" x 2' rectangular sewer to the 5'-2" x 4'-11" basket handle Beargrass Interceptor. A dam is located on the Broadway sewer downstream of the diversion. Overflows top the dam and continue through the Broadway sewer to Beargrass Creek.

CSO NO.	118
CSO Name.	Reg. No. 15-E Broadway
Location	Broadway west of BGC
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	169.76
Overflow Frequency (NO/YR)	64
Avg. Overflow Duration (HRS)	7.29
Percentage of Entire System(AAOV)	4.85%

CSO 083 is located on Broadway at Brent Street under the railroad overpass. The CSO is located on a 30" sewer flowing west on Broadway. An 8" high diversion dam diverts low flows through an 8" side outlet sewer to a manhole located on a 15" sewer flowing north on the East Side of Beargrass Creek. The flow drops into the manhole and exits through a 18" sewer. The free drop is about 8'. Overflows top the dam and continue through the 30" sewer to Beargrass Creek. The diverted flow from this overflow is discharged to the 15" sewer carrying the diverted flow from CSO 084 and is upstream of CSO 119.

CSO NO.	83
CSO Name.	Brent St. & Broadway Connect
Location	Brent & Broadway
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	2.67
Overflow Frequency (NO/YR)	36
Avg. Overflow Duration (HRS)	1.86
Percentage of Entire System(AAOV)	0.08%

CSO 084 is located in Brent Street approximately 150' south of Broadway. The CSO is located in a manhole on the 54" circular sewer flowing northwest on Brent Street at Beargrass Creek and Broadway. The 54" sewer has a 12" wide by 6" deep slot cut into the invert of the sewer. A 15" side outlet sewer with an invert matching the bottom slot conveys low flows to a downstream manhole, which intercepts diverted flow from CSO 083. There is a small dam on the 54" sewer downstream of the slot. Overflows top the dam and continue to another manhole and discharge through a 42" sewer into Beargrass Creek.

CSO NO.	84
CSO Name.	Brent St. at BGC
Location	Brent St. at BGC
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	2.21
Overflow Frequency (NO/YR)	15
Avg. Overflow Duration (HRS)	1.2
Percentage of Entire System(AAOV)	0.06%

CSO 117 is located at the intersection of Logan and Caldwell Street. The CSO is located on the 9'-6" circular brick Dry Run Sewer flowing east on Caldwell Street at Logan Street. A 1'-1" deep slot cut into the invert of the Dry Run Sewer diverts low flow through a 2' x 2' side outlet to a regulator chamber and then into a 4'-6" circular Beargrass Interceptor. The regulator is operated by a "tell-taled" off the Beargrass Interceptor with a 4" pipe. A dam is located about 115' downstream of the diversion. A sluice gate is mounted on the 2' x 2' diversion. The overflow discharges to an improved portion of Beargrass Creek.

CSO NO.	117
CSO Name.	Reg. No. 11-Dry Run
Location	Logan & Caldwell
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	82.53
Overflow Frequency (NO/YR)	37
Avg. Overflow Duration (HRS)	3.02
Percentage of Entire System(AAOV)	2.36%

CSOs 149 and 179 are located on Kentucky Street at St. Paul Court. Both CSOs are located at the junction of the 9' circular brick Dry Run Sewer and the 8' circular brick Kentucky Street Sewer. Low flows traveling northeast of Dry Run Sewer are diverted by a concrete dam through a 4'-0" x 2'-9" connection and join the flows in the Kentucky Street Sewer. The combined flows continue northeastwardly in the 9'-6" circular brick Dry Run Sewer. Overflows that top the dam enter the 8'-6" reinforced concrete semi-elliptical Dry Run Relief Drain running east to Beargrass Creek. A side connection to the Dry Run Relief Drain where they combine with overflows topping the dam on the Dry Run Sewer. It should be noted that the crest elevation of the dam on the Dry Run Sewer is 3.11' below the elevation of the side outlet weir on the Kentucky Street Sewer. It appears that high flows in the Kentucky Street Sewer will travel backward through the low flow connection of the Dry Run Sewer and top the dam before discharging over the side outlet weir.

CSO NO.	149
CSO Name.	Dry Run Diversion
Location	Kentucky Street & St. Paul Ct.
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	6.9
Overflow Frequency (NO/YR)	19
Avg. Overflow Duration (HRS)	8.26
Percentage of Entire System(AAOV)	0.20%

CSO NO.	179
CSO Name.	Kentucky St. Sewer Overflow
Location	Kentucky St. & St. Paul Ct.
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0.08
Overflow Frequency (NO/YR)	14
Avg. Overflow Duration (HRS)	1.21
Percentage of Entire System(AAOV)	0.00%

CSO 146 is located on Swan Street just south of Beargrass Creek. The CSO manhole is located on the 7' circular brick Snead's Branch Sewer flowing north on Swan Street. A 16" high concrete dam diverts low flows through rack bars and into a flared 18" bottom orifice. The sewer conveying the low flow reduces from 18" to 12" to a 7" prior to discharging into regulator chamber no. 10 and subsequently to the 48" Beargrass Interceptor. The regular equipment has been removed. Overflows continue through the 7' brick sewer and exit over a stair-step configuration into Beargrass Creek. There is flap gate at this discharge point.

CSO NO.	146
CSO Name.	Sneads Branch Diversion
Location	Swan St. S of BGC
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	91.68
Overflow Frequency (NO/YR)	51
Avg. Overflow Duration (HRS)	6.72
Percentage of Entire System(AAOV)	2.62%

CSO 147 conveys base flows originating on the north side of Beargrass Creek, by way of the Swan Street Sewer diversion, through a 10" aerial crossing of the creek. The downstream end of this aerial crossing enters the 7' Snead's Branch Sanitary Sewer just upstream of the overflow dam at CSO 146. Flows in excess of the 10" sewer overflow to Beargrass Creek. The public sewer system on this area has been separated and scheduled to be closed by 3rd quarter of 2007.

CSO NO.	147
CSO Name.	Swan Street Diversion
Location	Swan St. S of BGC
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	1.3
Overflow Frequency (NO/YR)	65
Avg. Overflow Duration (HRS)	3.1
Percentage of Entire System(AAOV)	0.04%

CSO 091 is located on Schiller Avenue at Highland Avenue. The CSO manhole is located on a 24" sewer flowing southeast on Schiller Avenue near Beargrass Creek. An 8" bottom outlet orifice conveys low flows southeast on Schiller Avenue across Beargass Creek to the Beargrass Interceptor. There is a flapgate on the overflow at the creek wall.

CSO NO.	91
CSO Name.	Schiller Ave Overflow
Location	Schiller & Highland
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0.06
Overflow Frequency (NO/YR)	3
Avg. Overflow Duration (HRS)	1.33
Percentage of Entire System(AAOV)	0.00%

CSO 092 is located on Schiller Avenue between Kentucky Street and St. Catherine. The CSO manhole is located on a 24" sewer flowing east, between Kentucky Street and St. Catherine, east of Schiller Avenue. A leaping weir with a 15" side outlet conveys low flows to the 39" Beargrass Interceptor. The leap distance is about 3". Overflows continue through the 24" sewer to Beargrass Creek. There is a 24" drop inlet at Beargrass Creek. A 12" dam on the 24" overflow at the creek forces small overflows into the drop inlet.

CSO NO.	92
CSO Name.	St. Catherine @ BGC
Location	Schiller BTW KY & St. Catherine
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0.003
Overflow Frequency (NO/YR)	2
Avg. Overflow Duration (HRS)	1
Percentage of Entire System(AAOV)	0.00%

CSO 152 is located on Rufer Avenue and Beargrass Creek. The CSO is located on a 7' circular brick Southeastern Sewer flowing southwest on Rufer Avenue. Low flows drop through rack bars set into a diversion chamber and discharge through a 18" side outlet sewer. The 18" sewer conveys the flow to a siphon inlet chamber from which a 14" and 16" cast iron inverted siphon carries the flow under Beargrass Creek to Regulator No. 7. Flow through the regulator is controlled by a 24" float actuated flapgate and is conveyed to the Beargrass Interceptor via a 18" sewer at the regulator chamber. This float is "tell-taled" to the water level in the 18" sewer. Overflows continue beyond the diversion chamber and rack bars through an energy dissipater and drop to Beargrass Creek. Galvanized steel cages were installed in 1997 for the solids and floatables control.

CSO NO.	152
CSO Name.	Reg. No. 7- Southeastern
Location	BGC & Rufer Avenue
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	34.4
Overflow Frequency (NO/YR)	42
Avg. Overflow Duration (HRS)	2.88
Percentage of Entire System(AAOV)	0.98%

CSO 113 is located at the intersection of Schiller Avenue and Ellison Avenue. The CSO is located on a 48" sewer flowing northeast on Ellison Avenue. A 12" high dam diverts low flows through an 8" bottom outlet orifice into the Beargrass Interceptor flowing northwest of Schiller Avenue. Overflows top the dam and continue through the 48" sewer northeast to Beargrass Creek. COPA Cross Wave Static Screens were installed for the solids and floatables control.

CSO NO.	113
CSO Name.	Ellison Avenue Sewer
Location	Ellison & Schiller
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	7.83
Overflow Frequency (NO/YR)	46
Avg. Overflow Duration (HRS)	5.13
Percentage of Entire System(AAOV)	0.22%

CSO 151 is located on the east side of Beargrass Creek near the southend of Castlewood Dell across the creek from St. Michael Cemetery. The CSO is located on the 66" circular concrete sewer flowing west from Castlewood Avenue. Low flows in the 66" sewer drop through rack bars into a diversion chamber and exit through a 24" side outlet sewer. The 24" sewer conveys the flow to a siphon inlet/clean out chamber from which a 14" and 16" cast iron inverted siphon carry the flow under Beargrass Creek to regulator No. 5. Flow through the regulator is controlled by a 24" float actuated flapgate and is conveyed to the Beargrass Interceptor via a 20" sewer. The float is "tell-taled" to the water level in the 20" sewer. It is assumed that the float completely closes the flapgate at an elevation 439.12, which is the level at which full pipe flow is achieved in the 20" line to the Beargrass Interceptor. Overflows continue beyond the diversion chamber and rack bars through an energy dissipater and drop to Beargrass Creek. Galvanized steel cages were installed in 1997 for the solids and floatables control.

CSO NO.	151
CSO Name.	Reg. No. 5- Castlewood
Location	BGC & Castlewood Dell
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	143.91
Overflow Frequency (NO/YR)	64
Avg. Overflow Duration (HRS)	7.4
Percentage of Entire System(AAOV)	4.11%

CSO 148 is located on the north side of Eastern Parkway about 330' east of Beargrass Creek in front of the Medical Arts Building. The CSO manhole is located on the 24" Eastern Parkway Sewer flowing west to the Beargrass Interceptor. The diversion structure is a cross between a simple dam and a leaping weir. The structure differs from a leaping weir in that the crest of the down stream concrete dam is higher than the upstream leap point and the invert of the structure is not slanted upward at the leap point end. Low flows area diverted by a dam into an 8" side outlet sewer. The 8" sewer parallels the Eastern Parkway Sewer to the east side of Beargrass Creek where it drops into a siphon inlet chamber, crosses under the creek through dual 8" sewers, and joins with the diverted low flow from CSO 111 prior to discharging into the Beargrass Interceptor. Overflows continue westward through the Eastern Parkway Sewer, which increases in size from 24" to 30", to Beargrass Creek.

CSO NO.	148
CSO Name.	Eastern PKWY Diversion
Location	Eastern PKWY E of BGC
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0.27
Overflow Frequency (NO/YR)	12
Avg. Overflow Duration (HRS)	1.16
Percentage of Entire System(AAOV)	0.01%

CSO 111 is located west of Beargrass Creek and north of Eastern Parkway. The CSO is located on a 5'-2-1/2" x 4'-9" basket handle sewer flowing northeast of the north side of Eastern Parkway at Beargrass Creek. A small dam diverts low flows through a bottom 10" orifice and 10" sewer to a chamber and junction with a 15" sewer flowing west on Eastern Parkway. The low flow continues to an adjacent chamber and exits through a 15" sewer to the old gate chamber and then through a 21" connection to the Beargrass Interceptor. Overflows top the dam and continue to an energy dissipater and through a flapgate into Beargrass Creek.

CSO NO.	111
CSO Name.	Emerson Street Sewer
Location	BGC N of Eastern PKWY
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	9.55
Overflow Frequency (NO/YR)	39
Avg. Overflow Duration (HRS)	2.74
Percentage of Entire System(AAOV)	0.27%

CSO 110 is located west of Beargrass Creek and south of Eastern Parkway. The CSO is located on a 60" sewer flowing northeast from Polar Level Road at its junction with the Beargrass Interceptor. Low flows in the 60" sewer drop through a rack bar into a diversion chamber and side outlet through a 18" sewer to a grit chamber. Flows exit the grit chamber through a 12" x 15" regulated opening into a gate chamber. Flows exit the gate chamber through an 18" sewer to the Beargrass Interceptor. The opening to the gate chamber is regulated by a float system which "tell-taled" off the Beargrass Interceptor. As the flow in the interceptor increases the opening to the gate chamber is decreased until it is completely closed when the flow in the interceptor reaches elevation 440.51. Overflows continue beyond the diversion chamber through an energy dissipater to Beargrass Creek. Galvanized steel cages were installed in 1997 for the solids and floatables control.

CSO NO.	110
CSO Name.	Reg. No. 3 - Goss Ave.
Location	BGC S of Eastern PKWY
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	3.9
Overflow Frequency (NO/YR)	32
Avg. Overflow Duration (HRS)	1.9
Percentage of Entire System(AAOV)	0.11%

CSO 097 is located on the Beargrass Interceptor on the east side of the Beargrass Creek south of the Eastern Parkway. The CSO is located at a siphon under Beargrass Creek. The 39" Beargrass Interceptor is conveyed under Beargrass Creek through three 24" siphons. The inlet side of the siphon has a gate chamber followed by the inlet chamber of the siphon. The interceptor is split into a 39" sewer and a 36" sewer before entering the gate chamber. A set of stop planks can isolate one side of the gate chamber from the other. The flow exits the gate chamber to the inlet chamber of the siphon or through a 36" manual overflow to Beargrass Creek. A pair of sluice gates, one on the inlet side of the 39" and one on the outlet of the 36" sewer, can be used to divert the flow through the 36" manual overflow sewer to the creek for maintenance. A 15" corrugated metal pipe provides a high level of overflow to the creek. The 15" high level overflow has a flapgate and head wall on the outlet at the creek.

CSO NO.	97
CSO Name.	Cantonment Siphon No. 2
Location	BGC S of Eastern PKWY
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	49.81
Overflow Frequency (NO/YR)	56
Avg. Overflow Duration (HRS)	6.89
Percentage of Entire System(AAOV)	1.42%

CSO 106 is located in the fenced backyard of 1212 Royal Avenue. The CSO manhole is located at the junction of a 12" sewer and 15" sewer. A small dam diverts low flows through a 6" sewer and a 6" drop inlet into an 8" sewer. The 8" sewer discharges to the 39" Beargrass Interceptor through an 8" stack. Overflows that top the dam continues through a 18" sewer to another manhole and then through a 21" sewer to Beargrass Creek.

CSO NO.	106
CSO Name.	Royal - Neff
Location	Backyard of 1212 Royal
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0.1
Overflow Frequency (NO/YR)	11
Avg. Overflow Duration (HRS)	1.09
Percentage of Entire System(AAOV)	0.00%

CSO 137 is located in the Southwest part of Calvary Cemetery near Beargrass Creek. The CSO manhole is located at the junction of a 12" sewer flowing southeast from Neff Avenue and a 24" sewer flowing southwest from Newburg Road. An 8" high dam diverts low flows through an 8" sewer and an 8" stack to the 39" Beargrass Interceptor. Overflows that top the dam continues through the 24" sewer to a 42" sewer to Beargrass Creek.

CSO NO.	137
CSO Name.	Calvary Cemetery
Location	Calvary Cemetery @ BGC
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	1.1
Overflow Frequency (NO/YR)	19
Avg. Overflow Duration (HRS)	1.63
Percentage of Entire System(AAOV)	0.03%

CSO 109 is located at the junction of a 54" sewer flowing southwest from Newburg road and Beargrass Interceptor. Low flows in the 54" sewer drop through rack bars into a diversion chamber and side outlet to a grit chamber. Flows exit the grit chamber through a 12' x 15" regulated opening into a gate chamber. Flows exit a gate chamber through a 24" sewer. The opening to the gate chamber is regulated by a float system which is "tell-taled" off the Beargrass Interceptor. As the flow in the interceptor increases the opening to the gate chamber is decreased until it is completely closed when the flow in the interceptor reaches elevation 445.41. Overflows continue beyond the diversion chamber through an energy dissipater to Beargrass Creek. There is a small rise before the energy dissipater and drop to the creek. COPA Cross Wave Static Screens were installed for the solids and floatables control.

CSO NO.	109
CSO Name.	Ref No. 2 Deer Park
Location	Behind OLOP
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	2.97
Overflow Frequency (NO/YR)	19
Avg. Overflow Duration (HRS)	1.15
Percentage of Entire System(AAOV)	0.08%

CSO 108 is located on Newburg Road about 900' west of Trevilian Way. The CSO is located on twin 7'-6" x7'-0" rectangular sewers at their junction with the Beargrass Interceptor. Low flows drop through rack bars set in the invert of the twin sewer into a side outlet to a grit chamber. Flows exit the grit chamber through a 12" x 24" regulated opening into a gate chamber then thought a 36" circular sewer into the Beargrass interceptor. In February 1999, a COPA vortex unit was installed for the solids and floatables control.

CSO NO.	108
CSO Name.	Ref No. 1 - Newburg
Location	Newburg @ Trevilian
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	39.59
Overflow Frequency (NO/YR)	34
Avg. Overflow Duration (HRS)	2.17
Percentage of Entire System(AAOV)	1.13%

Snead's Branch (11 CSOs)

CSO 142 - Logan & St. Catherine

CSO 174 - Goss & Boyle

CSO 180 - Ormsby & Clay

CSO 182 - Burnett w. of Shelby

CSO 183 - Alexander & Keswick

CSO 184 - Fetter & Alexander

CSO 185 - Shelby & Keswick

CSO 186 - Logan & Oak

CSO 187 - Shelby & Camp

CSO 188 - Shelby & Clay

CSO 205 - Morgan & Hoertz

As noted earlier, the Snead's Branch Relief Drain was constructed to relieve flooding from an overloaded sewer in the area along Shelby Street near South Fork Beargrass Creek. The drain relieves combined sewers using overflow weirs at eleven (11) locations, and also receives storm water discharges from catch basins along its route. Because the Snead's Branch Relief Drain was constructed specifically to convey the excess flows from each of the noted CSOs, the Drain itself does not function as a consolidation sewer to bring the excess flows to a common point. As a part of Real Time Control Phase I, an inflatable gate was installed at Snead's Branch to capture flows from 11 CSOs. Pumps will send re-captured overflows back into the BGI for treatment at the MFWTP.

CSO NO.	142, 174, 180, 182, 183, 184, 185, 186, 187, 188
CSO Name.	Snead's Branch Relief Drain
Location	Shelby St. near SFBGC
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0
Overflow Frequency (NO/YR)	0
Avg. Overflow Duration (HRS)	0
Percentage of Entire System(AAOV)	0.00%

The storage capacity of Snead's Branch Inflatable Dam is approximately 2.5 MG. The AAOV in the table present zero overflow of the CSOs within the table for the typical rainfall year. During larger wet weather events, in excess of those in the typical year, the inflatable dam will modulate to maintain a water level to protect homes from flooding.

Middle Fork (9 CSOs)

CSO 086 - Payne Street and Spring Street

CSO 140 - Locust Street southwest of Spring Street

CSO 144 - Vance Street north of I-64

CSO 127 - Lexington Road opposite Etley Avenue

CSO 126 - North of I-64, east of Saunders Lane and west of Grinstead Drive

CSO 125 - Northwest of Grinstead Drive and I-64

CSO 166 - South of Lexington Road, northeast of I-64

CSO 206 - Cherokee Park at Spring Drive

CSO 130 - Webster Street Sewer

CSO 086 is located in the intersection of Payne Street and Spring Street. The CSO is located in a manhole on a 24" sewer flowing southwest on Payne Street. The manhole contains a leaping weir with a 10" side outlet that conveys dry weather flow northwest on Spring Street to a manhole and into a 15" sewer.

CSO NO.	086
CSO Name.	Payne at Spring
Location	Payne St. & Spring St.
Receiving Stream	MF BGC
2003 AAOV (MG/YR)	0
Overflow Frequency (NO/YR)	0
Avg. Overflow Duration (HRS)	0
Percentage of Entire System(AAOV)	0.00%

CSO 140 is located along Locust Street southwest of Spring Street. The CSO is located on a 42" sewer flowing southwest on Locust Street. Dry weather flow drops through rack bars into a 10" sewer that carries the flow to a drop manhole and into the 60" Middle Fork Trunk Relief Sewer (MFTRS). In March 1995, a 4" dam was constructed as part of a NMC measure to increase the retention of wet weather flows from this catchment area.

CSO NO.	140
CSO Name.	Locust Street
Location	Locust SW of Spring
Receiving Stream	MF BGC
2003 AAOV (MG/YR)	5.07
Overflow Frequency (NO/YR)	28
Avg. Overflow Duration (HRS)	1.92
Percentage of Entire System(AAOV)	0.14%

CSO 144 is located at the south end of Vance Street just north of Interstate I-64. This CSO is a regulator that was constructed by the Kentucky Department of Highways when I-65 was built. The structure is located on a 42" sewer flowing southwest on Vance Street. The 42" sewer enters a weir chamber that diverts dry weather flow through an opening into a gate chamber. The regulator is operated by a float system that is "tell-taled" off the weir chamber with an opening upstream of the weir. The flow exits the gate chamber through a 15" sewer and discharges to the Middle Fork Trunk Relief Sewer (MFTRS). The float starts to rise and the gate starts to close when the water surface is equal to the top of the weir. Until the gate completely closes, the flow is split between the CSO and the MFTRS. The overflow continues through the 42" sewer to a drainage channel that flows under I-64 to the Middle Fork of Beargrass Creek. COPA Cross Wave Static Screens were installed for the solids and floatables control.

CSO NO.	144
CSO Name.	Vance St. Regulator
Location	S end of Vance & I-64
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0.61
Overflow Frequency (NO/YR)	27
Avg. Overflow Duration (HRS)	3.7
Percentage of Entire System(AAOV)	0.02%

CSO 126 is located just north of the entrance ramp from Grinstead Drive to Westbound I-64 east of Saunders Lane and west of Grinstead Drive. The CSO is located on a 36" circular sewer flowing south from Bickel Avenue. A 27" circular sewer is flowing east from Saunders Avenue and enters the 36" sewer just upstream of the overflow structure. The Middle Fork Interceptor (MFI) is flowing west below the 27" sewer. The 36" sewer enters a diversion chamber where the dry weather flow drops through bar racks and discharges through a 15" sewer to a regulator chamber. The flow exits the 15" sewer into the regulator through a regulated opening. The regulator is operated by a float system that is "tell-taled" off the Middle Fork Interceptor through a 10" sewer. The flow exits the regulator chamber through an 18" sewer to the 33" Middle Fork Interceptor. When the float system shuts the regulated opening the overflows exit the diversion chamber through a 4' x 3' box culvert with a 12" dam to the Middle Fork Beargrass Creek. COPA Cross Wave Static Screens were installed for the solids and floatables control.

CSO NO.	126
CSO Name.	Reg. No. 26-Raymond Ave.
Location	I-64 and Sauders Lane
Receiving Stream	MF BGC
2003 AAOV (MG/YR)	0.27
Overflow Frequency (NO/YR)	6
Avg. Overflow Duration (HRS)	1.16
Percentage of Entire System(AAOV)	0.01%

CSO 125 is located northwest of Grinstead Drive and I-64 near the northwest ramp to westbound I-64. The overflow structure is located on a 7'-3" semi-elliptical sewer flowing west on Grinstead Drive. Dry weather flows drop through rack bars and discharge through a 15" sewer to a regulator chamber. A gate on the 15" outlet regulates flow by means of a float system that is "tell-taled" off the Middle Fork Interceptor (MFI) through a 10" pipe. Flows exit the regulator chamber through an 18" sewer to the 33" MFI. Overflows continue across the drop and rack bars through the 7'-3" sewer to a 10' x 3' box culvert under I-64 and then to the Middle Fork of Beargrass Creek. COPA Cross Wave Static Screens were installed for the solids and floatables control.

CSO NO.	125
CSO Name.	Reg. No. 24 - Grinstead Dr.
Location	Grinstead at I-64
Receiving Stream	MF BGC
2003 AAOV (MG/YR)	18.4
Overflow Frequency (NO/YR)	30
Avg. Overflow Duration (HRS)	7.16
Percentage of Entire System(AAOV)	0.53%

CSO 166 is located south of Lexington Road and northeast of I-64 near the underpass. The overflow is located on the 10'-3" Beals Branch Trunk Sewer. Dry weather flows drop through bar racks into a diversion chamber. The flow exits the diversion chamber through a 24" side outlet sewer that serves as the influent to CSO 162. A 24" high concrete dam is located just downstream of the rack bars that cause the flow to pond over the rack bars before topping the dam and overflowing to the Middle Fork of Beargrass Creek. COPA Cross Wave Static Screens were installed for the solids and floatables control.

CSO NO.	166
CSO Name.	Beals Branch San. Div
Location	Lexington Rd. & I-64
Receiving Stream	MF BGC
2003 AAOV (MG/YR)	16.32
Overflow Frequency (NO/YR)	31
Avg. Overflow Duration (HRS)	1.83
Percentage of Entire System(AAOV)	0.47%

CSO 206 is located in Cherokee Park where Spring Drive, Cherokee Road and Park Boundary Road converge. The sewer system tributary to CSO 206 was originally constructed with separate storm and sanitary sewers with shared common manholes with a concrete divider wall. The storm system was connected to an 87" drain that discharged to the Middle Fork of Beargrass Creek while the sanitary sewer was connected to an 18" interceptor that discharged to the MFTRS. In 1991, MSD discovered that there were sanitary connections to the storm line and vice versa. Therefore, CSO 206 was constructed as a dam in the 87" concrete drain with an 8" dry weather connection to the 18" sanitary interceptor. This arrangement ensured that all dry weather flow made it to the interceptor and eliminated the possibility of dry weather overflows. Design for the sewer separation of the CSO 206 area was completed in the 2000 and the construction phase began. As of FY05, approximately 60% of the public system has been separated.

CSO NO.	206
CSO Name.	Cherokee Park @ Spring Dr.
Location	Cherokee Park and Spring Dr.
Receiving Stream	MF BGC
2003 AAOV (MG/YR)	88.89
Overflow Frequency (NO/YR)	63
Avg. Overflow Duration (HRS)	10.5
Percentage of Entire System(AAOV)	2.54%

CSO 130 is located in a parking lot south of Story Avenue opposite Webster Street. The overflow structure is an abandoned regulator located on a 24" circular brick sewer flowing southeast on Webster Street. A dam diverts low flows through a 12" sewer to the abandoned regulator chamber and exists through an 18" sewer to the 60" Middle Fork Trunk relief sewer. Overflows top the dam and continue through the 24" brick sewer to a 27" concrete sewer to Beargrass Creek.

CSO NO.	130
CSO Name.	Webster St.
Location	S of Story at Webster
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	6.51
Overflow Frequency (NO/YR)	26
Avg. Overflow Duration (HRS)	3.53
Percentage of Entire System(AAOV)	0.19%

Northeastern Area (8 CSOs)

CSO 081 - Letterle Avenue at Beargrass Creek

CSO 087 - Bluehorse

CSO 088 - Mellwood Avenue Interceptor

CSO 093 - Spring Street

CSO 131 - Regulator No. 33 - Mellwood and Frankfort

CSO 132 - Regulator No. 35 - Brownsboro Road Trunk

CSO 154 - Mellwood Sanitary Relief at Schoeffel Street

CSO 167 - Brownsboro Road Lateral No. 2

CSO 081 is located on a 10" sewer flowing northeast on Story Avenue. An 8" overflow sewer exits the structure about 3'-4' above the invert of the 10" sewer. A sluice gate is mounted on the inlet side of the overflow sewer and has been closed for years.

CSO NO.	81
CSO Name.	Letterle
Location	Letterle @ BGC PS
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0
Overflow Frequency (NO/YR)	0
Avg. Overflow Duration (HRS)	0
Percentage of Entire System(AAOV)	0.00%

CSOs 087, 088, 093, and 131 are located along the Mellwood Interceptor, one at the junction of each tributary sewer. The Mellwood Interceptor is a combined sewer specifically designed to accept only limited quantities of flow from the tributary combined sewers. Three of these CSOs are configured as "leaping weirs." At a leaping weir, if the velocity of approaching flow is sufficiently high, the flow will "leap" over the opening which normally conveys the flow to the interceptor. Thus, the width of the opening, approach angle of flow, and the height of the weir are all factors which affect overflow volume and frequency.

In January 2001, the public portion of CSO 088 was separated. An evaluation of CSO closure was performed during FY05 to determine the effectiveness of the separation and potential influence of a proposed downspout disconnection project. Through this evaluation it was determined that CSO 088 operates as a relief point for the Mellwood interceptor, therefore a downspout disconnection program would have a minimal impact on CSO volume and frequency. CSO 088 also has been identified as a CSO with potential backwater impact from the Beargrass Creek during high river elevation. CSO 087 has been designated a candidate for a mini-separation project and scheduled to be closed by 3rd quarter of 2006.

CSO NO.	**87**
CSO Name.	Bluehorse
Location	Frankfort @ Bluehorse
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0
Overflow Frequency (NO/YR)	0
Avg. Overflow Duration (HRS)	0
Percentage of Entire System(AAOV)	0.00%
CSO NO.	**88**
CSO Name.	Mellwood Ave Int.
Location	Brownsboro Rd. @ BGC
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0
Overflow Frequency (NO/YR)	0
Avg. Overflow Duration (HRS)	0
Percentage of Entire System(AAOV)	0.00%
CSO NO.	**93**
CSO Name.	Spring Street
Location	Spring St. N of Mellwood
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0
Overflow Frequency (NO/YR)	0
Avg. Overflow Duration (HRS)	0
Percentage of Entire System(AAOV)	0.00%
CSO NO.	**131**
CSO Name.	Reg. No. 33 Mellwood @ Frankfort
Location	Frankfort Ave. @ BGC
Receiving Stream	SF BGC
2003 AAOV (MG/YR)	0.22
Overflow Frequency (NO/YR)	3
Avg. Overflow Duration (HRS)	1.33
Percentage of Entire System(AAOV)	0.01%

CSO 132 is located at the connection between the Brownsboro Road Trunk Sewer and the NSTS, which is at the upstream end of the NSTS. Although the Brownsboro Road Trunk Sewer is a combined sewer, it also receives significant flows from upstream separately sewered areas. The sewer is over 10' in diameter and has a wet weather capacity well above the capacity of the NSTS.

CSO NO.	132
CSO Name.	Reg. No. 35- Brownsboro
Location	Brownsboro and Drescher B
Receiving Stream	MudF BGC
2003 AAOV (MG/YR)	117.66
Overflow Frequency (NO/YR)	64
Avg. Overflow Duration (HRS)	6.62
Percentage of Entire System(AAOV)	3.36%

CSO 167 is located on a 24" sewer flowing north from Brownsboro Road. Dry weather flows from this sewer enter the Brownsboro Road Trunk upstream of CSO 132, while overflows top a dam and continue through the same 9'-0" and 8'-6" sewer as overflows from CSO 132 to the Edward's Pond Branch of the Muddy Fork of Beargrass Creek. The limited capacity of the NSTS is the major factor influencing the two overflows discharging to the Edward's Pond Branch of the Muddy Fork of Beargrass Creek. CSO control options for these two CSOs need to be evaluated together due to the fact that they are located side by side with a common discharge pipe.

CSO NO.	167
CSO Name.	Brownsboro Lat No.2
Location	Brownsboro & Drescher B.
Receiving Stream	MudF BGC
2003 AAOV (MG/YR)	0
Overflow Frequency (NO/YR)	0
Avg. Overflow Duration (HRS)	0
Percentage of Entire System(AAOV)	0.00%

CSO 154 is located on the 48" circular concrete Mellwood Avenue Sewer flowing southwest on Mellwood Avenue. A 3'-10-1/2" high concrete dam diverts low flows into a side outlet 12" and/or 15" sewer tributary to the NSTS. Overflows continue through the 48" concrete sewer and combine with the overflows in the 8' 6" Brownsboro Road Trunk Sewer from CSO 132 just prior to discharging into Edward's Pond Branch and subsequently into the Muddy Fork of Beargrass Creek.

CSO NO.	154
CSO Name.	Mellwood @ Schoeffel
Location	Mellwood @ Edward Pond
Receiving Stream	MudF BGC
2003 AAOV (MG/YR)	1.53
Overflow Frequency (NO/YR)	12
Avg. Overflow Duration (HRS)	1.33
Percentage of Entire System(AAOV)	0.04%

2.2.3 Ohio River North Region Overview (formerly Region 2)

The Ohio River Interceptor (ORI) and Central Relief Drain (CRD) service areas are designated as the Ohio River North Region since they are downstream of the Robert J. Starkey Pumping Plant and overflow into the Ohio River. See Figure 2-13. The collection and conveyance networks in this Region are relatively small with limitations in wet weather capacity. The ORI conveys flows to the Main Diversion Structure (CSO 211) near the MFWTP from the Robert J. Starkey Pumping Plant, 4th Street and 34th Street Pump Stations, as well as gravity systems generally serving the areas along the south shore of the Ohio River. Forty-nine (49) individual overflow relief structures are widely scattered throughout the two service areas.

2.2.3.1 Ohio River North Region Major Interceptors/ Relief Sewer and Drains

The major interceptors and relief sewer and drains in the Ohio River North Region included as part of the combined sewer overflow study were designed to route sanitary flow and allotted quantities of diluting stormwater to the MFWTP for treatment and final discharge to the Ohio River. A description of the combined sewer system within the Beargrass Creek Region is presented below.

- **Ohio River Interceptor**

  In the mid-1950s, the State ordered the Metropolitan Sewer District to provide primary wastewater treatment and eliminate the discharge of raw sewage into the Ohio River. As a result, the Ohio River Interceptor (ORI) and three major pump stations were constructed to collect flow from eastern, central, and northwestern portions of the system and convey it to the MFWTP. Until that time, numerous individual sewers located in the north central section of the city discharged directly into the river. The design and construction of the Ohio River Interceptor enabled these lines to be intercepted and the sewage to flow by gravity to the treatment plant. In addition, the Robert J. Starkey, 4th Street, and 34th Street Pump Stations, which were constructed by the Corps of Engineers as part of the city's flood control system, were also designed to be utilized as sanitary pumping facilities during non-flood periods. The Ohio River Interceptor, Western Interceptor, and Southern Outfall join south of 45th Street and Winnrose Way at the Main Diversion Structure located on the Whayne Supply Company property.

  The ORI enters the diversion structure as an 8'-0" circular sewer and exits as an 11'-0" semi-elliptical sewer flowing to the MFWTP. The ORI passes under the Southern Outfall in a siphon type arrangement but is open on the top, on each side of the Southern Outfall, within the diversion structure. The Southern Outfall is also open on the top within the structure. The ORI is routinely backfilled by the Southern Outfall during wet weather. Because the ORI is lower, water surface elevations equalize in both sewers resulting in some storage being provided before an overflow occurs.

  Between the MFWTP and the Main Diversion Structure, the Ohio River Interceptor is an 11'-0" semi-elliptical sewer with a slope of 0.03%. The estimated full capacity of the line in this reach is about 250 MGD. Upstream of the main diversion structure, the interceptor varies in size, shape, and grade throughout its length. At its outlet end, the 8'-0" circular pipe on a slope of 0.08% has an estimated full flow capacity of 155 MGD. Typical daily flow is about 45 MGD.

- **38th Street Branch Interceptor**

  The 34th Street Pump Station serves the northwestern portion of the city from about 12th Street westward to the Ohio River. The flow from the station discharges into the 38th

Street Branch Interceptor at 35th Street and Northwestern Parkway. The 38th Street Branch Interceptor in turn conveys the flow southward in 38th Street to the Ohio River Interceptor at 38th and Herman Streets. The 38th Street Sewer parallels the branch interceptor along 38th Street but continues one block further south before discharging into the Northwestern Interceptor.

The 38th Street Branch Interceptor is circular in shape and varies in size and grade from a 36" sewer with a 0.15% slope at its outlet end to a 30" sewer with a 0.39% slope at its upstream terminus. Estimated full flow capacities range between 16.6 MGD and 17.2 MGD, respectively.

- **Central Relief Drain**

  In the mid to late 1930s, in response to flooding in the central business district from overtaxed combined sewers, the Central Relief Drain (CRD) was constructed. This drain was designed to only receive flow during wet weather and relieves the combined sewers in the central part of the city at fourteen locations. At each location, a side overflow weir was constructed on the sewer being relieved. When flow in the combined sewer reaches the level of the weir, a portion of the flow is relieved into the CRD and transported to the Ohio River. The remaining flow continues through the combined sewer to its destination. Around 1950, the CRD was extended south and relief was provided at thirteen additional locations. Any flow that enters the CRD must be discharged to the river.

  The CRD is protected by a flood control gate that is closed when the upper pool of the Ohio River reaches elevation 439.0. When this gate is closed all flow in the CRD is diverted to the fifth street Flood Pump Station and discharged to the river. Near its outlet end, the 6'-5" x 9'-7-1/2" inverted egg-shaped drain line with a slope of 0.335% has an estimated full flow capacity of 305 MGD.

- **4th Street Relief Sewer**

  The 4th Street Relief Sewer was designed and constructed to relieve sewers in the central business district that were being surcharged during periods of dry weather. For this reason, at each relief point, all flow in the combined sewers was diverted into the relief sewer. The relief sewer originally discharged flow into the Ohio River at the foot of 4th Street. The 4th Street Pump Station was built in conjunction with the Ohio River Interceptor when the treatment facilities were built. A dam was constructed across the relief sewer to divert dry weather flow into the pump station. The pump station discharges into the Ohio River Interceptor. Excess flow during wet weather tops the dam and continues through the relief sewer to the river. The majority of the 4th Street Relief Sewer was constructed in a tunnel and is of such depth that the crown of the sewer is below the basement level of most of the adjacent buildings. Just upstream of the pump station, the 7'-6" semi-elliptical relief sewer with a slope of 0.20% has an estimated full flow capacity of 215 MGD.

2.2.3.2 Ohio River North Major Pump Stations

- **4th Street Pump Station - Combination Sanitary/Flood Protection Stations**

  The 4th Street Pump Station, located on the southeast corner of 4th and Main Streets, was constructed by the USACE in the 1950s as part of Louisville's flood control system and also functions as a wastewater pumping facility. It is one of 16 flood pumping stations operated and maintained by the MSD. During non-flood conditions the flow in the 4th Street Relief Sewer is diverted into the pump station and discharged to the Ohio River

Interceptor. Per the USACE operational manual, during flood periods, the pump station can discharge into the Ohio River Interceptor or the Ohio River, depending on flow.

The 4th Street Relief Sewer was built in the late 1920s to relieve overloaded sewers along 4th Street, Muhammad Ali Boulevard, Chestnut Street and Broadway. The relief sewer was designed to relieve all flows in the overloaded sewers, not just excess flows. Therefore, sanitary flow is present in the relief sewer continuously. A plan view of the pump station, sewers, diversions and gates is presented in Figure 2-14.

The 4th Street Pump Station contains a sanitary wetwell, a flood wetwell and six pumps (three sanitary pumps and three flood pumps). The sanitary pumps can also be used as flood pumps. There are two 35 HP sanitary pumps rated at 4,000 GPM at 25' of head and one 60 HP sanitary pump rated at 5,900 GPM at 35.7' of head. The sanitary pumps discharge into a common header which leads to either the Ohio River Interceptor or the flood pump discharge chamber. Fourth Street has three 350 HP stormwater pumps with a total station capacity of 95,400 GPM.

The 4th Street Pumping Station is the ninth station to go on line should flooding occur on the Ohio River. This facility is not placed in flood operation mode until the river elevation exceeds elevation 436.3. This facility is expected to operate as a flood pumping facility about once every 5 years on average.

- **34th Street Pump Station - Combination Sanitary/Flood Protection Stations**

The 34th Street Pump Station, which is located just south of the levee on 34th Street, was constructed by the USACE in the 1950s as part of Louisville's flood control system and also functions as a wastewater pumping facility. It is one of 16 flood pumping stations operated and maintained by the MSD. The station conveys flow from the northern portion of the City to the Ohio River Interceptor or to the lower pool of the Ohio River, depending on flow and river elevation. A plan of the pump station, sewers, diversions and gates is presented in Figure 2-15.

A diversion dam on the sewer flowing north on 34th Street diverts low flows through a 24" sewer into the pump station. The pump station discharges to the 38th Street Branch Interceptor that conveys the flow to the Ohio River Interceptor at 38th Street and Herman Street. The diversion dam is designated as CSO 019. Excess flow tops the dam and is discharged through the sewer to the lower pool of the Ohio River. When the river stage exceeds elevation 421.00, the pump station is shut down and backwater and sewage is allowed to pond in the sewer system.

The pump station contains two sanitary pumps rated at 4,250 GPM each at 31.5' of head and four storm pumps rated at 15,600 GPM each at 34' of head. The sanitary pumps can also be used for flood pumping.

The 34th Street Pumping station is the thirteenth station to go on line should flooding occur on the Ohio River. This facility is not placed in flood operation mode until river elevation exceeds 434.6. This facility is expected to operate as a flood pumping facility about once every 5 years on average.

- **5th Street Pumping Station - Flood Protection**

The 5th Street Pumping station, which is located at 100 Place Montpelier, north of Main street adjacent to the floodwall, was constructed by the USACE in the 1950s as part of Louisville's flood control system. It is one of 16 flood pumping stations operated and maintained by the MSD. This facility is equipped with three 50 HP pumps and one 25 HP pump providing a total capacity of approximately 37,000 GPM at minimum design head.

The minimum water level elevation in the wet well is 426.75 based on the smaller pump and 437.00 for the larger pumps. The maximum design pumping elevation is 440.00.

The 5th Street Pumping Station is the seventh station to go on line should flooding occur on the Ohio River. This facility is not placed in operation until the river elevation exceeds 434.3. Above this level, the facility is used to pump excess combined flows from the sewers in 5th, 6th, and 7th Streets and storm flows accumulated between Main Street and the floodwall to the river. Normal flows in these sewers, up to the capacities of their appropriate diversion structures, are conveyed to the Ohio River Interceptor. This facility is placed in operation about once every five year on average.

- **10th Street Pumping Station - Flood Protection**

The 10th Street Pumping Station, which is located on the southwest corner of 10th and Rowan Streets, was constructed by the USACE in the 1950s as part of Louisville's flood control system. It is one of 16 flood pumping stations operated and maintained by the MSD. This facility utilizes three 200 HP pumps and one 25 HP unit to achieve a total capacity of approximately 90,000 GPM at minimum design head. The minimum water level elevation in the wet well is 420.50 based on the smaller pump and 427.70 for the larger pumps. The maximum design pumping elevation is 432.10.

The 10th Street Pumping Station is the eighth station to go on line should flooding occur on the Ohio River. This facility is not placed in operation until the river elevation exceeds 434.6. At various stages above this level, the facility is used to pump excess combined flows from the sewer in 8th, 9th, 10th, 11th, 12th, and 13th Streets and storm flows accumulated between Main Street and the floodwall to the river. At upper gauge elevation 439.00, flow in the Central Relief Drain is diverted to the pumping station. Normal flows in the numerous tributary sewers in 8th through 13th Streets, up to the capacities of their appropriate diversion structures, are conveyed to the Ohio River Interceptor. This facility is placed in operation about once every five years on average.

- **17th Street Pumping Station - Flood Protection**

The 17th Street Pumping Station, which is located at the beginning of 17th Street north of Northwestern Parkway and adjacent to the floodwall, was constructed by the USACE in the 1950s as part of Louisville's flood control system. It is one of 16 flood pumping stations operated and maintained by the MSD. The facility is equipped with three 75 HP pumps and one 15 HP pump providing a total capacity of approximately 496.0 GPM at minimum design head. The minimum water level elevation in the wet well is 427.25 based on the smaller pump and 433.00 for the larger pumps. The maximum design pumping elevation is 438.20.

The 17th Street Pumping Station is the eleventh station to go on line should flooding occur on the Ohio River. This facility is not placed in operation until the river elevation exceeds 437.5. Below this level, normal flow in the sewer in 17th Street is conveyed to the 34th Street Pump Station and discharged into the Ohio River Interceptor. High flows top the diversion dam in Northwestern Parkway just upstream of the 17th Street station and are discharged by gravity directly into the river. Above river elevation 437.5 on the upper gauge, combined flows in the sewer in 17th Street are routed to the 17th Street facility and pumped into the river. This facility is placed in operation about once every five to ten years on average.

- **27th Street Pumping Station - Flood Protection**

  The 27th Street Pumping Station, which is located at 27th Street and the floodwall, was constructed by the USACE in the 1950s as part of Louisville's flood control system. It is one of 16 flood pumping stations operated and maintained by the MSD. The facility utilizes four 350 HP pumps and one 60 HP unit to achieve a total capacity of approximately 198,150 GPM at minimum design head. The minimum water level elevation in the wet well is 419.25 based on the smaller pump and 428.20 for the larger pumps. The maximum design pumping elevation is 433.20.

  The 27th Street Pumping Station is the tenth station to go on line should flooding occurs on the Ohio River. The 27th Street Pumping Station is not placed in operation until the river elevation exceeds 436.8. Below Ohio River elevation 427.5, normal flows in the sewer in 22nd and 27th Streets are conveyed around the 27th Street facility to the 34th Street Pump Station and discharged into the Ohio River Interceptor. High flows overflow the diversion dam just upstream of the 34th Street station and are discharged by gravity directly into the river. Between upper gauge elevations 427.5 and 436.8, normal flows are handled in the same manner prescribed above, but a portion of the high flows is diverted by gravity directly into the Portland Canal instead of traveling all the way to 34th Street. Above river elevation 436.8 on the upper gauge, combined flows in the sewers in 22nd and 27th Streets are routed to the 27th Street Pumping Station and pumped into the river. This facility is placed in operation about once every 5 to 10 years on average.

2.2.3.3 Ohio River North Combined Sewer Overflows (18 CSOs)

The following is a list of CSOs located within the Ohio River North Region.

CSO 019 - 34th Street Pump Station
CSO 022 - 4th Street Pump Station
CSO 023 - 4th Street Overflow Weir
CSO 050 - 12th Street Overflow
CSO 051 - 11th Street Overflow
CSO 052 - 10th Street Overflow
CSO 054 - 7th Street Overflow
CSO 055 - 6th Street Overflow
CSO 056 - 5th Street Overflow
CSO 057 - 1st Street Overflow Weir
CSO 058 - Preston Street Overflow Weir
CSO 155 - Rowan Street - Sanitary Diversion at 12th Street
CSO 156 - 6th Street and Washington Sanitary Diversion
CSO 160 - East Side of 1st Street, North of Market Street
CSO 161 - Sanitary Diversion West of 1st Street
CSO 190 - 17th Street Sanitary Diversion

CSO 207 - 2nd Street and Jefferson
CSO 208 - 12th Street and Jefferson
CSO 172 - Adams Street
CSO 062 - Northeastern Trunk at Logan Company

Central Relief Drain (28 CSOs)

CSO 026 - Weir at 6th Street and Broadway
CSO 027 - Weir at 7th Street and Broadway
CSO 028 - Weir at 6th Street and York Street
CSO 029 - Weir at 8th Street and York Street
CSO 030 - Weir "A" at 9th Street and York Street
CSO 031 - Weir at 6th Street and Breckenridge Street
CSO 032 - Weir at 4th Street and Breckenridge Street
CSO 033 - Weir on York Street East of 4th Street
CSO 034 - Weir at 4th Street and York Street
CSO 035 - Weir at 2nd Street and Broadway No. 1
CSO 036 - Weir at 3rd Street and Broadway
CSO 038 - Weir at 5th Street and Broadway
CSO 053 - 8th Street Overflow
CSO 150 - 8th Street Sanitary Overflow
CSO 178 - Weir "B" at 9th Street and York Street
CSO 181 - Weir at 2nd and Broadway No. 2
CSO 192 - South Weir at 6th Street and Garland Avenue
CSO 193 - South Weir 6th Street and Kentucky Street
CSO 194 - South Weir at Oak Street West of 4th Street
CSO 195 - South Weir at 4th Street and Oak Street
CSO 196 - South Weir at 3rd Street and Oak Street
CSO 197 - South Weir at 3rd Street South of Oak Street
CSO 198 - South Weir at 3rd Street and Ormsby Street
CSO 199 - South Weir at 3rd Street North of Magnolia Avenue
CSO 200 - South Weir at 3rd Street and Magnolia Avenue
CSO 201 - South Weir at 5th Street and Kentucky Street
CSO 202 - South Weir at Ormsby Street West of 3rd Street
CSO 203 - South Weir at 4th Street and Ormsby Street

CSO 019 is located on an 11'-6" sewer near the 34th Street Pump Station. The overflow is located at a 2'-6" high diversion dam on the 11'-6" sewer flowing north on 34th Street. Low flows are directed through a 24" side outlet to the 34th Street Pump Station. The pump station discharges through a 24" force main to the 38th Street Branch Interceptor. Overflows top the dam and continue through the 11'-6" sewer through the flood wall and gate chamber to the river. At present, a large volume of direct runoff enters the CSS in this subcatchment. In addition, this overflow site serves as a relief point for the Ohio River Interceptor for flows that exceed the capacity of the ORI. As a result, the annual overflow volume from this CSO exceeds the total direct runoff generated within its own subcatchment area by 25%.

CSO NO.	019
CSO Name.	Miles Park Bypass
Location	South of 45th & Winnrose
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	95.45
Overflow Frequency (NO/YR)	49
Avg. Overflow Duration (HRS)	5.02
Percentage of Entire System(AAOV)	2.73%

CSO 022 is located on the 4th Street Relief Sewer in the immediate vicinity of the 4th Street Pump Station. Base flows in the 7'-6" 4th Street Relief Sewer are diverted into the 4th Street Pump Station through a 30" influent sewer. The pumps lift the influent flows to the ORI. Flows in excess of the pump station capacity discharge over a small dam located just downstream of the 30" sewer. Overflows at CSO 022 combine with overflows from CSO 023 (see below) and discharge to the Ohio River. Four different gates exist near this structure to control the direction and method of flow diversion, dependent on hydraulic conditions:

- A normally open 30" circular gate can be closed to isolate the pump station from the 4th Street Relief Sewer,
- A normally open 60" x 72" rectangular gate can be closed to prevent overflow from CSO 023 from entering the Relief Sewer,
- A normally open 96" x 96" rectangular gate on the ORI can be closed to divert flows in the ORI to the Relief Sewer, and
- A normally open 84" x 84" rectangular gate on the 4th Street Relief Sewer downstream of both CSOs 022 and 023 can be closed to isolate the Relief Sewer from the Ohio River.

In August 1994, this dam was raised approximately 2' as part of a NMC measure to increase the retention of wet weather flows from this catchment area.

CSO NO.	022
CSO Name.	4th ST. PS
Location	Fourth & Main
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	7.45
Overflow Frequency (NO/YR)	13
Avg. Overflow Duration (HRS)	1.15
Percentage of Entire System(AAOV)	0.21%

CSO 023 is located on the Ohio River Interceptor at the 4th Street Pump Station. The overflow weir is 13'-6" in length and is parallel to the direction of flow. The weir is to the side of the Ohio River Interceptor. The ORI widens over a distance of about 60' to accommodate this weir. Overflows drop through a series of baffles to the 4th Street Relief Sewer, downstream of CSO 022. Sluice gates on the Ohio River Interceptor can be operated to reduce the load on the MFWTP during flood conditions. When the gates are closed, the flow in the ORI is diverted to the pump station and subsequently discharged to the river. Although no direct runoff is associated with this subcatchment, an average annual overflow volume of about 0.85 MG/YR occurs here as a result of high flow levels in the ORI.

CSO NO.	023
CSO Name.	ORI @ 4th St. PS
Location	Fourth & Main
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0.85
Overflow Frequency (NO/YR)	3
Avg. Overflow Duration (HRS)	1.33
Percentage of Entire System(AAOV)	0.02%

CSO 050 is located on 12th Street between Main and Rowan Streets. The overflow is located on a 3'-8" x 5'-6" brick egg-shaped sewer flowing north on 12th Street. A dam diverts low flows through vertically installed rack bars and a 15" side outlet sewer east and then south on 12th Street to the Ohio River Interceptor. Overflows top the dam and enter an 84" storm sewer flowing north on 12th Street to the Ohio River. The Ohio River Interceptor is a 7'-6" semi-elliptical sewer at this point. In February 1998, a CDS unit was installed for the solids and floatables control.

CSO NO.	050
CSO Name.	12th STREET
Location	12th St. N of Main
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	7.09
Overflow Frequency (NO/YR)	34
Avg. Overflow Duration (HRS)	4.23
Percentage of Entire System(AAOV)	0.20%

CSO 051 is located on 11th Street just north of Main Street. The overflow structure is located on a 24" sewer flowing north on 11th Street. A diversion dam diverts low flows through an 8" side outlet sewer west to a drop inlet manhole and then through a 10" sewer south on 11th Street to the Ohio River Interceptor. Overflows top the dam and continue through the 24" sewer north on 11th Street and then east on Rowan Street to the Ohio River. The Ohio River Interceptor is a 7'-0" semi-elliptical sewer at this point. In June 1994, this dam was raised 6" as part of a NMC measure to increase the retention of wet weather flows from this catchment area.

CSO NO.	51
CSO Name.	11th STREET
Location	11th Street N of Main
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0.36
Overflow Frequency (NO/YR)	9
Avg. Overflow Duration (HRS)	1.11
Percentage of Entire System(AAOV)	0.01%

CSO 052 is located on a 48" sewer on 10th Street just north of Main Street. A diversion dam diverts low flows through a 10" drop inlet east and then south on 10th Street to the Ohio River Interceptor. Overflows top the dam and continue north on 10th Street through the 48" sewer to the Ohio River. The Ohio River Interceptor is a 7'-0" semi-elliptical sewer at this point.

CSO NO.	52
CSO Name.	10th STREET
Location	10th Street N of Main
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0.52
Overflow Frequency (NO/YR)	8
Avg. Overflow Duration (HRS)	1.25
Percentage of Entire System(AAOV)	0.01%

CSO 054 is located on 7th Street between Main and Washington Streets. A diversion dam diverts low flows through an 8" side outlet sewer and 8" stack into a 12" sewer and then a 10" sewer flowing south on 7th Street to the Ohio River Interceptor. Overflows top the dam and continue north on 7th Street through a 30" sewer then west to 6th Street to a 36" sewer and thence north to the Ohio River. The Ohio River Interceptor is a 7'-0" semi-elliptical sewer at this point. COPA Cyclone was installed for the solids and floatables control.

CSO NO.	54
CSO Name.	7th STREET
Location	7th St. N of Main
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0.96
Overflow Frequency (NO/YR)	18
Avg. Overflow Duration (HRS)	2.38
Percentage of Entire System(AAOV)	0.03%

CSO 055 is located on a 48" sewer flowing north on 6th Street. A diversion dam diverts low flows through a 12" side outlet sewer east and then south on 6th Street through a 15" sewer to the Ohio River Interceptor. Overflows top the dam and continue north on 6th Street through a 48" sewer and then a 36" sewer to the Ohio River. The Ohio River Interceptor is a 7'-0" semi-elliptical sewer at this point.

CSO NO.	55
CSO Name.	6th STREET
Location	6th St. N of Main
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	2.8
Overflow Frequency (NO/YR)	18
Avg. Overflow Duration (HRS)	1.33
Percentage of Entire System(AAOV)	0.08%

CSO 056 is located on a 3'-6" x 5'-3" egg-shaped sewer flowing north on 5th Street. A diversion dam diverts low flows through vertically installed rack bars and a 12" side outlet sewer east to a drop manhole and then south through a 12" sewer to the Ohio River Interceptor. Overflows top the dam and continue north through a 36" sewer to the Ohio River. The 12" sewer enters the Ohio River Interceptor. The Ohio River Interceptor is a 7'-0" semi-elliptical sewer at this point.

CSO NO.	56
CSO Name.	5th STREET
Location	5th St N of Main
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	4.6
Overflow Frequency (NO/YR)	33
Avg. Overflow Duration (HRS)	2.93
Percentage of Entire System(AAOV)	0.13%

CSO 057 connects the ORI and a 72" storm sewer flowing north on 1st Street. A 42" circular sewer is connected to the ORI at a junction structure at 1st and Main Streets. The 42" sewer is connected to the 72" storm sewer at a manhole. The ORI is an 8'-6" semi-elliptical sewer at this point, and the invert of the overflow point is approximately equal to the crown elevation of the ORI. If the ORI were to become surcharged, the overflow would exit "upgrade" through the 42" sewer and overflow into the 72" storm sewer which outlets to the river. This is a very infrequent occurrence due to the presence of a relief point at CSO 023, located at the 4th Street Pump Station. A sluice gate on the 72" sewer downstream of the overflow manhole prevents high river levels from backflowing into the storm sewer. This gate is closed at upper gauge 41.0, or elevation 448.50. When the gate is closed, the flow in the storm sewer surcharges and exits through the 42" connection to the ORI. Although the opportunity for an overflow from the ORI exists at this structure, it is believed to be a rare occurrence. Rather, the structure is more likely used in times of high river elevations as a relief point for the storm sewer. There is no direct runoff is associated with this CSO and no average annual overflow volume is predicted by the CSO model.

CSO NO.	57
CSO Name.	FIRST STREET OVFL WEIR
Location	1st & Main
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0
Overflow Frequency (NO/YR)	0
Avg. Overflow Duration (HRS)	0
Percentage of Entire System(AAOV)	0.00%

CSO 058 is an overflow weir 8'-0" in length located to the side of the Ohio River Interceptor parallel to the direction of flow. The ORI widens over a distance of about 36' to accommodate this weir. Overflows at the weir discharge into a 3'-8" x 5'-6" egg-shaped sewer flowing north on Preston Street to the Ohio River. A 48" sewer south of Main and flowing north on Preston Street enters the ORI downstream of the weir.

CSO NO.	58
CSO Name.	Preston St. OVFL Weir
Location	Preston & Main
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	5.26
Overflow Frequency (NO/YR)	22
Avg. Overflow Duration (HRS)	2.36
Percentage of Entire System(AAOV)	0.15%

CSO 155 is located on an 18" sewer flowing east on Rowan Street. A 4" high dam diverts low flows into an 8" side outlet sewer. The flow in the 8" sewer travels eastward across the intersection of 12th and Rowan Streets then turns south on 12th Street and combines with the diverted low flow from CSO 50 prior to entering the Ohio River Interceptor through a 15" sewer. Overflows top the dam and continue through the 18" sewer on Rowan Street and drop into an 84" storm sewer flowing north on 12th Street to the Ohio River. A sluice gate on the 84" storm sewer just downstream of the overflow connection isolates the sewer system from the river during specific flood conditions. The depth of the 84" sewer is such that it stays about 85% full up to a drop manhole at Main Street when the river is at normal pool elevation of 420.0. In June 1994, this dam was raised 5" as part of NMC measures to increase the retention of wet weather flows from this catchment area.

CSO NO.	155
CSO Name.	Rowan St. @ 12th Street
Location	Rowan & 12th
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0.07
Overflow Frequency (NO/YR)	4
Avg. Overflow Duration (HRS)	1.25
Percentage of Entire System(AAOV)	0.00%

CSO 156 is located on a 12" sewer flowing east on Washington Street. A 4" high concrete dam diverts low flows into a 6" side outlet sewer. The flow in the 6" sewer enters a 12" sewer flowing west on Washington Street then turns south on 7th Street and combines with the diverted flow from CSO 054 prior to entering the Ohio River Interceptor through a 12" and 10" sewer. Overflows top the dam and continue through the 12" sewer on Washington Street and discharge into a 48" reinforced concrete sewer flowing north on 6th Street. At a junction structure just downstream of the overflow connection, the 48" sewer becomes a 36" sewer continuing north on 6th Street to the Ohio River. In addition, a side outlet 36" sewer with a normally closed sluice gate exits the junction manhole and continues east to the 5th Street Pumping Station. A sluice gate on the 36" sewer downstream of the junction structure isolates the sewer system from the river during specific flood conditions. When this gate is closed the other gate is opened and the flow is diverted to the 5th Street Pumping Station. No direct runoff is associated with this site.

CSO NO.	156
CSO Name.	6th & Washington San Div.
Location	Washington West of 6th St.
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0
Overflow Frequency (NO/YR)	0
Avg. Overflow Duration (HRS)	0
Percentage of Entire System(AAOV)	0.00%

CSO 160 is located on the east side of 1st Street north of Market Street. A 7" high concrete dam diverts low flows into a 6" side outlet sewer, which exits the overflow manhole to the north and then turns 90 degrees to the west. It discharges through a 6" stack into a 30" sanitary sewer conveying flow north on 1st Street. Overflows top the dam and continue through the 15" sewer and drop through a 12" stack into a 72" storm sewer flowing north on 1st Street.

CSO NO.	160
CSO Name.	Sewer in Alley San Div.
Location	1st St. BTW Main & Market
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0.22
Overflow Frequency (NO/YR)	22
Avg. Overflow Duration (HRS)	1.45
Percentage of Entire System(AAOV)	0.00%

CSO 161 is located on a 12" sewer flowing east on Market Street at the intersection of 1st and Market Streets. A 9-1/2" high concrete dam diverts low flows into an 8" side outlet sewer. The 8" sewer discharges into a 30" sewer flowing north on 1st Street through a 12" drop inlet. Overflows top the dam and continue through a 27" sewer to an 18" stack and drop into a 66" storm sewer flowing north on 1st Street. The storm sewer becomes a 72" sewer just downstream of the stack and flows north to the Ohio River.

CSO NO.	161
CSO Name.	Market St. San Div.
Location	First & Market
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0.19
Overflow Frequency (NO/YR)	16
Avg. Overflow Duration (HRS)	2.31
Percentage of Entire System(AAOV)	0.01%

CSO 190 is located on the 3'-8" x 5'-6" egg-shaped sewer flowing northeast on 17th Street. A 5'-6" long dam is built across the structure and diverts low flows through a 24" side outlet sewer set at the invert of the structure. The 3'-8" x 5'-6" egg-shaped sewer continues north to the 17th Street Pump Station and the Ohio River. The 24" sewer flows northwest on Northwestern Parkway and ultimately discharges to the 34th Street Pump Station. A 24" shear gate is mounted on the 24" outlet sewer.

CSO NO.	190
CSO Name.	Seventeenth St. San Div.
Location	17th St. & NW PKWY
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	10.57
Overflow Frequency (NO/YR)	36
Avg. Overflow Duration (HRS)	3.52
Percentage of Entire System(AAOV)	0.30%

CSO 207 is located on a 24" circular brick sewer at Second Street and Jefferson Street. A 9" high dam diverts low flows contained in the sewer into an 8" side outlet, which discharges through an 8" drop inlet into a 12" sanitary sewer. The 24" brick sewer, the 12" sanitary sewer, and the 27" circular storm sewer all flow east on Jefferson Street. Overflows topping the dam discharge into a 27" storm sewer. The 27" storm sewer empties into a main 60" storm sewer on First Street, which discharges directly to the river. A sluice gate is on this sewer at First Street and Main Street.

CSO NO.	207
CSO Name.	2nd & Jefferson
Location	2nd & Jefferson
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0
Overflow Frequency (NO/YR)	0
Avg. Overflow Duration (HRS)	0
Percentage of Entire System(AAOV)	0.00%

CSO 208 is located on a 24" circular storm sewer flowing north on 12th Street at Jefferson Street. Several combined sewers are connected to this storm sewer. An 11" dam diverts low flows through a 12" sanitary sewer flowing north on 12th Street. Overflows topping the dam continue through the 24" sewer to a 78" sewer. From Jefferson and Twelfth Streets, the 78" storm sewer discharges northward into the river. When a sluice gate on this sewer is closed at upper gauge 27.8, flow is diverted to the 10th Street Pump Station and pumped into the river.

CSO NO.	208
CSO Name.	12th & Jefferson
Location	12th & Jefferson
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0.22
Overflow Frequency (NO/YR)	22
Avg. Overflow Duration (HRS)	1.45
Percentage of Entire System(AAOV)	0.00%

CSO 062 is located on the NSTS near the Robert J. Starkey Pumping Plant. An overflow weir with a crest elevation of 423.20 on the NSTS diverts flows into a 54" semi-elliptical sewer south to the Robert J. Starkey Pumping Plant. Overflows top the weir and continue west and then north through the NSTS to the Ohio River. The overflow sewer joins the overflow sewer from CSO 020 about 650' downstream of the overflow structure. This point is the junction of the NSTS and the Beargrass Creek Interceptor.

CSO NO.	062
CSO Name.	Logan Company
Location	N of Buchanan PS
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	48.42
Overflow Frequency (NO/YR)	47
Avg. Overflow Duration (HRS)	9.74
Percentage of Entire System(AAOV)	1.38%

CSO 172 is located on a combined sewer tributary to the Northeastern Storm Drain. This combined sewer drains a short section of River Road from near the Big Four Bridge, east to around Fulton Street.

CSO NO.	172
CSO Name.	Adam Street
Location	Adam Street & I-64
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0.17
Overflow Frequency (NO/YR)	14
Avg. Overflow Duration (HRS)	1.21
Percentage of Entire System(AAOV)	0.00%

2.2.4 Ohio River West Region Overview (formerly Region 3)

In the Ohio River West Region, the conveyance systems consist of much larger interceptors and trunk sewers than exist in either of the Beargrass Creek or Ohio River North Regions. Major sewers and service areas in Ohio River West Region include the Northwestern Interceptor (NWI), Western Interceptor, Western Outfall (WO), Southern Outfall (SO), and the Southwestern Outfall (SWO). See Figure 2-16. With the exception of the Western Interceptor, the conveyance capacities of these facilities are generally much larger than the capacity required for dry weather flow only, since they must also convey storm flows from small and large events. Taken together, the NWI, WO, SO, and SWO service areas can nearly contain wet weather flows from storms of 0.10 in./hr or less in intensity. Considerable overflow can occur for storms having greater intensities. Eight (8) CSO locations exist in this western part of the MSD service area, all of which are located near the most downstream ends of the conveyance systems in each area.

2.2.4.1 Ohio River West Region Major Interceptors

- Northwestern Interceptor and Western Interceptor

  The Northwestern Interceptor and Western Outfall were constructed around 1911 and 1870, respectively, and both at one time discharged directly into the lower pool of the Ohio River around Shawnee Park. In the early part of the 1900s, this area was extensively used by park visitors and patrons of a nearby amusement park. The direct discharges

from the Western Outfall produced some offensive conditions during periods of low water. Thus, the Western Interceptor was constructed in conjunction with the Northwestern Interceptor. The Western Interceptor was designed to intercept the dry weather flow in both the Northwestern Interceptor and the Western Outfall and convey it to the Southern Outfall, which then were discharged downstream of Shawnee Park and the amusement park.

When the treatment facilities at Morris Forman were constructed, the Western Interceptor was redirected into the Ohio River Interceptor just upstream of the CSO 211. Today, a CSO remains on the Western Interceptor at that point of redirection. Excess flow continues through the Western Interceptor to the Southern Outfall downstream of the CSO 211.

Between its outlet end and Broadway, the Western Interceptor is a 5'-0" circular sewer with a slope of .055% and provides an estimated full flow capacity of 36.8 MGD. At Broadway, the interceptor becomes a 3'-6" circular sewer on the same grade and remains as such until it terminates at its junction with the Northwestern Interceptor. The estimated full flow capacity of the smaller section is reduced to approximately 14.4 MGD. Peak wet weather flow in the Western Interceptor has been measured at up to 20 MGD.

- **Western Outfall**

The Western Outfall drains the area along Broadway from the Ohio River east to about 12th Street, encompassing about 1800 acres. Dry weather flow from the Western Outfall is directed into the Western Interceptor just south of Shawnee Park in Broadway. Excess flows top an overflow diversion dam and continue through the Outfall to the river. When the lower gauge reaches elevation 435.0, a flood control gate on the Outfall is closed and any excess flow is directed into the Shawnee Park Flood Pumping Station and is pumped to the river.

The eastern portion of the Western Outfall service area, notably that area located along Maple Street, has surcharged several times in recent years, flooding vehicles and yards with combined sewage. This low lying area is especially susceptible to flooding from sewer surcharges. Although the Western Outfall is relatively large in diameter, its flat slope results in insufficient capacity to convey all flows during high intensity storm events. The result is basement backups, sewer surcharging, and/or surface flooding during heavy rains. Surface flooding has occurred all along this sewer since as far back as 1910.

The segment of the Western Outfall in Broadway between Southwestern Parkway and 28th Street is a 10'-6" diameter circular brick sewer which was constructed circa 1873. Just west of the Southwestern Parkway, the sewer becomes 11'-9" in diameter. Based on plans developed during the underground sewer investigations of 1937, the outfall line has an estimated grade of 0.052% providing a full flow capacity of approximately 355 MGD upstream of the diversion dam. Peak wet weather flow in the Western Outfall has been measured at over 220 MGD at about two-thirds full. Typical daily flow is 3 or 4 MGD.

- **Southern Outfall**

The Southern Outfall serves a combined sewer area of about 3,500 acres and has an unsurcharged full flow capacity of about 765 MGD at its lower end. The Southern Outfall was constructed around 1912 and discharges to the lower pool of the Ohio River, just upstream of the treatment plant. Continued growth and development in the service area of the Southern Outfall has increased runoff to the extent that basement backups and surface flooding occur during intense storms.

When the diversion structure was built, a dam was constructed across the Southern Outfall to divert dry weather flow through a drop connection into the Ohio River Interceptor

to the MFWTP. High flows top the dam in the diversion structure and continue through the Southern Outfall to the river. Flood protection for the Southern Outfall is provided by the Western Parkway Flood Pumping Station. When the lower gauge of the river exceeds elevation 416.4, the flood control gates are closed and the pump station begins operation. Overflow from the diversion structure is then pumped to the river.

- **Southwestern Outfall**

The Southwestern Outfall serves the southwestern section of Louisville and through its branches, the south central portions of both the city and county. Flows collected in the south central area of the city basically north of the Watterson Expressway are routed via the Manning Road - Cardinal Drive Sewer and Upper Dry Run Trunk Sewer to a junction with the Southwestern Outfall at Taylor Boulevard and Oleanda Avenue. In a similar fashion, flows collected in the south central Louisville and Jefferson County south of the Watterson Expressway are conveyed through the Northern Ditch Trunk Interceptor and Mill Creek Trunk Sewer to the same junction point with the Southwestern Outfall at Taylor and Oleanda.

Flow in the Beargrass Interceptor Relief Sewer is discharged by the Nightingale Pump Station into the upstream end of the Manning Road - Cardinal Drive Sewer and thus enters the Southwestern system. In addition, other sewers normally tributary to the Beargrass Interceptor can be diverted behind the Bashford Manor Mall through the Southeastern Interceptor, Northern Ditch Trunk Interceptor, and Mill Creek Trunk Sewer to the Southwestern Outfall. This diversion can be accomplished manually and is limited by the capacity of the Northern Ditch Pump Station. The Southwestern Outfall is diverted near Bells Lane and Interstate 264 to the Southwestern Pump Station where the flow is pumped through the Southwestern Branch Interceptor to the MFWTP.

The Southwestern Outfall, constructed in the 1930s, drains a combined sewer area of about 7,700 acres. The expanse of the service area of the Southwestern Outfall dictated its large size, 18'-4" x 27'-6" at one point. This sewer is considered the outstanding accomplishment of the Commissioners of Sewerage. In both length and size it was one of the largest sewers built in the United States during that era. The Southwestern Outfall is an inverted egg-shaped sewer with varying width, height, and grade throughout its length. At the Southwestern Pump Station, the 18'-4" x 27'-6" line was constructed on a slope of 0.087% and provides an estimated capacity of 2,556 MGD flowing full.

Dry weather flow in the Southwestern Outfall is diverted by a 6' high dam into the Southwestern Pump Station and discharged through the Southwestern Branch Interceptor to MFWTP. For a majority of its length, the 6'-0" circular Southwestern Branch Interceptor was laid on a slope of 0.07% and provided an estimated full flow capacity of 74 MGD. The 104 MGD capacity of the pump station exceeds the maximum unsurcharged capacity of the Branch Interceptor.

Normal lower pool elevation on the Ohio River is 383.00. Because of the presence of the McAlpine Dam and Locks at Louisville, the lower pool elevations fluctuate much more than the upper pool elevations. Lower pool elevations exceed 400.00 quite regularly. In consideration, the Southwestern Outfall is protected by three large electrically operated sluice gates just below the Southwestern Pump Station. These gates are left open when the lower pool is below elevation 400.00. The gates are closed when lower pool reaches elevation 400.00 so that the pump station can continue to operate without pumping backwater. The gates are opened as necessary during wet weather to allow flow in excess of pump station capacity to discharge by gravity to the river. When the river

reaches elevation 417.00, the gates must be opened, since greater elevations would produce unseating heads on the gates that cannot be overcome by the electrical operators. When opened, the system floods with river water, the pump station is shut down and all discharge is by gravity to the river.

When the lower pool of the river reaches elevation 435.3, the flood protection facilities for the Southwestern Outfall begin operating. Flood gates on the Southwestern Outfall at the river are closed and Paddy's Run Flood Pump Station begins operating. The high level of wastewater in the Southwestern Outfall, which accumulates between elevations 417.00 and 435.30, is pumped out into the river. Normal dry weather operations of pumping base flows to the MFWTP resume until wet weather causes an overflow that must be pumped into the river. Between elevations 417.00 and 435.30, the system is flooded and all discharge is by gravity to the river.

- **Southwestern Branch Interceptor**

  The Southwestern Branch Interceptor conveys flow discharged from the Southwestern Pump Station to the MFWTP. For a majority of its length, the 6'-0" circular sewer was laid on a slope of 0.07% and provided an estimated full flow capacity of 72 MGD. It should be noted that the 104 MGD capacity of the pump station exceeds the maximum unsurcharged capacity of the Southwestern Branch Sewer.

2.2.4.2 Ohio River West Region Major Pump Stations

- **Northern Ditch Pump Station - Sanitary**

  The Northern Ditch Pump Station is located on the Northern Ditch Trunk Interceptor on New Way southeast of Strawberry Lane. The facility differs from other stations discussed herein in that it functions solely as a sanitary-only lift station. Flow in the 72" interceptor is lifted approximately 24' and discharged into a 60" downstream continuation of the interceptor that ultimately flows to the Mill Creek Trunk Sewer and Southwestern Outfall. See Figure 2-17. The Northern Ditch Pump Station utilizes four submersible propeller pumps each rated at 14,400 GPM for a total constructed capacity of 57,600 GPM. Due to limited capacity in the discharge chamber and downstream sewer, only three pumps are operated simultaneously. The fourth pump is used as a standby. Therefore, the maximum discharge from the pump station is 43,200 GPM or 62 MGD. The full flow capacity of the Northern Ditch Interceptor, upstream of the pump station is about 52 MGD.

- **Southwestern Pump Station- Combined Sewer Pump Station**

  The Southwestern Pump Station is located just south of Bells Lane on the west side of Interstate 264. The facility was designed to intercept flow in the Southwestern Outfall and convey it via the Southwestern Branch Interceptor to the MFWTP. Excessive high flows in the Southwestern Outfall overflow a diversion dam and continue through the outfall line to the Ohio River. See Figure 2-18.

  The pump station has an east and west wetwell, each fed by a 60" sewer. Mechanical screening is provided on both of the wetwell inlets. Two 30" centrifugal pumps draw from the west wetwell and two 20" centrifugal pumps draw from the east wetwell. The bottom elevation of the wetwells is 382.25. The wetwells are connected by an opening in the dividing wall at elevation 393.34. The four pumps are rated at 24,000 GPM each. The fourth pump is used as a standby. Therefore, maximum discharge from the pump station is 104 MGD.

- **Shawnee Park Pumping Station - Flood Protection**

  The Shawnee Park Pumping Station is located at 612 Southwestern Parkway in the middle of Shawnee Park. The facility has five 800 HP pumps and one 75 HP pump providing a total capacity of approximately 526,500 GPM at minimum design head. The minimum water level elevation in the wet well is 412.50 based on the smaller pump and 420.00 for the larger pumps. The maximum design pumping elevation is 426.50.

  The Shawnee Park Pumping Station is not placed in operation until the river level reaches elevation 435.00 on the lower gauge. Below this level, normal flows in the Northwestern Interceptor and Western Outfall enter the Western Interceptor and are eventually conveyed to the MFWTP. Excessive high flows in the Northwestern Interceptor are diverted at its junction with the Western Interceptor to the Ohio River. In a similar fashion, excessive high flows in the Western outfall overflow the diversion dam in Broadway and discharge to the river. Above river elevation 435.00 on the lower gauge, combined flows from both the Northwestern Interceptor and Western outfall are routed to the Shawnee facility and pumped into the river. Shawnee is the fourteenth station to go on line should flooding occur on the Ohio River. This pump station operates about once every 5 to 10 years on average.

- **Western Parkway Pumping Station - Flood Protection**

  The Western Parkway Pumping Station is located on the Southern Outfall west of Southwestern Parkway at 1300 Southwestern Parkway. The facility is equipped with four 1,250 HP and three 450 HP pumps capable of discharging a total flow of approximately 810,000 GPM at minimum design head. The minimum water level elevation in the wet well is 412.60 based on the smaller pumps and 417.00 for the larger pumps.

  The Western Parkway Pumping Station is not placed in operation until the river elevation exceeds 416.4 on the lower gauge. Below this level, normal flows in the Ohio River Interceptor, Southern Outfall, Western Interceptor, and 45th Street-Greenwood Avenue Sewer converge at the CSO 211 and continue to the MFWTP. Excessive high flows overflow the dam in the main diversion structure and are conveyed by gravity through the Southern Outfall to the Ohio River. Above river elevation 416.4 on the lower gauge, the Western Parkway facility is used to pump the combined flow in the Southern Outfall downstream of the CSO 211 into the river. Western Parkway facility is the first station to go on line should flooding occur on the Ohio River. This facility can be expected to operate about once or twice a year on average and one of the pumps may run for a short period of time.

- **Paddy's Run Pumping Station - Flood Protection**

  The Paddy's Run Pumping Station, which is located at 4200 Campground Road, is equipped with four 1,250 HP pumps and two 700 HP units providing a total capacity of approximately 607,500 GPM at minimum design head. The minimum water level elevation in the wet well is 402.25 based on the smaller pumps and 427.60 for the larger pumps. The maximum design ponding elevation is 434.00.

  The Paddy's Run Pumping Station is not placed in operation until the river elevation exceeds 435.3 on the lower gauge. Above this level, the facility is used to pump the surface water in Paddy's Run and excess combined flow in the Southwestern Outfall that overflows the diversion dam at the Southwestern Pump Station to the river. Paddy's Run is the twelfth station to go on line should flooding occur on the Ohio River. This facility can be expected to operate about once every 5 to 10 years on average.

2.2.4.3 Ohio River West Region Combined Sewer Overflows (8 CSOs)

The following is a list of CSOs located within the Ohio River North Region.

CSO 016 - Miles Park Bypass Structure (45th Street Sewer and Western Interceptor relief)

CSO 104 - Southwestern Parkway at Broadway (Southwestern Parkway and local sewer relief)

CSO 105 - Broadway at Southwestern Parkway (Western Outfall relief)

CSO 189 - Shawnee Park near the Shawnee Flood Pumping Station (Northwestern Interceptor relief)

CSO 210 - 45th Street and Winnrose

CSO 211 - Main Diversion Structure (Southern Outfall and Western Interceptor relief)

CSO 015 - Southwestern Pump Station at Bells Lane and I-264

CSO 191 - Algonquin Parkway Sanitary Diversion

CSO 016 is located south of 45th Street and Winnrose Way. A 4" diversion dam on the 45th Street Sewer diverts low flows through a 10" side outlet sewer to a diversion manhole on the 60" Western Interceptor. Overflows continue through the 5'-6" semi-elliptical 45th Street Sewer to the Southern Outfall downstream of CSO 211. At the diversion manhole on the existing 60" Western Interceptor, another diversion dam, consisting of stop planks across the 60" outlet, diverts low flows through a 48" reinforced concrete sewer to CSO 211. Overflows top the dam and continue through the 60" Western Interceptor to the Southern Outfall downstream of CSO 211.

CSO NO.	016
CSO Name.	Miles Park Bypass
Location	South of 45th & Winnrose
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	0
Overflow Frequency (NO/YR)	0
Avg. Overflow Duration (HRS)	0
Percentage of Entire System(AAOV)	0.00%

CSO 104 is located on the 42" sewer flowing north on Southwestern Parkway. A 1.6' high dam diverts low flows through a 24" side outlet sewer east on Broadway and then north to the Western Outfall flowing west on Broadway. CSO 105 is located downstream of this junction. Overflows at CSO 104 top the dam and discharge to the Western Outfall about 100' downstream of CSO 105 and discharge to the river.

CSO NO.	104
CSO Name.	SW PKWY Sewer & Broadway
Location	SW PKWY & Broadway
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	6
Overflow Frequency (NO/YR)	21
Avg. Overflow Duration (HRS)	1.9
Percentage of Entire System(AAOV)	0.17%

CSO 105 is located on the 11'-9" circular brick Western Outfall flowing west on Broadway at Southwestern Parkway. CSO 105 directs low flows in the Western Outfall into the Western Interceptor. A dam directs low flows through a 24" side outlet sewer, through an abandoned regulator chamber and then through a 24" connection, into the 5'-0" Western Interceptor flowing south. Overflows top the dam and continue west to the Ohio River. The diverted base flows from CSO 104 enters the 11'-9" sewer about 40' upstream of the diversion point.

CSO NO.	105
CSO Name.	Western Outfall @ Broadway
Location	Broadway @ SW PKWY
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	351.42
Overflow Frequency (NO/YR)	82
Avg. Overflow Duration (HRS)	6.26
Percentage of Entire System(AAOV)	10.05%

CSO 189 is located on the Northwestern Interceptor at the junction of the Western Interceptor. The Northwestern Interceptor is a 13'-6" x 9'-0" basket handle sewer flowing south just west of Southwestern Parkway. The Northwestern Interceptor itself turns west and flows through the Shawnee Park Flood Pumping Station to the Ohio River. An overflow dam about 27'-0" long directs low flows in the Northwestern Interceptor into the 3'-6" circular Western Interceptor, continuing to flow south just west of the Southwestern Parkway. Overflows top the dam and are discharged to the river. The Western Interceptor intercepts the low flows from CSOs 104 and 105 at Broadway.

CSO NO.	189
CSO Name.	Northwestern SAN. DIV.
Location	Shawnee Park PS
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	553.06
Overflow Frequency (NO/YR)	54
Avg. Overflow Duration (HRS)	8.59
Percentage of Entire System(AAOV)	15.81%

CSO 210 located on 66" 45th Street-Greenwood Avenue Sewer just downstream of the inlet from the Winnrose surge basin. A diversion dam approximately 8" in height, diverts low flows in the 45th Street-Greenwood Avenue Sewer through a 10" sewer to the 60" Western Interceptor just upstream of CSO 016. Overflow continues through the 5'-6" semi-elliptical 45th Street Sewer to the Southern Outfall downstream of CSO 211.

CSO NO.	210
CSO Name.	45th Street - Greenwood
Location	S of 45th & Winnrose
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	21.16
Overflow Frequency (NO/YR)	54
Avg. Overflow Duration (HRS)	3.96
Percentage of Entire System(AAOV)	0.60%

CSO 211 collects flows from the Ohio River Interceptor, the Southern Outfall, and the Western Interceptor and conveys these flows directly to the MFWTP. During periods of wet weather, the MFWTP is only capable of handling a limited amount of flow. This flow enters the MFWTP from both the Ohio River Interceptor and the Southwestern Branch Interceptor. During storm events, flows within the Southern Outfall alone can reach levels of 900 MGD, significantly more than MFWTP can handle. This can create backwater conditions within the Ohio River Interceptor and Western Interceptor and cause overflows at the CSO 211 and other CSO locations.

CSO NO.	211
CSO Name.	Main Diversion Structure
Location	Wayne Supply
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	511.89
Overflow Frequency (NO/YR)	43
Avg. Overflow Duration (HRS)	5.72
Percentage of Entire System(AAOV)	14.64%

CSO 015 is located on the 18'-4" x 27'-6" inverted egg Southwestern Interceptor at the Southwestern Pumping Station. A diversion dam approximately 6'-6" in height directs low flows in the Southwestern Interceptor through two 60" inlets into the wetwell of the Southwestern Pumping Station. The pump station lifts the flow to a discharge chamber where it discharges through the 72" Southwestern Branch Interceptor to the MFWTP. Flow diverted from CSO 191 enters the Southwestern Outfall through a 30" drop inlet just upstream of the diversion dam.

CSO NO.	015
CSO Name.	Southwestern PS
Location	Bells Lane & I-264
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	845
Overflow Frequency (NO/YR)	39
Avg. Overflow Duration (HRS)	7.46
Percentage of Entire System(AAOV)	24.15%

CSO 191 is located at the junction of the Southwestern Interceptor and the Algonquin Parkway Trunk Sewer. A diversion dam directs low flows in the Algonquin Parkway Sewer through a 24" side outlet sewer. The 24" sewer continues to a manhole and a 30" sewer and 30" drop inlet to the Southwestern Interceptor on the upstream side of the dam at CSO 015. Overflows top the dam and discharge down a "flight structure" to the Southwestern Outfall downstream of the dam at CSO 015.

CSO NO.	191
CSO Name.	Algonquin PKWY SAN DIV.
Location	Southwestern PS
Receiving Stream	Ohio River
2003 AAOV (MG/YR)	4.17
Overflow Frequency (NO/YR)	14
Avg. Overflow Duration (HRS)	1.21
Percentage of Entire System(AAOV)	0.12%

2.3 FLOW MONITORING

2.3.1 Review Initial Installations Purpose for Characterization and Model Development

The objective of the flow monitoring program is to collect the data necessary to characterize the system and to facilitate updating the calibration of the sewer system model. The calibration process compares the predicted results generated by the computer model to those events actually observed and recorded in the field. The flow monitoring data is collected to provide sewer system flow and flow levels during a number of different storm conditions. This data will be incorporated into a database that will be used to calibrate and verify the CSS model. The accuracy of the calibration is highly dependent on procuring good flow monitoring data.

MSD performed flow monitoring specifically for the purpose of calibrating the model during the years 1993 and 2002. The work done in 1993 was to provide data for the initial calibration of the model. In 2002, flow monitoring was performed to re-calibrate the model.

2.3.1.1 1993 Flow Monitoring Data

During the original development of the CSS model, flow monitoring was conducted in two phases due to the large combined sewer area and complexity of the system. The installation of the flowmeters for Phase I began in late November and early December 1991. By the first week of January 1992, twenty-three flowmeters were installed at various locations in the central and western part of the City and in the area around the Robert J. Starkey Pumping Plant. The 24th flow meter was installed on the Northwestern Sanitary Trunk Sewer during the third week of January. The flowmeter locations for Phase I are shown on Figure 2-19.

Phase II of the flow monitoring program commenced in April 1992. For this phase, seventeen (17) of the 24 flowmeters from Phase I were relocated from the western and central portions of the combined sewer area to the basins of the Middle and South Forks of Beargrass Creek.

The flow monitoring program officially ended on June 20, 1992. Nine (9) different storm events were chosen from the information obtained by the rain gauges and flow monitors during Phase I, and four different storm events were chosen from data recorded during Phase II for calibration purposes. A separate report, titled Report on Combined Sewer System Flow Monitoring (Tenney Pavoni Associates Inc., 1993) details the flow monitoring conducted on the combined sewer system. The flowmeter locations for the Phase II flow monitoring are shown on Figure 2-20.

2.3.1.2 2002 Flow Monitoring Data

During MSD Fiscal Year 2002 (FY02), additional flow monitoring of the CSS was performed as a part of the model maintenance activity. A total of nineteen (19) flowmeters were installed for the monitoring period of January 29, 2002 to April 11, 2002. Upon completion of this monitoring period, data from the flow monitors were analyzed to establish baseline flow(s) for dry weather flow characteristics in each basin. Additionally, wet weather and dry weather flow analyses were performed and the information was utilized to update the original model calibration. During the FY02 monitoring period five significant storm events (i.e. rain events exceeding 0.5") occurred. For calibration, the fourth and fifth events were selected for simulation. The fourth storm event, March 19th and the fifth storm event, March 25th, recorded totals of 2.9" and 2.8" of rainfall, respectively. The flow meter sites are exhibited in Figure 2-21. A separate report,

titled *Flow Monitoring Report* (GRW Engineers Inc., 2002) details the flow monitoring conducted on the combined sewer system.

2.3.2 Overview of Yearly Flow Monitoring Work

The yearly flow monitoring program is conducted to fulfill requirements of the Nine Minimum Controls (NMC) and to adequately characterize existing conditions, as well as to provide necessary calibration and verification data for system modeling. EPA's manual Combined Sewer Overflows-Guidance for Nine Minimum Controls (U.S. EPA, 1995) describes a monitoring program that develops information in three areas:

- General characterization of the system,
- Record of overflow occurrences, and
- Summary of incidents associated with CSOs.

As part of the Nine Minimum Control requirements, MSD monitors up to twelve combined sewer overflow locations. These locations, listed in Table 2-2, include a few sites in the western part of the system, but a majority of the sites are located in the Beargrass Creek area where the receiving waters are more sensitive. Flow data received from the monitored sites is reported in the CSOPs and/or WATERS Reports.

TABLE 2-2
COMBINED SEWER OVERFLOW MONITORING SITES

CSO NO.	CSO LOCATION	RECEIVING STREAM	MSD FISCAL YEAR								
			1995	1996	1997	1998	1999	2000	2001	2002	2003
19	34th STREET PS	OR									X
50	12TH ST N OF MAIN	OR				X		X			
88	BROWNSBORO RD @ BGC	SF BGC						X			X
108	NEWBURG @ TREVILIAN	SF BGC						X	X	X	X
110	BGC S OF EASTERN PKWY	SF BGC	X	X	X	X	X	X	X	X	
117	REG NO 11 - DRY RUN	SF BGC	X	X	X	X		X	X	X	X
118	REG NO 15 - E BRDWY	SF BGC	X	X	X	X					
123	RUTHERFORD - SULGRAVE	MF BGC	X	X	X	X					
125	GRINSTEAD @ I-64	MF BGC	X	X	X	X		X	X	X	X
127	LEXINGTON RD OP ETLEY	MF BGC							X	X	
132	REG NO 35 - BROWNSBORO	BGC - MudF	X	X	X	X	X	X			X
140	LOCUST SW OF SPRING	MF BGC							X	X	
147	SWAN ST N OF BGC	SF BGC								X	X
151	BGC & CASTLEWOOD DELL	SF BGC	X	X	X	X		X	X	X	X
152	BGC & RUFER AVENUE	SF BGC	X	X	X	X		X	X	X	X
153	COOPER STREET	SF BGC							X		
154	MELLWOOD @ SCHOEFFEL	BGC - MudF	X	X	X	X					
166	LEXINGTON RD & I-64	MF BGC	X	X	X	X					
189	NORTHWESTERN SAN DIV	OR									X
206	CHEROKEE PARK @ SPRING DR	BGC-MF						X	X	X	
209	CHEROKEE PARK @ PARK BD RD	MF -BGC						X	X	X	X
SWO	SOUTHWESTERN OUTFALL	OR	X	X	X	X					
SO	SOUTHERN OUTFALL	OR	X	X	X	X	X				X

2.3.3 Review Permanent Flow Monitoring Installation Programs

MSD is in the process of finalizing a permanent flow monitoring program. According to the Combined Sewer Overflows - Guidance for Monitoring and Modeling (EPA, 1999) document, a CSS monitoring program will support in-depth system characterization and post-construction compliance monitoring that are central elements in the LTCP.

As part of the implementation of Phase I of the Real Time Control (RTC) Program, three permanent area-velocity flow meters have already been installed. The identification and locations of these flow meters are as follows:

- Hike Point Sewer just upstream of the Southeastern Diversion
- Buechel Branch Sewer just upstream of the Southeastern Diversion
- Beargrass Interceptor just upstream of the diversion to the Nightingale Pump Station

These flow meters provide real time flow data to the RTC Central Station to assist in the management and control of the RTC control gates. Figure 2-22 exhibits the locations of the permanent flowmeters currently installed.

2.4 RAINFALL CONDITIONS

MSD has been actively monitoring rainfall since 1991. The initial work began with a cooperative agreement with USGS that has progressed to the current program, which consists of 15 gauges that are telemetered to a central receiving station at MSD.

2.4.1 Overview of USGS Work

The initial rain gauges were installed in 1991 as a joint effort between MSD and the United States Geological Survey (USGS). The rain gauge information was to be used for MSD studies and USGS research. In 1997, MSD took over sole responsibility for the rain gauge network. These data logger type rain gauges were non-telemetered and required MSD personnel to download the information that was stored within each of the rain gauges. Though labor intensive, these rain gauges worked extremely well.

The rain gauges recorded total rainfall in five-minute increments. Eight of these gauges were located within or adjacent to the combined sewer drainage area and the data from these gauges were used in the model calibration process. The locations of these eight gauges are shown in Figure 2-23.

TABLE 2-3
ORIGINAL RAIN GAUGE LOCATIONS

Rain Gauge No	Location
6	Seneca Golf Course along Bon Air Avenue
7	Louisville Water Tower at Zorn Avenue
9	Iroquois Golf Course along Taylor Boulevard
10	Morris Forman Treatment Plant along Algonquin Parkway
14	Standiford Field along Standiford Avenue
19	South Fork Beargrass Creek at Trevilian Way
20	USGS Office on Bradley Avenue
29	Downtown Louisville at MSD Headquarters, 6th & Cedar

Source: 1993 CSOP

2.4.2 Overview of Radar Rainfall Project & Products

In 1997, eleven telemetry-equipped rain gauges were installed. The primary purpose of these rain gauges was to provide real-time data for emergency response support and engineering support. The majority of these rain gauges were installed at MSD facilities located throughout Jefferson County. For the purposes of emergency response support, the rain gauges performed adequately. However, with the implementation of the RTC project, these telemetry-equipped rain gauges did not meet the requirements of RTC. Their geographic distribution and the telemetry system used at the time were deemed insufficient to provide the needed information in a timely manner. In order to meet the goals of the RTC project and to provide better emergency response support, the telemetry-equipped rain gauge system needed updating.

In the spring of 2003, fifteen new telemetry-equipped rain gauges were installed throughout Jefferson County. This updated rain gauge system serves two primary functions - to calibrate weather service NEXRAD radar with actual rain gauge data, and to assist in providing accurate two-hour predictive rainfall data. This information will be utilized by MSD's RTC project and for emergency response preparation. The new rain gauge network also provides a better geographical coverage of Jefferson County. See Figure 2-24.
Insert Figure 2-22

The majority of the storms approaching Jefferson County come from the northwest. Therefore, MSD established three additional satellite-enabled rain gauges in the southern Indiana counties of Harrison, Floyd and Clark. These rain gauges provided MSD with the ability to better calibrate rainfall predictions based on storms approaching from the northwest. Since the RTC project requires a 2-hour predictive capability, rain gauges located outside Jefferson County, Kentucky will provide MSD with the data needed to make these predictions. Figure 2-25 is a graphical presentation of radar rainfall.

2.4.3 Basis of Typical Year Analysis

EPA's CSO Control Policy (1994) requires the effectiveness of CSO controls to be evaluated on a "system-wide, annual average basis." Identification of annual average rainfall conditions is a fundamental step in the LTCP process.

At the time of the initial model development (Early 90s), thirty-one (31) years of rainfall records (1960 to 1991) were obtained from NOAA as recorded at the National Weather Service at Standiford Field. This data was categorized by peak intensity, total rainfall and duration. In 2004, MSD decided to change the method of calculating the annual average overflow volume (AAOV) from a reference storm approach to a typical rainfall year approach using continuous model simulation.

Several approaches were available to analyze the performance of the CSS. Continuous simulation of long-term rainfall records was thought to provide more reliable predictions of overflow quantity on a regional basis than other methods considered at that time. However, due to limitations in computer processing time and data storage considerations that existed in the early 90s, continuous simulation of an annual rainfall record was a severe limiting factor.

An alternate approach was developed which used detailed simulations for a number of discrete events. This approach allowed for generation of detailed model output (volumes, durations, peak rates) that would be useful for preliminary engineering planning, as well as data that would be useful for developing long-term overflow statistics. This approach was used in the initial stages of the project to estimate AAOVs.

A series of reference storms of varying return frequency were extracted from the 31-year rainfall record based on a statistical analysis of key parameters in the rainfall record (total precipitation, intensity, duration). Ten actual historical storms were simulated using the sewer system model, and overflow volumes for each CSO and runoff volume for each drainage catchment were obtained. A mathematical regression of the data points provided predictive equations for overflow volume and runoff based on total rainfall for each storm in the historical record. The predicted volumes for all storms over the year provided an estimate of the AAOV for each CSO.

The combination of improvements in computer hardware technology and improvements in the model software makes continuous model simulation over long time periods significantly more feasible today than had previously been the case. One of the many benefits from continuous simulation is that this technique automatically accounts for intermittent dry periods between rain events and for consecutive, closely spaced events.

A statistical analysis of a 54-year historical rainfall record (1948-2002) at KY4954 - Louisville Standiford Field gauge, was performed for the Jefferson County, Kentucky region in 2003 to determine the characteristics of a typical yearly rainfall that could be used for continuous simulation to obtain estimates of AAOV. Individual rain events were sorted and ranked according to five characteristics (total precipitation, average intensity, maximum intensity, duration, and antecedent dry period). Table 2-4 presents a summary of the analyses.

TABLE 2-4
COMPARISON OF HISTORICAL RECORDS TO 2001 RAINFALL EVENTS

	Average	Typical Year	
	1948-2002	Historical 2001	Compilation by Months
Number of Events	91.81	91	91
Total Duration (hrs)	530.37	516	568
Total Depth (inches)	41.25	42.83	40.84
Maximum (in/hr)	1.19	0.83	0.84
Average (in/hr)	0.08	0.08	0.07
Time from Last Event	91.94	91	89

Two different methods were used to determine the typical year. One method was to determine the typical year by selection of a historical year that matches the average value from 54 years of record. Each individual year was compared to the average values for six statistics listed in Table 2-3 above and the year having values closest to the mean was selected as the typical year. From this method, historical year 2001 is selected as the historical typical year.

A more complex method of determining a typical year was to build a year from 12 individual months, each closely matching the average for that particular month. The six statistics listed in Table 2-3 above was summarized according to month. The typical year composed of qualifying individual months is shown in Table 2-5:

TABLE 2-5
INDIVIDUAL MONTHS FOR TYPICAL YEAR

Month	Year
January	1995
February	1981
March	1977
April	1978
May	1986
June	1987
July	1970
August	1988
September	1951
October	1965
November	1997
December	1987

The typical year selected for the CSO program evaluation was constructed from twelve (12) typical months extracted from the 54-year historical record. An advantage of using a constructed year is that it captures the seasonal variability and thus represents more average

months throughout a year. Modeling of the typical rainfall year in a continuous simulation will better predict the results of overall system performance and the effects of system improvements that could be considered for implementation. Calculation of AAOV in the CSS area using the new method was initiated in 2005 and will be completed during 2006.

2.5 MODELING

2.5.1 Model Selection

The CSO Control policy describes modeling as a valuable tool for characterizing a CSS. The proper and effective use of models is supported by EPA and the sophistication of the model should relate to the complexity of the system to be modeled.

The MSD CSS hydraulic model was initially developed in 1991 and 1992 utilizing EPA's Storm Water Management Model (version 4.05 and 4.3) software, known as SWMM. The selection of the hydraulic model was based on the complexity and size of the MSD collection and conveyance system and the SWMM's ability to simulate full hydrodynamic equations. SWMM had been used on an array of projects as complex as CSO abatement programs in many different parts of the country because of its ability to simulate surcharging, backwater effects, or looped systems, and pertinent processes and system configurations.

In the late 1990s, the MSD CSS model was converted from EPA's SWMM to the proprietary XP-SWMM model in recognition of the need for a useful graphical user interface (GUI), geographic information systems (GIS), and enhanced SWMM capabilities. XP-SWMM is an enhanced version of EPA's SWMM model.

2.5.2 Historical Development of the Model

The development and calibration of the MSD CSS model was a part of early efforts associated with the CSO Abatement Program. The major objectives of the initial model development were to:

- Comply with CSO Policy Requirements
- Estimate CSO hydraulic and pollutant loads
- Assist in identifying the location of significant CSOs
- Assist in evaluating corrective actions
- Assist in prioritizing corrective actions

Figure 2-26 is a diagram exhibiting the History of Development of the CSS model.

2.5.2.1 Model Development

The SWMM model is a "deterministic" model, which requires input parameters to be accurate in order for the model to produce accurate results without calibration. In practice, there are generally a number of systems unknown or hydraulic complexities that preclude the possibility that all input parameters are known or entirely accurate. Therefore, it is essential that some calibration and verification of the model needs to be performed using actual flow monitoring data.

For the development of the initial CSS model, MSD provided the best available information regarding its system configuration and operating parameters. The basic sewer data and drainage area information used to develop the CSS model were based on interviews with the operational crews, review of the construction drawings, and field inspections. An intensive field reconnaissance of the CSS was conducted by MSD in the spring of 1991 and this information was also used to develop the initial model.

The combined sewer system operated by MSD is a very large and complex system. At the time of the original model development, it was not feasible to develop the model as one overall model because of the complexity and large size of the combined sewer system. Therefore, the entire system was broken down into three separate regions and six separate models, generally based on drainage basins and system were developed. Figure 2-27 indicates these region and sub-regions. The various model designations are indicated within the boundaries of each area. These are discussed below.

- **Model BG12**

  Includes Beargrass Creek Interceptor, Beargrass Interceptor Relief and Snead's Branch Relief from Watterson Expressway to Kentucky Street and Logan Street.

- **Model BGR**

  Includes lower Beargrass Interceptor from Kentucky Street and Logan Street to the Robert J. Starkey Pumping Plant, Middle Fork Trunk Sewer Mellwood Avenue Sewer, and the Northeastern Sanitary Trunk Sewer and Storm Drain.

- **Model CRD**

  Includes the entire potential drainage area of the Central Relief Drain

- **Model ORI**

  Includes drainage area tributary to the Ohio River Interceptor

- **Model NWSO**

  Includes those drainage areas tributary to the Northwestern Interceptor, Western Outfall, Western Interceptor, Southern Outfall, and the area around the Main Diversion Structure.

- **Model SWO**

  Includes that drainage area tributary of the Southwestern Pump Station, including the Southwestern Outfall and Upper Dry Run Trunk.

As stated above, the CSS model was initially developed using EPA's SWMM and converted from EPA's SWMM to proprietary XP-SWMM software. At the time of the software conversion, there was a limit to the number of nodes but by the beginning of 2000, the six individual models were combined to create one system-wide model covering the entire CSO study area. Four primary benefits were derived from combining the initial six EPA SWMM models and developing the current XP-SWMM model.

- Useful graphical user interface (GUI)
- Utilization of geographic information systems (GIS)
- Enhanced SWMM capabilities
- One simulation for entire CSO service area
- Fewer input/output boundary conditions to reconcile between simulations

2.5.2.2 Model Structure

The original version of the SWMM model consisted of two major programs or "blocks," RUNOFF and EXTRAN. The RUNOFF block was used to simulate the overland runoff hydrographs and the EXTRAN block was used to perform dynamic routing of flows throughout the combined sewer system to the outfall(s) into the receiving water. The current Version 9.5 of the XP-SWMM model redefines the RUNOFF and HYDRAULICS modules that are equivalent to the RUNOFF and EXTRAN blocks.

To accurately represent the surface runoff from each subcatchment, various characteristics for each subcatchment were defined. The six characteristics are listed below. Additional information can be found in the draft Modeling Quality Assurance Project Plan for the CSS model.

- Subcatchment area
- Width
- Percent Impervious factor
- Surface Slopes
- Infiltration factors
- Overland Resistance Factor

To accurately represent the system, the EXTRAN block required extensive input data of the physical structure characteristics as found in the field. The major input data for the EXTRAN block is listed below. Additional information can be found in the draft Modeling Quality Assurance Project Plan for the CSS model.

- Junction
- Conduit
- Storage Junction
- Orifice
- Weir
- Pumps

The CSS pipe network was developed from the best available data at the time. The information utilized was as-built drawings, construction drawings, and CSO inventory records.

2.5.2.3 Special Modeling Consideration

Most of the real physical structures found in the CSS were presented in the EXTRAN block of the original model but in some cases it was not possible to model exact conditions due to the software and hardware limitations. Special modeling considerations were given to determine the best approach for simulating actual conditions. Below is a list of special modeling considerations. Additional information can be found in the draft Modeling Quality Assurance Project Plan for the CSS model.

- Odd shaped pipes
- Mechanical Regulators
- Main Diversion Structure
- Pump Stations

In Version 9.5 of the XP-SWMM model, now being used for this project, no limitation exists on the number of weirs, special shape conduits and other special structure options. Actual configurations of many complex structures can now be simulated in the model. These improvements allowed for changes due to advances in computer hardware and software. Additional information can be found in the WATERS Report under CSO Model Maintenance section.

- Reconfiguration of CSO Structures
- Reconfiguration of Special Sewer Shape
- Modifications to make continuous simulation

2.5.3 Model Calibration Work

One of the early phases of work conducted for the abatement program was the flow monitoring program. Data gathered for sewer system flows and flow levels during various storm conditions provided the data necessary to calibrate and verify the CSS model. The model baseline condition was that dry weather flow was normally occurring in the system, upon which wet weather flows were superimposed. Model input consisted of dry weather flow directly entered as a constant flow and wet weather hydrographs generated in the runoff module are routed through the sewer system.

Many reaches of the CSS are susceptible to backwater and surcharge influences. Comparison of model flows with flows calculated from Manning's or Kutter's equations would have been an indirect method of calibration and would have required in-depth knowledge of the effects of backwater and surcharge conditions at all times to compute the flows from measured level data. Thus, a more appropriate comparison between measured and predicted values was judged to be that between the water surface levels predicted by the model and the level actually measured in the sewer. The primary measurement in the sewer (depth) inherently accounts for backwater and surcharge and the model was constructed such that those effects were also considered.

2.5.3.1 Dry Weather Flow

Dry weather flows in the original CSS models (1992) were distributed based on flow monitoring at a number of locations within the system, as well as available treatment plant and pump station flow rates. Dry weather flows were allocated so that the cumulative total of these flows equaled the total daily average flow rate at pump stations and the treatment plant. A model simulation was executed with zero rainfall to ascertain that the model appropriately calculated the dry weather flows at various points in the system. Once the model accounted for dry weather routing of flows, a storm simulation was executed to examine the system reaction to a wet weather event.

When the CSS model was upgraded in 2004, the existing dry weather flows were redistributed and adjusted throughout the system based on the 2002 flow meter data. A number of model simulations were executed with zero rainfall to verify that the updated model appropriately calculated the dry weather flows at various points in the system.

2.5.3.2 Wet Weather Flow

The objective of the model calibration was to simulate a storm event, by use of best available data, and compare data predicted to actual data recorded at particular locations. Realistically, it would be impossible to exactly simulate any particular storm event, due to the large number of input variables, but by adjusting portions of the input data, results were obtained which reasonably approximated actual storm events.

Originally in 1992, nine different storm events were chosen from the information obtained at the rain gauges and flow monitors during Phase I, and four different storm events were chosen from data recorded during Phase II for the wet weather calibration. The storm events were chosen because they represented a wide range of storm types. Some of the storms represented an average duration storm with a fairly uniform intensity. Other storms represented an average duration with very light intensity; some, an average storm duration and a high intensity, and lastly, storms with an average or long duration and a high intensity. The storm events were also chosen based on the fact that sufficient data from flowmeter locations were available, as well as knowledge of specific system operations during those storm events.

Frequently, a good correlation was achieved between two or three individual storm events at most sites, although some deviation between observed and predicted data was observed for another event. Careful analysis was required to establish whether such a deviation was due to a deficiency in the model configuration or due to a variation in data input.

In order to re-calibrate the model in 2004 two different storm events were selected: March 19th with a total of 2.9" of rain, and March 25th with a total of 2.8" of rain. The model was then executed using a two week (March 15 to April 2, 2002) continuous simulation.

Initial calibration runs were performed using the March 25th rainfall data. At the boundaries where separate sewers enter the combined system, the monitored flow data were input as direct user inflow. The model predicted hydrographs within the system were compared to the monitored data and a good correlation was found in most cases. The shapes and magnitudes of the hydrographs indicated that the original model was well calibrated for most of the service area. At flow monitoring Site 29, MH# 30437-AG, the model substantially under-predicted the total flow volume. An adjustment was made to the percent impervious values in the subcatchment tributary to this location which improved the model prediction results.

2.5.3.3 Boundary Condition Adjustments

Another step in the calibration process was to develop and apply the proper boundary conditions for the CSS model. Four locations exist where the CSS model receives flow from separate sewer systems (SSS) upstream of the CSS, as summarized in Table 2-6.

TABLE 2-6

CSS MODEL BOUNDARY LOCATIONS

Site	MH No.	Location
6	45899	Middle Fork at Seneca Park Road (MF Boundary)
8	23211	Goldsmith Lane at Trout Creek (BGI Boundary)
9	51175	Southeast Diversion Structure at Mall Road (BGI Boundary)
14	12599	Mellwood Avenue Sewer at Mellwood Lane (NSTS Boundary)

Although separate sanitary and storm sewer systems exist in the service areas upstream of the CSS, the sanitary sewers are susceptible to significant wet weather inflow and infiltration. As a consequence, the quantities of flow entering the CSS from the sanitary sewer systems can be substantially greater during wet weather periods than during dry weather periods. Efforts were undertaken during the 2004 wet weather calibration process to quantify the amount of deviation between the dry weather and wet weather conditions at these model boundary locations.

The end product of this significant undertaking during the early 90s and 2004 was a working computer model of the combined sewer system for use in predicting and analyzing the response of the system to various rain events. The model has also been used as a "tool" to perform numerous analyses such as flooding analyses and development analyses as well as to evaluate the AAOV and percent capture impact of the initial draft 1996 LTCP elements and compliance with NMC requirements.

2.5.4 Progression of Model

The CSS model was created approximately 13 years ago and has undergone many changes during this period. It has been updated to reflect current conditions by incorporating system changes due to the physical/field conditions and by taking advantage of the recent advances in computer technology. This section briefly describes the major changes to the model.

2.5.4.1 Conversion to XP-SWMM

In late 1997, the existing six EPA SWMM models were converted to XP-SWMM. When the original models were developed an arbitrary manhole and conduit numbering system was utilized. At the time of conversion from EPA SWMM to XP-SWMM, the manholes and conduits were renumbered in accordance with MSD's standard manhole numbering system. In addition, the coordinates for each manhole were obtained from Louisville and Jefferson County Information Consortium (LOJIC). With this standard system, the location and manhole ID could easily identify XP-SWMM with the MSD's GIS system.

2.5.4.2 Combining Six Models

The original version of XP-SWMM was limited to 500 nodes. Upon completion of the conversion to XP-SWMM, the same six models, as described previously, were available individually. In 1998, one system-wide model was created by combining six individual models into one XP-SWMM model with 5000 node capacity.

2.5.4.3 Expansion of Model

The CSS model of the Ohio River North and Ohio River West Regions was utilized to predict flooding during selected design storm events for the US Army Corps of Engineers (USACE). The USACE model is entirely contained within the CSS area and generally represents sewers sized 18" and greater. During 2002, the CSS model for the USACE was expanded to include the Beargrass Creek Region. With an expanded model, sensitivity is improved and applicability is greater. This model expansion and enhancement was possible due to the recent advances in the computer processor speed and memory capacity now readily available allowing efficient use of larger more complex models.

2.5.5 Update of Current Model

MSD has frequently updated the CSS model to reflect changing system conditions in the CSS by incorporating physical changes to various system features, and to take advantage of significant advances in computer hardware and software since the development of the model. During MSD's fiscal year 2004, the CSS model was updated to:

- Reflect changing system conditions within the CSS by incorporating physical changes to various system features,
- Take advantage of significant advances in computer hardware and software since the original model construction, and
- Modify the model to be able to simulate typical rainfall (long term) simulation accurately and effectively.

The end product of 2004 efforts is an updated XP-SWMM model for the combined sewer system that more accurately reflects existing system performance and is capable of evaluating potential system improvements and changing operational strategies within the system.

During fiscal Year 2004, the Quality Assurance Project Plan (QAPP) and Standard Operating Procedures (SOPs) were drafted for CSS program wide hydraulic modeling with standardization of format, content, criteria and model parameters for all collection system models wherever possible. These documents include model calibration and bias criteria, field-monitoring requirements to verify the model input data at key locations, field-monitoring requirements to verify the wet-weather phenomena and field-monitoring requirements to verify model results as appropriate. The final SOP will include a procedure for adjusting the existing model based upon filed-monitoring data and the final QAPP will include a process to evaluate the accuracy of the smaller overflow locations and a set of criteria to evaluate the accuracy of the model calibration results.

The model modification, calibration and verification process updates as well as QAPP and SOP updates will continue as the program proceeds and additional data and operating information become available as well as the system operational modifications and other suggested improvements are made to the system.

2.6 RECEIVING WATER QUALITY CHARACTERIZATION

2.6.1 Study Area Water Quality Classifications and Standards

Kentucky's Water Quality Regulations establish surface water use classifications for all waters of the Commonwealth. The identified use classifications can be summarized as follows:

- WAH Warm Water Aquatic Habitat
- CAH Cold Water Aquatic Habitat
- PCR Primary Contact Recreation
- SCR Secondary Contact Recreation
- DWS Domestic Water Supply
  (applicable at existing points of public water supply disposal)
- OSRW Outstanding State Resource Water

The designated stream uses for the surface water bodies within the Ohio River in the vicinity of Louisville and the Beargrass Creek Basin is summarized in Table 2-7.

TABLE 2-7
STREAM USE DESIGNATION

Stream	Use Designation
Ohio River - Main Stem	WAH, PCR, SCR, DWS
South Fork Beargrass Creek and Tributaries	WAH, PCR, SCR
Middle Fork Beargrass Creek and Tributaries	WAH, PCR, SCR
Muddy Fork Beargrass Creek and Tributaries	WAH, PCR, SCF

For warm water aquatic life, the water quality standards require that

- The dissolved oxygen is to be maintained at a minimum concentration of 5.0 mg/l daily average; the instantaneous minimum shall not be less than 4.0 mg/l.
- Total dissolved solids and total suspended solids are not to be changed to the extent that the indigenous aquatic community is adversely affected.
- The addition of settleable solids that may alter the stream bottom so as to adversely affect productive aquatic communities is prohibited.
- The concentration of un-ionized ammonia shall not be greater than 0.05 mg/l at any time in-stream after mixing.

For recreational waters that are designated for primary contact recreation, the fecal coliform or Escherichia Coli (E. Coli) shall not exceed 200 colonies/100 ml or 130 colonies/100 ml, respectively, as a geometric mean based on not less than five samples taken during a 30-day period. Further, the fecal coliform concentration shall not exceed 400 colonies/100 ml in 20% or more of all samples taken during a 30-day period, nor 240 colonies/100 ml for E. Coli. The above limits apply to the recreational season defined as May 1 to October 31.

For the non-recreational period from November 1 to April 30, the fecal coliform concentration criteria are the same as the criteria for secondary contact recreation. These criteria require that the fecal coliform content be no greater than 1,000 colonies/100 ml as a 30-day geometric mean, and no greater than 2,000 colonies/100 ml in 20% or more of the samples taken during a 30-day period.

For the main stem of the Ohio River, the dissolved oxygen is to be 5.0 mg/l or higher per day, and shall not be less than 4.0 mg/l, except during the August 15-June15 spawning season when a minimum of 5.1 mg/l is to be maintained.

The KDOW 2002 303(d) listing of impaired water in the Commonwealth provide additional insight into the ability of these surface water to meet their designated uses, and lists the pollutants of concern that are the likely causes of the impairments. See Table 2-8.

TABLE 2-8
2002 KENTUCKY 303(d) LIST

Streams	2002 303(d) Listing		
	Priority	Impaired Use	Pollutant of Concern
Beargrass Creek of Ohio River (mile 0.0 to 1.5)	First	Aquatic Life (Nonsupport)	Metals, Organic Enrichment/Low DO
Middle Fork of Beargrass Creek (mile 0.0 to 2.3)	First	Aquatic Life (Nonsupport) Swimming (Nonsupport)	Organic Enrichment/Low DO, Habitat Alteration, Metals, Pathogens
Middle Fork of Beargrass Creek (mile 2.3 to 15.2)	First	Aquatic Life (Nonsupport) Swimming (Nonsupport)	Metals, Pathogens
Muddy Fork of Beargrass Creek (mile 0.0 to 6.9)	First	Swimming (Nonsupport)	Pathogens
South Fork of Beargrass Creek (0.0 to 2.7)	First	Aquatic Life (Partial Support) Swimming (Nonsupport)	Metals, Pathogens, Organic, Enrichment, Low DO
South Fork of Beargrass Creek	First	Aquatic Life (Partial Support) Swimming (Nonsupport)	Pathogens, Organic, Enrichment, Low DO
Ohio River (main stem) (mile 317.1 to 981.0)	Second	Fish Consumption (Partial Support)	Priority Organics
Ohio River of Mississippi River (mile 606.8 to 619.2)	Second	Fish Consumption (Partial Support) Swimming (Partial Support)	PCBs, Dioxin, Pathogens
Ohio River of Mississippi River (mile 619.3 to 629.9)	First	Swimming (Nonsupport) Fish Consumption (Nonsupport)	PCBs, Dioxin, Pathogens

2.6.2 Ohio River Considerations

ORSANCO conducted a study of wet weather impacts on the Ohio River beginning in 2000, concluding with a final report in late 2004. The report was entitled Wet Weather Impact Study on the Ohio River - Louisville/Southern Indiana Area, 2004. This study examined on a preliminary basis the impacts on water quality from wet weather discharges from major tributaries, WWTPs and CSOs in Kentucky and Indiana. The study area lay within the McAlpine and Cannelton pools of the Ohio River, with the major communities of Louisville, KY and Jeffersonville, IN being the major communities in the study area. Major conclusions from the ORSANCO study are summarized below.

- CSOs sources account for about 18% of the fecal coliform load and 22% of the E. coli load to the Ohio River on an annual basis. Louisville's share of the total annual fecal coliform load was 15.7%, and 16.9% of the annual E. coli load.
- CSOs cause between 5 and 10 percent of the days to exceed pathogen criteria during the recreation season. Although other days exceeded criteria, sources other than CSOs were believed to be the causes.
- The ORSANCO model was believed to be very useful as a planning tool, but was not well-suited for use as a predictor of absolute concentrations in the river.
- The report indicated that the most realistic CSO reduction scenario (control of most, but not all CSOs) would have very little benefit in reducing the frequency of days that exceed the single sample maximum water quality standard, although the alternative would have a noticeable benefit in reducing peak in-stream concentrations."
- 100% control of CSOs could reduce the number of days exceeded from 60% to 40%, a 20% reduction. Data was presented for the removal of the total CSO load (without stormwater), and for the removal of only the sanitary component of the wet weather load (with stormwater). The latter includes the wet weather storm loads that would continue to discharge to the river if sewer separation were implemented. Comparison of the two option results indicate that sewer separation would be of negligible benefit, since the number of days exceeding would be nearly the same for the sewer separation case as it is for the existing condition case. Thus, the 20% reduction seems to be achievable only if both the CSO and storm water were cleaned up.
- Eliminating CSOs appeared to be less beneficial than eliminating tributary sources (by 5 to 10%). It appears that either CSOs or tributaries alone will cause water quality exceedances. That is, removing either one alone will not significantly reduce the days of exceedances; rather, both would need to be reduced to achieve significant benefits. This supports the watershed approach to achieving WQS.
- MSD will be performing a cursory peer review of the ORSANCO study.

The sampling activities associated with the ORSANCO study were completed by October of 2001. Data collected during three dry weather events, five wet weather events and two dye surveys were provided to develop a water quality model. Over 15,000 water quality data points were collected by the ORSANCO, Louisville MSD, and the Indiana communities of Jeffersonville and New Albany through the course of this study.

2.6.3 Beargrass Creek Watershed

Several efforts have been undertaken over the past 13 years to obtain better information on the pollutant load characteristics being discharged into Beargrass Creek from combined sewer overflows, sanitary sewer overflows and storm sewer discharges. One effort included a sampling program in 1992 and 1993 in which samples were taken at several CSOs and at several locations in-stream. Other sources of data were included in *The Synthesis Report* of 1999, which summarized sampling results taken in the Beargrass Creek Basin over several years. In addition, another effort is currently in progress that will result in the development of TMDLs for the three branches of Beargrass Creek.

Beginning in 2005, a significant monitoring and modeling effort was undertaken to support the development of TMDLs as well as development of a water quality tool model (WQT). The continuous monitoring effort consisted of 14, in-stream, "continuous" monitors collecting water temperature, pH, dissolved oxygen (DO), dissolved oxygen saturation (%DO), and specific

conductance at 15-minute intervals. Ammonia data were also collected using continuous monitors at some locations. "Continuous" (15-minute interval) stream flow data was monitored at three USGS gauges. Discontinuous data was collected during dry and wet weather conditions. Sampling occurred within the stream, at combined sewer overflow locations, and from runoff from specific land uses according to the Quality Assurance Project Plans (QAPPs) developed specifically for the Beargrass Creek Water Quality Tool/TMDL project.

Additional discrete event sampling project is being conducted to support the Water Quality Tool Model calibration/validation. Eight CSOs in Beargrass Creek watershed have been selected based on a sample population of 15% of the total CSO population. Each of these sites is being sampled for F-coli, TP, TN, TSS and BOD. The sites also have flow meters in place recording flow and have probes in place measuring temperature, conductivity, pH and DO. The maximum CSO samples collected per site is 9, which include 8 grab sample and 1 event composite at a time interval of 15minutes for the first hour and every 2 hours up to 6 hours. Table 2-9 presents the location of CSO sampling sites as well as the list of parameters being collected. This project is scheduled for completion in 2006.

TABLE 2-9 CSO SAMPLING TABLE

CSO	Receiving	Parameter	Field&Probe
206	MF	F-Coli, TP, TN, TSS	Flow, Temp, Conductivity, pH
127	MF	F-Coli, TP, TN, TSS	Flow, Temp, Conductivity, pH
140	MF	F-Coli, TP, TN, TSS	Flow, Temp, Conductivity, pH
108	SF	F-Coli, TP, TN, TSS	Flow, Temp, Conductivity, pH
110	SF	F-Coli, TP, TN, TSS	Flow, Temp, Conductivity, pH
151	SF	F-Coli, TP, TN, TSS	Flow, Temp, Conductivity, pH
152	SF	F-Coli, TP, TN, TSS	Flow, Temp, Conductivity, pH
117	SF	F-Coli, TP, TN, TSS	Flow, Temp, Conductivity, pH

In-stream samples are being collected to define background loading as well as to characterize the individual impacts of the CSOs on the receiving waters of Beargrass Creek. A total of 24 sites are being sampled for the same parameters as CSOs. The sampling schedule for the in-stream would be initiated immediately after the onset of precipitation and at interval of 2,4,6,12,24, and 48 hours.

2.6.3.1 South Fork Beargrass Creek

The South Fork of Beargrass Creek watershed encompasses about 27 sq. miles, including the southeastern portion of downtown Louisville. This watershed is the most urban of the 11 watersheds in Jefferson County, KY. It stretches from the Ohio River through portions of the combined sewer sections, to the separate sewer section of northern and eastern Jefferson County. The South Fork of Beargrass Creek serves as the receiving stream for 45 CSO discharges.

The sampling program conducted along the South Fork of Beargrass Creek during 1992 and 1993 included five (5) stream locations and five (5) CSO sites as shown on Figure 2-28.

Samples were analyzed for the following parameters:

- Total Suspended Solids (TSS)
- Dissolved Oxygen (DO)
- Biological Oxygen Demand (BOD)
- pH
- VSS
- Fecal Coliform
- Fecal Streptococcus

The sampling results were included in the July 1993 CSOP Report to the KDOW, and also in a separate report. Few firm conclusions could be drawn from the limited data, because many of the samples were composited before analyses were conducted, and it was suspected that first flushes may have been missed due to tight response times after the onset of an event. CSO concentrations varied widely but were still relatively low for BOD and TSS, averaging 36 mg/l and 104 mg/l, respectively. Dissolved oxygen in Beargrass Creek remained high even during CSO events. Bacteria levels were elevated at all points along Beargrass Creek, including those upstream of CSOs. Section VI of the 1993 CSOP provides details on the sampling and analytical results.

As noted in *The Synthesis Report* of 1999, the South Fork of Beargrass Creek has approximately 15 miles of stream listed on the 303(d) list for aquatic life and recreational impairment (swimmable). The causes of impairment are organic enrichment, low dissolved oxygen and pathogens. The Synthesis Report indicated that approximately 60% of all samples collected were in violation of the fecal coliform standard. There were also a number of metals violations for cadmium (10%), and zinc (7%). Low flow contributions indicated significant point source or ground water influences on TDS, copper, iron and zinc.

2.6.3.2 Middle Fork Beargrass Creek

The Middle Fork of Beargrass Creek watershed encompasses about 25 square miles and includes an eastern section of metropolitan Louisville. This watershed includes sites where CSOs frequently occur and SSOs occasionally occur. The Middle Fork of Beargrass Creek receives discharges from CSOs at nine locations along its length.

Sampling conducted along the Middle Fork of Beargrass Creek during 1992 and 1993 consisted of five (5) stream samples and four (4) CSO samples as shown on Figure 2-28. The samples were analyzed for the same parameters as listed above for the South Fork Beargrass Creek.

The Synthesis Report indicated that the Middle Fork of Beargrass Creek has approximately 16 miles of stream on the 303(d) list for aquatic life and recreational impairment (swimmable). The causes of impairment are organic enrichment, low dissolved oxygen and pathogens. The Report indicated that approximately 45% of all samples were in violation of the fecal coliform standard. Metal violations included cadmium (about 4%), iron (about 5%), and zinc (about 3%). The low flow contributions for total dissolved solids (TDS), biochemical oxygen demand (BOD), nitrates (NO3, a nutrient), copper and zinc indicated significant point source or possible ground water influence on these parameters.

2.6.3.3 Muddy Fork Beargrass Creek

The Muddy Fork of Beargrass Creek covers about nine (9) square miles and much of the area consists of paved surfaces. The Muddy Fork is frequently subject to backwater from the Ohio River. It also serves as a receiving stream for three CSOs along its reach. The sampling effort conducted during 1992 and 1993 did not include this tributary of the Beargrass Creek.

The Muddy Fork has almost seven miles of the stream listed on the 303(d) list for recreational impairment (swimmable). The cause is pathogens with over a 30% rate of fecal coliform violations. There were also violations for cadmium (about 15%), iron (about 12%), copper (about 4%), and zinc (about 4%). Low flow contributions were indicative of possible ground water influence on total dissolved solids. Nutrients and fecal coliforms seem to be associated primarily with higher flows.

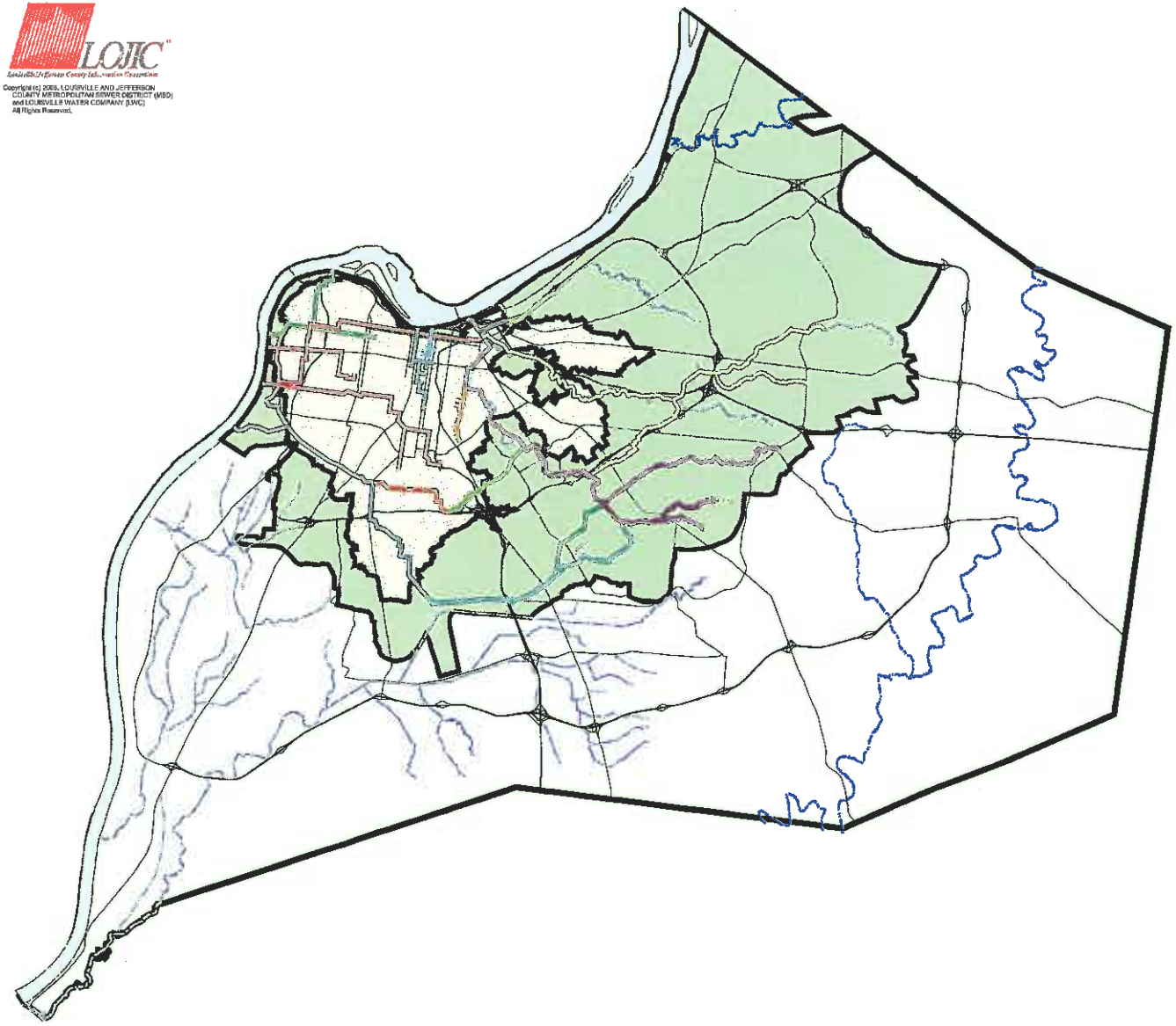
2.6.4 CSO Discharges and Water Quality Issues

The ORSANCO study showed that CSOs are a significant source of bacteria loadings to the Ohio River. However, other sources, such as tributaries and stormwater discharges, also contribute substantially to the bacteria loadings. Further definition of the relative significance of these sources will be undertaken during the development of the CSO LTCP. Dissolved oxygen was not identified as a concern in the 303(d) listing for the Ohio River.

In the Beargrass Creek watershed, the presence of pathogens, organic enrichment and low dissolved oxygen, and the presence of some metals, are common in all the tributaries. The TMDL effort currently under way in the watershed will identify the respective contributions of CSOs, SSOs, storm water discharge loads, and potential other sources, and develop a strategy for controlling this varied sources to meet water quality standards, if possible.

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FIGURE 2-1
MFWTP SERVICE AREA



LEGEND

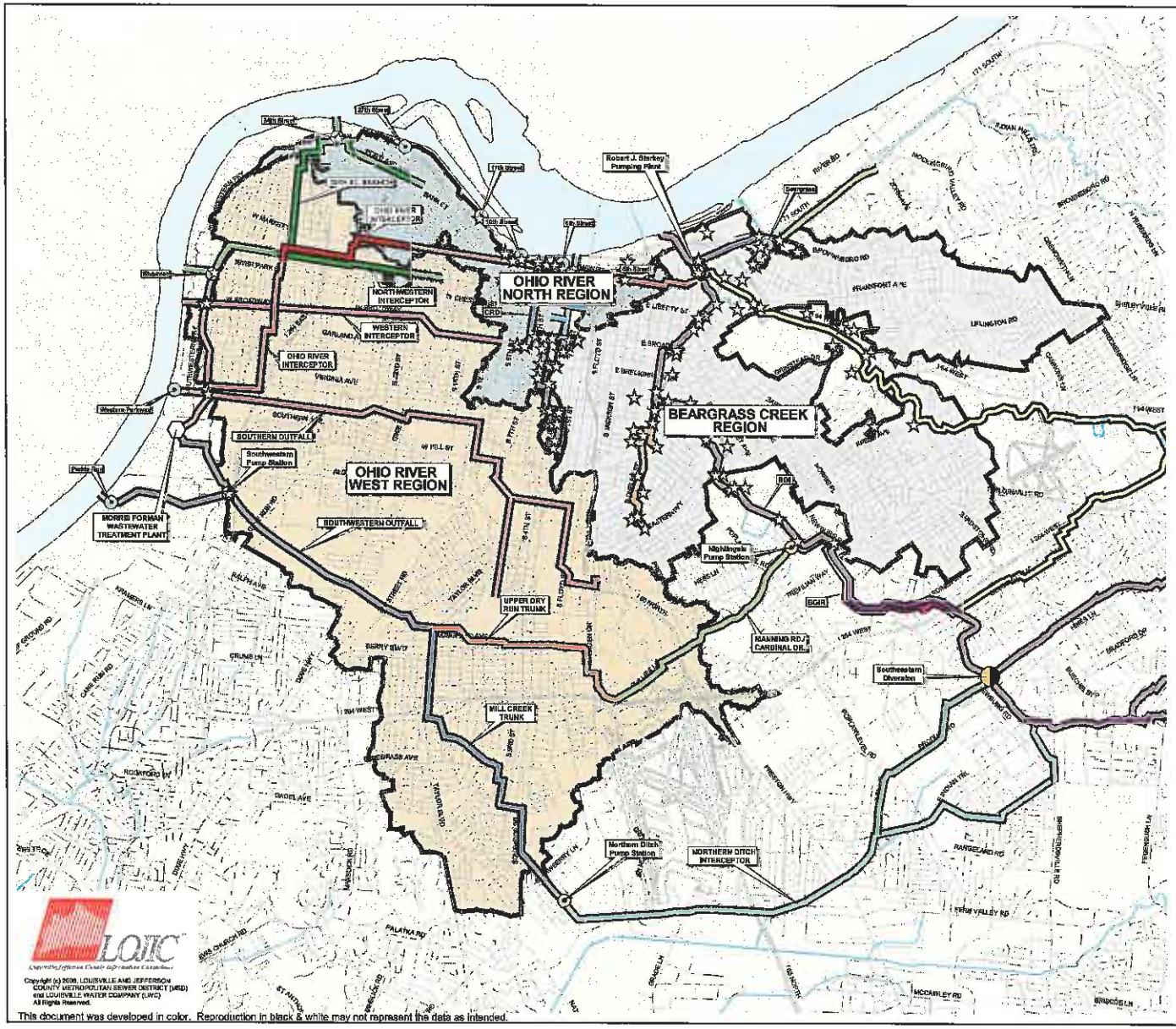
Major Sewers

- 38TH ST. BRANCH
- 4TH STREET RELIEF
- BEARGRASS INTERCEPTOR
- BEARGRASS INTERCEPTOR RELIEF
- CENTRAL RELIEF DRAIN
- GOLDSMITH LANE TRUNK
- MANNING RD./CARDINAL DR. SEWER
- MELLWOOD AVE. SEWER
- MIDDLE FORK TRUNK
- MILL CREEK TRUNK
- NORTHEASTERN INTERCEPTOR
- NORTHERN DITCH INTERCEPTOR
- NORTHWESTERN INTERCEPTOR
- OHIO RIVER INTERCEPTOR
- SNEADS BRANCH RELIEF
- SOUTHEASTERN INTERCEPTOR
- SOUTHERN OUTFALL
- SOUTHWESTERN OUTFALL
- UPPER DRY RUN TRUNK
- WESTERN OUTFALL
- Major Roads
- Major Streams
- Combined Sewer Area
- MFWTP Service Area

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FIGURE 2-2
COMBINED SEWER SYSTEM REGION MAP



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FIGURE 2-3
TYPICAL SYSTEM CONSTRICTIONS
BEARGRASS INTERCEPTOR
BEARGRASS CREEK REGION

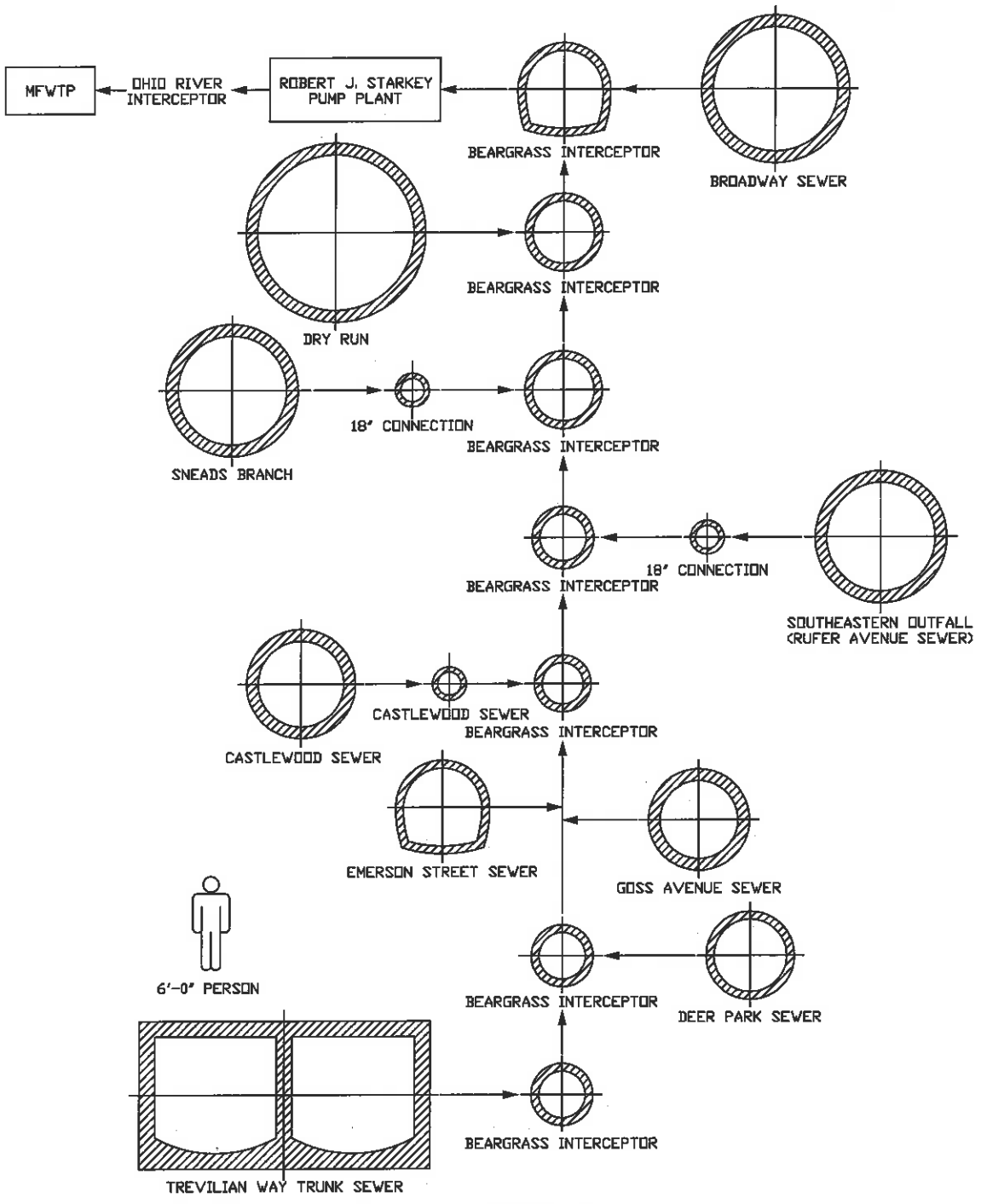


FIGURE 2-4
TYPICAL SYSTEM CONSTRICTIONS
MIDDLE FORK TRUNK
BEARGRASS CREEK REGION

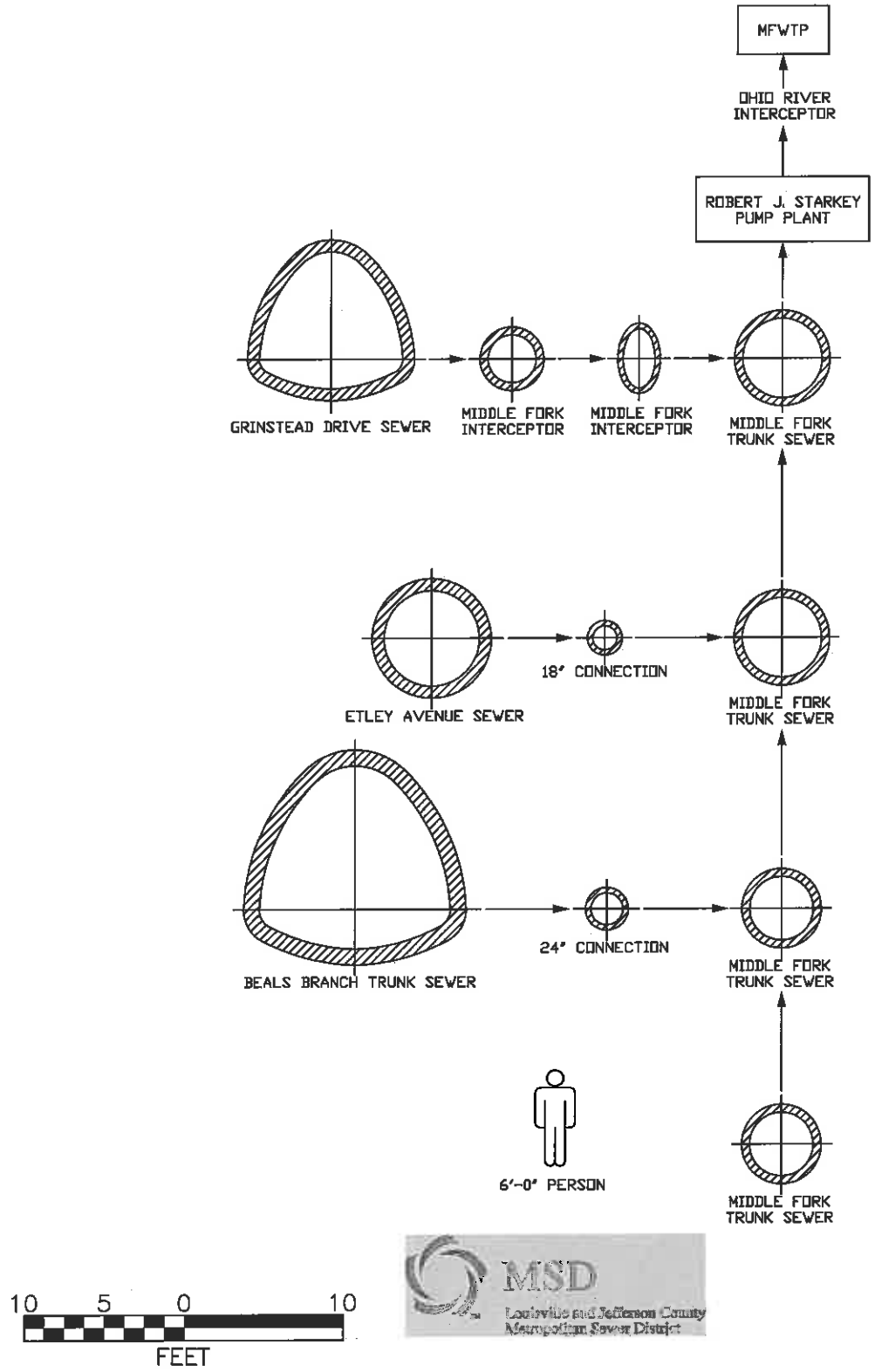
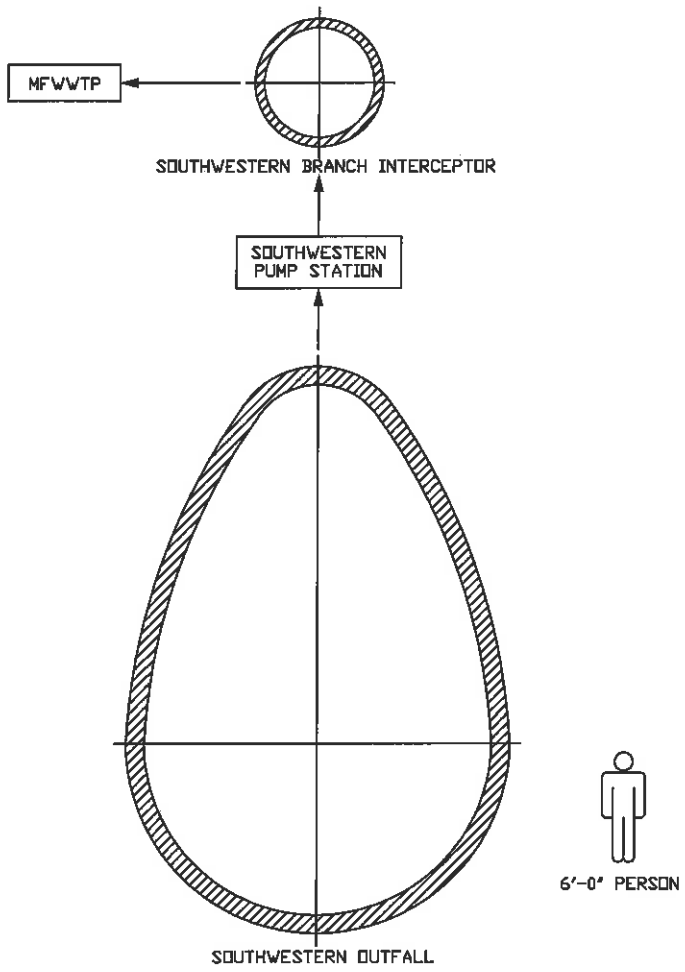


FIGURE 2-5
TYPICAL SYSTEM CONSTRICTIONS
SOUTHWESTERN OUTFALL
OHIO RIVER WEST REGION



10 5 0 10
FEET

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FIGURE 2-6
TYPICAL SYSTEM CONSTRICTIONS
NORTHWEST CITY
OHIO RIVER WEST REGION

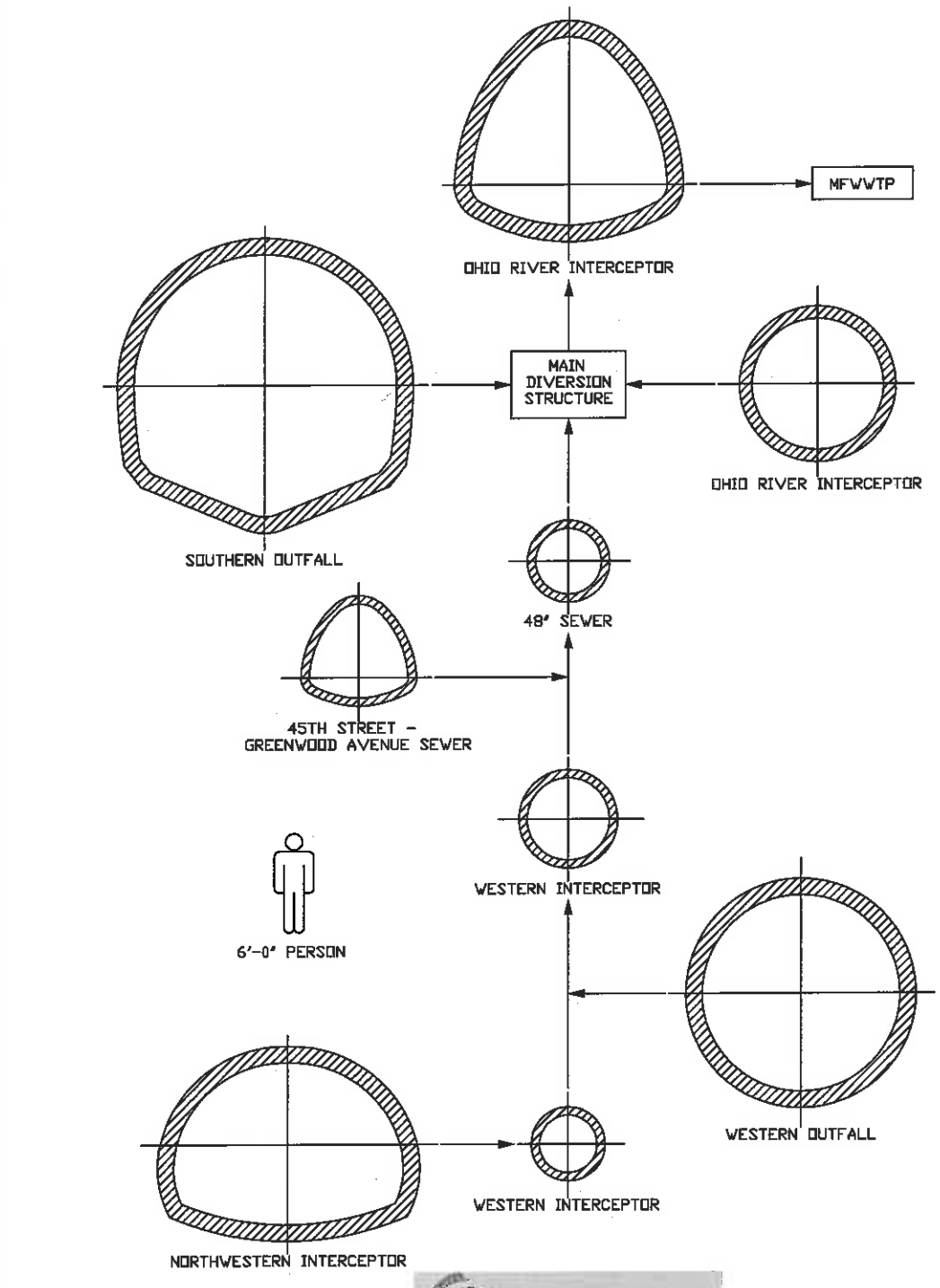
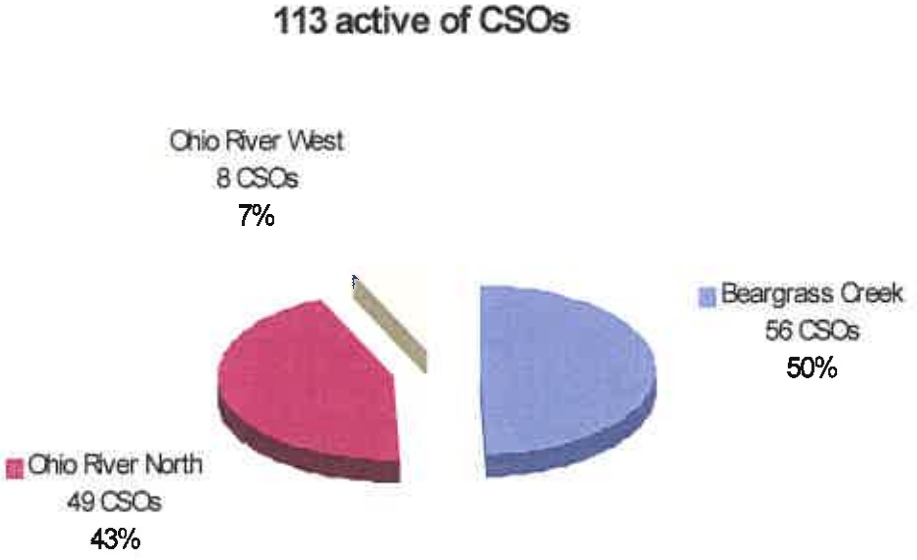
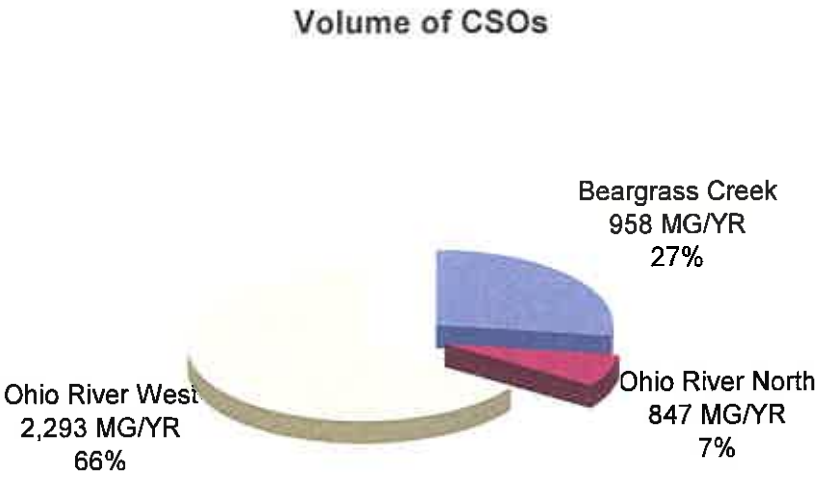


FIGURE 2-7
LOCATION OF CSOs



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FIGURE 2-8
OVERFLOW VOLUME OF CSOs



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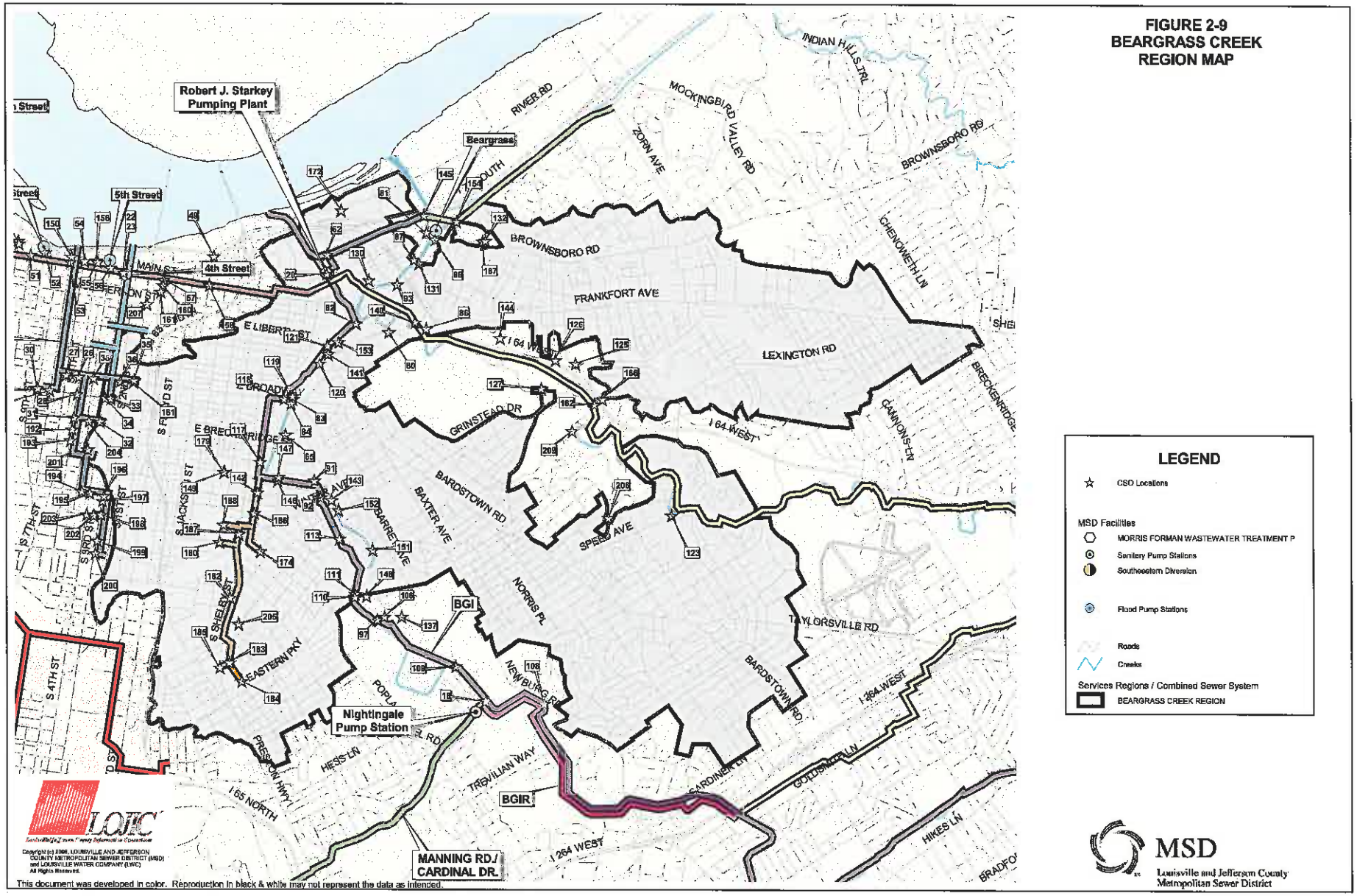
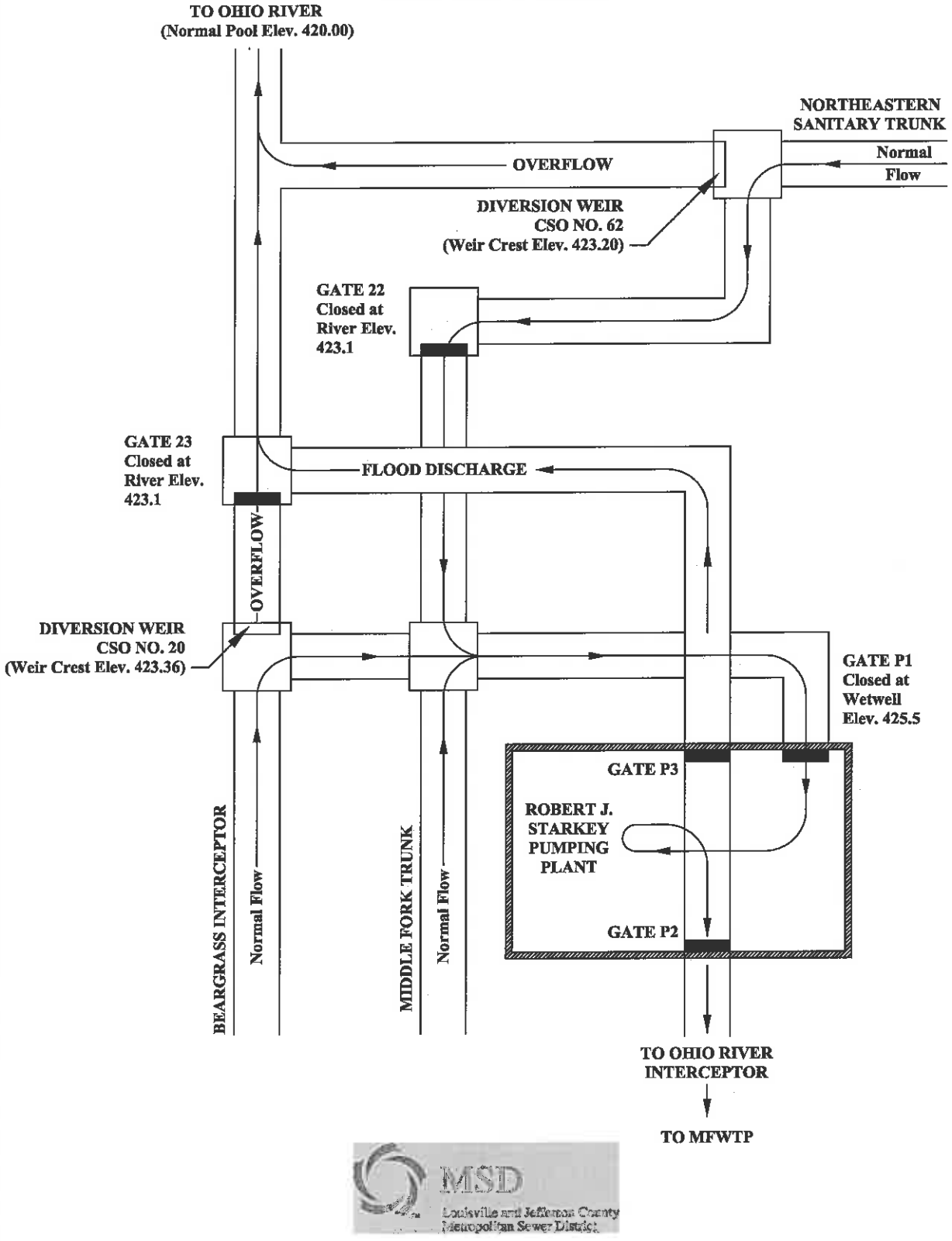


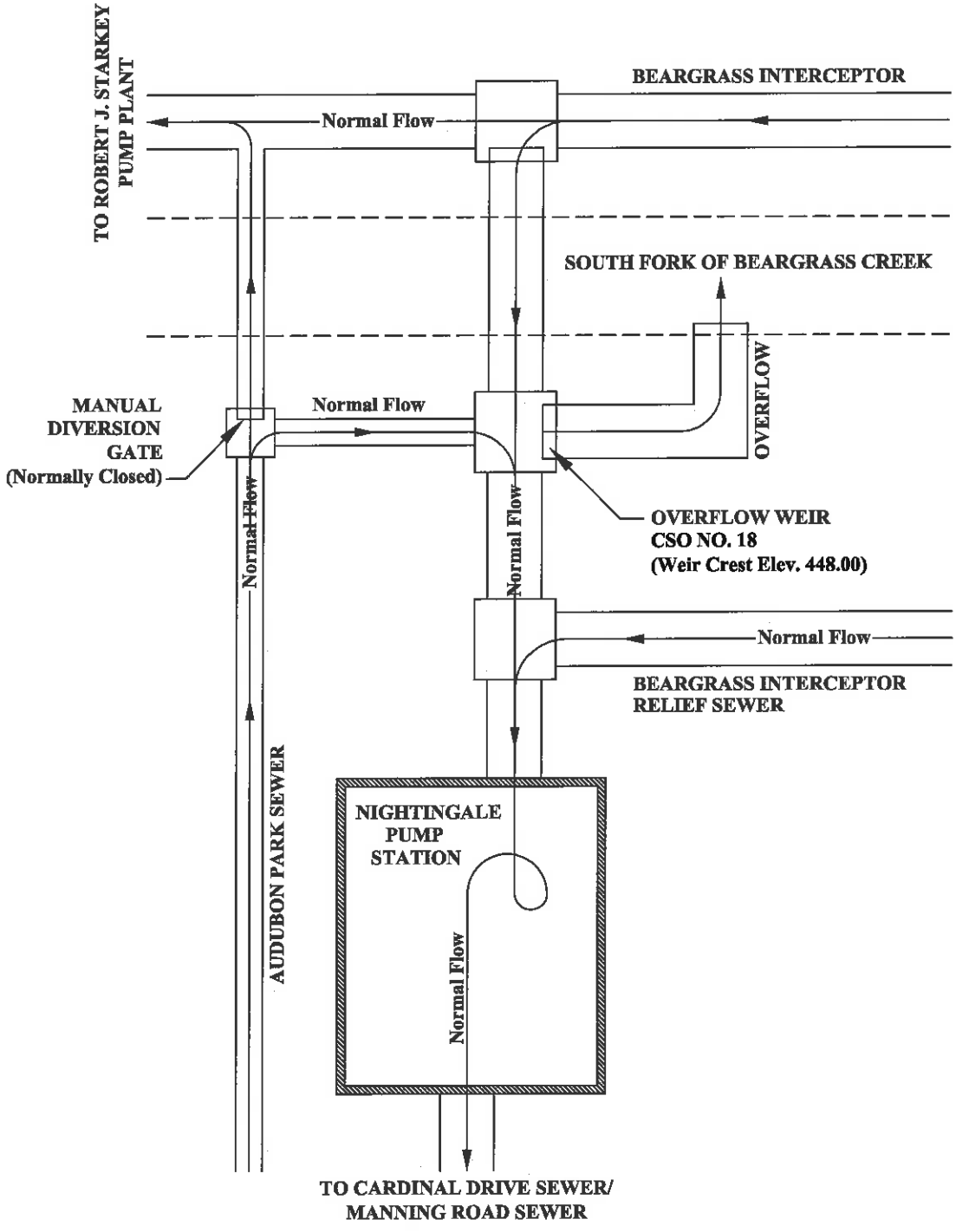
FIGURE 2-9
BEARGRASS CREEK
REGION MAP

FIGURE 2-10
ROBERT J. STARKEY
PUMPING PLANT



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FIGURE 2-11
NIGHTINGALE
PUMP STATION



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FIGURE 2-12
SAMPLE
CSO INVENTORY SHEET

DATE: JUNE 4, 1991
CSO SERIAL NO. 126
REGULATOR NO. 25 - RAYMOND AVENUE SEWER
LOCATION: North of I-64, east of Saunders Lane and west of Grinstead Drive
OVERFLOW TYPE: REG

STRUCTURE OVERFLOW ELEVATION:

438.83 - Crest of dam

OVERFLOW TYPE AND SEWER GEOMETRY:

The overflow is located on a 36" circular sewer flowing south from Bickel Avenue. A 27" circular sewer flowing east from Saunders Avenue enters the 36" sewer just upstream of the overflow structure. The Middle Fork Interceptor is flowing west below the 27" sewer. The 36" sewer enters a diversion chamber at invert elevation 437.93 where the low flows drop through missing rack bars and discharge through a 15" sewer at invert elevation 434.44 to a regulator chamber. The flow exits the 15" sewer into the regulator chamber through a regulated opening. The regulator is operated by a float system, which is "tell-tales" off the Middle Fork Interceptor through a 10" sewer. The flow exits the regulator chamber through an 18" sewer at invert elevation 434.08 to the 33" Middle Fork Interceptor. The invert elevation of the interceptor at this point is 433.07. The float system shuts the regulated opening when the flow in the Middle Fork Interceptor reaches elevation 435.77. The overflows exit the diversion chamber through a 4' x 3' box culvert with a 12" dam located about 5' downstream of the diversion chamber. The crest of the dam is at elevation 438.83.

The shut-off elevation is taken from construction plans. The actual working elevations and capabilities of the regulator are unknown.

BACKWATER LENGTHS AND STORAGE VOLUMES:

The 36" sewer is at a 2.375% grade. A 12" dam corresponds to backwater length of about 42 feet. The storage is about 40 cubic feet.

DOWNSTREAM BACKWATER EFFECTS:

The overflow discharges to a 5' x 4' box culvert flowing south under I-64 to the Middle Fork of Beargrass Creek. High levels in the creek may backup into the overflow.

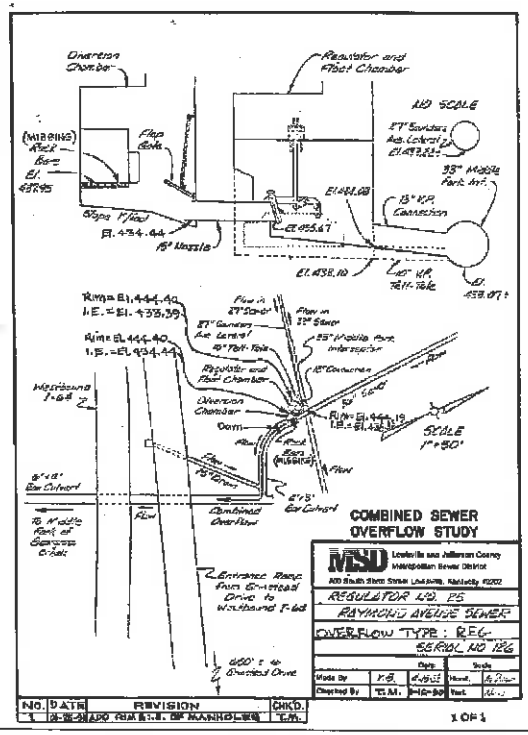
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12/00

COMBINED SEWER OVERFLOW INVENTORY
FIELD INVESTIGATION REPORT

CSO NO.: 126 NAME OF STRUCTURE: Regulator No. 25
LOCATION: In easement east of Saunders Lane, north of I-64, west of Grinstead Drive
DATE INSTALLED: 1930 TYPE OF STRUCTURE: Regulator chamber
MSD ATLAS NO: J-15 RECORD NOS.: G-51, 56, 57, 58
INTENDED OPERATION AND FUNCTION: To divert low flow from Raymond Avenue area combined to Middle Fork Interceptor sanitary. Tell-tale works by the depth of flow in Beargrass Interceptor.
FUNCTION AND OPERATION FOUND DURING FIELD INVESTIGATION: As should be.

DRY WEATHER FLOW CONDITIONS
NAME OF INLET SEWER: Raymond Avenue Sewer
RECORD NOS.: G-51, 56, 57, 58 SIZE: 36" GRADE: 2.75%
LOW FLOW CONNECTION: SIZE: 15" GRADE: N/A
NAME OF OUTLET SEWER: Middle Fork Interceptor
RECORD NOS.: A-75 SIZE: 33" GRADE: 0.11%
NAME OF EVENTUAL RECEIVING BODY OF WATER: Middle Fork of Beargrass Creek
REMARKS:

FIELD INVESTIGATED BY: Tom Middaler DATE: 8/22/89



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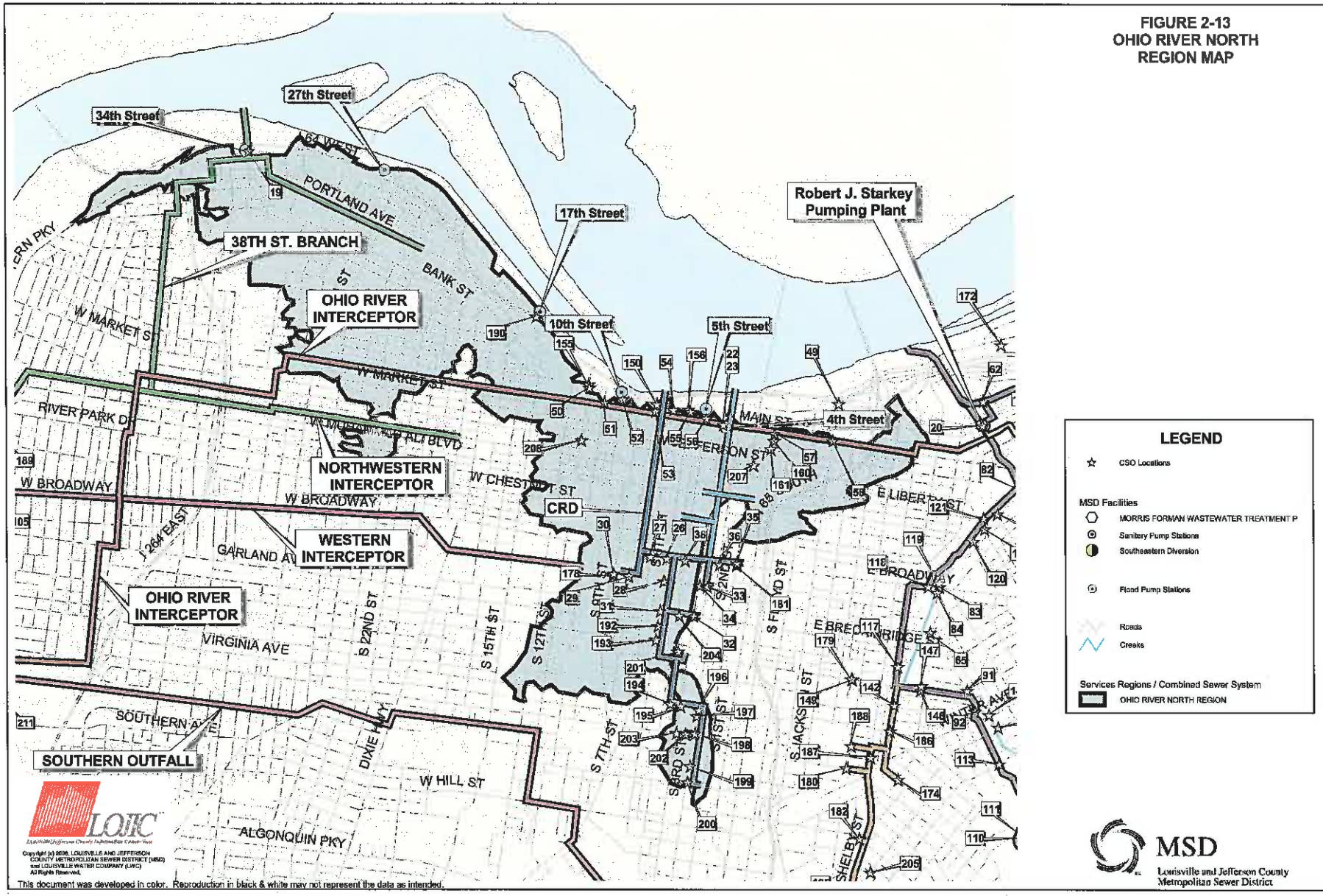
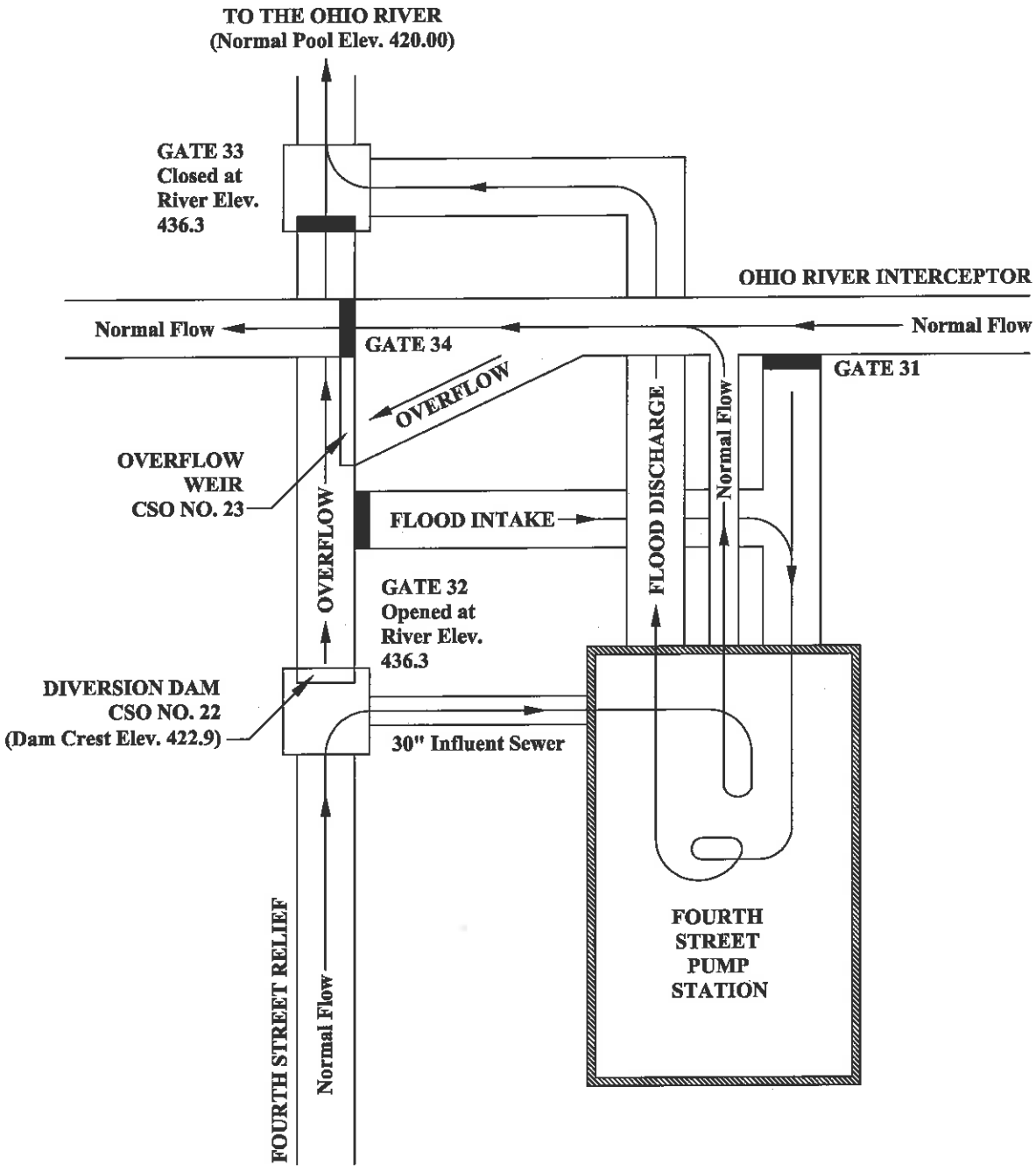


FIGURE 2-13
OHIO RIVER NORTH
REGION MAP

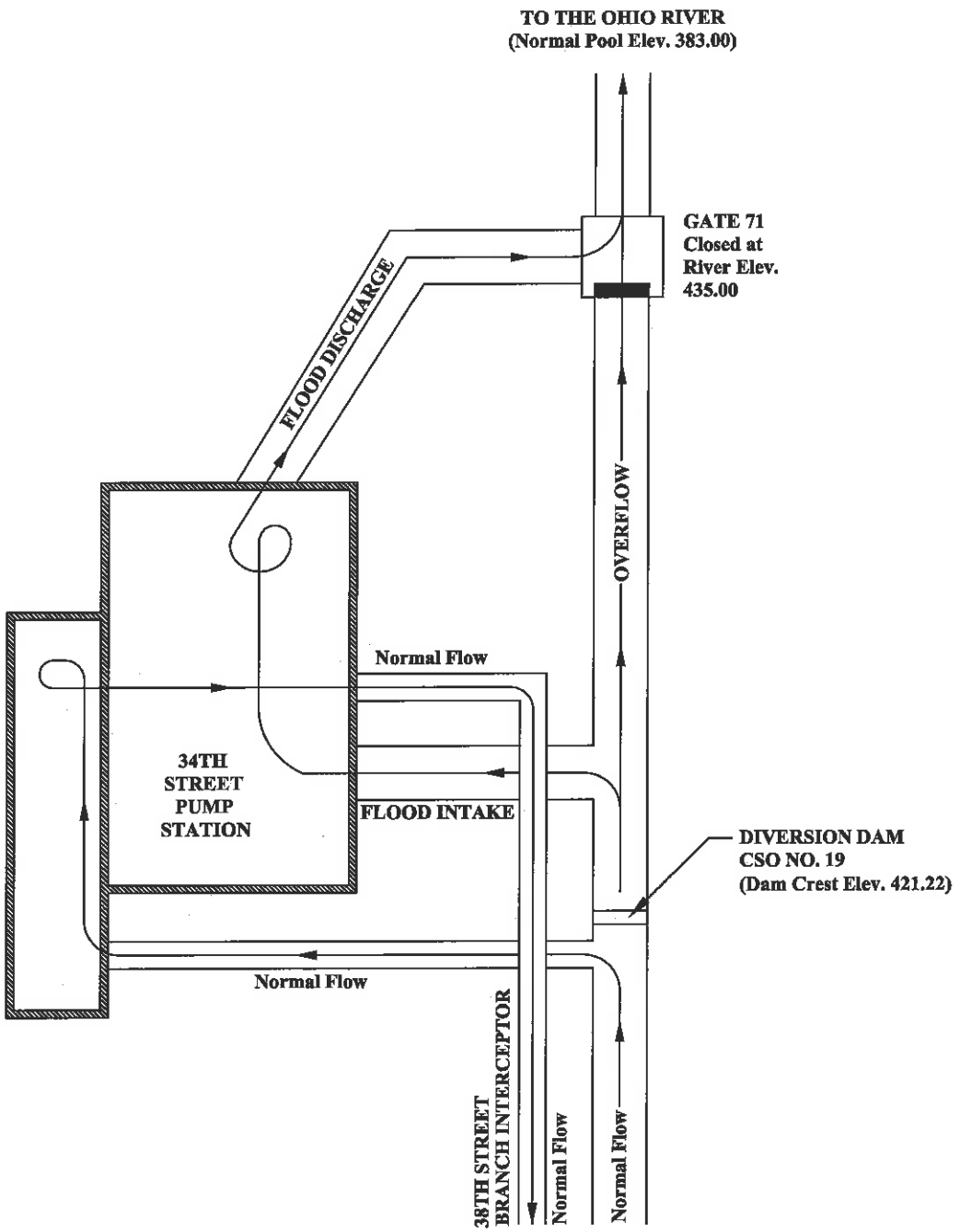
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FIGURE 2-14
FOURTH STREET
PUMP STATION



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FIGURE 2-15
34TH STREET
PUMP STATION



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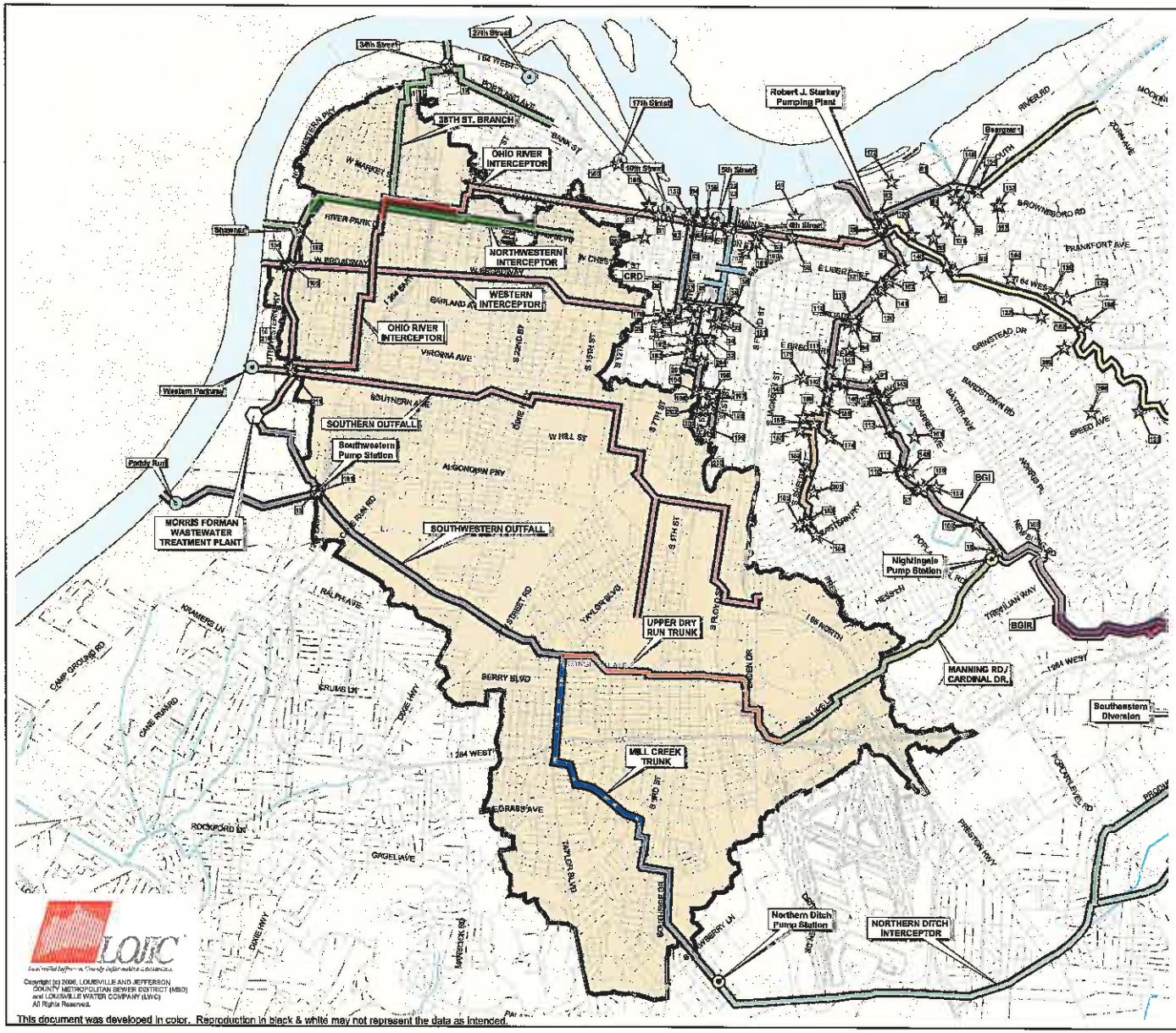


FIGURE 2-16
OHIO RIVER WEST REGION MAP

LEGEND

- CSO Locations

MSD Facilities

- MORRIS FORMAN WASTEWATER TREATMENT P
- Sanitary Pump Stations
- Southeastern Diversion
- Flood Pump Stations
- Roads
- Creeks

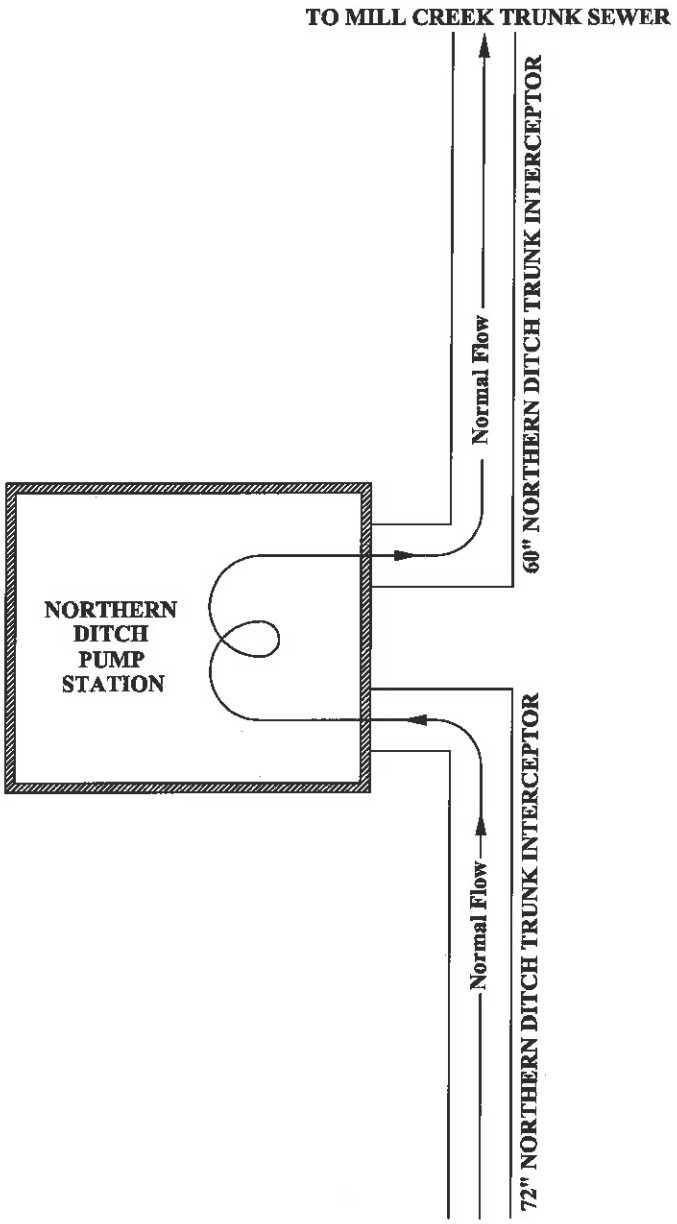
Services Regions / Combined Sewer System

- OHIO RIVER WEST REGION

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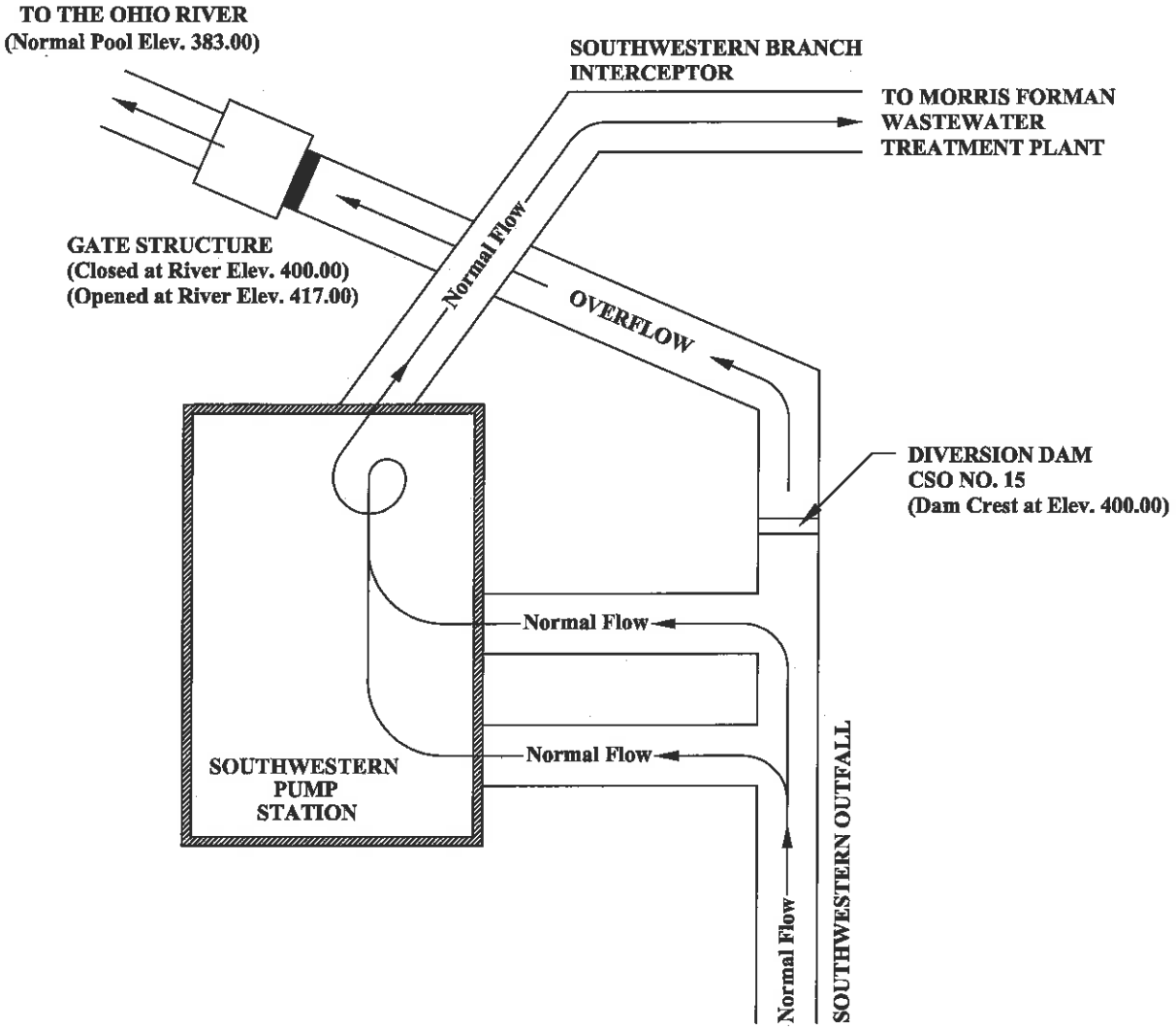
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FIGURE 2-17
NORTHERN DITCH
PUMP STATION



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FIGURE 2-18
SOUTHWESTERN
PUMP STATION



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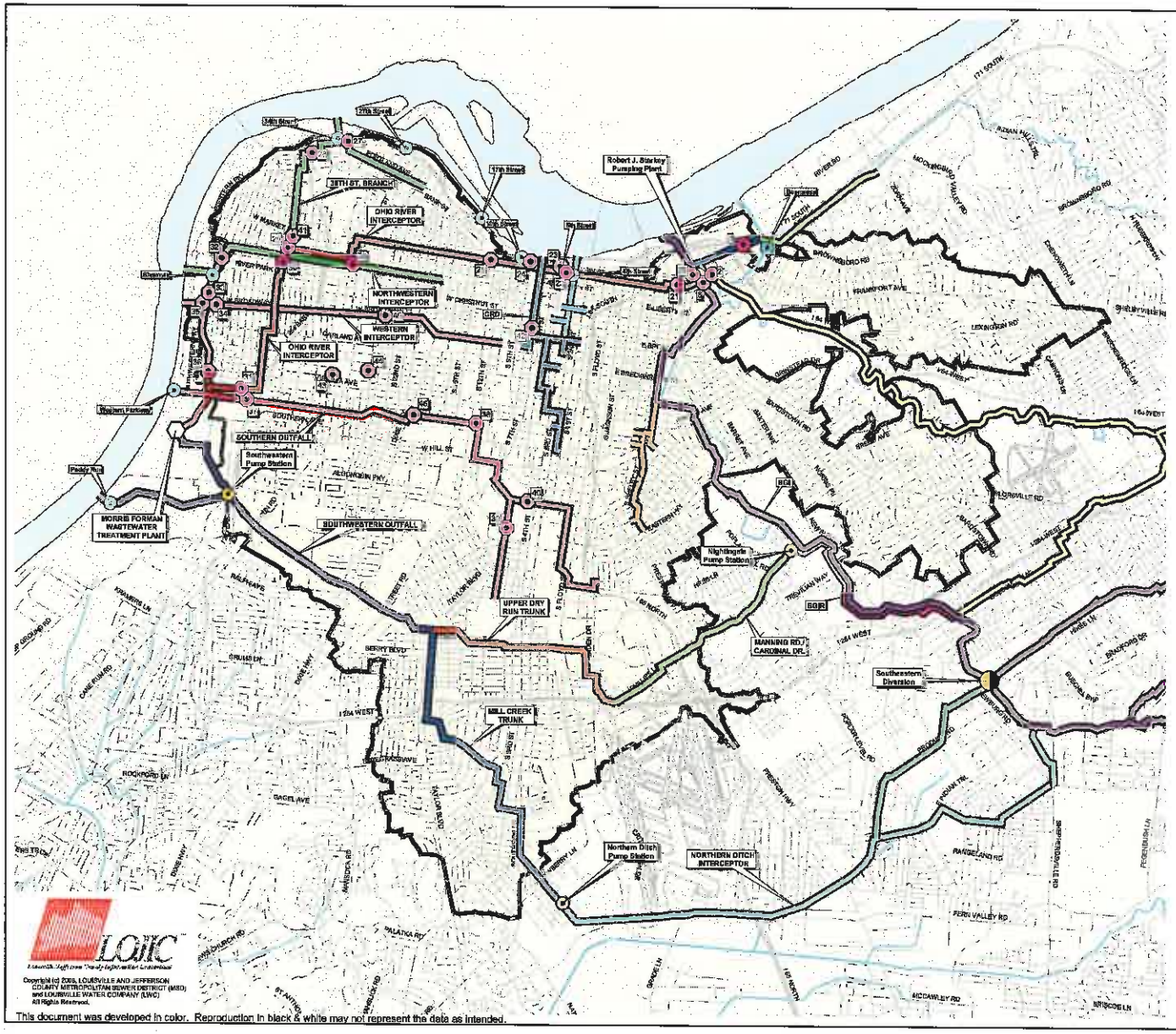


FIGURE 2-19
1993 PHASE I FLOW METER LOCATION MAP

LEGEND

- Phase I Flow Meters

MSD Facilities

- MORRIS FORMAN WASTEWATER TREATMENT P
- Sanitary Pump Stations
- Southeastern Diversion
- Flood Pump Stations
- Roads
- Creeks
- Combined Sewer Area

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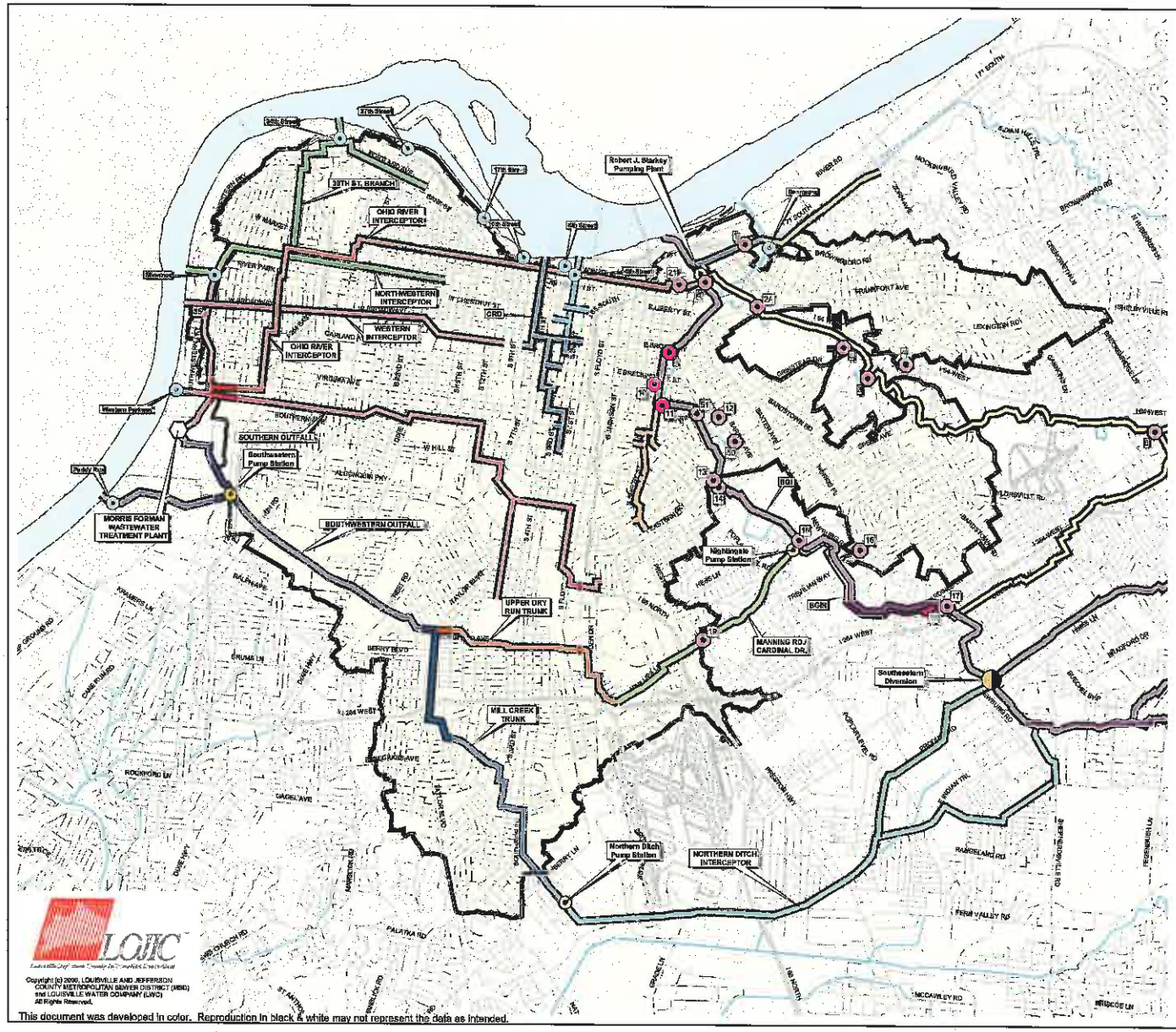


FIGURE 2-20
1993 PHASE II FLOW METER LOCATION MAP

LEGEND

- Phase II Flow Meters

MSD Facilities

- MORRIS FORMAN WASTEWATER TREATMENT P
- Sanitary Pump Stations
- Southeastern Diversion
- Flood Pump Stations
- Roads
- Creeks
- Combined Sewer Area

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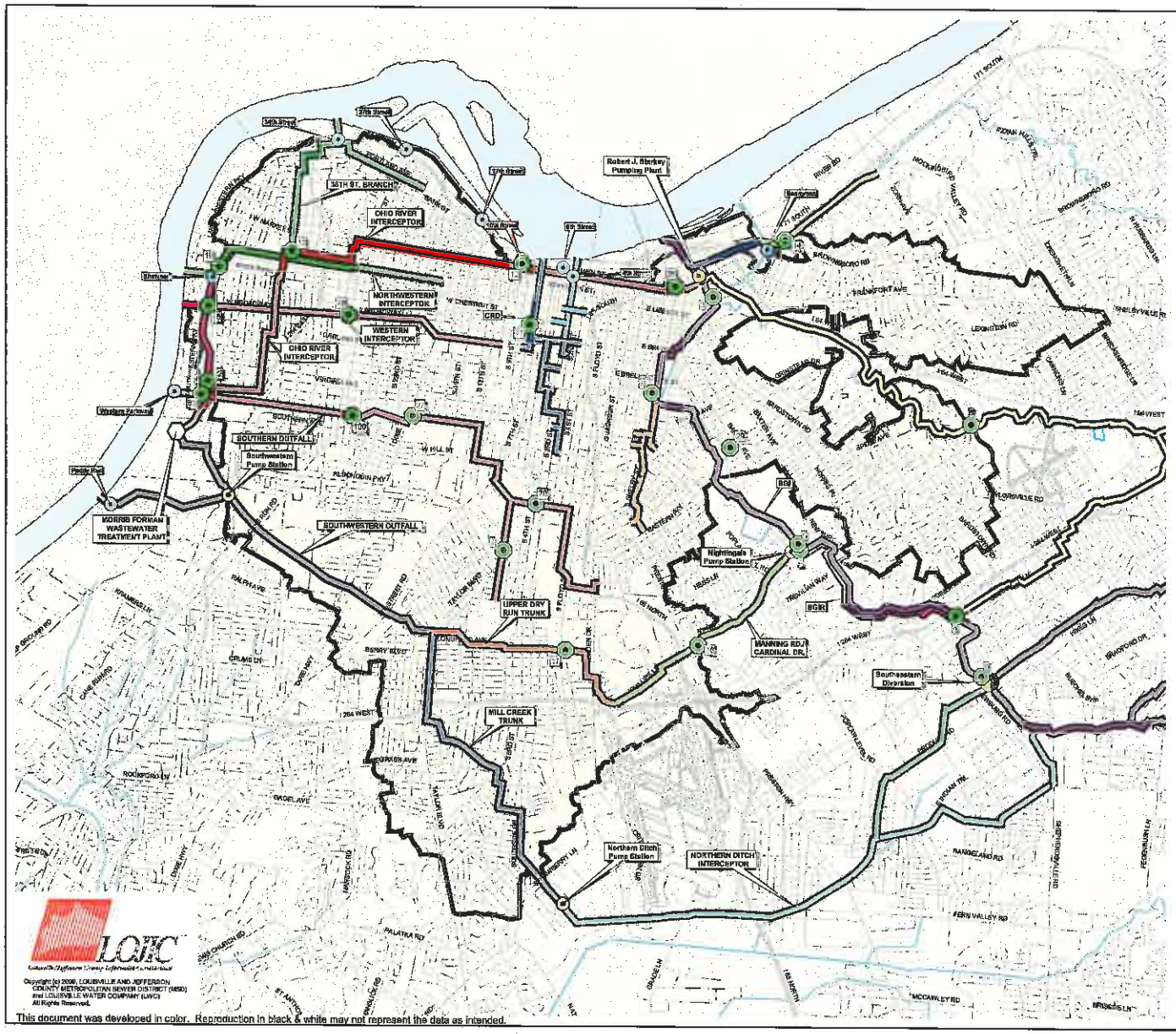


FIGURE 2-21
2002 FLOW METER LOCATION MAP

LEGEND

- 2002 Flow Meter Locations

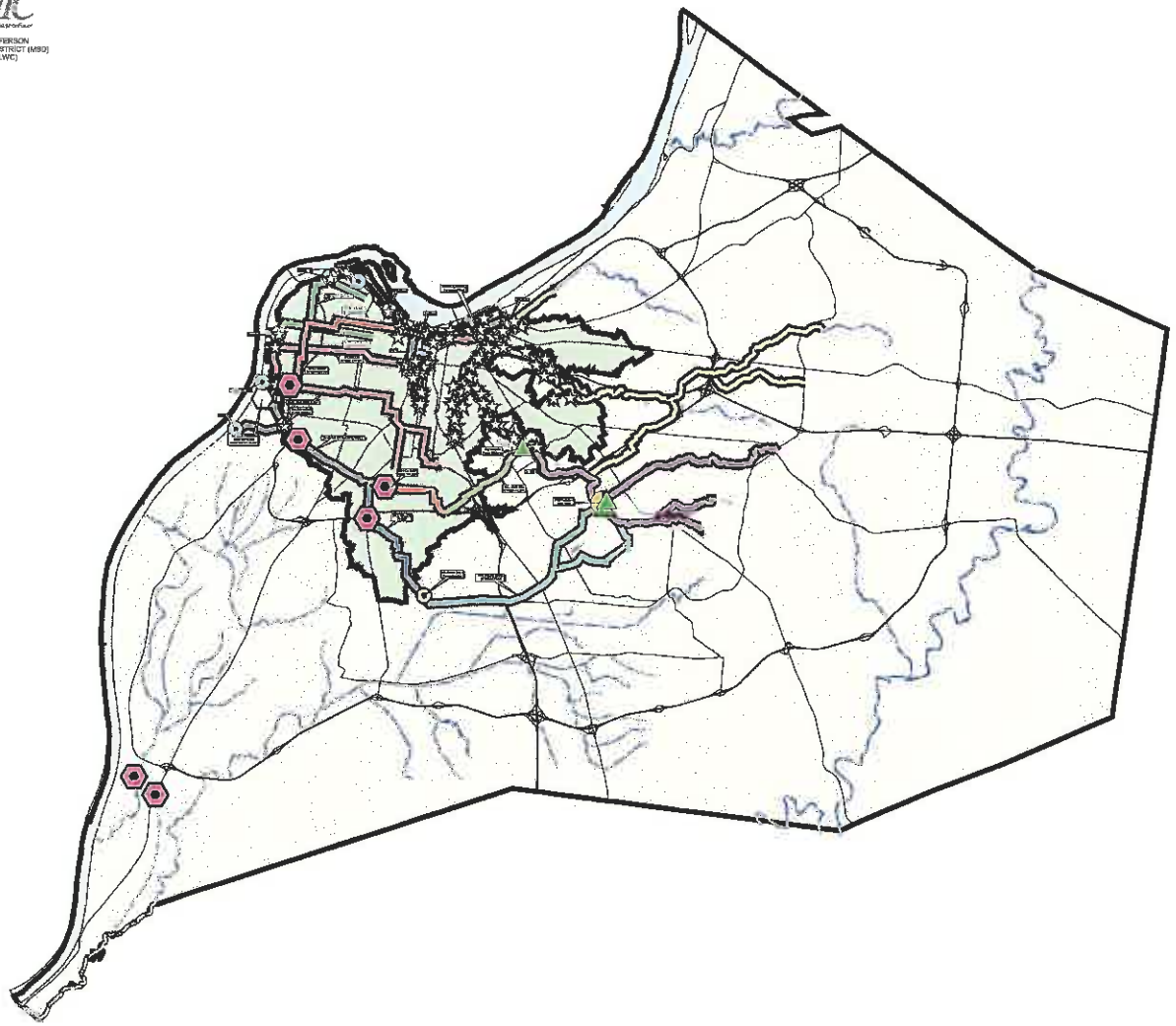
MSD Facilities

- MORRIS FORMAN WASTEWATER TREATMENT P
- Sanitary Pump Stations
- Southeastern Diversion
- Flood Pump Stations
- Roads
- Creeks
- Combined Sewer Area

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FIGURE 2-22
PERMANENT FLOW MONITORING LOCATIONS



LEGEND

- Permanent Flow Meters
- RTC Locations
- CSO Locations

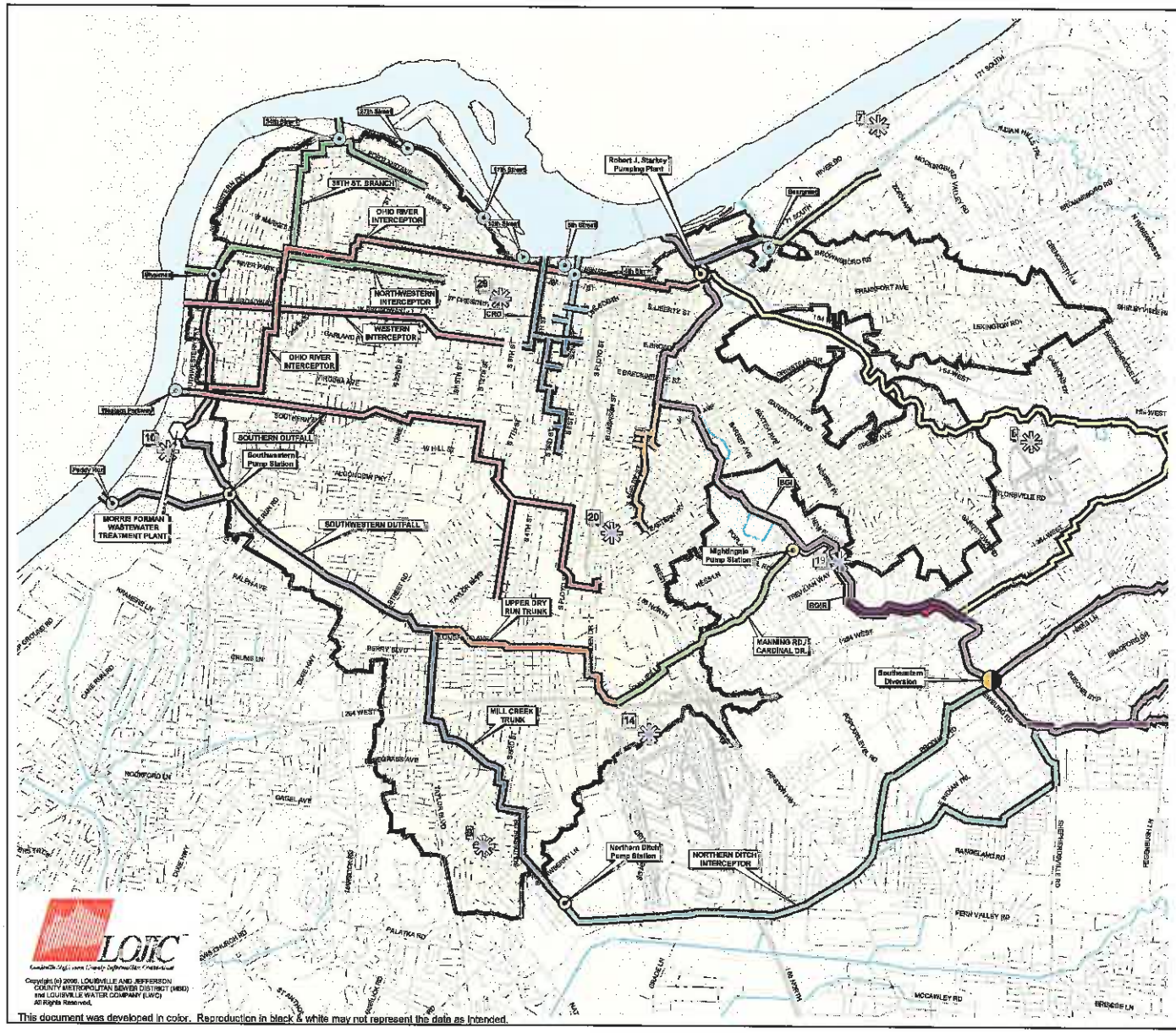
MSD Facilities

- MORRIS FORMAN WASTEWATER TREATMENT P
- Sanitary Pump Stations
- Southeastern Diversion
- Flood Pump Stations
- Major Roads
- Major Streams
- Combined Sewer Area

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FIGURE 2-23
ORIGINAL RAIN GAUGE LOCATION MAP



LEGEND

- Rain Gauge Locations

MSD Facilities

- MORRIS FORMAN WASTEWATER TREATMENT P
- Sanitary Pump Stations
- Southeastern Diversion
- Flood Pump Stations
- Roads
- Creeks
- Combined Sewer Area

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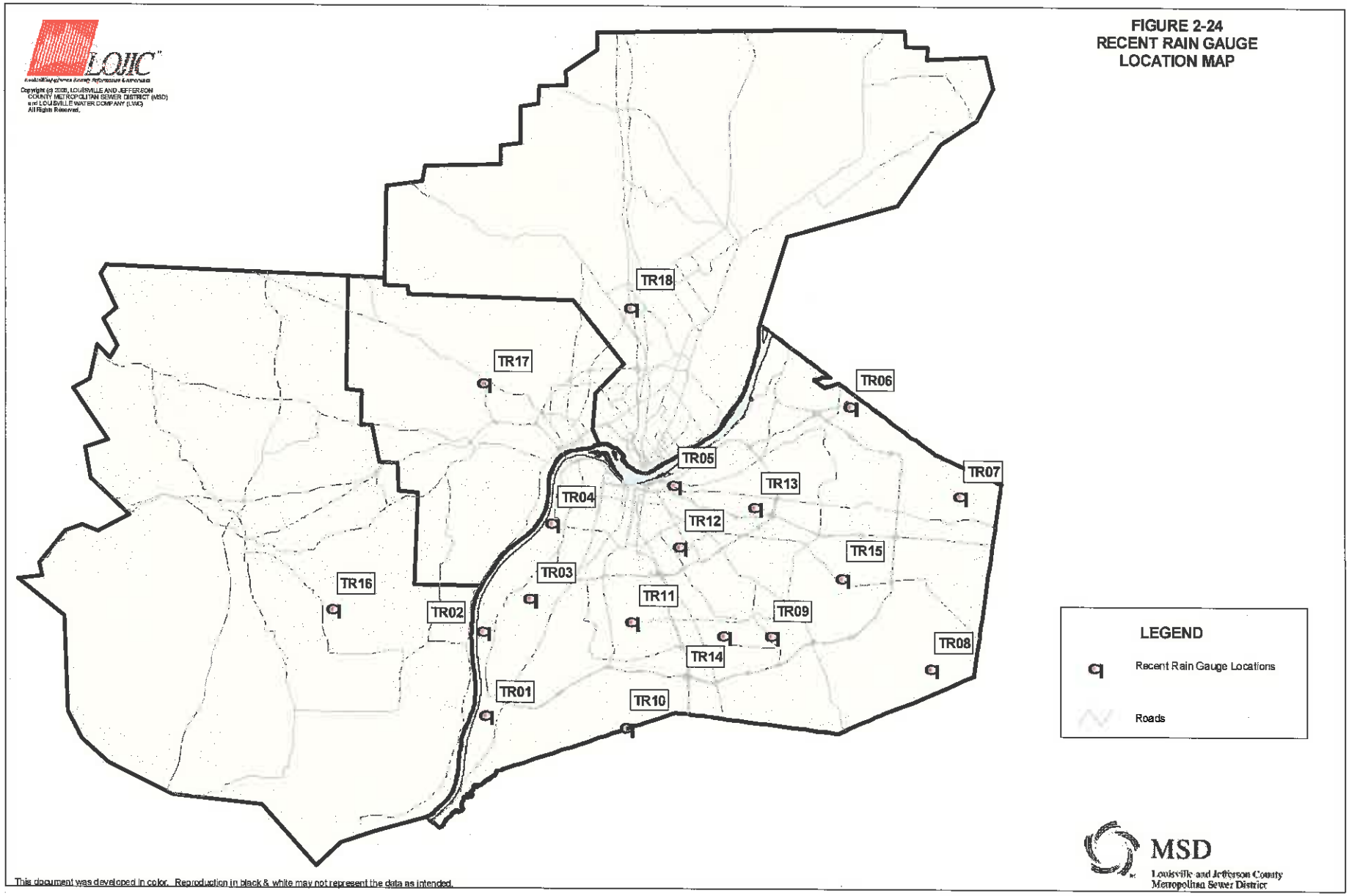
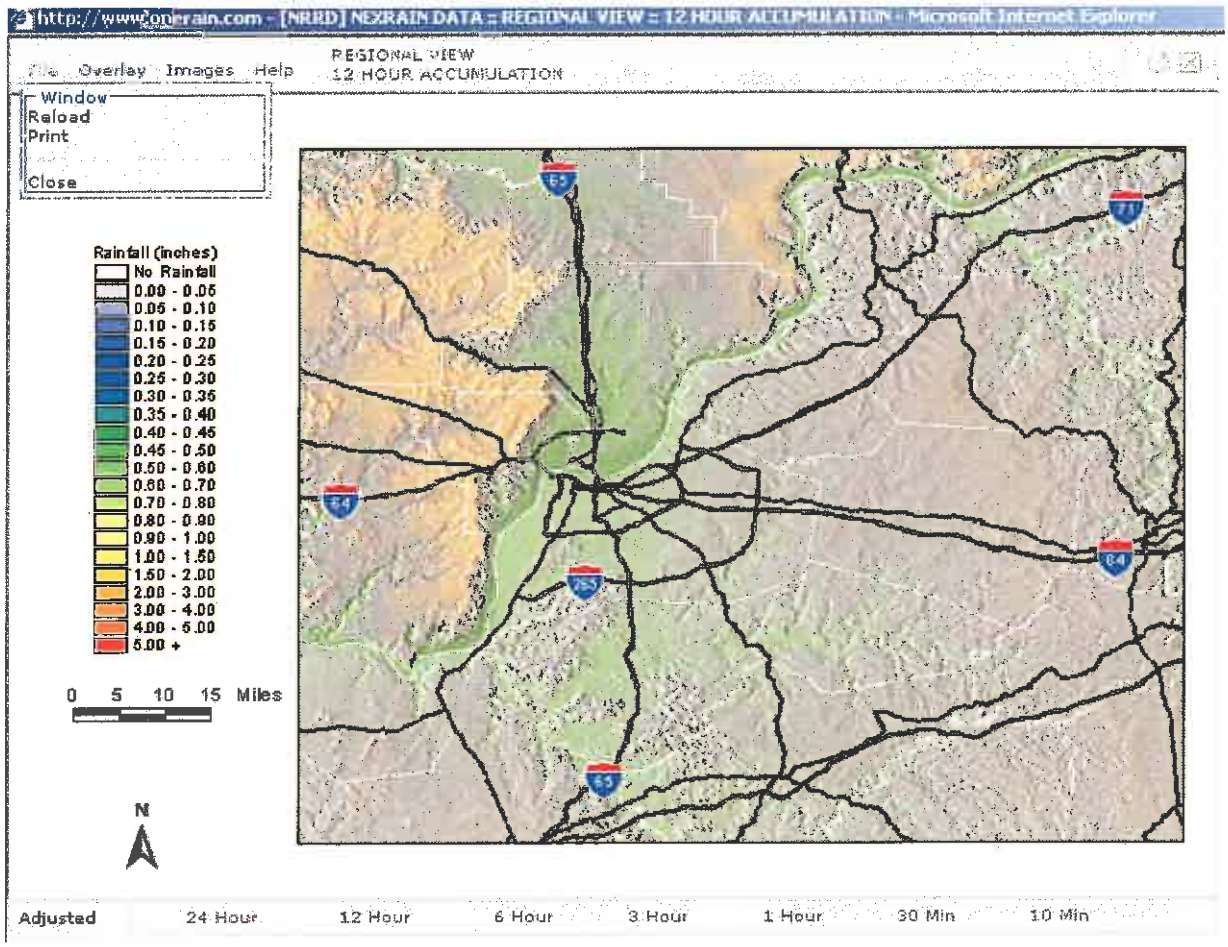
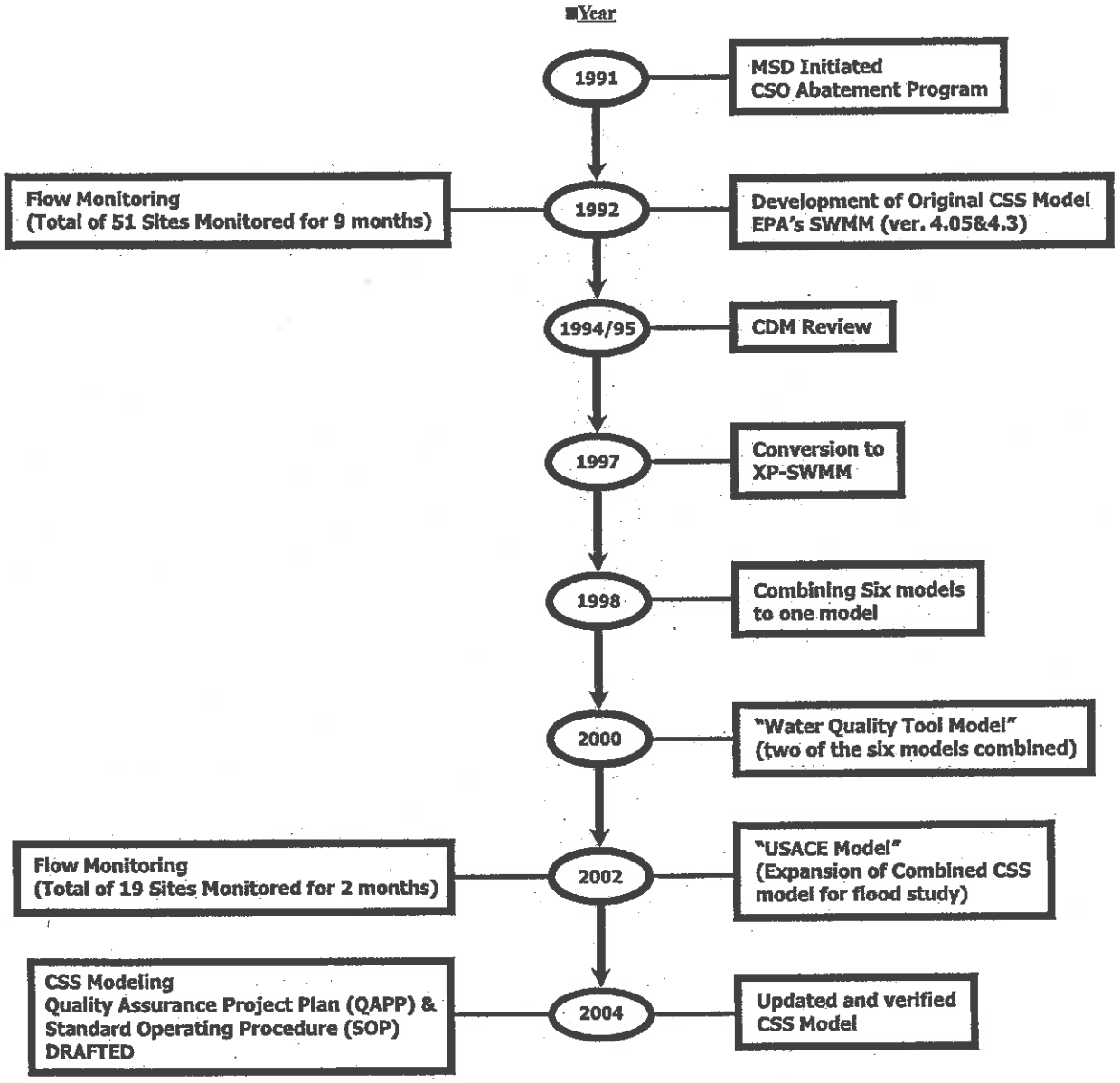

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FIGURE 2-24
RECENT RAIN GAUGE LOCATION MAP
TR18
TR17
TR06
TR05
TR07
TR13
TR04
TR12
TR15
TR03
TR16
TR02
TR11
TR09
TR08
TR14
TR01
TR10
LEGEND
Recent Rain Gauge Locations
Roads
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FIGURE 2-25
RADAR RAINFALL VIEW



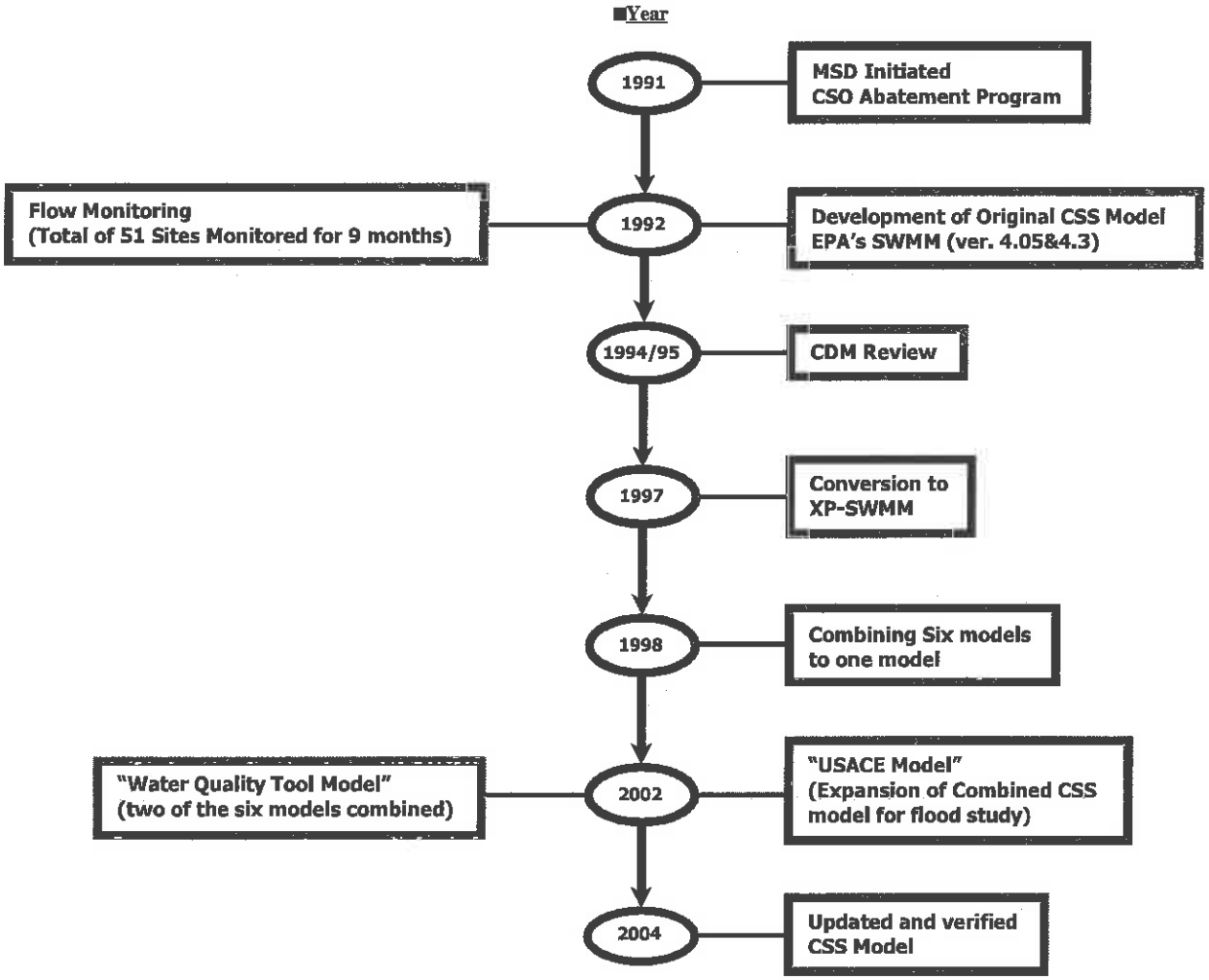
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FIGURE 2-26
CSS MODEL TIME TABLE



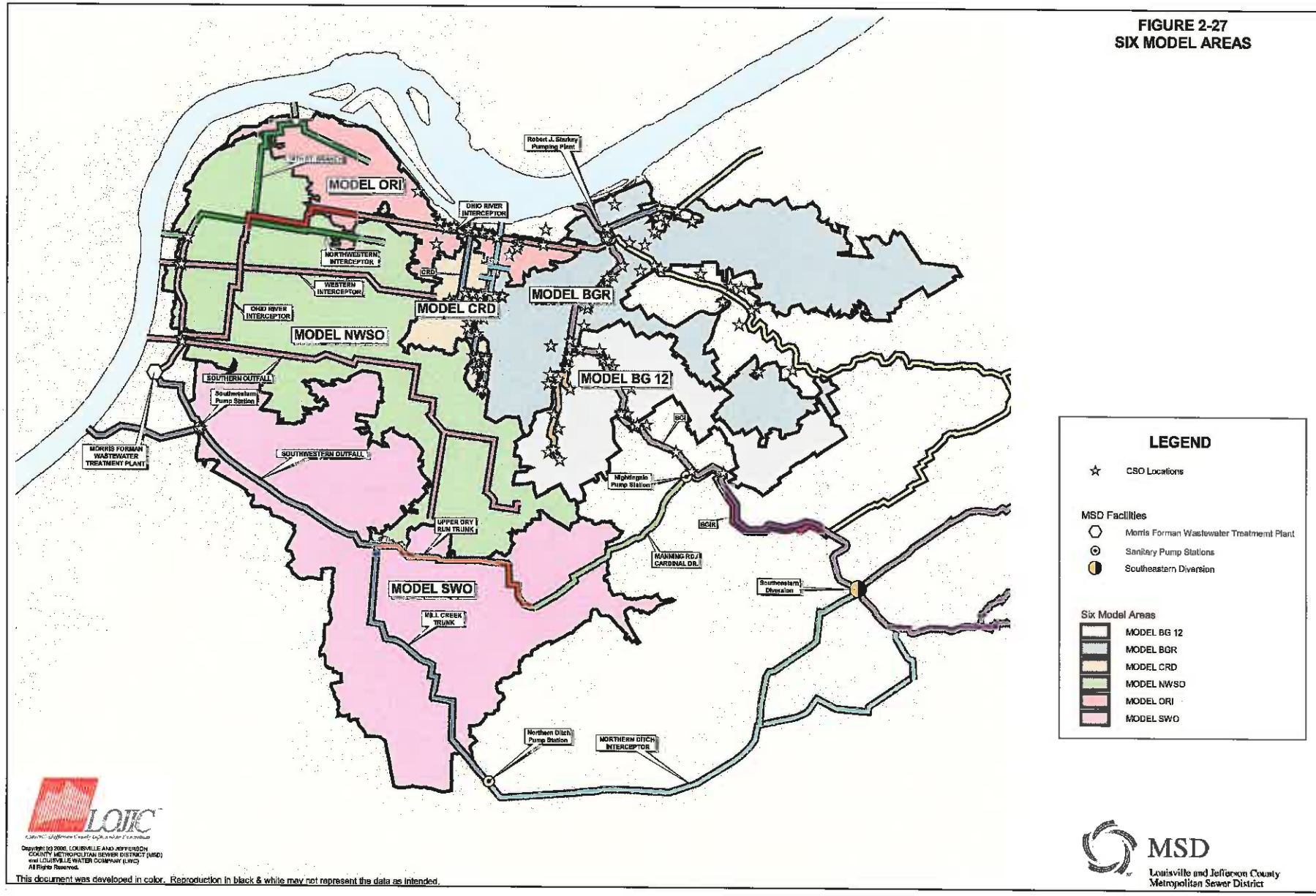
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FIGURE 2-26
CSS MODEL TIME TABLE



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FIGURE 2-27
SIX MODEL AREAS



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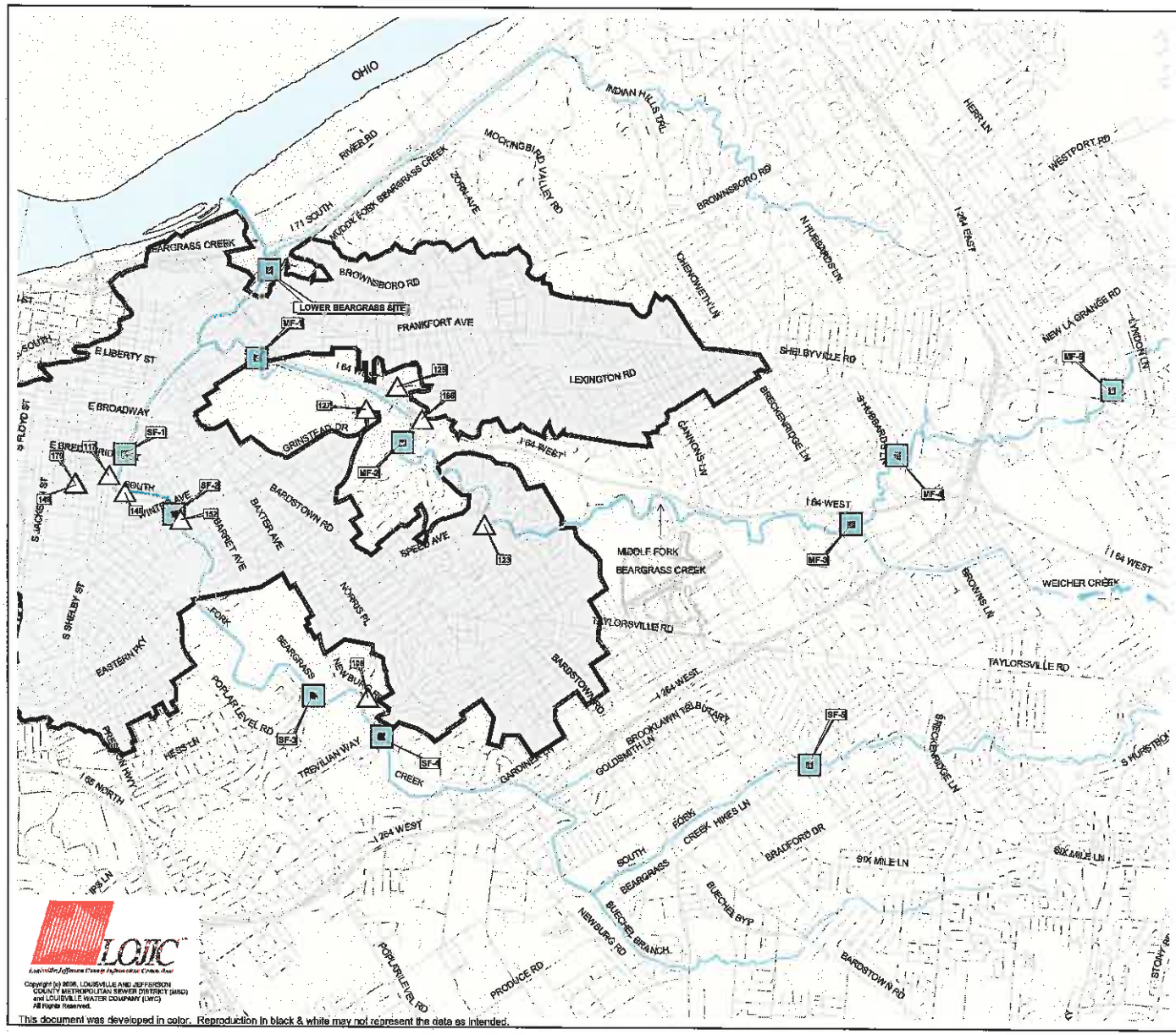


FIGURE 2-28
1992-1993
SAMPLING LOCATION MAP
FOR
BEARGRASS CREEK

LEGEND

- CSO Sample Locations
- Stream Sample Locations
- Roads
- Creeks

Services Regions / Combined Sewer System
BEARGRASS CREEK REGION

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SECTION 3

SECTION 3: PUBLIC PARTICIPATION

3.1 INTRODUCTION

MSD has made a major commitment to implement an active public participation program educating the customers so that they might provide input on the appropriate decisions. This commitment is the recognition of the responsibility to be accountable to the MSD ratepayers. The goal of MSD's public participation program is to serve the community. The commitment to public education and participation will persist as the focus continues for development of the CSO LTCP.

There are many levels of pubic participation and public education including the Pardon Our Dust meetings to introduce a construction project to a neighborhood; Mayor's Night Out meetings and meetings held by other public officials to answer questions put forth by the public; and participation in the Beargrass Creek Watershed. This section provides an overview of the many activities performed by MSD to communicate and educate the public.

Additional related information is located in the Nine Minimum Controls Compliance Report dated June 3, 2006. Specifically, Sections 8 and 9 contain expanded public notification and education overviews with supporting materials included in the corresponding Supplemental Information binder.

3.2 PUBLIC EDUCATION

There are many public education activities that have been performed to date. These include education efforts for the general public but also include a structured and detailed internal education effort. Below is only a sampling of the many activities sponsored by MSD.

3.2.1 The CSO Warning Signs

MSD modified the CSO warning signs in 2004 to include international symbols, and added warning information in Spanish due to the increasing local Hispanic population in the community. These signs will be replaced with an enhanced warning message written in English as well as Spanish as part of the Nine Minimum Controls program. Placement of these signs will be reviewed and is expected to be expanded

3.2.2 Operation Brightside

MSD helps finance a "Louisville Metro Brightside," which teaches elementary and secondary school children about environmental issues. Launched in 1986 by Mayor Jerry Abramson, Brightside promotes civic pride by partnering with citizens to keep our community clean, green and environmentally aware. Brightside organizes community-wide and neighborhood cleanups and oversees more than 75 BrightSites throughout Louisville Metro.

3.2.3 Water Quality Reports

MSD released a series of publications focusing on watershed issues providing the community with a basic understanding of water quality issues. The following reports were produced:

- Water Quality in Jefferson County, KY - A Watershed Synthesis Report (1999) - Saffran and Jarrett - Water quality monitoring data from MSD's sampling sites was compiled and published.
- Beargrass Creek Water Quality Report 2000 - A Closer Look at Local Watersheds (2000) - Summarized water quality in each of Jefferson County's eleven watersheds, and presented information to the public in layman's terms.
- Beargrass Creek Watershed - A Community Lifeline in Critical Condition (2003) - Concentrated on percentage of impervious surface in Beargrass Creek Watershed and discussed impacts to water quality.
- Beargrass Creek Watershed - State of the Streams (2005) - Guide for public to address personal impacts on the watershed. The report includes environmental indicators of the watershed's overall health.

3.2.4 MSD's Website

MSD's website, *www.msdlouky.org* contains extensive information on MSD's CSO program and related CSO projects, pollution prevention measures, MSD watershed related publications and water quality information. The website enables the public to submit customer service comments, read about upcoming events, summarizes board meetings and capital construction activities, and lists construction projects and associated schedules. Real time rain data is available, as well as product reviews. Website contains current and past reports, and other MSD initiatives.

3.2.5 Education Videos

MSD prepared an education video entitled "MSD - Our History and Mission" detailing its role in Louisville's water quality improvements. The tape was distributed to local libraries, schools and interested citizens.

MSD prepared a second educational video entitled "Lifeblood & Floods: Our Rivers and Streams." The intent of the video is to raise awareness of wet weather issues primarily focusing on flooding. The video was sent to civic groups, elected officials, educators, media, and local neighborhood associations.

The Louisville Nature Center through coordination with the 1993 Beargrass Task Force produced an educational video geared for elementary aged children. The video was broadcast on the local cable network and distributed to the Jefferson County Public Schools. The tape explores the native flora and fauna of the watershed targeted for a younger audiences.

MSD prepared a video series titled "Celebrate Our Streams" in 1999. The video was used for stakeholder and general public education. This video series included the following chapters:

- Celebrate Our Streams;
- Combined Sewers and CSOs;
- Sanitary Sewer Overflows;
- Stormwater Drainage and Non-point Source Runoff; and
- Conclusion.

3.2.6 Employee Education

While in the "Public Comment" period of the Consent Decree, MSD started an internal education program to communicate the details of the Consent Decree, an overview of the Clean Water Act, and the KPDES permitting program to each employee. MSD recognizes the importance and value of educating the employees as it will ultimately be the staff within MSD who will create success of carrying out the intent of the Consent Decree. This program included handouts for the employees to keep as reference material for the future.

3.2.7 Public Education Materials

MSD prepared and distributed numerous public information articles through newsletters, billing inserts, pamphlets, and annual reports. These included the following:

- Combined Sewer Overflows
- Plumbing Code Modifications
- Nine Minimum Controls
- Stream Sampling
- Plumbing Modification Program
- Keeping Sewers Fat Free
- Wet Weather/Water Quality
- Sewer TVI
- Keeping Rainwater and Wastewater Apart
- Challenges for the Community
- Various COS and Wet Weather features in Annual Reports

3.3 EVENTS

Public Education covers a wide selection of public events and enables MSD to interact with the community on a more personal basis. This section explains some of the MSD initiatives including partnering activities with Louisville Metro Government and other local neighborhood annual occasions.

3.3.1 Tours of Treatment Plants

Tours are available upon request for any of the MSD wastewater treatment plants, including Morris Forman WTP, Cedar Creek WTP, and Floyds Fork WTP. For several years MSD conducted "After We Flush" field trip to the newest MSD treatment plant - Floyds Fork WTP which included educational activities, and curriculum based on Kentucky Education Reform Act requisites.

3.3.2 Beargrass/Ohio River Clean Sweeps

For the past 15 years, MSD facilitates and participates in clean sweeps along the Ohio River and Beargrass Creek in Jefferson County. MSD will continue to partner with Natural Resource Conservation District with a focus on the three forks of Beargrass Creek Watershed. At these events, MSD and public volunteers walk and canoe along the river and creeks, removing trash and collecting data on the annual amounts of debris.

3.3.3 Earthsave Annual Healthy People, Healthy Planet Funfest: A Taste of Health

An amount of 250 native plants and packets of Louisville Green (a fertilizer made of organic, nutrient rich and highly treated solids left over after municipal wastewater treatment) are given away.

Information on the importance of native plant communities is available as well as landscape management techniques utilizing Louisville Green and compost.

3.3.4 Big Rock Jazz Festival

MSD staffs a booth with educational materials, information on the watershed, and interactive demonstrations.

3.3.5 Enviroscape at Earth Day

Non-point source interactive tabletop model on stream protection and water quality presented during Earth Day festivities.

3.3.6 Inservice Days with Jefferson County Public School Educators

MSD conducts professional development workshops for Jefferson County Public School teachers and staff on outdoor classroom planning and installation, CSO education, stream restoration, and age appropriate environmental literature.

3.3.7 Native Plant Landscape Design at the Louisville Nature Center

MSD conducted seven, six week sessions on landscape design, and will continue to facilitate these classes. Topics include drainage, site analysis, design concepts using rain barrels, disconnecting downspouts, and other community best management practices. Classes focus on residential property as the base unit for watershed management.

3.3.8 Earth Day at the Louisville Zoo

MSD participates in the yearly Earth Day event at the Louisville Zoo. Water Quality Reports are handed out to those who stop by the booth. Water quality and watershed related questions are also addressed.

3.4 PUBLIC MEETINGS

A significant amount of time is invested in preparing for and attending the many public meetings. On average, MSD staff attends approximately 400 meetings each year. Each of these meetings provides attendees an opportunity to ask questions about anything that MSD is involved with.

Over the past year, MSD's Executive Director, H.J. "Bud" Schardein, Jr., conducted or participated in more than 100 public meetings. At these meetings, Mr. Schardein presented his philosophy that MSD will concentrate on its basic mission: *to provide quality wastewater and stormwater facilities for the people of our community.*

TABLE 3-1

2005 ELECTED OFFICIAL/PUBLIC MEETINGS

Date	Group/Subject
1/17/05	Knights of Columbus
1/24/05	Mayor's Community Conversation
1/25/05	Metro District 19
1/26/05	Rick Blackwell's Town Meeting
2/22/05	Troubleshooter Tour/WAVE 3
2/28/05	Mayor's Community Conversation
3/1/05	Troubleshooter Tour/WAVE 3
3/7/05	14th District Community Meeting
3/14/05	City of Watterson Park
3/21/05	Mayor's Community Conversation
3/22/05	Kentuckiana Construction User's Council
3/22/05	City of Woodland Hills
3/23/05	Lake Forest Community Meeting
3/28/05	District 13 Community Meeting
3/29/05	District 12 Councilman Meeting
4/4/05	Phillips House
4/5/05	Leonard Watkins Presentation and Tour
4/6/05	Reception for David Orr
4/11/05	Council District 20 Town Hall Meeting
4/12/05	City of Norbourne Estates
4/14/05	Wisertown Neighborhood Association
4/18/05	Mayor's Community Conversation
4/23/05	Salt River Watershed Watch Group
4/26/05	City of St. Matthews
5/3/05	City of St. Regis Presentation
5/9/05	City of Forest Hills
5/12/05	City of Bancroft
5/16/05	Mayor's Community Conversation
5/16/05	City of Prospect
5/17/05	City of Worthington Hills
5/18/05	City of Glenview Council Meeting
5/19/05	Greater Louisville Inc. - Louisville Chamber of Commerce
5/23/05	Neighborhood Association Meeting
5/25/05	South Louisville Rotary Club
5/26/05	City of Strathmoor Manor Council Meeting
5/26/05	All Hazards Mitigation Plan
5/31/05	Metro District 12
6/2/05	Candlelight Neighborhood Association
6/9/05	Metro District 4

Date	Group/Subject
6/9/05	Rate Increase Public Hearing
6/14/05	Environmental Health Committee
6/14/05	Louisville Coalition of Metro United Way
6/15/05	Wolf Trace Subdivision
6/20/05	Mayor's Community Conversation
6/20/05	All Consultants Meeting
6/20/05	City of Audubon Park
6/27/05	Rangeland Blockwatch Community Meeting
6/28/05	Metro District 12
7/5/05	Louisville Metro Council Presentation
7/7/05	City of Murray Hills
7/11/05	City of Windy Hills
7/12/05	Metro District 17
7/13/05	WHAS News
7/14/05	Highland Christian Ministry Senior Center
7/18/05	Mayor's Community Conversation
7/19/05	City of Middletown
7/20/05	Houston Acres Neighborhood Meeting
7/21/05	Smithton Road Neighborhood Watch
7/26/05	Metro District 12
7/28/05	Okolona Business & Professional Association
8/4/05	Congresswoman Northup's Office
8/5/05	KWA Beargrass Creek Watershed Roundtable Meeting
8/8/05	St. Joseph's Area Neighborhood Meeting
8/11/05	City of Hurstbourne Acres
8/15/05	Mayor's Community Conversation
8/18/05	City of Cherry Village Block Watch Meeting
8/24/05	Western Kentucky Center for Water Quality Study
8/30/05	Metro District 12
9/12/05	Metro District 14
9/13/05	Metro District 1
9/13/05	Cane Run Business Association
9/13/05	Senior Adults of Jefferson Community College
9/14/05	City of Meadow View Estates
9/19/05	Mayor's Community Conversation
9/20/05	Metro District 1
9/21/05	5 Cities Conference - Consent Decree Presentation
9/27/05	Metro District 12
9/28/05	Valley Women's Club
10/3/05	Pat Carver's Internship Class
10/4/05	Southwest Rotary Club
10/10/05	Metro District 13

Date	Group/Subject
10/17/05	Mayor's Community Conversation
10/21/05	Congresswoman Northup's office
10/22/05	Neighborhood City Hall - Metro District 9
10/25/05	Metro District 24
10/25/05	Metro District 12
10/25/05	Democratic Headquarters
10/27/05	KY State Representative Riggs
11/7/05	Metro District 5
11/8/05	Lessons for Merger Workshop
11/9/05	Metro District 11
11/10/05	Apple Valley Homeowners Association
11/15/05	Clifton Heights Community Council
11/17/05	Metro District 20
11/21/05	Mayor's Community Conversation
11/29/05	Metro District 22
12/5/05	Metro District 20
12/12/05	City of Seneca Gardens
1/3/06	Fern Creek Community Association and Chamber of Commerce
1/3/06	Okolona Women's Club
1/17/06	Mayor's Community Conversation
1/18/06	City of Hickory Hill

3.5 PUBLIC PARTICIPATION IN THE BEARGRASS CREEK WATERSHED

Over a decade ago, MSD realized the importance of watershed planning. MSD began programs working with experienced consultants, neighborhood leaders, and local government representatives, MSD developed ideas to formulate a strategy that could serve as a model for other watersheds.

In 1991, Mayor Jerry Abramson along with the MSD Executive Director appointed members to the Beargrass Creek Task Force. The task force was convened to study a 2.5-mile segment of Beargrass Creek from Trevilian Way to Eastern Parkway to examine the resources of Beargrass Creek, access and address various methods to best utilize and/or protect resources, and offer suggestions and models of examples as ways the public can preserve and protect the watershed. Several committees were formed from this task force including Conservation Easement, Environmental Assessment, Education, Historical, and Recreation.

From 1991-1994, the task force:

- Mapped Beargrass Creek and located critical areas,
- Conducted an ornithological survey,
- Conducted a native plant survey,
- Continued to partner with MSD to conduct annual clean sweeps,

- Created and planted a "no mow zone" in Joe Creason Park to demonstrate benefits of riparian buffers, and
- Organized a workshop on bio-engineering for local forms.

In 1999, Mayor David Armstrong re-convened the task force to study a plan for the confluence of Beargrass Creek and the Ohio River. Plan was developed to reconstruct wetlands and access floodplain to an area that is now used for soccer fields.

The Beargrass Creek watershed initiative began in 2002, resulting in a draft resource management plan document for the watershed.

In 2004, with the leadership of Kurt Mason as chair, the Beargrass Creek Watershed Council accomplished the following:

- Prepared a work plan for the Beargrass Creek Watershed,
- Produced the Impervious Surface Brochure (2003) and the State of the Streams Report (2005),
- Activated the Beargrass Watershed website,
- Compiled a community best management practice information from other communities,
- Along with MSD coordinated a daylong roundtable meeting in August 2005, which attracted 135 citizens. Included sessions, and MSD speakers on impacts to the urbanized watershed, water quality monitoring results, low impact design, best management practices, and other watershed related subjects. Panelists included the Kentucky Environmental Protection Cabinet Secretary, MSD Executive Director, Consultants, Developers, Local Government Officials, and
- Continued to hold the Annual Beargrass Creek Clean Sweep.

To date, the majority of MSD's focus for public participation has been in the Beargrass Creek watershed area through the Beargrass Creek Watershed Council (BGWC). This group was composed of representative stakeholders from Metropolitan Sewer District, Metro Local Government, the development community, industry, Metro Parks, Louisville Coalition of Neighborhoods, Soil and Water District, Natural Resource Conservation District, Jefferson County Public Schools, Salt River Basin Water Watch, and Kentucky Waterways Alliance. The BGWC group drafted a mission statement: to protect & improve the water quality of the watersheds of Jefferson County and to change public attitude through public education, public policy development, enhancement projects by grassroots voluntary action. A majority of the members continue to organize events and educational opportunities.

Each public participation effort within the Beargrass Creek Watershed has included presentations and/or discussion of challenges related to improving water quality. Topics included sanitary sewer overflows, combined sewer overflows and urban run-off.

3.6 PUBLIC PARTICIPATION – PATH FORWARD

As noted in the EPA's Guidance document for developing CSO LTCPs, MSD understands the importance and value of public involvement throughout the LTCP planning process. The goal of the public participation program is to involve the community in the development of alternative solutions that protect the local waterways and consider the financial impacts to the community as a whole. Section 11 discusses MSD's future development of the stakeholder and the public participation program within the wet weather planning process.

MSD

Louisville and Jefferson County
Metropolitan Sewer District

SECTION 4

SECTION 4: MAXIMIZATION OF TREATMENT AND FLOW TO MFWTP

4.1 BACKGROUND

The Morris Forman Wastewater Treatment Plant (MFWTP) is the largest treatment facility in MSD's system. With a permitted capacity of 120 MGD (annual average flow), MFWTP treats flows generated from the entire combined sewer area served by MSD, and some separate sanitary sewered area as well. Approximately 75 percent of the wastewater generated in the MSD service area is treated at the MFWTP. With all units in service, MFWTP has a short duration peak flow capacity of 350 MGD, with a sustainable peak capacity of approximately 325 MGD, depending on several operational factors described in more detail later. MFWTP also provides solids handling facilities for all biosolids generated in the service area, regardless of where the treatment is accomplished. MSD has made a considerable capital investment in both the combined sewer system and the MFWTP in recent years to maximize flow to the plant and its ability to treat flow. Improvement made within the combined sewer collection system and the MFWTP was a coordinated effort to maximize flow to the plant for treatment that ultimate reduces combined sewer overflows to Beargrass Creek and the Ohio River. The following sections detail these capital investments.

4.2 INCREASED CAPTURE OF WET WEATHER FLOW WITHIN THE CSS

MSD has implemented numerous projects that have increased the capture of wet weather flow within the combined sewer system and aided in the maximization of flow to the MFWTP. These projects can be described as follows:

4.2.1 Main Diversion Structure

The Main Diversion Structure (MDS) receives the base dry weather flows from the entire MFWTP area, except for flows pumped directly to the plant via the Rubbertown force main and flows pumped to the plant by the Southwestern Pump Station. The base flow from the Southern Outfall that reaches the MDS is directed to the MDS Interceptor on the downstream side of the MDS, which conveys flow to the MFWTP. Excess flows beyond the capacity of the treatment plant overflow to the Ohio River through CSOs 015 and 211. To improve the reliability of the MDS flow control gates, a project replaced the main gate stems and actuators, and added a standby generator to power the gate actuators during electrical service interruptions. The project cost was $883,000.

Additionally, MSD wanted the flexibility to have the MFWTP receive as much flow as possible (up to the full MFWTP capacity) from the Southern Outfall during wet weather. Calculations indicated that with the current piping configuration, the MDS could not deliver 350 MGD to the MFWTP. To achieve 350 MGD from the Southern Outfall, a project was completed to raise the overflow level at the outfall of the MDS to elevation 422.0 in order to convey more flow through to the MFWTP. An inflatable gate was placed at the overflow that affords the opportunity to raise the water level to provide sufficient head to deliver the entire peak flow of 350 MGD to MFWTP. The gate will reduce the annual overflow volume at this location. Operation of the gate will ultimately be incorporated into the Real Time Control effort for achieving system-wide optimization of in-line storage of wastewater. The project cost for the inflatable gate was approximately $565,000.

4.2.2 Upper Dry Run Trunk Storage Facility

This project included the construction of two earthen basins (17.25 MG and 15.25 MG) on the Kentucky Fair and Exposition Center (KFEC) property, and the construction of 1,922 LF of 60" sewer. Construction of the project started in March of 2001 and was completed in June of 2004. The project cost was approximately $4,500,000.

The Executive Inn Basin and the Brady Lake Basin are located within MSD's CSO Ohio River West Region. The two facilities are both storm water retention basins that discharge their stored flow to the combined sewer system via the Upper Dry Run Trunk Sewer and ultimately to the Southwestern Outfall and CSO 015. During the project development it was determined through computer analysis that 19 MG of storage was needed to provide flood protection to mitigate the localized surface flooding resulting from the August 8, 1992 storm (approximately a 100-year storm event). Consequently, there is an available storage capacity of 13.5 MG that can be dedicated to CSO reduction. Both the Executive Inn Basin and the Brady Lake Basin will be operated as part of the Real Time Control (RTC) System currently being developed and implemented by MSD. The control strategy that will be employed by RTC will fulfill both the flood protection and the CSO reduction goals. The RTC scheme will adjust to the necessary priority depending upon the magnitude of events and flows. Both basin outlets will be controlled. Essentially, the control strategy consists of minimizing overflows by holding 100% of the flow that enters the basins up to the point where the 13.5 MG CSO storage capacity has been achieved. At this time the control strategy will switch from CSO control to flood protection and the gates will modulate open to maintain the water levels consistent with the 13.5 MG of storage. If this is not possible the gates will fully open to provide maximum storage capacity under the flood control mode. The project cost was approximately $7,500,000.

4.2.3 Wheeler Avenue CSO/Flood Control Basin Project

The Wheeler Avenue area is a residential neighborhood in a topographically shallow "bowl" at an elevation 2'-3' below the surrounding ground and is drained by a combined sewer to the Mill Creek Trunk Interceptor. The Mill Creek Trunk Interceptor is a very large (12'-8" wide by 19' tall) combined sewer located in Taylor Boulevard that receives the entire flow from the Wheeler Avenue area. The Mill Creek Trunk Interceptor then flows to the Southwestern Outfall and ultimately to the Southwestern Pump Station where the flow is sent to the MFWTP. During very large storms, the Mill Creek Trunk surcharges into the low lying area along Bicknell Avenue and its side streets. On August 8, 1992 the area along Bicknell Avenue and several side streets was flooded by a major storm event (3.84" of rain in 2.5 hours, an approximate 100-year storm). Following this flooding, MSD conducted a major study of the causes and potential solutions for the flooding problems that resulted in the implementation of the Wheeler Avenue CSO/Flood Control Project.

The objective of the Wheeler Avenue CSO/Flood Control Project was twofold: (1) to reduce the combined sewer overflows that occur at CSO 015 and (2) to reduce the occurrence of neighborhood flooding. This was accomplished by constructing a 4.9 MG flood control basin, constructing a 553,000-gallon CSO Basin inside the flood control basin, providing 1.1 MG of storage in the 78" combined sewer, regulating the rate of flow to the Mill Creek Trunk and preventing the Mill Creek Trunk from backing up into the area. The project cost was approximately $4,900,000.

4.2.4 Snead's Branch In-Line Storage Project

This project is located just east of the intersection of Logan Street and East Kentucky Street. CSO control is accomplished by utilizing the Snead's Branch Relief Drain (SBRD) as a CSO storage facility through operation of an inflatable rubber gate, which is located approximately 200' from the outlet of the SBRD to the South Fork of Beargrass Creek channelized section. The SBRD is an 11'-1" semi-elliptical drain that collects flows from eleven CSOs. Prior to the installation of the gate, combined sewage would discharge directly to the South Fork of Beargrass Creek during relatively small rain events. Since installation of the inflatable rubber gate, the in-line storage project captures and stores 100% of the flow from a 6-month storm event which equals approximately 2.5 MG. Once the wet weather event has concluded, the facility pumps the recaptured overflow from the eleven CSOs tributary to the SBRD into the Beargrass Interceptor which is conveyed to the Robert J. Starkey Pumping Plant (formerly known as the Buchanan Street Pump Station) and then on to MFWTP for treatment. The project cost was approximately $1,500,000.

4.2.5 Robert J. Starkey Pumping Plant

The Robert J. Starkey Pumping Plant is a critical pump station, which is at the terminus of the Northeastern Sanitary Trunk Sewer, the Beargrass Creek Interceptor, and the Middle Fork Trunk Sewer. The rebuild project consisted of upgrading the existing pump station capacity from 125 MGD to 140 MGD as well as improving the reliability of this combined sewer and flood pumping plant. It is estimated that this project will result in a reduction of approximately 475 MGD in the average annual overflow volume (AAOV).

The upgraded pumping plant includes the following:

- New wet well adjacent to the old wet well
- Four (4) new variable speed, submersible pumps capable of handling 35 MGD each.
- Two (2) channel monsters with hydraulic motors for screening
- Hydraulically operated slide and sluice gates for control of flow through the pump station
- New electrical substation, which includes MCC's, VFD's, Control Panel, and lighting panel.
- New instrumentation and control, including provisions for future telemetry.
- New HVAC which includes at least six (6) air changes per hour in the pump station building and at least twelve (12) air changes per hour in the wetwell.
- New 1,250 KW diesel generator and transfer switch as an alternate power source during power outages to mitigate overflows.

The pumping plant is both a sanitary sewer lift station and a flood pumping station. It is operated as a sanitary sewage lift station during normal river stage periods (below 15.6 on the upper river gauge). The pumping plant is the first lift station on the upper pool that goes into flood pumping at upper river gauge 15.6 and is generally in flood pumping mode at a minimum of 3 times per year. During normal river stages, the flow into the station is pumped into the Ohio River Interceptor and transported to the MFWTP. When flood-pumping mode is activated at the station, gates are closed in the outfall piping to prevent the Ohio River from backing up into the sewer system, and therefore, prevent flooding. During flood conditions, excess water that cannot be conveyed to MFWTP is pumped to the Ohio River. The existing pumping plant remained in operation during the construction of the new pumping plant. The project was completed in January 2005. The project cost was approximately $14,000,000.

4.2.6 NSTS Cleaning Project

Cleaning of the Northeastern Sanitary Trunk Sewer NSTS) was performed to restore full-flow conveyance capacity to the Robert J Starkly Pumping Plant, which ultimately reduced combined sewer overflows. The NSTS Cleaning project involved the removal of an estimated 1'-3' of deposition or approximately 1,500 cubic yards of grit within the 5"-6" diameter NSTS. In addition to increasing conveyance capacity, the cleaning project greatly increased usable storage volume for smaller, more frequent storm events. The NSTS was cleaned from the Robert J. Starkey Pumping Plant to the Letterle Pump Station, approximately 4,700 LF. The cost of this project was approximately $1,000,000.

4.2.7 Increases in Overflow Weir Elevations to Reduce Overflows

Since 1994, MSD has continually looked for opportunities to modify the system to reduce overflows and increase the flow conveyed to the MFWTP for treatment. During this time, 16 CSO structures have been adjusted and two is-system flow diversion has been implemented to increase the capture of wet weather flows for conveyance to the MFWTP. Additional detail relative to these in-system improvements is provided in the NMCs Compliance Report, Section 3.4.3 (NMC2).

4.3 MORRIS FORMAN WASTEWATER TREATMENT PLANT (MFWTP)

4.3.1 Background

The MFWTP was originally commissioned in 1958, as the Fort Southworth Wastewater Treatment Plant, providing primary treatment to flows generated in the combined sewers serving the City of Louisville. Treatment performance at that time was dictated by federal standards requiring 45 percent removal of total suspended solids (TSS). The Fort Southworth plant routinely achieved 65 percent removal of TSS, well within applicable standards of the time.

Construction of secondary treatment facilities began in 1972 at the newly renamed Morris Forman Wastewater Treatment Plant. While construction was scheduled for completion in 1974, the plant was not dedicated until 1976 - nearly 2 years behind schedule. Performance problems with the secondary portions of the plant led to years of lawsuits between MSD and the designer and constructors of the plant. Performance problems also led to enforcement actions by USEPA that resulted in a negotiated agreement signed in December of 1980 that outlined modifications and repairs required at the plant. MSD embarked on an extensive program of repair and modification in 1980. The MFWTP finally achieved secondary treatment standards for the first time in the summer of 1985.

Modifications to the plant continued through the 1980s and into the early 1990s in accordance with the plan negotiated between MSD and USEPA. Standards were achieved intermittently, with violations most common during wet weather periods. With the introduction of whole effluent toxicity (WET) requirements in the early 1990s, the MFWTP was faced with a new treatment challenge. To meet established WET limits, MSD proposed to install a discharge diffuser in the Ohio River. The Sierra Club filed a lawsuit against MSD and KDOW to halt construction of the diffuser and require MSD to achieve compliance with the standard through treatment rather than in-stream dilution. An agreed order (AO) was negotiated to resolve the lawsuit, and MSD completed a 2-year investigation of the possible remedies to the issue. In

May 1999 the AO was settled with an agreement to achieve compliance with toxicity standards through modified process control measures. The concept of the river diffuser was abandoned.

In 1991, a study was commissioned to address the chronic performance problems at MFWTP. One of the first projects resulting from that study was the construction of 2 "bioroughing towers." The bioroughing towers are highly loaded trickling filters designed to smooth out the highly variable organic loadings and strong recycle streams that were experienced at MFWTP. The facilities were put in service in 1994 and performed well until a structural failure in 1995 that resulted in a facility shutdown and another round of lawsuits against designers and constructors.

Implementation of the rest of the 1991 study (including repair and reconstruction of the bioroughing towers) was more successful. Between the years of 1997-2004, over $165,000,000 in capital improvements were made at the MFWTP. In contrast to previous difficulties, these projects achieved the established performance objectives and were completed without legal action between MSD against any of the designers or constructors.

During this construction period, the plant continued to treat wastewater without interruption. All dry weather flow was taken through the plant for treatment during this time period. Due to capacity limitations caused by rehabilitation work on major treatment processes, secondary treatment standards were often not met, and wet weather treatment capacity was often severely limited during the major construction. The majority of the plant construction activities were complete and commissioned by the end of 2003.

The reconstructed facilities have performed as expected, with an excellent record of secondary treatment standard compliance during 2004 and 2005. Figure 4-1 shows the monthly averages for both biochemical oxygen demand (BOD) and TSS for these 2 years. Early in 2004, a flap gate (not part of any reconstruction effort) failed in the interceptor system causing significant intrusion of very cold and silt-laden Ohio River water into the MFWTP. High river stages prevented repairs to this gate until the water level receded. The river water intrusion due to the gate failure resulted in the relatively poor treatment performance in January and February 2004. After this problem was repaired, the MFWTP has consistently met standards for BOD and TSS effluent limits.

4.3.2 Plant Configuration – Liquid Treatment

A schematic of the liquid treatment process is shown in Figure 4-2. A description of the individual unit processes follows.

4.3.2.1 Influent Routing

Wastewater arrives at the plant through one of three sources. Approximately 75 percent of dry weather flow is delivered by two major interceptors that combine at the Main Diversion Structure (MDS) that is located approximately a half mile from the treatment facilities. The MDS is a complex gate structure that includes CSO 211. MDS is represented schematically in Figure 4-3. An inflatable dam on the CSO 211 outfall pipe controls the water level in the structure, providing some in-line storage of wet weather flows, and also ensuring sufficient hydraulic head to deliver up to 350 MGD to the MFWTP from this location. During dry weather, flows received at MDS are routed directly to the MFWTP preliminary treatment facilities. During wet weather, when in-line storage volumes behind the inflatable dam are at maximum capacity, combined sewage flows in excess of the available capacity of the MFWTP, overflow the inflatable dam and are discharged to the Ohio River via CSO 211.

Flows are also routed to MFWTP through the Southwestern Pump Station (SWPS) that serves southern and western Jefferson County. SWPS has a capacity of 104 MGD, and can pump up to this amount from the Southwestern Interceptor if sufficient capacity is available at MFWTP. During wet weather events when interceptor flows exceed the SWPS capacity or under high river conditions when USACE procedures govern operation of the pump station and related gates, some or all of the combined sewage flows from the Southwestern Interceptor overflow to the Ohio River through CSO 015.

The third pathway for flow to reach the MFWTP is through the Rubbertown Force Main. This force main serves a highly industrialized part of Jefferson County commonly referred to as "Rubbertown." This force main delivers sanitary and industrial wastewater and does not have a CSO associated with it. All flow from the Rubbertown Force Main is delivered to the treatment facilities at MFWTP.

4.3.2.2 Preliminary Treatment

All flow received at the MFWTP (except from the Rubbertown Force Main) receives screening and grit removal. A Headworks facility constructed in the late 1990s provides screening and grit removal for up to 200 MGD peak flow. Wet weather flows in excess of 200 MGD are routed through the original Headworks facility that was substantially rehabilitated as part of the recent program. The combination of both Headworks facilities provides a firm preliminary treatment capacity in excess of the peak flow capacities of the downstream processes.

4.3.2.3 Primary Treatment

Following preliminary treatment, flow is routed to the primary sedimentation tanks for primary settling. The peak flow capacity of the four sedimentation basins is 350 MGD. Above this flow rate the effluent weirs in the sedimentation tanks become flooded, and treatment efficiency is lost. Due to the inherent variations in flow rates caused by precipitation events, plant operators have found that an average flow of 320-330 MGD is the maximum that can be sustained. Attempting to operate at higher flows results in periodic loss of treatment effectiveness that has serious impacts on downstream processes. For this reason, the peak sustainable treatment capacity of the primary sedimentation basins with all units in service is considered to be approximately 325 MGD with short-term variations peaking at 350 MGD. Actual performance of unit processes determines the maximum flow that can be treated on a case by case basis.

MFWTP has the capability to chemically enhance the performance of the primary sedimentation basins through the addition of chemical flocculants. Currently, the MFWTP can add ferric or ferrous compounds and cationic or anionic polymers to improve TSS removal. Under normal loading conditions, primary sedimentation TSS removals are better than 60 percent, so chemical enhancement of primary sedimentation is not practiced unless unusually high TSS loading conditions indicate that this enhancement is needed to achieve discharge permit limits. Chemical enhancement improves the treatment performance but does not affect the hydraulic capacity of the process.

4.3.2.4 Secondary Treatment

Primary effluent is collected in a channel at the end of the sedimentation basins. The Bioroughing Tower Pump Station takes suction off the channel and pumps up to 140 MGD into the Bioroughing Towers. In the Bioroughing Towers soluble BOD is converted to cell mass that

is continuously formed and sloughs off of the surface of the media in the towers. This conversion serves as a buffer for the variations in loads that can occur in the MFWTP service area. It also meets a portion of the oxygen demand for the secondary system and "seeds" the aeration reactors with dense and highly settleable solids.

Primary effluent in excess of that pumped to the Bioroughing Towers is mixed with tower effluent in the influent channel for the aeration basins. Typically, flows up to 140 MGD are taken through the basins, where primary effluent and tower effluent are mixed with return activated sludge (RAS). The aeration basins are sealed reactors that use high-purity oxygen generated on site to provide oxygen for cell growth and metabolism.

After being treated in the aeration reactors, mixed liquor passes on to the secondary clarifiers where the cell mass is separated from the secondary effluent. A portion of the cell mass is returned to the aeration basins as RAS, and a portion is "wasted" to the solids handling system. The clean water passes on to the disinfection system.

During wet weather the combination of primary effluent and tower effluent can be as much as 350 MGD peak flow. The maximum capacity of the secondary treatment system is 140 MGD with all units in service, based on secondary clarifier loading limitations. Operating experience has demonstrated that this flow rate cannot be sustained indefinitely, due to clarifier limitations Refer to Item 5-1 in the NMC Supplemental Information binder for more detail. Flows through the secondary process are gradually reduced below the maximum capacity when deterioration of effluent quality or biomass wash-out appears imminent. Flows in excess of the secondary treatment capacity are routed around the secondary treatment system directly to disinfection. Flows routed around secondary treatment are controlled by a flow control sluice gate, with the flow rate measured by a Parshall flume in the channel. The capacity of the flume and channel is 210 MG, providing for flow routing of the entire peak instantaneous flow capacity of 350 MGD.

4.3.2.5 Disinfection

Secondary effluent, (and the primary effluent routed around secondary treatment during wet weather flow), are directed to the chlorine contact chambers for disinfection. A sodium hypochlorite (bleach) solution is metered into the wastewater at the head end of the chlorine contact chamber. After passing through the chlorine contact chamber the disinfected wastewater is treated with sodium bisulfite to neutralize the residual chlorine in accordance with discharge standards.

4.3.2.6 Effluent Pumping

When the Ohio River is at normal elevation, the dechlorinated effluent flows by gravity to the Ohio River. During high river conditions the Final Effluent Pump Station (FEPS) pumps the effluent. FEPS has a firm capacity of 350 MGD, pumping against the 100-year flood elevation.

4.3.2.7 Determination of Treatment Capacity

In the subsections of 4.3.2, peak and sustained unit process capacities were cited based on the assumption that all treatment units are in service, and each unit process is operating under ideal conditions. In reality, the determination of the plant treatment capacity requires consideration of a combination of factors including influent conditions, the number of treatment units available for service, and current performance of the various unit processes as indicated by depth of blanket

(DOB) readings for both the primary sedimentation basins and the secondary clarifiers. Operating experience shows that DOB readings provide an early warning of impending effluent degradation or solids washout.

Capacity studies had previously been conducted in 1994 (hydraulics only), 1995 (primary sedimentation only) and 1996 (full treatment facility). These previous studies identified both hydraulic and treatment process bottlenecks that limited the peak wet weather capacity in 1996 to 225 MGD. Capital improvements described in subsection 4.3.4 have been made to correct the bottlenecks identified, leaving the primary sedimentation basins, the final clarifiers, and the Final Effluent Pump Station (FEPS) as the potentially limiting unit processes. An FEPS upgrade in 1999 provided adequate firm pumping capacity to remove it as a limiting unit process, assuming that at least 3 of the 4 pumps are available during peak flows. The primary sedimentation basins and final clarifiers remain the limiting unit processes, based on their size and configuration.

In 2002, a series of wet weather stress tests were conducted to determine the capacity of the primary sedimentation basins and the secondary clarifiers, and to ascertain the extent of mixing in the chlorine contacts basins under high flow conditions. The primary sedimentation basins can hydraulically accept 100 MGD of flow in each tank, but did not perform well initially when the blanket depths were 8 feet. The test was conducted again with blanket depths of 3 feet and the performance improved significantly. Testing also showed that while individual sedimentation basins could accept flows up to 100 MGD, downstream hydraulics limited the combined flow through all basins to not more than 350 MGD. At total flows above 350 MGD the sedimentation basin effluent weirs become flooded, resulting in the total loss of treatment effectiveness.

The secondary clarifiers were tested at flow rates up to 10 MGD per clarifier with good removal at that rate for a relatively short time (30 minutes). However, the 10 MGD also included the RAS flow, so that needs to be taken into account when determining the maximum flow the plant is willing to accept in the secondary system. The RAS flow is typically 25% to 30% of influent flow, so the effective pass-through flow was slightly more than 7 MGD. Note that the 2001 WATERS Report suggested that the capacity of the secondary treatment system could be 160 MGD following the completion of ongoing system modifications. The stress testing showed, however, that 7 MGD per secondary clarifier was the limiting flow, and the total flow that could be treated through the 20 secondary clarifiers was not more than 140 MGD. Refer to Item 5-1 in the NMC Supplemental Information binder for additional information on the stress testing.

In 2004, additional wet weather stress testing was performed on the chlorination/dechlorination system at the MFWTP. This testing showed that the MFWTP disinfection system can effectively disinfect the effluent and successfully neutralize the chlorine residual at plant flows up to 350 MGD if chlorine residual set-points are increased at higher flows. Refer to Item 5-2 in the NMC Supplemental Information binder for additional information.

To assist plant operators in determining the maximum flows that can be treated without jeopardizing the long-term viability of the treatment process, a spreadsheet-based "capacity calculator" was developed that incorporated the results of the stress testing. The stress testing showed that process upset limits (loss of treatment effectiveness) are based on both hydraulic loading rate and sludge blanket levels. Operating guidelines have been established to typically maintain sludge blankets below the point that would impact unit capacity. Sludge blanket level is one of the key operating parameters that impact downstream processes, so blankets can not be drawn down too far (even in anticipation of a wet weather event) or other processes are put at risk.

The optimal operating conditions during a wet weather event are significantly different from the optimal operating strategy during dry weather. Since the MFWTP is a high purity oxygen plant, the activated sludge tanks are much smaller than in a standard activated sludge plant. When the plant is carrying an ideal biomass level, there is about 800,000 to 1,200,000 pounds of solids under aeration. Over half of the solids are carried in the secondary clarifiers. If all systems are operating at peak capacity, approximately 300,000 pounds of solids per day can be removed from the activated sludge system. However, on an average day, an additional 200,000 pounds of suspended solids enters the plant, with approximately 40% removed in the primary sedimentation tanks. During a rain event the removal rate will be even less, due to the high flow rates. That only gives us an opportunity to remove 180,000 pounds from the system with 24 hours notice.

Removing unusually large amounts of solids in a short duration may provide some short-term benefit during a high flow period, but will generally have a negative long-term effect, particularly if the plant flow remains high for several days. Several days of maximum secondary flow may wash out the biomass if it is kept at a very low level to accommodate a storm event. Since January 1, 2006 we have already had one day with the average flow for the day at 237 MGD and another at 223 MGD. Additionally there have been three days this year where the peak flow has been in excess of 300 MGD. In April of 2006, the average plant flow for the entire month was over 150 MGD.

Use of the capacity calculator has proven valuable in the MFWTP efforts to maximize the treatment of wet weather flow peaks without compromising long-term treatment efficiency. Refer to Item 5-2 in the NMC Supplemental Information binder for more information on the capacity calculator.

4.3.3 Plant Configuration – Solids Handling

A schematic of the solids handling system at the MFWTP is depicted in Figure 4-4. A brief description of the unit processes follows.

4.3.3.1 Anaerobic Digestion

The underflow from the primary sedimentation basin (primary sludge) is pumped to the anaerobic digestion process. Pumping is accomplished at a controlled rate slow enough to give the solids time to compact in the basin, thus minimizing the hydraulic load on downstream solids handling processes. Pumping must also be fast enough to ensure that solids are removed from the sedimentation basin in a timely manner so they don't build up and flow over the effluent weirs.

In the digesters the primary solids are treated anaerobically by active bacteria growing in the absence of oxygen. As a result, approximately 50 percent of the organic portion of solids is converted from solid mass to liquid and gaseous by-products. The biogas generated in the digesters contains approximately 60 percent methane, and is recovered for use in fueling the biosolids dryers. The liquid by-products are separated from the remaining solids by downstream processes.

4.3.3.2 Dissolved Air Flotation

The underflow from the secondary clarifiers is either returned to the process as return activated sludge (RAS), or wasted from the process as waste activated sludge (WAS). WAS is sent to the dissolved air flotation thickeners (DAFT) where the influent WAS is mixed with pressurized water containing dissolved air. As the flow streams are mixed the pressure is released and the dissolved air comes out of solution as fine bubbles that attach to the biosolids particles. As the bubbles float to the surface they carry the biosolids particles with them, forming a dense float layer on the surface of the DAFT tank. This float layer is skimmed off the surface, and the thickened biosolids send on for further treatment. The relatively clear underflow is returned to the head of the aeration basins for treatment.

4.3.3.3 Dewatering

The thickened WAS (TWAS) is mixed with the digested solids, with the resulting mixture conditioned with a cationic polymer and pumped through high-speed centrifuges to separate the free water from the solids. The centrifuges are able to concentrate the mixture from a feed solids content of less than 5 percent to a dewatered cake of approximately 25 percent. This volume reduction greatly reduces the cost of the drying process. Centrate is returned to the primary influent channel.

4.3.3.4 Drying

The dewatered centrifuge cake is conveyed from the centrifuge discharge to the drying system. The drying system receives the centrifuge cake at 25 percent solids and dries it in a rotary dryer to a solids concentration of 92 percent or higher. The dried biosolids are formed into small pellets, 4 mm in diameter or smaller. These biosolids pellets have significant value as a soil conditioner, and can be sold or given away to a variety of potential customers. MSD actively markets this product under the name Louisville Green.

4.3.4 Construction Activities – 1990-2004

As noted previously, the MFWTP has been under re-construction almost continuously from 1972 through 2004. Early efforts to add secondary treatment had mixed success, resulting in lawsuits and enforcement actions by regulators. From the period of 1990-2005 over $188,000,000 in capital construction was completed at the plant, to improve treatment performance, improve reliability of treatment, and expand both the annual average capacity and the peak weather capacity of the plant. Projects have ranged in size from $10,000 pump replacements to the $80,000,000 replacement of the solids handling system. Table 4-1 lists the projects associated with each area of the MFWTP. The following is a description of some of the more significant construction projects that significantly impacted plant capacity or treatment performance.

TABLE 4-1
SUMMARY OF MFWTP CONSTRUCTION PROJECTS 1990-2005

	Year Completed	Capital Cost ($1,000)
CSO 211 (Main Diversion Structure)		
MDS Phase 1	2001	$883
MDS Phase 2	2003	$565
MDS Biofilter Media	2002	$170
SWPS		
SWPS Modifications	2002	$3,505
SWPS Gate Control	2002	$265
SWPS Outfall Repair	2003	$467
SWPS Minor Projects		$907
Headworks		
New Headworks	2000	$9,010
Grit System Rehab	2002	$239
Bar Screen Rehab	2002	$208
Grit conveyor replacement	2002	$427
Headworks conveyor replacement	2001	$383
Headworks Minor Projects		$952
Primary Sedimentation		
Sed Basin Rehab	2003	$213
Sed Basin Rail Refurb	2005	$367
EPS Primary	1999	$418
Ferric /Ferrous Improvements	2002	$179
Primary Minor Projects		$496
Bioroughing Towers		
Bioroughing Construction	1993	$13,200
Bioroughing Rebuild	2000	$4,436
Bioroughing Odor Control	2001	$3,498
Bioroughing Minor Projects		$443
Primary Effluent Flow Routing		
Wet Weather Capacity Flow Mods	2001	$1,507
Aeration Basins		
HPO Modifications	2003	$9,289
Secondary Clarifiers		
Secondary Clarifier Mods	2003	$2,883
Secondary Clarifier Metering	2003	$950
WAS Pump Replacement	2003	$578
Secondary Clarifier Minor Mods		$238
Disinfection		
Chlorine Area Mods	2000	$144
Sodium Hypo Mods	2000	$187
Disinfection Minor Projects		$58
FEPS		
FEPS Upgrade	1999	$4,896
FEPS Minor Mods		$472

	Year Completed	Capital Cost ($1,000)
Solids Handling Modifications		
Fume Incinerator	1998	$1,220
Back-up Fume Incinerator	2002	$1,019
DAFT Odor Control	2002	$1,025
Storage Tank Covers	1999	$1,209
Solids Handling Minor Mods		$1,786
New Solids Handling		
Alternative Solids Processing	2004	$80,172
Solids Receiving and FM Separation	2005	$5,680
DAFT Polymer	2005	$115
DAFT Rebuild	2003	$800
General Plant Systems		
Power System Phase 1	2000	$1,897
I&C Improvements	2001	$1,889
Process Control Migration	2000	$669
Electrical Mods	1998	$2,918
General Process Improvements	1999	$377
General Plant Mods & Prof Svcs		$25,448
Total 1990 - 2005		**$188,657**

4.3.4.1 Main Diversion Structure

Main Diversion Structure (MDS) was rehabilitated in two phases for a total construction cost of approximately $1,448,000. In the first phase of modifications, gate actuators were replaced, gates were rehabilitated, and a standby power generator was added to ensure that effective flow control was available under all conditions. In the second phase of modifications, an inflatable dam was added to CSO 211. The inflatable dam provides better control of overflows, by ensuring that sufficient hydraulic head could be developed to allow the full peak flow capacity of the plant to be delivered if river conditions or other factors limited the availability of the SWPS to deliver flow to the MFWTP. This second phase was completed for a cost of approximately $565,000.

4.3.4.2 Southwestern Pump Station

The SWPS underwent a major rehabilitation to improve the reliability of the pumping systems. The four pumps and motors were replaced, along with the bar screens and other ancillary systems. The construction cost of this project was $3,500,000.

4.3.4.3 Headworks

A new Headworks facility with a peak flow capacity of 200 MGD was constructed for a cost of $9,010,000. This project improved the reliability of the preliminary treatment facilities as compared to the screening and grit removal facilities provided as part of the original 1958 construction. After completion of the new Headworks, the old Headworks was rehabilitated in a series of projects that totaled approximately $1,300,000. After completion of the various

headworks projects, the firm capacity of the headworks system exceeded the peak flow capacity of the primary sedimentation basins, and the reliability was improved to the point that headworks capacity is not a flow limiting factor at MFWTP.

4.3.4.4 Primary Sedimentation

Primary sedimentation basins received a major rehabilitation in 2 phases, at a cost of $580,000. Additional improvements included a series of projects to provide chemical feed capabilities for enhanced primary sedimentation. The sum of these projects totaled approximately $1,100,000.

4.3.4.5 Bioroughing Towers

The original construction of the Bioroughing Towers cost approximately $13,200,000. After the collapse of the media and supports in 1996, a complete reconstruction of the media support structure was completed, along with a replacement of all the media. The pump station was also rehabilitated. The total cost of the rehabilitation project was $4,400,000. Covers and odor control equipment were also added to the Bioroughing Towers, for a cost of $3,500,000, and a series of small projects were completed for an additional $443,000.

4.3.4.6 Primary Effluent Flow Routing

A project to increase the capacity of the Primary Effluent flow routing facilities was completed for a cost of $1,500,000. This increased the capacity of this system to 210 MGD, allowing the full capacity of the primary sedimentation basins to be used (assuming a secondary treatment capacity of 140 MGD).

4.3.4.7 Aeration Basins

The $9,300,000 HPO Modifications project replaced the submerged turbine aerators with more conventional surface aerators. It also provided a level control system, and repaired cracks in the reactor concrete. With the completion of this project the full organic treatment capacity of the aeration system was restored, reliability of the system was improved, and operating costs were reduced due to reductions in oxygen leakage.

4.3.4.8 Secondary Clarifiers

Each of the 20 MFWTP secondary clarifiers were rehabilitated with new center torque tubes, and metal repair and repainting of the mechanisms. This project cost $2,900,000, and was essential for reliable operation of the clarifiers. An associated project costing $950,000 provided new flow meters in the feed piping to improve flow split capability and allow for full utilization of clarifier capacity. WAS pumps were replaced for a cost of $578,000 and a series of minor projects were also completed for a cost of $238,000. The secondary clarifiers are the limiting factor for treatment capacity in the secondary treatment system.

4.3.4.9 Disinfection

Modifications to the disinfection system replaced a chlorine system feeding gaseous chlorine from rail cars with a liquid sodium hypochlorite system. Dechlorination using sodium bisulfite

was also installed. Both systems were added to improve the safety of the MFWTP operation, and remove the potential hazard of the gas systems. Total costs for disinfection improvements were approximately $370,000.

4.3.4.10 Final Effluent Pumping Station (FEPS)

The FEPS modifications replaced the drive units with new variable speed drives for a cost of $4,900,000. This project greatly improved the reliability of the FEPS system, since the original variable speed drives were unreliable and often failed during effluent pumping operations. This project had multiple positive results, including the ability to decrease the amount of CSO volumes discharged from CSO 211 due to an improved reliability of the final effluent pump station.

4.3.4.11 Solids Handling

The largest project in this improvement program was the replacement of the vintage 1974 solids handling system with the new biosolids drying system. This $80,000,000 project replaced an aging system that was mechanically unreliable due to its age, capacity limited due to age and reliability, and expensive to operate. The Low Pressure Oxidation solids conditioning system (Zimpro) was highly odorous, and generated a very strong recycle stream that consumed treatment capacity. Eliminating the Zimpro system and installing the system in place today is part of the reason the plant capacity has been rerated to 120 MGD. It also provides a more mechanically reliable system with many levels of redundancy to reduce the potential for solids handling capacity limitations to impact liquid train treatment efficiency.

Other significant solids handling improvements include rebuilding the DAFT units for better performance, higher reliability and reduced operating costs. A solids receiving facility has been constructed to allow solids received from the outlying plants to be stored and routed directly to solids handling, rather that the past practice of delivering to the influent sewers and retreating at the MFWTP. This will avoid using plant capacity for retreating loads that have already been removed in the outlying plants.

4.3.4.12 General Plant Systems

In addition to the projects that can be associated with specific unit processes, several significant projects were completed to strengthen the basic plant infrastructure. Two significant electrical system projects and two major instrumentation and control projects are included on the list of general plant upgrades that support the overall operation of the MFWTP.

4.4 HISTORY OF PLANT FLOWS OVER THE PAST 10 YEARS

The MFWTP Service area consists mainly of the original City of Louisville. Over the past 10 years, residential customer populations have been stable to declining, and industrial dischargers have similarly declined. Figure 4-5 shows the trend in annual base flows (defined as the minimum month average day flow for the year) over the past 10 years. A linear regression of base flows indicates a strong downward trend. Figure 4-5 also shows annual average flows for the same time period, indicating a stable or slightly declining trend.

The difference between annual base flow and annual average flow is the annual wet weather capture, as shown on Figure 4-5. The trend clearly indicates an increase in wet weather capture, from a "daily average" of approximately 17 MGD in 1996 to almost 25 MGD in 2005.

Extended over a calendar year, these average daily wet weather capture values indicate an increase in wet weather capture of almost 3 billion gallons per year. In addition to providing disinfection for this additional 3 billion gallons of flow, it is estimated that over 600 tons of BOD and 1,200 tons of TSS are prevented from reaching the Ohio River each year.

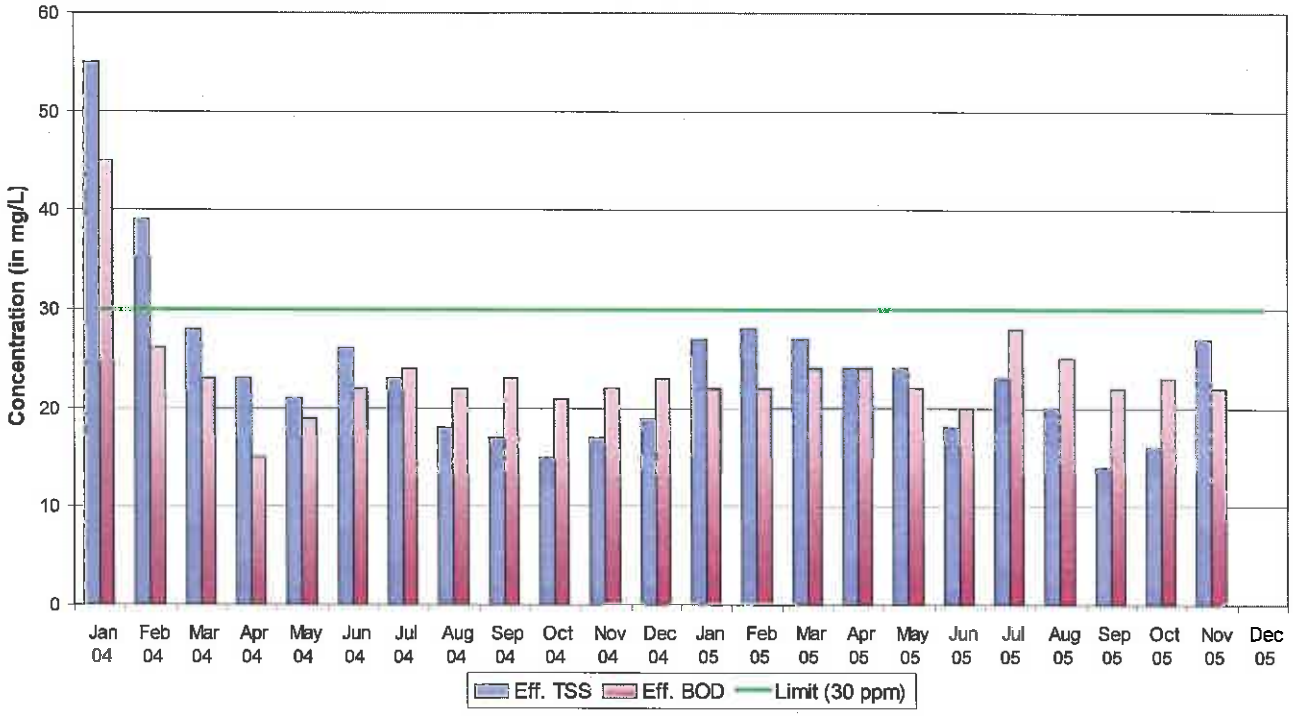
4.5 HISTORY OF PEAK FLOWS

Over the past 7 years, several projects have been completed to increase the peak wet weather capacity of the MFWTP. As noted previously, the peak instantaneous capacity of the plant is 350 MGD. Due to the inherent variations in flow resulting from precipitation events, the peak instantaneous flow rate cannot be sustained without risking process washout in the primary sedimentation basins. The peak sustainable flow rate, with all facilities in service is estimated to be 325 MGD.

Evaluating trends in flow peaking is difficult at the MFWTP, as hourly flow peaks are not archived in the plant reporting database. Only daily flows are captured and archived. For most wet weather events peak flow rates are not sustained for an entire day, and the reported daily flow is typically much lower than the instantaneous flow peak actually taken through the plant. Trends in daily peaks will indicate trends in accepting wet weather peaks, but cannot be directly correlated to instantaneous peaks.

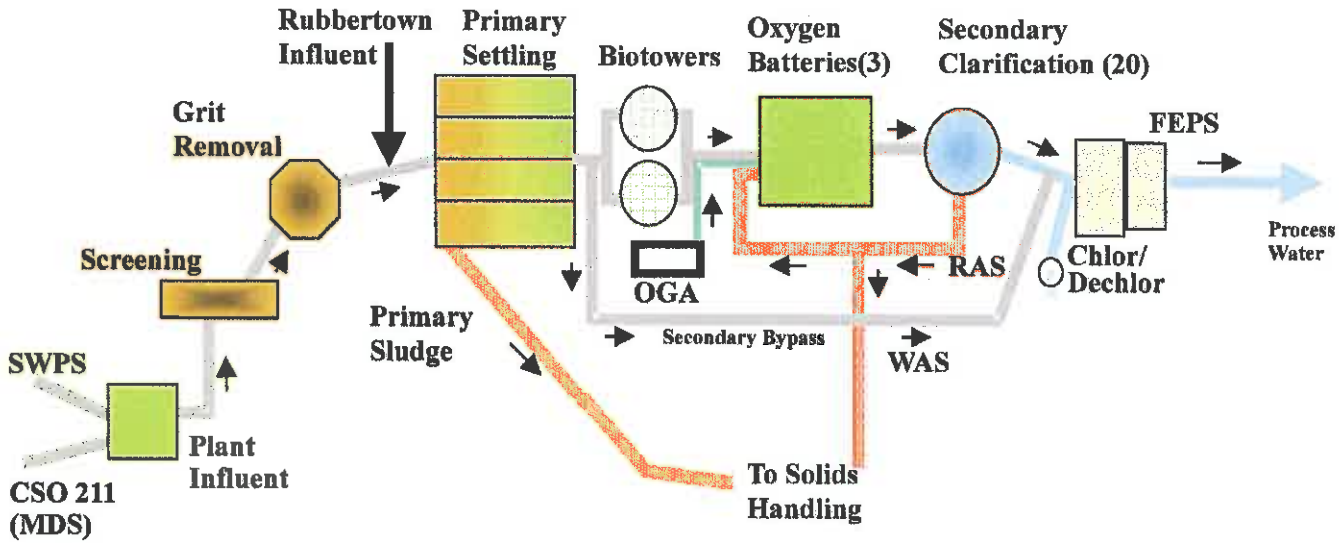
The project to increase the capacity of the primary effluent flow routing to disinfection had the largest impact on the plant's ability to handle wet weather peaks. This project was under construction during 2000, and completed and put into operation in 2001. Figure 4-6 shows the trend in peak daily flows reported from 1999-2005. As expected, there was a drop in peak flows accepted during 2000, when the flow routing improvements were being constructed, and a sharp jump in peak day flows in 2001. Data collected between 2001 and 2004 indicates a continued upward trend in peak flows through 2005. The drop in peak flow rates in 2005 is due to sedimentation basin repair and reconstruction that resulted in only 3 sedimentation basins being available for most of the year, thus reducing the peak instantaneous and sustained peak capacities of the plant by 33 percent.

FIGURE 4-1
MFWTP PERMIT COMPLIANCE
2004 - 2005



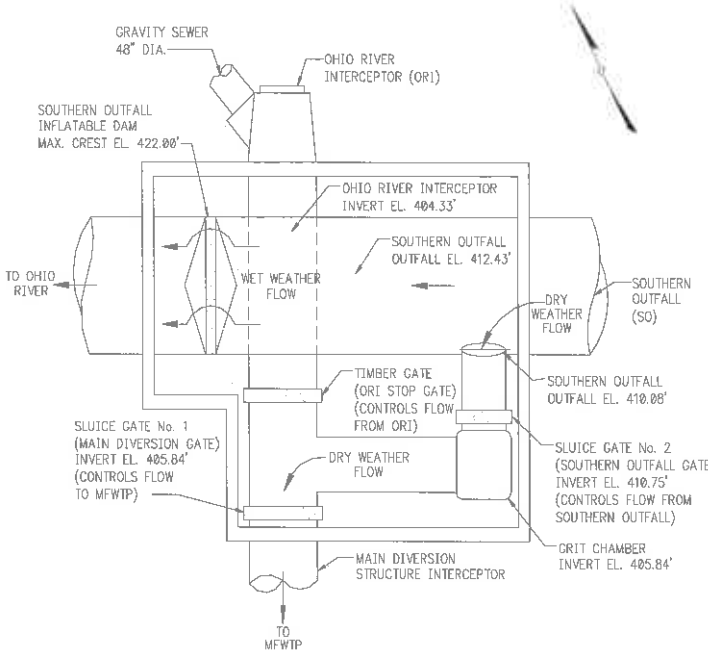
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FIGURE 4-2
MFWTP LIQUID PROCESS
FLOW SCHEMATIC



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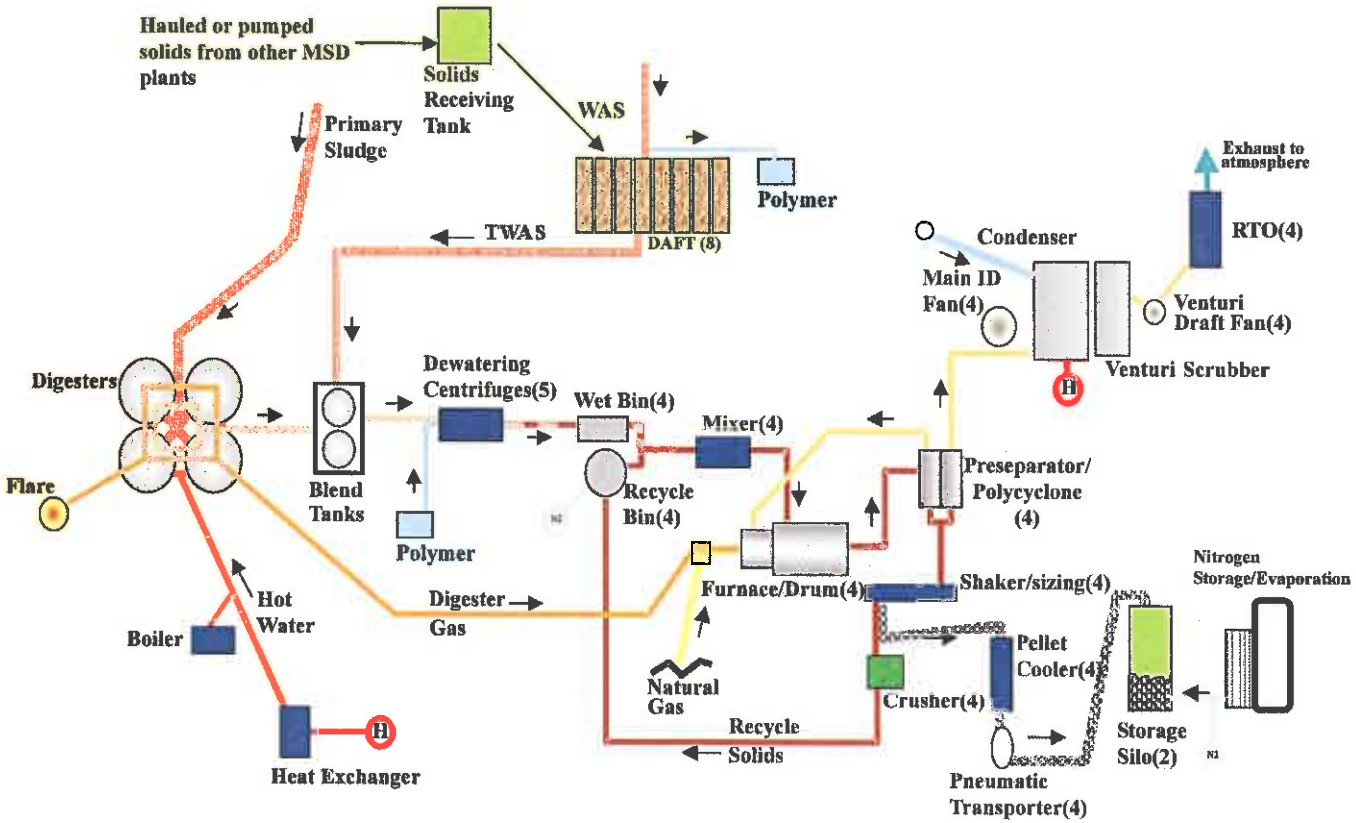
FIGURE 4-3
CSO 211
MAIN DIVERSION STRUCTURE





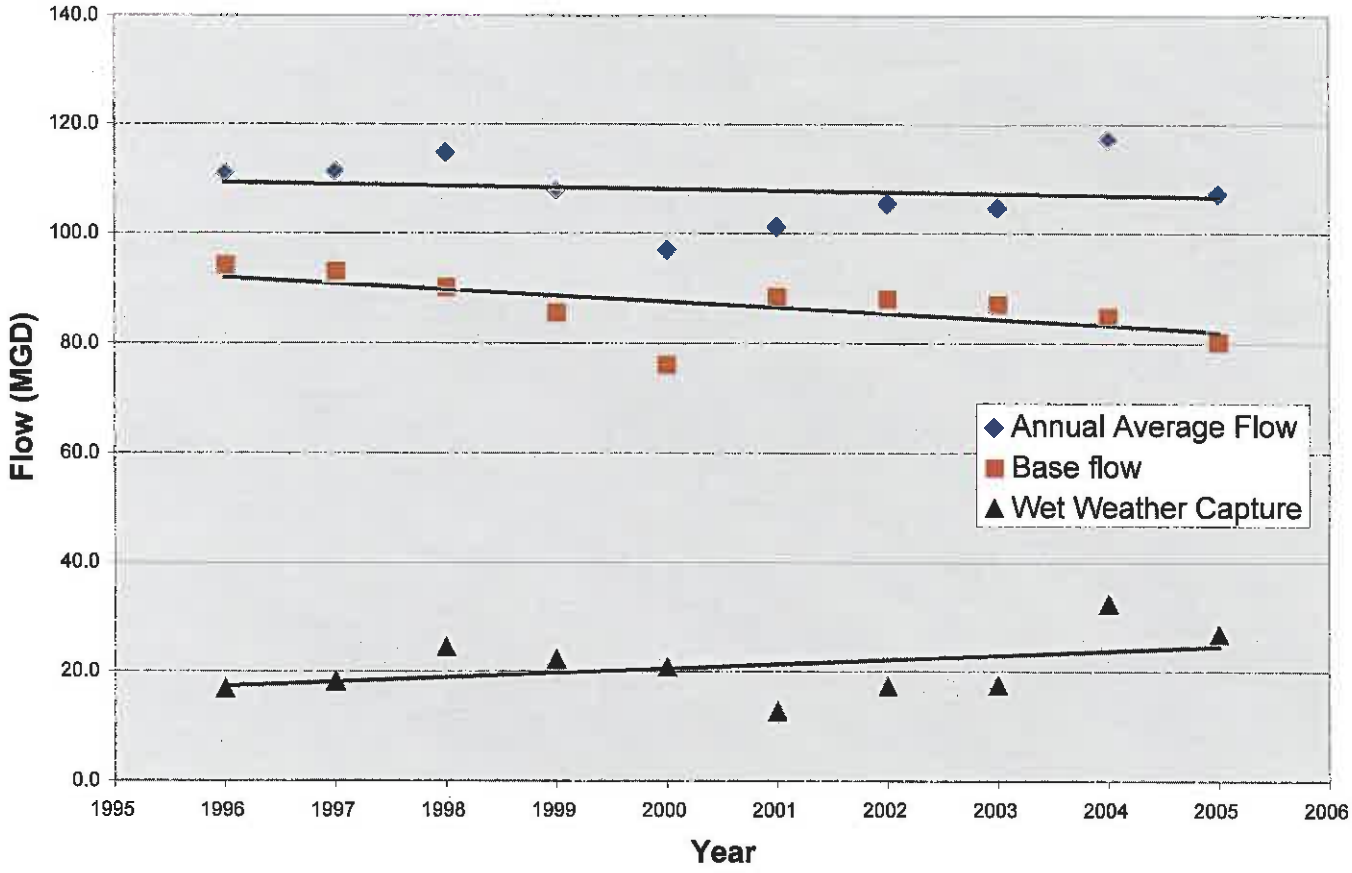
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FIGURE 4-4
SOLIDS HANDLING PROCESS
SCHEMATIC



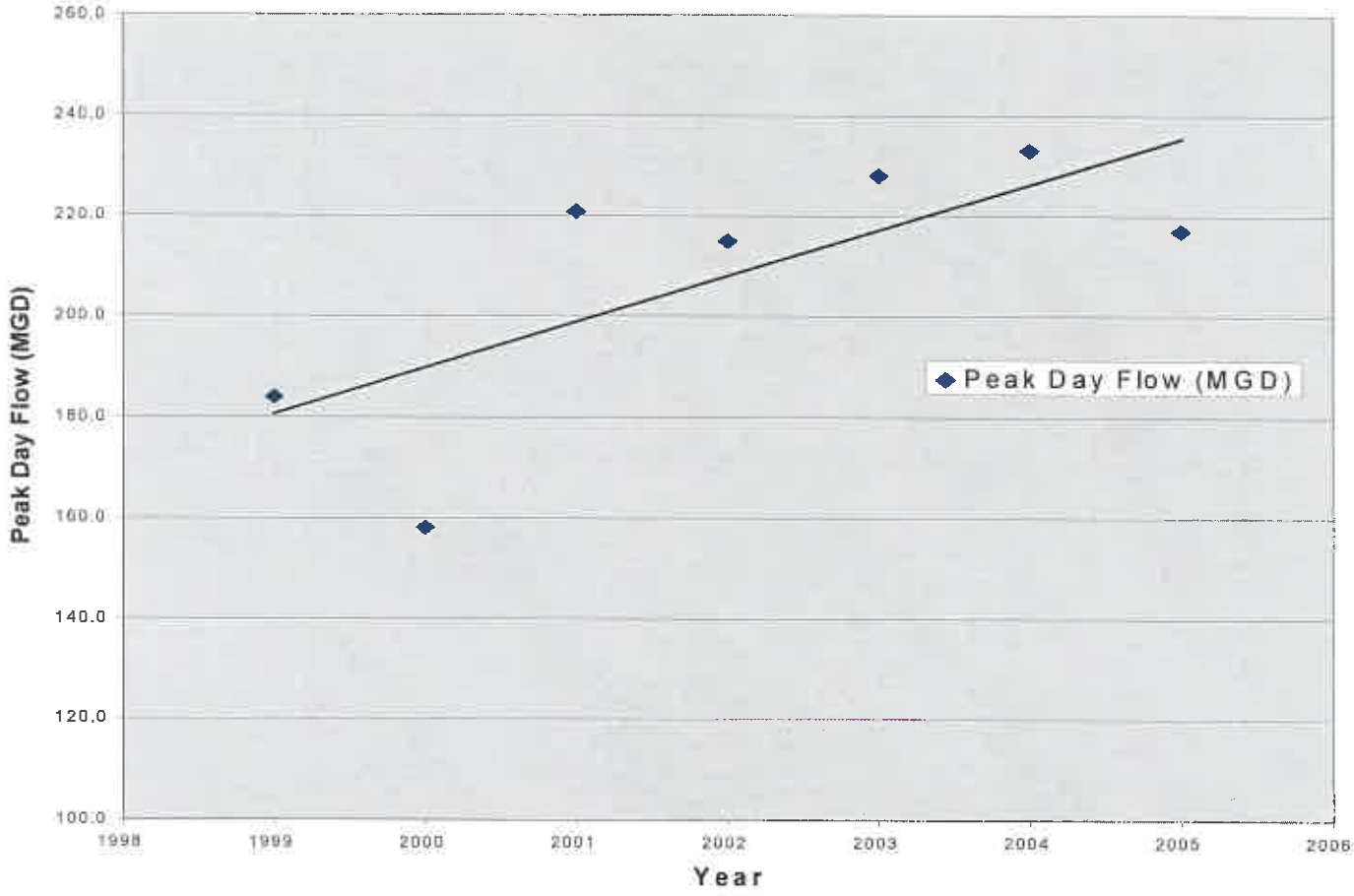
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FIGURE 4-5
WET WEATHER
CAPTURE TREND



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FIGURE 4-6
PEAK DAY
FLOW TREND



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SECTION 5

SECTION 5: CONSIDERATION OF SENSITIVE AREAS

5.1 EPA POLICY REQUIREMENT

The EPA CSO Control Policy describes several options, which can be pursued by CSO permit holders to achieve compliance with the policy. In areas where water quality resources are particularly sensitive to CSO discharges, the LTCP is expected to give the highest priority to controlling overflows to these sensitive areas. Sensitive water bodies should be identified as well as the CSO outfalls that discharge to them. Sensitive areas are those identified by the NPDES authority, in coordination with other State and Federal agencies as appropriate.

According to the CSO Control Policy, sensitive areas include:

- Outstanding Natural Resource Waters,
- National Marine Sanctuaries,
- Waters with threatened or endangered species or their designated critical habitat,
- Primary contact recreation waters, such as bathing beaches and boating ramps,
- Public drinking water intakes or their designated protection areas, and
- Shellfish beds.

Specifically related to sensitive areas, the EPA CSO Control Policy indicates LTCP should:

- Prohibit new or significantly increased overflows;
- Eliminate or relocate overflows that discharge to sensitive areas wherever physically possible and economically achievable, except where elimination or relocation would provide less environmental protection than additional treatment; or
- Where elimination or relocation is not physically possible and economically achievable, or would provide less environmental protection than additional treatment, provide the level of treatment for remaining overflows deemed necessary to meet QAS for full protection of existing and designated uses; and
- Where elimination or relocation has been proven not to be physically possible and economically achievable, permitting authorities should require, for each subsequent permit term, a reassessment based on new or improved techniques to eliminate or relocate, or on changed circumstances that influence economic achievability. (EPA, 1994)

5.2 KENTUCKY STREAM USE CLASSIFICATIONS

Kentucky's Water Quality Regulations establish surface water use classifications for all waters of the Commonwealth. The identified use classifications can be summarized as follows:

- WAH - Warm Water Aquatic Habitat
- CAH - Cold Water Aquatic Habitat
- PCR - Primary Contact Recreation
- SCR - Secondary Contact Recreation
- DWS - Domestic Water Supply (applicable at existing points of public water supply withdrawal)
- ORW - Outstanding Resource Water

The designated stream use classifications for the surface water bodies within the Beargrass Creek Basin and Ohio River Basin is summarized in Table 5-1. Figure 5-1 shows a graphic representation of this data.

TABLE 5-1
STREAM USE DESIGNATIONS

Stream	Use Designation
Ohio River Main Stem	WAH, PCR, SCR and DWS
Paddy's Run and Tributaries	PCR and SCR
South Fork Beargrass Creek and Tributaries	WAH, PCR, SCR
Middle Fork Beargrass Creek and Tributaries	WAH, PCR, SCR
Muddy Fork Beargrass Creek and Tributaries	WAH, PCR, SCR

Table 5-2 summarizes the existing uses of the receiving water related to the sensitive areas classifications:

TABLE 5-2

Sensitive Area Classification	General Assessment
Outstanding Natural Resource Waters	None of the receiving waters are designed on ONRW
National Marine Sanctuaries	None of the receiving waters are designed on National Marine Sanctuaries
Endangered/Threatened Species	Endangered plants and animals reported to exist in the Beargrass Creek Region
Primary Contact Recreation Waters	Some stretches of Ohio River are currently in use for the Primary Contact Recreation Waters.
Public Drinking Water Intakes	None of the receiving waters are designed as protected area for drinking water supply.
Shellfish Beds	None of the receiving water support shell fishing.

5.3 GENERAL ASSESSMENT OF CSO AREA

5.3.1 Beargrass Creek Region

The Beargrass Creek drainage basin located in eastern Jefferson County has three major branches, the South Fork, Middle Fork and Muddy Fork. These tributaries stretch from the Ohio River, through portions of the combined sewer sections, to the separate sewer section of northern and eastern Jefferson County. These creeks also serve as relief points for over 50 combined sewer overflow points.

The development throughout the Beargrass Creek drainage basin is primarily established residential communities with some commercial development. Construction of combined sewers including the interceptor sewers serving these areas subsided more than 50 years ago. Due to the development and increased runoff in this area, the lower sections of South Fork branch were lined with concrete from 1910 to 1940 to eliminate flooding. Native plant and animal life along this section has been eliminated, and the downstream stretches have been impacted. The development has disturbed natural areas along the creeks and forced limited areas to

become the remaining areas for native plants and animals to live, increasing the need for protecting remaining potential habitat. Areas of special concerns are monitored by the Kentucky State Nature Preserve Commission.

In 1996, the Kentucky State Nature Preserves Commission and Kentucky Department of Fish and Wildlife have determined that nine occurrences of endangered, threatened or special concerns mammals, flora and fauna, plants have occurred in the combined sewer area of the Beargrass Creek Region. The plants and animals reported to exist in these areas are summarized in the Table 5-3.

TABLE 5-3

Scientific Name	Common Name	Status
Cabomba Caroliniana	Carolina Fanwort	State Threatened
Catanea Pumila	Allegheny Chinkapin	State Threatened
Pontederia Cordata	Pickerel Weed	State Threatened
Trifolium Stoloniferum	Running Buffalo Clover	State Threatened
		Federal Endangered
Myotis Grisescens	Gray Bat	State Endangered
Myotis Sodalis	Indiana Bat	State Endangered
Orconectes Jeffersoni	Louisville Crayfish	State Threatened
		Federal Endangered
Nyctanassa Violacea	Yellow-crowned Night Heron	State Threatened

State Endangered species are in danger of extirpation and/or extinction throughout all or a significant portion of its range in Kentucky. State Threatened species are likely to become endangered within the foreseeable future throughout all or a significant portion of its range in Kentucky. Protecting the remaining habitats ensures their survival.

5.3.2 Ohio River North and Ohio River West Regions

The development throughout Ohio River North and Ohio River West Regions is highly variable and contains residential, commercial and industrial areas. Construction of combined sewers including the interceptor sewers serving these areas subsided more than 50 years ago. This development has disturbed natural areas along the creeks and limited areas for local plants and animals to live. The Kentucky State Nature Preserve Commission monitors these areas of special concern.

Eight major interceptors convey a majority of the stormwater in Ohio River North and Ohio River West Regions. These interceptors include the Ohio River Interceptor, Northwestern Interceptor, Western Interceptor, Western Outfall, Southern Outfall, Southwestern Outfall, Upper Dry Run Trunk, and Mill Creek Trunk. The CSOs located in Ohio River North and Ohio River West Regions either discharge directly to the Ohio River or discharge to outfall pipes that discharge to the Ohio River. Areas along the Ohio River are considered primary contact recreation waters.

In previous reviews in the late 90s, the Kentucky State Nature Preserves Commission and Kentucky Department of Fish and Wildlife have determined that nine occurrences of endangered, threatened or special concerns mammals, flora and fauna, plants have occurred in the Ohio River North and Ohio River West Regions. The plants and animals reported to exist in these areas include:

TABLE 5-4

Scientific Name	Common Name	Status
Clonophis Kirtlandii	Kirkland Smale State	Endangered
Potamalius Copax	Fat Pocketbook	State Endangered
Pleurobema Clava	Clubshell	State Endangered
Plethobasus Cooperianus	Orange-Foot Pimpleback	State Endangered
Obovaria Retusa	Ring Pink	State Endangered
Lampsilis Abrupta	Pink Mucket	State Endangered
Cyprogenia Stegaria	Fanshell	State Endangered
Uycticorax Nycticorax	Black-Crowned Night Heron	State Endangered
Nycticeius Humeralis	Evening Bat	State Threatened

For a previous study prepared in 1991, the CSOs discharging directly to the Ohio River have no significant impact on environmental conditions along the river. However, there are sections along the river where primary contact recreation is practiced, and the waste from the CSO discharges presents a potential for human contact.

5.3.3 Letters of Request

Letters were sent to the appropriate agencies requesting information about the possible impact on sensitive areas within the combined sewer area:

- United States Department of the Interior - Field Supervisor
- United States Army Corp of Engineers
- Kentucky State Historic Preservation Office

Copies of these responses are included in Figure 5-2, Figure 5-3, Figure 5-4a and Figure 5-4b. Specific locations of projects for the CSO LTCP Update have not been identified. Each agency acknowledged receipt and asked to be involved when more detail is available.

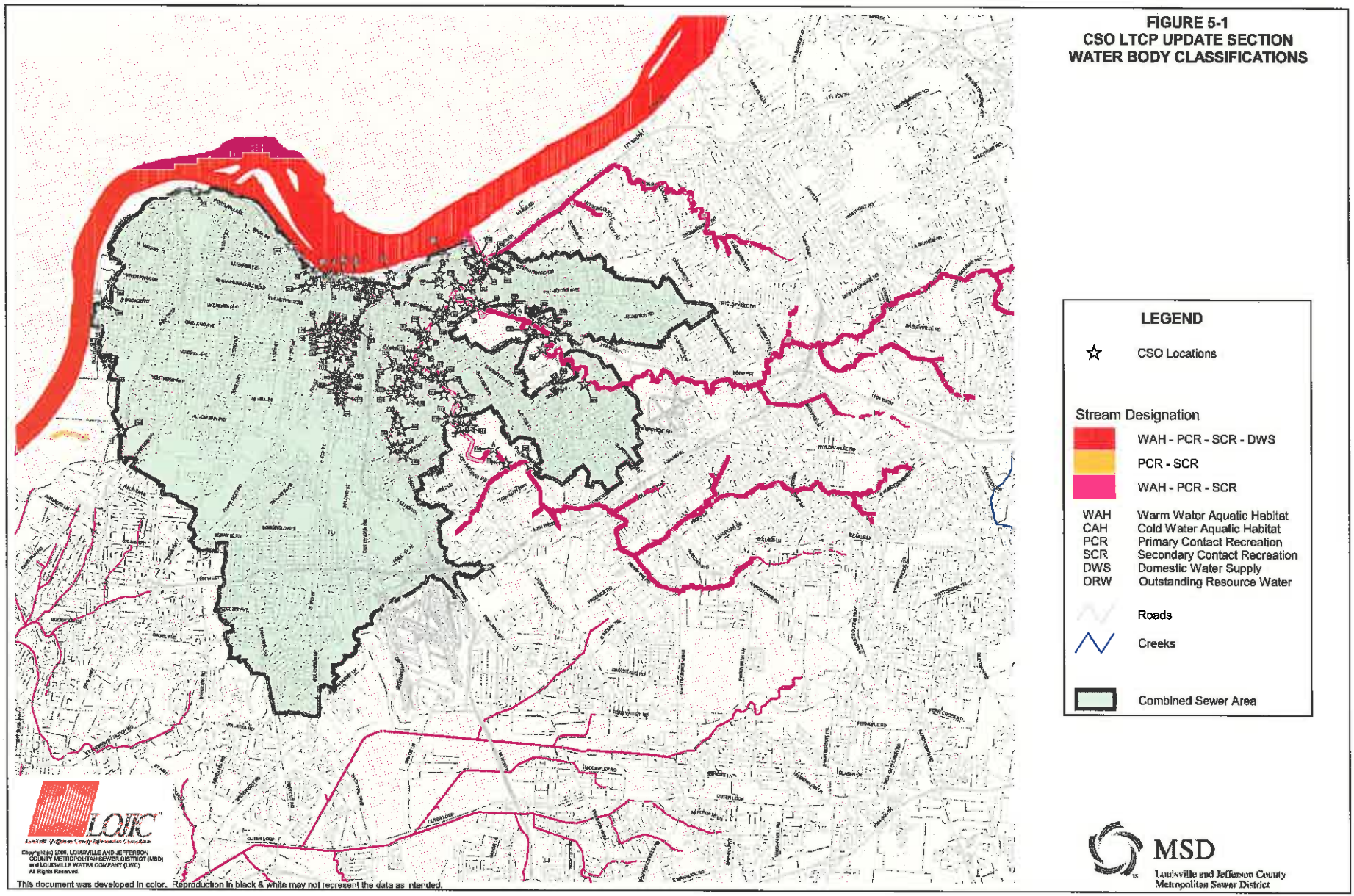

FIGURE 5-1
CSO LTCP UPDATE SECTION
WATER BODY CLASSIFICATIONS
LEGEND
CSO Locations
Stream Designation
WAH - PCR - SCR - DWS
PCR - SCR
WAH - PCR - SCR
WAH Warm Water Aquatic Habitat
CAH Cold Water Aquatic Habitat
PCR Primary Contact Recreation
SCR Secondary Contact Recreation
DWS Domestic Water Supply
ORW Outstanding Resource Water
Roads
Creeks
Combined Sewer Area
LOJIC
Louisville Jefferson County Information Consortium
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FIGURE 5-2
SENSITIVE AREA LETTER

FWS 05-0290

MSD

Louisville and Jefferson County Metropolitan Sewer District
700 West Liberty Street
Louisville, KY 40203-1913
502-540-6000
www.msdlouky.org

KY FIELD OFFICE

OCT 14 2005

RECEIVED

October 13, 2005

Mr. Virgil Lee Andrews, Jr.
Field Supervisor
United States Department of the Interior
Fish & Wildlife Service
3761 Georgetown Road
Frankfort, KY 40601

Re: Louisville MSD-Sensitive Area

File: 10777/35816.111.111 #2

Dear Mr. Andrews:

The Louisville/Jefferson County Metropolitan Sewer District (MSD) is updating a long-term control planning document for management of combined sewer overflow (CSO) discharges to the Ohio River main stem and three forks of the Beargrass Creek. A site map provided as an attachment to this letter identifies the location of the CSO outfalls associated with the combined sewer system. Development of the long-term CSO control plan includes consideration of sensitive areas that may be present at the point of discharge, as required by The US Environmental Protection Agency (EPA) policy (Federal Register: April 19, 1994).

In order to comply with the EPA policy, MSD requests that U.S. Fish & Wildlife Service files be reviewed to identify the presence or absence of rare, threatened or endangered species in the vicinity of the site. Please forward relevant information to my attention. In responding, please refer to the Louisville/Jefferson County CSO discharge area.

Should additional information be required to complete your review, please contact me at (502) 540-6000. Your prompt response to this request is appreciated.

Very truly yours,

W. Brian Bingham,
Regulatory Management Services Director

Enclosure (1)

No significant adverse impacts to wetlands or federally listed endangered or threatened species are anticipated from this proposal.

for Field Supervisor Date Nov 16, 2005
U. S. Fish and Wildlife Service
Frankfort, KY 40601

Beneficial Use of Louisville's Biosolids
www.louisvillegreen.com

MSD
Louisville and Jefferson County
Metropolitan Sewer District

FIGURE 5-3
SENSITIVE AREA LETTER

COMMERCE CABINET
KENTUCKY HERITAGE COUNCIL

Ernie Fletcher
Governor

The State Historic Preservation Office
300 Washington Street
Frankfort, Kentucky 40601
Phone (502) 564-7005
Fax (502) 564-5820
www.kentucky.gov

George Ward
XXXXXXXXXXXX
Secretary

David L. Morgan
Executive Director and
State Historic Preservation Officer

December 8, 2005

Mr. W. Brian Bingham
Regulatory Management Services Director
Louisville and Jefferson County Metropolitan
Sewer District
700 West Liberty Street
Louisville, Kentucky 40203-1913

Dear Mr. Bingham:

I am writing as a follow-up to your letter of October 13, 2005 concerning the Louisville and Jefferson County Metropolitan Sewer District's long-term control planning document for management of combined sewer overflow discharges to the Ohio River main stem and three forks of the Beargrass Creek in Jefferson County, Kentucky. Mr. Charles Hockensmith of my staff met with Ms. Susan Bahng of O'Brien & Gere on December 8, 2005 to discuss this planning document. As a result of our meeting, we understand that the final plan will be developed and submitted for our review in 2008. Once specific ground disturbing activities are identified in the final plan, we will be happy to comment on specific project impacts. We look forward to future consultation with your office.

Should you have any questions, feel free to contact Charles Hockensmith of my staff at (502) 564-7005.

Sincerely,

David L. Morgan, Director
Kentucky Heritage Council and
State Historic Preservation Officer

KentuckyUnbridledSpirit.com

Kentucky UNBRIDLED SPIRIT

An Equal Opportunity Employer M/F/D

MSD
Louisville and Jefferson County
Metropolitan Sewer District

FIGURE 5-4a
SENSITIVE AREA LETTER

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
P.O. BOX 59
LOUISVILLE, KENTUCKY 40201-0059
FAX: (502) 315-6677
http://www.lrl.usace.army.mil/

December 7, 2005

Operations Division
Regulatory Branch (South)
ID No. 200501678-kmb

Mr. W. Brian Bingham
Louisville and Jefferson County
Metropolitqan Sewer District (MSD)
700 West Liberty Street
Louisville, Kentucky 40203-1913

Dear Mr. Bingham:

This is in regard to your letter dated October 13, 2005, concerning your long term plan for management of combined sewer overflow discharges into the Ohio River and its tributaries as well as Beargrass Creek and its tributaries, all located in Jefferson County, Kentucky.

Based on the information provided, it appears that a permit would be required for at least one or more sites due to the discharge of dredged or fill material into "waters of the United States (U.S.)."

Once a detailed site development plan is developed, a request for authorization should be submitted for Corps approval. The information necessary to process a permit request are as follows: a completed ENG Form-4345 application, a delineation according to the Corps of Engineers 1987 Wetland Delineation Manual of any areas of proposed wetland impacts, United States Geological Survey (USGS) topographic maps; county soil survey maps, and Federal Emergency Management Agency (FEMA) floodplain maps. This information should be provided for each proposed impact location and clearly indicated on each drawing and map. You are reminded that all drawings and maps must be submitted on 8½ x 11-inch paper and be of reproducible quality.

Once this information is submitted, the Corps would determine whether a Department of the Army (DA) permit would be required. Note that the processing time for non-controversial DA permit applications requiring individual review takes approximately 90 to 120 days. Please allow sufficient time in your pre-construction schedule for the processing of a DA permit application.

MSD
Louisville and Jefferson County
Metropolitan Sewer District

FIGURE 5-4b
SENSITIVE AREA LETTER

Your request has been assigned ID No. 200501678-kmb. Please reference this number on all correspondence pertaining to this project. If you have any questions concerning this matter, please contact this office at the above address, ATTN: CELRL-OP-FS or call me at (502) 315-6688.

Sincerely,

Kimberly M. Beasley
Biologist, South Section
Regulatory Branch

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SECTION 6

SECTION 6: CONSIDERATION OF CONTROL STRATEGIES

6.1 INTRODUCTION

The National CSO community has developed many practices and technologies for control and treatment of CSOs. The earliest technologies were in response to NMC requirements in the 1990s. As NMC technologies were implemented, the industry began to develop new technologies that represented the second generation of control strategies. Many of these next generation technologies are under consideration for application to Louisville MSD's Combined Sewer System (CSS). This section reviews those technologies.

Each technology is grouped below within one of several categories: Collection System, Storage, Treatment and Receiving Water Improvement. A detailed summary of each technology is presented along with MSD's experience with the technology. Technologies are summarized in Table 6-1.

6.2 COLLECTION SYSTEM CONTROLS

Collection system control technology is designed to increase the capacity of the sewer system and/or minimize extraneous flows into the system. The reasons behind the need for collection system modification or rehabilitation may include:

- Change in design philosophy,
- Inadequate design,
- Poor construction practices (e.g. improper bedding),
- Root intrusion,
- Chemical attack on the system (e.g. H_2S),
- Normal aging and weathering,
- Damaged and leaking pipes, and
- Soil movement.

Methods of collection system control include relining existing sewers, in-situ replacement (pipe bursting), infiltration reduction and new sewer construction. The techniques are described below:

6.2.1 Sewer Relining

Relining is the practice of applying an improved coating to the wetted perimeter of the pipe in order to reduce the resistance to flow (Manning's Roughness Coefficient). An additional benefit of this technology is the sealing action of the coating, which can greatly reduce or even eliminate Infiltration. Relining can take the form of cured in place (CIP) liners or prefabricated HDPE liners (slip lining). The CIP liners may be easier to place in the sewers, as they do not require excavation. They do require heated curing. Slip lining requires some excavation to allow the installation of the HDPE pipe. MSD has applied sewer-relining technology with some success within the separate sanitary sewer system. MSD has been very successful applying sewer relining uses in house resources on sanitary house server lines that connect to the main sewer.

6.2.2 Pipe Bursting

Pipe bursting technology uses special equipment that makes it possible to increase the size of existing pipes without excavating and replacing the pipe. Pipe bursting involves pulling a polyethylene pipe through the old pipeline of equal or smaller size. The previous pipeline is shattered as the new pipeline is pulled through, with the broken up pieces pushed out into the soil. This no-dig process is suitable for enlarging the size of utility pipes, existing sewers or other pipelines without excavation. MSD has applied pipe-bursting technology in limited applications with some success.

6.2.3 Infiltration Reduction

Infiltration is ground water that enters the collection system through leaking pipe joints, cracked pipes, manholes, and other damaged devices. Infiltration is most likely to occur in low-lying areas and during periods of high ground water levels. Infiltration reduction technology is designed to reduce the non-inflow wet weather flow in the system, thereby allowing the system to accommodate more combined sewer influent. Rehabilitating system components is the primary method for reducing infiltration. The primary components of a typical CSS are sewer lines, laterals and manholes. Their respective rehabilitation technologies are as follows:

- **Sewer Lines** - removal and replacement, in-place replacement, and relining or sealing.
- **Laterals** - removal and replacement and relining or sealing.
- **Manholes** - sealing the manhole cover, spot repairs to patch defects, coating systems to rebuild structural integrity and protect manhole, replacement, and inserts and liners in manholes.

6.2.4 Sewer Separation

Sewer separation is the conversion of a combined sewer system into a system of separate sanitary and storm sewers. Sewer separation, by definition eliminates a CSO. This alternative is most likely to prevent sanitary wastewater from being discharged to receiving waters. It has the additional advantages of increasing available plant capacity and reducing the publics' exposure to raw sewage. A survey of NPDES files indicates that sewer separation is the most widely used CSO control, accounting for half of CSO control measures found in LTCP documentation (*Office of Water. 2001 Report to Congress-Implementation and Enforcement of the Combined Sewer Overflow Control Policy. EPA 833-R-01-003*).

However, being the most widely used CSO control does not imply that it is the most effective or most suitable control technology for a particular CSS. Construction of these new sewers may cost much more than other viable treatment technologies. When combined sewers are separated, storm sewer discharges increase and may contribute more pollutant load to the receiving waters because it is now untreated. Also, sewer separation may not eliminate the overflow, but actually cause the overflow to be redefined as an SSO. With that designation, a more stringent control plan may be required. Sewer separation is typically the most expensive CSO control measure. Because of the high cost and the negative impacts of major construction projects on local traffic, sewer separations are traditionally planned as part of a greater infrastructure rehabilitation project.

In practice, there are three distinct approaches to sewer separation:

- **Full Separation** - New sanitary sewer lines are constructed with the existing CSS becoming a storm sewer system. This is probably the most widely used form of separation. Another option is where an entirely new storm sewer system is constructed with the existing CSS remaining as a sanitary sewer system. This form of separation is not often used because the capacity of the existing CSS was designed to accommodate storm water runoff, which is more than what is required to accommodate sanitary flows.
- **Partial Separation** - Wherein a new storm sewer system is constructed for street drainage, but roof leaders and basement sump pumps remain connected to the existing CSS.

Sewer separation projects have been successfully implemented by MSD as part of the CSO Program, but as stated above, they have been part of major redevelopment efforts in downtown Louisville or have been implemented where circumstances made it cost effective. The sewer system for CSO 209 for example, already had separate pipe networks for both storm and sanitary sewage. However, these pipes combined at the manholes. The scope of the project, in this case, consisted of separating the manholes, reconnecting some drainage basins and correcting private property connections.

6.3 STORAGE

The objective of storage is to reduce overflows by capturing combined sewage during wet weather for controlled release into wastewater treatment facilities after the storm flows subside. Storage technology has three major sub-groups: In-line, off-line and on-site. While the NMC requirements in the 1990s required the implementation of low-cost optimization of in-line storage, current storage technology is much more complex utilizing real-time controls (RTC) technology and flow control structures. A typical modern storage facility may include an RTC controlled diversion regulator and an open or covered storage device; an RTC controlled return regulator and an emergency relief point. The emergency relief point may be equipped with netting, disinfection or other CSO control devices.

Storage facilities are widely used as CSO control because they effectively reduce the volume, frequency, and duration of CSO events. Storage facilities can provide a relatively constant flow into the treatment plant and thus reduce the size of treatment facilities required. They may be located at overflow points or near treatment facilities. A major factor determining the feasibility of using storage facilities is land availability. Operation and maintenance costs are generally small; requiring only collection and disposal cost for residual sludge solids, unless inlet or outlet pumping is required. The following technologies are most important in regards to storage.

6.3.1 Real Time Control (RTC)

Real-time control seeks to optimize sewer system performance during wet weather events. RTC is applicable in CSSs, because these systems typically include large pipes for transport of wet weather flows. RTC uses system wide dynamic controls to implement control tasks such as in-line storage flow maximization and flow diversion. There are two types of system-wide dynamic RTCs: reactive systems and predictive systems.

In reactive RTC, sewer level and flow data are measured in "real time" at key points in the sewer system. The collected data is transferred to a central computer where custom software applies feedback loops and optimization rules, to operate system elements so as to maximize

use of the existing sewer system and to limit overflows. Predictive control goes one step further by incorporating weather forecast data to allow for advanced planning of control tasks and control tasks sequencing. RTC technologies are capable of reducing the frequency, duration, and volume of CSOs through optimization of sewer system operations. CSSs use RTC technology to control system regulator elements such as weirs, gates, dams, valves and pumps in a real-time environment.

RTC may be more effective in areas with level, as opposed to steep, terrain where it is more practical to store wastewater in existing sewers. Further, a CSS that is operating at or near capacity will not benefit greatly from real-time control. Systems that have capacity that is not being fully utilized stand to gain more. RTC has proved useful to divert flows to and from storage systems during wet weather. Some other advantages of RTC include the ability to manage storage facilities in such a way as to minimize overflows; hydraulic models can be integrated into RTC control techniques to refine operational strategies; and system response can be predicted through use of rainfall forecast and gauge data.

While the initial costs of enhanced real-time control can be significant, the monitoring costs will likely be a fraction of the cost of large capital projects that would achieve similar levels of CSO reduction. MSD is scheduled to complete phase-one of a major CSO Predictive RTC program in the summer of 2006. This new RTC program is expected to be a significant part of the LTCP.

6.3.2 In-line Storage

In-line storage is the term used to describe storage of wet weather flows within the sewer system. Taking advantage of this type of storage may reduce the frequency and volume of CSOs without a large capital investment. The amount of potential storage available in the sewer system largely depends on the available capacity of the pipes that will be used for storage, the grade of the pipes, and on the availability of suitability sites for installing regulating devices. In-line storage techniques typically use RTC to control the use of flow regulators, in-line tanks or basins, and parallel relief sewers. Storage tanks and basins constructed in-line are typically governed by flow regulators which optimize in-line storage during wet weather events by damming or limiting flow in specific areas of the sewer system. Dry weather flows pass directly through in-line storage facilities. In-line storage tanks and basins may be either tanks or open or closed basins and may include facilities to minimize their aesthetic and environmental impact. These may include odor control systems, washdown/solids removal systems, and access for cleaning and maintenance. Closed tanks have been constructed below grade such that the surface at grade can be used for parks, playgrounds, parking or other light uses. In-line capacity can also be created by installing relief sewers parallel to existing sewers or by replacing older sewers with larger diameter pipes. One factor that may limit the applicability of in-line storage is the possible increase in basement backups and street flooding (EPA 1999). In-line storage also slows flow, allowing solids to settle in the sewer. If allowed to accumulate, these solids can reduce available storage and conveyance capacity. Therefore, it is important to design the facility in such a way that adequate flow velocities are provided during dry weather service to move the solids to the public owned treatment works (POTW).

To date, MSD has constructed and installed inflatable dams as in-line storage controls at the Sneads Branch Relief Drain and at CSO 211. These projects have been very successful as means to reduce the volume and frequency of combined sewer overflows.

6.3.3 Off-line Storage

Off-line storage is the term used to describe facilities that store wet weather flows adjacent to the sewer system. Off-line storage facilities have broad applicability and are adapted to site-specific conditions by changing basin shape, size, inlet or outlet type and disinfection mechanism. Off-line storage may consist of a large single tank or several smaller tanks operating in an "as-needed" parallel configuration. This configuration allows the first tank to capture the highly polluted first flush. RTC controlled diversion devices are typically used to pass flow to the other tanks after the first tank has reached capacity. The use of off-line storage tends to be more expensive than inline storage; it is usually considered in areas where in-line storage is insufficient or unavailable.

Deep tunnel storage facilities are used where large storage volumes are required and opportunities for near-surface storage are unavailable. Deep tunnels are located 100'-400' below ground. Tunnel diameters range from 10'-50', and many are several miles in length. During dry weather, untreated wastewater is routed around, not through, off-line storage facilities. In contrast, during wet weather, flows are diverted from the sewer system to the off-line storage facilities by gravity drainage or with pumps. The wastewater is detained in the storage facility and returned to the sewer system once downstream conveyance and treatment capacity become available. Overflows can occur once the capacity of off-line storage structures is exceeded. Some treatment is provided through settling; however, the primary function of such facilities is storage and the capture of peak wet weather flows.

6.3.4 On-site Storage

On-site storage is storage developed at the wastewater treatment facility. It is most applicable in systems where conveyance capacity exceeds treatment capacity. On-site storage provides operators with the ability to manage and store excess flows. The methods of on-site storage may be either new construction or rehabilitation of under-utilized or abandoned equipment. The costs associated with the development of on-site storage are typically lower than for other storage facilities built outside the bounds of the treatment plant. Utilizing abandoned treatment facilities reduces costs even more. Much of the cost savings derive from siting storage facilities on land already owned by the utility. Sewer system conveyance capacity is a limiting factor with on-site storage and should be analyzed early in the design.

6.4 SUPPLEMENTAL TREATMENT

The recent development of wet weather treatment systems presents an alternative to storing excess flows. Supplemental treatment technologies are end-of-pipe controls, used to provide some level of physical, biological, or chemical treatment to excess wet weather flows immediately prior to discharge from a CSS. This level of treatment, while less than expected from a conventional WWTP, may significantly reduce the pollutant loads from a CSO. Specific treatment technologies can address different pollutants, such as floatables, settleable solids, and pathogens.

6.4.1 Primary Clarification

The objective of clarification is to produce an effluent treated by gravitational settling of the suspended particles. Sedimentation also provides storage capacity, and as well as an opportunity for disinfection. Clarification is adaptable to chemical additives, such as lime, alum,

ferric chloride, and polymers, which provide higher rates of suspended solids and BOD removal. Louisville MSD's existing excess flow treatment train at MFWTP utilizes this process to treat up to 350 MGD during storm events.

6.4.2 Swirl Concentrators/Vortex Separators

Vortex separators (swirl concentrators) are designed to concentrate and remove suspended solids and floatables from wastewater or storm water. Flow enters the unit at a controlled tangential velocity and is directed around the perimeter of a cylindrical shell, creating a swirling, vortex pattern. Vortex separators use centrifugal force, inertia, and gravity to divide combined sewage into a smaller volume of concentrated sewage, solids, and floatables; and a large volume of more dilute sewage and surface runoff. The swirling action causes solids to move to the outside wall and fall toward the bottom, where the solids concentrated flow is conveyed through a sewer line to the WWTP. The overflow is discharged over a weir at the top of the unit. Various baffle arrangements capture floatables that are subsequently carried out in the underflow. Removal effectiveness is a function of the hydraulic loading rate with better performance observed at lower loading rates. Principal attributes of the swirl concentrator are the ability to treat high flows in a very small footprint, and a lack of mechanical components and moving parts, thereby making it less operation and maintenance intensive. This technology, when coupled with disinfection, may provide an acceptable level of supplemental treatment.

6.4.3 High Rate Physical/Chemical Treatment (HRPCT)

High rate physical/chemical treatment is a traditional gravity settling process enhanced with flocculation and settling aids to increase loading rates and improve performance. The pretreatment requirements for high rate treatment are screening and degritting. In the first stage of HRPCT a coagulant is added and rapidly mixed into solution. This is followed by a flocculation stage where polymer is added and mixed to form floc particles that will settle in the following stage. Finally, the wastewater enters the gravity settling. Sludge is collected at the bottom of the clarifier and either pumped back to the flocculation stage or wasted periodically when sludge blanket depths become too high. Disinfection may be applied downstream of HRPCT. The two principal manufacturers of HRPCT processes are Infilco Degremont Incorporated, which manufacturers the DensaDeg process, and US Filter, which manufactures the Actiflo process. For either unit, performance varies with rise rate and chemical dosages, but in general removal rates of 80 - 95% for TSS and 30 - 60% for BOD can be expected. Phosphorous and nitrogen are also removable with this process, although the removal efficiencies are dependent on the solubility of these compounds present in the wastewater. Removal efficiencies are also dependent on start-up time.

6.4.4 Disinfection

The objective of disinfection is the control of the discharge of pathogenic microorganisms into receiving waters. The disinfection methods considered for use in combined sewer overflow treatment include chlorine gas, calcium or sodium hypochlorite, chloride dioxide, peracetic acid, ozone, ultraviolet radiation, and electron beam irradiation. The chemicals are all oxidizing agents that are corrosive to equipment and in concentrated forms are highly toxic to both microorganisms and people. Each is described below.

- **Chlorine gas** - Chlorine gas is effective and inexpensive. However, it is extremely toxic and its use and transportation are strictly controlled. It is a respiratory irritant and in high concentrations can be deadly.
- **Calcium or Sodium Hypochlorite** - Hypochlorite systems are common in wastewater treatment installations. For years, large, densely populated metropolitan areas have employed hypochlorite systems in lieu of chlorine gas for safety reasons. The hypochlorite system uses sodium hypochlorite in a liquid form much like household bleach and is similarly effective as chlorine gas although more expensive. It can be delivered in tank trucks and stored on-site.
- **Chlorine Dioxide** - Chlorine dioxide is an unstable and explosive gas. It must be generated on site. The overall system is relatively complex to operate and maintain compared to more conventional chlorination.
- **Ozone** - Ozone is a strong oxidizer and must be applied to CSO as a gas. Due to the instability of ozone, it must also be generated on site. Ozone disinfection is relatively expensive with high primary capital cost and high power consumption during operation. Ozonation is also relatively complex to operate and maintain compared to chlorination.
- **UV Disinfection** - UV disinfection uses light with wavelengths between 40 and 400 nanometers for disinfection. Light of the correct wavelength can penetrate cells of pathogenic organisms, structurally altering DNA and preventing cell function. Because UV light must penetrate the water to be effective, the TSS level of CSOs can affect the disinfection ability. UV disinfection is most applicable downstream of a settling technology.
- **Electron Beam Irradiation** - Electron Beam Irradiation uses a stream of high-energy electrons directed into a thin film of water. The electrons break apart water molecules and produce a number of reactive chemical species, which can kill pathogenic organisms.

Disinfection reduces potential public health impacts from CSOs but needs to be used in conjunction with other technologies. In order to protect aquatic life in the receiving waters, dechlorination facilities must be installed whenever chlorination is used as a disinfectant. Dechlorination is typically accomplished by injection of sodium bisulfite in the flow stream before discharge of treated CSO flow to waterways. Dechlorination with sodium bisulfite is rapid; hence no contact chamber is required since the reaction with chlorine is immediate.

6.4.5 Deep Bed Filtration

A deep bed filter system consists of a series of large tanks filled with coarse medium (typically sand or anthracite). Excess wet weather flows are directed to the top of each tank and exit at the bottom of the tank. Pollutants may either attach to the filter media or become trapped in the interstitial space of the filter; the filter is later cleaned through backwashing. Chemical additives can be used to improve removal rates.

6.4.6 Trickling Filters

Trickling filters are biological treatment technology for treating excess wet weather flows. In a trickling filter system, microorganisms are maintained as a biological film attached to a fixed media. Supplemental treatment facilities with any biological process must operate continuously with a minimum flow rate to maintain the biomass necessary for treatment of wet weather flows.

During dry weather, effluent from biological supplemental treatment facilities is typically returned to the sewer system for further treatment and discharged at the wastewater treatment plant.

6.4.7 Constructed Wetlands

Constructed wetlands use natural biotic systems to treat wastewater. Aquatic plants and bacteria utilize the organic wastes, nutrients, greases and bacteriological pollution found in CSOs in much the same way as in a traditional WWTP. Constructed wetlands act as storage and treatment for CSO flows. There are two types of constructed wetlands; subsurface flow (SSF) and free water surface (FWS).

SSF wetlands consist of a series of planted cells. They are 2'-6' deep basins filled with rock or other media and planted with aquatic plants. These plants hide the rock and feed off of the sewage flowing below the surface. These wetlands are designed to not have any exposed sewage. This reduces odor and vector problems making them more acceptable to the public. The downside is that the wholly subsurface requirement greatly reduces the volume treated or stored per acre.

FWS wetlands consist of two types of cells. The first type is the open water cell. This cell contains submerged aquatic vegetation. It has a design depth of 4' and cannot tolerate floating aquatic vegetation. The large air to water contact area and penetrating sunlight raise DO and allow for the release of nitrogen gas to the atmosphere. This cell has a hydraulic retention time (HRT) of 2-3 days. Extending the HRT beyond 3 days, especially in sunny conditions, may cause an algae bloom that would blanket the cell and prevent gas exchange.

The second cell type in an FWS wetland is the fully vegetated cells. It is highly vegetated with aquatic plants that either float or grow from the bed and break the surface of the water. Fully vegetated cells are approximately 2' deep. Up to 60% of the cell volume is taken up by the flora planted in it. The purpose of the vegetated cell is to prohibit sunlight, drop the DO level, allow anaerobic processes, and kill the algae.

Typically, FWS wetlands are constructed as alternating open-water and vegetated cells with the first cell being vegetated to trap solids and floatables and enhance settling. The HRT for each cells is 2-3 days. The process is primarily settling in the first cell with nitrification-denitrification cycle processes beginning as well. The second cell is an open-water cell, which allows for sunlight, algae and release of nitrogen gas. The cells continue in an alternating series to the point at which the design goals are met. The last cell will always be vegetated to kill any algae. Aeration and disinfection may be added prior to the outfall.

Little energy is required to maintain treatment processes. Typically energy consumption is limited to pumping if required to deliver CSOs to the wetland area and clear water recirculation pumping during periods of low flow to maintain the health of the facility. Additionally, wetlands provide a storage component with the treatment component. A wetland will typically provide 1-million gallons of storage per acre of wetland. They also provide sanctuary for aquatic flora and fauna. Drawbacks with constructed wetlands are (1) they require relatively large areas of land, (2) treatment processes are slow (especially in winter) and (3) CSO effluent is left open to the environment.

6.4.8 Plant Modification

Excess wet weather flows cause sudden changes in the hydraulic and pollutant loads impacting the WWTP. Modifications to existing wastewater treatment facilities can increase their ability to handle wet weather flows. Modifications may involve changes to the physical configuration of various treatment processes and /or the operation of specific plant processes during wet weather. Most modifications require the active involvement of the treatment plant operator to ensure effective implementation. Example modifications that maximize the treatment of wet weather flows include:

- Baffles to protect clarifiers from hydraulic surges and ensure the even distribution of flow;
- Using metal salts and polymers to increase suspended solids removal;
- Switching the mode of delivering flow from the primary to the secondary treatment units; and
- Switching from "series" operation to "parallel" operation during wet weather flows.

Performance evaluations are required to determine whether additional capacity can be obtained from existing facilities. While plant modifications are generally more cost effective than new construction, some modifications that improve wet weather performance may result in increased concentrations of pollutants in treatment plant effluent during dry weather. For example, if not properly designed, a clarifier modified for wet weather flows may have inadequate settling characteristics during dry weather (Metcalf and Eddy 2003). Further, modifications that require operator attention before and after a wet weather event may interrupt regular dry weather operations and potentially compromise the quality of treated wastewater during dry weather.

MSD has made a significant investment maximizing the treatment capacity of the Morris Forman Wastewater Treatment Plant. A commitment has been made to make best use of the asset that exists and to make the process as effective as possible. Refer to Section 4 for details.

TABLE 6.1
CSO TECHNOLOGY ASSESSMENT

CSO Control Technology	Improvement Potential				Implementation and Operational Factors	
	CSO Volume	Bacteria	Floatables	Suspended Solids	Positive or Neutral	Negative
6.2 Collection System Controls						
Sewer Relining	Medium	None	None	None	Reduction in friction may result in slight improvement in capacity, reduces infiltration and exfiltration. Sealing action may prevent root intrusion. May not require excavation.	Requires special equipment and thorough cleaning prior to installation
In-situ Pipe Replacement (Pipe Bursting)	Medium	None	None	None	Increase in diameter and reduction in friction may provide substantial improvement in capacity, reduces infiltration and exfiltration. Sealing action may prevent root intrusion.	Requires special equipment. May not work with certain backfill materials such as flowable fill. Bursting action may damage adjacent utilities. Requires excavation.
Infiltration Reduction	Medium	None	None	None	Reduces CSO Volume.	Infiltration must be done on a large scale. Spot repairs simply move clear water to the next crack in the pipe.
Sewer Separation						
Full (Sanitary is New)	High	High	High[1]	High	May provide a highly effective long lasting solution	Disruptive to affected areas, cost intensive, potential for increased stormwater pollutant loads, requires homeowner participation.
Full (Storm is New)	High	High	High[1]	High	May provide a highly effective long lasting solution. May provide additional capacity for new development.	Disruptive to affected areas, cost intensive, potential for increased stormwater volumes and pollutant loads.
Partial (Roof Leaders and Sump Pumps remain on Sanitary)	Medium	High	High[1]	High	Reduce volume of CSO. Does not require a great deal of customer appreciation. May provide additional capacity for new development.	Potential for CSO still exists. Disruptive construction in separated areas.
6.3 Storage						
Real Time Controls	Medium	Medium	Medium	Medium	Highly automated, programmable, predictive and adjustable system.	Expensive, increased O & M increased potential for sewer backups.
In-Line Storage	Medium	Medium	Medium	Medium	Reduces potential for CSO while continuing to provide treatment to storm water component. Aesthetically acceptable, provides storage and conveyance.	Disruptive to affected areas, potentially expensive in congested urban areas. May have a significant O & M cost due to sewage pumping and basin cleaning.

CSO Control Technology	Improvement Potential				Implementation and Operational Factors	
	CSO Volume	Bacteria	Floatables	Suspended Solids	Positive or Neutral	Negative
6.3 Storage (Con't)						
Off-line Storage	Medium	Medium	Medium	Medium	Reduces potential for CSO while continuing to provide treatment to storm water component. Aesthetically acceptable, provides storage and conveyance. May be constructed under parking lot or other similar use facility.	Disruptive to affected areas. May have a significant O & M cost due to sewage pumping and basin cleaning.
On-site Storage and Flow equalization basins	Medium	Medium	Medium	Medium	Requires available areas at the current treatment location, disruptive to affected area, cost intensive, aesthetically acceptable.	Requires available site at current WWTP location, disruptive to affected areas, cost intensive. May have a significant O & M cost due to sewage pumping and basin cleaning.
6.4 Treatment						
Primary Sedimentation	None	Medium	Medium	Medium	Provides reduction in bacteria, solids, and floatables. Disinfection may be added for even better treatment.	Expensive to construct, especially in an urban environment. Will generate additional O & M costs. May have to haul sludge from facility.
Swirl Concentrators / Vortex Separators	None	Low	Medium	Medium	Relatively inexpensive, many models, small footprint.	Variable pollutant removal. Increased O&M. Ineffective against CSO volume.
High Rate Physical / Chemical Treatment	None	Medium	High	High	Very effective on solids and floatables. Supports certain downstream disinfection technologies.	Requires extensive new construction, remote chemical storage, high O&M costs.
Disinfection	None	High	None	None	Controls potentially dangerous pathogenic microorganisms.	Increased O & M. Possible remote storage of hazardous chemicals. Possible high power consumption.
Deep Bed Filtration	None	Medium	High	High	Effectively treats sewage of different concentrations.	May require dry weather pumping to maintain required minimum flow. Increased O & M. Siting issues in an urban environment.
Trickling Filters	None	Medium	High	High	Effectively treats sewage of different concentrations.	May require dry weather pumping to maintain required minimum flow. Increased O & M. Siting issues in an urban environment.
Plant Modification	High	High	High	High	Dependable technologies that the operator understands.	High Cost increased O & M. Ineffective unless adequate transportation system upstream.

[1] *The potential exists for the discharge of solids and floatables to increase with sewer separation. After separation, a portion of solids and floatables within the stormwater flow that previously were treated at the WWTP, are now discharged to the stream.*

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SECTION 7

SECTION 7: EVALUATION OF DRAFT STRATEGIES

7.1 INTRODUCTION

The CSO Control Policy directs the permittee to develop and implement a long-term control plan based on characterization, monitoring and modeling of the combined sewer system. The plan should consider the site-specific nature of CSOs and should employ a public participation process involving the ratepayers, industrial users, persons residing downstream of combined sewer overflows and other interested parties. The plan should also give highest priority to controlling overflows in sensitive areas. The plan should include both fixed date project implementation schedules and a financing plan to design and construct the selected plan as soon as practicable.

The Policy also tasks the permittee to develop appropriate cost/performance curves to demonstrate the relationships among a comprehensive set of reasonable control alternatives that correspond to control more and less stringent than those listed under the presumptive approach. This includes an analysis of where the incremental pollution reductions achieved diminish compared to the increased costs. This "knee-of-curve" approach was used to guide preliminary selection of controls.

The CSO LTCP needs to identify water quality problem areas and provide a plan to prioritize construction activities that result from implementing the plan. Any construction activity is potentially disturbing to plants and animals resident to the area. To minimize impacts of construction activities, improvements will wherever possible be limited to areas that have not been identified as "areas of endangered, threatened or special concerns." In addition, wherever possible, CSOs will be grouped together to minimize construction disturbances. If work in "special concerns" areas is unavoidable, a preliminary investigation to identify endangered or threatened species, as well as potential mitigating measures, will be completed before design is finalized.

CSO LTCP's were developed for each of three defined regions within the combined sewer service area: the Beargrass Creek Region, the Ohio River North region and the Ohio River West region. These LTCPs were submitted to the Kentucky Environmental and Public Protection Cabinet, Department for Environmental Protection's Division of Water (DOW) in 1996 and 1997. A number of CSO control technologies were considered and evaluated in considerable detail. Cost projection factors were prepared using the Engineering News Record Magazine Construction Cost Index (ENR CCI). These cost factors have been recorded and tracked since 1907 and represent costs for standard materials and trades used in the construction process.

The following provides a brief summary of the more probable CSO controls identified to date, and the evaluations conducted to date, for each of the three regions noted above.

7.2 SUMMARY OF THE LTCPS FOR THE THREE REGIONS IN THE COMBINED SEWER AREA

7.2.1 Summary of LTCP for the Beargrass Creek Region

The information that follows summarizes the Long Term Control Plan (LTCP) for the Beargrass Creek Region of MSD's combined sewer system that was presented in detail in the 1996 CSOP Update.

Significant efforts were undertaken by MSD in the early '90s, to develop and apply a sewer system mathematical model, conduct flow monitoring and sampling programs, and assess the performance of the collection and conveyance capacities of various system components under both dry and wet weather conditions. With these various activities as background elements, certain features of the system appeared to offer opportunities for immediate reductions in CSO discharges, regardless of the final CSO LTCP solution.

7.2.1.1 CSO LTCP Base Control Options

Base Control Options, that is, projects that made sense to schedule for implementation as soon as practical, regardless of the specific benefits to CSO control (they just made sense to improve system operations and performance) were identified. They were generally common to all alternatives developed, and were to be incorporated into the final CSO control plan regardless of how the final alternatives were packaged. The majority of the base control options have been completed to date. For a complete list of completed projects, refer to Section 8. The base control options detailed in 1996 were as follows:

- Removal of debris from the Northeastern Sanitary Trunk Sewer (NSTS) along the South and Middle Forks of Beargrass Creek. The cleaning of the NSTS was completed in September 2004.
- Expansion and upgrade of the Robert J. Starkey Pumping Plant (formerly the Buchanan Street Pump Station), that was completed in April 2005.
- Mini-separation projects within the Beargrass Creek Region. As part of the LTCP for this Region, it was determined that it would likely be more cost effective to separate the sewers in certain areas than to provide some form of detention, retention, or other CSO control facilities. The CSO locations deemed appropriate for separation within this Region included the following:

  CSO 080 Lexington Road west of Payne Street; this project was completed in September 2001 and the CSO was eliminated.

  CSO 087 Blue Horse

  CSO 088 Mellwood Avenue Interceptor; this project was completed in January 2001. However, the CSO will not be eliminated until the remaining downspouts within the area are removed or otherwise addressed.

  CSO 091 Schiller Avenue Overflow

  CSO 092 St. Catherine at Beargrass Creek

  CSO 093 Spring Street

  CSO 130 Webster Street

  CSO 131 Mellwood & Frankfort

CSO 147 Swan Street Diversion, this project was completed in September 2001. However, the CSO will not be eliminated until the remaining downspouts within the area can be addressed.

- In-system diversions - Three diversions were analyzed and included: the Goldsmith Lane Diversion, the Southeastern Diversion, and CSO 108 Diversion. The Southeastern Diversion project was implemented and has been effectively operating. The CSO 108 Diversion resulted in the construction of a demonstration CSO treatment facility that incorporated a process known as Continuous Deflective Separation (CDS). This facility provided MSD insight into the problems and successes of applying remote technologies for CSO control.

Concurrent with the development and pursuit of implementing the base control options, other control options were identified for application in specific areas within the Beargrass Creek watershed. The watershed was separated into three distinct areas for analysis: the South Fork of Beargrass Creek, the Middle Fork of Beargrass Creek, and the Northeastern Area of Beargrass Creek. The options evaluated as part of the LTCP development included the following within each area.

As noted earlier in this section, the CSO Control Policy of 1994 provided guidance on two different strategies that could be applied to satisfy the policy requirements: a Presumptive Approach, or a Demonstration Approach. Selection of the Demonstration Approach would have required considerable knowledge and information about the water quality characteristics and many physical, chemical and biological reaction rates of the receiving waters, that is, of Beargrass Creek. In 1996 and 1997, the in-stream data gathering efforts were underway, but detailed and specific data was not yet available on which to establish the appropriateness of the Demonstration Approach as the CSO control strategy.

However, the Presumptive Approach did lend itself to the identification and evaluation of CSO control technologies, since the objectives of CSO control targets were more definable numerically in terms of CSO reduction and system-wide CSO capture rates. Thus, while water quality investigations were underway, including an intensive sampling program on the Ohio River being conducted by ORSANCO, evaluation of CSO controls that could satisfy the Presumptive Approach were undertaken.

Since the Presumptive Approach required 85% capture, it became clear early on that CSO control solutions capable of capturing this high level percentage would require either extensive off-line storage, high-rate treatment, or a combination of both. The sewer system model was applied to generate annual CSO hydraulic loading estimates for each CSO, and to provide peak flow rates from which conveyance and/or high-rate treatment facilities could be sized. Facility configurations were developed that consisted of consolidating several CSOs into common facilities, increasing conveyance capacities, and identifying potential sites for CSO facilities.

Analytical spreadsheets were developed to compute the CSO percent capture that would result for various conveyance, storage and/or treatment rates for each CSO and groupings of CSOs. Output from these spreadsheets provided data needed to provide the framework for estimating probable construction costs for the CSO control facilities.

The results of these efforts were reported to DOW with the submission of the 1996 and 1997 CSO LTCPs. The process of developing these alternative CSO capture strategies was well defined during this period of evaluation. The techniques and methodologies applied were consistent with the requirements of the CSO Policy, and so provide an appropriate framework

for further evaluation and decision-making during the stakeholder process. The following summarizes the results of the evaluations for each area of the Beargrass Creek watershed.

7.2.1.2 South Fork of Beargrass Creek Area

Nine candidate sites for satellite storage/treatment locations were identified for potential inclusion in the Beargrass Creek Region LTCP. CSOs to be incorporated into these nine candidate sites, if selected, were as follows:

- Group 1: CSO 082, CSO 120, CSO 121, CSO 153
- Group 2: CSO 083, CSO 084, CSO 118, CSO 119
- Group 3: CSO 117, CSO 179, CSO 149
- Group 4: CSO 091
- Group 5: CSO 092, CSO 113, CSO 152
- Group 6: CSO 110, CSO 111, CSO 148, CSO 151
- Group 7: CSO 097, CSO 106, CSO 137
- Group 8: CSO 109
- Group 9: CSO 108

Three candidate sites for regional storage/treatment facilities within the South Fork were also identified for potential inclusion in the Beargrass Creek Region LTCP. CSOs to be incorporated into a regional facility, if selected, would be:

- Group 1: CSO 082, CSO 084, CSO 118, CSO 119, CSO 120, CSO 121, CSO 153
- Group 2: CSO 117, CSO 179, CSO 149, CSO 091, CSO 092, CSO 113, CSO152, CSO 146
- Group 3: CSO 097, CSO 106, CSO 108, CSO 109, CSO 110, CSO 111, CSO 137, CSO 148, CSO 151

7.2.1.3 Middle Fork of Beargrass Creek

In addition to the base control options described previously, numerous CSO control options were evaluated for the twelve CSOs located within the Middle Fork of Beargrass Creek. The following controls were evaluated within the Middle Fork of the Beargrass Creek area:

- Storage/treatment facility for CSOs 125, 126, 127, 144, and 166
- Satellite storage/treatment facility for CSOs 086 and 140
- Separation of tributary areas for CSOs 206 and 209, separation of the combined sewers within the CSO 209 area was completed in September 2001. Additional downspout disconnection projects were completed and CSO 209 was closed in September 2005. The combined sewers within the CSO 206 area have been partially separated.

7.2.1.4 Northeastern Area of Beargrass Creek

Three candidate sites for satellite storage/treatment facilities were identified within the Northeastern area for potential inclusion into the Region 1 LTCP. These sites would include:

- CSO 132 and CSO 167
- CSO 154

- CSO 172

In addition, one regional storage/treatment facility location within the Northeastern area was considered:

- Regional facility for CSO 132, CSO 167 and CSO 154

An option of a wet weather interceptor and centralized storage/treatment facility was also evaluated as an alternative to satellite or regional storage/treatment for the Northeastern area. As noted earlier, consideration of these various CSO control options are continuing to be integrated into the overall watershed needs in the Beargrass Creek Basin.

7.2.2 Summary of the LTCP for the Ohio River North and Ohio River West Regions

The information that follows summarizes the CSO control options that have been evaluated within the Ohio River North and the Ohio River West Regions that was presented in detail in the 1997 CSOP Update.

In conducting these analyses, considerable attention was paid to potential opportunities for improving system performance and to increasing delivery of wet weather flows to the Morris Forman Wastewater Treatment Plant (MFWTP). However, due to the size and complexity of the sewerage system in these regions, substantial capture of CSO discharges required major capital facilities to be considered as the primary options.

Following the same general approach as was used in the Beargrass Creek Region, potential options for increasing the capture of wet weather flow included in-line and off-line storage facilities and increased conveyance opportunities (relief sewers, sewer diversions, etc.). In some instances, e.g., the area in downtown Louisville served by the Central Relief Drain, extensive sewer cleaning was identified as being sufficient to achieve the 85% capture rate for CSOs in this particular tributary area. The sewer cleaning would increase conveyance capacity to MFWTP and provide for minor storage within the Central Relief Drain. However, in other areas of the system, other more capital-intensive alternatives were investigated.

The level of CSO control required to achieve compliance with water quality standards in the Ohio River was also unknown at that time. ORSANCO was in the process of developing and implementing a large-scale wet weather flow monitoring and sampling program on the Ohio River in the vicinity of Cincinnati, Ohio. At that time it was anticipated that the results of that investigation would shed a great deal of light on the potential impacts CSOs on a large river from a large urban area. The results were expected to be very helpful to MSD in establishing its CSO reduction needs as well.

As the evaluations of the CSS conditions were being undertaken (flow monitoring, sampling, modeling, etc.), a general overview of the performance and capacity conditions in the overall system was being conducted. Many portions of the CSS had a long history of surface flooding and basement backups. As early as 1942, several areas with chronic problems were identified and targeted for remedial action in the final report issued by the Commissioners of Sewerage. That report documented the basis for the design and construction of the main combined sewers, and outlined a sewer expansion program to be implemented when the system's capacity was exceeded. The largely unchecked urban and suburban development that took place after World War II greatly surpassed the original design standards for the combined sewer system. Lack of financing and inadequate planning delayed construction of relief sewers to serve many of the problem areas. Continued increases in impervious areas such as parking lots, streets,

expressway widening, and airport expansion added to the flow in the CSS and increased the frequency of flooding and basement backups.

Thus, it was apparent that the system had substantial flow capacity limitations. Any solutions to the CSO problems would necessarily require consideration of the impacts on surface flooding and basement backups. Thus, a flooding analysis was conducted, and both short-term and long-term solutions were evaluated. Short-term solutions to protect against basement backups included diversion of flow from one part of the system to another, and installing protective devices to protect individual homes. A significant program was undertaken to install these basement backup prevention devices during that period. To date, over 6,900 individual devices have been installed at no cost to the homeowner to protect their home from sewer backup during wet weather.

It was recognized that the long-term solution to both the basement backup problem and the surface flooding problem would need to consist of more than the short-term measures. So, an effort was undertaken to identify and evaluate ways to provide additional significant increases in capacity to the system. Relief sewers, retention facilities and sewer separation alternatives were considered, with the identification of at least two areas in which immediate relief was planned and eventually implemented - Wheeler Basin and the Upper Dry Run Trunk Regional Storage Facility. Other potential retention basins were considered, but further evaluations were necessary to consider availability of sites, and to assess the benefits in the context of the overall plan.

At the same time, sewer system evaluations were continuing. Significant effort was being expended to more specifically identify the magnitudes of each of the CSO discharges. Projections were made with the sewer system model to estimate the annual average overflow volumes being discharged from each overflow location, and a prioritization of critical overflows was being developed, along with a strategy for dealing with them.

As the knowledge of system performance grew during this period, additional sewer system improvement projects were identified and, where possible, these projects were implemented. During this period, the Central Relief Drain was cleaned of debris and grit, to reduce the frequency of discharges. In addition, it became apparent that cleaning of other parts of the conveyance system could be beneficial to better controlling CSOs, e.g., the Northeastern Sanitary Trunk Sewer and certain areas in the Beargrass Creek Interceptor.

A number of projects were identified as base control options. Base control options included upgrading certain pump stations, implementing mini-separations in several CSO catchment areas, and adding sewer diversion capabilities at selected locations to improve overall capture of wet weather flows.

Efforts were also undertaken through the mid-90s to identify ways to reduce the number of individual CSO facilities that might be required to achieve compliance with the CSO Policy. Because of the combined need to reduce/eliminate CSOs and to reduce basement backups and surface flooding, retention facilities appeared to offer the best solutions, since conveyance was severely limited. Analyses were conducted to determine the retention facility sizes throughout the service areas. Elements of these evaluations included:

- Consolidating sewers for several CSO locations
- Routing alignments of sewers
- Documenting issues related to availability of sites for the basins
- Preliminary construction cost estimates for pipelines and basins

In general, several variations for implementing these projects was possible, and efforts to identify the more feasible ones were undertaken during that time as well. At the same time, methods for directly controlling solids and floatables at the CSO outlets were being evaluated. Demonstration projects were identified, designed and implemented at selected locations to provide operational and performance data on these newly developing technologies. Net bag capture systems were implemented at three CSO locations, CDS units were installed at two locations, and a vortex regulation system installed at another to control flow rates within the system.

During this period as well, various discussions were being held with the Kentucky Fair and Exposition Center, the Louisville International Airport, the Department of Transportation, and the University of Louisville. Each of these entities had greatly increased impervious area draining into the combined sewer system without significant mitigation. They were considered major facility changes for imminent implementation, the effects of which could/would significantly affect conveyance system capacity needs, surface flooding prevention and CSO control needs. These issues all played into the CSO planning efforts undertaken in the mid-90s, culminating in the CSO LTCP of 1996/1997. The following summarize the potential control options developed at that time.

7.2.2.1 Ohio River North Region

Ohio River Interceptor

CSOs 049, 056, 057, 156

- No Action

CSOs 051, 052, 054, 055, 058, 155, 160 and 161

- Solids and Floatables Control

CSO 019

- I-64 and 34th Street - Off-Line Storage
- Centralized Treatment Facility

CSO 190

- 17th Street and Lytle Street - Off-Line Storage
- 17th Street and Portland Avenue - Off-Line Storage
- Centralized Treatment Facility

CSO 022

- Off-Line Storage in the vicinity of Main Street and 2nd Street
- Centralized Treatment Facility

Central Relief Drain

The CRD has been cleaned of grit and deposited material and nearly all CSOs are at or near 85% capture. For this reason, these CSOs could be provided with solids and floatable control as a lower priority compared to other CSOs and no other action would be proposed at this time.

7.2.2.2 Ohio River West Region

Northwestern/Southern Outfall Area

CSO 189: CSO Discharge Control Options

- Off-Line Storage within Shawnee Park near Southwestern Parkway & Shawnee Terrace
- Centralized Treatment Facility

CSOs 104 and 105: CSO Discharge Control Options

- Off-Line Storage within Shawnee Park near Broadway and Southwestern Parkway
- Centralized Treatment Facility

Main Diversion Structure (CSO 211) and CSO 016: CSO Discharge Control Options

- Off-Line Storage within Shawnee Park near Broadway and Southwestern Parkway
- Park Drive Relief Sewer with In-Line Storage
- Centralized Treatment Facility
- In-Line Storage - Southwestern Outfall
- Centralized Treatment Facility
- Upper Dry Run Trunk Regional Storage Facility, this project was completed in June 2004
- Wheeler Avenue CSO Flood Control Basin, this project was completed in May 1998

7.3 CSO SCREENING AND RANKING OF CSOS

As a result of the evaluations conducted during the early-90s and mid-90s, MSD developed a draft procedure to provide a preliminary ranking of the severity of impacts from CSO discharges within the combined sewer system. It was hoped that a ranking process would be of benefit in identifying priority areas on which to focus CSO control efforts. This screening and ranking process was based upon the EPA Guidance Document Combined Sewer Overflows Guidance for Screening and Ranking, EPA 832-B-95-004, dated August 1995. As detailed within the EPA Guidance document, CSOs were screened and prioritized based upon identified criteria that most likely would cause significant adverse impact on the environment and the community. Those CSOs identified as having the potential for larger impact, received the highest overall ranking. Many criteria were used covering a broad range of categories, including the 2004 303(d) List of Waters for Kentucky (Final Draft), USGS Streamflow Statistics for Kentucky, KPDES permit information, CSO Program modeling data, USGS Stream data and MSD's work order management data system.

In total, seven criteria were utilized to rank the CSOs. These criteria include human health contact, dry weather stream water quality, receiving stream mixing characteristics, stream flow values, proximity of drinking water intakes, composition of stream flow and other important subjective factors. The screening and ranking consists of a process in which points can be assigned for the various attributes within each criterion. A discussion of some of the criteria is provided below as an example of how the process works. As the stakeholder and public involvement efforts increase as part of the development of the LTCP, weighting of the criteria and additional criteria will be added and ratings can be assigned as to their relative contribution to the solution matrix. The screening and ranking memo that was developed in 2004 is included as Figure 7-1, which is at the end of this section.

7.4 SUMMARY OF CURRENT LTCP EFFORTS

Since the initial development of the 1996 and 1997 LTCPs, MSD has changed direction and focus of the LTCP efforts. MSD has shifted to an approach that is more efficient and cost effective than the plan originally proposed and approved by DOW. The major focus of current LTCP efforts is Real Time Control (RTC). The RTC approach maximizes the use of available in-line storage within the existing combined sewer system while minimizing overflows through the application of advanced technology.

In 2000 and 2001 MSD commissioned engineering studies to evaluate the potential costs and benefits of RTC for the combined sewer system. The main purpose of the studies was to evaluate the feasibility and performance of real time control for managing flow at a selection of major CSO locations. Refer to Exhibits 11 and 12 of the 308 Submittal for copies of these studies. The results of the studies can be summarized as follows:

7.4.1 Beargrass Creek Region

In order to evaluate the performance of RTC for the Beargrass Creek Region, the analysis was based on two scenarios:

- A short-term horizon (Scenario 1) that considers the existing network with Base Control Options which have already been programmed or executed, together with the implementation of control sites (gates) chosen to optimize flow management and reduce overflows.
- A long-term horizon (Scenario 2) which represents Scenario 1, plus additional storage basins located at the selected CSO control sites and sized to attain the desired 85% capture at those sites.

A Scenario 0 representing reference conditions, such that it considers the existing network with Base Control Options which already have been programmed or executed, is used to compare simulation results and determine the performance of Scenarios 1 and 2.

As a result, system-wide RTC proves to be an efficient solution to control CSOs, for the Beargrass Creek Region as well as for the three integrated regions.

For the Beargrass Creek Region, the predicted overall reduction in CSO volume amounts to 39%, considering eight flow control sites that takes advantage of existing in-line storage capacity. In absolute terms, this Scenario 1 eliminates 472 MG of overflow at an estimated cost of $10,000,000. This represents a unit cost of $0.021 per gallon, which is 4 to 10 times lower than the solution presented in the original LTCP. These eight control sites can be described as follows:

- BGI1 - Broadway Collector for CSO 118
- BGI2 - Dry Run Collector for CSOs 083, 084 and 119
- SBS1 - Snead's Branch Sewer for CSO 174
- BGI3 - Nightingale Pump Station for CSOs 018 and 108
- SED1 - Southeastern Diversion
- NEI1 - Northeastern Interceptor for CSOs 132 and 167
- MFT1 - Middle Fork Trunk Sewer for CSO 166
- BGI4 - Beargrass Interceptor for CSOs 97, 151 and 110

In addition, to attain the 85% capture objective at the selected major CSO sites in the Beargrass Creek Region, six retention basins with a total of 33 MG of capacity were originally deemed necessary, considering a conventional approach used for the LTCP. Using system-wide RTC eliminates the need for one of these retention basins and reduces the total storage needs from 33 MG to 20.3 MG.

Scenario 2 applied to the Beargrass Creek Region consists of 8 control sites and 5 retention basins. The total wet weather capture rate for the Beargrass Creek Region for this scenario amounts to 82%. MSD could easily attain the objective of 85% capture by using an additional diversion or including some of the complementary controls considered in the 1996 CSOP.

Phase I of the RTC implementation project is well under way, with startup of the facilities completed in mid-2006. Detailed performance evaluations will be conducted to establish the actual effectiveness of the RTC system, and to gauge its ability to achieve the target CSO reductions predicted in the study phase.

7.4.2 Ohio River North and West Regions

RTC for the Ohio River North and West Regions focuses on the MFWTP, as well as major CSOs, collectors and interceptors. Of a total of more than 113 CSOs, 4 CSO groups located within the Ohio West Region show overflow volumes that represent close to 70% of the total for the three regions. Essentially, these overflows are linked to six interceptors and occur in the downstream portions of the following outfall service areas:

- Ohio River Interceptor (ORI)
- Northwestern Interceptor
- Western Interceptor
- Western Outfall
- Southern Outfall
- Southwestern Outfall

Although significant overflow does occur, residual capacity exists along these trunks for in-line storage, since flow levels can be very low. During frequent events, peak flows generate maximum water levels that can be significantly less than half of the diameter of those major trunks. Space is available in some of those trunks and, with proper flow control, in-system storage could help prevent overflow. A potential for in-line storage was identified and available capacities were estimated to be approximately 72 MG.

Control sites are established according to the location of available storage. Table 7-1 presents the effective storage volume associated with the control sites. With RTC, the network system can be made to perform more efficiently according to inflow and adapt to variations during wet weather conditions. In this case, automation allows for flow control by opening and closing gates. Temporary storage of significant volumes is made possible, and flows are simply conveyed to the WTP after peak flows have subsided at the plant.

TABLE 7-1
EFFECTIVE STORAGE VOLUME

Trunk	Control Sites	Effective Storage Volume (MG)
Southwestern Outfall	SWOR1 SWOR2	32 13
Southern Outfall	SOR1 SOR2	11 5
Northwestern Interceptor	NWIR1	5
Western Outfall	WOR1	4
Western Interceptor	WIR1	--
34th Street Collector	34THR1	2
Total		**72**

Flood gates are already installed at various sites in the network to prevent river flooding. Most sites chosen correspond with the locations of existing flood gates. As facilities are already present, costs could be minimal in comparison to the implementation of new chambers.

From the XP-SWMM model of the existing sewer network, an additional model was developed representing major trunks of the system and integrating control sites and RTC. This was done with MED, a model-based Decision Systems capable of applying and simulating RTC. It globally controls operations based on rules and objectives geared toward minimizing overflow volume. A hydraulic model is integrated into the model to produce a detailed evaluation of the hydraulic impact of the modulation of automated gates.

Performance evaluation is based on compared simulations of system behavior under reference conditions and Global RTC. Reference conditions refer to the existing system, in which performance was enhanced by two modifications: 1) increasing the capacity at the MFWTP to 320 MGD, and 2) the Upper Dry Run storage facility. Each scenario was developed with MED using 4 reference storms (1-month, 3-month, 6-month and 2-year events) taken from the MSD reference storm approach.

Interest for Global RTC is evident in view of the simulation results: for the main CSOs concerned, overflows are almost eliminated for 1-month events and significantly reduced for the 3-month event. For the 4 events simulated, a reduction of approximately 70 to 90 MG per event in overflow was obtained.

These volumes that would normally overflow are successfully conveyed to the MFWTP. They are significantly reduced with the maximization of flow toward the MFWTP and the use of available in-line storage capacity.

To further demonstrate the potential benefits of Global RTC, Average Annual Overflow Volumes and % Capture have been estimated. Tables 7-2 and 7-3 present the impact and reduction in overflow volume. Global RTC brings to all CSO sites significant reductions in Average Annual Overflow (overall reduction of 64%). The most significant reduction in MG and percentage were obtained at the major CSO sites such as the Southwestern Outfall and the Main Diversion Structure. In these cases, percentage capture approaches the 85% goal of the presumptive approach (83 and 75% respectively).

TABLE 7-2
AVERAGE ANNUAL VOLUME OVERFLOW

CSO Sites	Description	Average Annual Volume Overflow (MG)		
		Reference Condition	Global RTC	Reduction
15 + 191	Southwestern Outfall	1730	560	68%
211 + 16	Main Diversion Structure	1210	360	70%
104 + 105 + 189	Western Outfall and North Western Interceptor	660	320	51%
19	34th Street	180	100	42%
Total		**3780**	**1340**	**64%**

TABLE 7-3
PERCENT CAPTURE

CSO Sites	Description	% Capture	
		Reference Condition	Global RTC
15 + 191	Southwestern Outfall	48%	83%
211 + 16	Main Diversion Structure	17%	75%
104 + 105 + 189	Western Outfall and North Western Interceptor	47%	74%
19	34th Street	25%	57%

Since no major facilities such as off-line storage are included for the Ohio River North and West Regions, the RTC strategy developed involves relatively low costs when compared to other alternatives considered up to now as part of the CSO LTCP. In fact, conceptual cost estimates predict an average unit cost of less than $0.01 per gallon of CSO reduced per year. In each case, it is less than $0.013 with an average of $0.006.

Two control sites also stand out from the others: Southwestern Outfall (R1) and Southern Outfall (R1) are the two control sites downstream of large collectors, the Southwestern and Southern Outfalls. Both have significant in-system storage capacity, which can be taken advantage of with the implementation of one gate. This phase could be realized at an estimated total cost of $5,500,000 and a unit cost of less than half a cent ($0.005) per gallon of CSO reduced per year.

Results show that a global RTC strategy applied to Ohio River North and West Regions could allow for a more efficient use of the existing system capacity and reduce the overall cost of the LTCP.

7.4.3 Summary of RTC for all Three CSO Regions

The controls in the Beargrass Creek Region have an impact on the flows delivered to the Ohio River North and West Regions. The two major influences are already present in the reference conditions:

- The Starkey Pumping Plant includes an upgraded pumping capacity to 140 MG

- The wet weather response of the Northern Ditch Area and of the tributary area of the Southeastern Diversion are now modeled as hydrographs instead of a lower constant inflow

As a result and considering all of the above, RTC enables an overall reduction in AAOV of 82% in the Beargrass Creek Region and 62% in the Ohio River North and West Regions. This includes a total of 16 control sites and 5 off-line storage facilities.

Tables 7-4 and 7-5 present the overall benefits of global RTC for the MSD combined sewer system.

TABLE 7-4

AVERAGE ANNUAL OVERFLOW VOLUMES FOR THE BEARGRASS CREEK REGION

Reference Storm	Total Rainfall (inches)	Total Overflow Volume (MG)				
		Scenario 0	Scenario 1	Reduction	Scenario 2	Reduction
1-month	0.95	19.6	7.2	63%	1.8	91%
3-month	1.18	37.0	24.8	33%	6.4	83%
6-month	1.24	40.2	28.9	28%	10.3	74%
2-year	2.77	143.1	126.1	12%	106.7	25%
Average Annual Basis		1,205.5	729.6	39%	507.8	58%
% Capture		56%	74%		82%	

TABLE 7-5

AVERAGE ANNUAL OVERFLOW VOLUMES FOR THE OHIO RIVER NORTH AND WEST REGIONS

Reference Storm	Total Rainfall (inches)	Total Overflow Volume (MG)		
		Scenario 0	Scenario 1	Reduction
1-month	0.95	76.9	5.2	93%
3-month	1.18	37.0	31.1	72%
6-month	1.24	40.2	28.9	66%
2-year	2.77	143.1	126.1	20%
Average Annual Basis		1,205.5	729.6	62%
% Capture		-	-	

MSD is currently in the process of completing Phase I of RTC implementation. It is anticipated that Phase I will be fully tested and operational in August 2006. The first phase implementation also includes five local stations. Three of them were part of the original 16 control sites identified during the studies (SED1, BGI3 & SWPS) while the two others are already operational facilities with automation capabilities. The five facilities in Phase I of the RTC project are as follows:

- Southeastern Diversion Structure (SED1) – for control of two gates. These gates allow the diversion of flow from the Beargrass Interceptor (BGI) to the Southeastern Interceptor (SEI) in Region 3
- Nightingale Pump Station (BGI3) – for control of one gate located in the BGI. This gate allows the diversion of flow from the BGI and the BGI Relief Sewer in Region 1 to the Upper Dry Run Trunk system in Region 3

- Southwestern Pump Station (SWOR1) – for optimal and local control of the gates in the Sluice Gate Chamber (SGC). Utilization of this gate will generate in-line storage capacity within the Southwestern Outlet (SWO). Under manual, degraded or emergency control, all three gates will be manipulated;
- Sneads Branch In-line Storage Site - for control of the dewatering pumps. This facility makes use of an inflatable dam that store overflows in a relief sewer and pumps that re-captured overflows back in the BGI and for treatment at MFWTP;
- Brady Lake and Executive Inn Basins - for control of the gates at the outlet of the basins. These gates allow the storm water flows to be strategically stored for CSO control and released into the Upper Dry Run Trunk system in Region 3 once capacity is available

A more detailed explanation of the operational aspects of RTC Phase I is presented in Section 9 of this report.

MSD has also begun design for RTC Phase II that includes a new control site on the Southwestern Outfall, a new control site on the Beargrass Interceptor at CSO 108 and integration of the operations of Southwestern Pump Station, the Wheeler Avenue CSO/Flood Control Basin, the Main Diversion Structure and the MFWTP into the global RTC control system. Details regarding the control sites are:

- Southwestern Outfall In-line Storage Site (SWOR2) – for control of an inflatable rubber dam to be installed in the Southwestern Outfall approximately 12,000 feet upstream of the Southwestern Pumping Station (SWPS). This gate is meant to create a second storage zone in the upstream section of the Southwestern Outfall, as a complement to the gates at the SGC of the Southwestern PS. At this point, the Southwestern Outfall consists of a 18'10" x 24'-pipe;
- CSO 108 (BGI3) - The project includes the new regulating structure with modifications to the existing interception conduit to the BGI and the addition of a link to the existing BGI relief manhole. An increase of intercepted flow from CSO 108 is possible because of the first phase SED and NPS control sites are respectively located upstream and downstream of CSO 108 along the BGI. Modifications at CSO 108 will maximize the benefits related to the automation of the two control sites;
- Wheeler Basin - New programming of the local PLC and improved instrumentation will allow the RTC system to automatically control the Wheeler Basin from the central station. The integration of the Wheeler Basin operations into RTC should allow for a more efficient use of the basin to control overflows. The basin will store flow more frequently and dewatering will take place only when overflows downstream have ceased. The automated control will make use of the existing sluice gate to control flow from the area entering Mill Creek Trunk;
- Southwestern Pump Station and Main Diversion Structure - New programming of the local PLCs at the Southwestern PS and the MDS will allow the central station to automatically control these facilities. The SWPS and the MDS are two major inflows to the MFWTP. The integration of their operation and the control of the flows with the RTC system will allow the optimization of the flow control strategies during wet weather conditions depending on the current status of the MFWTP and overflow priorities. The SWPS and two of the automated gates at the MDS will be controlled by the RTC system for prioritization and adjustments of the available hydraulic capacity.

MSD is implementing RTC as a foundation for the CSO LTCP. Implementation is expected to be more efficient than the plan developed in 1996 and 1997 by taking advantage of available in-line storage. In addition to RTC, it is anticipated that other projects will be implemented to enhance the benefit of RTC to improve water quality. The process forward for developing the CSO LTCP is presented in Section 11.

7.4.4 Beargreass Creek Water Quality Tool

Since 1988, MSD has been monitoring the water quality in Beargrass Creek with a network of long-term monitoring stations, rain gauges, and extensive biological and chemical testing. At five of the monitoring stations, the U.S. Geological Survey (USGS) maintains continuous flow monitors. Sewer system discharges to the stream, especially combined sewer overflows (CSOs) have been monitored and simulated with computer models since the early 1990s. Watershed modeling began in the 1990s. These efforts have provided a great deal of information, but did not provide MSD with means to predict and manage impacts to water quality in Beargrass Creek.

MSD began work on an integrated model system in 2000 that would simulate sewer overflows, non-point source runoff, and stream water quality. This system is called the Beargrass Creek Water Quality Tool (WQT). The WQT is an integrated system of several computer models that continuously simulate the quality and quantity of runoff, sewer overflows, and stream flows for periods of a year or more. Hydrological Simulation Program - FORTRAN (HSPF) is used for simulation of watershed loads, in-stream transport, and water quality in Beargrass Creek; XP Software's Storm Water Management Model (XP-SWMM) is used to predict CSO and SSO discharges and the CE-QUAL or EPD Riv1 model predicts receiving stream flow and water quality in the lower reaches of Beargrass Creek, near the Ohio River where flow dynamics are more complex.

Development and calibration of the Beargrass WQT is scheduled for completion in late 2006. MSD will use it for TMDL development as well as capital project evaluation and prioritization. The Kentucky Water Resources Research Institute (KWRRI) has joined the project team to oversee development of the Water Quality Tool and to develop the TMDL for the Kentucky Division of Water. The WQT will provide MSD with a means to manage capital projects and land use changes to meet the needs of the CSO LTCP, SSO abatement, storm water permit requirements, and attainment of water quality standards in Beargrass Creek.

FIGURE 7-1a
CSO Screening & Ranking

DRAFT MEMORANDUM

To: Angela Akridge
From: Timothy Kraus
Re: CSO Screening & Ranking
File: 33376
Date: May 5, 2004

cc: Angi Evans
Gary Boblitt

The following is a summary of the procedure utilized to prioritize the Combined Sewer Overflow (CSO) locations within the Louisville MSD system to assist with implementation of CSO Long Term Control Plan projects. This procedure was based upon the EPA Guidance Document "*Combined Sewer Overflows Guidance for Screening and Ranking*", EPA 832-B-95-004, dated August 1995. As detailed within the EPA Guidance document, the CSO outfalls were screened and ranked based upon identified criteria that most likely would cause significant adverse impact to the watershed and the residents of the community. Those CSOs identified as having the greatest total impact, received the highest overall ranking. Information used for this process included multiple sources. These include: 2004 303(d) List of Waters for Kentucky (Final Draft), USGS Streamflow Statistics for Kentucky, KPDES permit information, CSO Program modeling data, USGS Stream data and MSD's work order management data maintained by Louisville MSD.

Seven criteria were utilized to rank the Louisville CSOs. These criteria include human health contact, dry weather stream water quality, receiving stream mixing characteristics, stream flow values, proximity of drinking water intakes, composition of stream flow and other important subjective factors.

Criterion 1- Human Health Contact

This criterion focuses on adverse impacts to public health based upon human contact with streams that receive combined sewage overflow. The impaired uses category of the 2004 303(d) List of Waters for Kentucky was utilized. Points were assigned based upon CSOs that are located in a particular reach of stream. A relative high ranking (relative to other criterion) was applied to this criterion because it typically defines potential risks associated with CSOs.

The points were assigned in the following way:

Description	Priority Points
1st Priority for Contact Recreation	250
2nd Priority for Contact Recreation	125
No Priority Listing	0

A partial listing of the 2004 303(d) Listing Status of Jefferson County Streams – Impaired Streams is included in Appendix 1. No data exists for the lower reach of Beargrass Creek. Therefore, data for the reach of the stream immediately upstream was applied.

In summary, all CSOs within MSD's combined sewer system (CSS) received a score of 250.

Criterion 2 – CSS Dry Weather Flow Water Quality

This criterion focuses on adverse impacts that are created as a result of dry weather combined sewer overflows. A relative high ranking was also applied to this criterion because it typically defines potential risks associated with CSOs. Assessment of this criterion was based upon an inventory of recorded dry weather overflows (DWO) for the period from 1998 to 2003. Chronic DWOs were defined as CSOs, which experienced at least one DWO for five consecutive years. Infrequent DWOs were defined as CSO

FIGURE 7-1b
CSO Screening & Ranking

that experienced a DWO at least once. No known DWO were defined as CSOs that did not appear on the list.

The points were assigned in the following way:

Description	Priority Points
Chronic Dry Weather Overflows	150
Infrequent Dry Weather Overflows	75
No Known Dry Weather Overflows	0

Criterion 3 – Receiving Stream Mixing Characteristics

This criterion allocates points to the CSO based upon receiving stream turbulence and mixing characteristics. The lower the turbulence and energy within the receiving stream the greater points that were assigned. The water bodies with higher degree of turbulence will mix and flush more quickly than slower and therefore are more likely to dispense any pollutant loading from the system before they can sustain substantial impacts.

The following table outlines the points assigned for level of turbulence for different types of water bodies in Jefferson County. Within the table, a differentiation was created between the Ohio River and Beargrass Creek. The points were assigned in the following manner:

Turbulence/ Mixing

	Low	Medium	High
River	40	20	10
Streams	60	40	20

Muddy Fork = Low
South Fork (Channelized and Below) = Low
South Fork (Above) = Medium
Middle Fork = Medium
Ohio River = Medium

In Summary, there is an equitable distribution of points among the CSOs for this criterion.

Criterion 4 – Proportion of Receiving Stream Flow to CSO Flow

Criterion four assigns points to a CSO based on the relationship between the average annual stream flow rate and the average CSO flow rate. The greater the contribution of CSO discharge to the stream, the more likely the stream will sustain impacts.

The points were assigned in the following way:

Description	Priority Points
CSO Contributes > 50%	50
CSO Contributes between 25% and 50%	30
CSO Contributes < 25%	10

The published USGS Streamflow Statistics for Kentucky was utilized. These values are the average annual values for locations within Jefferson County and are included as an appendix. The CSO flow values recently calculated were also utilized. These values are the average annual flow at the outfall of the CSO.

FIGURE 7-1c
CSO Screening & Ranking

In summary only three CSOs received 50 points, seven received 30 points and the remainder received 10 points. All of the CSOs that discharge to the Ohio River received 10 points.

Criterion 5 – Proximity of Drinking Water Intake

Criterion five assign points based upon the distance from a CSO to the drinking water intakes for those CSOs that are upstream of an intake. Since there are no drinking water intakes within 10 miles downstream of a CSO outlet, there are no points to be assigned to any CSOs. This criterion does take into account drinking water intakes for cities in Kentucky and Southern Indiana.

Criterion 6 – Proportion of Industrial Wastewater Flow Within CSS

Criterion six assign points to a CSO based upon the proportion of flow within the CSO that is industrial waste. This is based upon the assumption that industrial discharges have the potential to contain hazardous material including oils, greases, or spilled materials. The point values are based upon dry weather flow of those users that have industrial user permits (SICs).
The points were assigned in the following way:

Description	Priority Points
Commercial/Industrial flow > 50%	50
Commercial/Industrial flow between 25% and 50%	25
Commercial/Industrial flow < 30%	0

In summary, all CSOs within the MSD system have both commercial and industrial flow contributing less than 30% of the dry weather flow and therefore were assigned zero points.

Criterion 7 – Other Considerations

Criterion seven addresses other concerns not accounted for within the previous six criteria, that are a major concern to MSD. It is broken up into six sub-criterions.

Criterion 7A- Accessibility to an impaired water body
Since boating is a common recreational activity in Jefferson County, boaters' access to water bodies in which CSOs contribute were assessed. The points for this sub-criterion are based on the likelihood of access of human contact with impaired water bodies. It has been determined that areas along the Ohio River upstream of the Second Street Bridge are areas of likely contact. Areas between the Second Street Bridge and the Sherman Minton Bridge are unlikely points of contact. Streams and improved channels have been determined to be unlikely points of contact, with the exception of streams in Cherokee Park.

The points were assigned in the following way:

Description	Priority Points
Likely Access	40
Unlikely Access	20
No Access	0

Criterion 7B – Quality of Life
There are certain "hot spots" or areas of new interest within Jefferson County. These include specific locations within the CSS such as the Cherokee Park, Fischer's site (CSOs 132, 167 & 154), the Girl Scout Headquarters site (CSO 127), the Greenways around Letterle PS, and the River Metals site. Because of the public interest and potential contact with the streams in these areas, CSOs near each of these hot spot locations was assigned seventy (70) points.

FIGURE 7-1d
CSO Screening & Ranking

Criterion 7C – F.O.G. (Fats, Oils, Grease) Issues
This sub-criterion is based on wastewater quality/industrial waste review maintenance requests. Only the CSO 206 area was identified as an area within the CSS as frequent flushing requests associates with grease blockages. This CSO was assigned fifteen (15) points for this sub-criterion.

Criterion 7D – Internal Capacity Issues
This sub-criterion assigns points to CSOs that have internal (collection system) flow limitations. Points were assigned to CSOs that have internal pipe segments within their collections system with dry weather flow that is greater than 50% of the calculated pipe capacity. The values were determined through modeling data. Those CSOs that have segments with flow limitations were assigned five (5) points.

Criterion 7E – Stream Aquatic Life Impairment Issues
This sub-criterion assigns points to the CSOs that discharge into streams with aquatic life impairments. The attached table "Table 2: 2004 - 303(d) Listing Status of Jefferson County Streams – Impaired Streams" describes the impacts to aquatic life in the different water bodies of Jefferson County.

In accordance with the list, the points were assigned as follows:

Description	Priority Listing	Points
Non – Support	1	70
Partial Support	2	35
Full Support	0	0

For those CSOs discharging to the Ohio River, zero points were assigned, as the Ohio River has no priority listing for Aquatic Life. The Middle Fork of Beargrass Creek is a priority one stream from river mile 0.0 to river mile 2.3 (just upstream of CSO 209) and therefore seventy (70) points were assigned. The Middle Fork of Beargrass Creek is a second priority from river mile 2.3 to river mile 15.2 and therefor thirty-five (35) points were assigned. The South Fork of Beargrass Creek is a second priority for its entire length and therefor thirty-five (35) points were assigned. The Muddy Fork of Beargrass Creek has no priority listing for aquatic life.

Criterion 7F – Maintenance Issues
This sub-criterion assigns points to CSOs that have been identified by MSDs Maintenance personnel as having a higher demand on their time. Situations include those CSOs with mechanical control devices and those CSOs that are remote or have limited access such as an unimproved driveway. Five points were assigned to the sites identified.

FIGURE 7-1e
CSO Screening & Ranking

DRAFT CSO RANKING (SORTED BY RANK)

CSO NO.	TOTAL SCORE	CURRENT CAPITAL PROJECT	CSO NAME	LOCATION	RECEIVING STREAM	AAOV (MG/YR)	REG	DAM	Criterion												Total Score
									C-1	C-2	C-3	C-4	C-5	C-6	C-7A	C-7B	C-7C	C-7D	C-7E	C-7F	
127	500	Thereafter	ETLEY AVENUE	LEXINGTON RD OP ETLEY	MF BGC	13.05		X	250	0	40	30	0	0	40	70	0	0	70	0	500
108	485	FY05&FY06-RTC	REG NO 1 - NEWBURG	NEWBURG @ TREVILIAN	SF BGC	39.44			250	0	40	50	0	0	40	70	0	0	35	0	485
154	485	FY06-RTC	MELLWOOD @ SCHOEFFEL	MELLWOOD AVE & EDWD POND	MudF BGC	1.44	X		250	0	60	10	0	50	40	70	0	0	0	5	485
015	480	FY05&FY06&FY 07-RTC	SOUTHWESTERN PS	BELLS LN & I-264	OR-R3	844.74		X	250	150	20	10	0	0	40	0	10	0	0	0	480
209	480	FY04/05-DS	CHEROKEE PK @ PARK BD RD	CHEROKEE PK @ PARK BD RD	MF BGC	4.77			250	0	40	10	0	0	40	70	0	0	70	0	480
083	475	FY05-S&F	BRENT ST & BROADWAY CONNE	BRENT & BROADWAY	SF BGC	2.52		X	250	75	60	10	0	25	20	0	0	0	35	0	475
121	475		REG NO 18 - GREEN ST	LEXINGTON RD W OF BGC	SF BGC	2.99			250	75	60	10	0	25	20	0	0	0	35	0	475
146	475	Thereafter	SNEADS BRANCH DIVERSION	SWAN ST S OF BGC	SF BGC	91.29			250	75	60	30	0	0	20	0	0	5	35	0	475
208	475	FY05&FY08-SS	CHEROKEE PARK @ SPRING DR	CHEROKEE RD & SPRING DR	MF BGC	88.83			250	0	40	50	0	0	40	70	10	0	35	0	475
131	470	FY09-SS	REG NO 33 - MELWD & FRANKFO	FRANKFORT AVE @ BGC	SF BGC	0.21			250	75	50	10	0	0	40	0	0	0	35	0	470
018	455	FY05&FY06-RTC	NIGHTINGALE PS	NIGHTINGALE & SFBGC	SF BGC	0.64		X	250	75	40	10	0	0	40	0	0	5	35	0	455
113	455	FY04-S&F	ELLISON AVENUE SEWER	ELLISON & SCHILLER	SF BGC	7.82			250	75	60	10	0	0	20	0	0	5	35	0	455
153	455		COOPER STREET	LEXINGTON & COOPER	SF BGC	6.89	X		250	75	60	10	0	0	20	0	0	0	35	5	455
132 & 167	450	FY06&FY07-RTC	REG NO 35 - BROWNSBORO	BROWNSBORO & DRESCHER B	MudF BGC	117.12			250	0	60	30	0	0	40	70	0	0	0	0	450
142, 174, 180, 182, 183, 184, 185, 186, 187, 188 & 205	450	FY07&FY07-CSO 174 RTC	SBR LOGAN ST @ ST CATHERIN	LOGAN & ST CATHERINE	SF BGC	0			250	75	60	10	0	0	20	0	0	0	35	0	450
020	445	FY07&FY08-RTC Thereafter-S&F	BUCHANAN PS	BUCHANAN & FRANKLIN	OR-R2	40.18		X	250	75	20	10	0	50	40	0	0	0	0	0	445
093	445	FY05-S&F, FY09-SS	SPRING STREET	SPRING ST N OF MELLWOOD	SF BGC	0			250	0	60	10	0	50	40	0	0	0	35	0	445
130	445	FY09-SS	WEBSTER STREET	S OF STORY OP WEBSTER	SF BGC	6.5			250	0	60	10	0	50	40	0	0	0	35	0	445
116	440	FY07&FY08-RTC	REG NO 15 - E BRDWY	BROADWAY W OF BGC	SF BGC	169.6			250	0	60	60	0	25	20	0	0	0	35	0	440
086	435	FY09-SS	PAYNE AT SPRING	PAYNE ST @ SPRING ST	MF BGC	0		X	250	0	40	10	0	25	40	0	0	0	70	0	435
165	430	FY04-S&F, Thereafter-RTC	BEALS BRANCH SAN DIV	LEXINGTON RD & I-64	MF BGC	16.12			250	0	40	30	0	0	40	0	0	0	70	0	430
052	425		10th STREET	10th ST N OF MAIN	OR-R2	0.48		X	250	75	20	10	0	50	20	0	0	0	0	0	425
120	425		PHOENIX HILL SEWER	E OF BGC & S OF BAXTER	SF BGC	4.32			250	0	60	10	0	50	20	0	0	0	35	0	425
087	420	FY09-SS	BLUEHORSE	FRANKFORT @ BLUEHORSE	SF BGC	0		X	250	0	60	10	0	25	40	0	0	0	35	0	420
211	420	FY08 & FY09&Thereafter-RTC	MAIN DIVERSION STRUCTURE	S OF 45th & WINNROSE	OR-R3	511.7		X	250	75	20	10	0	25	40	0	0	0	0	0	420
117	415	FY07&FY08&FY 09-RTC	REG NO 11 - DRY RUN	LOGAN & CALDWELL	SF BGC	82.51			250	0	60	50	0	0	20	0	0	0	35	0	415
125	410	Thereafter	REG NO 24 - GRINSTEAD DR	GRINSTEAD @ I-64	MF BGC	18.3		X	250	0	40	10	0	0	40	0	0	0	70	0	410
126	410	Thereafter	REG NO 26 - RAYMOND AVE	I-64 & SAUNDERS LN	MF BGC	0.24		X	250	0	40	10	0	0	40	0	0	0	70	0	410
140	410	Thereafter	LOCUST STREET	LOCUST SW OF SPRING	MF BGC	5.04		X	250	0	40	10	0	0	40	0	0	0	70	0	410
144	410	FY04-S&F	VANCE ST REGULATOR	S END OF VANCE & I-64	MF BGC	0.54			250	0	40	10	0	0	40	0	0	0	70	0	410
141	400		BAXTER AVE @ BGC	BAXTER AVE & BGC	SF BGC	0		X	250	0	60	10	0	25	20	0	0	0	35	0	400
152	400		REG NO 7 - SOUTHEASTERN	BGC & RUFER AVENUE	SF BGC	34.02	X		250	0	60	30	0	0	20	0	0	0	35	5	400
202	400		CRD S ORMSBY W OF 3rd	ORMSBY W OF 3rd ST	OR-R2	0.078			250	75	20	10	0	25	20	0	0	0	0	0	400
092	395	FY07&FY08-RTC, Thereafter-S&F	LOGAN COMPANY	N OF BUCHANAN PS	OR-R2	48.41		X	250	75	20	10	0	0	40	0	0	0	0	0	395
081	395		LETTERLE	LETTERLE @ BGC PS	SF BGC	0		X	250	0	60	10	0	0	40	0	0	0	35	0	395
082	395		BGI AT BGC	BGC @ OMFT	SF BGC	0.48		X	250	0	60	10	0	0	40	0	0	0	35	0	395
088	395		MELLWOOD AVE INT	BROWNSBORO RD @ BGC	SF BGC	0			250	0	60	10	0	0	40	0	0	0	35	0	395
151	395	Thereafter	REG NO 5 - CASTLEWOOD	BGC & CASTLEWOOD DELL	SF BGC	143.36		X	250	0	60	30	0	0	20	0	0	0	35	0	395
109	385	FY04-S&F	REG NO 2 - DEER PARK	BEHIND O. L. O. P.	SF BGC	2.85			250	0	40	10	0	0	40	0	0	5	35	5	385
092	380	FY09-SS	ST CATHERINE @ BGC	SCHILLER BTW KY & ST CATHER	SF BGC	0.03			250	0	60	10	0	0	20	0	0	5	35	0	380
019	375	FY08&FY09-RTC	34th STREET PS	34th & RUDD	OR-R2	95.08		X	250	75	20	10	0	0	20	0	0	0	0	0	375
033	375		CRD ON YORK E OF 4th	ON YORK E OF 4th	OR-R2	0.012			250	75	20	10	0	0	20	0	0	0	0	0	375
034	375		CRD 4th & YORK	4th & YORK	OR-R2	1.4			250	75	20	10	0	0	20	0	0	0	0	0	375
084	375		BRENT ST @ BGC	BRENT ST @ BGC	SF BGC	2.1		X	250	0	60	10	0	0	20	0	0	0	35	0	375
091	375	FY09-SS	SCHILLER AVE OVFL	SCHILLER & HIGHLAND	SF BGC	0.06			250	0	60	10	0	0	20	0	0	0	35	0	375
097	375	Thereafter	CANTONMENT SIPHON NO 2	BGC S OF EASTERN PKWY	SF BGC	49.28		X	250	0	40	10	0	0	40	0	0	0	35	0	375
106	375		ROYAL - NEFF	BACKYARD OF 1212 ROYAL	SF BGC	0.11			250	0	40	10	0	0	40	0	0	0	35	0	375
110	375	Thereafter	REG NO 3 - GOSS AVE	BGC S OF EASTERN PKWY	SF BGC	3.84			250	0	60	10	0	0	20	0	0	0	35	0	375
111	375		EMERSON STREET SEWER	BGC N OF EASTERN PKWY	SF BGC	9.36			250	0	60	10	0	0	20	0	0	0	35	0	375
119	375		BRENT STREET SEWER	BGC N OF BROADWAY	SF BGC	2.19			250	0	60	10	0	0	20	0	0	0	35	0	375
137	375		CALVARY CEMETARY	CALVARY CEMETARY @ BGC	SF BGC	0.95			250	0	40	10	0	0	40	0	0	0	35	0	375
147	375		SWAN STREET DIVERSION	SWAN ST N OF BGC	SF BGC	1.3			250	0	60	10	0	0	20	0	0	0	35	0	375
148	375		EASTERN PKWY DIVERSION	EASTERN PKWY E OF BGC	SF BGC	0.24			250	0	60	10	0	0	20	0	0	0	35	0	375
149	375	FY07&FY08&FY 09-RTC	DRY RUN DIVERSION	KENTUCKY STREET & ST PAUL C	SF BGC	6.84			250	0	60	10	0	0	20	0	0	0	35	0	375
156	375		ROWAN ST @ 12th ST	ROWAN & 12th	OR-R2	0.04		X	250	75	20	10	0	0	20	0	0	0	0	0	375
160	375		SEWER IN ALLEY SAN DIV	1ST ST BTW MAIN & MARKET	OR-R2	0.22	X	X	250	0	20	10	0	50	40	0	0	0	0	5	375

MSD
Louisville and Jefferson County
Metropolitan Sewer District

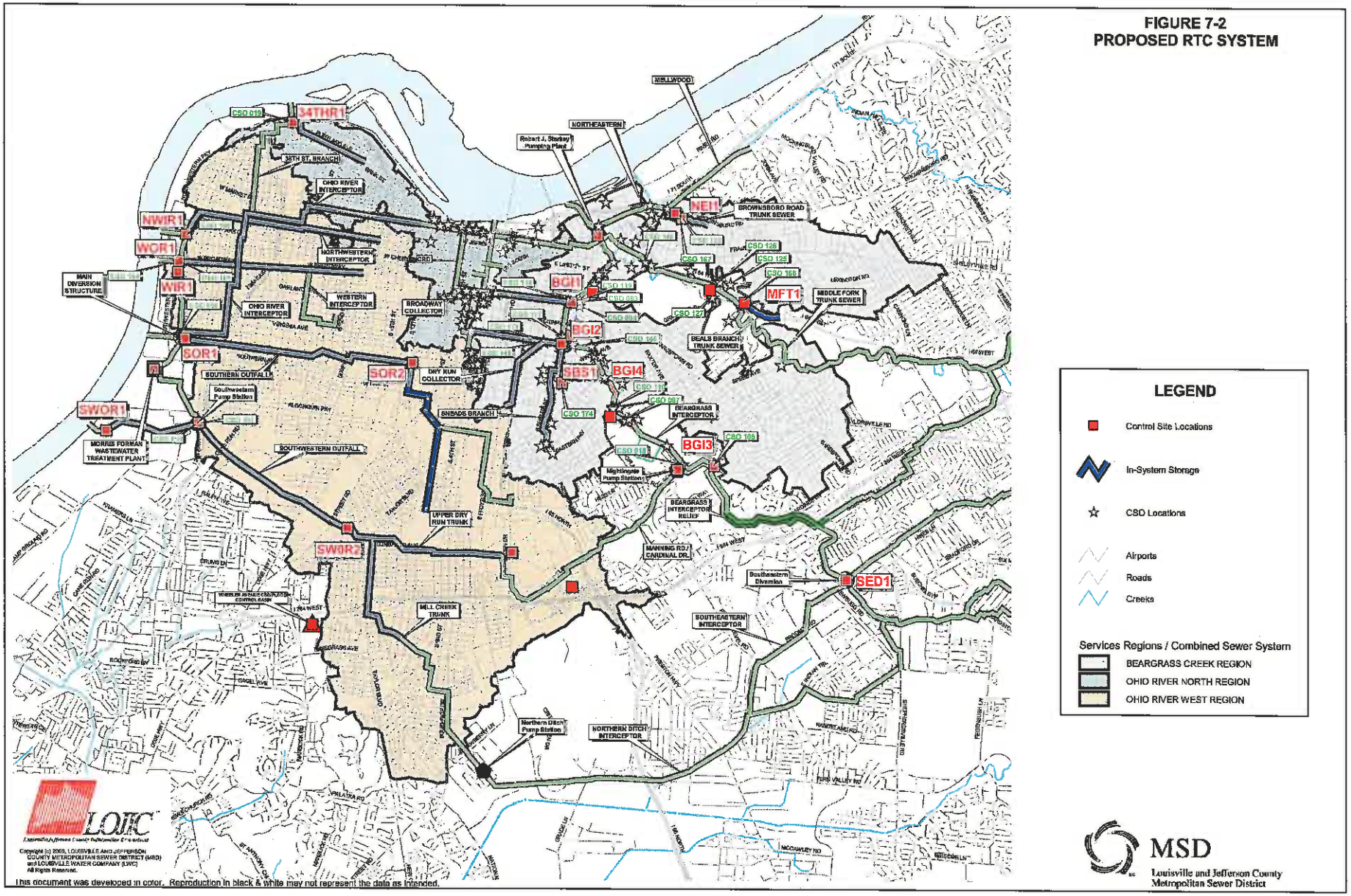
FIGURE 7-1f
CSO Screening & Ranking

DRAFT CSO RANKING (SORTED BY RANK)

CSO NO	TOTAL SCORE	CURRENT CAPITAL PROJECT	CSO NAME	LOCATION	RECEIVING STREAM	PeAOV (MGY)	REG	O+M	Criteria														Total Score
									C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10	C-11	C-12	C-13	C-14	
181	375		MARKET ST SAN DIV	FIRST & MARKET	OR-R2	0.15	X	X	250	0	30	10	0	5	40	0	0	0	0	0	0	0	375
178	375	FY07&FY08SPV 03-R7C	KENTUCKY ST SEWER OVFL	KENTUCKY ST & ST PAUL CT	SF BGC	0.084		X	250	0	60	10	0	5	20	0	0	0	0	30	0	0	375
068	370		PRESTON ST OVFL WEIR	PRESTON & MAIN	OR-R2	5.09		X	250	0	20	10	0	0	40	0	0	0	0	0	0	0	370
173	365		ORD 9th & YORK 'B'	9th & YORK	OR-R2	0.1	X		250	0	20	30	0	50	20	0	0	0	0	0	0	0	365
322	350		FOURTH ST PS	FOURTH & MAIN	OR-R2	7.41			250	0	20	10	0	50	20	0	0	0	0	0	0	0	350
027	350		ORD 7th & BROADWAY	7th & BROADWAY	OR-R2	0			250	0	30	10	0	50	20	0	0	0	0	0	0	0	350
228	350		ORD 6th & YORK	6TH & YORK	OR-R2	0.08			250	0	30	10	0	50	70	0	0	0	0	0	0	0	350
036	350		ORD 3rd & BROADWAY	3rd & BROADWAY	OR-R2	0.24			250	0	20	10	0	50	20	0	0	0	0	0	0	0	350
038	350		ORD 5th & BROADWAY	5th & BROADWAY	OR-R2	0.054		X	250	0	20	10	0	50	20	0	0	0	0	0	0	0	350
350	350		12th STREET	12th ST N OF MAIN	OR-R2	6.8		X	250	0	20	10	0	50	20	0	0	0	0	0	0	0	350
354	350		11th STREET	11th ST N OF MAIN	OR-R2	0.35		X	250	0	30	10	0	50	20	0	0	0	0	0	0	0	350
354	350		7th STREET	7th ST N OF MAIN	OR-R2	0.0		X	250	0	20	10	0	50	20	0	0	0	0	0	0	0	350
056	350		6th STREET	6th ST N OF MAIN	OR-R2	2.1		X	250	0	20	10	0	50	20	0	0	0	0	0	0	0	350
056	350	7/06 S&T	5th STREET	5th ST N OF MAIN	OR-R2	4.29			250	0	20	10	0	50	20	0	0	0	0	0	0	0	350
190	350		SEVENTEENTH ST SAN DIV	17th ST & NW PKWY	SF-R2	12.44			250	0	20	10	0	50	20	0	0	0	0	0	0	0	350
195	350		ORD S 4th & OAK	4th & OAK	OR-R2	0		X	250	0	20	10	0	50	20	0	0	0	0	0	0	0	350
053	330		8th STREET	8th ST N OF MAIN	OR-R2	1.44		X	250	0	20	10	0	25	20	0	0	0	0	0	0	0	330
181	330		ORD 2nd & BROADWAY NO 2	2nd & BROADWAY	OR-R2	0.03	X		250	0	20	10	0	25	20	0	0	0	0	0	0	0	330
025	325		ORD 6th & BROADWAY	6th & BROADWAY	OR-R2	0			250	0	20	10	0	25	20	0	0	0	0	0	0	0	325
182	325		ORD 9th & YORK 'A'	9th & YORK	OR-R2	1.36			250	0	30	10	0	25	20	0	0	0	0	0	0	0	325
150	325		5th ST N COMMON PLACE	5th ST & COMMON PLACE	OR-R2	3.02			250	0	20	10	0	25	20	0	0	0	0	0	0	0	325
177	325		ADAMS STREET	ADAMS ST & I-64	OR-R2	0.14	X	X	250	0	20	10	0	0	40	0	0	0	0	0	0	0	325
196	325		ORD S 3rd & ORMSBY	3rd & ORMSBY	OR-R2	1.21		X	250	0	20	10	0	25	20	0	0	0	0	0	0	0	325
219	320		MILES PARK BYPASS	S OF 45th & WINNROSE	OR-R3	0		X	250	0	20	10	0	0	40	0	0	0	0	0	0	0	320
05*	320		FIRST STREET OVFL WEIR	1st & MAIN	OR-R2	0			250	0	20	10	0	0	40	0	0	0	0	0	0	0	320
104	320	FY08&FY09&The Water - RTC	SW PKWY SEWER @ BROADWAY	SW PKWY & BROADWAY	OR-R3	0.09		X	240	0	20	10	0	0	40	0	0	0	0	0	0	0	320
105	320	FY08&FY09&The water - RTC	WESTERN OUTFALL @ BROADWAY	BROADWAY @ SW PKWY	OR-R3	358.92			240	0	20	10	0	0	40	0	0	0	0	0	0	0	320
189	320	FY08&The water - RTC	NORTHWESTERN SAN DIV	SHAWNEE PARK FLOOD PS	OR-R3	358.92			240	0	20	10	0	0	40	0	0	0	0	0	0	0	320
191	320		ALGONQUIN PKWY SAN DIV	SOUTHEASTERN PS	OR-R3	4.66		X	240	0	20	10	0	0	40	0	0	0	0	0	0	0	320
210	320		45th STREET GREENWOOD	N OF 45th & WINNROSE	OR-R2	21.08			240	0	20	10	0	0	40	0	0	0	0	0	0	0	320
182	305		ORD S 6th & KENTUCKY	6th & KENTUCKY	OR-R2	0.14	X		250	0	20	10	0	0	20	0	0	0	0	0	0	0	305
104	305		ORD S OAK (N OF 4th)	OAK ST N OF 4th ST	OR-R2	0	X		250	0	20	10	0	0	20	0	0	0	0	0	0	0	305
323	300		OR @ 4th ST PS	FOURTH & MAIN	OR-R2	0.84			250	0	20	10	0	0	20	0	0	0	0	0	0	0	300
223	300		ORD 6th & YORK	6th & YORK	OR-R2	2.89			230	0	20	10	0	0	20	0	0	0	0	0	0	0	300
251	300		ORD 6th & BRECKINRIDGE	6th & BRECKINRIDGE	OR-R2	0			230	0	20	10	0	0	20	0	0	0	0	0	0	0	300
338	300		ORD 4th & BRECKINRIDGE	4th & BRECKINRIDGE	OR-R2	0			230	0	20	10	0	0	20	0	0	0	0	0	0	0	300
036	300		ORD 2nd & BROADWAY NO 1	2nd & BROADWAY	OR-R2	0			230	0	20	10	0	0	20	0	0	0	0	0	0	0	300
169	300		6th & HUBBINGTON SAN DIV	6th & HUBBINGTON WCF A/C	OR-R2	0		X	250	0	20	10	0	0	20	0	0	0	0	0	0	0	300
192	300		ORD S 6th & GARLAND	6th & GARLAND	OR-R2	3.14		X	230	0	20	10	0	0	20	0	0	0	0	0	0	0	300
198	300		ORD S 3rd & OAK	3rd & OAK	OR-R2	1.16		X	230	0	20	10	0	0	20	0	0	0	0	0	0	0	300
197	300		ORD S 2nd S OF OAK	2nd ST S OF OAK ST	OR-R2	2.93		X	250	0	20	10	0	0	20	0	0	0	0	0	0	0	300
199	300		ORD S 2nd N OF MAGNOLIA	2nd ST N OF MAGNOLIA	OR-R2	0.011			250	0	20	10	0	0	20	0	0	0	0	0	0	0	300
200	300		ORD S 3rd & MAGNOLIA	3rd & MAGNOLIA	OR-R2	0.248			250	0	20	10	0	0	20	0	0	0	0	0	0	0	300
201	300		ORD S 5th & KENTUCKY	5th & KENTUCKY	OR-R2	0.27			250	0	20	10	0	0	20	0	0	0	0	0	0	0	300
203	300		ORD S 4th & ORMSBY	4th & ORMSBY	OR-R2	0			250	0	20	10	0	0	20	0	0	0	0	0	0	0	300
207	300		2nd & JEFFERSON	2ND & JEFFERSON	OR-R2	0			250	0	20	10	0	0	20	0	0	0	0	0	0	0	300
208	300		12th & JEFFERSON	12th & JEFFERSON	OR-R2	0			250	0	20	10	0	0	20	0	0	0	0	0	0	0	300

Notes
OR - Ohio River
SF-BGC - South Fork of Beargrass Creek
MF-BGC - Middle Fork of Beargrass Creek
L-BGC - Lower Beargrass Creek
SBR - Shreads Branch Relief Sewer
CRD - Central Relief Ditch

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FIGURE 7-2
PROPOSED RTC SYSTEM
LEGEND
Control Site Locations
In-System Storage
CSO Locations
Airports
Roads
Creeks
Services Regions / Combined Sewer System
BEARGRASS CREEK REGION
OHIO RIVER NORTH REGION
OHIO RIVER WEST REGION
34THR1
NWIR1
WOR1
WIR1
SOR1
SOR2
SWOR1
SWOR2
BGI1
BGI2
BGI3
BGI4
SBS1
NEI1
MFT1
SED1
MSD
Louisville and Jefferson County Metropolitan Sewer District
LOJIC
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SECTION 8

SECTION 8: CSO LTCP IMPLEMENTATION THROUGH JUNE 2005

8.1 INTRODUCTION

Since the development of MSD's current LTCP under the Combined Sewer Abatement Program, MSD has been implementing elements of the plan to ensure progress of the program and to move toward the ultimate goal of reducing the pollutant load on receiving streams from combined sewer overflows. The following provides a summary of the CSO LTCP Implementation accomplishments through June 2005.

8.2 CSO LTCP IMPLEMENTATION - JANUARY 1991 TO JUNE 1993

The initial 2 years of the CSO program focused on characterization, monitoring, and modeling activities as these are the basis for selection and design of effective CSO controls. Specific activities included inventorying the assets comprising the combined sewer system (CSS) and developing the tools that would be required to move forward with the development of a CSO Long Term Control Plan (LTCP). The accomplishments achieved during this period can be summarized as follows:

- Developed a detailed inventory and defined operational status of all assets comprising the CSS.
- Evaluated pump stations, overflows and regulators in the CSS.
- Reviewed and/or developed maintenance programs for the assets comprising the CSS.
- Conducted a flow monitoring program to provide calibration data for the CSO SWMM model that was being developed.
- Developed a SWMM model of the CSS.
- Executed a CSO and stream sampling program to quantify the impact of CSOs on the receiving streams.
- Projected estimated annual CSO nutrient release to quantify the impact of CSOs on the receiving streams.
- Performed a flooding analysis associated with the CSS, focused on the Ohio River North and Ohio River West regions.
- Evaluated major stormwater impacts to the CSS.
- Evaluated industrial loadings to the CSS.
- Summarized MSD's public education effort relative to the CSS.

8.3 CSO LTCP IMPLEMENTATION - JULY 1993 TO NOVEMBER 1998

During the period from July 1993 to November 1998, MSD's CSO Program continued to focus on the development and implementation of a long-term capital program for planning, design, and construction of new facilities and the improvement of existing facilities and systems, known as the CSO Long Term Control Plan (LTCP).

The implementation of the LTCP program was intended to bring wet weather CSO discharges into compliance with the technology and water quality-based requirements of the Clean Water Act and to involve the public and stakeholders in the decision making process.

Consistent with EPA's CSO Control Policy and the State of Kentucky NPDES permits issued to MSD, the objectives of the MSD CSO control program are:

- To ensure that if CSOs occur, they are only as a result of wet weather;
- To bring all wet weather CSO discharge points into compliance with the technology and water quality based requirements of the CWA; and
- To minimize negative CSO-related impacts to water quality, aquatic biota, and human health.

MSD has characterized the two watersheds (Ohio River and Beargrass Creek) that comprise the CSS, understands their interaction with the CSS, and has listened to stakeholder input. Based on that information and an understanding of the CSS, MSD has established seven Programmatic Objectives of its LTCP. This is recognition that a program, not a project, is needed to control CSOs within and across the waters of Jefferson County. Specific projects, operations and informational technologies are first evaluated to determine if they meet these Programmatic Objectives.

MSD Programmatic Objectives of the LTCP:

- Maximize storage in the existing system,
- Provide treatment for captured combined flow (this includes control of solids and floatables and disinfection where possible),
- Minimize overflows and consolidate overflow points,
- Focus on attaining water quality standards,
- Demonstrate new technologies and approaches, implementing economically achievable, best available technologies (BAT),
- Involve the community and stakeholders, and
- Monitor and model to determine long-term effectiveness of LTCP and watershed-based strategies.

Alternatives are also evaluated based on cost, performance in meeting the programmatic objectives, contribution toward attainment of water quality standards, and operational performance. The specific projects are then chosen, and incorporated into a rolling 5-year Capital Improvement Program and budget.

From characterization through application, MSD's entire process of developing our LTCP meets or exceeds the elements required of a LTCP as laid out in the CSO Policy.

Specific program accomplishments during this time period relative to implementation of the LTCP can be summarized as follows:

- Developed the LTCP for Beargrass Creek Region.
- Developed the LTCP for Ohio River North and Ohio River West Regions.
- Implemented the Plumbing Modification Program on a countywide basis - The Plumbing Modification Program (PMP) has been ongoing for more than ten years. The program was initially intended to provide protection to designated critical areas in the combined sewer systems that had experienced chronic problems with basement backups. On March 1, 1997, the MSD area experienced its worst flooding since 1964. As a result of this flood event, the PMP was opened to MSD customers throughout Jefferson County. A major accomplishment of this program has been the minimization of public health concerns resulting from the combined and sanitary sewer systems backing up into customer

basements. The program also reimburses for the removal of downspouts directly connected to the combined sewer thereby reducing storm inflow into the CSS. Additionally, the PMP reimburses for disconnection of sump pumps and downspouts in the To date over 6,900 backflow prevention devices have been installed. This program is currently being implemented on a priority area and evaluated need basis.

- Flow monitoring and sampling at selected CSOs
- Evaluation of flooding at various locations throughout the CSS
- Implemented a CDS unit at CSO 050 for S&F control - CDS is a liquid-solids separation technology typically used for storm water management. The CDS Demonstration Project at CSO 50 was the first combined sewer application of CDS technology. CDS is a unique technology consisting of a stainless steel perforated and deformed separation plate placed in a hydraulically balanced separation chamber. The facility was put into operation in February 1998 and has operated exceedingly well as a solids and floatables control for this location.
- Constructed the Wheeler Avenue CSO/Flood Control Basin to provide flooding relief for the area and to reduce overflows at CSO 015 - This was accomplished by constructing a 4.9-MG flood control basin, constructing a 553,000-gallon CSO Basin inside the flood control basin, providing 1.1 MG of storage in the 78" combined sewer, regulating the rate of flow to the MCT and preventing the Mill Creek Trunk from backing up into the area. The Wheeler Basin will ultimately be operated as part of the Real Time Control (RTC) System currently being developed and implemented by MSD.



Wheeler Avenue CSO/Flood Control

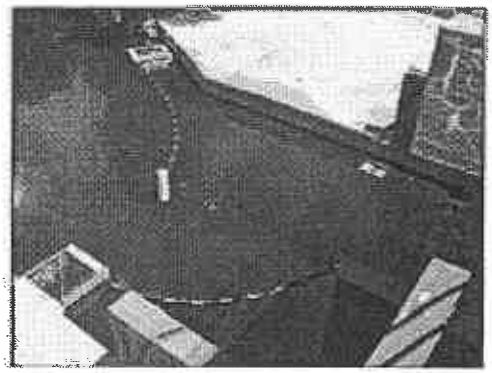
8.4 CSO LTCP IMPLEMENTATION - DECEMBER 1998 TO JUNE 2005

During the period from December 1998 to June 2005 MSD's CSO Program continued to focus on the development and implementation of a program to ensure CSO compliance through the continued evolution and development of their LTCP efforts. Specific program accomplishments during this time period can be summarized as follows:

- Installed CDS Unit as a demonstration project for Solids and Floatables control on CSO 108 - This liquids-solids separation technology has typically been applied to storm water management. This facility was designed to process approximately 34 cfs (22 MGD). This CDS facility became part of a NSF, ETV for combined sewage treatment. Additional information is provided in Section 10.
- Installed Solids and Floatables controls on CSOs 109 and 113 using COPA Cross Wave Static Screens - The static screen reduce the volume of solids and floatables within the overflow stream. The installation at CSO 113 required a new diversion chamber, while the installation at CSO 109 utilized the existing diversion chamber.
- Installed Solids and Floatables control on CSO 082 using COPA Cyclone Screen - The device is a low maintenance solids and floatables screen. The cylindrical shaped unit is gravity driven, self-cleaning, and operational when fully submerged. The flow capacity of the unit is approximately 1.5 cfs with a 6 mm screen opening size.
- Installed Solids and Floatables controls on CSOs 126, 127 and 166 using COPA Cross Wave Static Screens - All three CSOs now utilize static screens to reduce the amounts of

solids and floatables in the overflow stream. Each of the three installations utilized the existing diversion chambers.

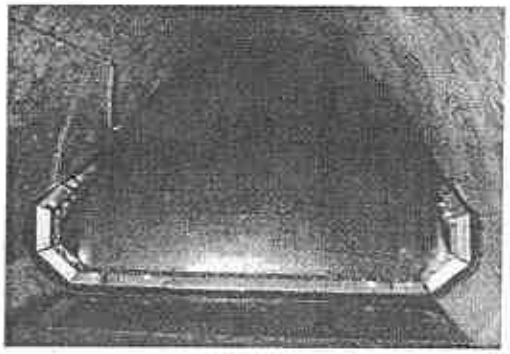
- Installed Solids and Floatables controls on CSOs 125 and 144 using Hydro International Wave Static Screens - Both of the CSOs utilized static screens to reduce the amounts of solids and floatables within the overflow stream. Both installations utilized the existing diversion chambers.
- Installed Solids and Floatables controls on CSOs 028, 030, 034, 054 and 119 using COPA Cyclones - The low maintenance solids and floatables screening device is a gravity driven, cylindrical shaped unit, that is self-cleaning, and operational when fully submerged. The flow capacity of the unit is approximately 1.5 cfs with a 6 mm screen opening size.
- Beargrass Creek Gross Screening using two diversion booms and two trash baskets to collect S&Fs from the creek - This project installed two diversion booms and two trash baskets to collect solids and floatables from the creek. This concept differed from other solids and floatables controls in that it screened the entire stream channel. The objective was to remove solids and floatables within the stream channel, capture solids and floatables originating from point and non-point sources, and create a more aesthetically pleasing environment suitable for recreation.



Beargrass Creek Solids & Floatables diversion beams and trash baskets.

- Eliminated CSO 123 through Sewer Separation - CSO 123 had three distinct areas contributing to the overflow. Each area had new storm sewers constructed and the existing combined sewers were converted to sanitary. Following a one-year flow monitoring period the regulator was removed and the overflow was permanently eliminated.
- Reduced CSO 088 through Sewer Separation - The original combined sewer was transformed into a sanitary sewer and a new storm sewer was constructed. This project resulted in the elimination of a CSO that had an average annual overflow of approximately 4.0 MG/YR into Lower Beargrass Creek. A flow meter was installed in spring of 2002 to monitor the effectiveness of the sewer separation project and to determine the need for downspout removal prior to closing the CSO.
- Eliminated CSO 080 through Sewer Separation - Initial sewer separation efforts were part of the Breckinridge/Franklin Elementary School Sewer Relocation Project. Once the project was completed, it was noted that additional sanitary connections were found just upstream of CSO 080. These connections were removed through the implementation of a mini-separation project and the CSO was permanently closed.
- Reduced CSO 147 through Sewer Separation - The existing combined sewer was transformed into a sanitary sewer and a new storm sewer has been constructed. This project resulted in the elimination of a CSO that had an average annual overflow of approximately 5.4 MG/YR. A flow meter was installed in May 2002 to monitor the effectiveness of the sewer separation project and to determine the need for downspout removal prior to closing the CSO. The CSO 147 sewershed is scheduled for downspout removal by 2007. The CSO will be permanently closed following completion of the downspout removal project.

- On-going Sewer Separation project on CSO 206 - The purpose of the CSO 206 Sewer Separation Project is to determine connectivity in the combined sewer areas, and to recommend a plan for separation of storm and sanitary sewers. The field investigation was completed during October 1999 and recommended a three-phased sewer separation project for the elimination of CSO 206. Recommendations included reconnection of sanitary and storm sewers to their proper conveyance pipe, manhole remodeling, downspout disconnection, relining of sanitary sewers and relining of home services that run under the parallel storm sewers. Design of the sewer separation for the CSO 206 area was initiated in 1999. The CSO 206 Project was separated into 15 subareas and the design was completed and construction began in 2000. Subareas 1 through 9 have been completed to date.
- Eliminated CSO 209 through Sewer Separation - The 105-acre area served through CSO 209 consists of approximately 350 residential properties. The physical characteristics of the pipe network upstream of this CSO are not typical of the other CSO systems. This system contained two pipe networks (storm and sanitary) with approximately 37 common manholes. Within each common manhole there was a wall dividing the systems. During a heavy rain, the water level rose such that there was a transfer of flows within the manholes. The pipe system contains 14,225 LF of "sanitary sewer" pipe and 15,075 LF of "storm sewer" pipe. The system was separated and the CSO was permanently closed in September 2005 following completion of the related downspout removal project.
- Snead's Branch Relief In-line Storage Project - The facility uses the Snead's Branch Relief Drain (SBRD) as a CSO storage facility by operation of an inflatable rubber gate which is located approximately 200' from the outlet of the SBRD to the South Fork of Beargrass Creek channelized section. The SBRD is an 11' semi-elliptical drain that collects flows from eleven CSOs. Prior to the installation of the gate, combined sewage could discharge directly to the South Fork of Beargrass Creek. The storage capacity of this facility when the gate is fully inflated is approximately 2.5 MG. The facility is designed to capture flows from the eleven CSOs tributary to the SBRD and pump the stored volume to the Beargrass Interceptor to be conveyed to the Robert J. Starkey Pumping Plant and then on to the Morris Forman Wastewater Treatment Plant (MFWTP) for treatment. Operation of the gate will ultimately be incorporated into the Real Time Control effort for achieving in-line storage of wastewater.

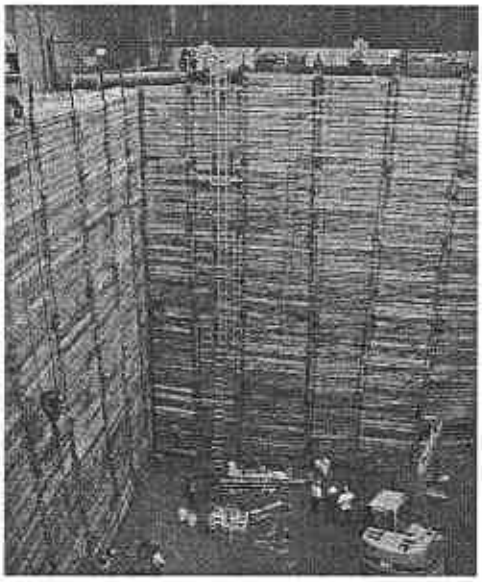


Snead's Branch Relief/in-line inflatable dam stoarge project.

- CSO 211 (MDS) In-line Storage Project - The goal of this project was to maximize flows to the MFWTP (up to the full MFWTP capacity) from the Southern Outfall during wet weather. Calculations indicated that with the current piping configuration at the Main Diversion Structure (MDS) could not deliver the 350 MGD instantaneous peak flow that MFWTP could treat. To provide treatment for the maximum flow quantity possible, a project was completed to raise the overflow level at the outfall of the MDS to an elevation of 422.0 in order to convey more flow through to the MFWTP. An inflatable gate was placed at the overflow from the MDS. The gate provides the ability to raise the water level to provide sufficient head to provide the 350 MGD flow rate to the MFWTP. The gate reduces the annual overflow volume at this location. Operation of the gate will ultimately

be incorporated into the Real Time Control effort for achieving in-line storage of wastewater.

- Cleaning of the Northeastern Sanitary Trunk Sewer to increase the sewer's carrying capacity and reduce overflows - The NSTS Cleaning project involved the removal of an estimated 1'-3' of deposition within the 5-1/2' diameter Northeastern Sanitary Trunk Sewer (NSTS). The cleaning restored full capacity to the NSTS and greatly increased usable storage volume for smaller, more frequent storm events. The cleaning was also necessary to remove the grit prior to starting the Robert J. Starkey Pumping Plant reconstruction project. The NSTS was cleaned from the Robert J. Starkey Pumping Plant to the Letterle Pump Station (approximately 4,700 L.F.) with approximately 1,500 cubic yards of grit removed.
- Reconstruction of the Robert J. Starkey Pumping Plant to increase its pumping capacity from 125 MGD to 140 MGD and reduce overflows at CSOs 020 and 062 - It is estimated that this project resulted in a reduction of approximately 70 MGD in the average annual overflow volume (AAOV). The upgraded pumping plant included a new wet well adjacent to the old wet well; four new variable speed, submersible pumps capable of handling 35 MGD each; two channel monsters with hydraulic motors for screening; hydraulically operated slide and sluice gates for control of flow through the pump station; a new electrical substation; new instrumentation and control, including provisions for telemetry; and new HVAC which provides six (6) air changes per hour in the pump station building and at least twelve (12) air changes per hour in the wetwell.



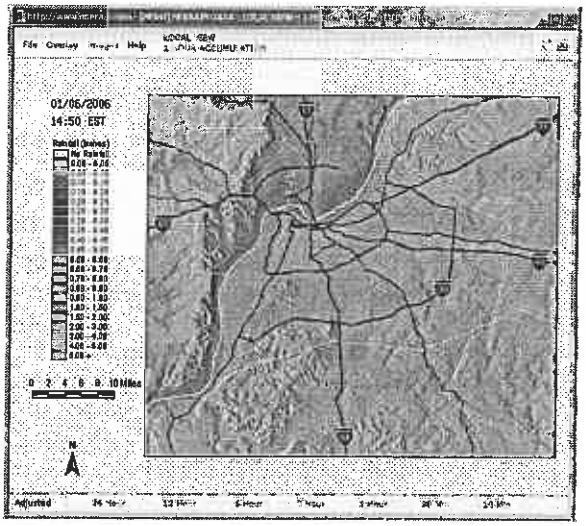
Robert J. Starkey Pumping Plant under construction.

- Construction of the Upper Dry Run Trunk Storage Basins to provide flooding relief and to reduce overflows at CSO 015 - The project included the construction of two earthen basins (17.3 MG and 15.3 MG) on the Kentucky Fair and Exposition Center (KFEC) property, and the construction of 1,922 LF of 60" sewer. The two facilities are both storm water retention basins that discharge their stored flow to the combined sewer system via the Upper Dry Run Trunk Sewer and ultimately the Southwestern Outfall and CSO 015. During the project development it was determined through computer analysis that 19 MG was needed to provide flood protection. Consequently, there is an available storage capacity of 13.5 MG that can be dedicated to CSO reduction. Both the Executive Inn Basin and the Brady Lake Basin will be operated as part of the Real Time Control (RTC) System currently being developed and implemented by MSD.



Upper Dry Run Trunk Storage Basin.

- Implementation of the Real Time Control (RTC) Phase I Project - The initial phase of RTC consisted of remotely controlling five sites by means of a centralized decision making system. The objectives for this ongoing project are a better use of the existing in-line storage capacity, a decrease of CSO volumes in the Beargrass Creek and Ohio River Watersheds, and an increase of the wastewater volume conveyed to the MFWTP. The RTC approach is both global and predictive, which means that the decision making system will use available information monitored on the sewer network, and predicted by the Radar Rainfall Data System (RRDS), to determine the best flow management strategy. The initial phase included the set up of a centralized decision making system (Csoft), a radar rainfall data system to predict weather over a two hour window, and remote control of five sites within the CSS. The initial five sites included Southeastern Diversion Structure, Nightingale Pump Station - CSO 018, Southwestern Pump Station - CSO 015, Upper Dry Run Trunk Storage Basins - CSO 015, and Snead's Branch Relief In-line Storage Project.
- Radar Rainfall Data System - The intent of the RRDS project is two fold: to calibrate NEXRAD radar with rain gauge data, and to provide predictive rainfall data two hours in advance of rainfall. The information provided by the RRDS will be utilized by the RTC system in an effort to better utilize the in-line storage capacity of the existing combined sewer system.
- MFWTP - Many improvements at MFWTP have been built as part of LTCP Implementation. These projects are discussed in detail in Section 4.3.4 of this report.
- Northern Ditch Pump Station Pump Replacement - The four existing pumps at the pump station were replaced with new 14,000 GPM submersible tubular casing pumps. The existing cast iron flap gates were replaced with flexible flap gates. These renovations of the pump station will greatly increase the station reliability and improve the functioning of the Real Time Control system.
- 11th and Rowan Connections - The purpose of this project was to correct improperly connected property service connections tied to the storm sewer system near the intersection of 11th Street and Rowan Street, and the sanitary services located at the 10th Street Flood Pumping Station. Construction of the project was completed in late 2002.
- Riverside Area Sewer Reconnection Project - When the area west of the Beargrass Creek Pump Station, east of Second Street and inside the floodwall was redeveloped and separate storm and sanitary sewers were provided. However, 27 commercial and residential properties were left connected to the storm sewer resulting in dry weather overflows. These properties were successfully reconnected to the sanitary sewer in 1997 and the DWOs were eliminated.



Radar Rainfall Data System screen shot.

The *CSO LTCP Implementation through June 2005* table on the following pages provides a detailed summary of the accomplishments of MSD's CSO Program from its inception until June 2005:

CSO LTCP IMPLEMENTATION THROUGH JUNE 2005

PROJECT	LOCATION	REGION	PROJECT TYPE	STATUS	DATE COMPLETED	COST	PROJECT DESCRIPTION
CSO 143 Elimination	Kentucky Street	Beargrass Creek	Maintenance	Complete	December-94	$3,000	The CSO was eliminated. An 8-inch high level overflow on a local 8-inch sanitary sewer was determined to be unnecessary and was blocked up.
Robert J. Starkey Pumping Plant (formerly Buchanan Street Pump Station) Modifications to Wetwell Operating Levels	Buchanan Street	Beargrass Creek	Maintenance	Complete	January-96	$2,000	The operating levels were raised to reduce overflows.
CSO 65 Elimination	Lampton Street	Beargrass Creek	Maintenance	Complete	May-96	$1,500	After monitoring the inactivity of CSO 065, the dam was removed and the overflow discharge pipe was plugged.
CSO 162 Elimination	Cherokee Park	Beargrass Creek	Maintenance	Complete	July-97	$6,000	A vortex valve was installed in the main line between CSO 162 and CSO 166. The vortex valve regulates the flow advancing to CSO 162. After limiting the flow from CSO 166, the Middle Fork interceptor was monitored to see if the regulated flow could be contained in the interceptor. CSO 162 was then closed.
CSO 49 Elimination	Preston Street North of Jackson Street	Ohio River North	Maintenance	Complete	August-99	$10,000	The sewer system tributary to CSO 049 was separated through redevelopment in the area and the CSO was permanently closed.
CSO 204 Elimination	Fifth Street and Breckenridge Street	Ohio River North	Maintenance	Complete	May-00	$1,500	After completion of the reconnection of several catch basin inlets the overflow discharge pipe was plugged, and CSO 204 was eliminated.
CDS Demo Project at CSO 50	Twelfth Street and Rowan Street	Ohio River North	S&F Control	Complete	February-98	$300,000	CDS is a liquid-solids separation technology that has applications in storm water management. CDS is a unique technology consisting of a stainless steel perforated and deformed separation plate placed in a hydraulically balanced separation chamber. The facility was put into operation in February 1998 and has operated exceedingly well as a solids and floatables control for this location.
CDS Demo Project at CSO 108	Newburg Road north of Trevillian Way	Beargrass Creek	S&F Control	Complete	February-99	$1,600,000	The facility was designed to process a total of approximately 34 cfs (22 MGD). The facility provides control of S&F.
Beargrass Creek Gross Screening Project	Beargrass Creek at Beargrass Creek Flood Pumping Station	Beargrass Creek	S&F Control	Complete	October-04	$250,000	This project consists of the installation of two diversion booms and two trash baskets to collect solids and floatables from the creek. This concept differs from other solids and floatables controls in that it screens the entire stream channel.
CSO 123 Elimination	Cherokee Park @ Spring Valley Lane	Beargrass Creek	Sewer Separation	Complete	April-99	$308,000	CSO 123 had 3 distinct areas contributing to the overflow. All 3 areas had new storm sewers constructed and the existing combined sewers were converted to sanitary. Following a one year flow monitoring period the regulator was removed and the overflow was permanently eliminated.
CSO 88 Sewer Separation Project	Brownsboro Road near Beargrass Creek	Beargrass Creek	Sewer Separation	Complete	January-01	$600,000	The original combined sewer was transformed into a sanitary sewer and a new storm sewer has been constructed. This project resulted in the reduction of a CSO that has an average annual overflow of approximately 4.0 MG/YR into Lower Beargrass Creek. A flow meter was installed in spring of 2002 to monitor the effectiveness of the sewer separation project and to determine the need for downspout removal prior to closing the CSO. The CSO 88 sewershed has been scheduled for downspout removal by 2006. The CSO will be permanently closed following completion of the downspout removal project.
CSO 80 Elimination	Lexington Road West of Payne Street	Beargrass Creek	Sewer Separation	Complete	September-01	$250,000	Initial sewer separation efforts were part of the Breckenridge / Franklin Elementary School Sewer Relocation Project. Once the project was completed, it was noted that additional sanitary con-nections were found just upstream of CSO 80. These connections were removed through the implementation of a mini-separation project and the CSO was permanently closed.
CSO 209 Sewer Separation Project	Bonnycastle Avenue/Eastern Parkway Area near Middle Fork Beargrass Creek	Beargrass Creek	Sewer Separation	Complete	September-01	$1,900,000	The 105-acre area served through CSO 209 consists of approximately 350 residential properties. The physical characteristics of the pipe network upstream of this CSO are not typical of the other CSO systems. This system contained two pipe networks (storm and sanitary) with approximately 37 common manholes. Within each common manhole there was a wall dividing the systems. During a heavy rain, the water level rose such that there was a transfer of flows within the manholes. The pipe system contains 14,225 lin-ear feet of "sanitary sewer" pipe and 15,075 linear feet of "storm sewer" pipe. To date, the MSD public system has been separated. The CSO will be permanently closed following completion of the downspout removal project.

CSO LTCP IMPLEMENTATION THROUGH JUNE 2005

PROJECT	LOCATION	REGION	PROJECT TYPE	STATUS	DATE COMPLETED	COST	PROJECT DESCRIPTION
CSO 147 Sewer Separation Project	Swan Street near Beargrass Creek	Beargrass Creek	Sewer Separation	Complete	September-01	$1,175,000	The existing combined sewer was transformed into a sanitary sewer and a new storm sewer has been constructed. This project resulted in the reduction of a CSO that has an average annual overflow of approximately 5.4 MG/YR. A flow meter was installed in May of 2002 to monitor the effectiveness of the sewer separation project and to determine the need for downspout removal prior to closing the CSO. The CSO 147 sewershed has been scheduled for downspout removal by 2007. The CSO will be permanently closed following completion of the downspout removal project.
CSO 206 Sewer Separation Project	Bardstown Road/Speed Avenue Area on Middle Fork Beargrass Creek	Beargrass Creek	Sewer Separation	On-going	On-going	$3,000,000	Similar to CSO 209, the purpose of the CSO 206 Sewer Separation Project is to determine connectivity in the combined sewer areas, and to recommend a plan for separation of storm and sanitary sewers. The field investigation was completed during FY99 and recommended a three-phased sewer separation project for the elimination of CSO 206. This includes reconnection of sanitary and storm sewers to their proper conveyance, manhole remodeling, downspout disconnection, relining of sanitary sewers and relining of home services that run under the parallel storm sewers. Design for the sewer separation of the CSO 206 area was initiated in 1999. The CSO 206 Project was separated into 15 subareas. In 2000, the design phase was completed and the construction phase began. Subareas 1 through 9 have been completed.
Wheeler Avenue CSO/Flood Control Basin	Wheeler Avenue	Ohio River West	Basin	Complete	May-96	$4,925,000	The Wheeler Avenue area is drained by a combined sewer to the Mill Creek Trunk (MCT) Interceptor. When the MCT is backed up, the flow from within the area has nowhere to go. The MCT Interceptor then flows to the SWO and ultimately to the SWPS where the flow is sent to the MFWTP. During very large storms, the MCT surcharges into the low lying area along Bicknell Avenue and its side streets. The objective of the Wheeler Avenue CSO/Flood Control Project was twofold: (1) to reduce the combined sewer overflows that occur at the SWPS and (2) to reduce the occurrence of neighborhood flooding. This was accomplished by constructing a 4.9 MG flood control basin, constructing a 553,000-gallon CSO Basin inside the flood control basin, providing 1.1-MG of storage in the 78" combined sewer, regulating the rate of flow to the MCT and preventing the Mill Creek Trunk from backing up into the area. The Wheeler Basin will be operated as part of the Real Time Control (RTC) System currently being developed and implemented by MSD.
Upper Dry Run Trunk Regional Storage Facility	Kentucky Fair and Exposition Center	Ohio River West	Basin	Complete	June - 04	$4,500,000	The project includes the construction of two earthen basins (17.25 MG and 15.25 MG) on the Kentucky Fair and Exposition Center (KFEC) property, and the construction of 1,922 LF of 60-inch sewer. The two facilities are both storm water retention basins that discharge their stored flow to the combined sewer system via the Upper Dry Run Trunk Sewer and ultimately the Southwestern Outfall and CSO 15. During the project development it was determined through computer analysis that 19 MG was needed to provide flood protection. Consequently, there is an available storage capacity of 13.5-MG that can be dedicated to CSO reduction. Both the Executive Inn Basin and the Brady Lake Basin will be operated as part of the Real Time Control (RTC) System currently being developed and implemented by MSD.
Real Time Control Phase I Study for Ohio River North and West Regions	Ohio River North and West Regions of the Combined Sewer System	Ohio River North & West	RTC	Complete	June-00	$75,000	The initial RTC feasibility evaluated Beargrass Creek CSO Region to determine the applicability of RTC technology to the existing combined sewer system. The results of the study identified 8 control sites.
Real Time Control Phase II Study for Beargrass Creek Region	Beargrass Creek Region of the Combined Sewer System	Beargrass Creek	RTC	Complete	June-01	$125,000	The second RTC feasibility study evaluated Beargrass Creek CSO Region to determine the applicability of RTC technology to the existing combined sewer system. The results of this study also identified 8 control sites. Additionally, the evaluation of Beargrass Creek CSO Region also recommended the incorpation of 5 off-line storage basins from the original Beargrass Creek CSO Region LTCP.

CSO LTCP IMPLEMENTATION THROUGH JUNE 2005

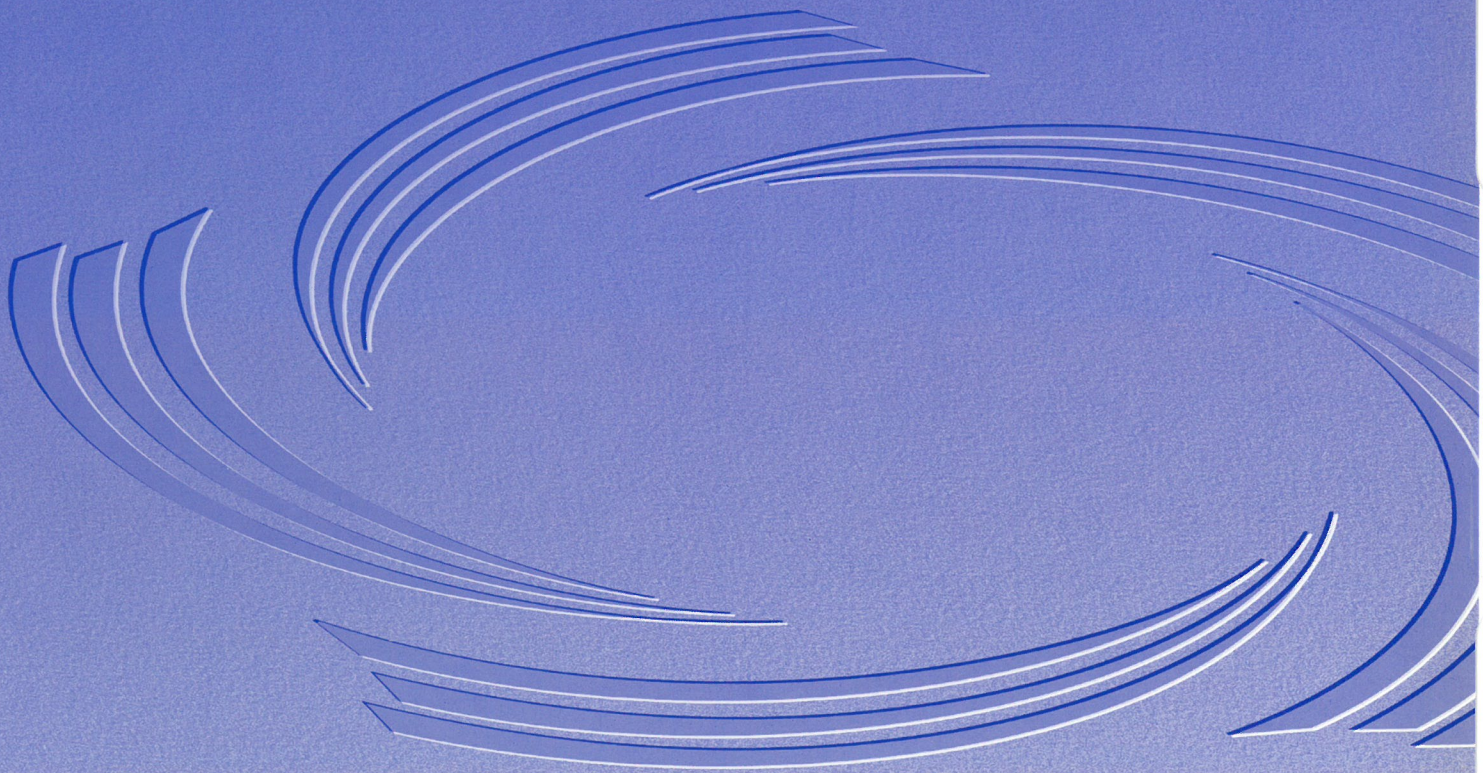
PROJECT	LOCATION	REGION	PROJECT TYPE	STATUS	DATE COMPLETED	COST	PROJECT DESCRIPTION
Real Time Control Phase I Implementation Project	Combined Sewer System	All	RTC	On-going	On-going	$3,122,000	The initial phase of the RTC project consists of remotely controlling five sites by means of a centralized decision making system. The objectives pursued are a better use of the existing in-line storage capacity, a decrease of CSO volumes in the Beargrass Creek and Ohio River Watersheds, and an increase of the wastewater volume conveyed to the Morris Forman Wastewater Treatment Plant (MFWTP). The RTC approach is geospecific, prgrammable and predictive, which means that the decision making system will use available information monitored on the sewer network, and predicted by the Radar Rainfall Data System, to determine the best flow management strategy. The five facilities involved in this project are: (1) Southeastern Diversion Structure, (2) Nightingale Pump Station, (3) Southwestern Pump Station, (4) Upper Dry Run Trunk Storage Facility and (5) Sneads Branch In-Line Storage. When implemented, the initial RTC project will provide a water quality benefit by maximizing in-line storage and minimizing the annual overflow volume.
Sneads Branch In-Line Storage Project	Logan Street and Kentucky Street	Beargrass Creek	In-Line Storage	Complete	September-01	$1,500,000	The facility uses the Sneads Branch Relief Drain (SBRD) as a combined sewer overflow (CSO) storage facility by the operation of an inflatable rubber gate which is located approximately 200' from the outlet of the SBRD to the South Fork of Beargrass Creek channelized section. The SBRD is an eleven-foot semi-elliptical drain that collects flows from eleven CSOs. Prior to the installation of the gate, combined sewage could discharge directly to the South Fork of Beargrass Creek. The storage capacity of this facility when the gate is fully inflated is approximately 2.5 million gallons. The facility is intended to capture the flows from the eleven CSOs tributary to the SBRD and pump the stored volume to the Beargrass Interceptor to be conveyed to the Robert J. Starkey Pumping Plant and then on to the MFWTP for treatment. Operation of the gate will ultimately be incorporated into the Real Time Control effort for achieving in-line storage of wastewater.
Main Diversion Structure In-line Storage	Headworks to the MFWTP	Ohio River West	In-Line Storage	Complete	June-03	$348,500	MSD wanted the flexibility to have the MFWTP receive as much flow as possible (up to the full MFWTP capacity) from the Southern Outfall during wet weather. Calculations indicated that with the current piping configuration at the MDS could not deliver 350 MGD to the MFWTP. To provide treatment for the maximum flow quantity possible, a project was completed to raise the overflow level at the outfall of the MDS to elevation 422.0 in order to convey more flow through to the MFWTP. An inflatable gate was placed at the overflow from the MDS. The gate provides the ability to raise the water level to provide sufficient head to provide the 350 MGD flow rate to the MFWTP. The gate is expected to reduce the annual overflow volume at this location. Operation of the gate will ultimately be incorporated into the Real Time Control effort for achieving in-line storage of wastewater.
NSTS Cleaning	From Robert J. Starkey Pumping Plant to Letterle PS	Beargrass Creek	Capital Project	Complete	September-04	$533,000	The NSTS Cleaning project involved the removal of an estimated 1'-3' of deposition within the 5½' diameter Northeastern Sanitary Trunk Sewer (NSTS). The cleaning restored full flow capacity of NSTS to its design level and greatly increases usable storage volume. The cleaning was also necessary to remove the excessive grit that would possibly shift when the modifications at the Robert J. Starkey Pumping Plant drop the elevation of the wet well approximately 15'. The NSTS was cleaned from the Robert J. Starkey Pumping Plant to the Letterle Pump Station (approximately 4700 L.F.) with approximately 1,500 cubic yards of grit removed.

CSO LTCP IMPLEMENTATION THROUGH JUNE 2005

PROJECT	LOCATION	REGION	PROJECT TYPE	STATUS	DATE COMPLETED	COST	PROJECT DESCRIPTION
Robert J. Starkey Pumping Plant Modifications	Buchanan Street	Beargrass Creek	Capital Project	Complete	July-05	$13,500,000	This Robert J. Starkey Pumping Plant Project consisted of upgrading the existing pump station capacity from 125 MGD to 140 MGD. It is estimated that this project will result in a reduction of approximately 70 MGD to the average annual overflow volume (AADV). The upgraded pumping plant included the following: - New wet well adjacent to the old wet well - Four (4) new variable speed, submersible pumps capable of handling 35 MGD each. - Two (2) channel monsters with hydraulic motors for screening - Hydraulically operated slide and sluice gates for control of flow through the pump station - New electrical substation which includes MCC's, VFD's, Control Panel, lighting panel. - New instrumentation and control, including provisions for future telemetry. - New HVAC which includes at least six (6) air changes per hour in the pump station building and at least twelve (12) air changes per hour in the wetwell.
Plumbing Modification Program	Countywide	All	Capital Project	On-going	On-going	$13,000,000	The Plumbing Modifications Program has been in existence for eleven years with expenditures over $13M. The program was initially intended to provide protection to designated critical areas in the CSS that had experienced chronic problems with basement backups due to wet weather surcharged sewers. On March 1, 1997, the Louisville Metropolitan area experienced its worst flooding since 1964. As a result of this flood event, the Plumbing Modifications Program was temporarily expanded to the entire MSD service area which included both the combined and separate sanitary sewer areas. The program reduces and retards inflow by removing direct connections to the combined sewer, such as groundwater sump pump and downspouts. Redirecting these direct connections and discharging them onto the grass allows the water to be absorbed into the ground instead of using capacity within the combined sewer. Over 1400 structures within the CSS have had downspouts disconnected through this voluntary program. Historically, it is estimated that 80 - 90% of these locations also had sump pumps disconnected from
Radar Rainfall Data System	Combined Sewer System	All	Capital Project	On-going	On-going	$618,000	The Radar Rainfall Data System (RRDS) project is actually an element of the Real Time Control (RTC) project. The intent of the RRDS project is two fold – to calibrate NEXRAD radar with rain gauge data, and to provide predictive rainfall data two hours in advance of rainfall. The information provided by the RRDS will be utilized by the RTC system in an effort to better utilize the in-line storage capacity of the existing combined sewer system.
Norther Ditch Pump Station Pump Replacement	New Way at Mac Brae Road	Ohil River West	Capital Project	Complete	February-06	$1,300,000	The four existing pumps at the pump station were replaced with new 14,000 GPM submersible tubular casing pumps. The existing cast iron flap gates were replaced with flexible flap gates. These renovations of the pump station will greatly increase the station reliability and imprvoe the functioning of the Real Time Control System.
11th and Rowan Connections	11th Street and Rowan Street	Ohio River North	Capital Project	Complete	May-02	$192,000	The purpose of this project was to correct improperly connected property service connections tied to the storm sewer system near the intersection of 11tn Street and Rowan Street, and the sanitary services located at the 10th Street Flood Pumping Station.
Riverside Area Sewer Reconnection Porject	Area west of Beargrass Creek Pump Stationk, East of 2nd Street and Within the floodwall	Ohio River North	Capital Project	Complete	May-97	$150,000	When this area was redeveloped separate storm and sanitary sewers were provided. However, 27 commercial and residential properties were left connected to the storm sewer creating DWOs. These properties were successfully reconnected to the sewer and the DWOs were eliminated.

MSD

Louisville and Jefferson County
Metropolitan Sewer District



SECTION 9

SECTION 9: CURRENT OPERATIONAL PLAN

9.1 INTRODUCTION

The overall operations and maintenance program encompasses many facilities and staff, from the Operations Division to the Infrastructure and Flood Protection Division (I&FP) that exist as an integral part of the combined sewer system. Each of the facilities has protocols for proper operation and maintenance in accordance with the manufacturers recommendations. Within each operation and maintenance program there are components detailing the equipment and features of the facility, operating strategy, safety considerations and operating instructions and decisions. Many of the facilities have been evaluated to determine improvements that can be implemented to improve and optimize operations.

This section will outline completed operational changes, operational changes that are currently underway and a process forward to ensure proper operation and maintenance is integrated into future projects.

9.1.1 MSD Operations and Maintenance Divisions

The responsibility for operating and maintaining the facilities within the combined sewer system are distributed into the following areas:

- Collection system (I&FP),
- Overflow structures and flow regulators (I&FP),
- Flood Protection Pump stations (I&FP),
- Combined Sewer Pump Station and Combination Sanitary/Flood Protection Stations (Operations),
- Treatment facilities (Operations).

Pertinent items for each of the critical facilities are addressed within this section.

9.1.2 Infrastructure and Flood Protection Division

Infrastructure and Flood Protection has primary responsibility for operations and maintenance of the entire collection system (separate and combined), overflows and regulators. I&FP also operates and maintains the 16 flood pumping stations, several drainage pump stations, the floodwall and flood control levee system, and other drainage systems throughout Jefferson County. Some of the flood pump stations are dual-purpose, pumping combined sewage during normal conditions, and drainage pumping during flood conditions.

The I&FP Senior Manager has overall responsibility for collection system operation and maintenance activities. The I&FP staff includes 211 personnel in Administration and Support Services (including CCTV and CSO crews) for sewer, flood protection and drainage operations and maintenance. As part of their duties in operating and repairing the sanitary and combined sewer collection system including force mains, overflows and regulators, I&FP crews provide condition assessment, root cutting, sewer flushing and provide routine catch basin cleaning and other related maintenance services. I&FP crews also perform repairs and some replacements of failed pipes. The Area Teams under the direction of Chief Engineer manage the design, bidding and construction of major repairs, replacements and all capital projects.

MSD owns and operates a fleet of over 600 pieces (including 400 for I&FP) of heavy equipment and vehicles, including the following: backhoes; cranes of various types; excavators; portable pumps; sewer flush trucks and vacuum catch basin cleaners. Additional details about the means and practices of I&FP are provided in the NMC Compliance Report dated February 10, 2006.

9.1.3 Operations Division

The Operations Division has primary responsibility for operations and maintenance of treatment and pumping facilities. The 120 MGD Morris Forman Wastewater Treatment Plant (MFWTP) is the largest plant in the MSD system, and serves the entire combined sewer service area. MSD operates 24 additional wastewater treatment plants that provide service to separated sewer areas only. The Operations Division also operates and maintains approximately 275 sewage pump stations and other regional treatment facilities.

The Operations Division includes a total of 154 personnel. Of the total, 93 positions are assigned to the MFWTP. MSD's in-house laboratory is headquartered at the MFWTP, but is not a part of the Operations Division. Laboratory Services report independently through the Regulatory Management Services Division.

9.2 COMPLETED OPERATIONAL CHANGES

9.2.1 US Army Corps of Engineers (USACE) Flood Control System

MSD has completed several recent efforts to review and modify operational characteristics of the USACE flood protection system to reduce dry weather overflows and improve wet weather operations. When the flood protections system was developed in the 1940s to 1950s the only focus was to provide flood protection. Reviews of the system operations manual revealed opportunities to modify procedures to improve wet weather operations and reduce dry weather overflows at CSOs with relatively small negative impacts to flood protection. These efforts can be summarized as follows:

9.2.1.1 2002 USACE Flood Protection Pumping Station O&M Manual Revisions

The intent of this review of the USACE Flood Pumping Station O&M Manual was to identify operational modifications that would result in reduced frequency or volume of overflow, while at the same time reducing or at least not increasing the frequency or severity of neighborhood flooding. The following revisions to the O&M Manual were approved by the USACE in 2002 and were fully implemented at that time.

9.2.1.1.1 4th Street Flood Pumping Station

In 1994 the overflow dam on the 4th Street relief sewer was raised 2' to elevation 425.3. At that point the station is placed in plant idle and all flow is diverted to the Ohio River. Between 425.3 and 436.4 the pump station is in plant idle. At 436.3 flood pumping is initiated. The sanitary pumps are used to pump dry weather flow and flow during light rains to the Ohio River Interceptor. This modification resulted in the elimination of overflows when the Ohio River is below 425.3.

9.2.1.1.2 34th Street Flood Pumping Station

The 34th Street pump station pumps combined flow to the MFWTP below elevation 407.0. At that time the station is placed in plant idle mode until the river reaches 434.6, at which time flood pumping is initiated. The operating level of the 34th Street station was initially set to coincide with the treatment plant shut down when the Ohio River reached 407.0. For maximizing combined sewer flow to MFWTP, the controlling elevation should be the diversion dam in the 138" sewer in 34th Street. This dam is at elevation 421.00. The operating procedures for this pump station were modified so that the sanitary pumps remain in operation until the Ohio River reaches the top of the overflow dam for CSO 019.

9.2.1.1.3 Robert J. Starkey (formerly Buchanan) Pumping Plant

See Section 9.2.4 of this document for information related to the Starkey Pumping Plant.

9.2.1.2 Evaluation of Flood Pumping Stations

In August 2004, MSD completed an updated evaluation of the condition of the flood pumping stations. Most of the flood pumping stations, and their associated components, have been installed for 50 years or more. The project provided a condition assessment of mechanical, structural and electrical components for fourteen (14) of the sixteen (16) existing flood pump stations. Two stations were not evaluated because they were recently constructed. The scope of the assessment included an evaluation of condition based on station age, visual inspection of station components, operational concerns and maintenance history. The assessment included a review of structural site access, process mechanical, HVAC systems, electrical and instrumentation, control components and potential safety hazards. This information was then used to prioritize capital improvements, along with cost estimates for the rehabilitation or replacement of station components. The fourteen (14) existing flood pump stations included in this evaluation can be summarized as follows:

- Western Parkway Flood Pump Station,
- Lower Mill Creek Flood Pump Station,
- Upper Mill Creek Flood Pump Station,
- Pond Creek Flood Pump Station,
- Riverport Flood Pump Station,
- Beargrass Creek Flood Pump Station,
- 5th Street Flood Pump Station,
- 10th Street Flood Pump Station,
- 4th Street Flood Pump Station,
- 27th Street Flood Pump Station,
- 17th Street Flood Pump Station,
- Paddy's Run Flood Pump Station,
- 34th Street Flood Pump Station, and
- Shawnee Flood Pump Station.

9.2.2 Wheeler Avenue CSO/Flood Control Basin Project

The Wheeler Avenue area is in a shallow "bowl" at an elevation 2'-3' below the surrounding ground and is drained by a combined sewer to the Mill Creek Trunk Interceptor. When the Mill Creek Trunk is backed up, the flow from within the area has nowhere to go. The Mill Creek Trunk Interceptor is a (12'-8" wide by 19' tall) combined sewer located in Taylor Boulevard and receives the entire flow from the Wheeler Avenue area. The Mill Creek Trunk Interceptor then flows to the Southwestern Outfall and ultimately to the Southwestern Pump Station where the flow is sent to the MFWTP. During very large storms, the Mill Creek Trunk surcharged into the low lying area along Bicknell Avenue and its side streets. On August 8, 1992 the area along Bicknell Avenue and several side streets were flooded by a major storm event (3.84" of rain in 2.5 hours, an approximate 100-year storm). Following this flooding, MSD conducted a major study of the causes and potential solutions for the flooding problems that resulted in the implementation of the Wheeler Avenue CSO/Flood Control Project.

The objective of the Wheeler Avenue CSO/Flood Control Project was twofold: (1) to reduce the combined sewer overflows that occur at the Southwestern Pump Station (CSO 015) and (2) to reduce the occurrence of neighborhood flooding. This was accomplished by constructing a 4.9-MG flood control basin, constructing a 553,000-gallon CSO Basin inside the flood control basin, providing 1.1 MG of storage in the 78" combined sewer, regulating the rate of flow to the Mill Creek Trunk and preventing the Mill Creek Trunk from backing up into the area. This project was completed and became operational in May 1998.

9.2.3 Main Diversion Structure

The Main Diversion Structure (MDS) receives the base dry weather flows from the entire MFWTP area, except for flows pumped directly to the plant via the Rubbertown force main and flows pumped to the plant by the Southwestern Pump Station. The base flow from the Southern Outfall that reaches the MDS is directed to the Ohio River Interceptor (ORI) on the downstream side of the MDS, which conveys flow to the MFWTP. Excess flows beyond the capacity of the treatment plant overflow to the Ohio River through CSOs 015 and 211. To improve the reliability of the MDS flow control gates, a project replaced the main gate stems and actuators, and added a standby generator to power the gate actuators during electrical service interruptions.

Additionally, MSD wanted the flexibility to have the MFWTP receive as much flow as possible (up to the full MFWTP capacity) during wet weather. Calculations indicated that with the current piping configuration, the MDS could not deliver 350 MGD to the MFWTP. To provide treatment for the maximum flow quantity possible, a project was completed to raise the overflow level at the outfall of the MDS to elevation 422.0 in order to convey more flow through to the MFWTP. An inflatable gate was placed at the overflow from the MDS. The gate provides the ability to raise the water level to provide sufficient head to provide the 350 MGD flow rate to the MFWTP. The gate will reduce the annual overflow volume at this location. Operation of the gate will ultimately be incorporated into the Real Time Control effort for achieving in-line storage of wastewater. This project was completed and became operational in June 2003.

9.2.4 Robert J. Starkey Pumping Plant

The Robert J. Starkey Pumping Plant Project consists of upgrading the existing pump station capacity from 124 MGD to 140 MGD. It is estimated that this project will result in a reduction of approximately 70 MG to the average annual overflow volume (AAOV).

The upgraded pumping plant included the following:

- New wet well adjacent to the old wet well
- Four (4) new variable speed, submersible pumps capable of handling 35 MGD each
- Two (2) channel monsters with hydraulic motors for screening
- Hydraulically operated slide and sluice gates for control of flow through the pump station
- New electrical substation, which includes MCC's, VFD's, Control Panel, lighting panel
- New instrumentation and control, including provisions for future telemetry
- New HVAC which includes at least six (6) air changes per hour in the pump station building and at least twelve (12) air changes per hour in the wetwell

The pumping plant is both a sanitary sewer lift station and a flood pumping station. It is operated as a sanitary sewage lift station during normal river stage periods (below 423.6 on the upper river gauge). The pumping plant is the first lift station on the upper river that goes into flood pumping at upper river gauge 423.6 and is typically in flood pumping mode a minimum of 3 times per year. During normal river stages, the flow into the station is pumped into the Ohio River Interceptor and transported to the MFWTP. When flood-pumping mode is activated at the station, gates are closed in the outfall piping to prevent the Ohio River from backing up into the sewer system, and therefore preventing flooding. During wet weather conditions, excess water that cannot be conveyed to MFWTP is pumped to the Ohio River.

Following is a list of project milestones with actual completion dates.

- August 1998 - Design for the Robert J. Starkey Pumping Plant Modifications Project initiated.
- October 2001 - Design for the Robert J. Starkey Pumping Plant Modifications Project completed.
- February 2002 - Contract for construction awarded.
- April 2002 - Construction began.
- January 2005 - Construction Complete.

The existing pump plant remained operational during the construction of the new pump station.

9.2.5 Southwestern Pump Station (SWPS)

The SWPS receives its flow from the Southwestern Outfall. The incoming flow goes into the two wet wells and is pumped by four pumps into the Southwestern Branch Interceptor to the MFWTP. In the past, when the water level in the Southwestern Outfall reached the crest level of the diversion dam (elevation 400.0) located in the Outlet, an overflow occurred. This overflow was directed towards the Ohio River through the Sluice Gate Chamber (SGC) which prevented high river waters from flowing back into the sewer system. The SGC contains three isolation gates. Those gates normally stay open except when emergency river flooding procedures are in effect (i.e., when the Ohio River elevation reaches 400.0). They are re-opened if the river reaches an elevation of 417.0 for which no flood control is possible.

MSD has modified their SOP for this station to take advantage of the inline storage capacity within the SWO. These operational modifications can be summarized as follows:

- Ohio River Elevation Below 400.0 - The gates at the SGC are closed. The Operator monitors the SWPS when wet weather is forecast. This is to ensure that the screens remain in service and that the water level in the Southwestern Outfall is below 410 (instead of the previous elevation of 400). If the water level elevation in the Southwestern Outfall increases to 410 and is rising quickly, the Operator opens the SGC gates to prevent flooding. When the water level in the Southwestern Outfall returns to levels below elevation 410, the SGC gates will be closed and the screening systems are placed in MANUAL-CONTINUOUS run mode. The Operator monitors the screens to ensure that they remain in service. This modification takes advantage of storage within the SWO from elevation 400 to 410 that previously would have resulted in an overflow
- Ohio River Elevation Between 400.0 and 417.0 - If the SGC gates are not already closed, they are closed manually. Closing the SGC gates prevents Ohio River water from being pumped to the MFWTP if the River elevation is above elevation 400. SWPS operates in AUTO mode.

  The Operator monitors the SWPS when wet weather is forecast. This is to ensure that the screens remain in service and that the level in the Southwestern Outfall remains below 410. If the wastewater elevation in the Southwestern Outfall increases to 410 and is rising quickly, the Operator opens the SGC gates (manual) and shuts down the dry pit centrifugal pumps, screens and conveyors. The Operator also opens the inlet overflow sluice gate and close both the East and West inlet sluice gates. The SWPS will remain in this condition until the level in the Southwestern Outfall drops below 410.0, at which time the SGC gates are closed and the pumps and other equipment put back in service. The East and West inlet sluice gates are slowly opened and the screening systems are placed in MANUAL-CONTINUOUS run mode. The Operator monitors the screens to ensure that they remain in service. Again this mode of operation allows the station to operate and reduce overflows between elevations of 400 and 410 in the SWO, where in the past all flow would have been sent to the Ohio River at elevations of 400 and above.
- Ohio River Elevation Above 417.0 - The SWPS is not staffed and is taken out of service to prevent flooding of the pump station (pumps, screens, and conveyors shut down). The inlet overflow gate and the SGC gates are opened before both the East and West inlet sluice gates are closed. Paddy's Run Flood Pumping Station (downstream of SWPS) is placed in operation when the Ohio River elevation reaches elevation 431.33 on the lower gauge. This mode of operation has remained unchanged to protect the area from flooding and to protect MSD's assets.

These interim operational modifications will remain in effect until Phase I of the RTC Program becomes fully operational. Phase I of the RTC program is scheduled to become operational in August 2006.

9.3 OPERATIONAL CHANGES CURRENTLY UNDERWAY

9.3.1 Flood Pump Station and Flood Control Gate Operational Evaluation

MSD has responsibility for the operation and maintenance of an extensive flood protection system that was developed by the USACE in the 1950s. A significant portion of this flood protection system, 16 flood pump stations (FPSs) and 162 flood control gates (FCGs), are

associated with MSD's combined sewer system (CSS). Therefore, the flood protection system and the CSS operate in an integrated manner when the flood protection system is activated as a result of elevated river levels. When the USACE developed the flood protection system, the focus was to protect the community from flood damage. Through the development of MSD's CSO Abatement Program, specific opportunities have been identified where modifications in the original procedures outlined in the USACE Manual can be implemented to reduce overflows from the CSS and still maintain the integrity of the level of flood protection provided by the system. This process led to a 2002 revision to the USACE O&M Manual for several locations and led to the development of the first phase of reviews for the flood protection system as it relates to the operation of the CSS. The objectives of this project can be summarized as follows:

- Minimize or eliminate dry weather overflows at 3 selected FPSs and their associated FCGs that are operated in conjunction with the CSS for both normal and elevated river levels.
- Optimize flow from the CSS to the MFWTP during wet weather events for both normal and elevated river levels.
- Propose modifications to the USACE Flood Control Manual based upon the results of this project and attempt to secure approval from the Louisville District USACE.

This evaluation will evaluate the following flood pump stations and their associated flood control gates for potential operational modifications to reduce overflows at CSOs:

- 4th Street Flood Pump Station and 17 FCGs,
- 27th Street Flood Pump Station and 12 FCGs, and
- 34th Street Flood Pump Station and 20 FCGs.

Recommendations resulting from this project are currently scheduled to be submitted to the USACE by September 30, 2006.

9.3.2 Real Time Control (RTC) Phase I Implementation Project

Real Time Control (RTC) is a program that is a foundation for the CSO LTCP. It represents a major initiative for MSD to use advance technology to effectively store combined sewer flow in existing pipes for treatment at MFWTP. Operationally, the RTC program will require considerable personnel. The summary below provides an overview of the many operational changes that are currently underway to properly control the system.

The initial phase of the RTC project consists of remotely controlling five sites by means of a centralized decision making system. The objectives of this system are a better use of the existing in-line storage capacity, a decrease of CSO volumes in the Beargrass Creek and Ohio River Watersheds, and an increase of the wastewater volume conveyed to the MFWTP. The RTC approach is both global and predictive, which means that the decision making system will use available information monitored on the sewer network, and predicted by the Radar Rainfall Data System, to determine the best flow management strategy.

The present project is a first phase implementation, since remote control and operation is only deployed over a selected number of control points. The five facilities involved in this project are:

- Southeastern Diversion Structure,
- Nightingale Pump Station,
- Southwestern Pump Station,

- Upper Dry Run Trunk Storage Facilities, and
- Snead's Branch Relief In-Line Storage.

The initial RTC implementation project also relies on telemetry from the following locations:

- Northern Ditch Pump Station - The pumped flow (pump status), wet well conditions, and available capacity relative to the operation of the Southeastern Diversion Structure (SED) will be telemetered.
- Southwestern Pump Station - The pumped flow (pump status), wet well conditions, and available capacity relative to the operation of the gates of the Sluice Gate Chamber and at the Upper Dry Run Trunk Storage Facility will be telemetered.
- Robert J. Starkey Pumping Plant and CSO 020 - The pumped flow (pump status), wet well conditions, and pumping and overflow status relative to the operation of the Snead's Branch In-Line Storage will be telemetered.
- Existing Rain Gauge Network - The rainfall measurements in the MSD service area will be telemetered.

Table 9-1 below defines the average annual overflow volume (AAOV) reduction that results with the implementation of the initial RTC project:

TABLE 9-1

RTC ANNUAL OVERFLOW VOLUME REDUCTION - PHASE I

Region	Predicted Annual Overflow Volume Reduction (MG/YR)
Region 1	63.6
Region 2	0
Region 3	421.4
Total	485

The range of Annual Overflow Volume Reduction shown within the Ohio River West Region is based upon the amount of flow that is diverted from the Beargrass Creek Region to the Ohio River West Region, and is dependent upon the storm event. Phase I of RTC is currently in startup and testing and is scheduled for completion in August 2006. At that time Phase I will be operational

9.3.2.1 Southeastern Diversion Structure

The Southeastern Diversion (SED) is located in the upstream part of the Beargrass Creek Region at the head of the Beargrass Interceptor (BGI). The Southeastern Diversion and Southeastern Interceptor (SEI) were added at the junction of the Buechel Branch and the Hikes Point Interceptor. The 33" Buechel Branch and the 30" Hikes Point Interceptors discharge into the 33" BGI, which constitutes a system flow constriction on the BGI that required some relief. Both interceptors convey flow from sanitary sewers that have increased flows during wet weather.

The two outlets at the SED are currently equipped with manual gates and are manually operated. The BGI gate is left open for all conditions and the SEI gate is opened by only 4" during normal dry weather conditions. During dry weather, the flow is directed toward the BGI

gate by a weir within the diversion chamber. However, during peak dry weather flow, the wastewater level in the SED chamber exceeds the weir elevation and a fraction of the incoming flow is diverted into the SEI. During smaller wet weather events, as the level rises, part of the flow is diverted to the SEI through the SEI gate. This wastewater is eventually pumped by the Northern Ditch Pumping Station (NDPS). If inflow exceeds the hydraulic capacity of the two outlets, excess is overflowed into the Beargrass Creek at a SSO located downstream of the BGI gate.

When significant wet weather events occur, the operating staff responds to close the SEI gate in order to protect the homes downstream and the Northern Ditch PS. The standard procedure is to completely close the gate when two out of the three pumps at the Northern Ditch PS have been running for some time. During the past years, the gate has been closed a few times a year.

As part of RTC project, the role of the SED local control station consists of diverting more flows from the Beargrass Creek Region (i.e. the Hikes Point and Buechel Branches) to Ohio River West Region (i.e. the Southeastern Interceptor) during rainfall events. The concept is to utilize the Northern Ditch Pump Station at its maximum capacity before generating any overflows in the Beargrass Interceptor downstream of the SED (namely CSOs 097, 110, 151, 152). Due to the flow travel time between the Southeastern Diversion Structure and the Northern Ditch Pump Station and the inflows located along the SEI, only a predictive model-based control strategy based on predicted rainfall information can enable a reliable management of the SED. The Northern Ditch PS is a critical point downstream of the SED because of the sewer backups and flooding risks just upstream of this facility. Conversely, the Northern Ditch PS can receive more flow than at present during frequent wet weather events if properly managed. Taking advantage of this capacity while maintaining a comfortable level of security is the core of the operating strategy of the SED. Actuators, instrumentation and automation equipment permit remote operation and provide a better use of the available pumping capacity of the Northern Ditch PS. Figure 9-1 presents the physical configuration of the SED.

Four level sensors were installed: two in the gate chamber; one downstream of the BGI gate and one downstream of the SEI gate. These level sensors are used for flow computation under the two control gates. The two upstream sensors are used for high level alarms, for overflow computation and for the control of the BGI gate.

Two flow meters were also installed: one in the Hikes Point Branch, the other in the Buechel Branch. These two flow meters are used to calibrate the hydraulic model defined in the optimization program and to determine the control strategy to apply during communication breakdowns lasting more than one hour. Under supervisory and manual control, the flow rates provided by the two flowmeters can also be used by the operator to define flow set points or gates openings. The two existing gates controlling the flows through the Beargrass Interceptor and through the SEI were replaced by flow control gates. Specifically, the SEI gate was replaced by a smaller gate for better flow control.

The global predictive real time control program controls the operation of the gate installed on the BGI and the gate installed on the SEI. During normal dry weather conditions, the main control objective is to convey flow through the BGI (i.e. the natural path of the flow). To accomplish this goal, the BGI gate remains fully opened and the SEI gate is opened 4". No flow is therefore transferred to the SEI during dry weather, except if the level reaches the elevation of the weir.

During normal wet weather conditions, the control objective is to convey as much wastewater as possible into the BGI without creating overflows downstream of the BGI control gate and to send

the excess flow to the NDPS via the SEI. During significant rainfall events, when the flow rate in the SEI approaches the NDPS maximum pumping capacity, the gate control strategy favors overflows at permitted CSOs downstream on the BGI.

9.3.2.2 Nightingale Pump Station

The Nightingale PS (NPS) is located upstream in the Beargrass Creek Region. This pump station is designed to relieve the flow in the BGI and pump the flow collected in the BGIR. The NPS and the Beargrass Interceptor Relief (BGIR) were constructed in the early 1960s. The BGIR parallels the existing BGI with three relief points from the BGI to the BGIR. At the downstream end of the BGIR, the NPS conveys the flows from the BGIR and flows diverted from the BGI to the Southwestern Outfall basin in the Ohio River West Region. The BGIR does not have any overflow points along its entire length, the only overflow is CSO 18 located at the influent structure to the NPS where flows from the BGIR and diverted flows from the BGI merge and flow into the NPS. Both the BGIR and the NPS have been used continuously since their implementation.

The implementation of a control gate in the BGI near the NPS, allows additional flow diversion from the BGI to the NPS. The control gate at the NPS, manages flow from the BGI and an 18" sanitary collector. These incoming flows continue through the gate chamber into the BGI and towards the Robert J. Starkey Pumping Plant. When the level in the gate chamber reaches the weir, a portion of the flow is diverted to the NPS via two 24" pipes. The NPS pumps the flow from the BGI and flow from the BGIR into the Dry Run Interceptor. When the incoming flow at the NPS exceeds its maximum pumping capacity, the level in the BGIR rises and, eventually, an overflow occurs at CSO 018.

As part of Phase I of the RTC project, the NPS control site plays a role similar to that of the Southeastern Diversion. The control objective is to divert, during rainfall events, a portion of the flow from the Beargrass Creek Region to the Ohio River West Region and to use the NPS to its maximum capacity before creating overflows into Beargrass Creek downstream of the NPS (namely CSOs 137, 106, 097, 110). Global control of this site will result in a reduction in CSO volume and frequency during wet weather events. Achieving this goal depends on the pumping capacity of the Robert J. Starkey Pumping Plant (Beargrass Creek Region) and the Southwestern Pump Station (Ohio River West Region). The control strategy will take into account the available capacity of these two pumping stations in order to divert flow between the two regions and to achieve maximum levels of treatment at the MFWTP.

Actuators, instrumentation and automation equipment were installed in a chamber on the BGI to enable remote operation and provide control of diverted flows to the BGIR and the NPS. Figure 9-2 presents the physical configuration of the Nightingale control site.

Three level sensors were installed. Two in the gate chamber, one downstream of the BGI gate. These level sensors are used for flow computation under the control gate. Moreover, the two upstream sensors are used for high level alarm in the gate chamber and for flow computation over the weir. A fourth, but existing level sensor is used in the RTC strategy. This sensor is installed in the wet well of the NPS and provides information about the wastewater elevation in the wet well.

A flow meter was installed in the BGI just upstream of the gate chamber. This flowmeter is used to calibrate the hydraulic model defined in the optimization program and to determine the control strategy to apply during communication breakdowns lasting more than one hour. Under

supervisory and manual control, the flow rates provided by the flowmeter can also be used by the operator to define flow set points or gates opening.

The existing gate and actuator at the outlet of the gate chamber were replaced to meet RTC requirements. They are used to control the flow conveyed to the Robert J. Starkey Pumping Plant and provide the number of gate movements and the gate displacement speed required for good performance.

The GORTC program controls the operation of the gate installed on the BGI. There is no need to globally control or modify the operation of the pumps and the gate controlling the inflow into the NPS.

During normal dry weather conditions, the main control objective is to convey all flow to the Robert J. Starkey Pumping Plant. To accomplish this goal, the control gate will remain fully opened. No flow should be transferred to the NPS during dry weather.

During normal wet weather conditions, the control objective is to convey as much wastewater as possible into the Beargrass Interceptor without creating an overflow downstream of the control gate and to send the excess flow to the NPS. During large rainfall events, when the flow rate in BGIR reaches the NPS's maximum pumping capacity, the gate control strategy favors overflows downstream in the Beargrass Interceptor Relief rather than overflows at the NPS. The control strategy makes a better use of the NPS pumping capacity, thus reducing the overflows in the BGI. Moreover, the strategy does not create more overflows at the NPS than before the implementation of the GORTC system.

9.3.2.3 Southwestern Pumping Station

The Southwestern Pump Station (SWPS) is located downstream of a large combined sewer in the Ohio River West Region, the Southwestern Outfall (SWO). This outlet, with a significant in-system storage capacity, can be readily available considering the use of facilities at the Sluice Gate Chamber (SCG) to restrict overflow to the Ohio River.

The SWPS receives its flow from the SWO. The incoming flow goes into two wet wells (West and East) to be pumped by 4 pumps (2 per well) into the Southwestern Branch Interceptor to the MFWTP. When the flow in the SWO reaches the crest level of the diversion dam located in the Outlet, an overflow occurs. This overflow is directed towards the Ohio River through the Sluice Gate Chamber (SGC) which prevents high river waters from flowing back into the sewer system. The SGC contains three isolation gates. Those gates normally stay open except when emergency river flooding procedures are in effect (i.e., when the Ohio River elevation reaches 400.0). They are re-opened if the river reaches an elevation of 417.0.

The RTC control strategy consists of using the gates at the SGC to restrict flow and temporally store the incoming flow in excess to the SWPS capacity along the SWO up to a higher elevation. A comfortable level of security and actuator capability will influence the maximum allowable level and in-line storage capacity.

Actuators, instrumentation and automation equipment were replaced or added at the SGC to enable remote operation and provide control of in-line storage capacity in the SWO. Figure 9-3 presents the physical configuration of the Southwestern Pump Station control site.

Three new level sensors were installed: one in the SGC, upstream of the gates, one in the SGC, downstream of the gates and one upstream of the diversion dam. The three level sensors located at the SGC are used for computing flow under the gates and for the detection of high

levels upstream and downstream of the SGC. The fourth level sensor proposed is used along the level upstream of the SGC for the computation of the wastewater volume accumulated in the SWO. Only the level located upstream of the diversion dam can be used for volume computation when the level in the SWO is below the level of the diversion dam crest. The SWPS is also equipped with two level sensors located in the pumping station wet wells. These two level sensors are already in place but they are not directly used in the RTC scheme, and are used to monitor the level in the East and West wet wells.

Actuators for each of the three gates have been replaced. The actuators now have the capability to move the gates under significant head. Therefore, the gates can operate at river levels between 400.0 and 417.0 to minimize overflows.

Under normal condition (no river flooding status), the gates in the SGC are to be used by the RTC system for level control into the SWO. This elevation will vary depending on system capability and security level. Only the middle gate will modulate and the two outside gates will stay closed in normal conditions. In case of failure, high level or when there is a pumping station problem, the RTC system will fully open the gates and inform operators of the situation.

Five other existing gates are also part of the SWPS control site. Two of these gates are located at the entrance of the pumping station. They are used to control the level in the East and the West wet wells. The control of these gates does not need to be remotely controlled under GORTC. However, they have to be properly modulated and locally controlled to maintain maximum levels and protect against flooding the wet wells. This is especially important since under GORTC, the level in the SWO could be maintained to a higher level than would normally occur during rainfall events. The other three gates are used to isolate the two wet wells and to bypass the pumping station during a shut down.

The GORTC program controls the operation of the gates located in the SGC. The control scheme developed does not integrate the need to globally control the operation of the pumps and the gate controlling the flow into the SWPS.

During normal dry weather conditions, the two outside gates in the SGC are kept closed and the middle gate is opened at 50%. This prevents any risk of flooding during a dry period that could be caused by mechanical or electrical breakdowns at the pumping station. No overflow should occur since during dry weather, the level in the SWO is below the crest of the Diversion Dam.

During normal wet weather conditions, the control objective is to use the SWO as a detention facility in order to reduce overflows into the Ohio River. Currently, overflows occur each time the level in the Southwestern Outfall exceeds 400 (i.e., the elevation of the Diversion Dam). After the implementation of the GORTC system, overflows will occur, in the normal wet weather operating mode only when the level will exceed the level set point. This set point is defined in Csoft and is configurable by the system engineer.

To reach the desired control objective during wet weather conditions, the sluice gate located at the SGC will be modulated to maintain a level set point in the SWO.

The control strategy translates into a permanently closed control gate for small storm events and at the beginning and at the end of major storms. Once the elevation upstream of the control gate approaches the level set point, the middle gate gradually opens to maintain the desired level and prevent any overflows at CSO 191. During the dewatering period, the control gate gradually closes to maintain the level set point. This will minimize the overflow into the Ohio River from CSO 015.

9.3.2.4 Upper Dry Run Trunk Storage Facilities

The Brady Lake and Executive Inn Basins comprise the Upper Dry Run Trunk Storage Facilities and are part of Ohio River West Region. The Executive Inn Basin and the Brady Lake Basin will have a retention capacity of 15.75 MG and 17.25 MG respectively for a total of 33.0 MG. During the design and development of this project, analysis determined that 19 MG would be needed for flood control to mitigate the flooding produced by the August 8, 1992 storm (approximately a 100-year storm event). Consequently, there is an available storage capacity of 13.9 MG that can be used for CSO control.

The basins fulfill two needs: flooding protection and CSO control. The control scheme has to adjust itself to the current priority depending on the magnitude of wet weather events and flows. Also, both outlets of the basins have to be controlled. Essentially, the control strategy consists of minimizing overflows until hydraulic conditions in the basins reach threshold levels. Once attained, the control strategy converts its priority from overflow control to flooding protection and if possible, the gates will modulate to maintain these levels or fully open when the levels cannot be maintained.

The control devices and sensors at the Brady Lake and Executive Inn Basin control sites use three control gates to allow for storage of flows in the basins and the control of their dewatering: one located at the Executive Inn Basin outlet, the other two at the outlet of the Brady Lake Basin. Figure 9-4 presents the physical configuration of the Brady Lake and Executive Inn Basins control sites.

Five level sensors were installed for implementation. Among these sensors, four are installed in the basins, two in the Executive Inn and two in the Brady Lake. These sensors will be used for several applications including the assessment of the accumulated volumes, the computation of flow rates under the controlled gates and the control of the gates. The other level sensor is installed downstream of the Executive Inn Basin gate for flow assessment when the gate is submerged.

The level in the Executive Inn Basin is controlled by a single 24" by 24" gate located at the outfall of the basin. This gate has an actuator that will allow modulation of the gate for flow or level control. The Brady Lake Basin is equipped with two 24" by 24" control gates at the outlet of the basin. Both gates are controlled by actuators that will allow the modulation of the gates for flow or level control.

The GORTC scheme controls the operation of the two gates located at the outfall of the Brady Lake Basin and the gate located at the outfall of the Executive Inn Basin. During normal dry weather conditions, the objective is to keep the basins dry to have a maximum storage capacity available for incoming rainfall events. To achieve this objective, the three gates are kept fully opened.

During normal wet weather conditions and aside from flood control, the control objective is to convey as much flow as possible to the SWPS without creating overflows downstream at CSO 015. When it is not possible to convey flows to the SWPS, the gates close and flows are accumulated in the two basins. To decide whether or not flows can be conveyed to the Upper Dry Run Trunk without creating downstream overflows, the GORTC scheme takes into account parameters such as the predicted flows and levels along the Upper Dry Run Trunk and the SWO, the flow rates predicted at the SWPS, the maximum pumping capacity of the SWPS and the flow and level constraints existing between the Brady Lake basin and the SWPS.

9.3.2.5 Snead's Branch Relief In-line Storage

The Snead's Branch Relief In-line Storage (SBR-ILS) control site is located in the Beargrass Creek Region at the outfall of the Snead's Branch Relief Drain (SBRD). The SBRD receives overflows from eleven tributary CSOs located along the Snead's Branch Sewer. Volume is detained in the SBRD using an inflatable gate located approximately 200' from the outlet of the SBRD to the South Fork of Beargrass Creek and pumped back into the BGI. The objective is to store the wastewater exceeding the capacity of the Snead's Branch Sewer into the SBRD up to its maximum storage capacity (2.5 MG) before creating an overflow.

The local control strategy works as follows:

- In dry weather conditions and at the start of a rainfall event, the inflatable gate is at its rest position (half inflated) and the pumps are off; and
- In wet weather and when upstream overflows are occurring, the level rises in the SBRD and the pumps are turned on if no overflow is detected at CSO 020 (a CSO point located upstream of the Robert J. Starkey Pumping Plant). If CSO 020 overflows, the pumps are turned off.

In wet weather and when the level is between 435 and 443 in the SBRD, the gate is fully inflated. Between 442 and 443, the gate is modulated to maintain a level of 442. During these periods, overflow occurs at the Snead's Branch site. If the level exceeds 443, an alarm signals the gate to deflate to prevent sewer backups at the tributary CSOs and especially at CSO 174 (overflow elevation of 445). If the level measured downstream of the gate indicates the creek level could overtop the gate, a signal is sent to inflate the gate in order to prevent the facility from pumping creek water into the BGI.

The RTC control strategy optimally manages the pumps to dewater the Snead's Branch Relief Sewer Drain. This minimizes the dewatering time of the relief sewer and maximizes the storage capacity available for an upcoming rainfall event. The strategy pumps as the maximum flow possible into the BGI with the constraints that no additional overflows are generated downstream, especially at CSO 020. As with the SED and the NPS, the dewatering of the SBRD can only be effectively controlled using a global and predictive management scheme. In fact, without meteorological forecasts and a sewer model to predict flow rates and levels along the BGI, there is always a risk of creating downstream CSOs by pumping too much flow into the BGI.

Figure 9-5 presents the physical configuration of the Snead's Branch control site. The control devices and sensors at the Snead's Branch control site stores overflows in the SBRD up to its maximum storage capacity and optimally controls its dewatering using centrifugal pumps. The existing two level sensors located upstream of the inflatable gate are used locally for gate control and at the central station to estimate the volume detained in the SBRD. The level sensor located downstream of the inflatable gate is used to prevent backflows into the SBRD when the level of the creek is high. The fourth level meter already in operation and located in the BGI not far from CSO 020 is used in the RTC strategy for pump control. Specifically, this sensor defines a RTC alarm when an overflow is detected at CSO 020.

The GORTC scheme controls the operation of the two centrifugal pumps installed just upstream of the inflatable gate. The control scheme developed does not require the need to globally control the inflatable gate. The gate remains locally operated using the rules described above.

During normal dry weather conditions, the objective is to maintain a dry SBRD in order to have a maximum storage capacity available for incoming rainfall events. To achieve this objective, the

pumps are turned on if the level in the SBRD is greater than 431, and turned off when the SBRD is emptied.

During normal wet weather conditions, the control objective is to convey as much flow as possible into the BGI without creating overflows. During large rainfall events, when it is not possible to pump flows from the SBRD without creating overflows in the BGI, the pumps are turned off. Flows accumulate in the SBRD according to the local control rules defined for the inflatable gates. To decide whether or not flows can be pumped into the BGI, the GORTC scheme takes into account parameters such as the predicted flows and levels along the BGI according to the SWMM model, the flow rates predicted at the Robert J. Starkey Pumping Plant by the SWMM model, the maximum pumping capacity of the Robert J. Starkey Pumping Plant and the flow and level constraints existing between the Snead's Branch Pump Station and the Starkey Pumping Plant.

The station operates in a mode to achieve the objectives pursued during normal wet weather conditions. Typically, pumps will be turned on at the beginning and end of rainfall events, and turned off during peak flow periods. For rainfalls having a return period of less than 6 months, no overflow should occur into Beargrass Creek from the inflatable gate. However, for major storms with a return frequency of more than 6 months, the SBRD is used to its maximum capacity and overflows are likely to occur.

9.3.2.6 RTC Operation and Maintenance

A critical factor in the success of the RTC Program will be the operation and maintenance of the various instrumentation and controls associated with each of the sites. To ensure that proper O&M is conducted for the various components of the RTC system, MSD has prepared a detailed analysis of the O&M requirements for each of the control sites comprising Phase I of RTC. Table 9-2 provides an example of this O&M analysis and outlines specific information for each instrument, actuator, control gate, PLC and communication device.

9.3.3 MFWTP Wet Weather Operations

The MFWTP provides treatment for the portion of the MSD sewer system that contains all of the combined sewers and a portion of the sanitary sewers. During wet weather events the flow in the MFWTP basin can far exceed the capacity of the plant, so flow is controlled through permitted CSOs at the SWPS (including CSO 015) and at the Main Diversion Structure (including CSO 211). The amount of flow accepted into the MFWTP during wet weather events is calculated by the plant's operation staff based on the number of treatment units in service at the time of the wet weather event.

As part of MSD's Wet Weather Abatement Program and in cooperation with the Kentucky Environmental and Public Protection Cabinet, Department for Environmental Protection's Division of Water (DOW), MSD has committed to an instantaneous peak of 350 MGD, with a sustained capacity of 325 MGD, of flow into the MFWTP during wet weather events. To accommodate 350 MGD a number of construction projects needed to be implemented. These projects and their associated cost are presented in detail in Section 4 of this report.

With the completion of these projects, the MFWTP has the capacity to consistently accept 140 MGD through the secondary system, if all treatment units are available. The secondary capacity, along with the secondary bypass capacity of 210 MGD, will allow the MFWTP to

accept a peak flow of 350 MGD during wet weather events, with a sustainable capacity of 325 MGD.

Table 9-3 summarizes the capacity of each treatment unit at the MFWTP and provides a calculator for determining the flow that can be accepted into the plant based on the treatment units on line at the time of the high flow event. The computer operators at the plant will perform this calculation at 6:00 AM, 2:00 PM and 10:00 PM on days where storm flow is expected and limit the influent flow to the plant at the calculated level. The operations supervisor will be notified and the flow will be regulated accordingly. Each calculated sheet will be archived for future reference.

In the example shown below, the secondary flow to the plant will be limited to 140 MGD, the maximum level that is ever accepted in to the secondary system and the overall plant flow will be limited to 310 MGD based on the capacity of the primary sedimentation basins.

TABLE 9-3

MFWTP CAPACITY CALCULATOR (EXAMPLE)

Process Area	Number of Units (A)	Capacity per Unit (MGD) (B)	Number of Units Available (C)	Current Capacity (MGD) (BxC)
New Headworks				
a.) Bar Screens	4	50	4	200
b.) Grit Systems	4	50	4	200
Old Headworks				
a.) Bar Screens	3	84	2	168
b.) Grit Systems	3	84	2	168
Total Headwork Capacity				
a.) Bar Screens				**368**
b.) Grit Systems				**368**
Primary Sedimentation Basins				
a.) DOB > 5'	4	70	2	140
b.) DOB = 3'-5'	4	80	1	80
c.) DOB < 3'	4	90	1	90
Total Primary Sedimentation				**310**
Secondary Treatment				
a.) Clarifiers (DOB < 3')	20	10	16	160
b.) Secondary Bypass	1	210	1	210
Total Secondary (a+b)				**370**
Chlorination/Dechlorination				
a.) CL Residual = 0.3 mg/l	**2**	**137.5**	**0**	**0**
b.) CL Residual = 0.5 mg/l	**2**	**175**	**2**	**350**
Total Chlorination/Dechlorination				**350**
FEPS	**4**	**120**	**4**	**480**

During Phase II of RTC, MFWTP will be incorporated into the global predictive RTC program and the main RTC system will control flows within the system and the throughput at MFWTP to maximize the amount of wastewater processed in order to minimize CSOs.

9.4 PROCESS FOR UPDATING OPERATIONAL PLAN

9.4.1 Introduction

This section discusses plans for developing and modifying guidelines for operation and maintenance of the combined sewer system per guidelines provided in EPA's CSO Control Policy. The goal of this control is to ensure proper operation and maintenance of the sewer system and related facilities and compliance with KPDES-related requirements to reduce the frequency, magnitude, and duration of CSOs. CSO Policy guidelines on system operation include the following activities:

- Identify a manager responsible for operations and maintenance of the collection system and the treatment system,
- Inspect and maintain the collection system to prevent solids deposition or obstructions which could lead to wet or dry weather overflows,
- Inspect and maintain CSO structures/regulators, pumping stations, and treatment facilities to minimize untreated discharges,
- Provide alternate or standby power sources for operation of pump stations and treatment facilities,
- Comply with operator certification regulations, and
- Maintain a system of user charges sufficient for operations, maintenance, renewal and capital replacement for the collection and treatment system.

Operational plans for the projects listed in Table 11-2 and other projects that are identified for completion prior to December 31, 2008, will be updated as part of the design scope of services using above outline. The design team will work with MSD I&FP and Operations personnel to prepare a written Standard Operating Procedures (SOP) manual which will contain information necessary to properly operate and maintain the facility. Once complete, these SOP manuals will be scanned and made available through MSDs HANSEN system. For those projects that are improvement or replacement projects, the existing SOP manual will be updated.

9.4.2 Certification and Training

The MFWTP operates under the direction of a certified Class IV Wastewater Operator who is responsible for compliance with the KPDES permit and is responsible for submitting the monthly Discharge Monitoring Reports (DMRs). Many of the other MFWTP operators hold certifications at various levels. MSD's Human Resources department tracks operator certifications and maintains a training CEU data base for the purpose of maintaining and upgrading operator certification. Operations staff are trained and tested on various job duties as requirements for promotion. MFWTP Operations staff are trained and tested to become qualified for various unit process areas. Factors in determining promotions include certification level, unit process qualifications, and other general skill training and testing.

I&FP operates under an internal certification program to support promotions through the ranks of utility worker. Utility Worker 1 is the entry level position. Utility Worker 2 and 3 are higher

level positions that staff become eligible for after they are trained and demonstrate competence in specific areas such as operation of specific items of heavy equipment. HR tracks each Utility Workers progression in training to determine eligibility for promotion.

Both I&FP and Operations Division staff receive general safety training. Based on job classification and duties they may also be trained in emergency response, confined-space entry, road and traffic safety, etc. Records of this program are maintained by HR. On-the-job training is also completed as needed for new staff and procedures.

In addition, Operations staff are provided with manufacturer training as a standard part of the contractual requirement for purchase and installation of major equipment. Vendor-supplied O&M manuals are also provided for new equipment to supplement the overall facility O&M manual and standard operating procedures. Facility and equipment O&M manuals are maintained at the appropriate work stations and in a central location for reference.

9.4.3 Maintenance Scheduling and Tracking

MSD schedules and tracks maintenance activities through electronic work order systems. Work orders may be classified as predictive, preventive, corrective, or emergency. Predictive maintenance programs are under development but not widely implemented at this time.

I&FP initiates and tracks work orders through the HANSEN (computerized asset management system) that provides linkages to the LOJIC GIS database. LOJIC maintains a database on MSD's inventory of underground and fixed assets, including the collection system, overflows, regulators, pump stations and treatment facilities. The ability to access and track activities through detailed GIS maps of the collection system is a powerful tool that's used routinely. The Operations Division initiates and tracks work orders and associated costs through the SAP financial management program. Since the Operations Division deals with fixed assets in specific locations, the LOJIC GIS linkage is not as critical, and the direct link to the SAP financial management system is more useful. MSD is in the process of developing reporting tools that can poll both databases and produce combined reports when needed.

9.4.4 Staffing

The Operations Division staffs 24-hour operations at the MFWTP. Other facilities are staffed either one or two shifts per day, depending on facility size and complexity. MSD's 5 regional treatment plants serve as operations centers for associated geographies during hours when they are staffed. MSD's SCADA system monitors alarms at facilities. Alarm responses for unstaffed facilities are coordinated from the MFWTP central computer room. Portable generators, portable pumps and other standby and backup equipment is available to the staff in cases of system failure.

I&FP operates on a day shift basis, with staff on-call during off hours to respond to emergency conditions.

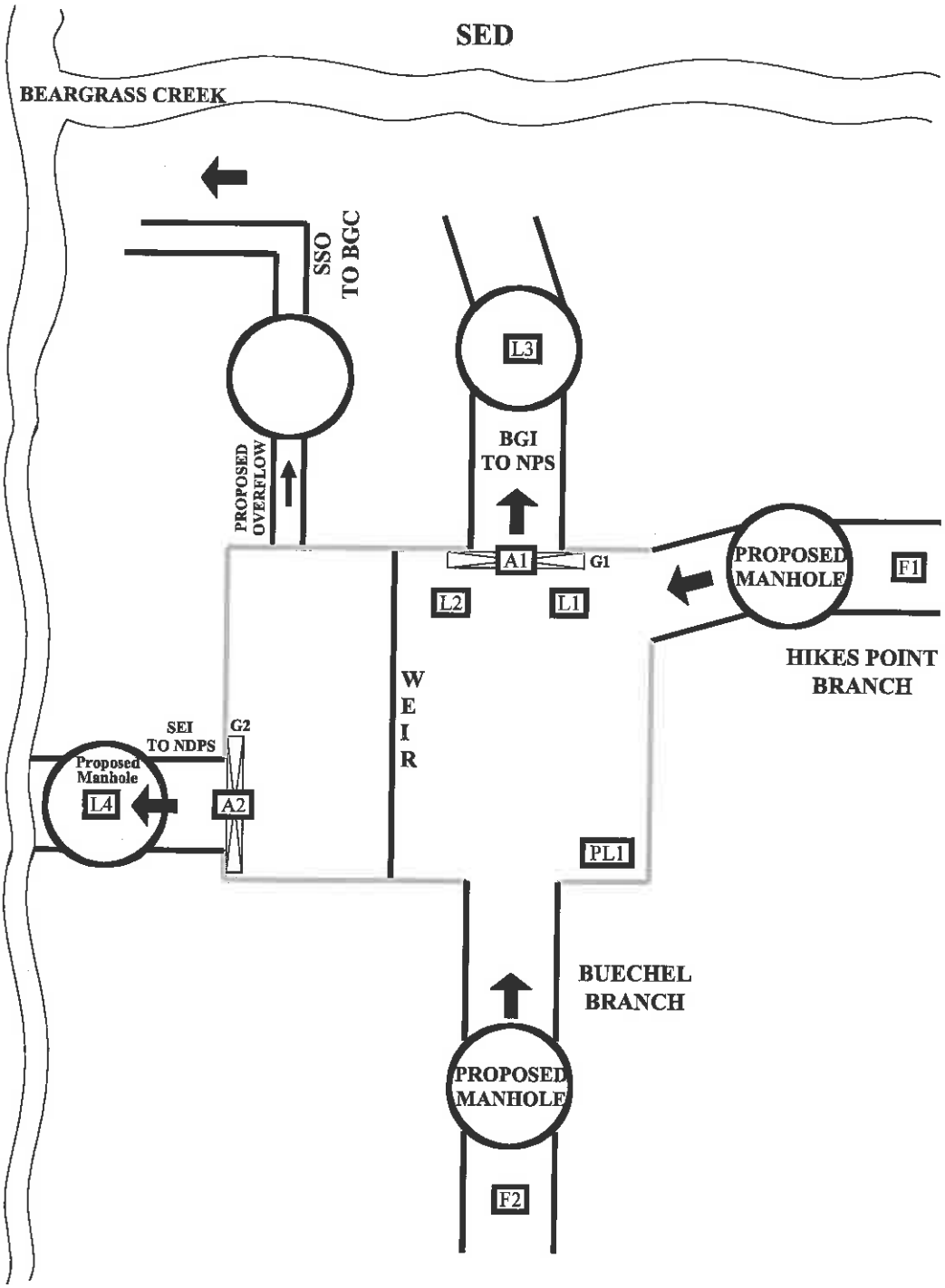
9.4.5 Budgets and Funding

MSD currently has over 600 approved staff positions and is governed by an 8-member Board that approves budgets, rates, policies and initiatives. Board members are appointed by the Mayor and serve 3-year overlapping terms. Daily operations of MSD are managed by the Executive Director.

TABLE 9-2
RTC INSTRUMENTATION AND CONTROL EQUIPMENT O&M

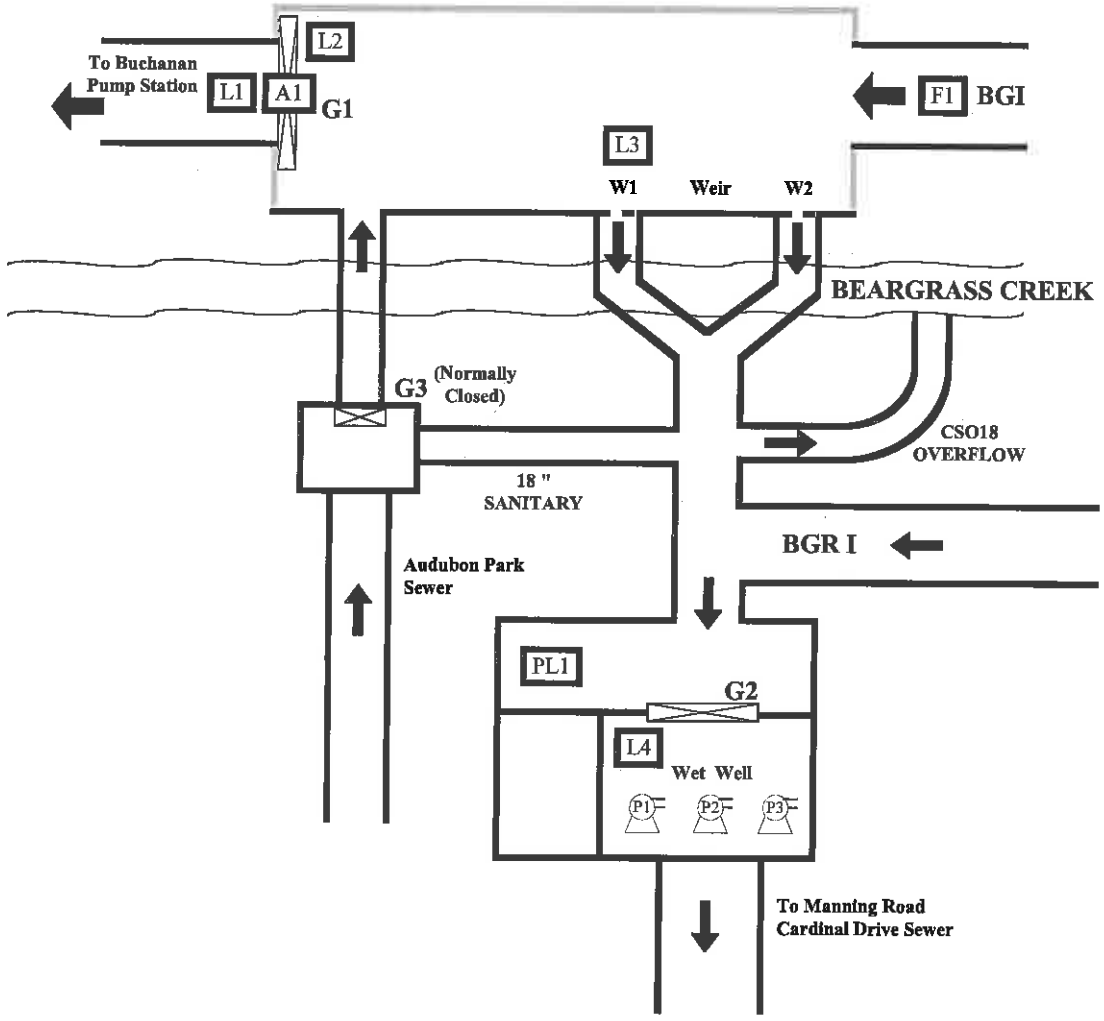
I&C	Type	Location	Named Equipment	Status	Implementation Responsibility	Required Preventative Maintenance (PM)	PM Schedule	PM Time Required	Annual MHs
Southeastern Diversion									
L1(LE2)	Water Level Sensor	Upstream of the Control Gate to the BGI in the Diversion Structure	Ultrasonic by Endress & Hauser or Equal	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	Calibration of 4-20 mA and field verification over the entire span when possible	Once a year	4 hours for 3 workers	12
L2(LE6)	Water Level Sensor	Upstream of the Control Gate to the SEI in the Diversion Structure	Pressure Transducer by WIKA Inst. Corp. or Equal	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	Calibration of the 4-20 mA to correct drifts over long periods: Requires zeroing. Field verification over the entire span when possible. The desiccant should be replaced frequently. Clean and unclog the submersible probe and clean the measurement tube.	Field calibration, zeroing and cleaning 4 times a year for submersible probes. Replacement of dessicant 2 times a year.	4 hours for 3 workers for calibration, zeroing and cleaning 4 times per year. 1 hour for 1 worker for dessicant replacement twice per year.	60
L3(LE3)	Water Level Sensor	Downstream of the Control Gate to the BGI	Ultrasonic by Endress & Hauser or Equal	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	Calibration of 4-20 mA and field verification over the entire span when possible	Once a year	4 hours for 3 workers	12
L4(LE4)	Water Level Sensor	Downstream of the Control Gate to the SEI	Ultrasonic by Endress & Hauser or Equal	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	Calibration of 4-20 mA and field verification over the entire span when possible	Once a year	4 hours for 3 workers	12
LSH1, LSHH1	Water Level Sensor	Downstream of the Control Gate to the SEI	Tilt Sensor by Flygt ITT Industries or Equal	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	Signal verification and debris removal	Once a year	2 hours for 3 workers	6
F1(LE1,FE1)	Flowmeter	Upstream of the Gate Chamber on the Hikes Point Sewer	Ultrasonic Area-Velocity Flowmeter (ADS Model 3600 or MGD Tech. Model ADFM)	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	Calibration and field verification. Debris removal on the probes. Dessicant replacement if submersible level probe is installed. Clean probes.	Once every year for flow measurement and twice a year for level measurement and dessicant replacement. 4 times a year for debris removal.	8 hours for 2 workers for flow verification every year. 2 hours for 3 workers for level verification and dessicant replacement twice per year. 2 hours for 3 workers for probe cleaning 4 times per year.	52
F2(LE4,FE4)	Flowmeter	Upstream of the Gate Chamber on the Buechel Branch Sewer	Ultrasonic Area-Velocity Flowmeter (ADS Model 3600 or MGD Tech. Model ADFM)	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	Calibration and field verification. Debris removal on the probes. Dessicant replacement if submersible level probe is installed. Clean probes.	Once every year for flow measurement and twice a year for level measurement and dessicant replacement. 4 times a year for debris removal.	8 hours for 2 workers for flow verification every year. 2 hours for 3 workers for level verification and dessicant replacement twice per year. 2 hours for 3 workers for probe cleaning 4 times per year.	52
A1(BGI)	Actuator	Control Gate to the BGI	Rodney Hunt or Equal	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	Stem lubrication and torque verification. Gate positioning and travel time verification: 2 full strokes and opening. Drive bush replacement. Hydraulic pump verification.	Lubrication, torque verification and 2 full strokes: 4 times a year. Gate positioning, travel time verification and hydraulic pump verification: once a year. Drive bush replacement every 2 years depending on control level.	1 hour for 1 worker 4 times per year. 6 hours for 2 workers once a year. 8 hours for 2 workers one time every 2 years.	24
A2(SGI)	Actuator	Control Gate to the SEI	Rodney Hunt or Equal	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	Stem lubrication and torque verification. Gate positioning and travel time verification. 2 full strokes and opening. Drive bush replacement. Hydraulic pump verification.	Lubrication, torque verification and 2 full strokes: 4 times a year. Gate positioning, travel time verification and hydraulic pump verification: once a year. Drive bush replacement every 2 years depending on control level.	1 hour for 1 worker 4 times per year. 6 hours for 2 workers once a year. 8 hours for 2 workers one time every 2 years.	24
G1	Control Gate	Control Gate to the BGI	Rodney Hunt, Fontaine or Equal	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	Inspect, Clean and Grease. Leakage, wear of the stem threads, gasket and slides verification, tightening of nuts and screw.	Every 6 months	4 hours for 3 workers twice per year	24
G2	Control Gate	Control Gate to the SEI	Rodney Hunt, Fontaine or Equal	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	Inspect, Clean and Grease. Leakage, wear of the stem threads, gasket and slides verification, tightening of nuts and screw.	Every 6 months	4 hours for 3 workers twice per year	24
PL1	PLC	Southeastern Diversion	Siemens S7-300	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	None	None	None	0
CDPD	Telemetry	Southeastern Diversion	CDPD Modem-Raven II by Air Link	Scheduled for Construction 10/02 - 7/03	MSD Contract No. 14,352	None	None	None	0

FIGURE 9-1
PHYSICAL SET-UP OF THE SOUTHEASTERN DIVERSION



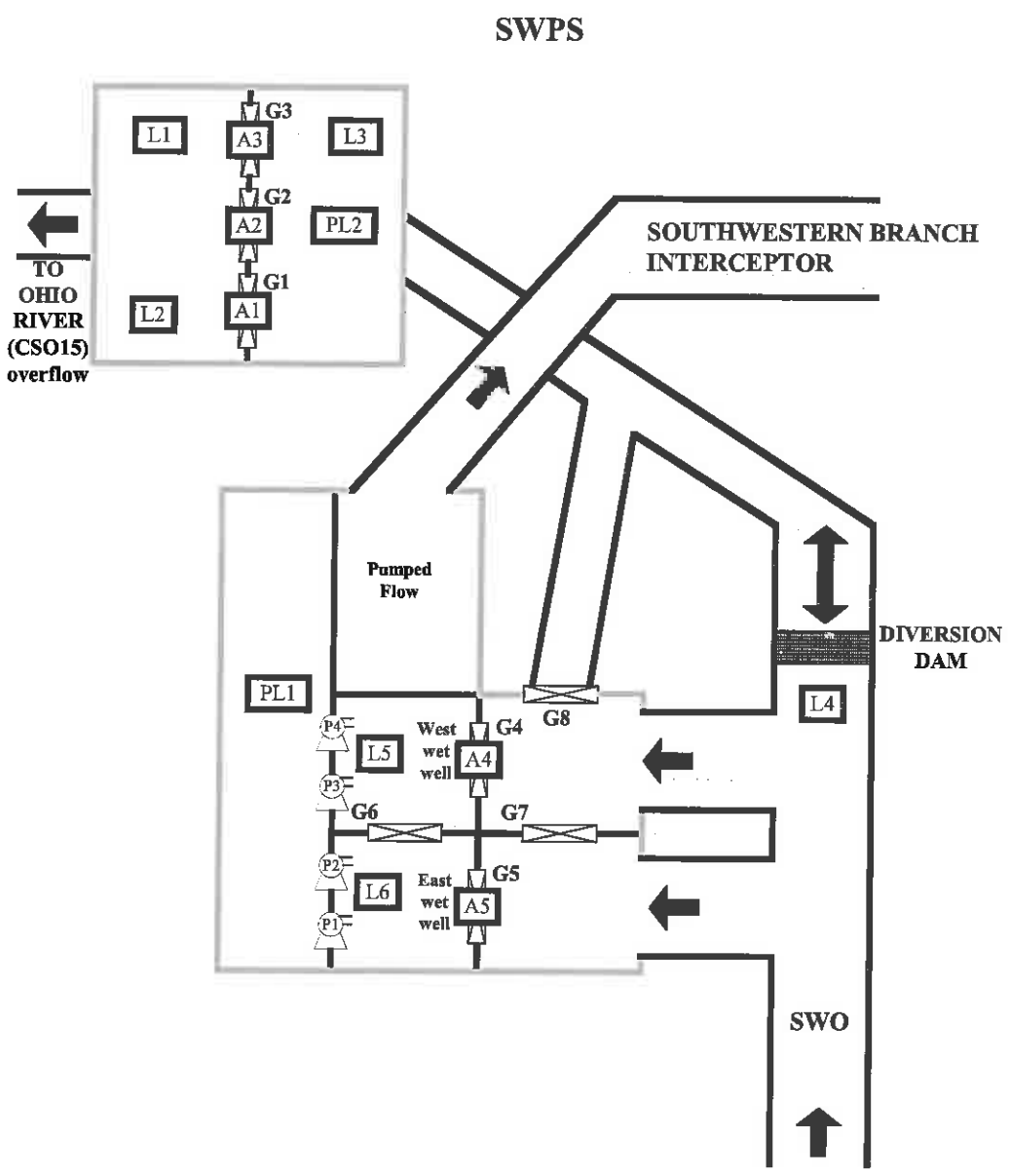
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FIGURE 9-2
PHYSICAL SET-UP OF THE
NIGHTINGALE PUMP STATION



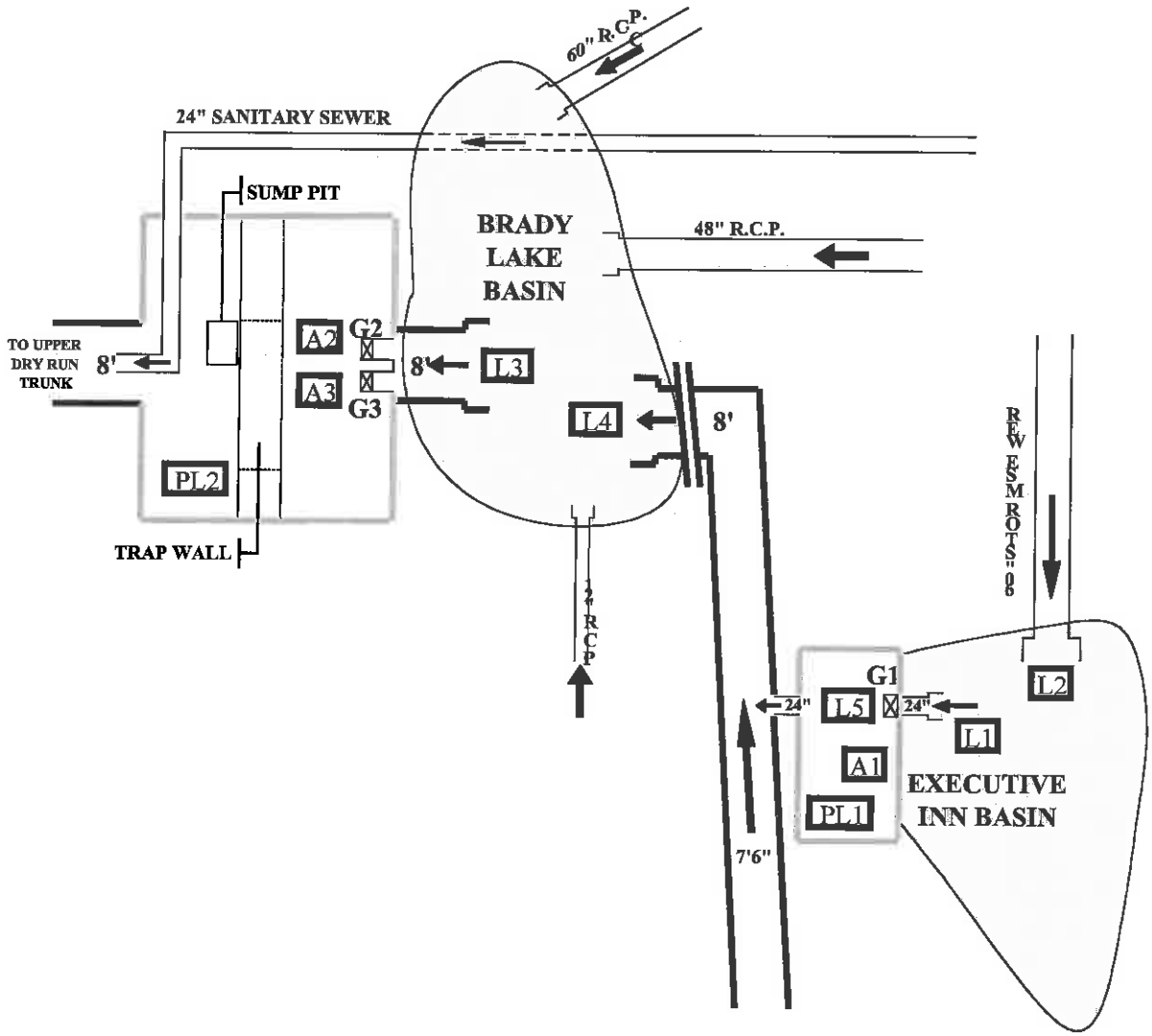
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FIGURE 9-3
PHYSICAL SET-UP OF THE SOUTHWESTERN PUMP STATION



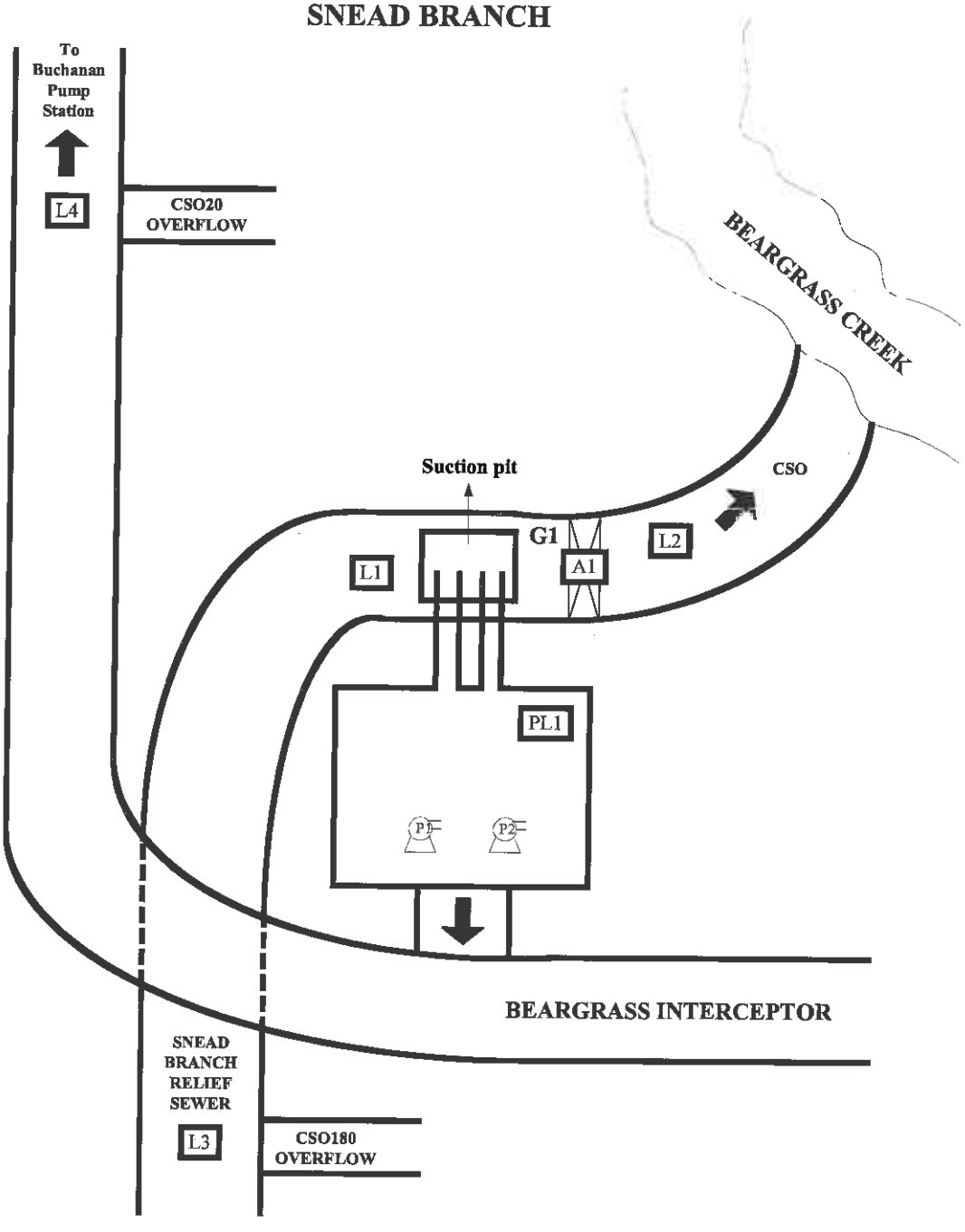
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FIGURE 9-4
PHYSICAL SET-UP OF THE BRADY LAKE AND EXECUTIVE INN BASINS



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FIGURE 9-5
PHYSICAL SET-UP OF THE SNEAD BRANCH RELIEF IN-LINE STORAGE FACILITY



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SECTION 10

SECTION 10: CURRENT POST-CONSTRUCTION COMPLIANCE MONITORING PROGRAM

10.1 INTRODUCTION

Within the CSO Guidance document, EPA issued a performance plan for combined sewer overflow programs. This plan establishes three national goals for the CSO program relating to compliance monitoring that are described as follows:

- Increasing the number of CSO communities implementing the CSO policy;
- Reducing CSO contributions to point source loadings; and
- Reducing CSO contributions for receiving water improvement.

To measure progress towards attainment of the above-defined goals, EPA defined specific performance measures. Conducting a monitoring program during and after the CSO LTCP implementation helps to determine the effectiveness of the overall program in meeting these goals. More specifically, the compliance monitoring program shall verify compliance with water quality standards and verify protection of designated uses as well as to ascertain the effectiveness of CSO controls. To date, the focus of the compliance monitoring program for MSD has been concentrating on reductions in combined sewer overflow volume and frequency.

10.2 MSD'S CSO PROGRAM COMPLIANCE MONITORING

The purpose of the post-construction compliance monitoring program is to help MSD determine the effectiveness of the overall program in meeting CWA requirements and achieving local water quality goals. As described in Section 2 of this report, a Water Quality Tool (WQT) model is being developed for a TMDL in the Beargrass Creek Region and ORSANCO model was developed for Ohio River. Both of these projects will play very important role of understanding the existing receiving water quality condition and will allow assessment of water quality conditions during and after program implementation to assist/supplement the monitoring program. MSD will design the long-term monitoring program to monitor the performance of final LTCP.

10.2.1 CSO Compliance Monitoring Review and Utilization

Reasonable programmatic and capital program flexibility is critical for successful implementation of the CSO LTCP. Constant changes in technology coupled with the evaluation of the post-construction compliance monitoring for previously implemented improvements enable the refinement and improvement of the CSO LTCP and ultimately the water quality of the receiving streams. This results in a continuous cycle of scoping, review and assessment, implementation through design and construction, post-construction monitoring, evaluation and recommendation, and plan refinement. Utilization of the EPA Adaptive Management Approachment Approach ensures that elements of the LTCP will be periodically reviewed and modified when appropriate to make the best use of resources while meeting the objectives of CSO management and receiving water quality improvements.

10.2.2 CSO Program Performance Monitoring

To determine the success of the CSO Program in reducing average annual overflow volumes and frequencies, MSD published CSO Performance Summary Reports in 1997 and 2000. The

purpose of these reports was to provide a detailed summary of MSD's progress towards compliance with national goals. These reports presented a summary of the reduction in average annual overflow volumes and average annual frequency of overflow reductions that have been accomplished since inception of the Program in 1993 (baseline period was July 1993). The results were determined based upon computer model simulations.

MSD elected to use a reference storm approach within the computer model to derive the required performance data. This approach utilizes a series of ten pre-determined reference storms that were extracted from the historical rainfall record (1960-1990). These are actual storms with return frequencies ranging from less than 1 month to 5 years, based on peak intensity. These reference storms, together with two smaller three-hour synthetic storms of constant intensity, were simulated using the computer model to obtain existing overflow volumes for each combined sewer overflow point and runoff volumes for each drainage catchment. A mathematical regression analysis of the data points based upon reference storms was used because it provided a predictive equation for overflow and runoff volume based on total rainfall for any storm in the historical record, eliminating rainfall differences in a given year.

The predictive equations describe the regression line and take the form of:

RUNOFF or OVERFLOW = CONSTANT x RAINFALL EXPONENT

When applied to each storm in the historical record and averaged, the equation allows determination of average annual overflow and runoff volumes for any individual CSO or group of CSOs.

To compute the results, a determination of the untreated combined sewer overflow volume for a desired capture rate was made. For individual CSOs, the volume collected in the combined sewer system during a storm event equals the normal dry weather flow and the runoff from the precipitation event. Note: A detailed description of the approach used to estimate average annual overflow and runoff volumes was provided in Section V of the 1994 CSOP Update.

The approach developed an average annual average of overflow volumes and frequencies for each CSO within the CSS. Once the overflow volumes were determined for each CSO, they were summed and averaged to determine the regional and overall improvement.

Table 10-1 (as published in 2000) provides a summary of the reduction in average annual overflow volumes and frequencies as of July 1999.

TABLE 10-1

REDUCTION IN AVERAGE ANNUAL OVERFLOW VOLUMES AND FREQUENCIES

CSO Region	Drainage Area (Acres)	Annual Overflow Volume Reduction (MG/Yr) 7/93 to 7/99	Percent (%) Overflow Volume Reduction (MG/Yr) 7/93 to 7/99	Approx. Frequency Reduction (OF/Yr) 7/93 to 7/99	Percent (%) Frequency Reduction (OF/Yr) 7/93 to 7/99
Beargrass Creek Region	6,662	495	27.0%	190	7.3%
Ohio River North Region	2,102	66	18.3%	1260	53.3%
Ohio River West Region	11,119	120	4.1%	13	3.4%
Total CSS	**19,883**	**681**	**13.2%**	**1463**	**27.3%**

In 2003, MSD changed from a reference storm approach for calculating average annual overflows to a synthetic year. There is a project currently underway to calculate the CSO program compliance monitoring using the revised rainfall method. This data will be presented in one of the upcoming consent decree required reports.

10.3 CSO PROJECT COMPLIANCE MONITORING

In addition to the CSO Program compliance monitoring work, and as a component of implementation of the CSO LTCP, MSD is performing compliance monitoring on specific CSO projects. The focus of this work to date has been to evaluate the effective reduction of AAOV as a result of the projects completed.

To date the post-construction project compliance monitoring protocols have been developed for three components of the CSO LTCP. These projects include: Upper Dry Run Trunk Storage Facility; Wheeler Avenue CSO/Flood Control Basin Project; Snead's Branch In-Line Storage Project; Maximization of Flow to MFWTP and Assessment of Solids and Floatables Projects.

10.3.1 Upper Dry Run Trunk Storage Facility

The Upper Dry Run Trunk Storage Facility (UDRT) project includes the construction of two earthen basins (17.25 MG and 15.25 MG) on the Kentucky Fair and Exposition Center (KFEC) property, and the construction of 1,922 LF of 60" sewer. Construction of the project started in March of 2001 and was completed in June of 2004. The project cost was approximately $4,500,000.

During the summer of 2003, an evaluation was conducted on the UDRT facility to set up a procedure to measure the performance of the facility when it is put into operation during FY05. The following summarizes the results of this evaluation.

The Executive Inn Basin and the Brady Lake Basin are located within the Ohio River West Region. The two facilities are both storm water retention basins that discharge their stored flow to the combined sewer system via the Upper Dry Run Trunk Sewer and ultimately the Southwestern Outfall and CSO 015. During the project development it was determined through computer analysis that 19 MG was needed to provide flood protection to mitigate the surface flooding resulting from the August 8, 1992 storm (approximately a 100-year storm event). Consequently, there is an available storage capacity of 13.5 MG that can be dedicated to CSO reduction. Both the Executive Inn Basin and the Brady Lake Basin will be operated as part of the Real Time Control (RTC) System currently being developed and implemented by MSD. The control strategy that will be employed by RTC will fulfill both the flood protection and the CSO reduction goals. The control scheme will adjust to the current priority depending upon the magnitude of events and flows. Essentially, the control strategy consists of minimizing overflows by holding 100% of the flow that enters the basins up to the point where the 13.5-MG storage capacity has been achieved. At this time, the control strategy will switch from CSO control to flood protection and the gates will modulate open to maintain the water levels consistent with the 13.5 MG of storage. If this is not possible, the gates will fully open to provide maximum storage capacity under the flood control mode.

To date, the post-construction compliance monitoring has not been completed. Once Phase I of the RTC Program is implemented, the performance post-construction compliance monitoring will

commence. The data that will be available from these basins that will be utilized for performance evaluation purposes includes the following:

- Executive Inn Basin - Water level elevation in the basin, discharge gate position and flow under the gate.
- Brady Lake Basin - Water level elevation in the basin, water level elevation in the discharge chamber, gate position on both discharge gates and flow under the gates.

It is proposed that the performance evaluation of the UDRT facilities be based upon the volume of water stored within both basins during wet weather events. This will be accomplished by developing rating tables for both basins that equates water depth to stored volume. The volume stored will be assumed to be the volume of AAOV reduced for the facilities on an annual basis.

10.3.2 Wheeler Avenue CSO/Flood Control Basin Project

The Wheeler Avenue area is a residential area in a shallow "bowl" that sets 2'-3' below the surrounding ground and is drained by a combined sewer to the Mill Creek Trunk Interceptor. When the Mill Creek Trunk backs up, the flow from within the area has no outlet. The Mill Creek Trunk Interceptor (12'-8" wide by 19' tall) combined sewer located in Taylor Boulevard, receives the entire flow from the Wheeler Avenue area. The Mill Creek Trunk Interceptor then flows to the Southwestern Outfall and ultimately to the Southwestern Pump Station where the flow is sent to the Morris Forman Wastewater Treatment Plant (MFWTP). During very large storms, the Mill Creek Trunk surcharges into the low lying area along Bicknell Avenue and its side streets. On August 8, 1992 the area along Bicknell Avenue and several side streets were flooded by a major storm event (3.84" of rain in 2.5 hours, an approximate 100-year storm). Following this flooding, MSD conducted a major study of the causes and potential solutions for the flooding problems that resulted in the implementation of the Wheeler Avenue CSO/Flood Control Project.

The objective of the Wheeler Avenue CSO/Flood Control Project is twofold: (1) to reduce the combined sewer overflows that occur at CSO 015 and (2) to reduce the occurrence of neighborhood flooding. This was accomplished by constructing a 4.9-MG flood control basin and a 553,000-gallon CSO Basin inside the flood control basin, providing 1.1 MG of storage in the 78" combined sewer, regulating the rate of flow to the Mill Creek Trunk and preventing the Mill Creek Trunk from backing up into the area.

During MSD's fiscal year 2004 a Performance Analysis was performed for the Wheeler Avenue CSO/Flood Control Project to set up a procedure to measure the performance of the facility. The following summarizes the results of this performance analysis.

The data available from the Wheeler Avenue CSO/Flood Control Facility that will be usable for performance evaluation purposes includes the following:

- Position of the sluice gate at Ashland Avenue,
- Water level elevation in the concrete basin, and
- Water level elevation in the earthen basin.

It is proposed that the performance evaluation of the Wheeler Avenue CSO/Flood Control Facility be based upon the volume of water stored within both the concrete and earthen basins during wet weather events. This will be accomplished by developing rating tables for both basins that equates water depth to stored volume.

Performance data for the facility for the time period from August 2001 to August 2004 reveals that the CSO basin has stored and therefore, reduced AAOV by more than 26 MG, and the Flood basin has stored over 4 MG during this time period.

10.3.3 Snead's Branch In-Line Storage Project

The Snead's Branch In-Line Storage (SBR-ILS) project is located just east of the intersection of Logan Street and East Kentucky Street. The facility uses the Snead's Branch Relief Drain (SBRD) as a combined sewer overflow (CSO) storage facility by the operation of an inflatable rubber gate which is located approximately 200' from the outlet of the SBRD to the South Fork of Beargrass Creek channelized section. The SBRD is an 11' semi-elliptical drain that collects flow from eleven CSOs. Prior to the installation of the gate, most combined sewage would discharge directly to the South Fork of Beargrass Creek.

The storage capacity of this facility when the gate is fully inflated is approximately 2.5 MG. The facility is intended to capture the flows from the CSOs tributary to the SBRD and pump the stored volume to the Beargrass Interceptor to be conveyed to the Robert J. Starkey Pumping Plant and then on to the MFWTP for treatment.

During the summer of 2003 a post-construction performance analysis was performed for the SBR-ILS Facility to set up a procedure to measure the performance of the facility.

The data available from the SBR-ILS Facility utilized for performance evaluation purposes includes the following:

- Pump run times,
- Water level elevation at the outlet of the SBR to BGC,
- Water level elevation just upstream of the inflatable gate, and
- Water level elevation approximately 2,000' upstream of the inflatable gate.

The performance evaluation of the SBR-ILS Facility was based upon the pump run times, which were converted to a volume pumped. The volume pumped was assumed to be the total volume of AAOV reduced for the facility.

Raw data from the SBR-ILS facility has been downloaded and analyzed for the months of June, July and August 2003 as part of this performance evaluation process. The results of the evaluation process are summarized as follows:

- *June 2003* - 1.693 MG captured and returned to the BGI. Total rainfall for the month based upon MSD closest rain gauge was 2.67".
- *July 2003* - 7.067 MG captured and returned to the BGI. Total rainfall for the month based upon MSD closest rain gauge was 4.33".
- *August 2003* - 6.997 MG captured and returned to the BGI. Total rainfall for the month based upon MSD closest rain gauge was 2.88".

10.3.4 Maximization of Flow to MFWTP

The MFWTP Service area consists mainly of the original City of Louisville. Over the past 10 years, residential customer populations have been stable to declining, and industrial dischargers have similarly declined. Figure 4-5 in Section 4 shows the trend in annual base flows (defined as the minimum month average day flow for the year) over the past 10 years. A linear

regression of base flows indicates a strong downward trend. Figure 4-5 also shows annual average flows for the same time period, indicating a stable or slightly declining trend.

The difference between annual base flow and annual average flow is the annual wet weather capture, as shown on Figure 4-5. The trend clearly indicates an increase in wet weather capture, from a "daily average" of approximately 17 MGD in 1996 to almost 25 MGD in 2005. Extended over a calendar year, these average daily wet weather capture values indicate an increase in wet weather capture of almost 3 billion gallons per year. In addition to providing disinfection for this additional 3 billion gallons of flow, it is estimated that over 600 tons of BOD and 1,200 tons of TSS are prevented from reaching the Ohio River.

Over the past seven years several projects have been completed to increase the peak wet weather capacity of the MFWTP. As noted previously, the peak instantaneous capacity of the plant is 350 MGD. Due to the inherent variations in flow resulting from precipitation events, the peak instantaneous flow rate cannot be sustained without risking process washout in the primary sedimentation basins. The peak sustainable flow rate, with all facilities in service is estimated to be 325 MGD.

Evaluating trends in flow peaking is difficult at the MFWTP, as hourly flow peaks are not archived in the plant reporting database. Only daily flows are captured and archived. For most wet weather events peak flow rates are not sustained for an entire day, and the reported daily flow is typically much lower than the instantaneous flow peak actually taken through the plant. Trends in daily peaks will indicate trends in accepting wet weather peaks, but cannot be directly correlated to instantaneous peaks.

The project to increase the capacity of the primary effluent flow routing to disinfection had the largest impact on the plant's ability to handle wet weather peaks. This project was under construction during 2000, and completed and put into operation in 2001. Figure 4-6 in Section 4 shows the trend in peak daily flows reported from 1999-2005. As expected, there was a drop in peak flows accepted during 2000, when the flow routing improvements were being constructed and a sharp jump in peak day flows in 2001. Data collected between 2001 and 2004 indicates a continued upward trend in peak flows through 2005. The drop in peak flow rates in 2005 is due to sedimentation basin repair and reconstruction that resulted in only 3 sedimentation basins being available for most of the year, thus reducing the peak instantaneous and sustained peak capacities of the plant.

10.3.5 Real Time Control

Implementation of Real Time Control (RTC), is currently the foundation for the CSO LTCP. As presented within this plan, RTC uses MSD's existing infrastructure in a cost-effective way, storing combined sewer flow within the pipe until capacity exists at MFWTP.

In order to perform post-compliance monitoring, detailed documentation of all aspects of the initial implementation project consistent with the global, optimal, predictive (GOP) RTC approach are being prepared. Specific performance elements to be detailed are as follows:

- Define the control objectives and reach consensus about their prioritization for configuration of the control rules: Management priorities; Physical, operating and maintenance constraints; Water quality objectives for the receiving water bodies; Level of sophistication of the RTC system; and Level of security (redundancy, fail-safe mode & devices).

- Evaluate the application of RTC to the SWPS and Paddy's Run Pump Station by reviewing the current control structures and their operation.
- Analyze the constraints and benefits of integrating the Snead's Branch In-line storage structure, the Brady Lake Basin and the Executive Inn Basin as control in the initial RTC implementation project.
- Review applicable SWMM models for appropriateness to include in determining control setpoints and programming of overall RTC application.
- Perform a sensitivity analysis on input data to determine the influence on the overall RTC system. The following data will be analyzed: Rainfall forecasting system; Flow and water level monitoring; and SWMM models.
- Evaluate the cost-benefit of different configurations in terms of robustness and performance relating to the following elements: Number and location of monitoring sites; Number of sensors; Length of control period in the optimization process; and Meteorological forecasting horizon.
- Identify system verification methodology and predict system performance in terms of overflow reduction to be achieved for the initial implementation project under the proposed RTC approach.
- Develop a plan that provides for no interruption to the operation of the combined sewer system, MFWTP and existing telemetry/SCADA/automation centralized station at MFWTP under normal, wet weather and emergency conditions.

The final step to verify RTC performance verification is to document results in a technical memorandum.

10.3.6 Solids and Floatables Control Projects

10.3.6.1 NSF International/Environmental Technology Verification (ETV) Verification of the CDS Unit at CSO 108

NSF, partnering with ETV and EPA, approved a generic verification protocol for vortex separation to be used to test and sample the CDS PCS70_70 unit at CSO 108, in the Beargrass Creek Region.

This protocol was established to achieve the goals of ETV to evaluate the performance of innovative and commercially available environmental technologies; provide objective information about technology performance to permit writers, buyers and users, among others; and facilitate "real world" implementation of promising technologies.

Using this protocol, the wet weather sampling effort at CSO 108 took place over three years, and allowed MSD the information to adjust parameters of device, such as the programming and configuration of screening, to best capture solids and floatables at this site.

Results of this ETV verification assisted MSD's Infrastructure and Flood Protection (I&FP) to tailor the operations and maintenance program specific for this technology. In addition, the ETV verification provided information to assist with proper site selection criteria for the CDS technology.

10.3.6.2 S&F Site Visit Evaluation Work of 2005

In 2005, an evaluation was performed of the existing solids & floatables installations. During rain events, site visits were made to evaluate the performance of various CSO sites with installed solids and floatables control. The focus in the evaluation was to determine if an overflow was occurring and: 1) was the device working properly, 2) if screens were employed, were they blinded, and 3) if the device was to be self-cleaning, did it perform in that way. Observations were documented through field notes, photographs and video.

An example of observations was that screened technologies were more effective in the more urbanized areas of the CSO system, where the presence of leaves and other organic material was minimal. MSD NMC technologies that are advertised as self-cleaning nonetheless require a basic level of regular service.

The information that was obtained is being incorporated into the on-going S&F technology selection process. Information such as that presented above is being used for technology selection criteria for site selection criteria and to assist defining requirements for proper operations and maintenance.

10.4 DEVELOPMENT OF STANDARD GUIDELINES FOR POST-CONSTRUCTION MONITORING

MSD currently has a project underway to develop standard guidelines for executing post-construction compliance monitoring for reduction of the volume and frequency of average annual overflows. The project will finalize the guidelines and procedures for performance assessment of CSO LTCP components building on the work noted above. The project will address items such as data acquisition, QA/QC of data, presentation of performance data and summary of information.

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SECTION 11

SECTION 11: CSO LONG TERM CONTROL PLAN – PROCESS FORWARD

***Note**: Parts of this Section have been revised in response to comments from regulatory agencies. The revised text is shown in italics. The pages with revisions have a revision date noted at the bottom of the page. Tables and figures embedded or referenced in the revised text have been numbered sequentially. Tables are numbered A-1 through A-3 and figures are numbered A-1 through A-13d. Figures that are not embedded in the text are attached as the last two figures at the back of the Section.*

11.1 INTRODUCTION

MSD's final CSO Long Term Control Plan will be developed to meet the three goals that have been set forth in the U.S. Environmental Protection Agency's (EPA) National CSO Strategy. These are paraphrased as follows:

- To ensure that if CSO discharges occur, they are only as a result of wet weather,
- To bring wet weather CSO discharge points into compliance with requirements of environmental quality standards and objectives, and
- To minimize water quality, aquatic biota, and human health impacts from wet weather overflows.

As specified in the Consent Decree, the final CSO LTCP will include specific projects, schedules, and timetables for remedial measures that achieve full compliance with the EPA's CSO guidance and will be completed as soon as practicable based upon sound engineering judgement, but in no event later than December 31, 2020.

Because of the physical characteristics of MSD's sewer system and MSD's permit responsibilities, various aspects of the wet weather program will be integrated. MSD has permit responsibility for stormwater, combined sewage, and wastewater, and therefore, these components must be integrated. Integrating these initiatives will provide for successful development of the final plans for the wet weather programs, producing a final LTCP and a comprehensive wet weather plan by December 31, 2008.

The LTCP is one of the key elements of this wet weather plan. The following description of the LTCP process forward is organized to address the nine required elements of an LTCP as outlined in the CSO Policy. The nine elements are as follows:

- Characterization, monitoring, and modeling
- Public participation
- Sensitive areas
- Evaluation of alternatives
- Cost/performance considerations
- Operational plan
- Maximizing of treatment in existing wastewater treatment facilities
- Implementation schedule
- Post-construction monitoring

Figure 11-1 illustrates a timeline schedule for completion of the various elements (located at the end of this section). In most cases, the components are subdivided into activities. Significant milestones are indicated on the schedule as follows:

- Completion of a summary of current water quality in the various receiving streams and rivers, with an evaluation of the impact of current water quality on available water quality compliance options available
- Development and evaluation of control alternatives to address each CSO, and other activities that may address water quality issues but are not specifically linked to individual CSOs (e.g., source controls).
- Evaluation of the system-wide performance of the consolidated program of projects selected from the available control alternatives, and the basis of selection for either the demonstrative or presumptive approach to regulatory compliance
- Draft LTCP available for public comment
- Final LTCP submitted to DOW and EPA

Figure 11-1 also illustrates the interaction between the various required elements of the LTCP. The following is a detailed description of the planned approach for completing each of the required elements.

11.2 CHARACTERIZATION, MONITORING, AND MODELING

This subsection describes efforts required to expand upon the extensive characterization, monitoring, and modeling activities completed to date. Those past efforts are documented in Section 2 and in the update to the Nine Minimum Controls (September 15, 2006).

11.2.1 Public Participation and Agency Interaction

Section 11.3 of the LTCP Update (June 2006) presents a thorough discussion of the MSD public participation and agency interaction programs. This public participation and agency interaction program will be refined, as indicated in Section 11.3 of this update.

Procedures will be refined and improved to continually update presentation of the following topics:

- Scope of monitoring and assessment programs for system characterization
- The watershed approach to CSO control planning
- Identification of watersheds in the CSO area
- Identification and quantification on non-CSO sources
- Existing sewer system conditions and problems (e.g., flooding, basement backups)
- Quantification of CSO flows and loads and impacts of CSOs on receiving waters
- Results of CSS and receiving water monitoring programs
- Development and calibration of CSS and receiving water models
- Identification and implementation of the NMC
- Process for evaluating alternatives

11.2.2 Objective of System Characterization

The purpose of the system characterization, monitoring, and modeling is to assist in developing appropriate measures to support the selection of measures implemented as part of the Nine Minimum Control Plan and to support development of the LTCP. The monitoring and modeling together provide the tools used to objectively characterize the existing system, objectively define a baseline against which to evaluate the expected effectiveness of the NMC and the LTCP, and validate models that support consistent projection of expected conditions under alternative future conditions.

11.2.2.1 Implementation of the NMC

MSD implementation of the nine minimum controls is documented in the Nine Minimum Controls Compliance Report, September 15, 2006. Section 2 of that report details the characterization of CSOs and CSO impacts on receiving waters. MSD will build upon the NMCs, focusing on those which prove the most effective in reducing public concerns and improving receiving water quality.

11.2.2.2 Existing Baseline Conditions

Existing baseline conditions describe the original state of the three systems to be impacted by the CSO Long Term Control Plan. They objectively describe the baseline condition of the following:

- The Combined Sewer System (CSS),
- The Combined Sewer Overflows (CSOs), and
- The Receiving Water Quality (RWQ).

The documented, objective description of existing baseline conditions will be used throughout the CSO long-term control planning as the base against which all alternatives are evaluated.

The existing conditions are previously documented in several reports. CSO Performance Summary Reports prepared in 1997 and 2000 show improvements since 1993. The existing conditions are most recently summarized in Section 2 of the *Nine Minimum Controls Compliance Report* (September 15, 2006). Note that each previous report describes a different "existing" condition that reflects changes (projects complete, infrastructure deterioration, refined information) that impacted the system between the various reports.

Table 11-1 shows an example of how changes in CSO conditions have been objectively documented.

A single baseline condition will be defined that reflects the three systems as they would exist if projects already committed for implementation (e.g., those shown in Table 11-1). Definition of baseline condition will be confirmed with those responsible for implementation of the projects included.

Key steps to be undertaken to resolve and characterize existing baseline condition refinements include the following:

a) Expand the datasets to include the monitoring conducted through 2006.
b) Validate the models to better reflect the expanded monitoring data sets.
c) Define and resolve baseline conditions of projects to which MSD, or other entities, are already committed regardless of the findings of the LTCP.
d) Update the models and characterizations to reflect existing baseline conditions that include existing conditions, plus the committed projects defined above in Item c of this list.
e) Update the key characterization summaries to reflect the baseline conditions.

11.2.3 Summary of Minimum Control Measures

MSD implementation of the NMCs was summarized most recently in the Nine Minimum Controls Compliance Report updated September 15, 2006. As described therein and in Section 11.2.2.1, MSD is committed to several improvements to the NMCs during the planning period for the CSO LTCP. The MSD will continue to track implementation of the NMC. The final Long Term Control Plan will include an updated summary of the current status of MSDs NMCs.

11.2.4 Compilation and Analysis of Existing Data

MSD researched and compiled existing data describing the watersheds. Geographic and land use data are compiled primarily in the LOJIC GIS system. Receiving water quality characteristics, including biotic and habitat character, are compiled in a series of databases, primarily:

- LIMS, containing the results of all MSD laboratory analyses
- SONDE, containing extensive time series "high resolution" data from continuous SONDE sampling equipment
- RAINGAGE, containing the data from field gages of rainfall, augmented with radar rainfall virtual gaging
- FLOWMETER, containing the data from MSD sewer flow meters
- STREAMFLOW, containing the data from MSD/USGS cooperative stream gages
- BIOLOGICAL (spreadsheets), containing the data MSD field observations of macroinvertebrates, stream habitat, and riparian habitat

The following sections demonstrate the use of these data repositories for characterization of the watersheds, the sewer system systems, and the surface water quality.

11.2.4.1 Watershed Mapping

Watersheds are delineated within the LOJIC GIS. Maps of the watershed are frequently displayed in MSDs public participation materials and are available for viewing at www.msdlouky.org.

More detailed maps of the subwatersheds, and sewersheds within the combined sewer service area, are developed on the LOJIC GIS base mapping and used extensively in the analysis and modeling. These detailed maps were used to analyze characteristics of the CSO basins. Land use characteristics of the CSO basins are tabularly summarized in Section 10.3.1 of the NMC Compliance Report (September 2006). Summary maps of the watersheds (sewersheds) within the combined sewer service area are provided in Section 2 of the Interim LTCP, Figures 2-9, 2-13, 2-16.

11.2.4.2 Collection System Understanding

The collection system understanding is summarized in Section 2 of this report. That section summarizes sewers, regulators, diversion chambers, pump stations, interceptors, outfalls and other key hydraulic features. More detailed understanding of the collection is contained in the collection system models.

The condition of the collection system is continually changing (construction, degradation). The GIS and the MSD inspection files maintain a living record of current conditions. This live record will be referenced for critical sites during the LTCP planning.

11.2.4.3 CSO and Non-CSO Source Characterization

Land use characteristics, potentially related to runoff sources of pollutants, are included in the LOGIC GIS and summarized and evaluated in the models. Pollutant sources tributary the MSD sewer systems, and potentially reflected in CSOs, are inventoried in MSDs significant industrial user (SIU) databases. The locations of these SIUs are shown in Figure 11-2 (end of section). Past CSO and water quality modeling efforts have used measured overflow characteristics that include any discharges from SIUs. Ongoing CSO and water quality modeling (Section 11.2.5 and 11.2.6, respectively) will verify that these sources are adequately represented in the models, and hence, adequately represented in the loadings and impact analyses.

11.2.4.4 Field Inspections

MSD has been maintaining the sewer collection system including the combined sewer system and the combined sewer overflows since first constructed. Documentation exists as far back as the Commissioners of Sewage reports before MSD was formed, discussing the system and the various components of maintenance of the system. Through the years, the Commission and MSD have maintained the system utilizing the best available technology and best available resources.

Starting in the early 1990s with the beginning of the development of the Combined Sewer Overflow policy, MSD increased its focus of the maintenance efforts on the combined system. To enhance maintenance activity, additional information was needed. This included broader knowledge about how the CSO system functioned. Some of the early inspection work completed to increase knowledge of the system entailed detailed investigations of each CSO. This detailed investigation included descending into each manhole and structure to inventory every element of the CSO. Surveys were performed which included

confirming measurements within the CSO and elevations of critical parts of the CSO such as weirs, dams, etc. Information obtained through these inspections included the following:

- Determining the structural integrity of the CSO,
- Assessing the mechanical condition of the CSO components,
- Checking for problems, both short-term and long-term, and
- Creating a detailed drawing of each CSO.

A detailed inventory was created of each CSO (see Figure 11-3 at the end of the section). Along with detailed information about the CSO, mapping was developed which located the CSO within the collection system and located the CSO along the receiving stream or river.

Once this information was developed and documented, inspection and maintenance activity was enhanced for the CSOs. Inspections were scheduled on a regular basis and maintenance activity was scheduled based upon the observations made from the inspections.

Inspection and maintenance has been ongoing since they were constructed with fine-tuning of the program occurring on a regular basis. Monthly meetings were held whereby field observations were discussed among a group of maintenance personnel and engineering staff to decide on changes for maintenance activity. Fine tuning was discussed and implemented based upon these meetings.

Today, the inspection and maintenance activity is programmed within HANSEN (work order management system). Work orders are generated for both inspections and regularly scheduled maintenance activity. A sample is shown in Figure 11-4 at the end of this section. A recent action has been to create detailed checklists for each CSO to make it site specific. This will be completed in 2006, whereby it will be entered into HANSEN so that the work orders of maintenance activity will be site specific. An example is shown in Figure 11-5 (at end of section).

11.2.4.5 Receiving Water

Receiving waters in and adjacent to the Louisville MSD CSOs are summarized in Section 2.6.

The DOW 303(d) list, summarized in Table 11-2, identifies several of the receiving waters as currently not meeting standards prescribed to support designated uses.

LTCP planning efforts will continue to compile and evaluate receiving water quality data, particularly that inherent in the MSD long-term monitoring program and the MSD bio-integrity surveys. The public participation program (Section 11.3) will work with the stakeholders to clarify which receiving water values have highest priority, which receiving waters (if any) should be considered particularly sensitive, and which are most at risk from CSOs. Under the CSO Policy guidelines, all waters could be considered sensitive, since they are all classified as contact recreation. This interpretation, however, does not provide for the differentiation and prioritization that a "sensitive" classification is intended to provide, hence the initiative to have the stakeholder group identify locations that are more sensitive than others.

MSD is compiling receiving water quality data from external sources along with the extensive data from the long-term monitoring and bio-integrity surveys. These data are being augmented through the use of receiving water quality models (Section 11.2.6). The combination of monitoring and modeling data have been reviewed by the professionals involved in the long- term control planning and judged to be adequate for the support of LTCP evaluations of CSO impacts.

Some episodic sampling data will be collected and analyzed in 2006, and possibly in 2007, to refine representation and modeling in areas of particular concern to see if the cadmium violation was a valid data point. In addition, MSD continues to review the historic cadmium data. The models will be further refined, if necessary, to meet verification standards.

11.2.5 Combined Sewer System and Receiving Water Monitoring

Combined sewer system and receiving water monitoring are conducted primarily to characterize the frequency, volume, and combined sewer overflows and the impact of these overflows on the receiving waters.

Note that the monitoring data are necessarily supplemented extensively with modeling. This supplementation is mandated by two facts: it is not possible to monitor at all locations within either the sewer system or the receiving water system. Furthermore, it is not possible to monitor at all times, all flow conditions. Rather, the monitoring provides multiple "snapshots" at key locations and key flow conditions. Models provide the means to interpolate between the snapshots. Further, the models provide a consistent tool for evaluating the impact future sewer system improvements will have on CSO performance and water quality impact.

Past monitoring is summarized in Section 2.3.1. Specifics of the monitoring locations, frequencies, and parameters are further described in Sections 10.4 of the NMC Compliance Report (September 2006). The available data have been reviewed by the professionals involved in the MSD long-term control planning. The available data are sufficient to characterize combined sewer overflow frequency, volume, and receiving water quality impact.

However, some additional monitoring and data collection is planned to support refinement of the models. Specific planned monitoring objectives include the following:

- Monitoring sewer flow to **refine** the model representations of quantity of flow entering the combined sewer service area interceptors from the **boundary** with the sanitary sewer service area.
- Monitoring CSO flow rates at large volume CSO locations to **refine** the **overflow volume estimates**.
- **Monitoring** selected receiving water locations, flow and quality, to refine the Water Quality Tool (see Section 11.2.6.2) as necessary to **support** the **TMDL**. Data collected for this purpose is not considered essential to the long-term control planning and hence not discussed further in this summary of long-term control plan monitoring and modeling.

CSO Sampling Data

Monitoring data available for CSO characterization and planning includes both monitoring for flows and sampling for water quality characteristics.

Past flow monitoring data was summarized in Section 10.4.6 of the NMC Compliance Report (MSD, September 15, 2006)

Past sampling of CSOs in the Louisville MSD sewers yielded a multitude of observations of numerous distinct analytes. The full range of analytes and their observations are listed in NMC Appendix 10-1 CSS Sewer Data Details. Figure A-1 (oversized) shows the location of the CSO and CSS sites monitored to date within the Louisville MSD system.

Most samples reported in NMC Appendix 10-1 were collected by automated samplers using consistent sampling protocols that included more frequent sampling early in the storm, tapering off to less frequent through the remainder of the first 3 hours of the storm. This sampling protocol is biased toward the early 'first flush' portion of the overflow hydrograph. Site storm samples were composited on a flow proportional basis prior to analysis, thus each data point approximates a mean event concentration for that particular storm and event.

Table A-1 summarizes the data collected to date in the CSOs for TSS, BOD and FC. As previously noted, the samples show a variability that is characteristic of environmental sampling, and even more prevalent in wet weather sampling. The standard deviation of the observations is the selected measure of the variability. If the data are normally distributed, one can be 95% confident that the average of the population is within 1 standard deviation of the average calculated from the observations. The significance of multiple observations at one site is commonly graphed as explained in Figure A-2:

Figure A-2
Variability Chart

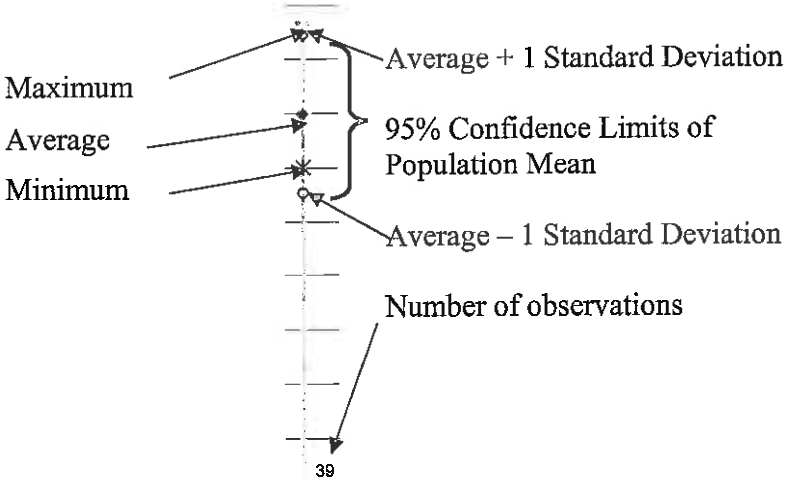


Table A-1
Summary of CSO Data for TSS, FC, and BOD

Site		BOD							Fecal							TSS						
Location	Description	No.	Min	Ave	Max	Std	Ave-1 Std	Ave+1 Std	No.	Min	Ave	Max	Std	Ave-1 Std	Ave+1 Std	No.	Min	Ave	Max	Std	Ave-1 Std	Ave+1 Std
C0000008	CSO 206	38	1	45	303	65	0	110	38	1	195060	3000000	568375	1	763435	39	1	162	1540	328	0	490
C0000009	CSO 209	17	1	23	88	28	0	51	30	1	19220	216000	45283	1	64503	17	0	91	713	173	0	264
C0000011	CSO 108 N Unit	6	8	10	11	1	9	11	6	11000	70000	98000	32150	37850	102150	6	32	49	58	10	39	58
C0000012	CSO 108 S Unit	6	9	11	17	3	8	14	6	3200	56333	93000	39784	16549	96117	6	55	66	83	10	56	77
C0000024	CSO 110	39	1	36	138	33	3	69	39	1	999820	34000000	5432671	1	6432491	40	1	129	567	125	4	254
C0000025	CSO 117	28	1	111	430	127	0	238	30	1	232297	2093000	505435	1	737732	28	1	246	1023	246	1	492
C0000026	CSO 125	15	7	193	1330	462	0	655	16	580	267524	1200000	465486	1	733010	15	28	125	538	140	0	265
C0000027	CSO 127	20	1	59	241	67	0	126	26	1	91631	1200000	246505	1	338136	19	1	214	780	219	0	433
C0000028	CSO 140	8	3	28	85	28	0	57	9	430	158067	1200000	391367	1	549433	9	1	118	312	136	0	254
C0000029	CSO 151	32	1	75	434	80	0	155	39	1	159507	1200000	305968	1	465475	33	1	207	797	202	5	408
C0000030	CSO 152	34	1	51	231	55	0	105	35	1	132094	1200000	273698	1	405792	34	0	137	402	120	18	257
C0000031	CSO 153	1	291	291	291				3	120000	120000	120000	0	120000	120000	1	623	623	623			
C0000042	CSO 16															8	1	325	552	210	115	535
C0000043	CSO 19															6	256	413	548	121	292	535
C0000044	CSO 50															11	49	97	176	45	53	142
C0000045	CSO 189															5	256	296	408	63	233	359
C0000046	CSO 190															2	136	164	192	40	124	204
C0000104	CSO 146	3	336	351	367	16	335	367								3	600	698	865	145	553	843

Note that statistically, the population mean is somewhere within the confidence limits. Any value within those limits is not statistically different from the sample average.

TSS, BOD and FC data are summarized here because of their perceived significance to CSO LTCP planning. TSS is summarized because it is commonly of interest in wastewater impact evaluations and it is commonly used as a surrogate for pollutants known to 'attach' to sediments. BOD is summarized because it is commonly of interest in wastewater impact evaluations and because it is related to DO, one of the two[1] parameters cited by KDOW as out of compliance in the receiving waters. FC is summarized because it is commonly of interest in wastewater impact evaluations and because it is cited by KDOW as out of compliance in the receiving waters.

Figure A-3 illustrates that the TSS data in the CSOs show a high degree of variability. With the degree of variability evidenced, it is not possible to conclude that any site has a TSS concentration that is significantly different from any other site. Site 019 shows some evidence of a higher concentration, but with only six observations it shows only weak evidence of a higher TSS concentration. It is expected that additional data will confirm high variability at site 019, yielding a higher standard deviation. Given the inherent variability evidenced in the data, it is unlikely that more samples would result in concentrations that show significant variation between the sites. If the development and evaluation of control alternatives indicates the need for additional characterization at any site, a specific characterization effort will be completed. Note that all of the sites with more than 6 observations have data consistent with a mean event concentration of 200 mg/l TSS. That is to say, 200 mg/l TSS is within one standard deviation of the mean for all sites with multiple observations.

[1] KDOW concerns in the receiving waters, as listed in the 303d report, are briefly summarized in Section 10.7 of the NMC Compliance Report (September 15, 2006). The 303d list cites DO and FC. It also lists cadmium as a concern, but notes that the concern may be an artifact of the sampling and analysis protocols.

Figure A-3
Summary of CSO Water Quality Data for TSS

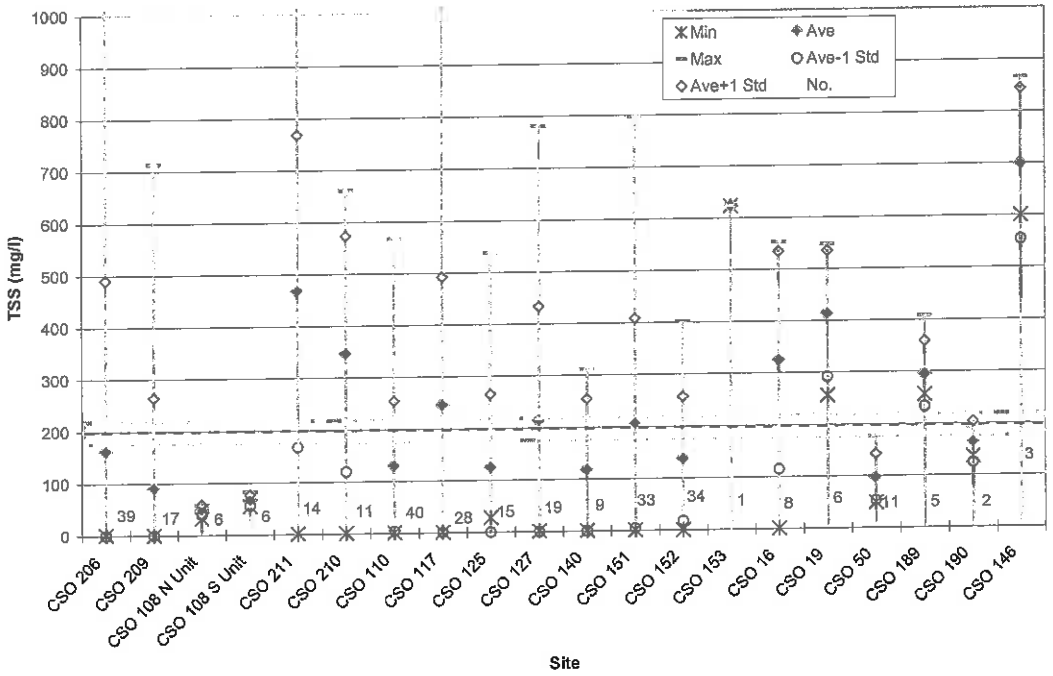


Figure A-4 illustrates that the BOD data in the CSO samples show a high degree of variability. With the degree of variability evidenced, it is not possible to conclude that any site has a BOD concentration that is significantly different from any other site. There is no statistically significant difference between sites draining highly commercialized or industrialized zones. Given the inherent variability evidenced in the data, it is unlikely that more samples would result in concentrations that show significant variation between the sites. . If the development and evaluation of control alternatives indicates the need for additional characterization at any site, a specific characterization effort will be completed. Note that most of the sites, particularly those with more than 6 observations, have observations consistent with a mean event concentration of 75 mg/l BOD. That is to say, 75 mg/l BOD is within one standard deviation of the average for the sites. The exceptions would indicate that some sites (e.g., CSO 140) may have lower average concentrations.

FIGURE A-4
Summary of CSO Water Quality Data for BOD

Figure A-4. Summary of CSO Water Quality Data for BOD

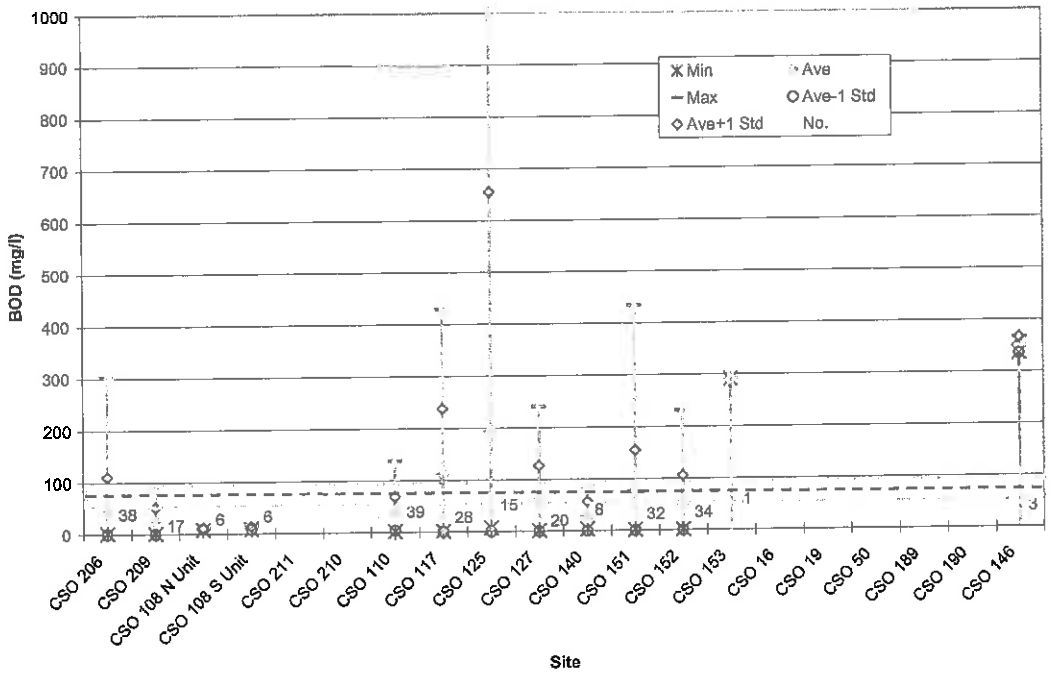
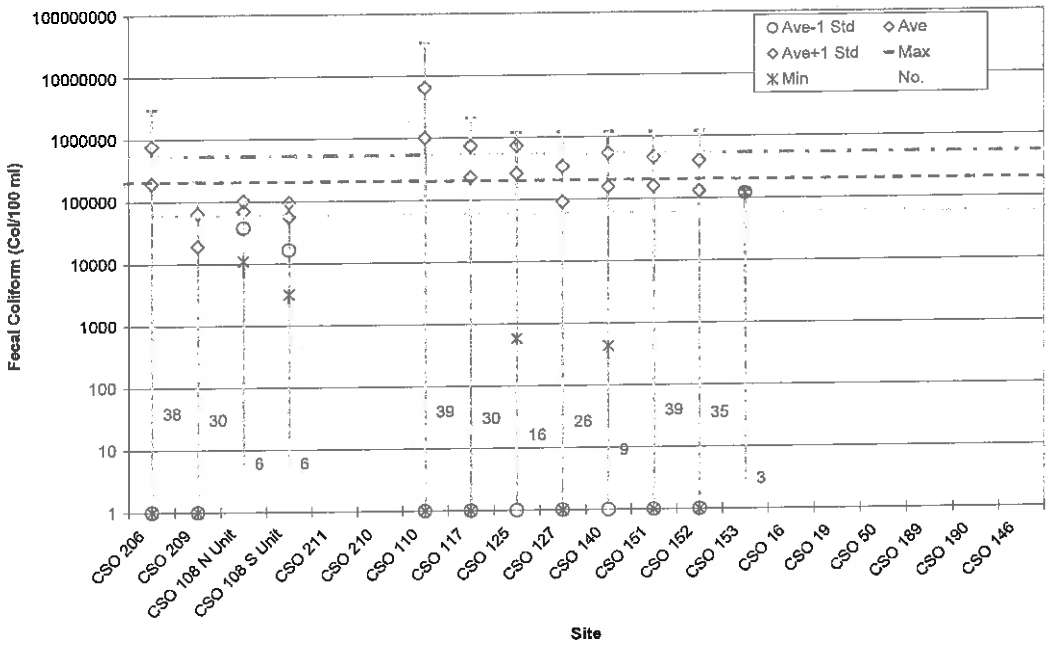


Figure A-5 illustrates that the FC data in the CSO samples show a higher degree of variability. Measurement of FC is itself imprecise, with expectations that duplicate measurements from one sample will often vary by an order of magnitude. Consequently, variations less than an order of magnitude are arguably insignificant. With the degree of variability evidenced in the CSOs it is not possible to conclude that any site has a FC concentration that is significantly different from any other site. There is no distinguishable difference between sites draining highly commercialized or industrialized zones. Given the inherent variability evidenced in the data, it is unlikely that more samples would result in concentrations that show significant variation between the sites. . If the development and evaluation of control alternatives indicates the need for additional characterization at any site, a specific characterization effort will be completed. Note that all of the sites have observations consistent with a mean event concentration of 250000 col/100 ml FC. That is to say, 250,000 col/100 ml FC is within one standard deviation of the mean for all sites.

FIGURE A-5
Summary of CSO Water Quality Data for Fecal Coliform

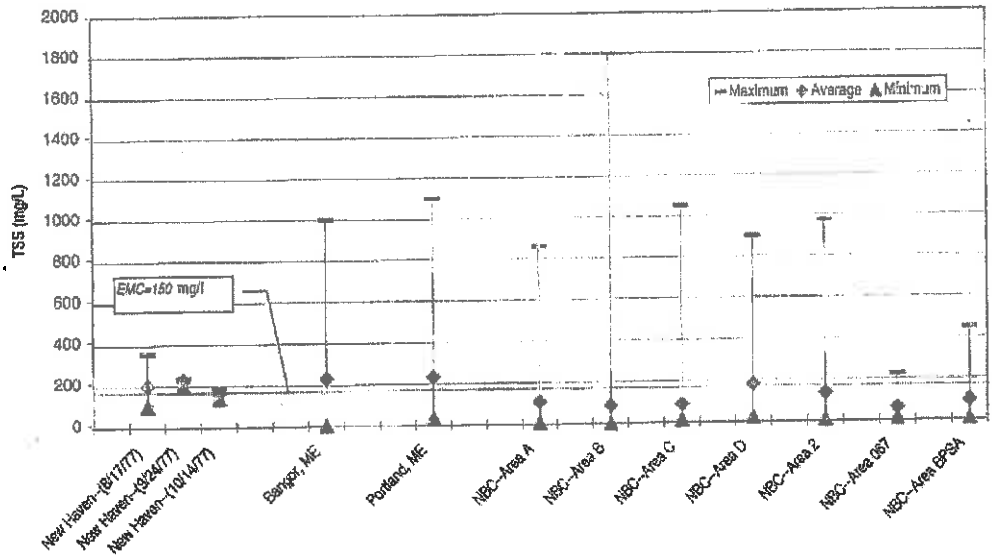
Figure A-5. Summary of CSO Water Quality Data for Fecal Coliform



The extreme variability shown in the data is not unexpected. Indeed, CSO long term control planning in several municipalities (Bangor ME, Portland ME, New Haven CT, Narragansett Bay Commission RI, Milwaukee WI, Atlanta GA) have observed similar variations and an inability to distinguish CSO concentrations from different land use areas. For example, Figure A-6 shows TSS data from 12 New England sampling sites where all were deemed consistent with as single EMC of 150 mg/l.

For purposes of analyzing loadings from CSOs, we recommend using the mean concentrations cited above for all CSO sites and all storm conditions. The data, and the precedents set in numerous other CSO planning studies, do not support varying the concentration estimates by site characteristics or by storm characteristics. That is not to say that variations do not exist. Even though the data do not show statistically valid higher concentrations for more urbanized sites, it is commonly assumed that more urbanized sites have a higher risk of spills of highly contaminated materials. Consequently, CSOs from highly urbanized sites may be prioritized for control despite a lack of sampling data that demonstrate a higher strength discharge. . If the development and evaluation of control alternatives indicates the need for additional characterization at any site, a specific characterization effort will be completed.

FIGURE A-6
Summary of CSO Water Quality Data for Multiple New England Sites

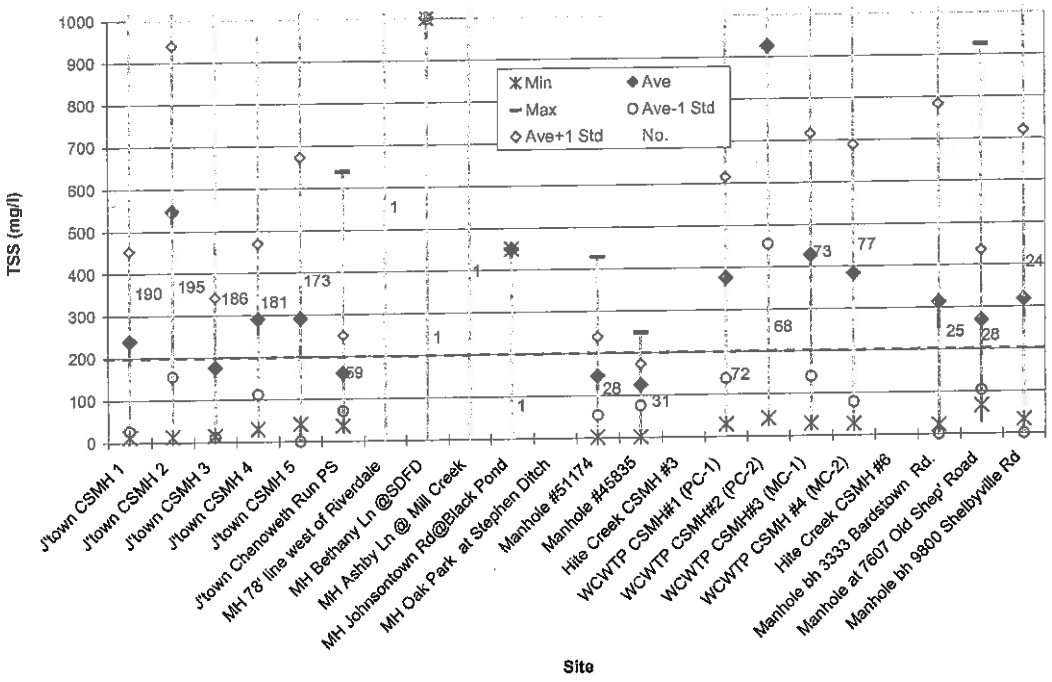


Non-CSO CSS Sampling

Data for the non-CSO sites within the MSD combined sewer service are summarized in Appendix 10-2 Non-CSS Sewer Data Details. The sampling sites for these data were shown, but not individually labeled, on Figure A-1. These data, too, show a high variability. The ranges TSS, BOD and FC data observed in the non-CSO CSS samples are charted in Figures A-7, A-8 and A-9, respectively. The non-CSO CSS data are often higher than the means (dashed lines) used for the CSO data. The non-CSO CSS data include primarily observations during dry weather conditions that are far different from the conditions prevailing when the CSOs can be sampled. The non-CSO CSS samples, however, provide observations of the constituents that potentially could flush into the CSOs.

MSD continues to scrutinize the non-CSO sampling data to identify impacts, if any, from significant industrial dischargers (SIUs) or other non-domestic dischargers of concern that have been issued general discharge permits (GDPs). The location of these non-domestic dischargers in relation to the CSOs are shown on Figure A-10 (oversized).

FIGURE A-7
Summary of non-CSO CSS Water Quality Data for TSS



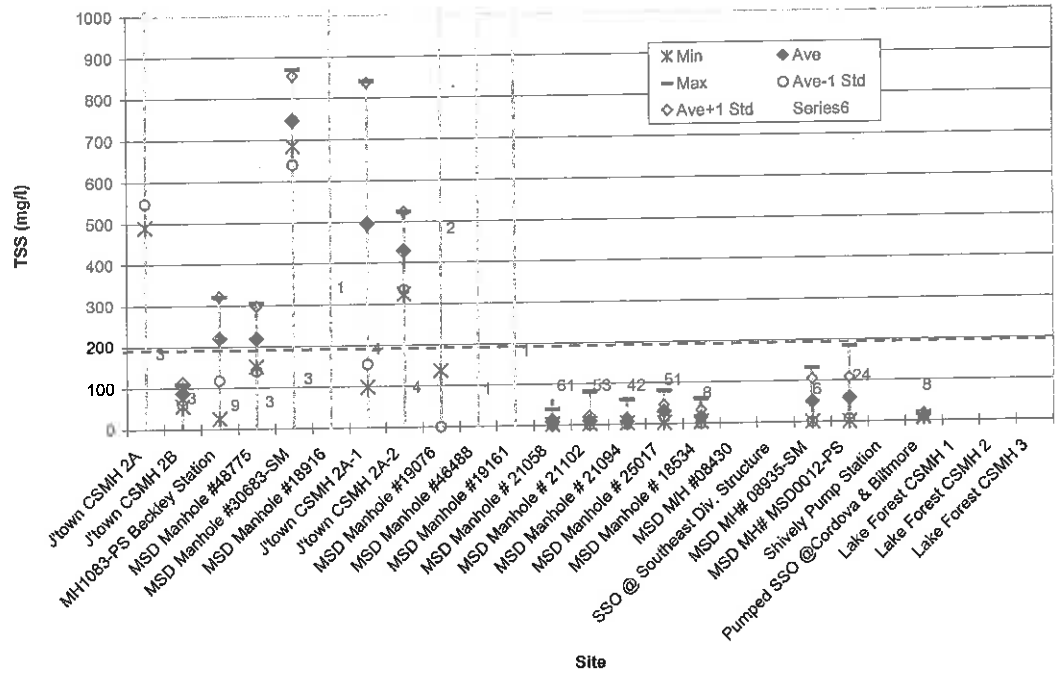
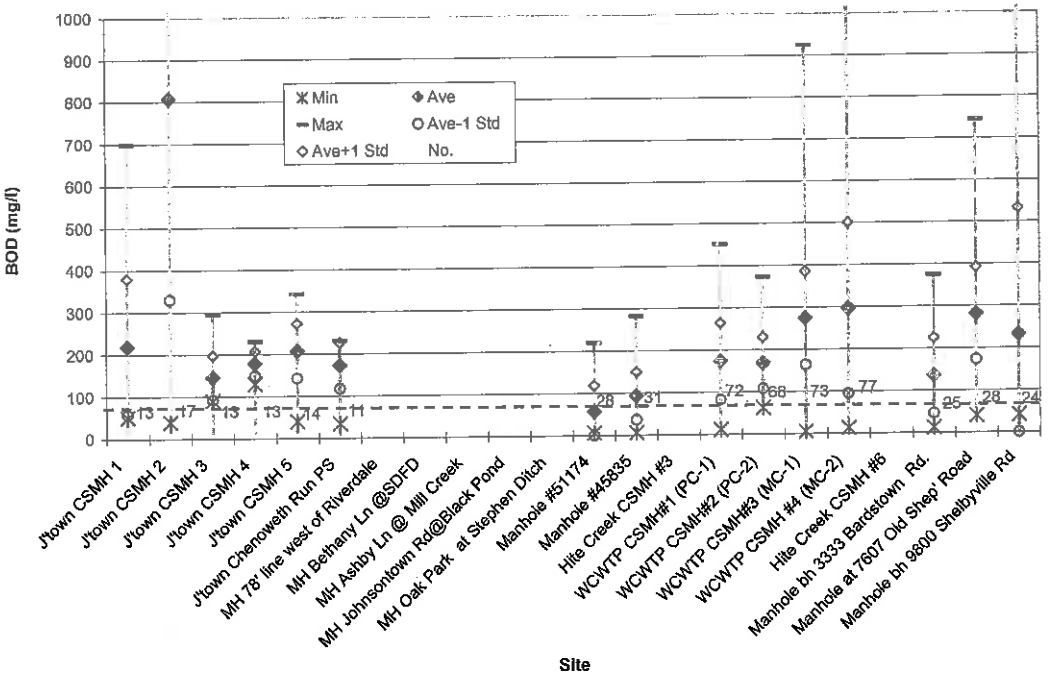


FIGURE A-8
Summary of non-CSO CSS Water Quality Data for BOD



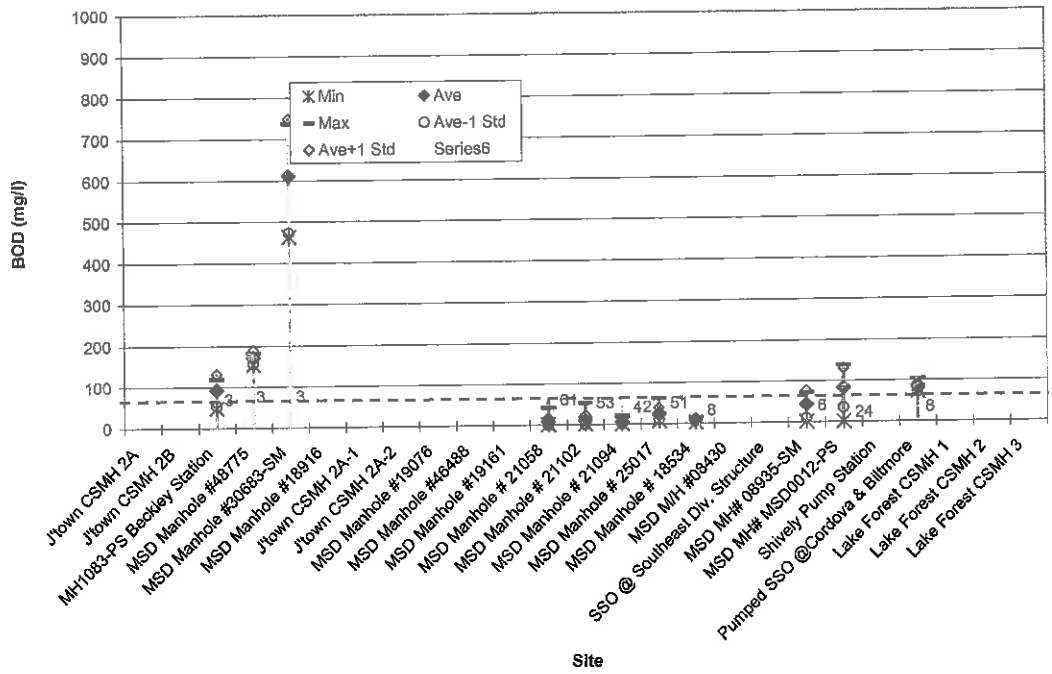
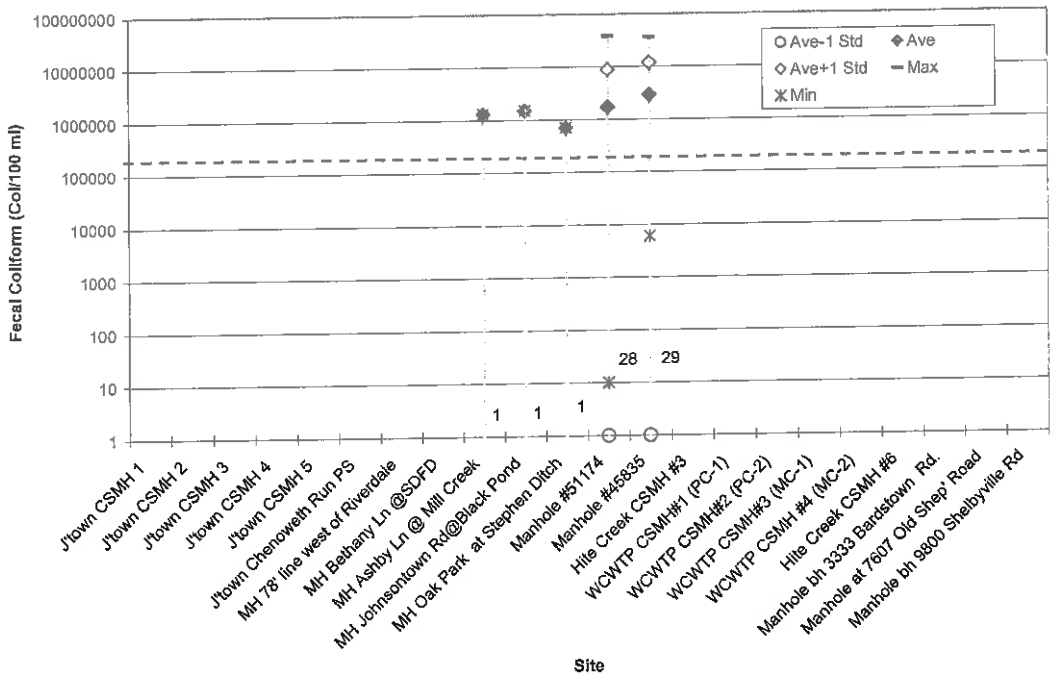
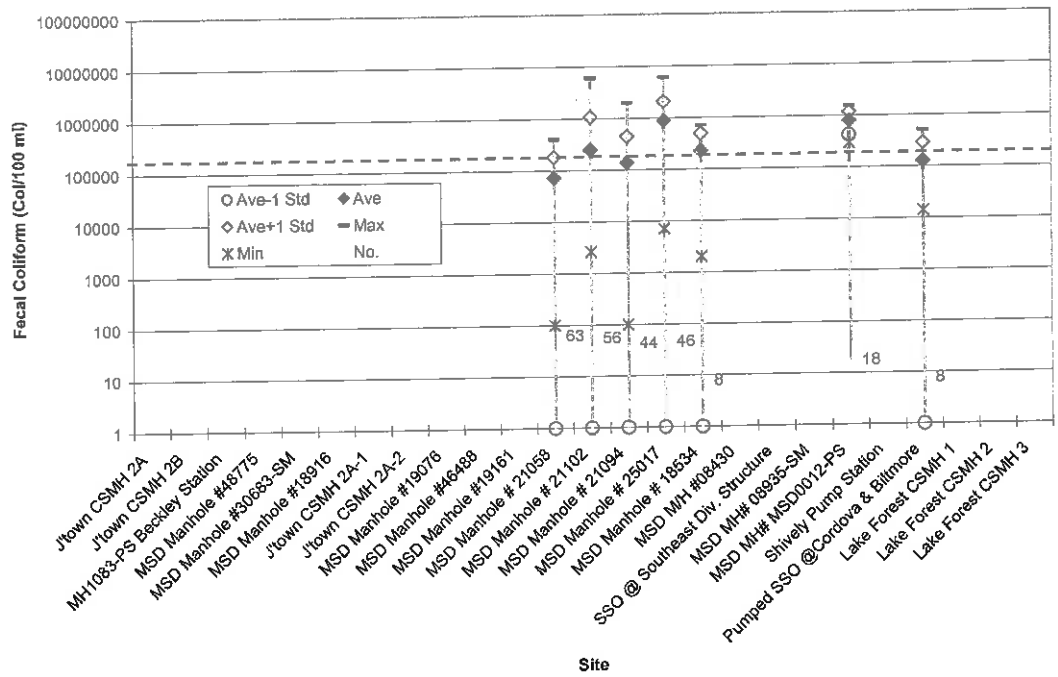


FIGURE A-9
Summary of non-CSO CSS Water Quality Data for FC





Receiving Water Quality Sampling Data

Water quality data gathered for the receiving waters in the MSD area also show a great deal of variability. There are some sampling locations on Beargrass Creek that demonstrate a higher variability than most, possibly indicating the wet weather impacts of CSOs. It should be noted, however, that the sampling locations on Mill Creek demonstrate a similar variability despite the absence of CSOs in the Mill Creek watershed. Given the number of CSOs in the Beargrass Creek watershed, and the likely overlapping influences of CSOs on sampling points, the impact of CSOs on receiving water quality cannot be quantified through simple comparisons. Detailed water quality modeling will be required to quantify the impacts of various loading sources.

Figures A-11, A-12 and A-13 summarize the water quality data gathered to date for receiving water TSS, BOD and FC, respectively. Receiving water quality data for locations with fewer than six sampling events should be ignored since their statistical significance cannot be quantified. These isolated samples were gathered for specific purposes, not for the general purpose of characterizing the receiving waters or calibrating the receiving water quality models.

The water quality evaluations completed as part of the KDOW tri-annual evaluations may be able to attribute causes to apparent high values in the receiving water sampling data, for example, identifying CSOs as a possible cause of the higher values. It is more likely that the ongoing TMDL studies will clarify the relationships between point and non-point sources and causes. It is expected that the TMDL studies will distinguish samples taken during dry weather, low flow conditions from those taken during wet weather, high flow conditions.

FC data presented in Figure A-13 are not suited for comparison to existing FC standards since they are presented as numerical, rather than geometric, averages. FC data in this memo are presented as numeric values since these are the values used in loadings analysis and numeric modeling to evaluate the relative impact of sources, therefore the potential impact of CSO controls.

FIGURE A-11
Summary of Receiving Water Quality Data for TSS

Figure A-11a. Summary of In-Stream Water Quality Data for TSS (Cedar Creek, Floyds Fork, Goose Creek and Harrods Creek)

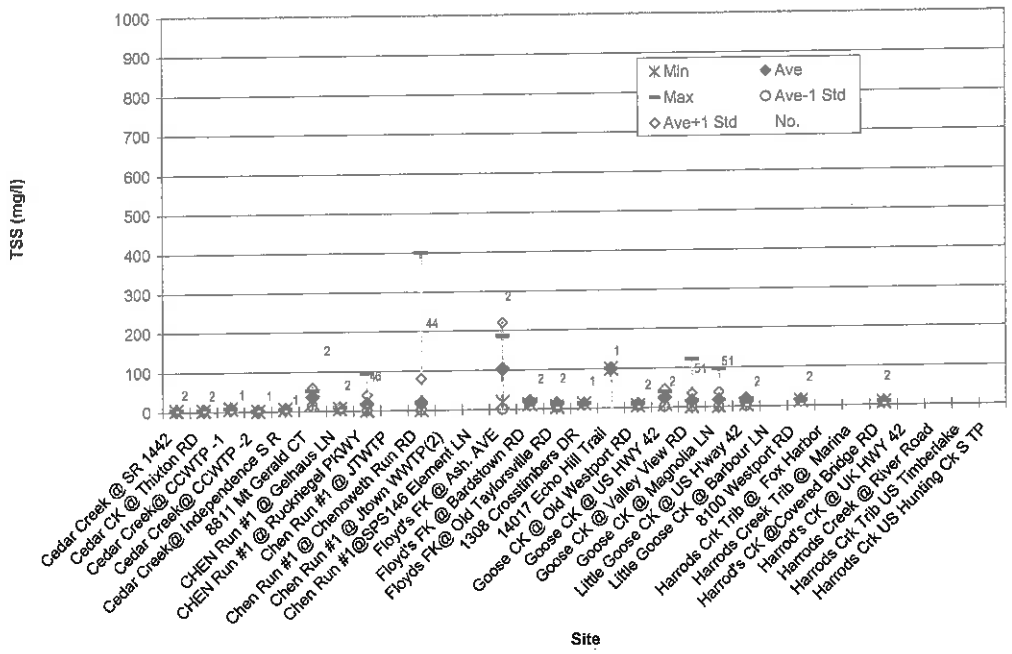


Figure A-11b. Summary of In-Stream Water Quality Data for TSS (Indiana & Mill Creek)

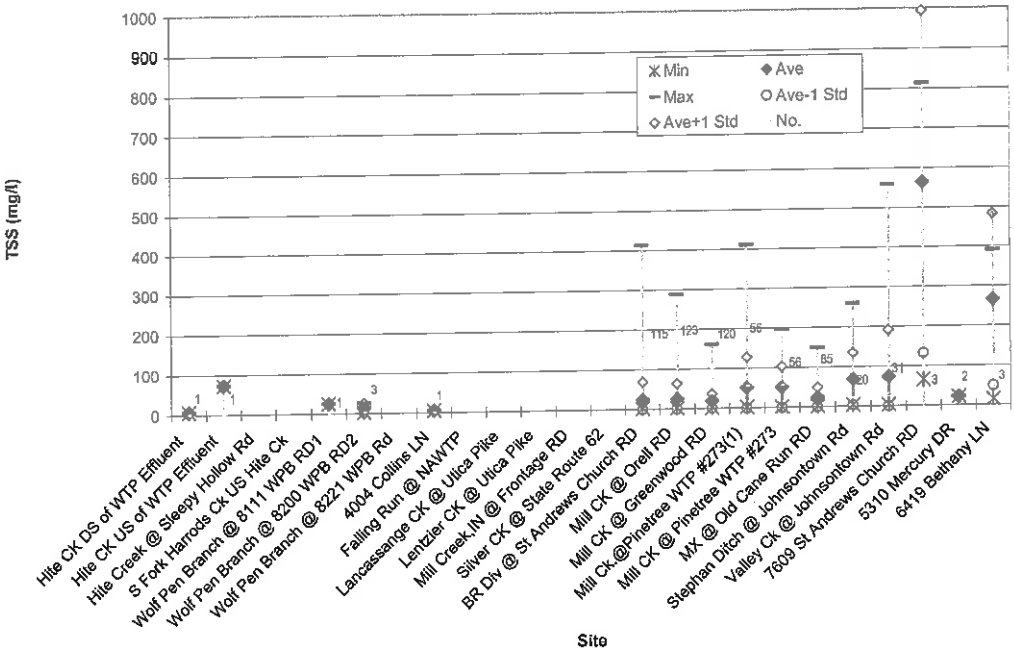


Figure A-11c. Summary of In-Stream Water Quality Data for TSS (Middle Fork, Muddy Creek, and Otter Creek)

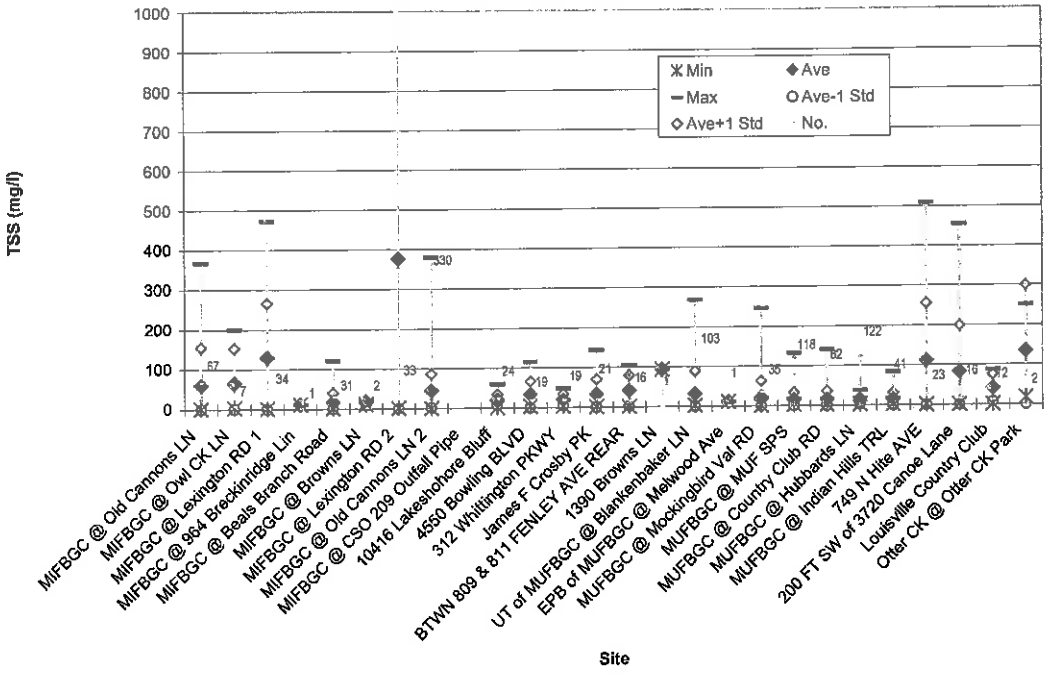


Figure A-11d. Summary of In-Stream Water Quality Data for TSS (Pond Creek, Pennsylvania Run, South Fork, Salt River, Wilson Creek)

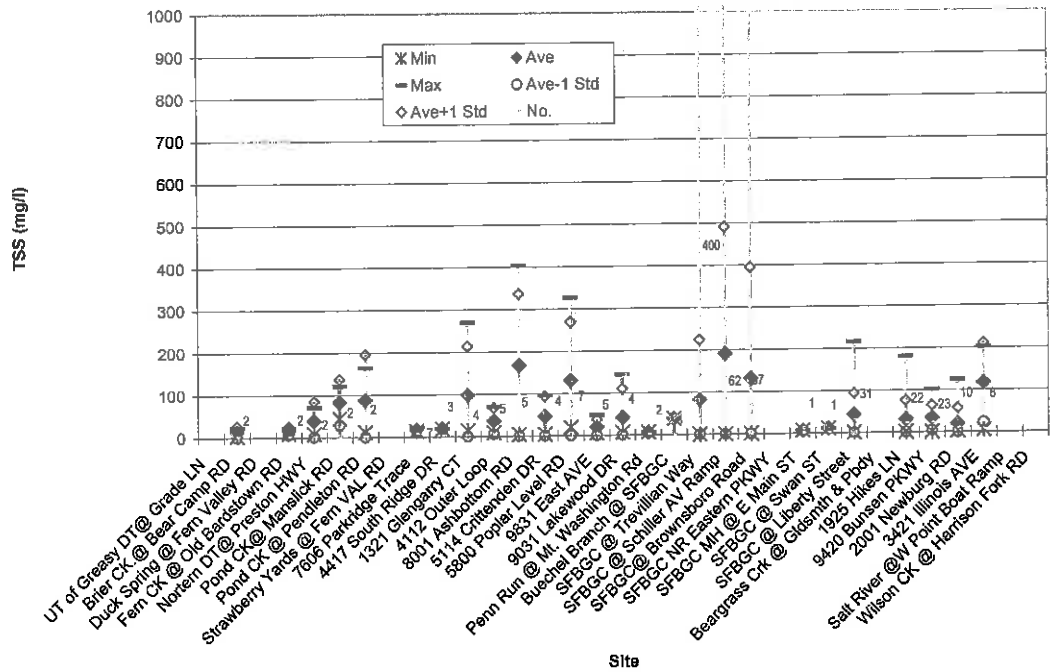


FIGURE A-12
Summary of Receiving Water Quality Data for BOD:

Figure A-12a. Summary of In-Stream Water Quality Data for BOD (Cedar Creek, Floyds Fork, Goose Creek and Harrods Creek)

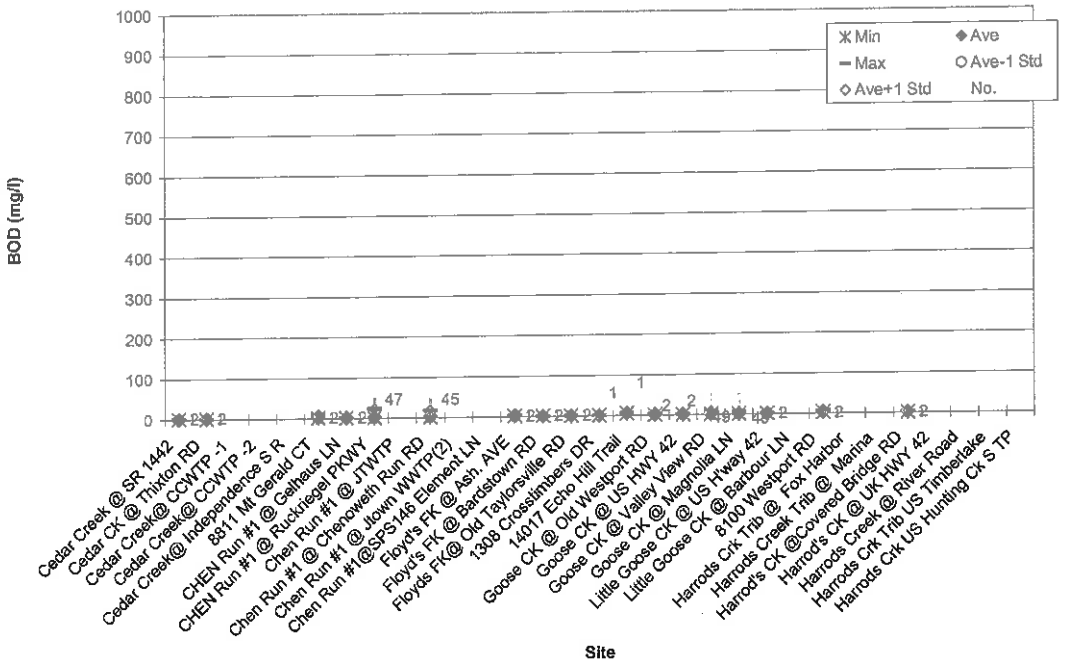


Figure A-12b. Summary of In-Stream Water Quality Data for BOD (Indiana & Mill Creek)

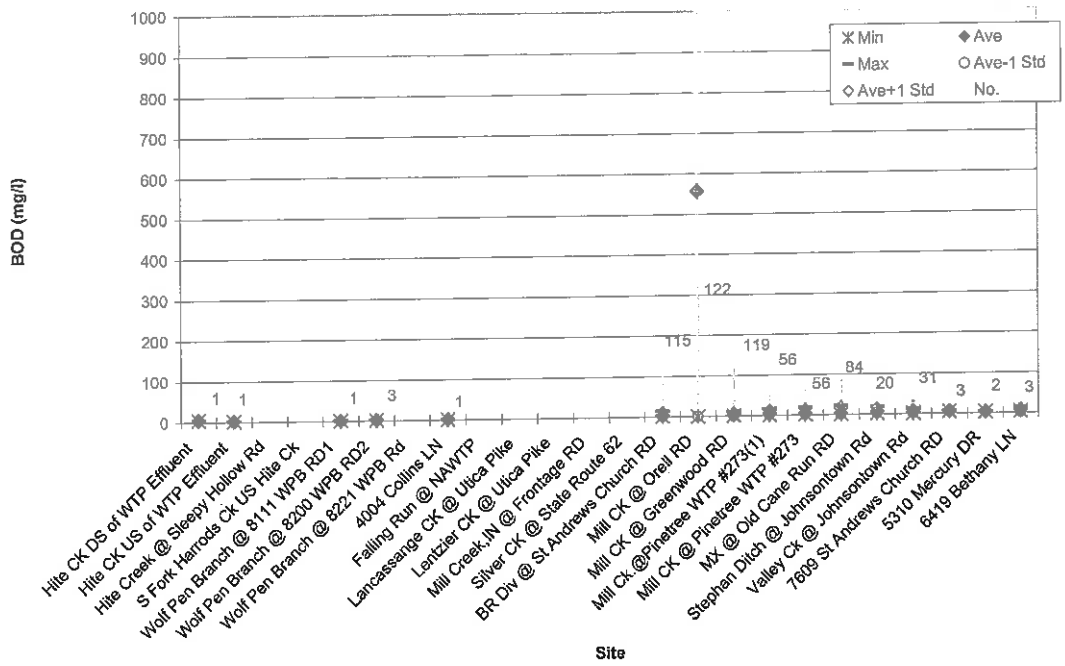


Figure A-12c. Summary of In-Stream Water Quality Data for BOD (Middle Fork, Muddy Creek, and Otter Creek)

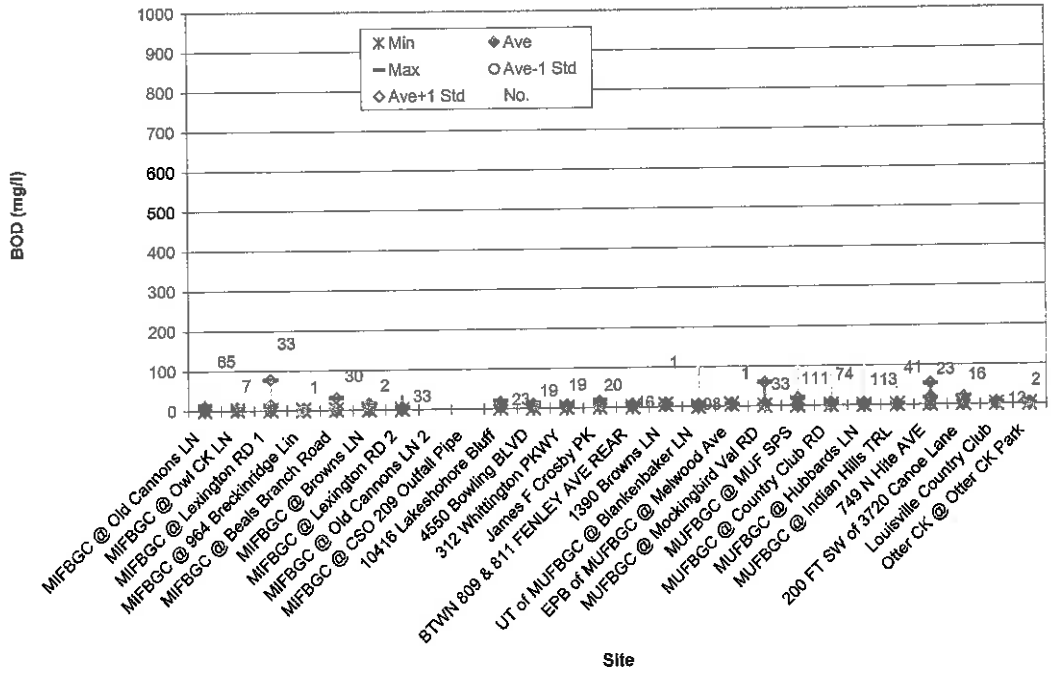


Figure A-12d. Summary of In-Stream Water Quality Data for BOD (Pond Creek, Pennsylvania Run, South Fork, Salt River, Wilson Creek)

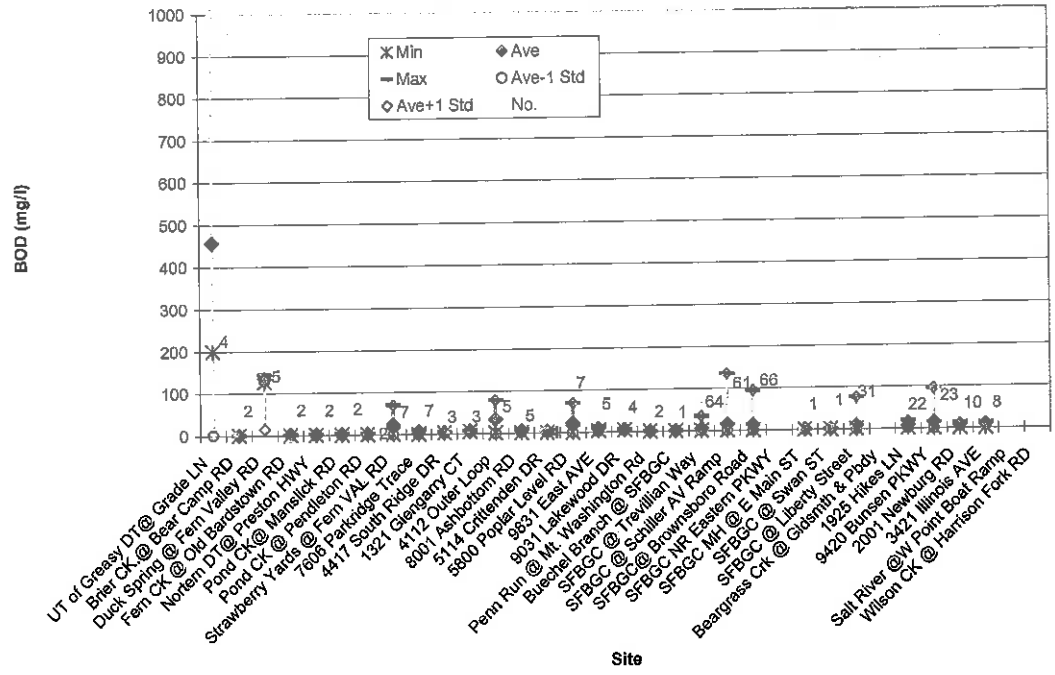


FIGURE A-13
Summary of Receiving Water Quality Data for FC:

Figure A-13a. Summary of In-Stream Water Quality Data for Fecal Coliform (Cedar Creek, Floyds Fork, Goose Creek and Harrods Creek)

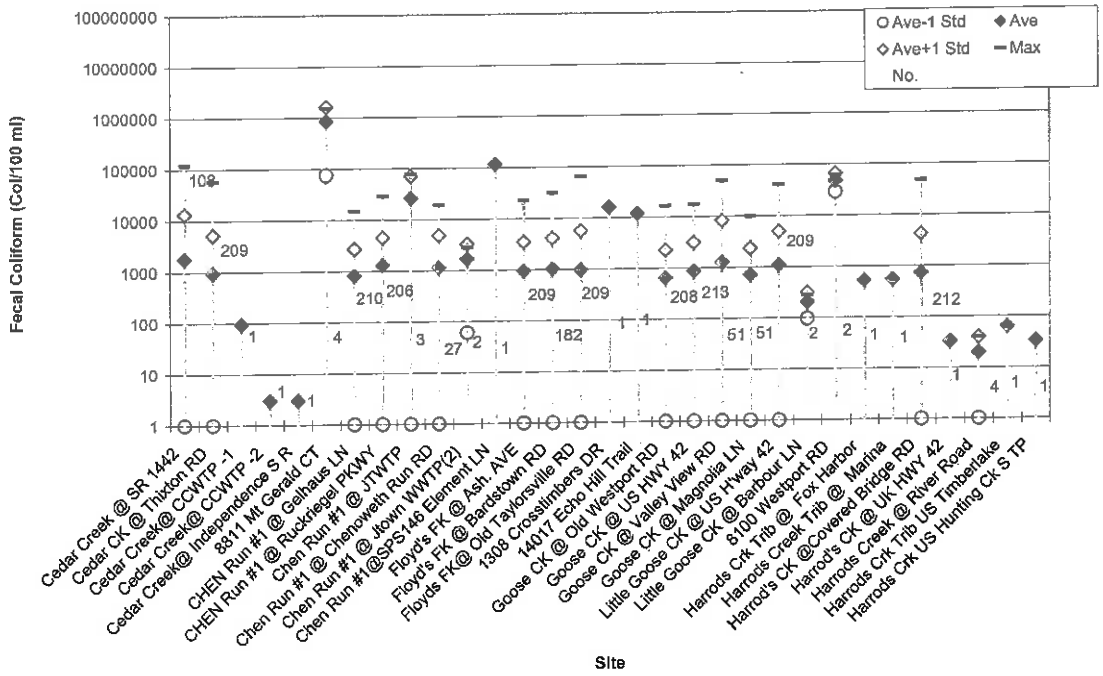


Figure A-13b. Summary of In-Stream Water Quality Data for Fecal Coliform (Indiana & Mill Creek)

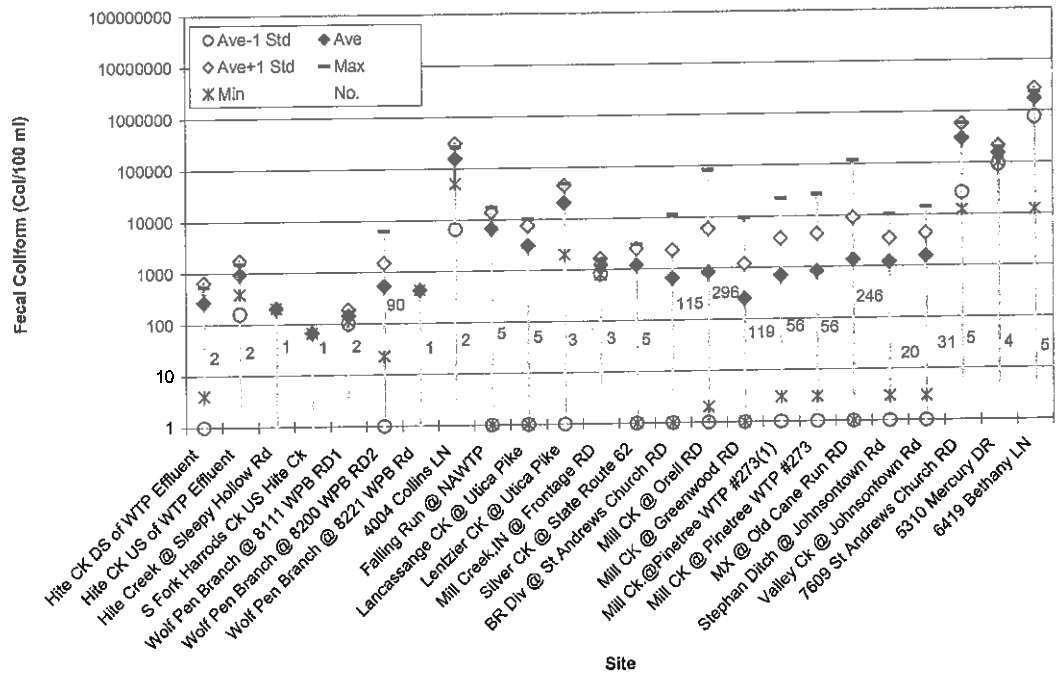


Figure A-13c. Summary of In-Stream Water Quality Data for Fecal Coliform (Middle Fork, Muddy Creek, and Otter Creek)

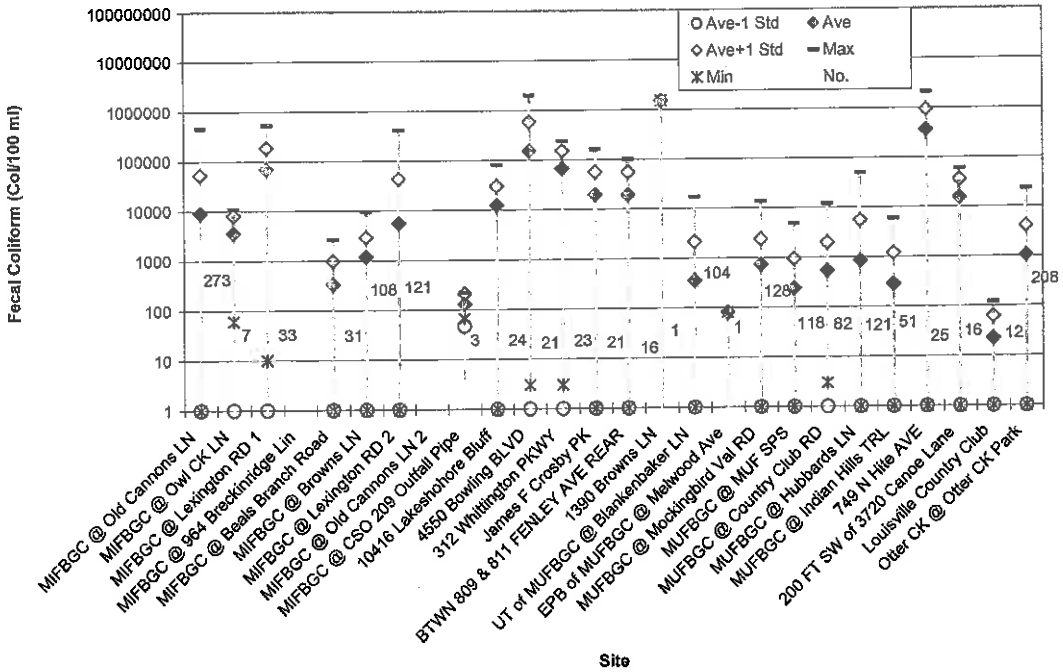
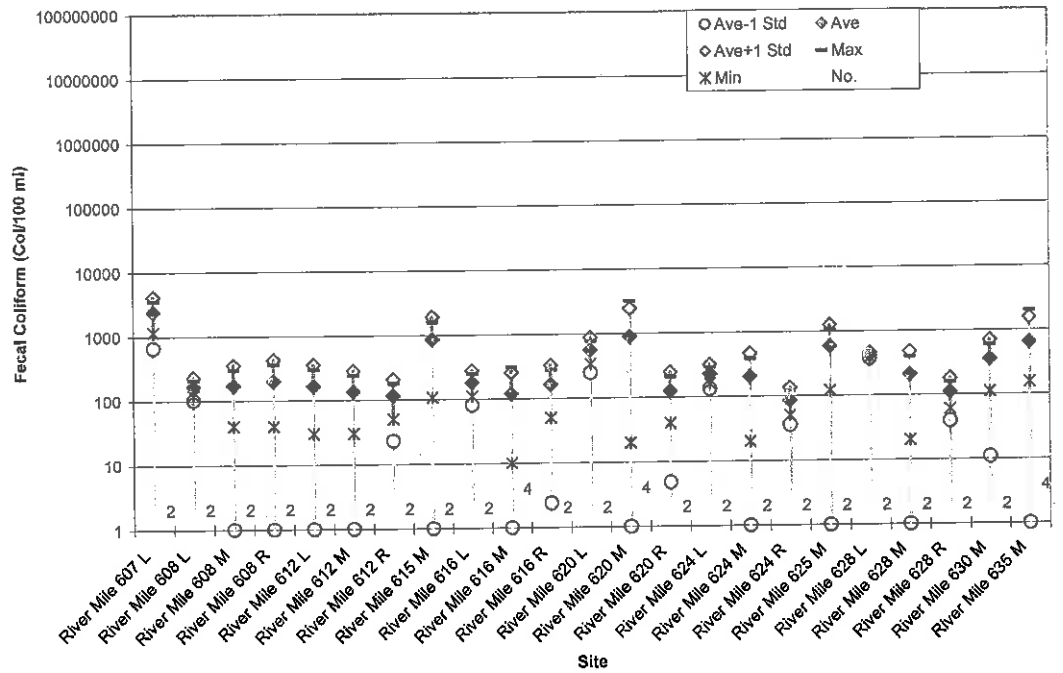


Figure A-13d. Summary of In-Stream Water Quality Data for Fecal Coliform (Ohio River 1)



The following subsections describe how the suggested supplemental long-term control plan monitoring programs will be developed.

11.2.5.1 Monitoring Plan Development

The monitoring plan development will first confirm the data gap then subsequently recommend specific monitoring locations, frequencies and parameters. Past monitoring is summarized in Section 2.3.1. Specifics of the monitoring locations, frequencies, and parameters are further described in Sections 10.4 of the NMC Compliance Report (September 2006). MSD will again review external data sources (e.g., ORSANCO, KDOW) and add external data to the repository of existing data. The existing models will be similarly reviewed and scrutinized for their ability to interpolate data.

Secondly, the objectives of each suggested supplementary monitoring program will be carefully reviewed to determine if they can be met through the use of the existing monitoring supplemented by the existing models.

Thirdly, the supplemental monitoring objectives will be reviewed to determine key factors required to ensure that data collected will be sufficient to meet the objectives. Factors to be determined include the following:

- Parameters to be monitored to meet the objectives,
- Frequency of sampling, or duration of continuous monitoring necessary to meet the objectives,
- Location of monitoring appropriate to meet the objectives,
- Accuracy of analyses required for the results to be statistically significant

The following summarizes preliminary development of monitoring programs to support the supplementary objectives suggested above.

11.2.5.2 Monitoring Program to Refine Sanitary/Combined Boundary Flows

Since the objective is to refine the flows, flow is the primary parameter under consideration for monitoring. Precipitation is frequently monitored coincident with flow monitors for analysis of wet weather phenomenon. In this case, however, the density of the existing MSD precipitation gage network and that availability of the calibrated radar rainfall network will likely preclude the need for additional precipitation monitoring.

For the monitored flows to be useful in refining and calibrating sewer flow models, they must reflect the range and nature of the variability of sewer flows at the boundary. Thus, the monitoring must reflect dry weather flow conditions and variations, moderately wet conditions, and extremely wet conditions. To achieve this, it is recommended that a continuously recording monitor be installed for a period sufficient to record flows from at least three storms. It is preferable to record at least one of which exceed intensities that recur no more frequently than once per year (e.g., greater than a 1-yr, 1-hr storm intensity). The duration of flow monitoring should probably be between 2 to 6 months in the rainy season to maximize the chance that significant storms will be captured.

Supplementary flow monitoring should be considered at points where the separate sanitary sewer system flows into the combined sewer system. The specific locations must be carefully screened for hydraulically stable flow regimes under dry weather and wet weather conditions, minimal backwater impacts, and safe, secure access for equipment installation and maintenance.

Maximum expected accuracy of temporary flow monitoring installations is +/- 10%. If the tributary areas between the suggested site and the nearest existing site on the same line is less than 10%, then the higher than normal flow monitoring accuracy would be required in order to produce data statically different than that at the existing meter.

11.2.5.3 Monitoring Program to Refine Overflow Estimates

Since the objective is to refine the overflow estimates, flow is the primary parameter under consideration for monitoring. Precipitation is frequently monitored coincident with flow monitors for analysis of wet weather phenomenon. However, the density of the existing MSD precipitation gage network and the availability of the calibrated radar rainfall network will likely preclude the need for additional precipitation monitoring.

For the monitored flows to be useful in refining overflow estimates, they must reflect the range and nature of the variability of sewer flows at the overflow. Thus, the monitoring must reflect dry conditions (accurately record 0 flow), moderately wet conditions, and extremely wet conditions. To achieve this, it is recommended that a continuously recording monitor be installed for a period sufficient to record flows from at least three storms. It is preferable to record at least one of which exceeds intensities that recur no more frequently than once per year (e.g., greater than a 1-year, 1-hour storm intensity). In this region, the duration of the flow monitoring should probably be between 2 to 6 months.

Supplementary flow monitoring is being considered at overflow locations previously estimated to discharge large flow quantities. The specific locations must be carefully screened for hydraulically stable flow regimes under dry weather and wet weather conditions, minimal backwater impacts, and safe, secure access for equipment installation and maintenance. Combined sewer outfalls commonly have complex hydraulic configuration unsuited to flow monitoring. The lack of a hydraulically stable location is often overcome by placing multiple monitors that measure the sewer flow into the diversion structure and out through the interceptor, then calculating the overflow quantity as the difference between the sum of the influent lines flow and the interceptor flow.

Maximum expected accuracy of temporary flow monitoring installations is +/- 10%. Combined sewer overflow monitoring seldom achieves this accuracy. Meter calibration in the overflow itself is precluded since flow only occurs episodically. If the overflow monitoring calculating the of overflow quantity from several distinct monitors, then the expected accuracy of differential calculation is no greater than the sum of the accuracies of the individual meters.

Section 11.2.5.3

Monitoring programs for CSO control planning serve many objectives, including those listed in the CSO Guidance for Long-Term Control Plan (EPA, September 1995):

- *Section 2.5:*
  - *Define the CSS's hydraulic response to rainfall*
  - *Determine CSO flows and pollutant concentrations/loadings*
  - *Evaluate the impacts of CSOs on receiving water quality*
  - *Support the review and revision of WQS*
  - *Support implementation and documentation of the NMC*
  - *Support the evaluation and selection of long-term CSO controls*
- *Section 2.5.2:*
  - *Gain a thorough understanding of the CSS*
  - *Adequately characterize the CSS response to wet weather events, such as the number, location, and frequency of the CSOs and the volume, concentration and mass of pollutants discharged*
  - *Support a mathematical model to characterize the CSS*
  - *Support the development of appropriate measures to implement the NMC*
  - *Support LTCP development*
  - *Evaluate the expected effectiveness of the NMCs and , if necessary, the long-term CSO controls*

Achievement of these objectives requires both monitoring for flows and sampling for water quality characteristics. Flow monitoring in the combined sewer service area, including CSOs, is commonly used to refine understanding of the system and to calibrate and verify models used to evaluate impacts of potential CSO control alternatives. Water quality sampling in the combined sewer system, including CSOs, is commonly use to characterize the contents of the combined sewer flows, identify "hot spots" of higher strength sewage, and characterize the quality of CSO discharges. The combination of flow monitoring and sampling is used to characterize pollutant loadings from CSOs into the receiving waters. Sampling in the receiving waters is used to evaluate impacts from CSOs relative to other pollutant loadings in the receiving waters and to calibrate and verify models for evaluation of alternative loading scenarios.

Section 11.2.5 discussed how the existing MSD sampling data is used to characterize the existing water quality characteristics of the CSOs and the receiving waters. These data will be combined with flow monitoring and physical system data to build combined sewer system models and receiving water quality models that will be applied to evaluate the impacts of future CSO controls.

MSD flow monitoring includes data from receiving water flow monitoring stations operated by USGS, data from 16 long term sewer flow monitoring stations and data from several study-specific short term flow monitoring locations. The locations of the long term sewer system and receiving water monitoring stations were shown in Figure10-9 in the September 15, 2006 submittal of the NMC Compliance Report. The sewer system flow monitoring data is being coupled with episodic CSO flow monitoring to calibrate and verify models that both expand the characterization of CSOs and allow evaluation of the effectiveness of CSO control alternatives.

Table A-2 describes the locations of 20 long term flow monitors, 7 of which were installed recently (in 2006) largely to improve the CSO characterization and modeling.

Flow monitoring is necessarily combined with models to characterize CSOs. It is infeasible to directly monitor flows at some CSO locations, hence hydraulic models are commonly calibrated and applied to estimate the frequency and volume of overflows from inaccessible or hydraulically complex CSO locations. The models use proven engineering principals, primarily hydrologic calculations, conservation of mass and conservation of energy to estimate flows at unmonitored locations. In addition, the accuracy of flow monitors is highly dependent upon the ability to calibrate and/or verify the installed monitor for the range of flow conditions. It is impossible to calibrate or verify monitors for peak flow conditions in the field, hence monitored flow data during high-flow CSO events is far less accurate than monitored data for non-overflow conditions. Hydraulic models are proven by testing them against measured conditions at the monitored locations during non-surcharged (non-peak) flow conditions when data are most reliable, then comparing them to the less accurate data collected during peak flow conditions.

In separate sanitary sewer systems, development of such hydraulic sewer models is largely dependent on flow monitoring data since the source of the wet weather flows into the sewer system is undefined (i.e., illicit connections unknown, cracks and root intrusions constantly evolving). In combined sewer systems, as in stormwater systems, the sources of the inflows are better understood and can be modeled largely in from physical data (mapping of catchments and impervious areas, count of connected residences, etc.). CSO and stormwater models are commonly developed and verified with a limited quantity of flow monitoring data at selected representative points and for selected, representative storms. In many locations with turbulent storm flow conditions, models that rely on continuity and sound engineering theory are sometimes considered as good, if not better, than measurements during peak flow conditions beyond the calibration range of the monitors.

MSD maintains the long term flow monitors in order to continually understand the flow rates in their systems. MSD operates 6 permanent, hard wired monitors, 4 in the combined sewer area and 2 in the west county area. The permanent monitors are integrated into the evolving real time control (RTC) systems. The monitors in the combined sewer area provide a strong base for quantifying the flows in the CSS and for calibrating hydraulic models of the combined sewer area. MSD deploys temporary monitors when necessary to further refine or confirm the understanding of the flows in the CSS. MSD will also deploy several simpler devices (floats, chalk lines) and post storm inspections to confirm the frequency of CSOs.

MSD resolved to monitor all CSOs estimated to have overflows exceeding 10 mgd. MSD remains committed to monitoring flows from these high flow sites wherever feasible. However, site specific investigations have concluded that several of these sites are not suitable direct monitoring.

Table A-2
Summary of Long Term Sewer Flow Monitors

	CSO No	Sites	Description	Receiving Water	Installation Date	Comments
1	019	34th & Rudd	34th STREET PS	OR	May-05	
2	105	Broadway & Western Pkwy	WESTERN OUTFALL @ BROADWAY	OR	FY07	Proposed for installation
3	108	Newburg Road	REG N0 1 - NEWBURG	SF BGC	Jun-05	
4	117	Dry Run Sewer @ BG Creek	REG NO 11 - DRY RUN	SF BGC	Jun-05	
5	118	Broadway & Beargrass Crk	REG NO 15 - E BRDWY	SF BGC	Jul-06	
6	127	Etley Avenue @	ETLEY AVENUE	MF BGC	Jun-05	
7	132	Brownsboro Rd @ Storage Co.	REG NO 35 - BROWNSBORO	MudF BGC	FY07	60ft Cable
8	151	Castlewood Avenue	REG NO 5 - CASTLEWOOD	SF BGC	Jun-05	
9	152	Ruffer Avenue	REG NO 7 - SOUTHEASTERN	SF BGC	Jun-05	
10	166	Lexington Rd @ 64 Over Pass	BEALS BRANCH SAN DIV	MF BGC	FY07	60ft Cable
11	182	Shelby & Burnett Street	SBR SHELBY & BURNETT	SF BGC	Jul-06	
12	189	Shawnee Park P.S.	NORTHWESTERN SAN DIV	OR	Apr-06	
13	190	Northwestern Pkwy	SEVENTEENTH ST SAN DIV	OR	Jul-06	
14	191	Bells Lane	SOUTHWESTERN PS	OR	Jul-06	
15	206	Cherokee Park	CHEROKEE PARK @ SPRING DR	MF BGC	Jun-05	
16	210	Whayne Supply @ Div Str	45th STREET-GREENWOOD	OR	Jul-06	60ft Cable
17	211	Whayne Supply @ Div Str	MAIN DIVERSION STRUCTURE	OR	Jul-05	
18	88	Brownsboro Rd @ BG PS		SF BGC	Jun-06	CSO Separation Project
19	110	Eastern Parkway			Jul-05	TMDL Wet Weather Sampling
20	140	Locust Street			Jun-05	TMDL Wet Weather Sampling

Experienced sewer system hydraulic modelers reviewed the available MSD flow monitoring data and concluded that it is already adequate for calibration and verification of combined sewer system hydraulic models. Nevertheless, MSD is committed to further sewer system flow monitoring where experienced review of the monitoring configurations indicates potential to provide reasonably accurate data that substantially adds to the characterization of CSS flows and CSOs in particular. Temporary monitors will be deployed episodically to further characterize flow conditions.

Table A-3 synopsizes how the available flow and sampling data will be used to answer key CSO LTCP questions.

Table A-3
Synopsis of Question Resolution with Monitoring Data

Question	***Answer from the Available Data***	***Expectation from Further Data***
Do CSOs carry pollutants of concern?	*Yes*	*Further confirmation and site-specific data where needed*
Do CSOs cause or contribute to violations of receiving water quality standards?	*Yes*	*Further confirmation and site specific data where needed*
Do CSOs from some land use categories carry higher concentrations of pollutants than CSOs from other land uses?	*Potentially, but the differences are masked by the variability.*	*Differences will continue to be masked by the variability. Site specific data gathering may be required to evaluate specific control alternatives.*
Do CSOs impact sensitive uses?	*CSOs impact contact recreation uses.*	*Since all receiving waters in Jefferson County are classified for the same sensitive use, stakeholder involvement may prioritize certain areas relative to contact recreation or other sensitive uses.*
What is the CSO pollutant loading to the receiving water?	*Will be calculated as the product of the mean concentration for CSOs (see section A-2) and the modeled overflow volume.*	*Confirmation of relative impact of CSOs vs. the other loads as being addressed in TMDL. Additional site specific data may be gathered based on the needs to evaluate control approaches.*

If further analysis of the data, including those being collected in late 2006 and early 2007, should indicate that additional data could significantly refine the understanding of the existing systems or significantly refine the verification of the models to be used in the evaluation of

alternative CSO controls and their impact, then MSD will gather the data so indicated. MSD remains committed to gathering sufficient data to definitively evaluate and refine CSO alternatives that result in demonstrable improvement to the quality of the water resources impacted by CSOs.

11.2.5.4 Monitoring Program to Support the TMDL

The monitoring effort to support the TMDL is being developed by the TMDL team for purposes beyond those of the LTCP. The LTCP may review data from the program for consistency with historic data and for further verification of the LTCP models. However, the LTCP team is not developing this monitoring program.

11.2.6 Combined Sewer System and Receiving Water Modeling

MSD has used combined sewer and receiving water modeling extensively to support CSO and CSO impact characterization. The models developed to date are summarized in Section 2.5 and 2.6, respectively. Efforts are currently underway to improve these models. Ongoing efforts to improve the models are summarized below.

MSD and consultants will use the sampling and flow monitoring data to calibrate both sewer system models and receiving water quality models. MSD and consultants will scrutinize the data, the outputs from these models and stakeholder observations to identify locations where the CSOs perceptibly contribute to water quality problems.

Tools and approaches for evaluating the data and the CSO impacts will include:

a. *Geographic information systems (LOJIC) will assist in evaluating, and depicting, the sewer network relationships between industrial discharges and CSOs. MSD and/or their consultants will continue to use LOJIC to identify the network relationship between existing industrial dischargers and CSOs, then scrutinize the sampling data for the dischargers, the downstream CSS and the CSOs to ascertain which CSOs are at risk for high concentrations of which pollutants. Note that all CSOs are at risk for episodic discharges of any pollutant that could be spilled on the road surface or illicitly discharged into a catch basin, manhole or sewer.*

b. *Geographic information systems (LOJIC) will assist in evaluating, and depicting, the stream network relationships between CSOs and observed receiving water conditions. MSD, their consultants, and the TMDL team will scrutinize the LOJIC coverages to identify which CSOs potentially impact which receiving water quality sampling sites. They will also scrutinize the in-stream water quality data (NMC Appendix 10-3) to evaluate whether the potentially impacted sampling sites show pollutant concentrations significantly different from sites not potentially impacted by CSOs.*

c. *Sewer models will be used to calculate volumes and frequencies discharging from the existing CSOs. MSD and their consultants will build, calibrate and verify sewer system models consistent with the data collected and with engineering science. Once verified, these models will be run for test conditions reflecting base line conditions expected if previously committed projects are completed.*

d. *Stormwater models will be used to calculate volumes from existing urban stormwater sources. These models will be defined in the TMDL modeling process. At a minimum*

these models will estimate runoff volumes and pollutant concentrations for test storm conditions using drainage areas and land use data available in the LOJIC system and concentrations from the National Urban Runoff Pollutant Studies refined for consistency with MSD sampling data.

e. *This spatial data analysis described in "b" above will be refined in the development, calibration and verification of receiving water quality models that calculate in stream characteristics from the known physical and biological characteristics, bio-chemical science, and the loadings calculated from the sewer models and from other sources reflected in the water quality sampling data. These models will be used to quantify loadings to critical points in the receiving waters. ,*

f. *Spreadsheets will be used to parse those total loadings from the models in "e" into relative contributions from major sources (e.g., percent of total contributed from upstream reaches, from CSOs, from urban stormwater, from non-point sources, etc.).*

g. *Engineering judgment will be used to evaluate cause-effect relationships between the quantified loads and the stakeholder perceptions of water quality impacts. These evaluations and measures of their significance will be presented to the stakeholders for refinement of a common understanding of the water quality impacts, causes and their relative significance.*

h. *Engineering science will be applied to identify, screen and evaluate alternatives to reduce the frequency and volume of CSO. These evaluations will follow the principles outlined in the Guidance manuals for CSO LTCPs and the recent Guide to Managing Peak Wet Weather Flows (WEF, August 2006) augmented with the evolving technologies (e.g., 'green' storages) and with the approaches outlined in the value-based risk management process (Sep. 15, 2006 Interim LTCP section 11.5.3.2).*

i. *Sewer models will be used to quantify the impact of CSO control alternatives on loadings to the receiving waters. This involves simulating the alternatives identified in "h" in the models developed in "d" and "e", then summarizing the results consistent with summaries presented to the stakeholders describing existing and baseline conditions to allow comparison.*

j. *These comparisons will include spreadsheets and graphics similar to those in g to evaluate the total receiving water loading impact of the alternative.*

k. *Engineering science, and potentially receiving water quality models, will be used to evaluate the receiving water quality impacts from CSO control alternatives.*

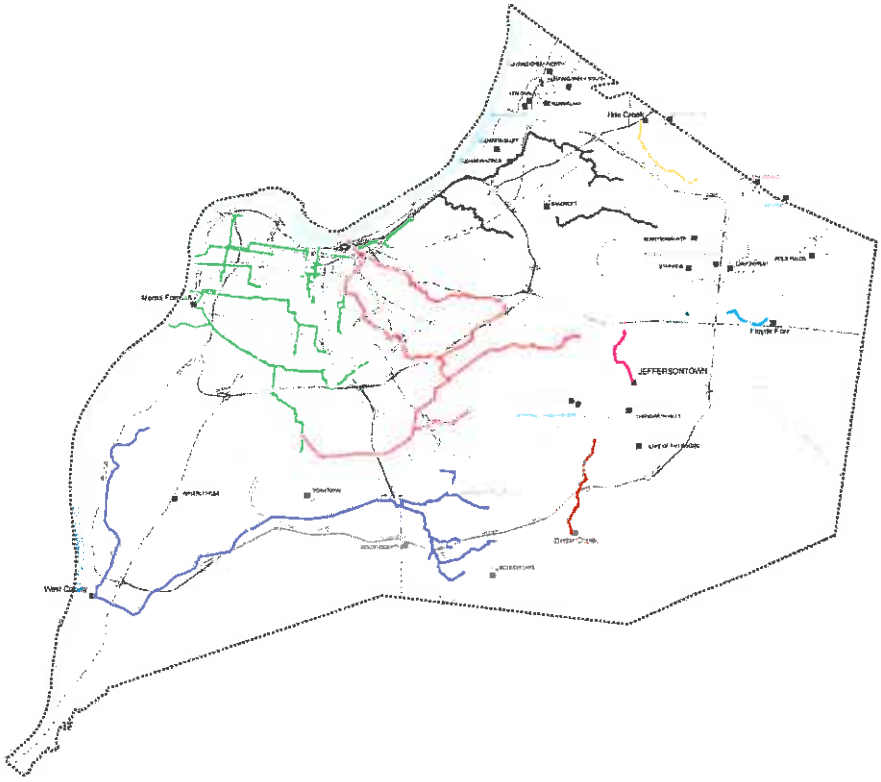
Engineering science and deductive logic will be used to perform comparative evaluations of potential CSO control alternatives. The monitoring, sampling and modeling will be used primarily to quantify decision criteria. However, many meaningful criteria are likely to be identified and objectively analyzed independent of the monitoring, sampling and modeling. For examples, engineering science may conclude that reductions in frequency of CSOs will reduce the stakeholder observations of objectionable materials in the waterways and reduce the potential for human exposure to pathogens even if predictive models cannot quantify this conclusion.

11.2.6.1 Combined Sewer System Modeling

While a great deal of effort has been spent on various sewer models throughout the County, work still remains to properly integrate the models to the level needed for alternatives analysis in

support of the LTCP. Each of the models is in the process of being updated to adhere to a consistent modeling standard (pipe size, parameter development, etc.). Additional calibration is also anticipated using the most current rainfall, flow monitoring, and water quality data. Figure 11-6 shows the sewershed pipe networks in different colors – each of which will require modeling updates to integrate.

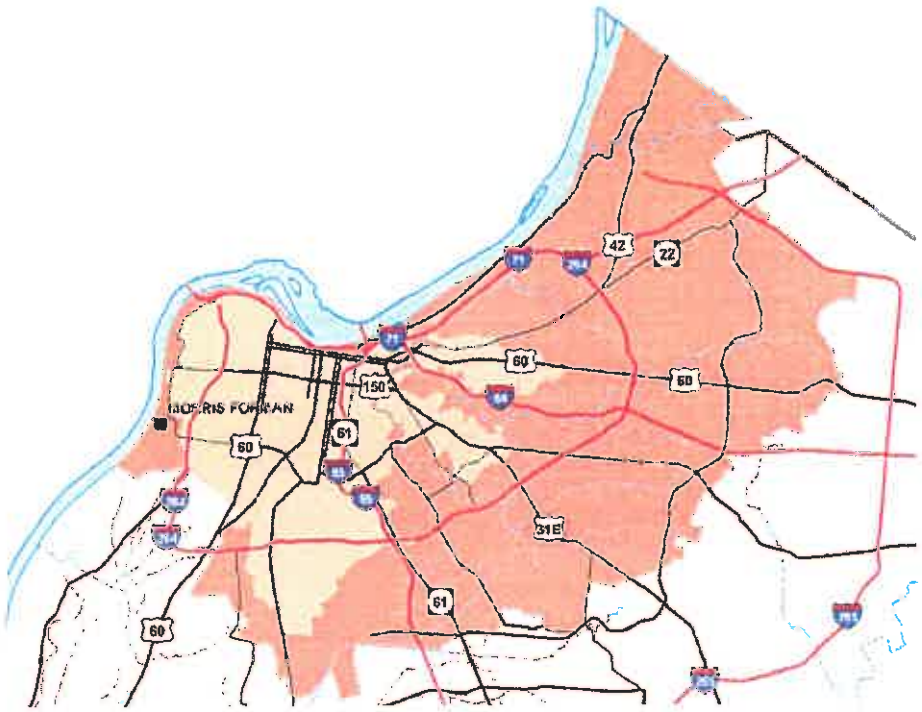
FIGURE 11-6
UPCOMING MODELING PROJECTS WITH
MAIN TRUNKLINES AND INTERCEPTORS IN BOLD



Beargrass Creek Integrated Model

The Beargrass Creek Watershed has been studied extensively over the past years. The watershed encompasses the Combined Sewer System (CSS) within the Louisville Metro area, which constitutes a large portion of the flow treated by the Morris Forman Wastewater Treatment Plant (MFWTP). This treatment plant is the largest within the State of Kentucky and also receives a large amount of flow from separate sewer systems lying mostly upstream of the CSS area. The plant has an average design daily flow of 120 MGD and peak storm flow rate of 350 MGD (peak sustainable flow is estimated at 325 MGD). Figure 11-7 depicts the MFWTP service inlayed with the CSS area.

FIGURE 11-7
MFWTP SERVICE AREA (RED) AND CSS AREA (YELLOW)



Historically, the sewer models produced for this service area have been separate hydraulic models for the CSS area and the various sanitary areas. This approach was driven, primarily, by the run-time and stability limitations of the modeling software being used at the time. Currently, two versions of the CSS model exist with varying levels of detail. A 2000 node model exists that has been utilized for most analytical purposes. A 6000 node model, built by the U.S. Army Corps of Engineers, exists, but is cumbersome to use. Sanitary models within MFWTP service area currently exist for Buechel Branch, Hikes Point, Middle Fork Beargrass Creek, and Prospect having 1750, 4750, 9300, and 1400 nodes respectively.

An integrated sewer model of the CSS and sanitary areas will be developed to provide a more accurate, seamless analytical tool for alternative selection. Over time, this integrated model will be invaluable in making reliable decisions related to the LTCP and will allow Real Time Controls to be coded into the detailed model for simulation. Use of this model will also ease some of the complexity related to the Water Quality Tool and the communication between the HSPF models and the sewer overflow model.

Collectively, 23,000 nodes within the MFWTP service area have been modeled to a varying pipe diameter limit in the CSS and sanitary models. The service area currently holds the following sewer assets:

TABLE 11-3
MFWTP SEWERS BY DIAMETER RANGE (TYPE, LENGTH, COUNT)

MORRIS FORMAN
length (ft)
# of segments

Diameter Range	C	CI	F	I	O	S	T	Total
< 4 Inches	7,592	0	28,436	0	0	44,084	0	80,112
	102	0	150	0	0	483	0	735
4-6 Inches	0	0	28,243	0	0	2,159	0	30,402
	0	0	177	0	0	19	0	196
6-8 Inches	2,487	0	24,941	0	0	76,120	0	103,549
	32	0	126	0	0	742	0	900
8-12 Inches	52,008	17	31,553	841	0	4,771,260	6,011	4,861,691
	419	2	177	24	0	28,339	28	28,989
12-18 Inches	1,033,627	215	12,737	621	0	370,529	29,559	1,447,288
	6,117	5	69	14	0	1,798	140	8,143
18-37 Inches	1,309,191	22,618	169,301	2,957	0	87,196	283,638	1,874,902
	7,336	113	660	43	0	411	1,226	9,789
37-72 Inches	280,597	73,411	7,842	299	258	17	51,715	414,140
	1,673	308	36	6	1	2	212	2,238
>72 Inches	117,561	140,843	0	0	0	0	0	258,404
	739	570	0	0	0	0	0	1,309
0.00	32,653	7,352	0	0	0	0	29,446	69,451
	194	27	0	0	0	0	99	320
Total	2,835,716	244,457	303,053	4,718	258	5,351,366	400,370	9,139,938
	16,612	1,025	1,395	87	1	31,794	1,705	52,619

Sewer Main Line Types

C - Combined Line
CI - Combined Interceptor
F - Forcemain
I - Siphon
O - Overflow
S - Sanitary Sewer
T - Trunk Line/Interceptor

While the MFWTP service area has 52, 600 pipe assets related, it is very doubtful that the integrated model will be detailed to the 4" or 6" diameter level. However, integration of the sanitary and combined sewer models and model development to a county-wide standard, currently under development, are crucial over the next 15 months.

Other Models

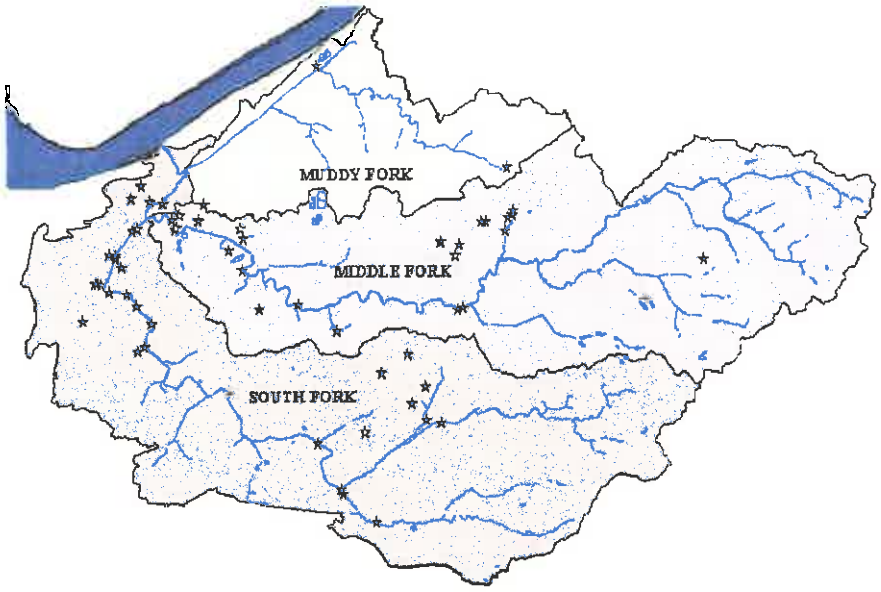
Other models exist or need to be developed in addition to those mentioned above. The RTC Spline model may need to be revised once the software conversion for the detailed modeling update have occurred. This model is used by BPR's CSoft to manage Louisville's Real Time Control system.

11.2.6.2 Receiving Water Modeling

Beargrass Creek Water Quality Tool (WQT)

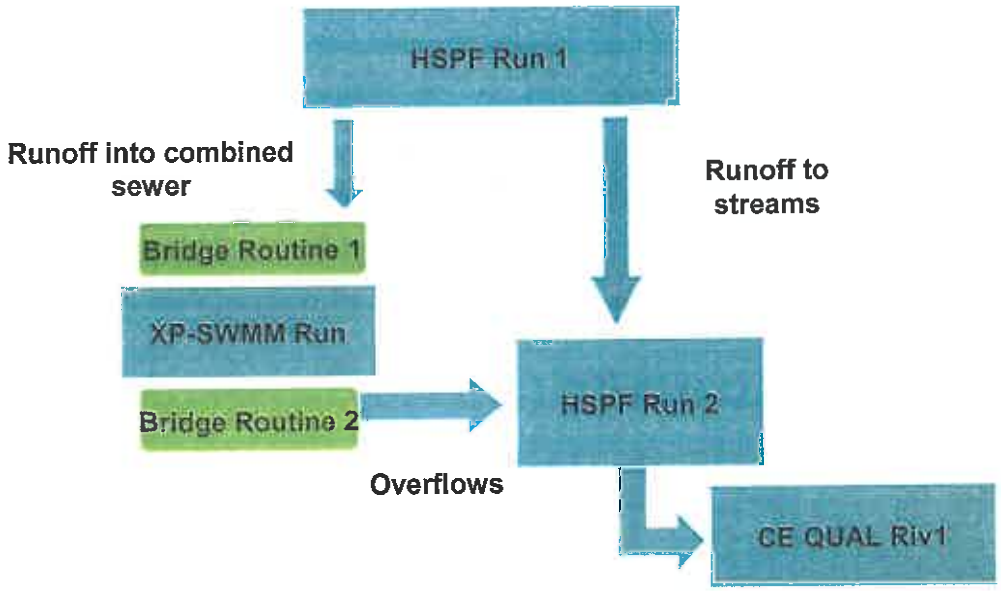
Since early 2003, MSD, in partnership with the University of Kentucky's Kentucky Water Resources Research Institute (KWRRI) and the Kentucky Division of Water (KDOW), has been collecting environmental data and developing a modeling tool to support Total Maximum Daily Load (TMDL) studies for pathogens, dissolved oxygen and organic enrichment in Beargrass Creek in eastern Jefferson County. EPA provide partial funding for this effort.

FIGURE 11-8
BEARGRASS CREEK WATERSHED



A complex network of hydrologic and hydraulic models is currently under development to serve as an analytical tool for load assessment and system reaction to pollution reduction alternatives.

FIGURE 11-9
INTERRELATED MODELS



The integrated HSPF, XP-SWMM, and CE-QUAL Riv1 models are collectively known as the Beargrass Creek Water Quality Tool (WQT). Begun in 2000, this project includes the following primary tasks:

- Data Management
  - QAPP development
  - Database development
- Modeling
  - SSO prediction
  - Watershed model refinement
  - CSO model refinement
  - Receiving water model development
  - Model calibration and validation
  - Modeling documentation
- Pollutant Allocation Analysis
  - Stream assimilative capacity assessment
  - TMDL load allocation assessment

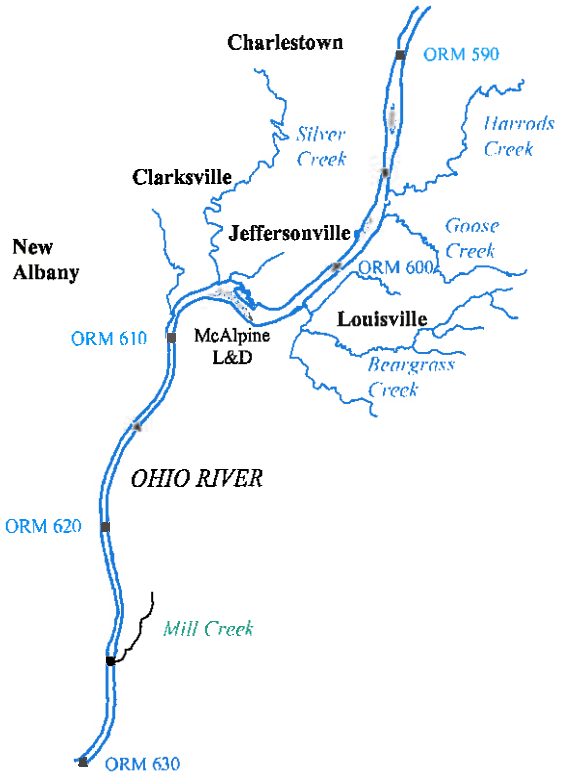
The project is currently in the model calibration and validation task with an anticipated end data of December 2006. Once completed, the WQT will be used to support the development of the TMDL reports by KWRRI. This tool will also be used in the LTCP process to evaluate the effectiveness of various CSO control alternatives.

ORSANCO Study

The Ohio River Valley Water Sanitation Commission (ORSANCO) produced draft report entitled, "A Study of Impacts and Control of Wet Weather Sources of Pollution on Large Rivers." The purpose of this study was to transfer the methodologies and technologies developed in a similar Cincinnati/Northern Kentucky area study to a segment of the Ohio River in the vicinity of in the vicinity of Louisville, Kentucky, for the evaluation of combined sewer overflows (CSOs) and other wet weather impacts on the water quality of a large river, and to evaluate resulting benefits from certain abatement scenarios.

Specific objectives of the study included: 1) determination of the extent and severity of wet weather water quality impacts on the Ohio River, 2) identification of the pollutants and sources of impairment, and 3) classification of the relative importance of the identified sources. Major project components included multiple wet and dry weather water quality surveys, dye surveys during both high and low-flow conditions to determine lateral mixing, landside modeling to estimate pollutant loadings from CSOs and other important sources, hydrodynamic modeling to simulate the complex hydrodynamics of the study area, particularly around the McAlpine Locks and Dam, setup and execution of a river model to determine the extent and severity of wet weather water quality impacts, and a special study to evaluate the Colilert method for Escherichia coli analysis. Project data was compiled on CD in a GIS-based storage and analytical tool. Select modeling results are viewable on CD in a special animator available with this report.

FIGURE 11-10
OHIO RIVER STUDY EXTENTS



MSD is reviewing this model to determine its suitability for more detailed evaluation of CSO control approaches. MSD may make some modifications to this model to improve its utility in evaluating alternatives developed in the LTCP, or may use the model as is.

11.3 PUBLIC PARTICIPATION

11.3.1 Major Issues Requiring Public Input

In accordance with the CSO policy, a public participation process will be implemented that actively involves the affected public in decision-making to select the long-term CSO controls. A complete public participation process includes components of outreach (to encourage participation by people not usually involved in issues like these), information and education (to convey both the background and the currently proposed activities necessary to make informed decisions), and involvement (to receive input from people outlining their perspectives on the issues).

An additional requirement of the Consent Decree is that a Wet Weather Team be formed that includes a variety of internal and external stakeholders to participate in the development of a program for public information, education and involvement, and to participate in the development of the funding plan.

In addition to the specific issues listed in the Consent Decree, the CSO Policy suggests that the stakeholder group should deal with a variety of issues including:

- Water quality monitoring, assessment, and problem identification
- Review of applicable water quality standards
- Identification, evaluation, and selection of CSO control technology
- User fees and tax rates
- Construction, relocation, and other implementation impacts

To facilitate stakeholder understanding of the water quality issues, a thorough review of the current water quality standards will be conducted and presented to the stakeholder group. Existing water quality conditions will also be discussed to define the levels of pollutant load reductions that will be required to meet the current standards. Pollutant loadings from a variety of point and non point sources will be reviewed to assist in defining performance expectations for the CSO controls.

To address these complex and potentially controversial issues, a systematic and well documented approach will be developed to consider the multiple viewpoints of the community in the decision process. The approach is described in the sections below and further elaborated upon in subsequent discussions.

11.3.2 Targeted Public

As stated in Paragraph 22 of the Consent Decree, MSD will "organize a Wet Weather Team regarding CSOs and SSOs." The Wet Weather Team:

"shall include all entities who have a stake in the outcome, and should be sufficiently multi-disciplinary to address the myriad of engineering, economic, environmental, and institutional issues that will be raised during the implementation of the remedial measures under this Consent Decree. The team will prepare a plan for funding the program and will develop a program for public information, education, and involvement."

The stakeholder group is the external portion of the overall Wet Weather Team. In assembling a representative stakeholder group, MSD has requested participation from individuals recognized as community "opinion leaders" who are associated with various interest groups such as:

- Environmental advocacy,
- Business and industry,
- Elected officials,
- Local government agencies,
- Local community neighborhood groups,
- Recreation,
- Public Health,
- Environmental justice, and
- Organized labor.

Table 11–4 lists the current (September 2006) members of the stakeholder group, including their name, place of employment (or relevant role in the community) and their specific interest area.

TABLE 11-4

STAKEHOLDER GROUP MEMBERSHIP (AS OF SEPTEMBER, 2006)

Name	Position/Organization	Interest Area
Steve Barger	Former Secretary-Treasurer and Business Manager, Kentucky State District Council of Carpenters	Organized Labor Interests
Susan Barto	Mayor, City of Lyndon	Elected Official, Small City
Stuart Benson	Councilman, Metro Council, District 20	Elected Official, Metro Government
Charles Cash	Director, Planning & Design Services Department, City of Louisville	Local Government
Allan Dittmer	Professor, University of Louisville	Education
Laura Douglas	Director, Internal/External Communications, E.ON U.S. LLC	Business & Industry
Faye Ellerkamp	Councilwoman, City of Windy Hills	Elected Official, Small City
Jeff Frank	Executive Director, Future Fund; Former President, Louisville Audubon Society	Environmental Interests
Arnita Gadson	Environmental Justice Coordinator, West Jefferson County Community Task Force	Environmental Justice
Mike Heitz	Director, Metro Parks, City of Louisville	Local Government, Recreation
Tom Herman	Environmental Manager, Zeon Chemicals	Business & Industry
Rick Johnstone	Deputy Mayor, Mayor's Office, City of Louisville	Local Government
Bob Marrett	Partner, CMB Development Company, LLC	Development
Kurt Mason	District Conservationist, Jefferson County Soil and Water Conservation District, USDA Natural Resources Conservation Service	Government
Suzy Post	Board Member and Director Emeritus, Metropolitan Housing Coalition, Louisville	Neighborhood Interests
Lisa Santos	President, Irish Hill Neighborhood Association	Neighborhood Interests
Bruce W. Scott	President, Kentucky Waterways Alliance	Environmental Interests
David Tollerud	Professor and Chair, Department of Environmental and Occupational Sciences, School of Public Health & Information Sciences, University of Louisville	Public Health, Education
Tina Ward-Pugh	Councilwoman, Metro Council, District 9	Elected Official, Metro Government
David Wicks	Coordinator, Center for Environmental Education, Jefferson County Public Schools	Education

The stakeholder participants were not asked to formally represent a specific interest organization. Requiring formal representation of community organizations could inhibit the input and timeliness of participation. It was, therefore, imperative to select individuals who were recognized as credible opinion leaders by the members of each interest group, so the larger group will accept their personal input as reasonable. The stakeholder decisions will be "consensus seeking" but not strictly consensus-driven, recognizing inherently conflicting view points and the need to make timely decisions to achieve the CD schedule requirements.

Part of the role of the Wet Weather Team is to develop and implement programs of broader community outreach, education, and involvement. It is expected that the stakeholder group will be instrumental in ensuring a broad coverage of the various activities that will be implemented. The target audience for this broader initiative will be to all the residents and businesses in

Jefferson County, and other individuals or organizations outside Jefferson County who are affected by the MSD CSO control program.

Regulatory agencies are also stakeholders in this process, and MSD intends frequent communication with ORSANCO, the Kentucky Division of Water, and EPA Region 4. Scheduled meetings to review the reports prepared at each of the milestone dates are anticipated. More frequent, informal communications (e-mails, phone calls, and issue-specific meetings) are also anticipated, but cannot be scheduled at this time.

11.3.3 Resources Committed to Public Participation

An active and effective public participation process requires a commitment of resources. These resources are expected to provide assistance as part of the LTCP development, the SSDP development, NMC activities such as notification and information about CSOs, and other activities of MSD that involve public participation. MSD has a long history of commitment to public participation and public information and education. Section 3 describes MSD's past activities. This level of activity also demonstrates MSD's willingness to commit staff time and outside resources to public programs.

The public involvement activities conducted through the stakeholder group will be facilitated by an outside professional facilitator. Ross & Associates Environmental Consulting, Ltd. (Seattle, WA) has been retained by MSD to set up the stakeholder group and work with other members of the Wet Weather Team to develop and begin implementation of a 2-½ year process of stakeholder input. It is anticipated that Ross & Associates will continue to support the stakeholder process through its completion in the summer of 2008 (when the components of the Wet Weather Plan will be issued for public comment).

In addition, private consultants will provide engineering and technical support. CH2M HILL Inc. has provided assistance in developing the decision process that the stakeholders will be involved in, and has provided technical input at a number of stakeholder meetings to date. Cubero & Associates, a public relations consultant, has also participated in stakeholder meetings and in preparing public informational materials associated with the NMC program. It is anticipated that CH2M HILL, Cubero, and several other private consultants will continue to support the public participation process.

In addition to private consultants, MSD has made a significant commitment of staff resources to support the overall public outreach, education, and involvement program. MSD's Executive Director, Regulatory Management Services Director, Chief Engineer, and Regulatory Policy Manager regularly attend stakeholder group meetings. The Executive Director personally makes presentations to community groups throughout Metro Louisville, speaking on a variety of subjects. In the future, these presentations will focus much more on progress towards Consent Decree compliance.

MSD's history of active outreach to the community will be expanded to a much larger program, as the community embarks on what will be a very significant new program, with wide-ranging opportunities and impacts on the community. CSO issues will be a high priority discussion topic as the public participation outreach is expanded in the community.

11.3.4 Public Participation Scheduled Activities

The Stakeholder group has been formed, and has already met three times as of the publication of this document (September 2006). The group meets monthly, with 3 open months in the

schedule for use as "make up" or ad hoc sessions if necessary. Table 11-5 presents the schedule of stakeholder group meetings, and the anticipated topics addressed at each of the meetings.

TABLE 11-5

STAKEHOLDER GROUP PROPOSED MEETING DATES

Meeting Number	Proposed Date	Meeting Topics
1	Thursday, July 20, 2006	Introduction, team charter, MSD and regulatory introduction
2	Tuesday, August 15, 2006	MSD and regulatory introduction (continued)
3	Tuesday, September 12, 2006	Decision process introduction, identify and define values
4	October 2006	Water quality baseline conditions, sensitive areas, value objectives
5	December 2006	Public involvement plans
6	January 2007	Risk evaluation framework, weighting factors for values
7	February 2007	Performance measures, threats and risks
8	March 2007	Site-specific threats, alternatives development, determination of benefits
9	April 2007	Introduction to affordability (rates and financing options)
10	May 2007	Risk management approaches (technology & strategy)
11	June 2007	Alternative review and screening
12	August 2007	Risk management approaches (alternatives and combinations)
13	September 2007	Performance effectiveness results
14	October 2007	Preliminary affordability review
15	December 2007	Funding measures and rate impacts
16	January 2008	Finances and rate structure
17	February 2008	Preliminary recommendations
18	April 2008	Review Draft
19	May 2008	Endorsement of Plan

In addition to the stakeholder meetings and MSD's ongoing community outreach meetings, MSD is planning at least four Consent Decree planning progress informational meetings scheduled around major milestone points. The exact dates of these meetings can not be anticipated at this time, since the meetings must be coordinated with other Consent Decree response activities to provide an overall Consent Decree update. These informational meetings will include a presentation of the status of Consent Decree projects, a recap of recommendations made to date, a summary of issues remaining to be addressed, and a forum for receiving public comment. The stakeholder group will assist in the development of the format and content of the issues presented at each meeting.

In addition to the informational meetings, the draft LTCP will be issued for public review and comment. A formal public hearing will be scheduled during the review period (currently expected to be in late August or early September, 2008. A formal response to public comments will be prepared and submitted with the final LTCP in December 2008.

11.3.5 Information Mechanisms Used in Public Outreach and Communication

Depending on the audience and the intent of the communication, MSD will use a variety of mechanisms to reach out to the public, both for education and for input from a wide audience. The details of the communication method and distribution will be developed with input from the stakeholder group, in accordance with the Consent Decree.

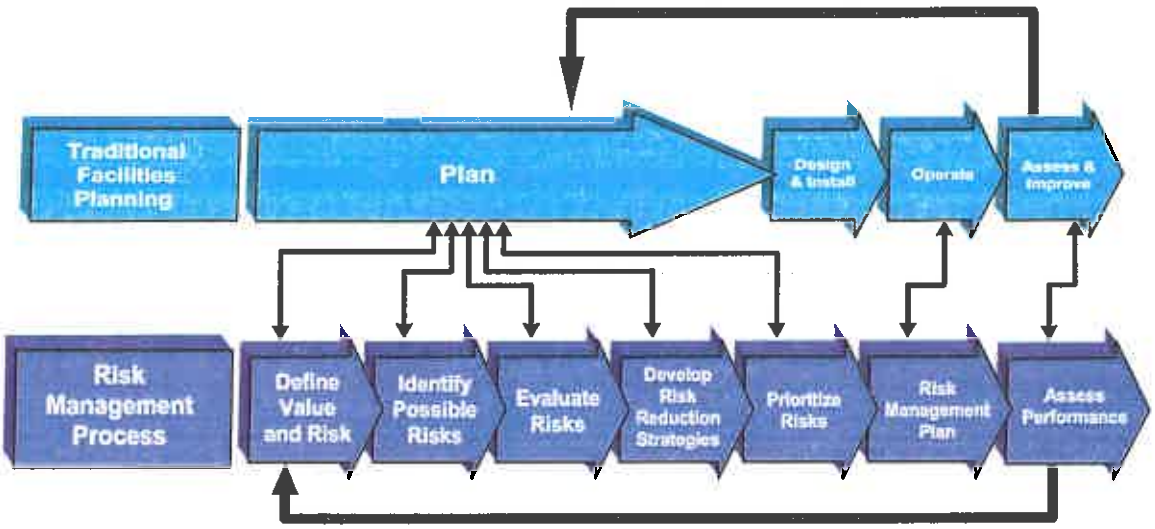
11.3.5.1 Stakeholder Process

The effectiveness of citizen advisory groups is highly dependent on the way they are used to provide planning and implementation guidance. Members of the citizen advisory groups are usually selected based on their ability to represent specific stakeholder segments. Generally these stakeholder representatives are not subject matter experts on engineering, wet weather management, public finance, aquatic life, or wastewater treatment plant operations, but they are asked to make technical choices associated with these subjects.

To provide more effective and meaningful stakeholder guidance, MSD will implement a value-based risk management approach to support decision-making on CSO controls, as shown in Figure 11-11.

In this approach, stakeholders are engaged in a structured process that emphasizes their role as subject matter experts in the area of community values. They define the values that CSO control (and other aspects of Consent Decree compliance) is expected to protect. The stakeholders will also define general objectives for each of the values, and the relative importance (weights) that those values have. The definition of values, performance objectives and relative weights is central to the development of a decision process that uses a multi-attribute risk management approach to developing the overall "benefits" in a cost/benefit analysis. The benefits derived from this evaluation process will be used to evaluate, select and prioritize the solutions that will make up the LTCP and the overall Wet Weather Plan, and result in compliance with the CWA. This process will comply with the intent of the CSO Policy both for public involvement in decision-making, and in developing a rational approach to consider a variety of performance and non-financial criteria in the decision process.

FIGURE 11-11
VALUE-BASED RISK MANAGEMENT
STAKEHOLDER INVOLVEMENT



To maximize the effectiveness of stakeholder input, essential and basic information will be provided to the group by MSD and other subject matter experts to develop a shared knowledge platform. Such information will include but not be limited to:

- How sewerage systems work, and how MSD's system is unique
- The regulatory framework of the CWA, CSO Policy, and discharge permits, etc.
- The specific requirements of MSD's Consent Decree
- The range of available CSO control technologies
- The specific alternatives being considered by MSD
- MSD finances and how rates are determined, what impacts rates, and how is "affordability" defined by EPA

A specific focus of the initial education step will be to distinguish between the decisions that are "on the table" (location and type of control, design storms and related level of service issues, etc.) and those that are not open for discussion (compliance with the CWA). Throughout the entire process, the plan development will be referred to as a "compliance strategy" to make it clear that compliance with the CWA is a requirement, but the approach to achieving that compliance remains to be determined. Stakeholder input into the planning process will be continuous to ensure that community values and objectives are fully integrated into the development, evaluation, and selection of compliance strategies.

11.3.5.2 Public Involvement

Other opportunities for involvement will be available to the general public, outside of the stakeholder process. As noted previously, MSD will hold at least four public information meetings at various times throughout the planning process. At each of these public meetings presentations will be made by MSD staff, members of the stakeholder group, or consultants on the status of MSD's LTCP progress and forthcoming projects. After the presentations there will be opportunities for public comment, either through question and answer sessions at the meeting, or through phone calls, e-mails or discussions following the meeting. Phone numbers, email addresses and MSD's web page address will be included in handout material available at the meetings.

It is also expected that each of the public education elements described below will describe how to contact MSD by phone, email or to access MSD's web page. These comments will be solicited throughout the planning process, and responses documented. All comments will get a response, in an individual communication and/or in a broadcast message (as in a newsletter feature).

The formal opportunity for public involvement will come when the draft LTCP is made available for public review. A public hearing will be scheduled at least 45 days in advance. An announcement will be published on MSD's web page and communicated directly to interested and affected parties who are known to MSD or who have requested this notification. A hearing officer will be assigned by MSD to run the meeting. An agent will be specified to take notes, distribute and collect public comment sheets, and document the results of the meeting. A record of the hearing proceedings will be made available by transcript or recording. All comments from the public hearing will be addressed in a formal response document appended to the LTCP submitted for regulatory approval.

11.3.5.3 Public Education

To provide the general public with background information to put the problems in context, and progress and recommendations for action, a broad-based public information program will be implemented. Some of the educational activities planned are as follows:

- CSO warning signs posted along waterways potentially impacted by CSOs (implemented by September 30, 2006, as part of NMC) including MSD contact information for follow-up if desired
- Media advisories (television and radio) warnings of CSO events (implemented by September 30, 2006, as part of NMC) including MSD contact information for follow-up if desired.
- Updates to the CSO informational brochure (planned by the end of October 2006) for distribution at public meetings, in information packets given to new customers, etc.
- Annual information billing inserts distributed to all customers (first one will be sent as a separate mailer and distributed in September 2006)
- Continuation of the MSD Speaker's Bureau (over 100 presentations made to various community groups in the last 12 months)
- Continuation of annual "River Sweeps" along various waterways in Metro Louisville
- Public Service Announcements distributed to local media outlets

- Billing inserts informing customers on issues of importance (including CD compliance progress) planned for 3-4 times per year
- A feature in MSD's monthly newsletter "Update" called "Consent Decree Spotlight" (September 2006 issue included as Figure 11–11) planned for at least 6 editions per year
- A designated page on MSD's web site with Consent Decree information, including all materials presented to the stakeholder group, meeting summaries from the stakeholder group meetings, completed deliverables from the planning process, and other general information of interest relative to the Consent Decree response program (specific stakeholder process web page to be implemented by the end of October, 2006)

Other public education activities will be identified as the CD compliance planning proceeds. The stakeholder group will have an active role in identifying gaps in the public education program, and suggesting ways to effectively fill those gaps.

11.3.5.4 Regulatory Communication Plan

The Consent Decree outlines a communication plan that includes quarterly reports and annual reports. It is expected that these reports will include the appropriate information to keep regulators apprised of progress.

In addition to progress reports, monthly conference calls and specific meetings will be held with KDOW and EPA at the milestone points shown on Figure 11-1 and described in Section 11.1. As the plan develops, it is expected that issues may arise that would benefit from face to face discussions. These meetings will be scheduled on an as-needed basis.

11.3.6 Consultation and Response Approach to Public Comments

Public input received through the stakeholder process will be used in the development and evaluation of CSO control measures. The input and responses will be fully documented in meeting summaries from the stakeholder meetings, that will posted on MSD's web page. The role of the stakeholder input will also be documented in the descriptions of the evaluation process in the LTCP.

Other public input will be acknowledged, documented, and responded to on an individual basis. This includes questions received at public information meetings, or questions or comments made by phone, email, or in a web page posting.

At the public hearing, the appropriate hearing rules will be followed. All comments and questions will be documented, and responses prepared in a formal response document. The response document will be included with the final LTCP submitted to KDOW and EPA. Depending on the hearing rules adopted, individual responses may or may not be made to comments received at the hearing.

11.3.7 Summary

MSD's public involvement program addresses all three elements of an effective program. Public outreach is achieved through signs, direct mail, bill stuffers, media messages, speakers, and public meetings. Information and education is provided through each of these methods, and a variety of existing communication pathways such as newsletters and MSD's web site.

The stakeholder group is the cornerstone of the public involvement process. Stakeholders will have an active role in defining community values, relative weights, and performance objectives. Stakeholders will be involved in the development, evaluation, and prioritization of control alternatives. They will be actively involved in planning and implementing the public involvement program, and will assist with funding concepts and rate structures.

11.4 CONSIDERATION OF SENSITIVE AREAS

The CSO Policy requires that the highest priority be given to controlling overflows to receiving waters considered sensitive. Examples of sensitive waters given in the CSO Policy include:

- Outstanding national resource waters
- National marine sanctuaries
- Waters with threatened or endangered species or their designated critical habitat
- Primary contact recreation waters, such as bathing beaches
- Public drinking water intakes or their designated protection areas
- Shellfish beds

Section 5 addresses the issue of sensitive waters and their current status relative to the criteria noted above. As noted in Section 5, all the waters under consideration are designated as contact recreation waters. In addition all the watersheds affected by CSOs could contain endangered, threatened, or species of special concern. Under this definition, all the waters of Beargrass Creek have the same level of sensitivity, and there is no basis for prioritizing any waters higher than another.

Based on a study prepared in 1991, the CSOs discharging directly to the Ohio River have no significant impact on environmental conditions along the river, and none of the listed species appear to be impacted by CSO discharges. The only sensitive waters criteria that is applicable in the Ohio River near Louisville is the contact recreation standard. Again, there is no reason to differentiate any waters based on this criteria.

The issue of sensitive waters will be discussed with the stakeholder group, to see if they wish to designate any particular water as "more sensitive." This definition would be a local choice, not required by the CSO Policy, but in agreement with the intent of the Policy in giving higher priority to certain areas with characteristics that differentiate them from the rest.

11.4.1 Public Access and Recreation

One of the factors that could be considered in the designation of certain waters as more sensitive would be the likelihood of public contact. Figure 11-12 shows the location of public boat launch areas, marinas, parks, and highly used public areas. Figure 11–12 also shows the locations of all CSOs.

The nearest boat launch area downstream from CSOs is several miles downstream. One area of high use on the Ohio River is Waterfront Park, on the riverfront next to the downtown area. Waterfront Park is downstream from several CSOs, including all those discharging into Beargrass Creek. The Beargrass Creek watershed also contains highly used urban parks. While most of the recreation activities in these parks do not involve contact with the waters of the Creek, wading is common in some areas, and some fishing occurs in the lower reaches. Canoeing and kayaking are sometimes observed, especially in the lower reaches of the Creek where stream flows are often high enough to float shallow-draft watercraft like this.

11.4.2 Identification and Prioritization Process

The issue of sensitive waters will be presented to the stakeholder group in meeting number four. A copy of Figure 11-10 will be presented to illustrate some of the potential high-contact areas. A facilitated discussion will establish if there are any waters that the stakeholders wish to designate as higher priority based on a higher potential for contact, or other factors as identified by the group.. If some of the sensitive waters are identified as higher priority by the stakeholder group, then protection of these sensitive waters will be assigned a higher relative weight and considered along with the other values in establishing benefits for the risk management decision process.

11.5 EVALUATION OF ALTERNATIVES

The development and evaluation of alternatives will combine traditional engineering approaches to CSO control planning with the use of a risk management approach to develop control strategies and a broader measure of "benefits" to be used in a cost/benefit evaluation.

11.5.1 Role of Public Participation

As noted in Section 11.3, the Wet Weather Team stakeholder group will have a key role in the development and evaluation of alternatives. The primary role will be in identifying important community values to form the basis of the non-financial benefits determination. Stakeholders will also identify the relative importance (weights) of the value identified, and will describe subjectively the desired objectives for these values. Using the values and objectives, the technical teams will develop scalable performance measures that will be used to quantify the impact of alternative CSO control measures. The stakeholders will follow the alternative development and evaluation from beginning to end, reviewing each step of the way and providing input to ensure that consideration is given to their input. The stakeholder input will affect and provide input on items such as:

- *CSO control goals*
- *Control alternative development*
- *Control alternative evaluation and selection*

Public participation will also impact alternative development and selection through the public meetings, public education initiative, and public outreach activities. Each of these represent an opportunity for the public to learn about progress in the planning process, and give feedback on their views. As noted in Section 11.3, every public comment received will be documented and will receive a response. The stakeholder group and the entire Wet Weather Team will be fully aware of public comments received and it is expected that these will impact the evaluation and prioritization of control approaches.

11.5.2 Demonstrative versus Presumptive

Since the water quality characterization of Beargrass Creek has not been completed yet, an early determination of demonstrative or presumptive approaches for the LTCP cannot be made at this time. In addition, the risk management approach to developing and evaluating CSO control options deals with holistic watershed issues, not specific to either compliance approach. EPA guidance for developing LTCPs notes "*...the choice between the demonstration approach and presumption approach does not necessarily have to be made before a municipality*

commences work on its LTCP. In some cases, it might be prudent for a municipality to assess alternatives under both approaches."

MSD plans to carry forward CSO control options that best meet its overall watershed management goals. The determination of the specific compliance approach may be determined following the completion of the water quality characterization and modeling, or may be deferred until the cost/performance evaluation as described later in this section

The characterization, monitoring, and modeling efforts described in Section 11.2 may provide an early indication of the likely direction for the compliance approach. If water quality characterization and models indicate that water quality standards will not be achieved in Beargrass Creek regardless of the level of CSO control, then the demonstrative approach will probably be used. KDOW development of a TMDL for the Beargrass Creek watershed is in process, and the resultant load allocation for CSOs will provide a control target for the demonstrative approach. MSD's stream monitoring program and water quality tool development will provide valuable information needed for the development of that TMDL.

For the Ohio River, the ORSANCO model study has already indicated that CSO control alone would not result in the consistent achievement of water quality standards. If further study validates this conclusion some form of TMDL calculation would be appropriate for the Ohio River as well. Since the Ohio River bordering Kentucky is a water of the Commonwealth, the Kentucky Division of Water is responsible for establishing water quality standards for this reach of the river, and would also be responsible for development of the TMDL, if needed. Since the Ohio River is an interstate water, the establishment of a TMDL is complicated, and would probably be coordinated through ORSANCO. At present neither KDOW or ORSANCO have plans to establish a TMDL for the Ohio River, and establishing such a TMDL probably cannot be achieved in the time frame required for completion of this LTCP.

In accordance with the CSO Policy, if the receiving water quality characterization and subsequent TMDL limit development shows that no reasonable level of CSO control will result in achieving water quality standards, a review of those standards may be appropriate. Responses to that review could result in a site-specific revision to the criteria, a variance from the criteria under certain conditions, a suspension of the use under certain conditions, or a review of the beneficial uses under a Use Attainability Analysis. It is premature to speculate what the results of the characterization might require.

It is expected that these issues and others will be discussed with the regulating agencies following the preparation of the water quality report shown on Figure 11-1.

11.5.3 Development of Approaches

The first step in developing approaches to CSO control is to consider the planning and evaluation that has gone on before. MSD's past planning efforts have been described in Section 7. The past planning efforts and the past CSO control projects described in Section 8 will serve as a basis for future planning efforts.

11.5.3.1 Interaction with Nine Minimum Controls

Nine Minimum Controls (NMC) activities completed to date have included items such as raising regulator dam elevations and installing solids and floatable controls. Consideration of the

benefits of these NMC activities will be considered in evaluating additional control requirements, in accordance with the LTCP guidance.

11.5.3.2 Risk Management Approach

While past planning and CSO control efforts provide a solid basis for the development of the final LTCP, the risk management approach allows for a "fresh look" at the planning process. The identification of values will address water quality goals and other goals of the community that relate to CSO control. Consideration of the non-financial goals up front will broaden the range of control measures and alternatives that are considered. The step-wise process for considering new approaches is illustrated in Figure 11-13:

FIGURE 11-13
VALUE-BASED RISK
MANAGEMENT PROCESS

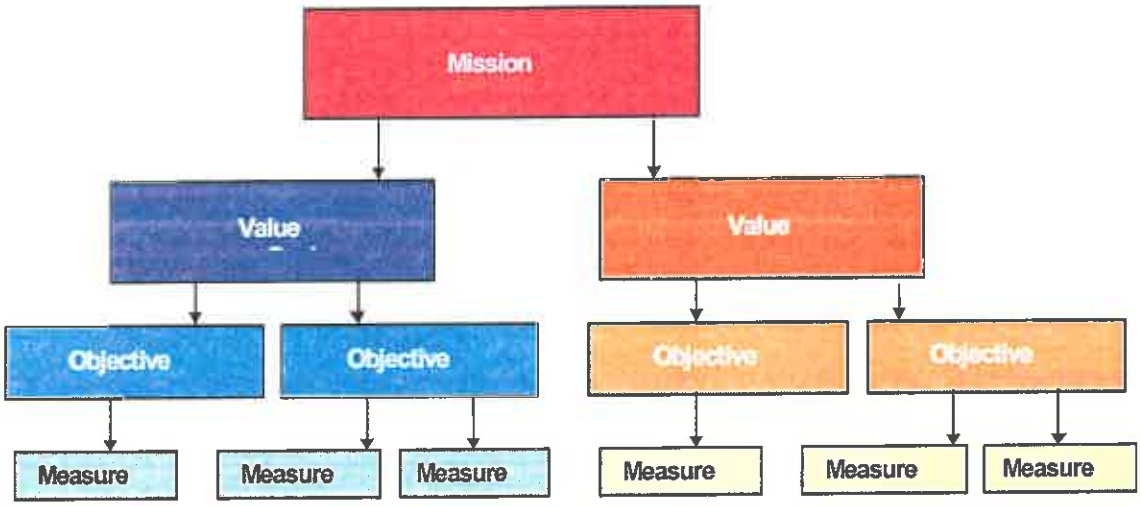


Step 1 - Define Values and Risk

In Step 1 of the risk management process, the planning mission is clearly stated. In this case, management of wet weather flows to achieve compliance with the CWA is a likely statement of the planning mission. Stakeholders are engaged to identify the values the community wants to be protected. These values are subsequently into goals, objectives and performance measures consistent with the overall mission.

- **Values and goals** are broadly stated results define how mission is attained. Examples might include environmental protection, protecting public health and safety, regulatory compliance, water quality standard compliance, or optimizing the use of available funds. They are usually not directly measurable.
- **Objectives** help explain the components of the values and what is expected of them. They are usually expressed in terms such as maximize, minimize or maintain.
- **Performance measures** quantitatively explain the how progress toward an objective is measured. Figure 11-14 illustrates that relationship between values, objectives and measures. Some objectives may have a single measure, while others may have several.

FIGURE 11-14
STRUCTURE FOR DEVELOPING VALUES & GOALS,
OBJECTIVES, AND PERFORMANCE MEASURES



In the Risk Management Process, a "risk" is defined as anything that can prevent an agency from protecting the values or achieving the related goals. A model to evaluate techniques for protecting these values (i.e. managing the risks) must have three basic components:

- Determination of what "risks" are associated with the decision that is being made;
- Quantitative means to measure how these risks relate to the values to be protected; and
- Method to quantify benefits and costs related to reduction in risks to values.

The completed evaluation model enables the consequences of various possible decisions to be measured, both qualitatively and quantitatively, in terms of their impact on an agency's ability to achieve its operational objectives and protect competing community values.

Step 2 - Identify Possible Threats and Risks to Values

In Step 2, potential threats to achieving values and objectives are identified. A threat is an event, or sequence of events, that can lead to failure to achieve an objective. Each threat includes a description of where and how often the event occurs, the magnitude of its impact, and the type of resources that could be impacted. A risk is then defined by the combination of the frequency of the threat event, and the magnitude or severity of its impact.

Numerous factors, directly related and unrelated to sewerage, pose risks to the values. Common steps to defining the sewerage-related risks to the values include:

- Brainstorm the threats to each community value (e.g., pathogens in recreational waters threaten public health);
- Determine the extent of the potential for sewerage impact on each threat (e.g., untreated sewer overflow could increase pathogens in recreational waters);

- Evaluate and document the nature of each threat (e.g., untreated sewer overflows discharge pathogens and could impact public health as a result of increased contact; non-point sources of pathogens could impact public health where no sewage is discharging).
- Evaluate and document the current probability of each community sewerage-related threat (e.g., the probability of sewer overflow from a combined sewer is high; probability of sewer overflow from a sanitary sewer is lower). Hydraulic models described in Section 11.2 will typically be the method used to develop the probabilities
- Evaluate and document the current potential severity of each threat. The hydraulic and the water quality models will be used to document the severity (*e.g.*, pathogen loadings from treated sewage discharge is low, pathogen loadings from dilute wet weather sewage discharge is intermediate, pathogen loadings from first flush or undiluted sewage discharge is high). Third-party experts (from outside agencies not connected to MSD) may also assist with establishing credible estimates of potential severity, since some of the scalable measures may not be directly translated to the community value being protected. For example, to determine the likelihood of illness resulting from different levels of pathogen loading a dose/response relationship must be identified from medical or public health literature.

Risk factors commonly identified by sewerage utilities are summarized in Table 11-6.

TABLE 11-6
TYPICAL COMMUNITY SEWERAGE RELATED VALUES AND RISKS

Community Value	Common Sewerage Associated Risks
Protection of the public health	Recreational use closures Fish consumption advisories Illness Sewer backups into buildings Sanitary sewer overflows Combined sewer overflows Catastrophic loss of treatment units
Protection of the environment	Nutrient discharges contributing to eutrophication of receiving water Organic discharge depressing dissolved oxygen levels in receiving water Solids discharges restricting access Floatables discharges affecting aesthetics and safety
Protection of real property	Sewage backups causing property damage High velocity sewage washing out equipment Sewage flooding destroying equipment Sewer collapse impacts transportation Sewer collapse impacts building foundations Street flooding making roads impassible
Provision of the community aesthetics	Septic sewage generating odors in populated locations Unscreened sewer overflows depositing objectionable materials (floatables) in visible areas
Meeting community sewer expansion needs	Perceived lack of sewer capacity results in building restrictions

Community Value	Common Sewerage Associated Risks
Affordability of sewer rates	Cost of capital improvements to treatment works Cost of capital improvements to the sewer systems Personnel costs of improved construction inspection Personnel costs of improved monitoring and documentation Increased O and M costs to implement MOM
Compliance with regulatory requirements	Misunderstanding of applicable regulations Changes in regulatory requirements Technically infeasible permit conditions

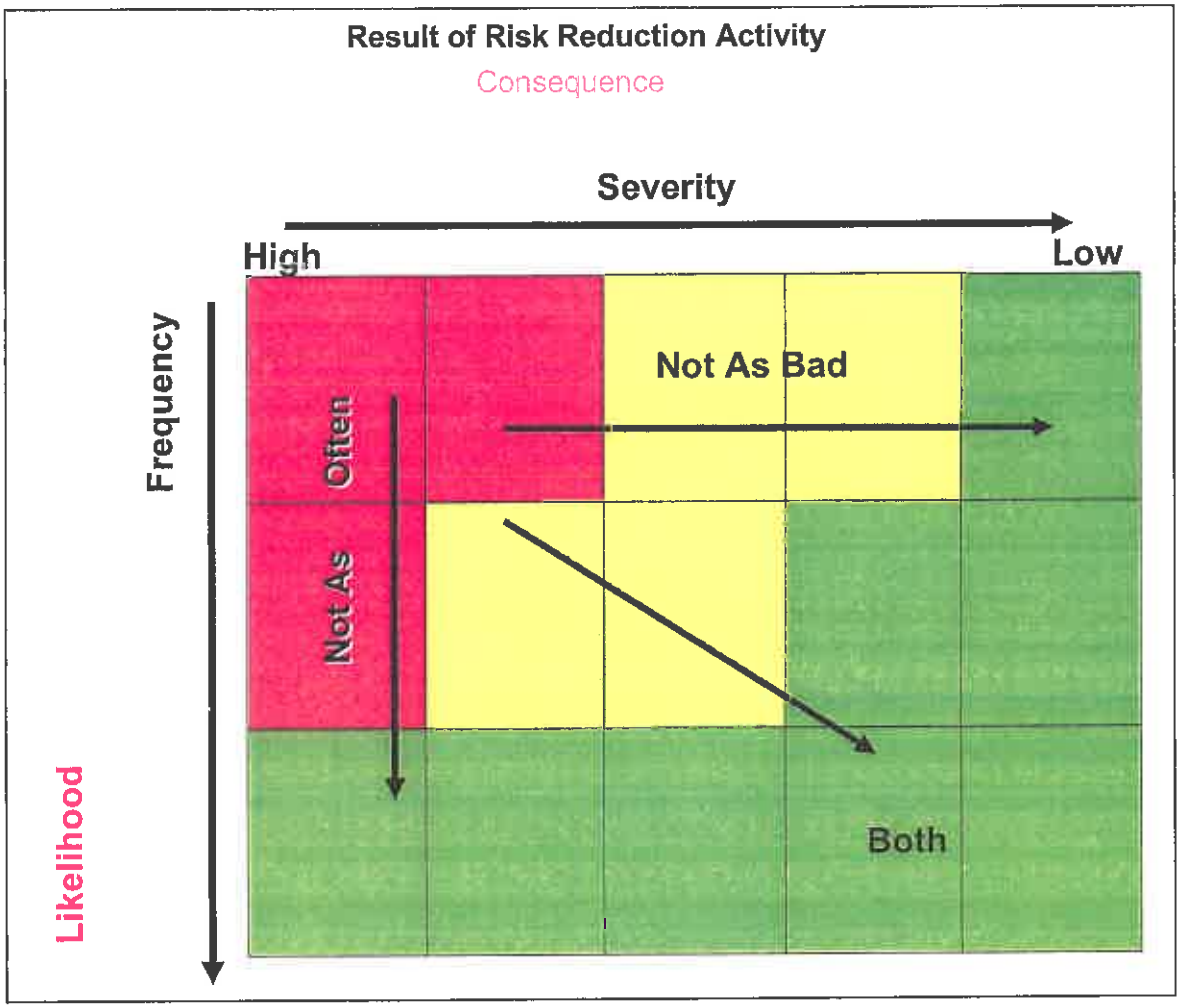
Step 3 - Risk Evaluation Measures

Developing scalable, objective measures is a necessary step in the alternative development process. Consideration of the eventual evaluation measures provides a means of tracking progress towards their achievement, encouraging those activities that reduce the risks while discouraging measures that increase the risks. Steps to defining objective measures of the sewerage related risks include the following:

- Brainstorm appropriate measures of each sewerage related risk. Some of these measures may be numeric; others may be objective categorization of the factors discussed in defining the probability and severity;
- Identify and document protocols for consistently evaluating impacts on each risk. Units of measurement must be practical, economical, and easy to obtain and maintain. This is where sampling, monitoring, data evaluation, and modeling tools are primarily used;
- Pilot test and/or peer review each identified risk measure. It is important to test that the protocol works consistently both for measuring the existing state of risk and for projecting the state of risk under alternative future control measures.
- Seek stakeholder endorsement of the risk measurement protocol; and
- Refine and document the protocol for risk measurement.

In **Step 3**, the likelihood and consequence of each threat event are evaluated as illustrated in Figure 11-15.

FIGURE 11-15
LIKELIHOOD AND CONSEQUENCE
FRAMEWORK



Likelihood is assessed based on tools such as hydraulic models. Consequences are often developed from the hydraulic and water quality models, or a combination of modeling and published performance reports on the experiences of other communities.

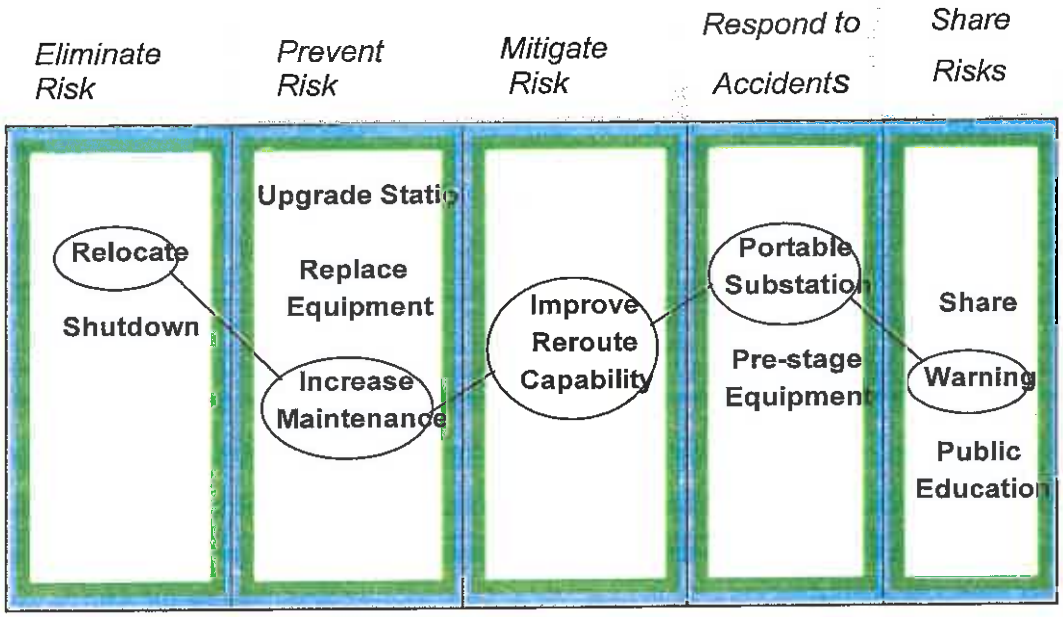
At this point a preliminary review screening those events that have a very low likelihood of occurring, or are already adequately protected against; have low consequences; and can quickly and inexpensively be dealt with or are already being addressed.

This step requires the development of prioritization criteria (weighting factors) to be used in estimating the probable severity of a given problem. These criteria will be used for two purposes: 1) to provide standard evaluation criteria while compiling problem areas and developing problem statements, and 2) to develop a method for priority ranking of potential projects.

Step 4 - Develop Risk Reduction Strategies and Approaches

In Step 4, methods of reducing the vulnerability for each risk scenario are brainstormed. These methods fall within a range of options, which include risk elimination, risk prevention, risk mitigation, response to accidents and risk sharing (Figure 11-16.). A stakeholder brainstorming session allows for identification and discussion of unconventional solutions or strategies.

FIGURE 11-16
STRATEGY TABLE
FOR RISK REDUCTION



To assist in the brainstorming efforts, a matrix of available discharge abatement technologies and non-structural approaches will be developed. The matrix will list known technologies and approaches that have been developed and implemented, what the performance objectives are, where they have been applied, and with what performance results. It is important that the matrix be comprehensive in scope and inclusive of technologies and approaches that may not appear to apply to the MSD system, so that a determination of non-applicability is clearly made at this point in the process. Section 6 presents a description of control strategies and technologies that will serve as the basis for this effort.

Available abatement technologies considered may include the following:

- Source controls – Porous pavement, flow detention, street sweeping, snow removal and deicing controls, animal waste removal, etc.
- Collection system controls – Increased sewer cleaning and flushing, sewer separation, infiltration control and inflow separation, flow diversion, real-time control, etc.
- Storage – In-line, off-line near surface, deep tunnel, etc.
- Treatment – Screening, sedimentation, disinfection, swirl or vortex solids removal, fine screens etc.

Sources of data for the matrix would include experience of the Wet Weather Team members, and reports in published literature, particularly technology reviews published by the U.S. Environmental Protection Agency, the Water Environment Federation, the Water Environment Research Foundation, and the International Water Pollution Control Association. The alternative matrix can be updated periodically based on new developments in the problem definition task or the appearance of new sources of review data. Particular attention will be paid to the following:

- Water quality benefits anticipated and how such benefits were established,
- Unit costs for capital and O&M, and
- Operational issues and problems for facilities that are now in operation.

Approaches may be tied to an individual CSO location, or a combination of several consolidated CSO locations, or may involve water quality improvements or other activities not directly tied to any specific CSOs. Examples of activities not tied to any specific CSO location might be expansion of the wet weather capacity at the MFWTP, or implementation of expanded source control. The treatment may be regionalized to deal with a large number of CSOs as it would be at the MFWTP, locally consolidated to deal with several CSOs at a location other than the MFWTP, or distributed to deal with individual CSOs.

11.5.4 Development of Alternatives

After risk reduction approaches are developed, the approaches must be converted into site-specific alternatives. In developing site-specific CSO control alternatives, most include a combination of storage to reduce wet weather peaks and increased conveyance and treatment capacity to treat higher wet weather peaks. It is also expected that other control measures such as source control will be developed and evaluated independently of any specific CSO locations. At least one form of control activity will be developed for each CSO location. Depending on the location and the risk reduction approaches identified, some locations will have a variety of potential alternatives to consider, that may include localized or regional consolidation of discharges. The risk management approach to benefit development is ideal for comparing the benefits of these non-specific control options.

11.5.4.1 WQ and CSO Control Goals

As described in Section 11.2, the Ohio River in the Louisville area is often out of compliance with existing water quality standards for contact recreation (due to fecal coliform levels). A water quality evaluation conducted by ORSANCO in 2004 identified non-point sources as the source of 80 percent of the fecal coliform load to the Ohio River in the Louisville area. The ORSANCO study also concluded that a complete elimination of the fecal coliform load from MSD's CSOs could significantly reduce the peak fecal coliform concentration in the river during and following storm events, but would have very little impact on the number of occurrences of violations of the contract recreation standards.

Similarly, the waters of Beargrass Creek are listed on the 303(d) list as non compliant for fecal coliform limits for contact recreation. Per the 303(d) list existing water quality standards are sometimes not met for dissolved oxygen (DO), cadmium, pH, and temperature. Relative impacts of CSOs on these water quality problems are not yet quantified, pending completion and validation of the Water Quality Tool (WQT) described in Section 11.2. It is expected,

however, that controls on CSOs in the Beargrass Creek watershed will not result in compliance with existing water quality standards.

If water quality characterization and modeling indicate that CSO control alone will not achieve water quality standards in Beargrass Creek and the Ohio River, then target levels of CSO control will be established through the development of a TMDL, or calculation of a control level that "does not cause or contribute to" water quality standards violations in the receiving streams.

In accordance with the CSO Policy, if the receiving water quality characterization and subsequent TMDL limit development shows that no reasonable level of CSO control will result in achieving water quality standards, a review of those standards may be appropriate. Responses to that review could result in a site-specific revision to the criteria, a variance from the criteria under certain conditions, a suspension of the use under certain conditions, or a review of the beneficial uses under a Use Attainability Analysis. It is premature to speculate what the results of the characterization might require.

11.5.4.2 Development of Alternatives

After developing a wide range of potential risk reduction approaches, a preliminary engineering review of potential alternatives will be performed. This preliminary engineering review will screen potential alternatives based on a variety of factors related to protecting community values, including an assessment of the potential hydraulic and pollutant load reduction, probable benefits in achieving water quality objectives, consideration of particularly sensitive areas, and probable costs. It is expected that a wide range of structural, non structural, and operational alternatives will be developed and carried forward for further analysis.

To protect the wide range of community values expected to be identified, different CSO control strategies and technologies may be applied to achieve the water quality objectives in different watersheds and different locations. In the Beargrass Creek service area, protecting the values in a diverse urban environment will need to be considered in the context of other pollutant sources in the watershed. Combined sewer overflows in the Beargrass Creek watershed discharge from many locations, and generally from smaller pipes, to a relatively low flow stream with a relatively high potential for public contact. It is expected that the Beargrass Creek watershed will have a higher potential for sensitive areas that require special consideration. In the Ohio River North Region, the CSO discharges are from somewhat larger pipes, but to a significantly larger receiving water. In the Ohio River West Region, the CSO discharges are fewer in number but the discharge pipes are quite large and convey substantially more flow than in the other regions. It is expected that the CSO control strategy and technology needs may be considerably different between the different regions.

For each control approach defined, specific alternatives will be developed. It is expected that each control approach will consider a range of design flows. Depending on the site and sensitivity of the CSO, the design flows may be equivalent to 12 discharges per year, or as few as one discharge per year. Specific CSO locations may require consideration of a variety of technologies, sizing, and consolidation configurations. Siting and operational considerations will also be factored into the development of control alternatives.

Another factor that must be carefully considered in determining the appropriate CSO controls is the interaction of the CSO LTCP operating strategy with the flood pumping requirements currently in place by the USACE. Current flood protection procedures established by the USACE (*US Army Corp of Engineers – Louisville District; Operation And Maintenance Manual;*

Flood Protection Works; Updated 1988) may result in dry weather CSOs due to flood pumping activities during periods of high river stage. MSD has already implemented a number of modifications to set-points for the initiation of flood pumping. A key component of the LTCP will be to work with the USACE to modify operating rules or identify facility modifications required to eliminate these dry weather CSOs. Integration of these two operating strategies into a single, effective program will be essential to the success of the LTCP.

11.5.5 Evaluating Alternatives

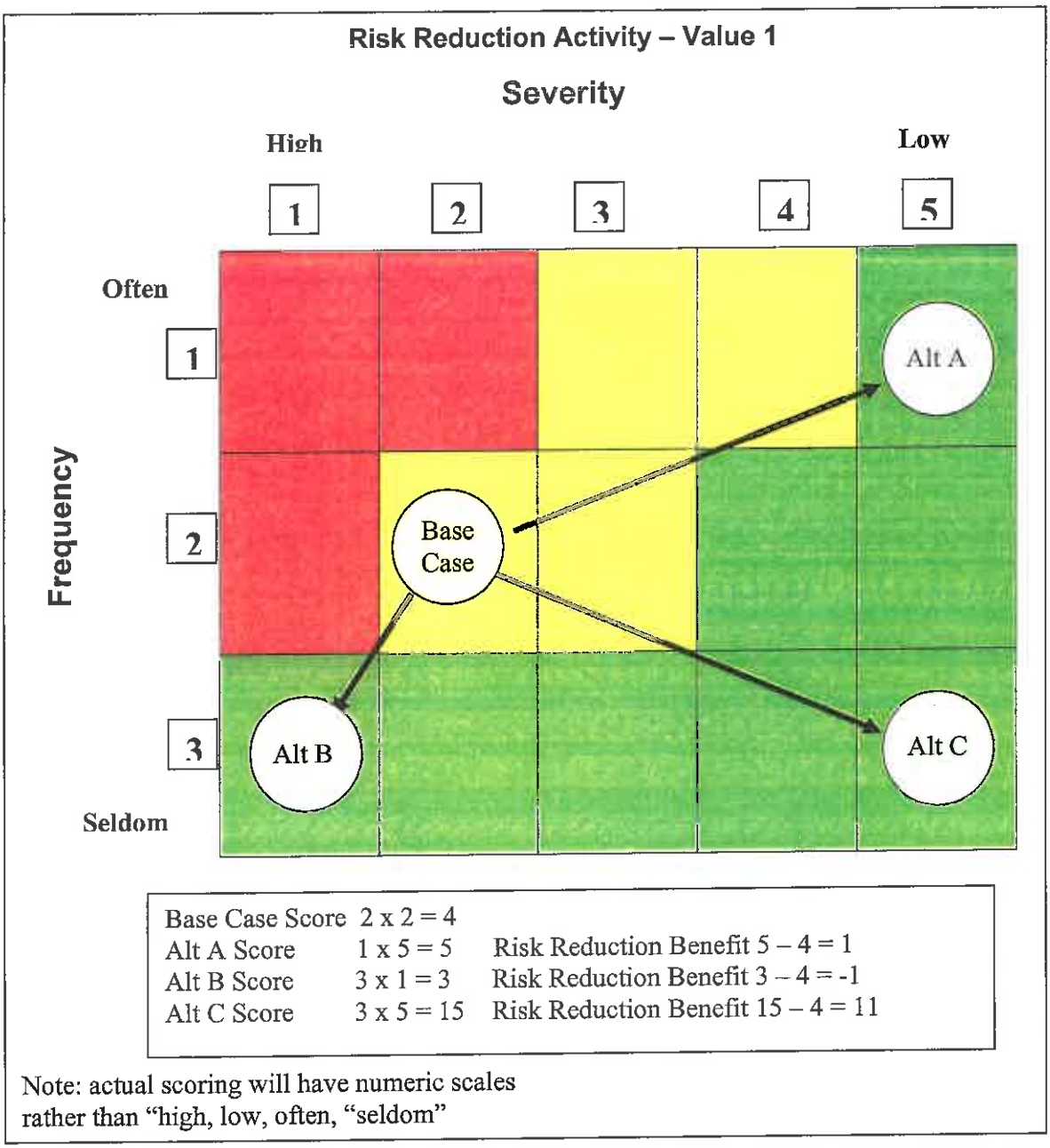
The effectiveness of CSO LTCP programs has historically been measured using a number of different methodologies. When direct assessment of water quality benefits or risk reduction is not possible, indirect measures have been used to assess progress in reducing discharge impacts. Two of the most common indirect measures that have been used are combined sewer capture rate, and CSO reduction. Either measure can be expressed as a quantity (loadings or million gallons), or as a percentage. However, the methods for calculating each are different and the results can have substantially different interpretations. While these two parameters can be used to indirectly measure progress in achieving CSO goals, the ultimate measure of effectiveness will be the ability of the program to protect the community values defined by the stakeholders and achieve compliance with water quality standards for the appropriate designated uses of the receiving waters.

In addition to direct performance measures, other factors are often used to evaluate and differentiate between alternatives. Some of these factors include the following:

- Reliability
- Ease of implementation
- Compatibility with existing facilities and equipment
- Discharge permit compliance
- Water quality goals
- Environmental impacts
- Improvements in biodiversity in the receiving waters
- Community disruption
- Health, safety, and welfare (both operating and general public)

Under a value-based risk management approach, direct measures of benefits to values are preferred. The severity and frequency scales developed as part of Step 3 will be used to refocus some of these historically-considered factors to deal with the direct measures of benefits and risks identified in previous steps. An example of how the severity and frequency scales will be used to develop measures of benefits is illustrated on Figure 11-17.

FIGURE 11-17
EXAMPLE RISK REDUCTION BENEFIT DETERMINATION



Base Case Score	2 x 2 = 4	
Alt A Score	1 x 5 = 5	Risk Reduction Benefit 5 – 4 = 1
Alt B Score	3 x 1 = 3	Risk Reduction Benefit 3 – 4 = -1
Alt C Score	3 x 5 = 15	Risk Reduction Benefit 15 – 4 = 11

Note: actual scoring will have numeric scales rather than "high, low, often, "seldom"

11.5.5.1 Project Costs

Construction costs will be developed based on a combination of techniques depending on the "uniqueness" of the item being priced. Most costing will be done using published cost curves developed for use in planning studies of this kind, or through parametric estimating techniques that use data bases derived from other projects. Preliminary layouts and preliminary take-offs may be used for unique items, but at this planning level that would be unusual. The estimating tools will be calibrated to reflect MSD's costing history and the Louisville construction market. For budgeting purposes, the construction costs will be converted to capital costs using MSD's historical experiences with engineering and administrative costs.

Operating costs will similarly be based on curves and parametric estimating techniques, or a detailed estimate of labor, materials and utility costs for unusual and significant facilities. MSD's past experiences in operating and maintaining similar facilities will be used to verify the cost curve and parametric cost information.

Costs will be presented as capital and operating costs, as equivalent annual costs, and as present worth costs. Capital and operating costs will be presented primarily for MSD's future budgeting needs. For cost/benefit analysis either equivalent annual or present worth costs will be used, as they represent the costs of the control measures over the life of the project.

The present worth analysis will be for a 20-year term at a discount rate equal to the latest MSD bond sale rate, unless regulatory agencies specify a planning discount rate.

11.5.5.2 Control Performance

For the various alternatives and scenarios, the CSO volume and frequency reductions will be based on use of the hydraulic models. Pollutant load reductions due to CSO control or other watershed modifications will be evaluated through the use of water quality modeling tools to assess their impacts on receiving water quality. At this time, it is anticipated that the water quality model previously developed by ORSANCO will be considered for use to evaluate impacts on the Ohio River. Based on a review of the features of the ORSANCO model, some updating of input data may be necessary and/or some further evaluation of contributing areas may be required. For the Beargrass Creek Region, the WQT currently being developed will be used to establish the water quality impacts on that receiving water.

As described previously, the water quality models may show that CSO reduction/control will not result in compliance with WQS and designated use attainment. The TMDL process or water quality standards review will consider the feasibility of water quality improvements, and an appropriate level of control will be developed for each of the pollutants of interest (*e.g.*, biochemical oxygen demand, total suspended solids, solids and floatables, pathogens).

11.5.5.3 Risk Management Determination of Benefits

The risk management process continues into step 5, to develop the benefits based on risk reduction analysis.

Step 5 - Prioritize Risks Reduction

In Step 5, the cumulative benefit achieved by performing each project or activity is estimated for each value. The results are expressed in non-dimensional "units of risk-reduction benefit". These "units of risk-reduction benefit" are then converted to total benefit using stakeholder-

determined weighting factors based on the priorities of the values previously identified in Step 1. Table 11–7 illustrates how each alternative will be scored based on the risk reduction units previously illustrated on Figure 11–16.

TABLE 11-7

EXAMPLE RISK REDUCTION BENEFITS TOTALIZING

	Value 1		Value 2		Value 3		Value 4		Total Weighted Risk Reduction Benefits
	Risk Reduction Score	Weighted Risk Reduction Score (WF=5)	Risk Reduction Score	Weighted Risk Reduction Score (WF=3)	Risk Reduction Score	Weighted Risk Reduction Score (WF=1)	Risk Reduction Score	Weighted Risk Reduction Score (WF=5)	
Alt A	1	5	3	9	12	12	6	30	56
Alt B	-1	-5	5	15	3	3	14	70	83
Alt C	11	55	2	6	-1	-1	12	60	120

The performance measure scales and consequences scores developed in Step 3 enable each risk-reduction method to be quantitatively rated.

11.5.5.4 Develop Detailed Cost/Performance Relationships for the Alternatives

Based on the cost estimates and the benefit totals described previously, a cost/benefit ratio will be developed for alternative evaluation process conducted above, detailed cost estimates for the recommended structural, operational, and non-structural LTCP options will be prepared. A separate summary of the cost/benefit results will be prepared for each of the CSOs and their service areas. The cost summaries will be evaluated on a present worth basis, based on capital expenditures and operating and maintenance cost estimates.

11.5.5.5 Cost/Benefit Analysis

The cost/benefit analysis will be conducted in phases. In the first phase, the cost/benefit ratios for control of specific CSO locations will be developed. This will include evaluations of control strategies for individual CSO locations, or multi-site scenarios including consolidated solutions and regional solutions. From this analysis, a specific approach to controlling each CSO will be selected based on cost/benefit evaluations. An example of how a specific site evaluation might look is presented in Figure 11-17.

After the "best project" has been identified for each CSO location, this analysis will be presented to the stakeholder group for review and comment. This will also be one of the major milestone points discussed in one of the public meetings described in Section 11.4.

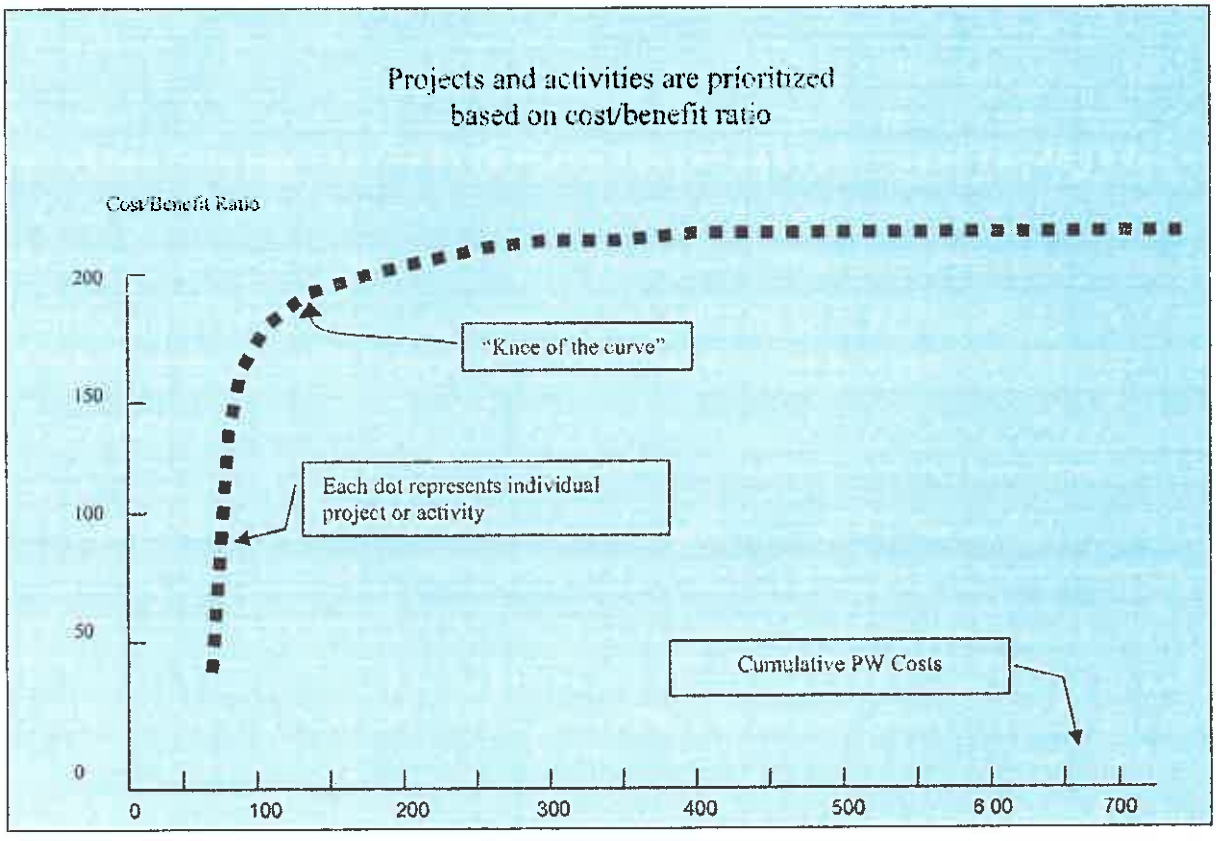
11.6 COST/PERFORMANCE CONSIDERATIONS

Determining the overall CSO control program requires a holistic evaluation and prioritization of the risk-reduction benefits of all the alternatives developed, including the specific sites and the watershed-wide activities as well.

11.6.1 Cost/Performance Curve Development

After CSO control strategies are selected for each individual site or groups of sites, the list of "best projects" for each CSO location will be combined with other overall programmatic activities such as expanded source control, expansion of the Real Time Control system, etc. The cost benefit ratios for each of these potential projects will be ranked and plotted. Various plots will be developed, including cost/benefits graphed against cumulative costs, cost/benefits developed for a subset of the overall benefit calculation (such as the overflow reduction benefit, etc.) An example of how these program plots might look is illustrated in Figure 11–18.

FIGURE 11-18
COST/BENEFIT RATIO



Consideration of costs will be consistent with EPA guidelines relative to the "feasibility" of alternatives, including knee-of-the-curve analyses, and the "affordability" of overall plans. Consideration of feasibility and affordability are factors in the selection of the target level of risk.

The knee of the curve analyses will be reviewed with the stakeholder group. It is expected that a number of sensitivity analyses will be requested to review the impact of certain value weightings on the selection of the final plan. This is appropriate, and in conformance with the LTCP guidance.

Step 6 - Risk Management Plan

In Step 6, the risk-reduction projects are ranked and prioritized using a benefit to cost approach previously shown in Figure 11-18. Fact-based decisions can then be made using this analysis to select performance objectives. This allows the adoption of performance objectives that are consistent with the target levels of risk.

Steps to adopting performance objectives consistent with the target risk level include:

- Identify facility performance objectives consistent with the target risk level(s);
- Seek stakeholder acceptance of the performance objectives;
- Select final performance objectives and obtain regulatory approval if required; and
- Develop an implementation plan with milestones, regularly monitor implementation, and report back to stakeholders.

This framework and method is designed to allow the WWT members to systematically consider decision factors and to help guide MSD's discharge abatement plans that result in compliance with water quality standards and the community investment in wet weather management represented in those plans.

11.6.2 Financial Capability

In selecting the final list of projects that make up the risk management plan, the total cost of the resultant program must be considered relative to MSD's financial capability to fund the program. To do this, the total capital and operating costs per household will be developed representing various levels of program spending. These costs will be compared to the median household income as one measure of financial capability.

In addition to median household income, the financial capability analysis will consider the overall MSD debt and its impact on bond ratings, the overall net debt as a percentage of full market property values, the socioeconomic indicators that reflect long-term trends in unemployment and projected household income, the property tax revenue collection rate, property tax revenue as a percentage of full market property values, and other financial indicators. The CSO Control Policy and associated specific guidance documents provide additional details on the calculation of a community's financial capability to fund a CSO control program.

11.7 OPERATIONAL PLAN

CSO LTCP guidance specifies that municipalities should develop and document programs for operating and maintaining the components of their combined sewer systems. Section 9 described MSD's current operating structure, significant operational changes underway, and the general process for updating the Operating Plan to address new facilities and strategies. Per the CSO LTCP guidance, once a LTCP has been approved, the municipality's operation and

maintenance program should be modified to incorporate the facilities and operating strategies associated with selected controls.

Each facility constructed as part of MSDs LTCP will have an operation plan detailing the equipment and features of the facility, including operating instructions. In addition, troubleshooting guides, safety considerations and special maintenance requirements maybe included. As examples of the process MSD uses, some existing base line components of the CSO LTCP are constructed and operating. These include the Sneads Branch In-Line Storage Facility and the modifications of the Robert Starkey Pumping Plant. Operational plans for the facilities have been developed. The Standard Operation Plan for Sneads Branch In-Line Storage Facility is presented as an example in Appendix 11-1. There are additional components of the CSO LTCP Plan such as Real Time Control Phase 2 that are currently in varying stages of planning, design and implementation. Once completed, these projects as well as the components of the Final CSO LTCP will have an operational plan prepared.

Through implementation of the Final CSO LTCP, MSD will operate the facilities as designed and stated in the operations manual. However, it is both environmentally responsible and fiscally prudent to be receptive to changing and unforeseen limitations and conditions such as improved technologies, shifting energy costs, and varying resources. In addition, results obtained from post-construction compliance monitoring may prompt an evaluation of modifications to the operations plan as originally detailed that, depending on the findings, could result in greater improvements in CSO capture and water quality benefit. An adaptive management approach will be employed to accomplish this flexibility. Ultimately, modifications to the standard operating procedures of CSO LTCP components, which demonstrate improvement, will be presented within the annual report outlined in the consent Decree.

11.8 MAXIMIZATION OF TREATMENT AT THE EXISTING POTW

11.8.1 Existing Hydraulic and Treatment Capacity

Section 4 addressed MSD's efforts to date to maximize treatment of wet weather flows at the Morris Forman Wastewater Treatment Plant (MFWTP). The current dry weather capacity of 120 mgd (average annual flow) is adequate to treat dry weather flows for the foreseeable future (since dry weather base flows have been declining over the past several years). Wet weather capacity has been increased to a peak hydraulic capacity (all units in service and optimal treatment conditions) of 350 mgd. Extensive studies conducted over the past 10 years have established this flow rate as the maximum capacity of the existing facilities. Providing more wet weather treatment capacity at the MFWTP would require the addition of major new facilities.

11.8.2 Consideration of Existing Site Constraints

Figure 11-18 shows the existing MFWTP site. This site is essentially a bowl, with the flood control levy to the west, and higher ground to the north, east, and south. Oil terminal tank farms are located to the north and south of the existing site. Some of the area between CSO211 and the plant site is undeveloped, but its elevation is well above the invert of the pipe from the Main Diversion Structure to the MFWTP Headworks.

Limited space remains at the MFWTP for additional expansion of wet weather treatment. Much of the existing open space has underground piping essential to the treatment process.

Alternatives will be developed to expand the wet weather treatment capacity at the MFWTP, potentially with small-footprint, high-rate treatment systems. These will be evaluated against remote treatment of consolidated sites (e.g., remote treatment adjacent to CSO 211 near the Main Diversion Structure), or remote treatment for individual CSOs (e.g., remote treatment at CSO 015, the Southwestern Pump Station).

11.9 IMPLEMENTATION SCHEDULE

An implementation schedule will be prepared as part of the LTCP development. This schedule will complete the program of improvements prior to the 2020 deadline provided in the Consent Decree.

11.9.1 Prioritization of Projects

The risk management approach previously described will allow MSD to develop a rank-order list of projects based on a cost/benefit ratio. The benefits used in the cost/benefit calculation will be based on managing risks to community values. While this approach to project prioritization will be appropriate for selecting the projects to be included in the Wet Weather Program, prioritizing for implementation requires an additional evaluation step.

Other considerations that impact the prioritization of projects for implementation include factors such as:

- Readiness to implement – is the land purchased, have easements been obtained, are the permitting processes completed
- Ability to show quick benefits – will the project have an immediate and noticeable impact on water quality or aesthetics, to build public support for the continued expenditures in the program
- Impacts on sensitive areas – while it is expected that consideration of locally-defined sensitive areas will be a factor in overall program selection, the weighting factor for this value will likely be increased when considering the order of project implementation

A revised prioritization process will be completed (considering only those projects selected to be part of the overall program) to revise the rank-order prioritization of implementation based on a revised and expanded set of criteria.

11.9.2 Financial and Cash Flow Considerations

After the revised rank order of projects have been developed, the project costs, from preliminary engineering through design, construction, start up and performance testing will be loaded into a scheduling tool (most likely Primavera Project Planner) to develop a preliminary schedule and cash flow analysis. Project start dates will be adjusted to optimize the cash flow to match a number of factors:

- Compliance with the 2020 completion date for all projects
- Provide uniform cash flow requirements that match MSD's ability to raise funds through bonds, loans, and rate increases.
- Recognize the market limitations of the local construction markets, and provide "ramp-up" time for the contractors to adapt to the increased project opportunities.

An overall financing plan will also be included. This plan will be developed with the assistance of the stakeholder group and other members of the Wet Weather team. The financing plan will consider capital funding options. MSD has typically financed construction programs with revenue bonds. Other options such as revolving loan funds will also be considered. MSD does not have taxing authority, so other revenue sources such as property taxes or sales taxes are not available to MSD. Rate increases greater than 7% require metro government approval.

Operating costs are recovered through sewer rates and other user fees. A review of the rate structure will be part of the stakeholder group's discussions. Given the likely significant impact of this program, affordability issues and financial burdens on lower and fixed-income residents is a concern.

11.9.3 Project Schedule

A master project schedule will be prepared, and loaded into MSD's critical-path method scheduling software. MSD currently uses Primavera Project Planner, and will likely continue to use Primavera products as they develop new versions. The schedule will have a standard template set of activity codes and cost codes to allow all projects to be set up uniformly. It is expected that the schedule will integrate LTCP projects with the remainder of MSD's capital budget, but will provide a project numbering system that will allow the LTCP projects to also be separated into a distinct program for tracking purposes.

11.9.4 Progress Monitoring

Progress will be monitored monthly for all active projects. The MSD project managers will follow established procedures for updating the schedule and cost progress of each activity within each project. Standard reporting templates will be reviewed during the LTCP development, and reports modified if appropriate to improve the tracking and managing information provided by the master schedule.

11.10 PLAN PREPARATION, APPROVAL, AND SUBMITTAL

Figure 11.1 illustrated the process of plan drafting, review, approval, and submittal by the December 31, 2008 deadline in the CD. After all the components of the plan have been determined, the plan will be drafted. The draft will include all 9 required elements as described in this section.

For alternatives that require construction, the draft plan will include diagrams, assumptions, design criteria, and site specific information about existing structures, soil conditions, wetlands, and other information required to adequately describe the facilities.

A programmatic cost estimate will be included, with a break-down by project of expected engineering, construction, site acquisition, and legal and administrative costs. O&M cost estimates will also be provided for budgeting purposes in advance of commissioning new facilities.

The draft report will be reviewed with the stakeholder group. It is expected that after discussion and revisions, the draft plan will be forwarded to the MSD Board with an endorsement and recommendation to approve. The draft plan will be reviewed with MSD's Board prior to release to the general public. After review and approval by the Board, the plan will be made available to

the public, and public notices will be issued announcing the availability of the report, and the date and time of the public hearing. This process is discussed in more detail in Section 11.4.

After the public comment period and public hearing have been completed, the report will be revised, with a response to public comment section appended. The revised report will again be reviewed by MSD's Board prior to submittal to the appropriate regulatory agencies.

11.11 POST-CONSTRUCTION COMPLIANCE MONITORING

LTCP Guidance states that the purpose of a LTCP post-construction monitoring program is to determine the effectiveness of the overall program in meeting CWA requirements and local water quality goals. The primary focus is to track, trend, and report on the effectiveness of the CSO controls in improving receiving water quality.

A complete compliance monitoring program considers a wider range of issues. MSD's post construction monitoring will be developed to meet the following defined objectives:

- Verify and document timely implementation of the long term control plan projects
- Verify and document compliance with National Pollution Discharge Elimination System (KPDES) permit requirements.
- Measure progress toward achievement of stakeholder watershed objectives
- Measure progress toward achievement receiving water quality standards
- Measure performance of long term control plan projects
- Support future watershed improvement planning efforts

The objectives include both verification and measurement. "Verification" implies a binary, "yes/no" type periodic checking. The verification objectives check that the activities planned are indeed implemented. Monitoring completed for these objectives are used primarily to ensure compliance with regulations. "Measuring" implies a scaled monitoring, allowing objective assessment of how well the systems are performing. The measurement objectives will support future management of the three systems (CSS, CSO, Receiving Water Quality [RWQ]), providing data essential to checking progress toward the achievement of the goals of the both the CSO control program and the receiving water quality management program.

Development of the post-construction compliance monitoring program will be inherently linked to the public participation activities. As the public, including the regulatory stakeholders, define values and perceptible measures appropriate to those values, the monitoring programs will necessarily flex to reflect those measures.

In the interim, until the public participation program has resolved the list of values and measures to be applied, the existing MSD monitoring programs achieve the objectives listed above. The existing MSD monitoring programs are described in more detail in Section 9 - Characterization of the Nine Minimum Control Update (September 2006). The following text summarizes how those programs relate to each of the objectives and how the program may be updated to better address anticipated evolutions of the regulatory requirements or public value measures. The post-construction monitoring program design will be refined as necessary during the planning to reflect the public values, including those of the regulators, prior to finalization and publication of the final LTCP.

11.11.1 Verify Implementation of the Long-Term Control Plan Projects

Verification of LTCP project implementation is documented through quarterly and annual reports specified in the Consent Decree. MSD will continue to monitor implementation of the defined LTCP projects throughout the long-term control planning period in a manner consistent with the Consent Decree requirements.

Once finalized, the LTCP will prescribe a list of defined projects, both construction and operational, to be completed by defined deadlines. This list, once finalized, will form the basis of a schedule. Subsequent reports are anticipated to use the format of a schedule update augmented by confirmation that the completed projects continue to be operated in the manner anticipated in the final LTCP. Development of the schedule and the procedures for updating schedule information are presented in Section 11.9.

11.11.2 Verify Compliance with Kentucky Pollution Discharge Elimination System (KPDES) Permit Requirements.

Currently KPDES permit requirements for the combined sewer service area are included in the MFWTP KPDES permit. Other KPDES permits within the combined sewer basin are held by individual point source dischargers, primarily industrial dischargers. In all cases, DOW verifies compliance with the permits through Discharge Monitoring Reports (DMRs) and other individually prescribed reports required to be submitted on a periodic basis. The individual permits list the data that must be included for DOW to track compliance with the permit terms.

At present, the monitoring and reporting prescribed in the permits is sufficient to enable DOW and EPA to verify KPDES permit compliance. If KPDES permit requirements change, then the prescribed reporting will presumably change appropriately to allow DOW, and EPA, to continue compliance monitoring.

11.11.3 Measure Progress Toward Achievement of Stakeholder Watershed Objectives

Measurement of progress toward achievement of stakeholder watershed objectives is paramount to the continued watershed quality improvement and to successful implementation of the LTCP. Stakeholders, particularly rate payers, expect perceivable improvements in their watershed values to balance the disruption and costs of the CSO control projects.

To date, MSD has identified watersheds and key stakeholders and initiated the process of engaging the stakeholders in defining values.

The breadth of experience of the professionals was applied to anticipate the probable values, and associated measures, that will be perceptible to the stakeholders. To the extent that the stakeholders values and measures are consistent with those currently anticipated by those involved in the CSO control planning, the existing MSD monitoring and modeling programs, augmented by ongoing monitoring and modeling by ORSANCO, USGS and KDOW, are sufficient support measurement of progress toward watershed objectives. This judgment of sufficiency is based on the weight of professional opinion of those actively involved in the Louisville MSD CSO wet weather planning. Nevertheless, some changes in the value measures may occur as the public involvement program proceeds.

While the monitoring and modeling programs are judged to be adequate to support measurement, the current analysis and reporting systems do not support easy access for the general public. The post-construction compliance monitoring program will develop improved

documentation and reporting procedures, to allow stakeholders and the general public to see and understand the water quality improvements of LTCP implementation, specifically related to local water quality objectives.

Major changes currently anticipated in measuring progress toward watershed objectives are summarized in Table 11-8.

TABLE 11-8
ANTICIPATED MEASUREMENT OF WATERSHED OBJECTIVES CHANGES

Anticipated Change	Anticipated Monitoring Adaptation
Stakeholders will identify measures of watershed value more related to their perceptions.	Update receiving water quality reporting protocols to include measures more readily perceived by stakeholders to relate to their values. It is anticipated that this update will include defining metrics calculated from multiple inter-related factors currently included in the MSD monitoring and modeling databases, and reporting these metrics in graphical formats.
Stakeholders may prioritize watershed values whose measure cannot be related to information currently monitored.	Develop a monitoring and measurement protocol appropriate to the value and update the MSD monitoring program accordingly.

11.11.4 Measure Progress Toward Achievement Receiving Water Quality Standards

Determination of achievement of receiving water quality standards is a primary function of the KDOW. MSD worked collaboratively with ORSANCO, USGS, KDOW and others to identify gaps in the pre-existing receiving water quality networks and, for nearly a decade, supplemented the regulatory monitoring networks with a long term monitoring network (LTMN) specific to Jefferson County.

To date, the compendium of data available from the several agencies monitoring receiving water quality in Jefferson County has proven sufficient to evaluate compliance (or non-compliance) with the existing receiving water quality standards. In rare cases, for example the evaluation of cadmium standards compliance, the legacy monitoring programs were deemed insufficient and updates to the programs are being implemented. MSD has implemented aggressive monitoring initiatives to measure the impact of individual CSOs on the nearby receiving waters, but those efforts have characteristically resulted in non-definitive results since the receiving waters were simultaneously impacted by time varying mixing phenomenon and multiple influences from upstream. Properly configured and verified models that interpolate between the long term monitoring sites have greater utility in isolating the impacts of individual CSOs.

If receiving water quality standards and measures of achievement remain substantially the same as those currently existent, then the existing long term monitoring network, augmented by the current modeling framework, is sufficient to meet future needs for measuring progress toward achievement of receiving water standards. This is particularly true since the long term monitoring sites efficiently bound the CSO impacted receiving. The MSD LTMN has sites

located above and within CSO impacted area on those streams which have enough length and flow support such monitoring. It also includes sites on streams that receive no CSOs. The network will continue to be scrutinized and refined to ensure continually more efficient monitoring of receiving water quality standards achievement. In particular, sampling sites and sequences will be reviewed to determine if the data they generate can be more efficiently generated through other means.

If receiving water quality standards should change substantially, for example if numeric standards are promulgated for chemical or biological entities not currently included in the monitoring programs, then the monitoring programs will require reevaluation.

Suggestions to modify sampling or analysis technique, monitor different analytes or change sampling location should be reviewed in light of the future ability to compare to previously monitoring records for trend analysis. Recommendations for additional sampling locations that occur during LTCP development should consider the following:

- Will the confounding factors (upstream influences, mixing limitations) render the new site substantially the same as currently monitored sites?
- Will the new site characterize unique sewershed characteristics?
- Will the new site substantially improve the quantification of discharge frequency and volume beyond the estimates available from the current monitoring/modeling combination?
- Does the new site support safe and secure access?

Major changes currently anticipated in measuring achievement of water quality standards are summarized in Table 11-9.

TABLE 11-9
ANTICIPATED WQS ACHIEVEMENT MEASURE CHANGES

Anticipated Change	Anticipated Monitoring Adaptation
Review the historic cadmium data.	Implement a revised cadmium data quality assurance protocol.
Revised protocols for linking models and historic data to evaluate interpolated between sampled incidents	Revise modeling and monitoring Standard Operating Procedures (SOPs) to document (and standardize) the interpolation procedures for stakeholder review.

While existing monitoring and modeling approaches are adequate to support evaluation of the progress towards achieving water quality goals, the analysis and distribution of results requires improvement. As part of the LTCP, a regular review and reporting of water quality trends will be implemented. An annual water quality report will look for statistical trends in water quality as compared to baseline data. Given the extensive database of water quality measurements, the baseline conditions are well established both in time and in location. This report will be included in the annual Consent Decree reporting. In addition to the annual regulatory report of water quality trends, a bi-annual comprehensive summary of water quality conditions and water quality trends will be prepared and posted on MSD's web site. This bi-annual summary will be

prepared to be understandable by the general public, and will be widely distributed through MSD's active public outreach and education programs described in Section 11.4.

11.11.5 Measure Performance of Long-Term Control Plan Projects

Measurement of the performance of long term control plan projects, is site and technology specific.

To date, MSD's experience in measuring CSO LTCP project performance has used frequency of overflows and modeled AAOV as the primary measure of performance.

If the LTCP calls for construction of CSO treatment facilities their performance may require technology specific performance measurement. For facilities other than treatment technologies, monitoring of frequency and volume of overflow using a combination of modeling and metering should be sufficient.

Major changes currently anticipated in measuring performance of LTCP projects are summarized in Table 11-10.

TABLE 11-10
ANTICIPATED MONITORING FOR LTCP PERFORMANCE CHANGES

Anticipated Change	Anticipated Monitoring Adaptation
Potential construction of CSO treatment facilities	Technology specific monitoring, probably accomplished under compliance monitoring as discussed in Subsection 11.11.3.
Potential reduction in CSO frequency and volume	Frequency may be confirmed through use of simple yes/no activation recording devices. Impacts would be measured in the water quality compliance monitoring discussed in Subsection 11.11.5.

11.11.6 Support Future Watershed Improvement Planning Efforts

Future efforts to evaluate and/or improve the health of the watershed will necessarily rely heavily on monitoring and modeling data. To track the health of the watershed, the monitoring program must be consistent over a number of years. To assess the watershed health under all conditions the monitoring data should reflect a broad range of conditions and be supported by modeling verified for the range of conditions and the ability to interpolate accurately for intermediate conditions. To assess the true health of the watershed, not just the chemical health of the waters, the monitoring program must address a wide range of physical and biologic factors both in and adjacent to the waterways.

To date, support of watershed improvement analysis and planning was and is the primary focus of the existing MSD long term monitoring network. Accordingly, the existing MSD long term water quality monitoring network, supported by the biologic monitoring and mathematical modeling provide sufficient data to support and sustain watershed health evaluations and improvement planning. The sufficiency of the program is judged on the weight of professional

opinion of the several professionals previously and currently involved in using and evaluating the wealth of the data developed through those programs.

If the stakeholders prioritize value measures that are not supported through the use of the existing monitoring network, adjustments to the existing programs will be investigated. Any such adjustments will be evaluated in light of their contribution to the purposed listed in the first paragraph of this subsection. In additions, each modification should be reviewed for conformance with the principals suggested for changes to water quality standards achievement monitoring (Subsection 11.11.5).

Major changes currently anticipated in measuring and modeling to support future watershed planning efforts are summarized in Table 11-11.

TABLE 11-11

ANTICIPATED MONITORING FOR WATERSHED IMPROVEMENT PLANNING CHANGES

Anticipated Change	Anticipated Monitoring Adaptation
Standardize evaluations of the index of biologic integrity (IBI).	IBI calculations are currently an objective means of combining numerous measurements and observations into one standard index. Interpretations to develop the index require the opinion of a trained professional. However, those interpretations will be facilitated and easier to document once the linked databases are programmed to develop IBI related information sheets.
The public participation program may suggest broader access to the data relevant to watershed health to support public participation and stakeholder awareness	MSD is currently organizing and documenting the multiple databases for easier access. Selected synopsis of these data, particularly value measures prioritized by the stakeholders, may be linked to maps available for Internet viewing.
Episodic modifications may be suggested to support research in specific geographic or technical areas.	Sites or analytes may be temporarily added to the MSD monitoring network. Data from the temporary efforts should be subject to quality assurance protocols governing the long term monitoring networks.

11.12 PROJECTS - 2006 THROUGH 2008

Concurrent with the development of the final CSO LTCP that will be submitted on December 31, 2008, MSD will continue implementing projects to improve water quality through the reduction or elimination of CSOs. The majority of these projects are based upon CSO LTCP components, which were identified in the draft CSO LTCP submitted in 1996 and 1997. They were identified as base control options (those projects that made sense for implementation as soon as practical, because of the specific benefits to CSO). The belief is that these projects will complement the Wet Weather Planning process.

Table 11-12 provides a brief description of the interim CSO LTCP projects along with location, cost and schedule information.

TABLE 11-12

INTERIM CSO LTCP PROJECTS

	Project Description	Project Cost	Completion Date	Receiving Stream
1	Snead's Branch Solids and Floatables Improvements	$ 300,000	August 30, 2006	South Fork - Beargrass Creek
2	Northern Ditch PS Pump Replacement *	$ 1,300,000	November 30, 2006	Ohio River
3	CSO 081 - CSO Elimination	$ 50,000	December 31, 2006	South Fork - Beargrass Creek
4	CSO 146 - Solids and Floatables	$ 300,000	December 31, 2007	South Fork - Beargrass Creek
5	Integration of Wheeler Basin Operations	$ 520,000	December 31, 2008	Ohio River
6	Integration of SWPS/MDS/MFWTP Operations	$ 870,000	December 31, 2008	Ohio River
7	Real Time Control at CSO 108 (BG13)	$ 670,000	December 31, 2008	Middle Fork - Beargrass Creek
8	Real Time Control in the Southwestern Outfall (SWOR2)	$ 5,300,000	December 31, 2008	Ohio River
9	CSO 206 - Sewer Separation	$ 2,200,000	March 31, 2009	Middle Fork - Beargrass Creek

* Project also included in updated SSOP
*CSOs may be closed in lieu of constructing S&F projects as long as the completion date is achieved

11.12.1 Fundamental Components for Development of the Final LTCP

The development of the Final LTCP as required in paragraph 24b(2) of the Consent Decree will be done in accordance with EPA's "Guidance for Long-Term Control Plan", EPA 832-B-95-002, September 1995. We acknowledge the requirement that the Final LTCP must present the results of characterization, monitoring, modeling activities and design parameters as the basis for selection and design of effective CSO controls. The Wet Weather Framework presented in this section will be used as the work plan for developing this Final LTCP. As part of, and in addition to the development, MSD will continue with commitments to ongoing capital investments and application of key elements for a successful wet weather program. Some of these fundamental components are as follows:

- Compliance with the Clean Water Act – As stated many times in this section, MSD will comply with the CWA through development and implementation of the CSO LTCP. This is a fundamental principal for the wet weather program.
- Select Approach: Presumptive vs. Demonstrative – At the present time, it is not known which approach is most appropriate for MSD. Based on the review of available data; existing CSS conditions and the results of field investigations undertaken, more information will be available with which to make a selection.
- Public Participation – As noted in the EPA's guidance document for developing CSO LTCPs, MSD will develop and maintain avenues for public involvement throughout the process. This is explained within this Section. The goal of the public participation program should be to involve the citizens in the development of alternative solutions that

protect the local waterways and consider the financial impacts to the community as a whole.

- Real Time Control – The RTC program is the foundation for MSDs CSO LTCP. It is an effective means to make the best use of existing infrastructure to reduce combined sewer overflows. MSD is committed to continuation of RTC with the implemenation and evaluaton of Phase I and the design; construction and implementation of RTC Phase II.
- USACE Pump Station Modifications – MSD will continue with the on-going effort of evaluating and modifying the existing USACE Flood Pumping Station to reduce the volume and frequency of CSO discharge.
- Development of the TMDL for Beargrass Creek – Development of the TMDL for the Beargrass Creek watershed is on-going. MSD will continue as a partner in this project and ultimately make use of the developed TMDL for the Final LTCP.
- Water Quality Sampling – Along with the ongoing water quality sampling work, MSD will re-evaluate the water quality-monitoring program to confirm alignment of this work with the needs of the wet weather program and development of the Final LTCP. This evaluation and possible redefining of the water quality work will begin during the fourth quarter of 2006. This effort will follow the EPA CSO Guidance for Monitoring and Modeling by first reformulating and documenting the objectives of the CSO Program. Once the objectives are determined, the various elements of water quality sampling will be established. An element of the water quality-monitoring program will include an implementation plan with a schedule.
- Flow Monitoring – In addition to the ongoing combined sewer system flow monitoring work, MSD will perform flow monitoring on approximately 22 CSO outfalls (those with a predicted AAOV greater than 10 million gallons). This work will commence during the fourth quarter of 2006. Data obtained as part of this monitoring will be used to validate the CSO model and to provide general guidance on the operational characteristics of the CSS.

ID	Task Name
36	Stakeholder Group Monthly Meetings
1	Develop WQ Monitoring Scope (ILTCP)
6	Review and Revised ORSANCO Model
3	WQ Monitoring (In-Stream & End of Pipe)
5	In System Hydraulic Modeling: CSO
7	Integrate Hydraulic Models
2	NMC Integration
9	Preliminary Project List
10	Develop Consolidated Alternatives
4	Water Quality Report
8	Validate Hydraulics
11	Preliminary Engineering Review of Altrnatives
12	Milestone 1 WQ Report & Regulatory Issues
13	Regulatory Compliance Discussions
15	Alternatives Costing & Performance Calculations
14	Milestone 2 - Annotated Outline of Final LTCP
37	Public Information Meeting No. 1
16	Populate Risk Matrices
17	Review & Confirm Risk Management
38	Public Information Meeting No. 2
18	Develop Cost Benefit Analysis
19	Program Preformance Evaluation
21	Affordability Analysis
20	Rate Impacts
22	Prioritize Projects
24	Milestone 3 - Presumptive or Demonstrative
25	Regulatory Compliance Discussions
26	Revise and Update Project List
39	Public Information Meeting No. 3
23	Develop Implementation Schedule
27	Draft Text
28	Board Review & Approve
29	Milestone 4 - Draft Plan Release
30	30 Day Comment Period
31	Public Info Mtg - Plan Review
32	Public Hearing
33	Final Draft to Board
34	Board Approval
35	Submit

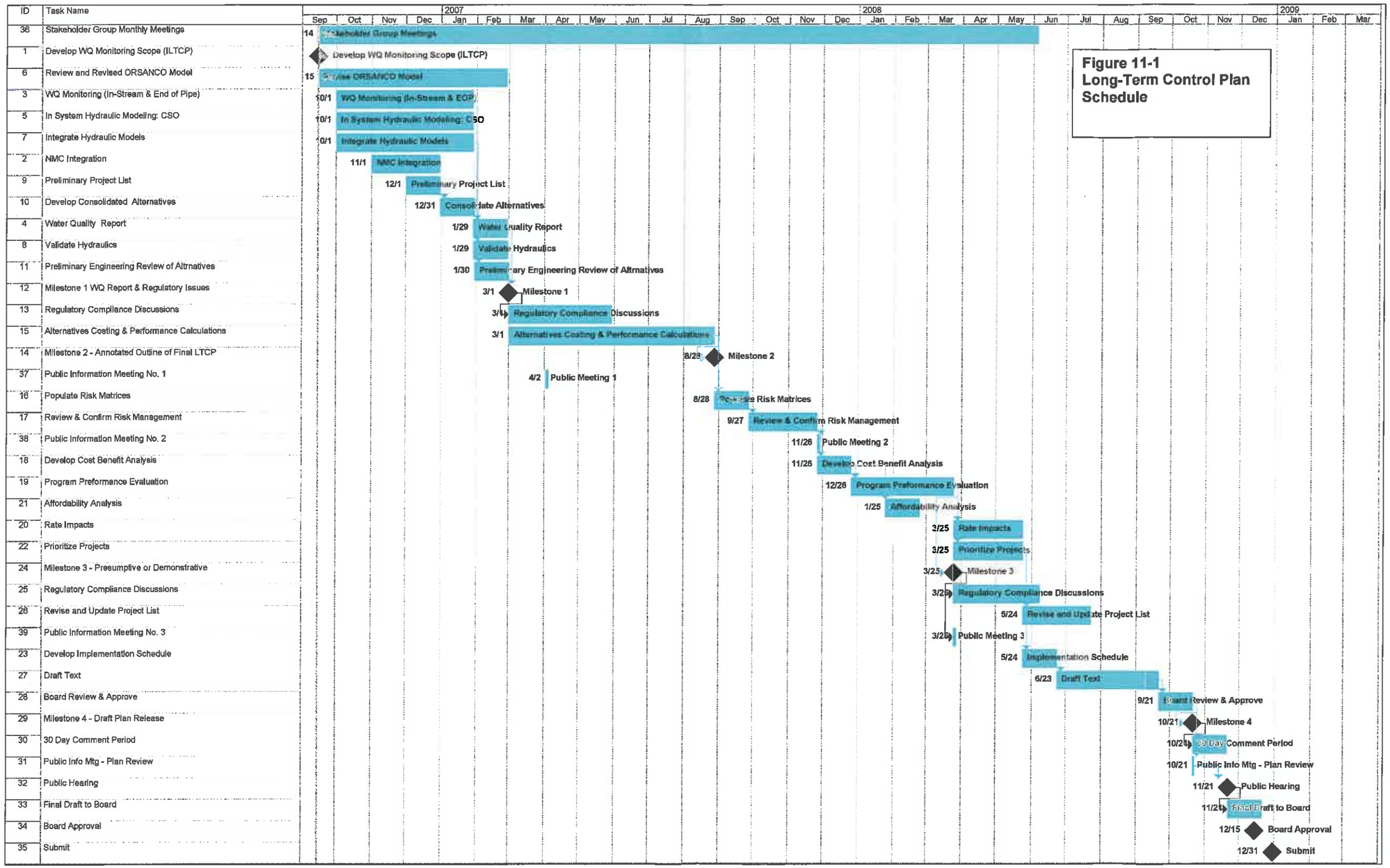


Figure 11-1
Long-Term Control Plan Schedule

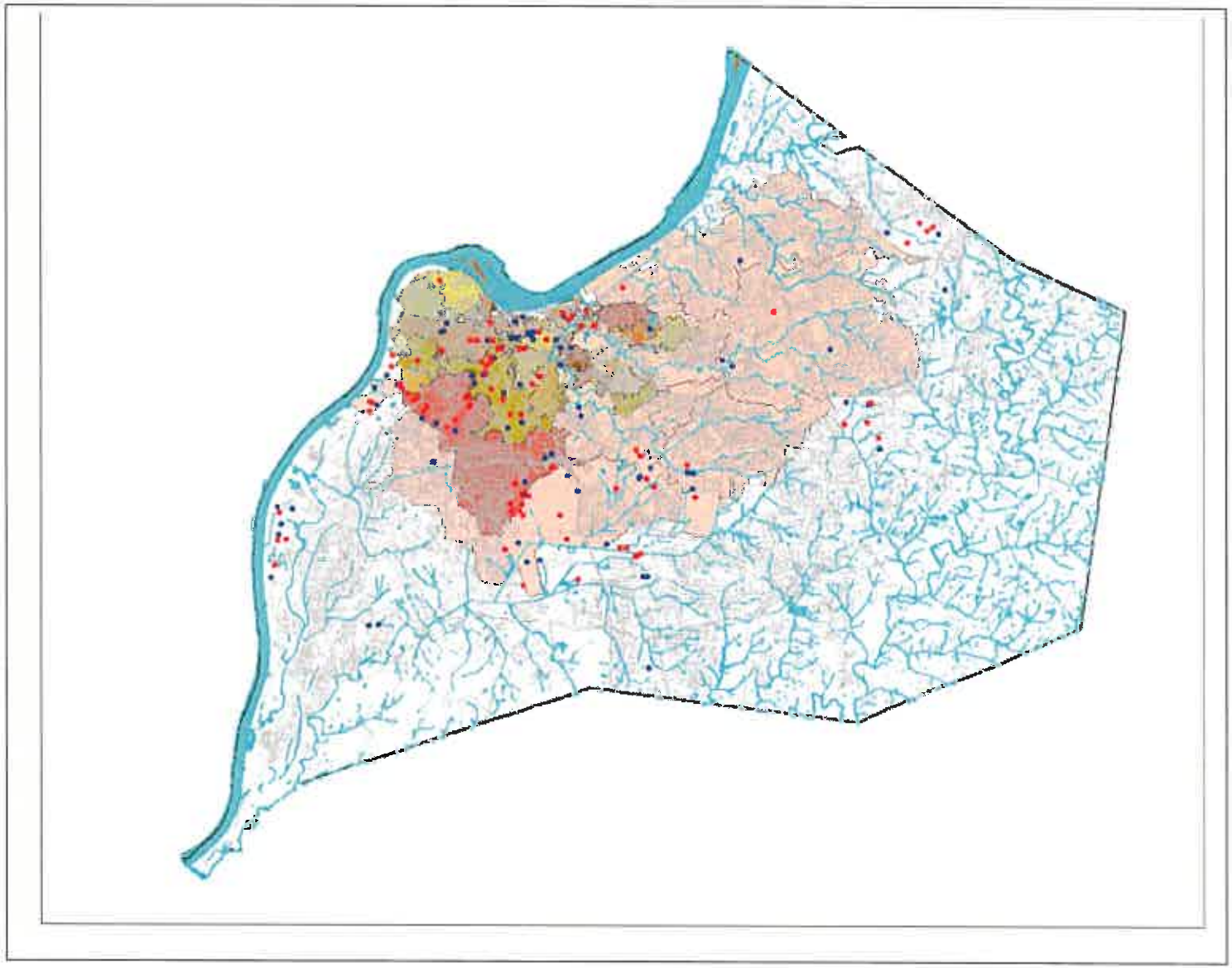


FIGURE 11-2

SIU AND GDP LOCATIONS

Figure 11-3
SAMPLE
CSO INVENTORY SHEET

DATE: JUNE 4, 1991
CSO SERIAL NO. 126
REGULATOR NO. 25 - RAYMOND AVENUE SEWER
LOCATION: North of I-64, east of Saunders Lane and west of Grinstead Drive
OVERFLOW TYPE: REG

STRUCTURE OVERFLOW ELEVATION:

438.83 - Crest of dam

OVERFLOW TYPE AND SEWER GEOMETRY:

The overflow is located on a 36" circular sewer flowing south from Bickel Avenue. A 27" circular sewer flowing east from Saunders Avenue enters the 36" sewer just upstream of the overflow structure. The Middle Fork Interceptor is flowing west below the 27" sewer. The 36" sewer enters a diversion chamber at invert elevation 437.95 where the low flows drop through missing rack bars and discharge through a 15" sewer at invert elevation 434.44 to a regulator chamber. The flow exits the 15" sewer into the regulator chamber through a regulated opening. The regulator is operated by a float system, which is "tail-tailed" off the Middle Fork Interceptor through a 10" sewer. The flow exits the regulator chamber through an 18" sewer at invert elevation 434.08 to the 33" Middle Fork Interceptor. The invert elevation of the interceptor at this point is 433.07. The float system alerts the regulated opening when the flow in the Middle Fork Interceptor reaches elevation 435.77. The overflows exit the diversion chamber through a 4' x 3' box culvert with a 12" dam located about 5' downstream of the diversion chamber. The crest of the dam is at elevation 438.83.

The shut-off elevation is taken from construction plans. The actual working elevations and capabilities of the regulator are unknown.

BACKWATER LENGTHS AND STORAGE VOLUMES:

The 36" sewer is at a 2.373% grade. A 12" dam corresponds to backwater length of about 42 feet. The storage is about 40 cubic feet.

DOWNSTREAM BACKWATER EFFECTS:

The overflow discharges to a 6' x 4' box culvert flowing south under I-64 to the Middle Fork of Beargrass Creek. High levels in the creek may backup into the overflow.

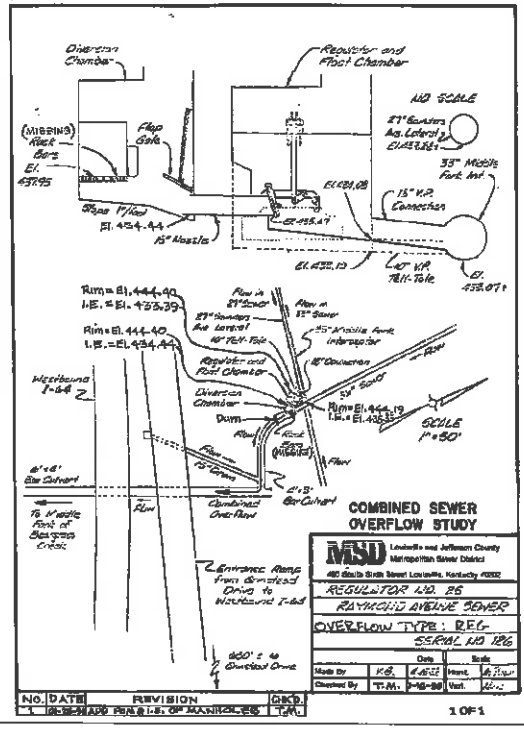
Updated
12/00

COMBINED SEWER OVERFLOW INVENTORY
FIELD INVESTIGATION REPORT

CSO NO.: 126 NAME OF STRUCTURE: Regulator No. 25
LOCATION: In easement east of Saunders Lane, north of I-64, west of Grinstead Drive
DATE INSTALLED: 1910 TYPE OF STRUCTURE: Regulator chamber
MSD ATLAS NO: I-15 RECORD NOS.: G-51, 56, 57, 58
INTENDED OPERATION AND FUNCTION: To divert low flow from Raymond Avenue area combined to Middle Fork Interceptor sanitary. Tell-tale works by the depth of flow in Beargrass Interceptor.
FUNCTION AND OPERATION FOUND DURING FIELD INVESTIGATION: As should be.

DRY WEATHER FLOW CONDITIONS
NAME OF INLET SEWER: Raymond Avenue Sewer
RECORD NOS.: G-51, 56, 57, 58 SIZE: 36" GRADE: 2.73%
LOW FLOW CONNECTION: SIZE: 18" GRADE: N/A
NAME OF OUTLET SEWER: Middle Fork Interceptor
RECORD NOS.: A-75 SIZE: 33" GRADE: 0.11%
NAME OF EVENTUAL RECEIVING BODY OF WATER: Middle Fork of Beargrass Creek
REMARKS:

FIELD INVESTIGATED BY: Tom Middeler DATE: 8/22/89



MSD
Louisville and Jefferson County
Metropolitan Sewer District

FIGURE 11-4

CSO034 Inspection Checklist

Date_____ **Time**_____-_____ **Work Order #**_____

Inspector (Employee #)_____ **801 S 4th St**

		Yes	No
Is there debris behind diversion dam?	*	☐	☐

If yes, DEBRIS work order # _____

		Yes	No
Does Cyclone need to be cleaned?	*	☐	☐

If yes, DEBRIS work order # _____

FIGURE 11-5
CSO151 Regulator Maintenance Checklist

Date_____ **Time**_____-_____ Work Order #_____

Inspector (employee #)_____ **Regulator # 5** 1316 Castlewood Dell

- ☐ **Spray/Wash Gate Chamber**
- ☐ **Spray/Wash Float Chamber**
- ☐ **Inspect Tell Tale for obstructions**
- ☐ **Vactor float chamber**
- ☐ **Grease fittings on gate arms**
- ☐ **Grease fittings on float arm**
- ☐ **Inspect chain to be in working order**
- ☐ **Exercise gate to insure it moves up and down properly**
- ☐ **Inspect float to be exercising properly**
- ☐ **Inspect weights on gate for accountability**
- ☐ **Flush I.S. 013**

Comments _____

_____

_____

_____

_____

News About Louisville and Jefferson County Metropolitan Sewer District

Update

September 2006

"We are providing a higher level of service, which brings a greater acceptance of our rates and we're very proud of that." – *Bud Schardein*

Service excellence praised at annual employee meetings

Extending MSD's open-door policy, Executive Director Bud Schardein and division directors opened doors to MSD facilities across Metro Louisville during a series of employee meetings held in August. "Having more than 600 employees makes it challenging for us to ensure all of our employees understand our new initiatives, our administrative policies and — most importantly — that we hear about all the outstanding work they've been doing," said Schardein.

During the series of 10 employee meetings, visits were made to the Central Maintenance Facility and wastewater treatment plants. Time during the meetings was dedicated mostly to addressing employee questions and comments, but Schardein and division directors also discussed ongoing initiatives such as clean water, flood protection and the continuation of Project DRI.

Citing the efforts of the employees, Schardein noted, "We are providing a higher level of service, which brings a greater acceptance of our rates and we're very proud of that."



More than 600 MSD employees gathered for annual employee meetings held at the Central Maintenance Facility, the Main Office and wastewater treatment plants.

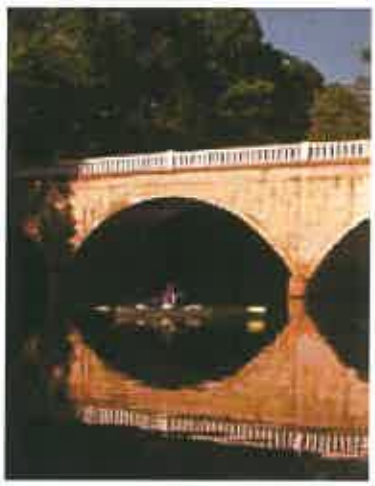
Consent Decree Spotlight

Expanded Public Notification Relative to Use of Our Waterways

MSD is expanding its public notification and education program as it relates to water pollution problems in our community's drainage channels, streams, and the Ohio River during and after rain events. MSD monitors surface water runoff for pollutants from both flooding and water quality perspectives. Our drainage channels, streams, and the Ohio River are subject to urban runoff contaminants such as fertilizers, petroleum products and other lawn treatments, and may be subject to sewage overflows during and after rain events.

Some of the new notification and education efforts will be in place in the next month, including additional signage in areas of sanitary sewer and combined sewer overflows, as well as along other potentially impacted streams and river banks. We will also be sending a letter to customers and posting information on our Web site with procedures for signing up to receive additional communications during and after measurable rain storms.

Care should be taken to avoid contact with surface streams and the Ohio River during and after rain storms to minimize health risks associated with urban runoff and sewage overflows. MSD continues to reduce and eliminate the occurrences and locations of sewer overflows, but much work needs to be done. MSD wants everyone to enjoy our local waterways, but also wants to protect our community when pollution levels are high.



MSD works to ensure that the community can enjoy clean waterways such as Harrods Creek. However, these areas should be avoided during and after heavy rains.

MSD

Connect With Us

24/7 Customer Relations:
502-587-0603
TDD/TTY: 502-540-6233

www.msdlouky.org

En español: 502-540-6423
(De 8 de la mañana a 5 de la tarde, de Lunes a Viernes)

Upcoming **Events**

September 4
MSD offices will be closed.
For emergency service anytime, phone MSD's Customer Relations Department at 587-0603.

September 7
DiverseWorks for You Certification Orientation
9 a.m., 700 W. Liberty, first floor

September 11
MSD Board Meeting
10 a.m., 700 W. Liberty, first floor

September 25
MSD Board Meeting
10 a.m., 700 W. Liberty, first floor

October 12
MSD Retirees Club meeting and luncheon
11 a.m., Masterson's Restaurant, Atrium B

MSD **Milestones**

We are proud to announce:
MSD Budget and Finance Director **Marion Gee** was profiled in the July 28 issue of *Business First*.

Laboratory Manager **Zonetta English** has received the August 2006 Award of Excellence from the U.S. Environmental Protection Agency's Environmental Laboratory Advisory Board.

Welcome to MSD:
Robert Carradine, Utility Trainee
Austin Duvall, Utility Trainee
William Phillips, Utility Trainee
Eric Sowards, Utility Trainee

Congratulations on your promotions:
Eddie McAfee, Utility Worker III
Donnie Stirneman, Utility Worker III

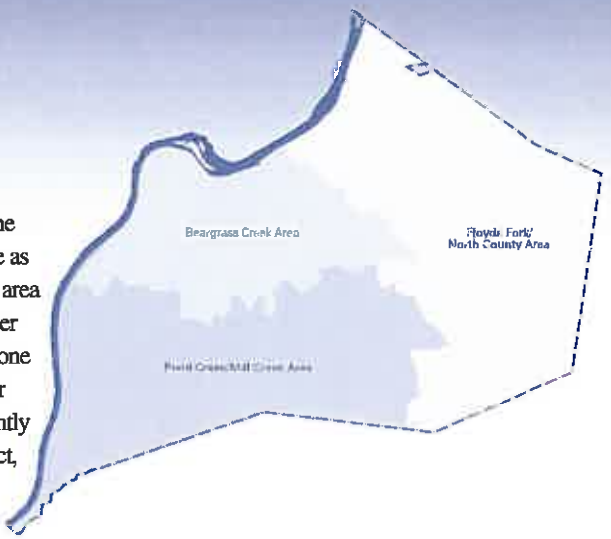
Changing the pace:
David Floyd, Utility Worker II - from Drainage to Physical Assets

We will miss:
Dave Carty, retired July 31

Certified Success

DiverseWorks for these recently certified businesses:
Clean Solutions (WBE)
Carpet cleaning, floor scrubbing and refinishing, floor waxing and janitorial supplies
Contact: Honey Paine, 502/778-6880

Area Team News



Development Team:
An 18-condominium development at Factory Lane and Old Henry Road will receive sewer service as part of an agreement with MSD to plan for future area development. LC Capital, LLC, will install a sewer interceptor that would allow the elimination of one of Woodmont's pumping stations. The new sewer system also will divert wastewater, which is currently treated by the Oldham County Sanitation District, to be treated by MSD facilities. MSD will pay $108,668 for the excess costs of the developer.

Floyds Fork/North County/Operations Area Team:
Neighbors near the **27th Street pumping station** will be better protected from flooding when a sluice gate actuator is replaced at the station. Sluice gates are opened or closed during floods to block flow. The $64,000 project includes replacement of the gate, electric motorized actuators, weather enclosures and other fixtures.

Webster Environmental Associates will provide technical expertise and consulting regarding odor control measures at the **Morris Forman, Cedar Creek and other wastewater treatment plants.** For $118,855, Webster will investigate odor complaints, conduct system testing and design odor control improvements.

MSD has selected CH2M Hill to provide engineering consulting services regarding process, structural and operational objectives at the **Morris Forman Wastewater Treatment Plant.** Specifically, the firm will help MSD market Louisville Green, design concrete repairs for the plant's decant tanks and design electrical modifications for the plant's effluent pump station.

Equipment used in the alternative solids process at the **Morris Forman Wastewater Treatment Plant** will be coated with a hardened metal material to prevent wear and reduce maintenance on the equipment. The improvements to the drying mixers will cost $77,426.

In order to further reduce odors at the **West County Wastewater Treatment Plant,** construction will soon take place to install aluminum covers, which will enclose treatment processes and pipe air to an existing biofilter. The project will cost $105,000.



A sewer rehabilitation project along Running Fox Circle has corrected low spots in the sewer line which have caused repeated backups for 13 of 30 area properties in the past five years.

Pond Creek/Mill Creek Area Team:
Since a sewer replacement project began on **Running Fox Circle** near Fern Creek Road, construction crews have discovered several sags in the existing sewer line that need to be repaired. The roadway, which has been damaged due to heavy equipment and inadequate sub-grade foundation, also will be repaired. The project will cost $279,724 and will be completed without disrupting service.

Construction will soon take place for the Watterson Woods Sanitary Sewer project impacting property owners near Watterson Trail and Stony Brook Drive. Approximately 1,830 feet of pipe will be installed and wastewater flow will be diverted from the **Watterson Woods Wastewater Treatment Plant,** which will be taken off-line and demolished. The project will cost $597,213.

Project DRI Progress

Project DRI has improved drainage throughout the Metro area with 381 projects completed during Phase 1. Since Phase 2 began in 2005, 45 percent of 345 planned projects are either underway or completed.



Project DRI Phase 2

Drainage Response Initiative Projects

The Project DRI partnership between Louisville Metro and MSD is solving drainage problems throughout the community. These projects are ready for construction:

- A $201,040 project along **Anita Boulevard and El Prado Street** will include installation of side-yard pipe, roadside paved swales, earthen swales and the replacement of driveway culverts and aprons. The project, which also involves several properties along *Granada Drive*, will address approximately 14 service requests and impact 49 properties.
- Rear-yard drainage improvements will be performed through a $64,100 project on **Dunkirk Lane** in the Valley Village Subdivision. Nine service requests will be addressed and 32 area properties will benefit from the project to correct a poorly defined drainage system.
- Three hundred feet of paved swale will be installed and driveway aprons and culverts will be replaced along **Mary Ellen Drive** to eliminate standing water. The $83,650 project will address nine service requests and benefit an additional 45 properties.
- Approximately 1,160 feet of rear-yard drainage improvements will be performed to correct a poorly defined drainage system between **Red Oak Lane** and **Red Fern Road.** The $108,980 project will address six service requests and benefit 35 properties.
- Eight service requests will be resolved and 92 properties will benefit from improvements to alleviate standing water in driveways and roadways along **Richmont** and **Shagbark** roads. Roadside pipe and a yard-drain system will be installed, roadside swales will be regraded and driveway aprons will be replaced as part of the $188,351 project. The project includes portions of Broadleaf and Oboe drives.
- Eighteen service requests will be addressed through improvements along **Tin Dor** and **Kirsch** ways. Paved swales will be installed and driveway aprons will be replaced with the $101,175 project, which benefits 54 properties.
- A roadside paved swale, driveway aprons and culverts will be constructed along **Winslow Drive,** including Albion Drive, to resolve approximately 12 service requests regarding a poorly defined drainage system. The $63,760 project also will include a rear-yard paved ditch between Juanita Lane and Winslow Drive and benefit 31 properties.

New Action Plan explores Jeffersontown expansion

MSD will explore ways to better use the capacity of the **Floyds Fork Wastewater Treatment Plant** by expanding its service area south and east of the plant. Specifically, the plan will determine the potential to divert wastewater from the **Jeffersontown Wastewater Treatment Plant** and pinpoint any changes the expansion may have on plant capacity. It also will examine how continued growth and development will impact the plant over the next 20 years.

The original Floyds Fork Action Plan, completed in 2004, made recommendations to eliminate 10 MSD and two private treatment plants and to provide regional wastewater treatment service to areas in northeastern Jefferson County. The Floyds Fork Wastewater Treatment Plant, located near Shelbyville Road, has been in operation since 2001. It has the capacity to treat 3.25 million gallons of wastewater per day.

Strand Associates was selected to perform the study and create the action plan based on their previous experience with MSD. The firm recently completed the 2004 Floyds Fork Service Area Update Master Plan.

Customer First at Work

"When I called on Saturday night I expected to get a recorded message, however, my call was answered by **Leila Cunningham.** Within an hour, **Terry Richardson** was here to analyze the problem. Thank you for your timely service."
— *Betty Kassulke, St. Matthews*

"Jill Allen did an outstanding job diagnosing the problem. She followed through on all phases of the solution. We've had several rains since the completion of the project and the ditch has functioned as we were told it would."
— *Don and Regina Stinson, Fairdale*

"After I reported a force main break located on my property, I woke the next morning to find that a nearby pump station was taken off line to prevent further spillage, a repair contractor had been mobilized, utility locates were in progress and the appropriate warning signs had been positioned around the area. Thank you, **Kevin Ries** for a job well done."
— *Gary J. Swanson, PE, Copperfield Subdivision*

"Darrell Goodwin and **Sean Brown** were very courteous, helpful and efficient. My compliments to their work."
— *Mitch Charney, Glenview*

Peer-to-Peer Praise

"Process Specialist **Mike Carter** filled in at the last minute to present an environmental education tour to 27 teenagers, five teachers and two UofL professors. Mike is a great example of how MSD employees have incorporated additional duties into their busy schedules."
— *Phyllis Croce, Eric Brady and Dennis Thomasson, MSD*

MSD

Louisville and Jefferson County
Metropolitan Sewer District

700 West Liberty Street
Louisville, KY 40203-1911

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Above: Porous concrete is installed in a two-foot strip along the curb of Liberty Street to catch stormwater runoff before it enters the drainage system.

Concrete test aims to reduce sewer overflows

One of MSD's efforts to reduce sewage overflows is taking place just outside of its administrative offices. Porous concrete, which is designed to allow stormwater to seep through rather than drain off, has been installed in a two-foot strip along the curb of Liberty Street.

Ideally, the concrete, which resembles compacted gravel, will reduce the amount of stormwater that enters the sewer system. When stormwater and wastewater overwhelm the system, dangerous overflows occur in the city's waterways.

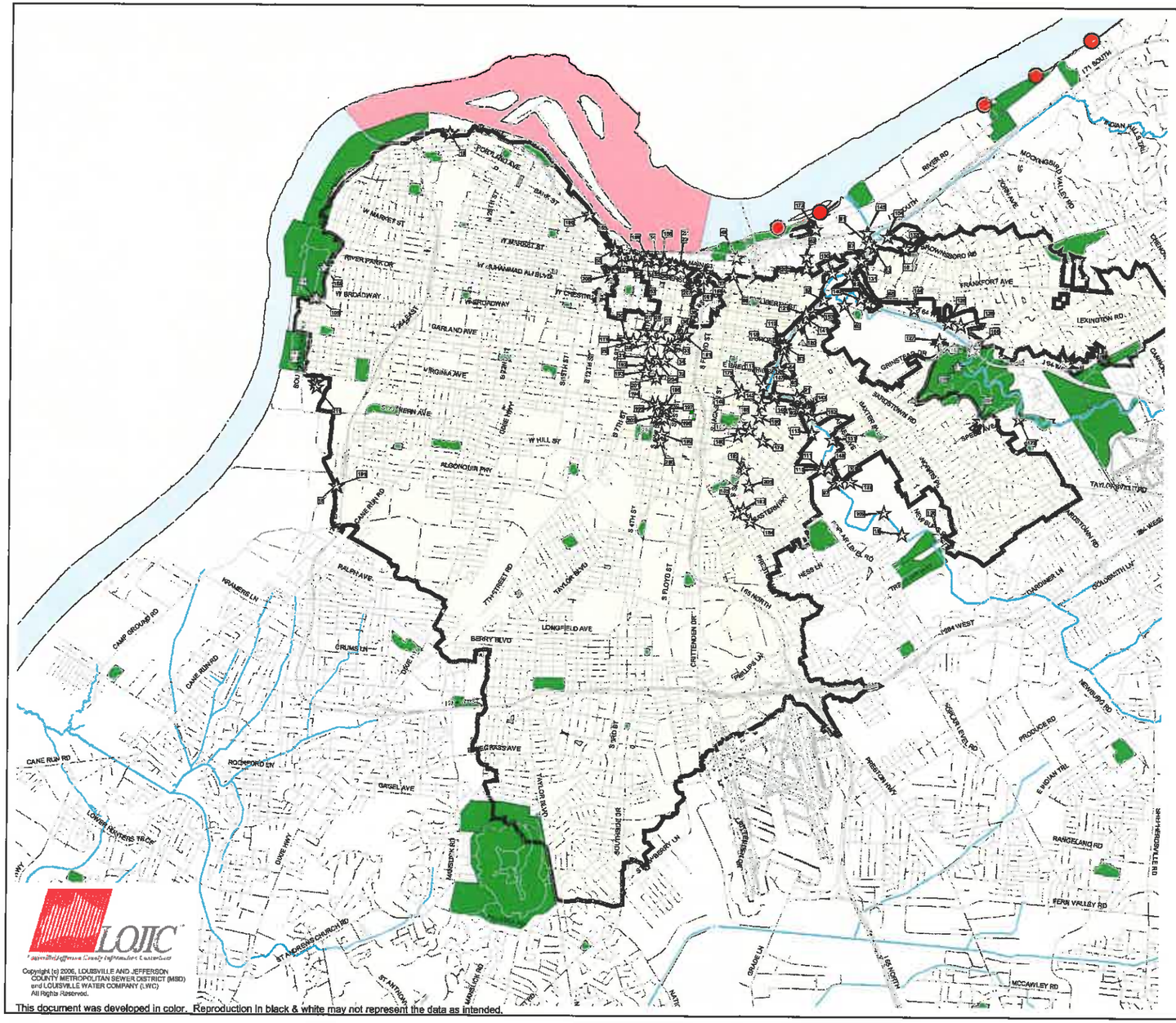
"If the concrete works as we hope it will, the stormwater that seeps into the ground will contain less pollutants since it hasn't washed across the roadways and collected urban contaminants," said MSD Executive Director Bud Schardein.



The new concrete was installed in August. MSD will monitor stormwater entering catch basins near the test site to determine the concrete's effectiveness. The initial test site was installed last year at a parking lot for the Girl Scouts of Kentuckiana's new headquarters on Lexington Road.

Left: Porous concrete contains less lime and finer particles than ordinary concrete.

Figure 11-12
CSOs and Public Use Areas



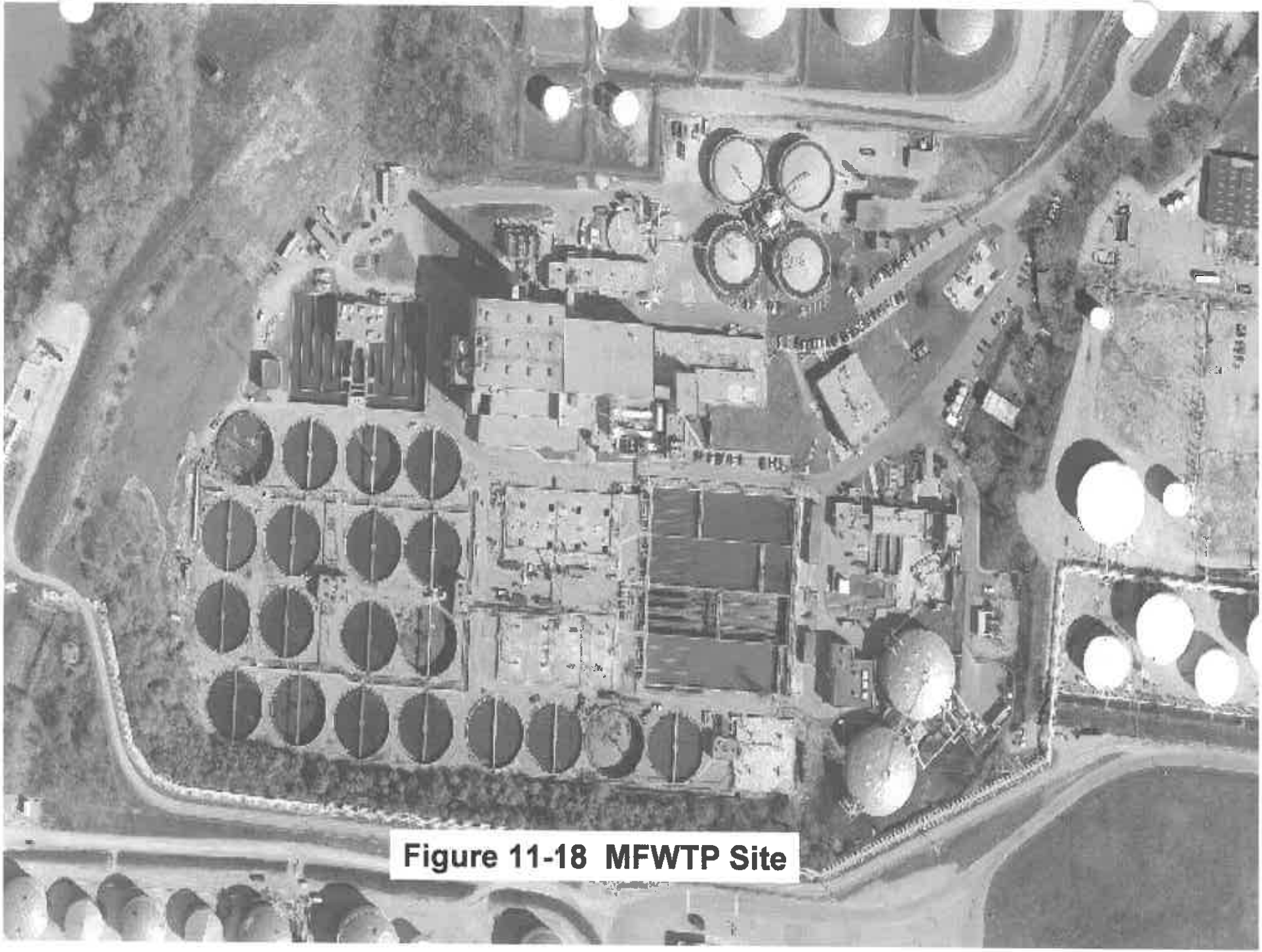
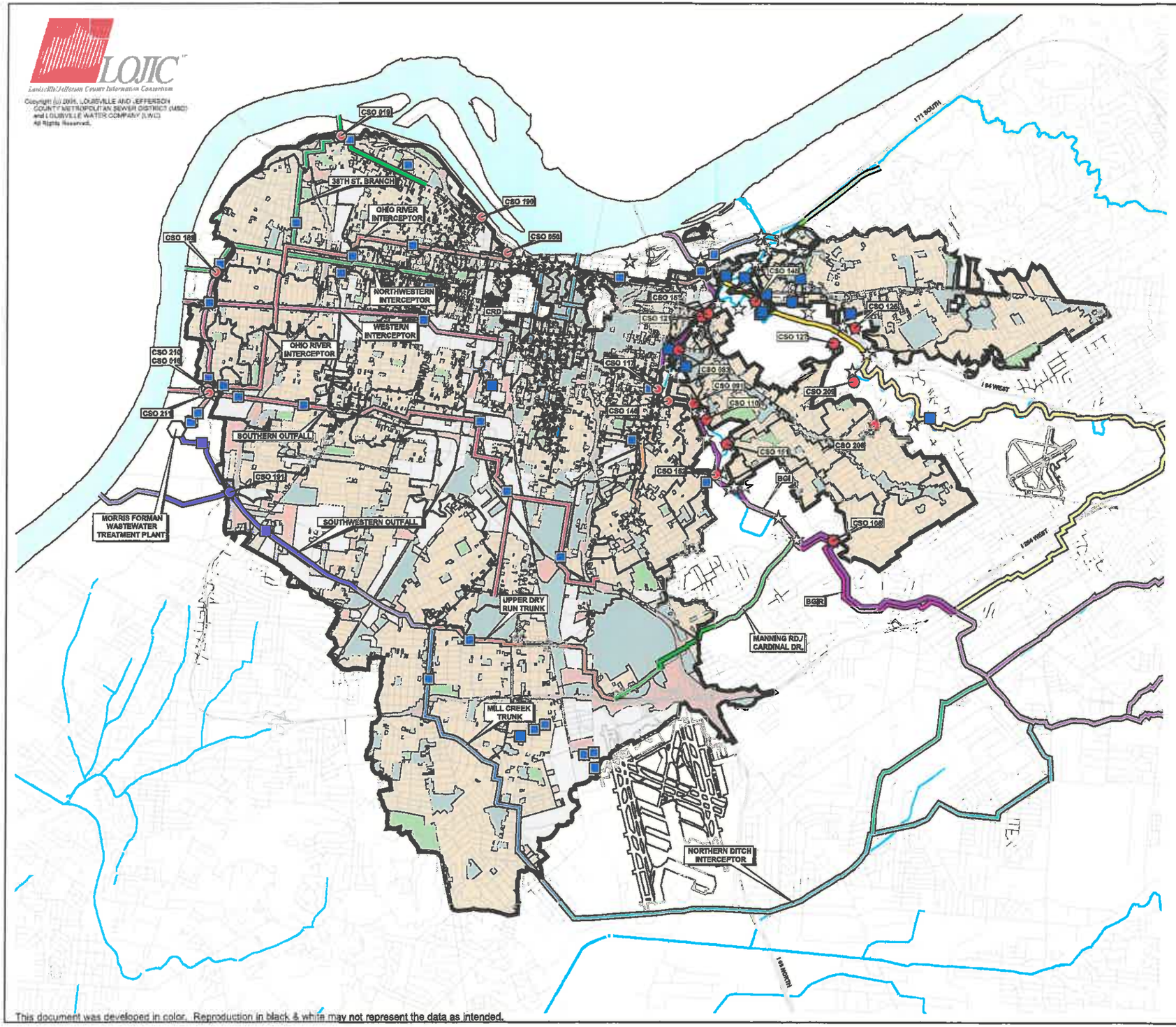


Figure 11-18 MFWTP Site

FIGURE A-1
CSO & CSS SAMPLING MAP

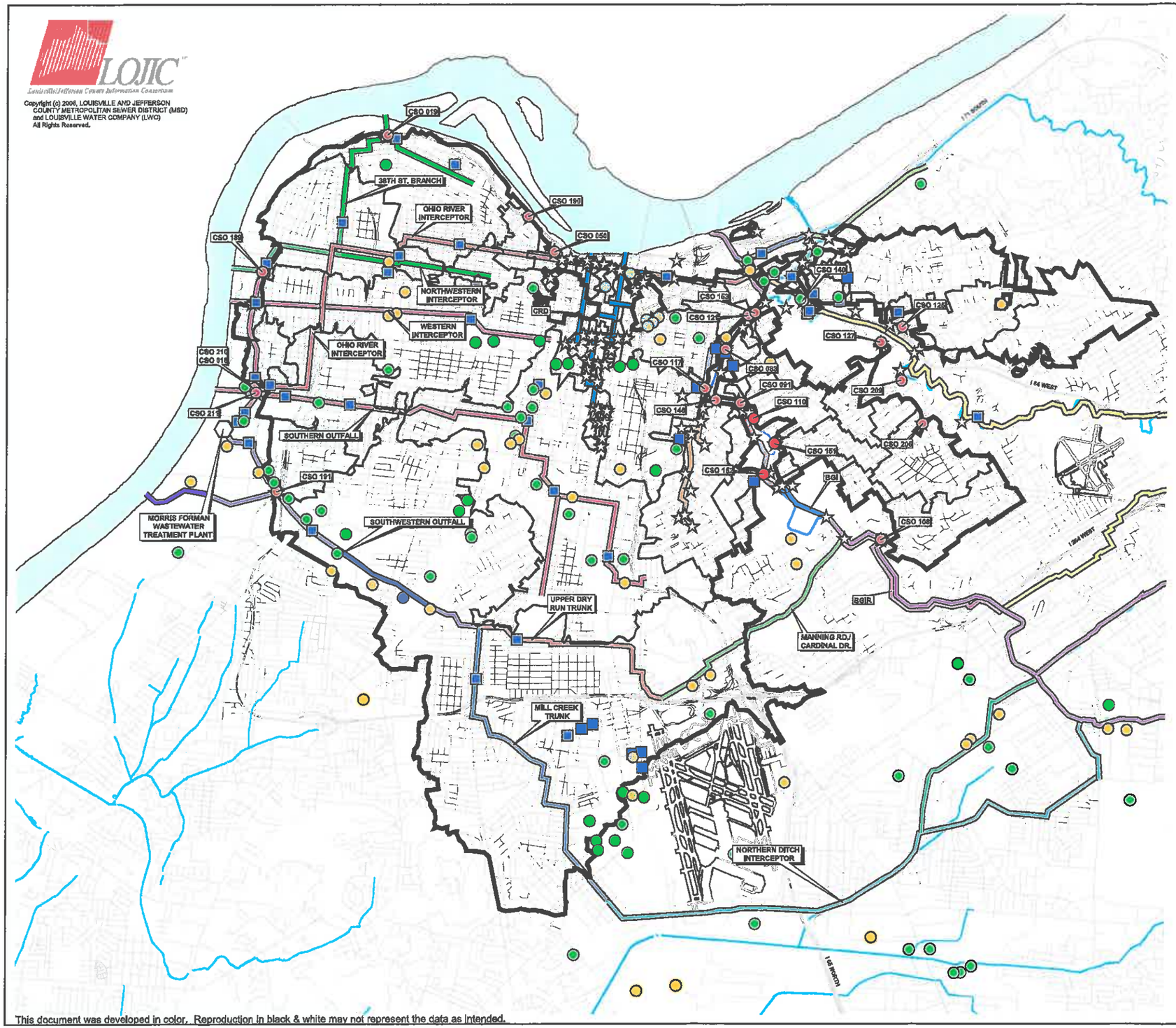


MSD
Louisville and Jefferson County Metropolitan Sewer District

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FIGURE A-10
NON-DOMESTIC DISCHARGERS, CSO & CSS SAMPLING MAP

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Louisville/Jefferson County Information Consortium
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LEGEND

Non-Domestic Dischargers
- GDP
- SIU

CSO Sampling Location

CSS Sampling Location

CSO Locations

Landuse
- Industrial
- Commercial
- Residential
- Parks
- Vacant

CSO Area

Combined Sewer Area

Roads

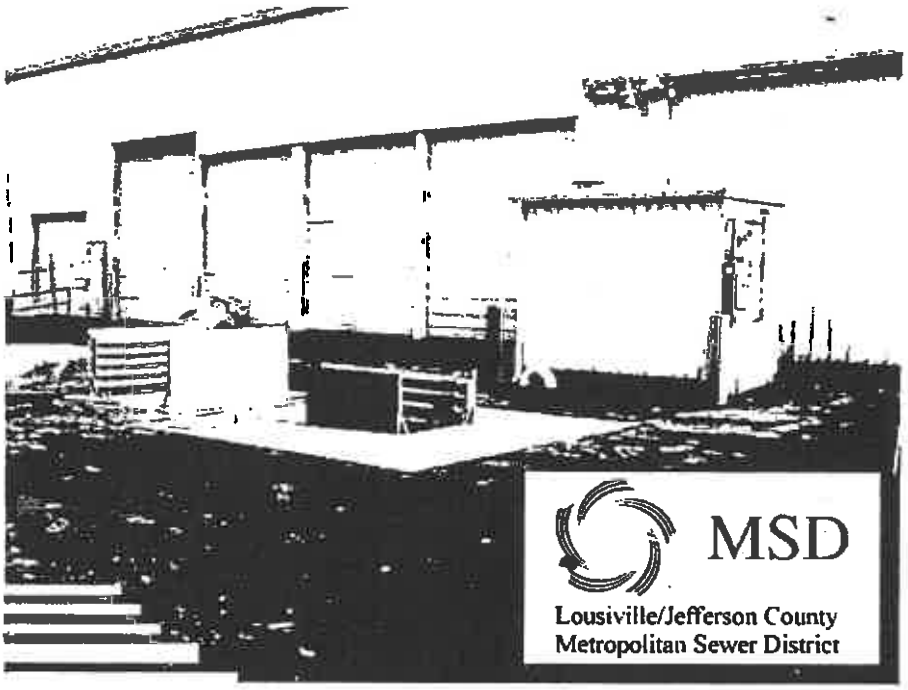
Creeks

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Appendix 11 – 1

Standard Operating Procedures Manual



MSD

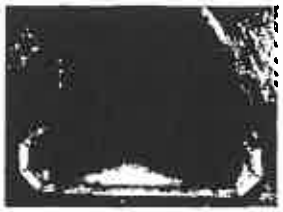
Lousiville/Jefferson County
Metropolitan Sewer District

OMNI

ENGINEERING INCORPORATED

Sneads Branch In-Line Storage Facility





October, 2002

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1. Contacts and Emergency Phone Numbers	3
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3. General Operation Summary	7
4. Bridgestone Panel	13
5. Pump Panel	21
6. Manual Valves	22
7. Uninterruptible Power Supply (UPS)	23

1. Contacts and Emergency Phone Numbers

Overall Facility Operation:

Mike Humphrey – office: 896- 6957, cell: 648-7419

Wayne Holsclaw – office: 540-6283, cell: 797-9910

Eric Kalbhin – office: 540-6823, cell: 558-1434

Instrumentation and Controls:

Rodney Hackney – office: 540-6729, pager: 672-2861

Ben Auclair – office: 540-6747, pager: 672-9763

Consultant (OMNI Engineering, Inc.):

Gary Boblitt: office: 491-2425, cell: 533-2719

2. OVERVIEW

The Sneads Branch In-Line-Storage Facility is located just east of the intersection of Logan Street and East Kentucky Street. The facility uses the Sneads Branch Relief Drain (SBRD) as a combined sewer overflow (CSO) storage facility by the operation of an inflatable rubber gate which is located approximately 200 feet from the outlet of the SBRD to the South Fork of Beargrass Creek channelized section. The SBRD is an eleven-foot semi-elliptical drain that collects flows from eleven CSOs. Refer to Figure 2 for map of the SBRD area. Prior to the installation of the gate, combined sewage could discharge directly to the South Fork of Beargrass Creek. Figure 1 below is a rendering of the basic components of the facility.

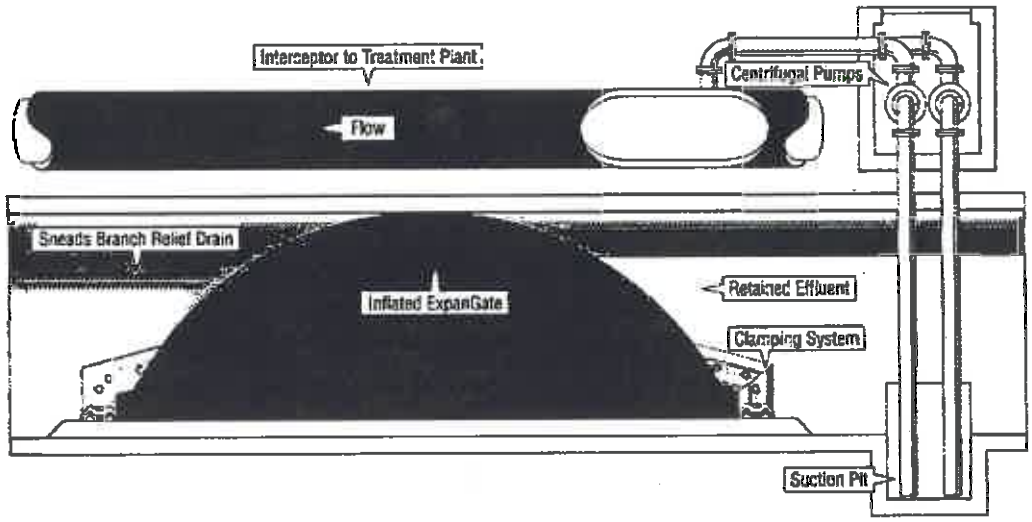
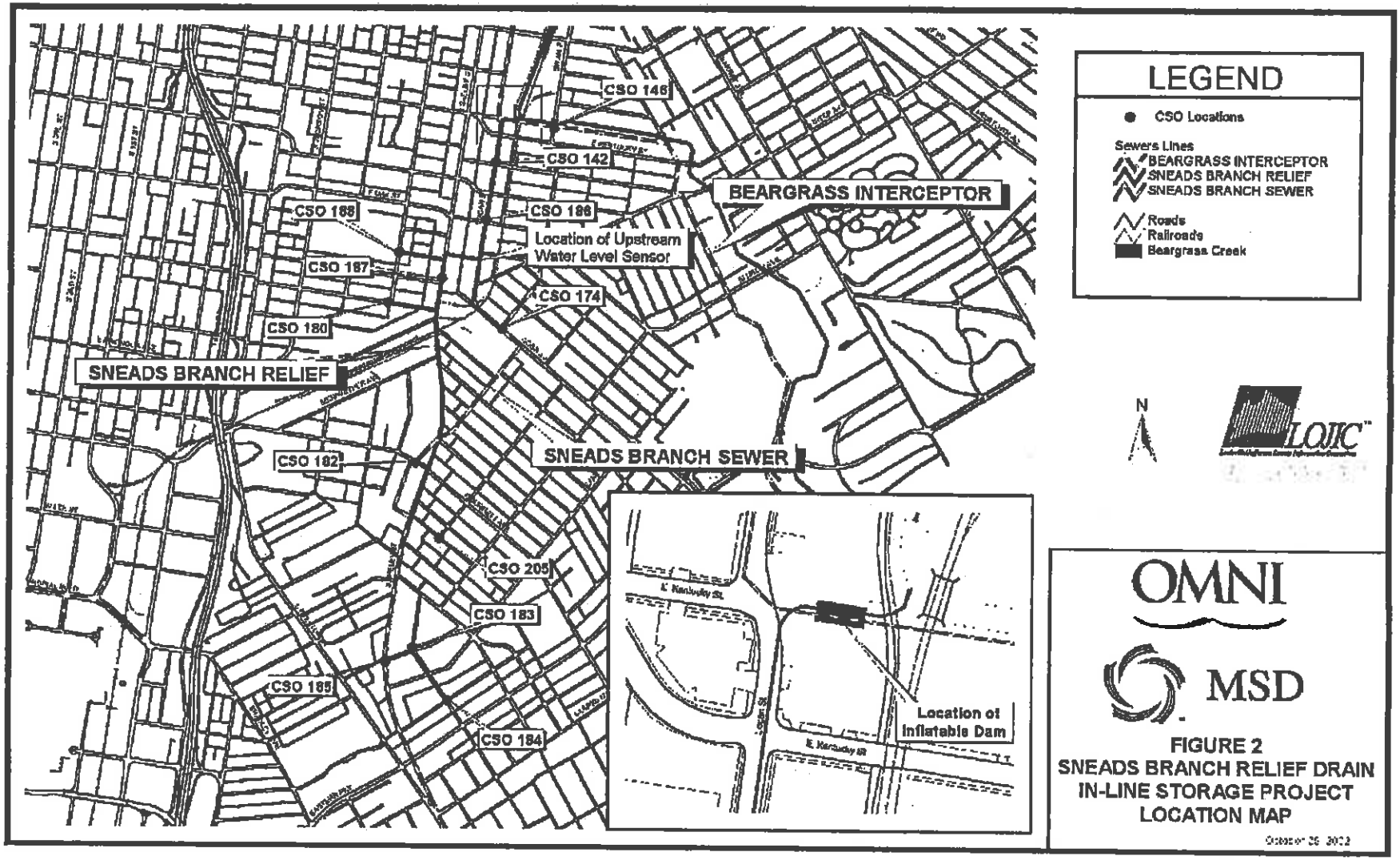


Figure 1. Sneads Branch Relief In-Line Storage Project conceptual profile

The storage capacity of this facility when the gate is fully inflated is approximately 2.5 million gallons. The facility is intended to capture the flows from the eleven CSOs tributary to the SBRD and pump the stored volume to the Beargrass Interceptor to be conveyed to the Buchanan Pump Station and then on to the Morris Forman Wastewater Treatment Plant for treatment. Figure 3 provides a picture of the inflatable gate in its deflated position and Figure 4 provides a schematic section view of the relationship between the inflatable gate, the pump suction intake and the pump vault.


CSO 146
CSO 142
BEARGRASS INTERCEPTOR
CSO 188
CSO 186
Location of Upstream Water Level Sensor
CSO 187
CSO 174
CSO 180
SNEADS BRANCH RELIEF
CSO 182
SNEADS BRANCH SEWER
CSO 205
CSO 183
CSO 185
CSO 184
Location of Inflatable Dam
LEGEND
CSO Locations
Sewers Lines
BEARGRASS INTERCEPTOR
SNEADS BRANCH RELIEF
SNEADS BRANCH SEWER
Roads
Railroads
Beargrass Creek
N
LOJIC
OMNI
MSD
FIGURE 2
SNEADS BRANCH RELIEF DRAIN
IN-LINE STORAGE PROJECT
LOCATION MAP

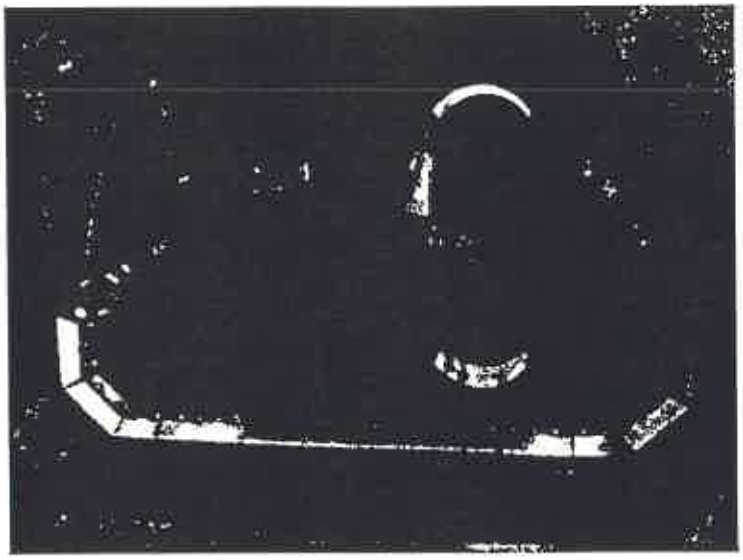


Figure 3 – Gate in place, deflated

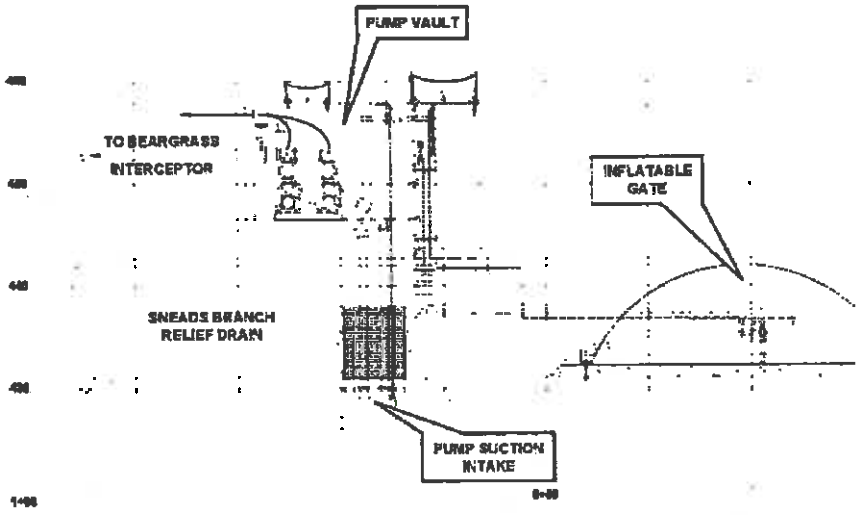


Figure 4 - Side view schematic showing the relationship of the pumps to the SBRD

3. GENERAL OPERATION SUMMARY

The following Figures (5 through 7) show the profile of the Sneads Branch Relief Drain with water level sensor (WLS) locations, the first seven tributary CSOs and their relationship to the water level within the relief drain. The water level sensors are ultrasonic. The inflatable gate is half inflated at its normal at-rest condition (Figure 5).

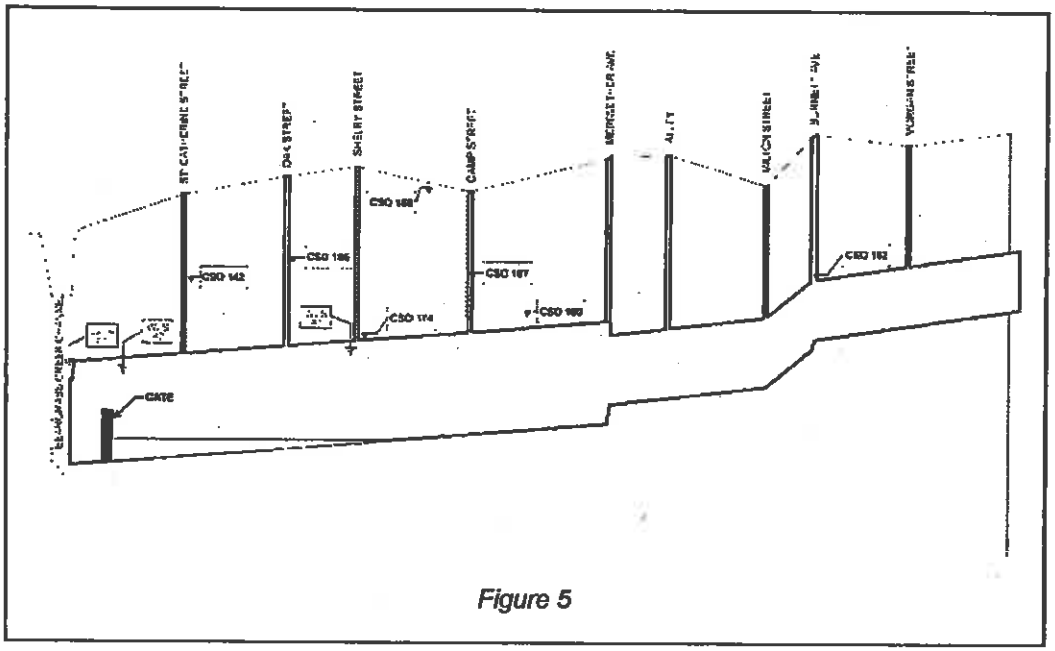


Figure 5

During a rainfall event, water collects behind the gate, the water level sensor at the gate detects the rising water and signals the gate to inflate (Figure 6).

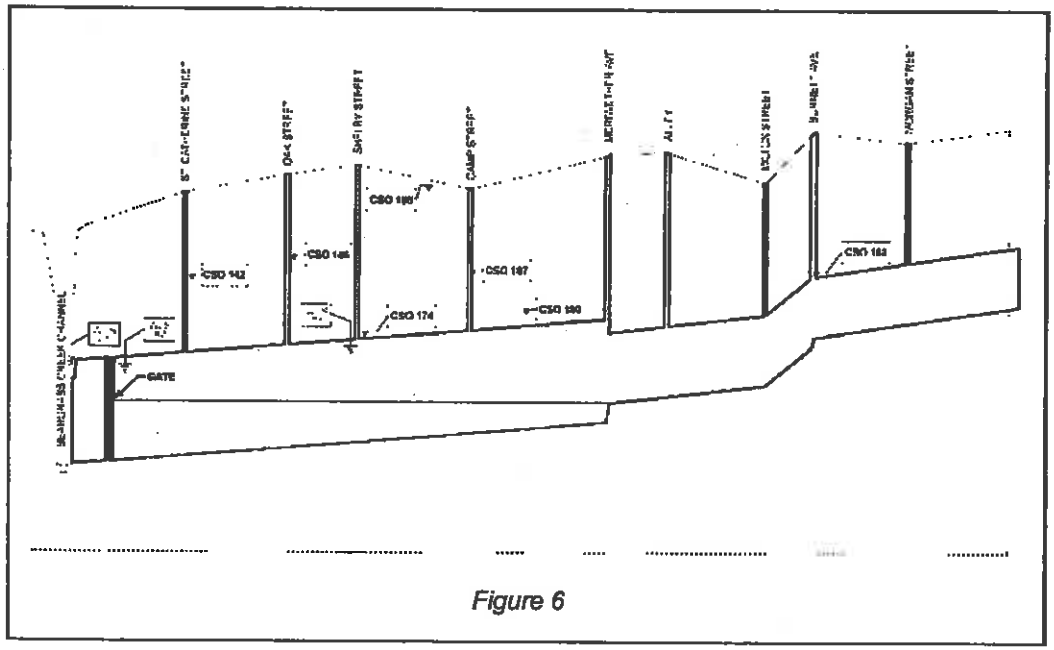


Figure 6

When fully inflated, the gate totally blocks the SBRD (Figures 7 & 8). If the level of the water collected exceeds the crown elevation, El. 442, of the SBRD at the gate, the gate is signaled to deflate until a constant maximum water level can be maintained without exceeding the crown elevation. The gate height is infinitely adjustable and can modulate in order to maximize storage without causing sewer backup at the tributary CSOs.

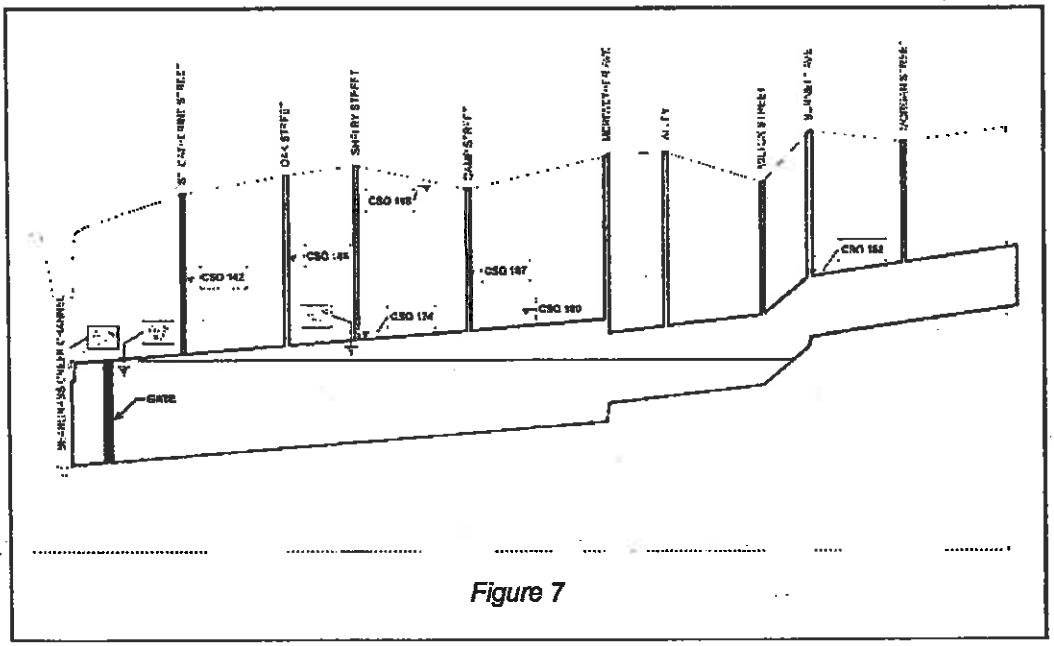


Figure 7

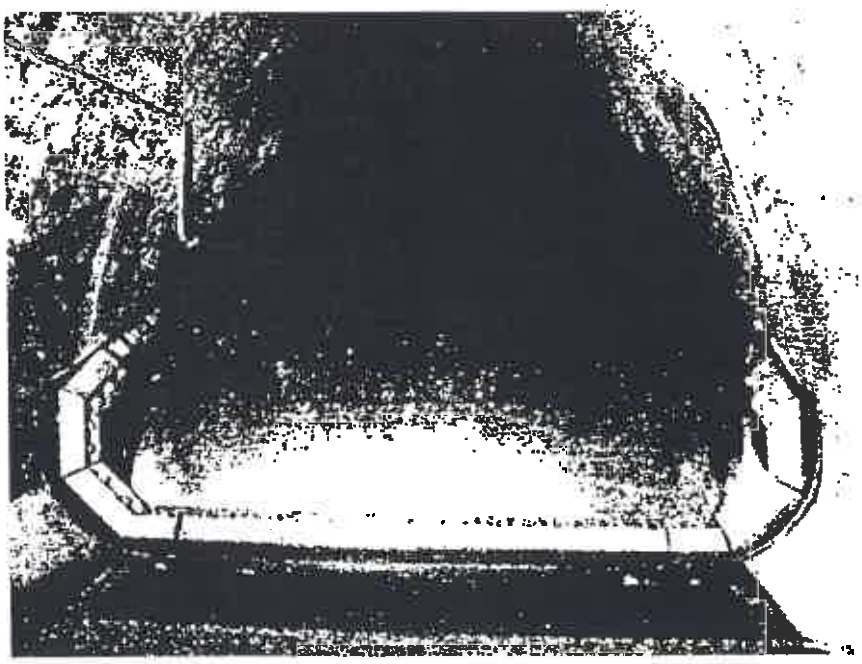


Figure 8 - Gate fully inflated

The eleven CSOs tributary to the SBRD are shown in Table 1. The invert elevation of the SBRD at the inflatable gate is approximately 431 ft. Maximum storage capacity is at an elevation of 442 ft. The lowest CSO overflow is CSO 174, with an overflow elevation of 445.08.

Table 1

CSO No.	CSO Description	Overflow Elevation
142	Logan & St. Catherine	451.05
174	**Goss & Boyle**	**445.08**
180	Ormsby & Clay	447.51
182	Burnett W. of Shelby	451.65
183	Alexander & Keswick	459.75
184	Fetter & Alexander	460.85
185	Shelby & Keswick	456.78
186	Logan & Oak	453.27
187	Shelby & Camp	451.65
188	Shelby & Clay	460.85
205	Morgan & Hoertz	460.85

The water level sensor just upstream of the gate (WLS #1) is the main control for gate operation. Another water level sensor (WLS #2) is located downstream of the gate primarily to warn of the South Fork of Beargrass Creek backing up the SBRD. In this event the gate will inflate to prevent the creek from overtopping the gate and prevent the facility from pumping creek water to the Beargrass Interceptor.

A third water level sensor (WLS #4) is located approximately 2000 feet upstream of the gate at the intersection of Logan Street and Shelby Parkway as an early warning signal. In the event that the SBRD is inundated with flow, the upstream water level sensor signals the gate to deflate to prevent sewer backup at the tributary CSOs.

A fourth water level sensor (WLS #3) is located at the end of the Beargrass Interceptor on Buchanan Street where flow can either enter the Buchanan Pump Station or overtop the weir at CSO 20, and discharge directly to the Ohio River.

As shown in Figure 3 above, two Gorman Rupp suction lift pumps are located in the pump vault at the site. These pumps lift the water trapped behind the gate into the Beargrass Interceptor (which passes next to the SBRD at the site). The water then flows to the Buchanan Pump Station.

Table 2 summarizes the various conditions of the gate operation.

Table 2

Water Surface Elevation Just Upstream of Gate	CSO 20 Condition*	Gate Status	Pump Status	Comment
431	No Overflow	At Rest	Off	Gate at rest in dry weather
432 - 435	No Overflow	At Rest	On	Start of wet weather event
432 - 435	Overflow	At Rest	Off	
435 - 442	No Overflow	Fully Inflated	On	Nearing six month storm
435 - 442	Overflow	Fully Inflated	Off	
>442	No Overflow	Modulating	On	six month storm exceeded, storage capacity exceeded
>442	Overflow	Modulating	Off	
>443		Fully deflated	Off	Manual Auto deflate trips, gate completely deflates

A Programmable Logic Controller (PLC) collects the inputs from the four water level sensors and executes gate operation and pump operation based on those inputs. The pumps (Figure 9 below) at Sneads Branch are controlled by the PLC. As flow collects behind the gate, the PLC will signal the pumps to turn on. The pumps will remain on until a low level is reached within the SBRD or a signal comes from the water level sensor at CSO 20 that the CSO is overflowing.

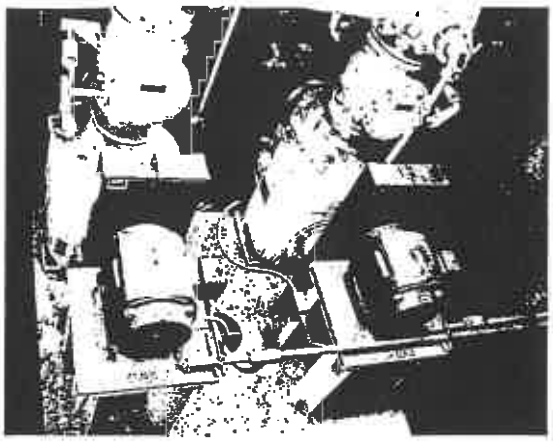


Figure 9
Suction lift pumps

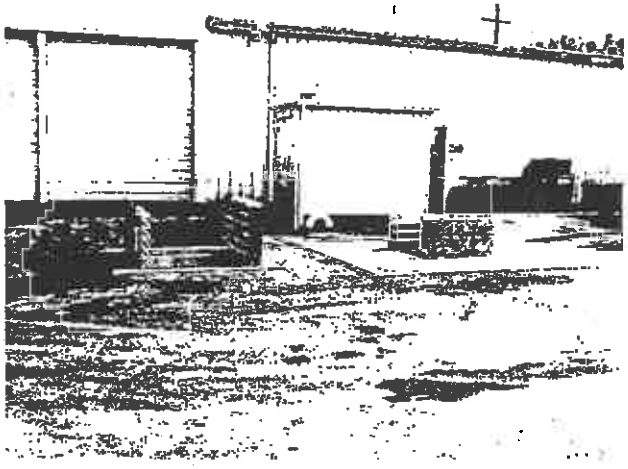


Figure 10
Sneads Branch Facility site

A small building at the Sneads Branch In-Line Storage Project site (Figure 10) houses the controls for the inflatable gate and pumps.

The hatch on the left is the access to the eleven-foot SBRD; the hatch on the right is the access to the pumps (Figure 9)

A Programmable Logic Controller (PLC) (Figure 11) processes the various signals sent from the four water level sensors.

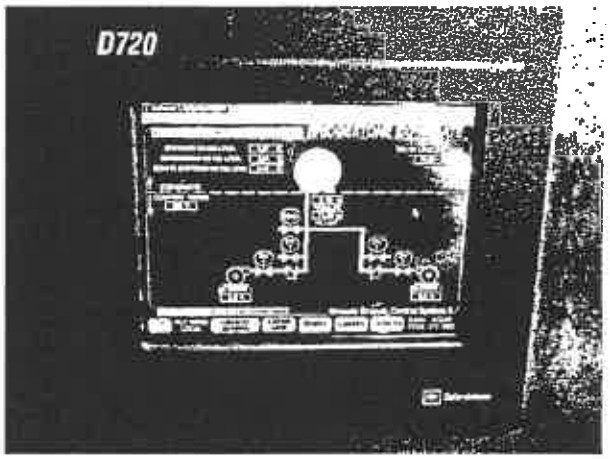


Figure 11
PLC panel

The PLC signals the blowers (Figure 12) to inflate the gate or valves to deflate the gate and signals the pumps to start pumping depending on incoming signals.

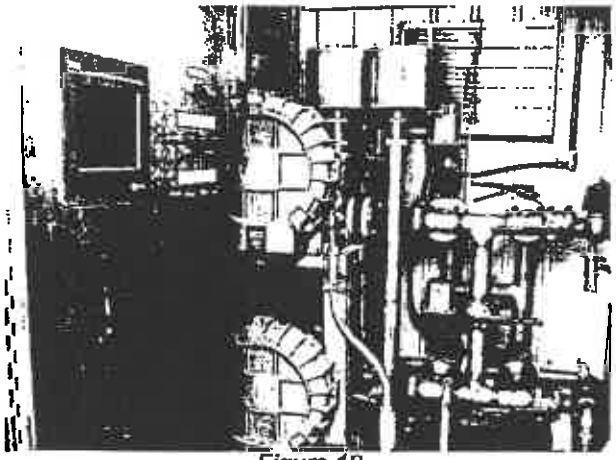


Figure 12
Blowers and stainless steel air piping

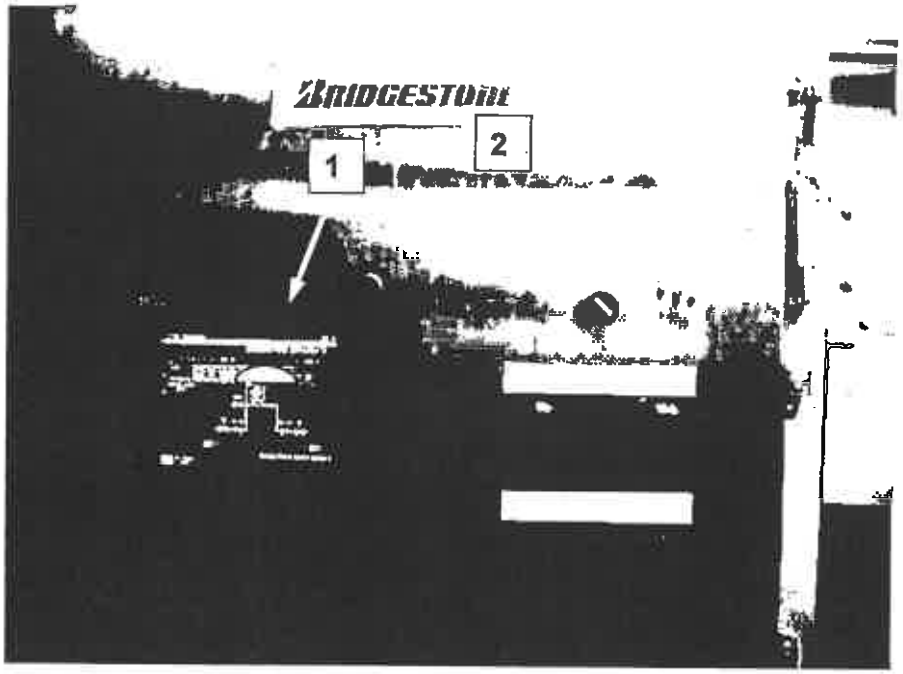
In the event that all electronic functions fail with the gate fully inflated, there is a manual auto deflate system to positively deflate the gate.

This manual system operates with a stainless steel float within the access shaft attached to a valve. When the water level within the SBRD reaches El. 443 or one foot above the crown, the float will trip the air valve and deflate the gate.



Figure 13
Auto Deflate System

4. Bridgestone Panel



The inflatable gate was manufactured by Bridgestone. The control panel, as shown above, consists of the following components:

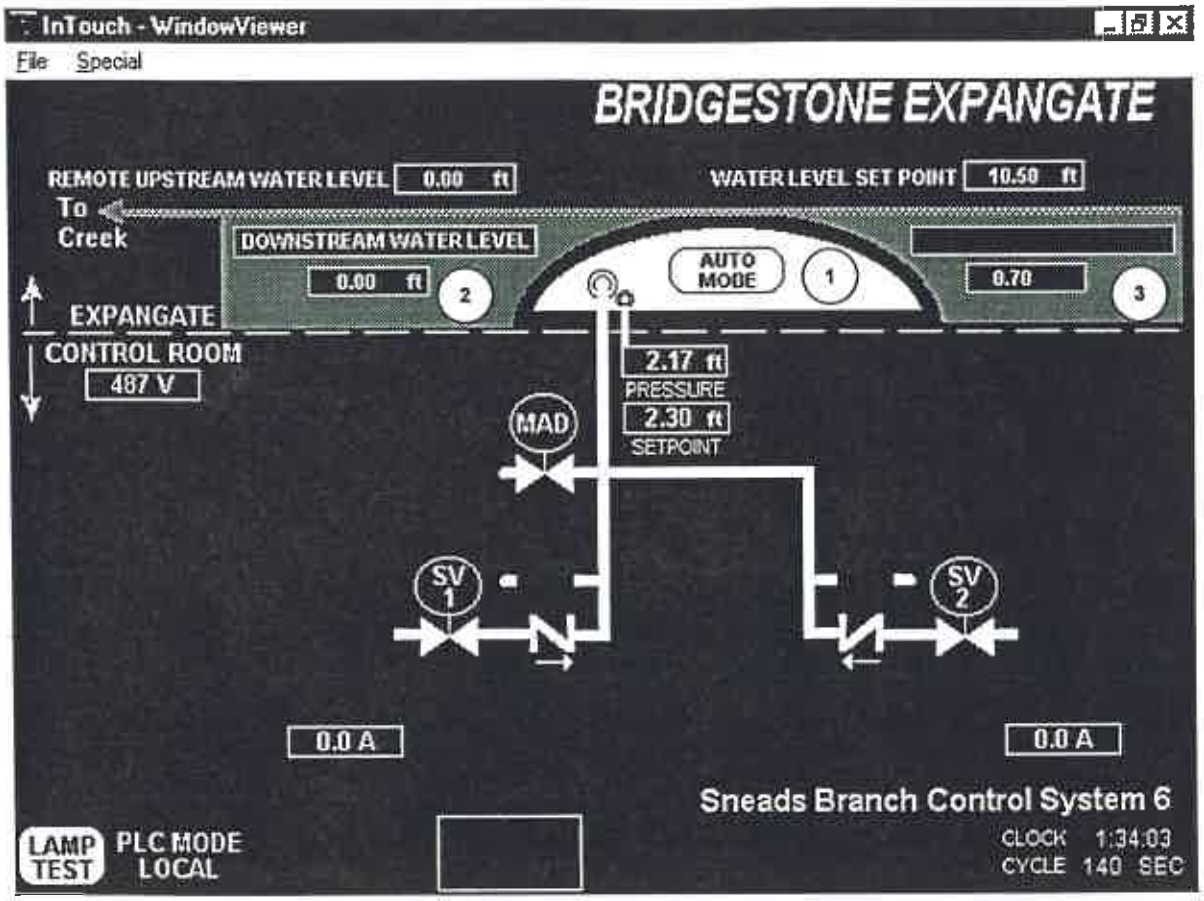
1 Touchscreen

2 Manual Operation Buttons

- **TOUCHSCREEN**

The touch screen has five buttons on the bottom edge that when pushed will lead to different screens. The touchscreen is password protected. The screens can be changed and history downloaded but no operations or changes can be made without first logging in on the OPTIONS screen. The main screen is the EXPANGATE screen.

EXPANGATE SCREEN



The EXPANGATE screen shows the current status of the rubber bladder, valves, blowers and water levels.

1. This graphic shows the current state of the rubber bladder. The pressure inside the bladder is shown as 2.17 feet. The bladder is considered at rest at this pressure. The actual bladder looks as though it is nearly fully inflated at this pressure. This graphic however shows the actual pressure not the actual physical state of the bladder. The maximum pressure allowed within the bladder is 12.7 feet.

   Inside the bladder graphic is a button that will allow change of the operation mode of the facility from AUTO MODE to MANUAL MODE. This can only be done after logging in.

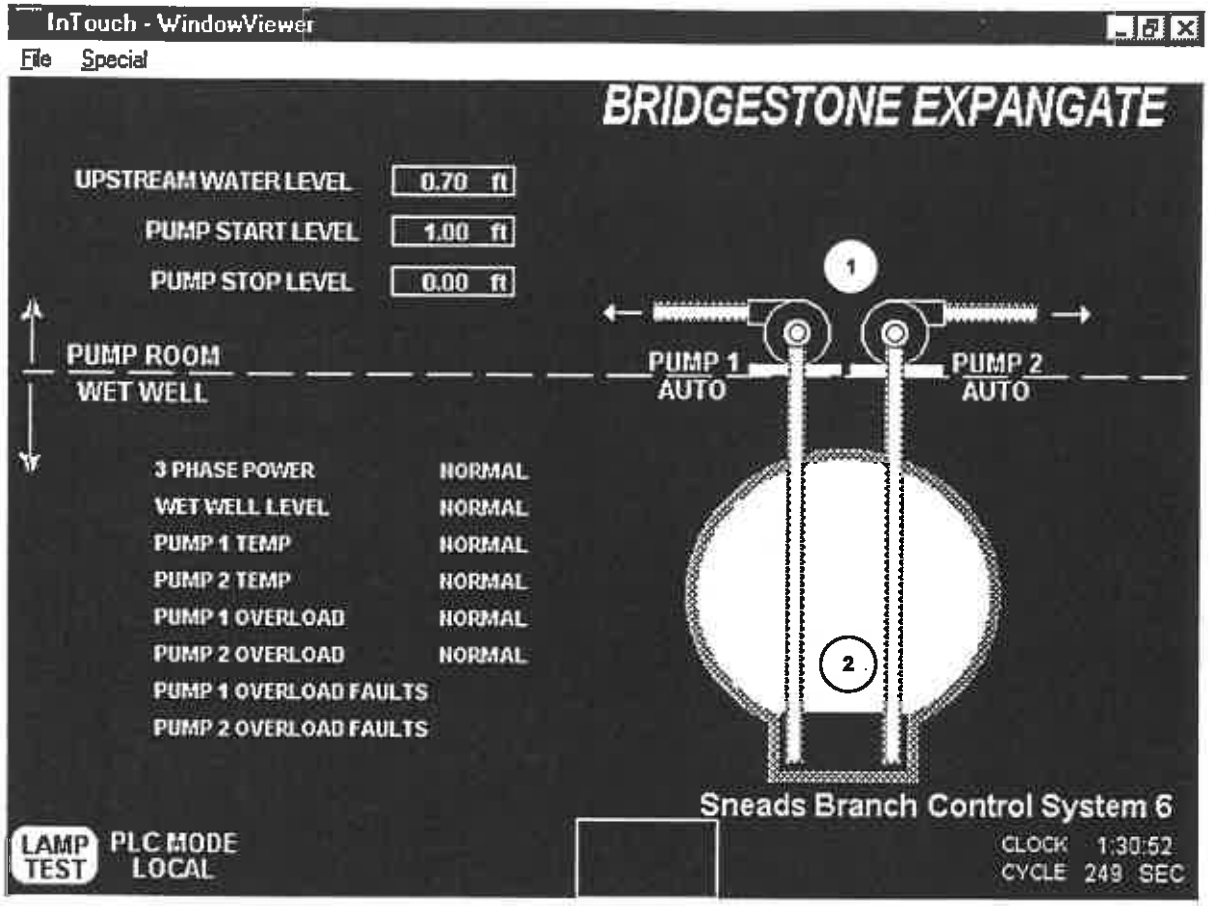
2. This area shows the current water level downstream of the bladder. The water level is shown as 0.00 feet. As the water level rises this area will be shaded blue corresponding to the actual water level.

3. This area shows the current water level upstream of the bladder. The water level is shown as 0.70 feet. As the water level rises this area will be shaded blue corresponding to the actual water level as presently shown.

OTHER ITEMS DEFINED:

- Remote Upstream Water Level – The water level within SBRD at the corner of Shelby Pkwy and Logan Street (WLS #4).
- Water Level Setpoint – This is the elevation that the bladder begins to deflate. This level may be changed, after logging in, by touching the value on-screen and entering a new level on the pop-up keypad.
- MAD – Mechanical Auto Deflation Device. When tripped this will turn blue.
- DV1, DV2 – Automatic Deflation Valves.
- SV1, SV2 – Automatic Supply Valves.

PUMPS SCREEN



The PUMPS screen shows the current status of the pumps.

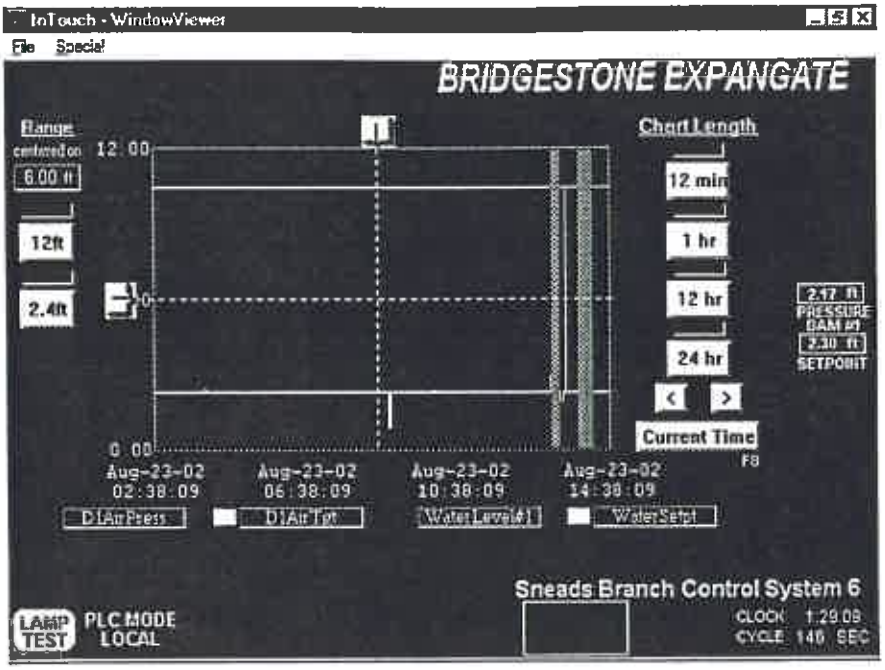
1. The pump graphic turns yellow when the respective pump turns on.

2. This graphic shows a cross section of the pipe with the pump wet well. The bottom of the wet well is approximately four feet below the invert of SBRD. The water level within the drain as shown is 0.70 feet; therefore, the water level in the wet well is 4.70 feet. The green shading will rise on the graphic as the actual water level increases.

OTHER ITEMS DEFINED:

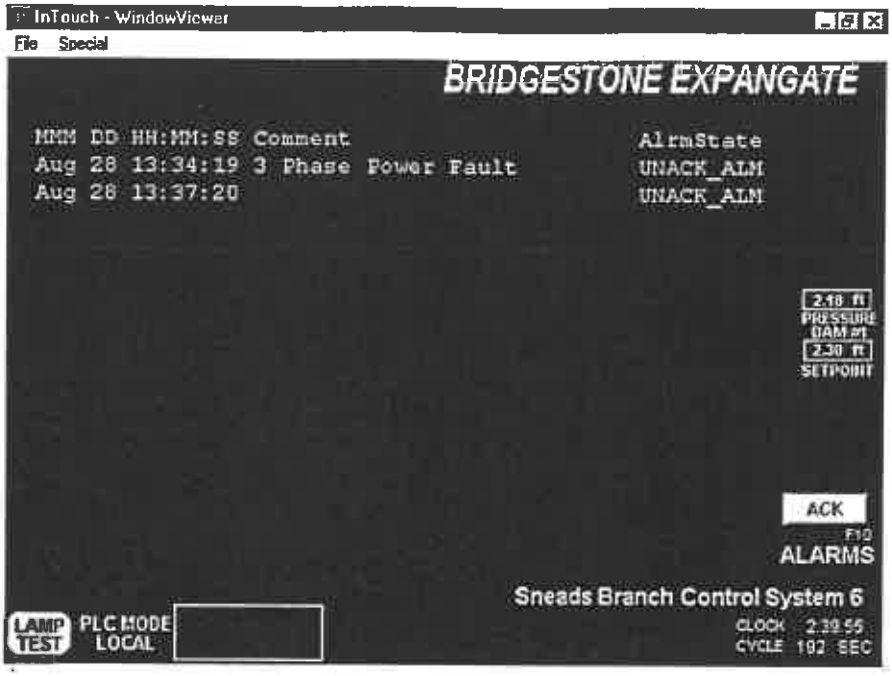
- Upstream Water Level – This is the same as the Upstream Water Level on the EXPANGATE screen.
- Pump Start Level – The water level where a pump is started. Based on the Upstream Water Level, the Pump Start Level can be changed, after logging in, by touching the value on-screen and entering a new level.
- Pump Stop Level – The water level where a pump is stopped. Based on the Upstream Water Level, the Pump Stop Level can be changed, after logging in, by touching the value on-screen and entering a new level on the pop-up keypad.

CHARTS SCREEN



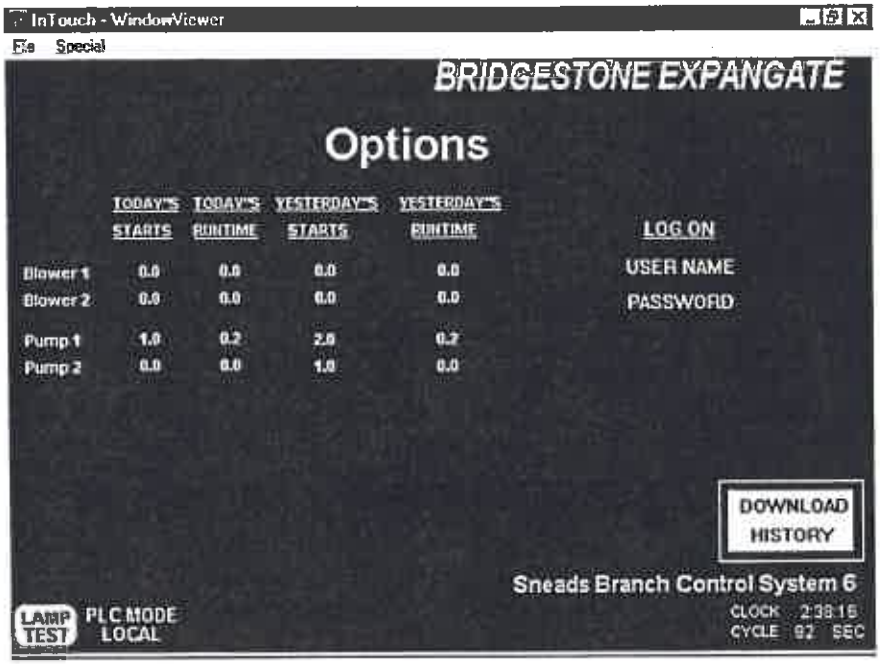
The CHARTS screen allows the viewer to see the bladder operation over time. By pressing Current Time, the current time period will be shown. The arrow keys allow the viewer to move backwards and forwards through the logged history. The Chart length buttons increase or decrease the viewable time period.

ALARMS SCREEN

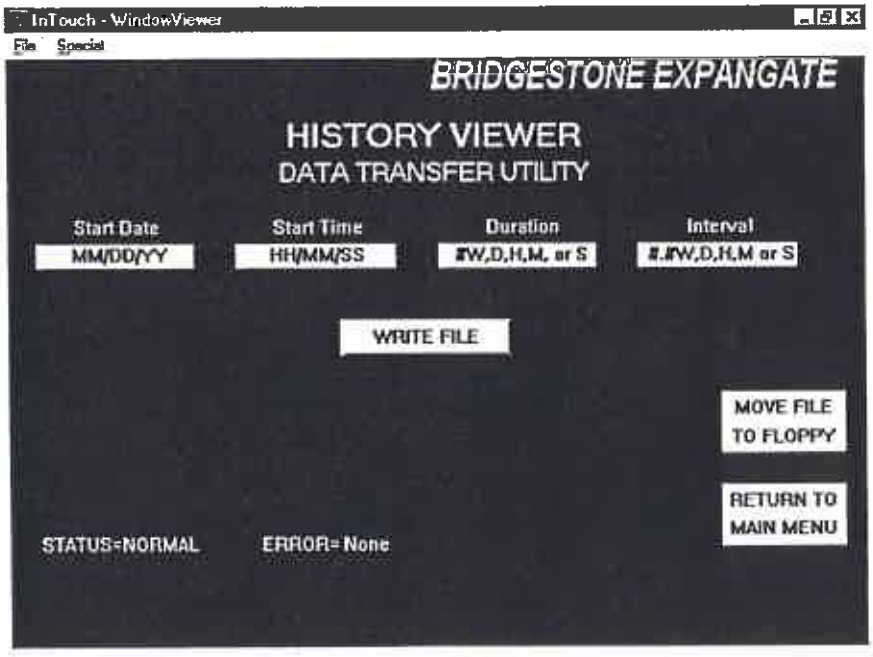


The ALARMS screen allows the viewer to see past faults and alarms.

OPTIONS SCREEN

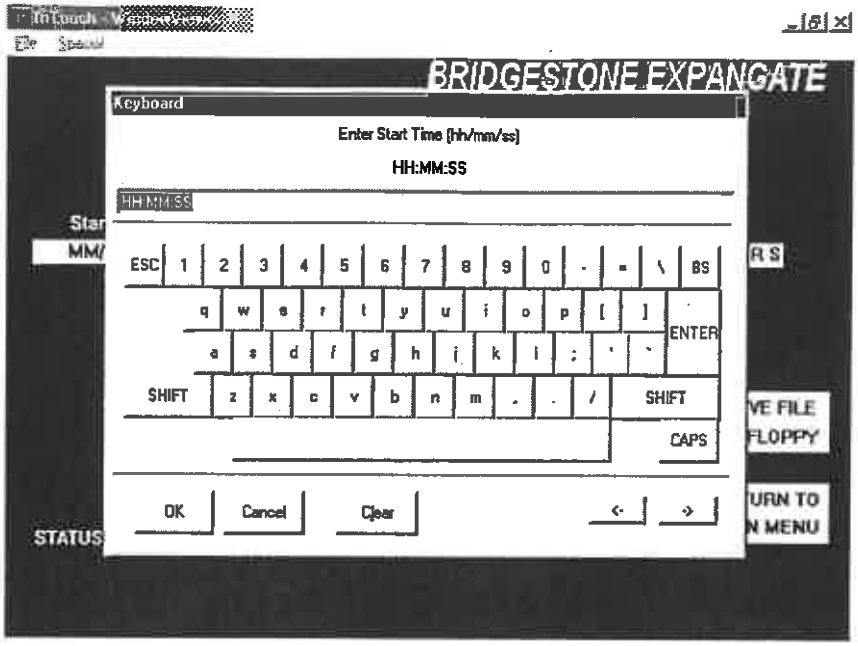


The OPTIONS screen is where the user may log on in order to change values, view pump and blower statistics and download the facility history. By pressing DOWNLOAD HISTORY, the History Viewer will pop up.



History logging files are kept for three months. The procedure for downloading the history is as follows:

1. Press the Start Date box and a keyboard will appear where the time period of data desired starts e.g. 08/01/02. Then press ENTER.



2. Press the Start Time box and enter the start time of the desired time period on the keyboard pop-up, e.g. 00/00/00 for 12AM. You may use the forward slash or colon to separate the value. Then press ENTER.

3. Press the Duration box and enter the duration of the desired time period on the keyboard pop-up, e.g. 4w for 4 weeks worth of logged data. The duration may be entered in weeks, days, hours, minutes, and seconds. Then press ENTER.

4. Press the Interval box and enter the interval of the desired time period on the keyboard pop-up, e.g. 5m for data presented in 5-minute intervals. The interval may be entered in weeks, days, hours, minutes, and seconds. Then press ENTER.

5. Press the WRITE FILE button. The screen will blink "WRITING" while the data is downloaded from the history files. For a four-week duration at five-minute intervals, "WRITING" will blink for approximately 20 seconds.

6. When "WRITING" no longer flashes, insert a 3.5 floppy disc in the computer inside the stainless steel panel door. Press MOVE FILE TO FLOPPY, the history file will be moved to the floppy disc. The light on the floppy disc drive will light while the file is being moved.

7. When the floppy drive light goes off, remove the disc, close the panel door and press RETURN TO MAIN MENU.

The downloaded file will be named DATA.CSV. This is a comma separated value file that Excel will recognize. To view the file in Excel, insert the floppy disc into a machine that has Excel, open Excel, click FILE, click OPEN, and navigate to the A:\ drive. In file types choose ALL FILE TYPES. DATA.CSV will appear, double click the file.

- **MANUAL OPERATION BUTTONS**

The manual operation buttons connected directly to there respective contacts. That means, the manual buttons bypass the PLC and operate the specific device directly. These buttons should only be used when the facility is in manual mode or the touchscreen and PLC have malfunctioned.

To operate the manual buttons:

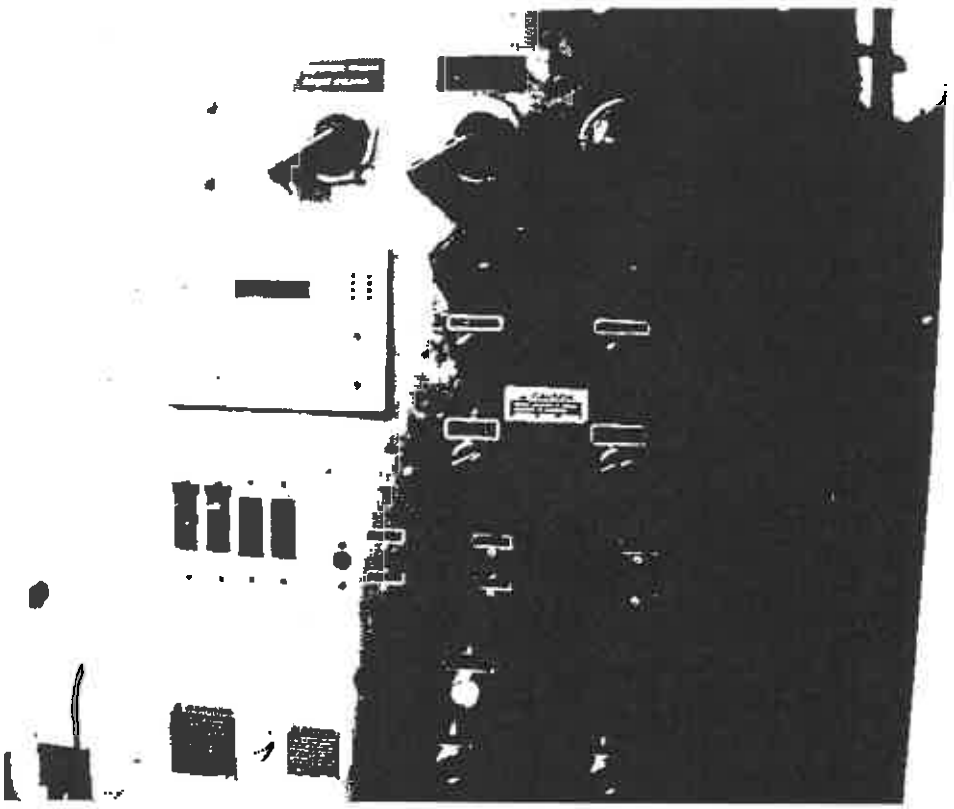
Blowers (red buttons)

- Starting - Pull and hold the button out until the blower starts. This takes several seconds due to the supply valve opening. Release the button after the blower starts.
- Stopping – simply push the button and release.

Deflation Valves (green Buttons)

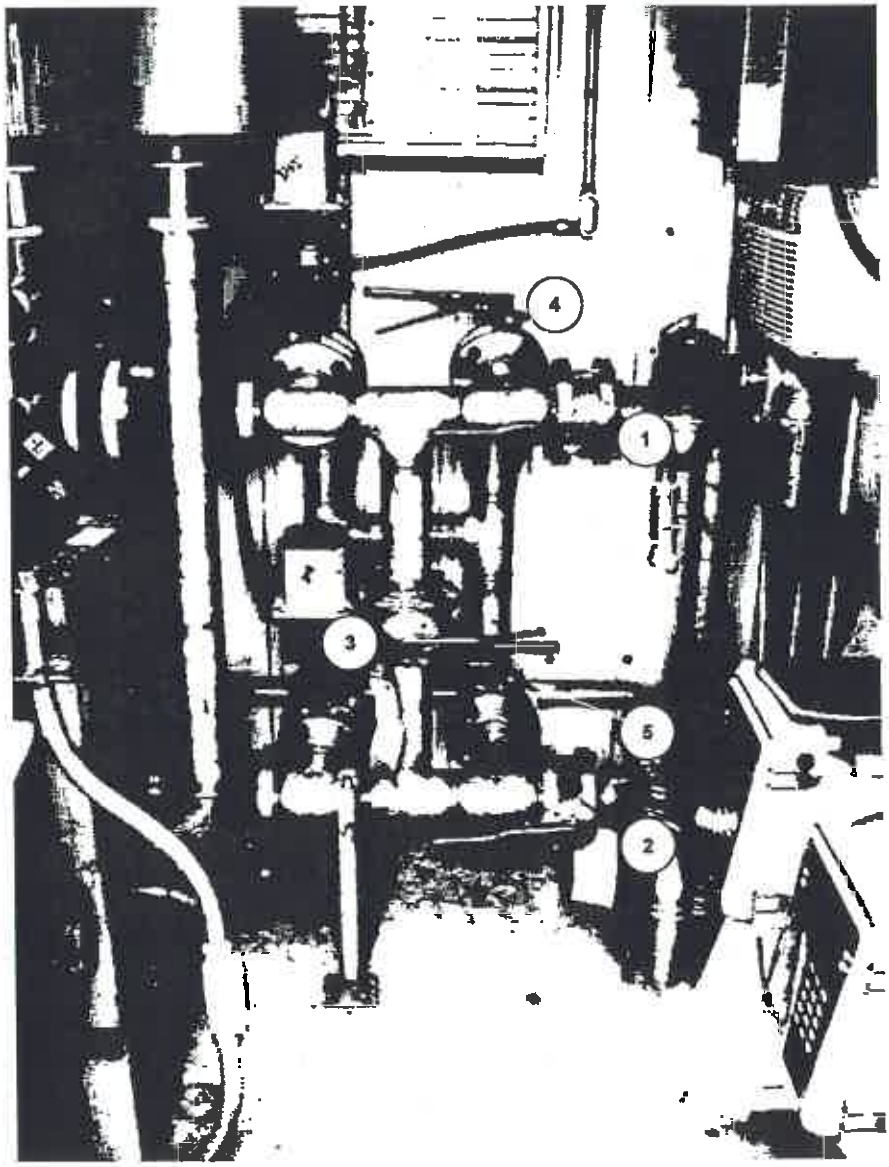
- Opening (to deflate the bladder) – Pull the button and hold until the valve is fully open, you will hear the valve open.
- Closing – Simply push the button and release.

5. PUMP PANEL



The pumps are controlled by the PLC in the Bridgestone panel. The default settings of the pump panel are shown in the picture above. Main power switches "ON"; individual pump switches set to "AUTO". The water level shown on the pump panel comes from a transducer in the pump wet well. This value should be two feet higher than that shown foe Upstream Water Level on the Bridgestone panel. In an emergency, the green pump switches should be turned to "OFF" and the main power switches turned to "OFF", Mike Humphrey should be notified immediately – office: 896-6957, cell: 648-7419.

6. Manual Valves



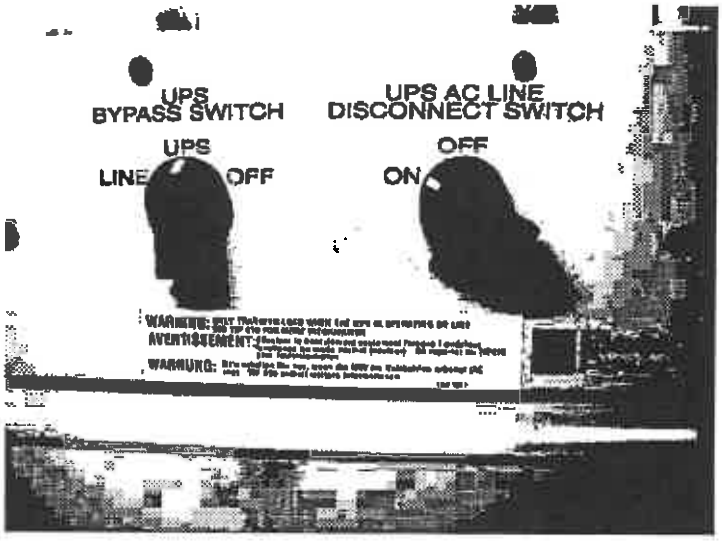
The Manual valves may be used to deflate the bladder or to isolate a blower or valve for maintenance.

1 and 2 – Normally open as shown, these valves isolate the bladder from the blowers and automatic valves when closed.

3 – Normally closed as shown, this valve is used to isolate the two blower systems.

4 and 5 – Normally closed as shown, these valves exhaust air from the bladder when open.

7. Uninterruptible Power Supply (UPS)



The default setting is shown. Refer to the O&M manuals for more information.