

City of St. Joseph

1100 Frederick Avenue, St. Joseph, Missouri 64501

February 14, 2008

Kevin Mohammadi, Chief of Compliance
Division of Environmental Quality
205 Jefferson Street P.O. Box 176
Jefferson City, MO 65102

Anthony Petruska
EPA, Region VII
726 Minnesota Ave.
Kansas City, KS 66101

RE: City of St. Joseph
Submittal of CSO Long Term Control Plan (2008 Update)

Dear Mr. Mohammadi and Mr. Petruska:

Enclosed you will find the City of St. Joseph's Long Term Control Plan, submitted as required by the Abatement Order on Consent between the City and the Missouri Department of Natural Resources (MDNR), dated October 18, 2007. This submittal is an update of the first LTCP submitted to the MDNR in 2002.

On November 21, 2007 representatives from the City and our engineering consultant Black & Veatch Corporation met with MDNR and Environmental Protection Agency (EPA) staff at the Kansas City regional office of MDNR. The preliminary results of the City's flow monitoring, sampling, system modeling, financial affordability analysis, and four proposed construction alternatives for addressing control of our combined sewer overflows (CSOs) were presented. Based on verbal comments from that meeting, the recommended alternative four was expanded into a three phase alternative so that it would meet the "presumptive approach" as accepted by the EPA to meet the CSO Control Policy. Phase I improvements will reduce overflow events to twelve per year. Phase II will further reduce overflow events to six per year, and Phase III will result in meeting the EPA goal of four overflow events per year.

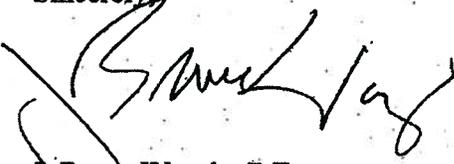
An important aspect of this plan is its implementation schedule. An affordability analysis study was performed by Black & Veatch in accordance with the guidelines of the EPA's "Guidance for Financial Capability Assessment and Schedule Development" (EPA 832-B-97-004). That analysis is included in Appendix H of the LTCP and indicates a high financial burden on St. Joseph rate payers. The implementation schedule in the submitted LTCP is based on a wastewater burden of 2.07% of the Median Household Income for St. Joseph residents. The City

is particularly concerned about the disproportionate impact of increased fees on the low-income portion of our population.

The proposed projects included in this plan would be the largest public works projects ever undertaken by the City of St. Joseph. A careful discussion of the increasing costs of this phased infrastructure program, concurrent with declining benefits over the course of full implementation should be an important part of review of this plan and all future reviews and updates as it is undertaken.

The City of St. Joseph takes pride in its accomplishments to date in advancing clean water and a healthy environment. This Long Term Control Plan program is an important commitment for our community and must be done in such a way that emphasizes good science and financial responsibility to ratepayers and the community at large. We intend to implement the program in a timely fashion, based on affordability, and we are planning to proceed with a Facility Plan for the Phase I improvements. The City looks forward to future discussions with both regulatory agencies with a goal of achieving a sound balance between the many diverse needs and the financial realities of all stakeholders in this important program.

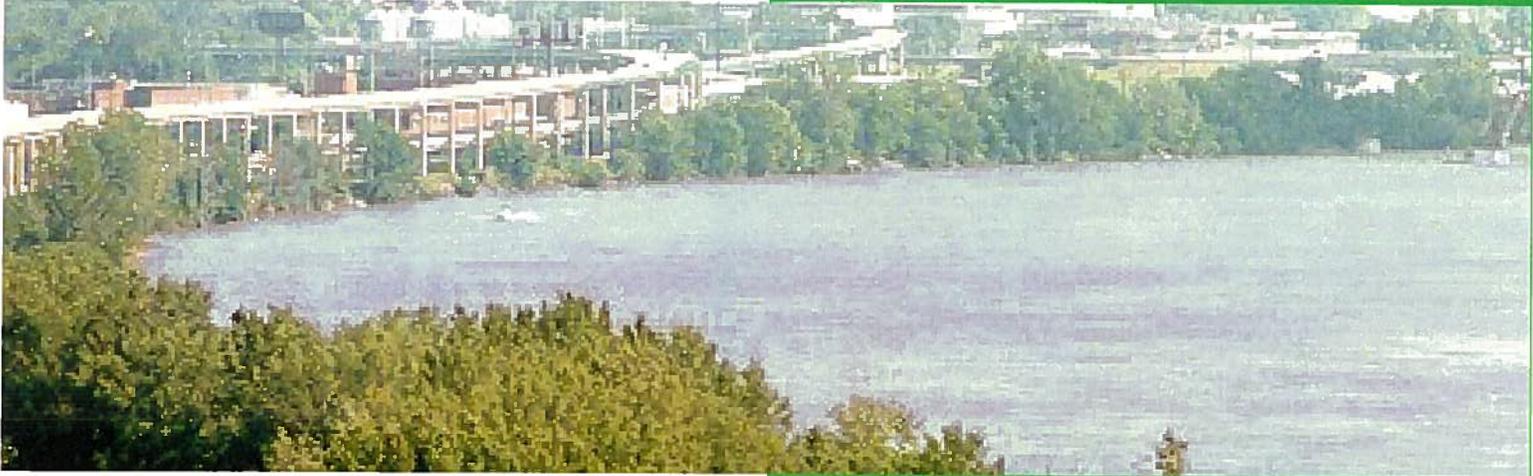
Sincerely,



J. Bruce Woody, P.E.
Director of Public Works and Transportation

Enclosure: Long Term Control Plan (2008 Update)

cc: Mayor and City Council
Vince Capell, City Manager
Andrew Clements, A.I.C.P., Assistant Director of Public Works
Roger Sparks, P.E., City Engineer
Don Gilpin, Superintendent of Wastewater Operations
Matt Schultze, P.E., Black & Veatch



City of St. Joseph, Missouri

Combined Sewer System Long Term Control Plan 2008 Update

Black & Veatch Project No. 140176.213

February 14, 2008



BLACK & VEATCH
Building a world of difference.®



Table of Contents

	<u>Page</u>
1.0 EXECUTIVE SUMMARY	1-1
1.1 Background and Scope.....	1-1
1.2 Watershed Description	1-2
1.3 Description of Combined Sewer System Facilities.....	1-3
1.4 Description of Nine Minimum Operational Controls	1-3
1.5 Public Participation	1-4
1.6 Sensitive Areas.....	1-4
1.7 Flow and Water Quality Monitoring.....	1-4
1.8 Collection System Modeling.....	1-5
1.9 Water Quality Modeling.....	1-6
1.10 Combined Sewer Overflow Alternatives	1-7
1.11 Recommended Combined Sewer Overflow Control Plan	1-8
2.0 INTRODUCTION.....	2-1
2.1 Background	2-1
2.2 Long Term Control Plan Update.....	2-2
3.0 WATERSHED DESCRIPTION	3-1
3.1 Area Description	3-1
3.2 Temperature	3-2
3.3 Precipitation	3-2
3.4 Vegetation	3-3
3.5 Soils.....	3-3
3.6 Topography	3-4
3.7 Natural Resources	3-4
3.8 Land Use	3-4
3.9 Recreational Areas	3-5
3.10 River Uses	3-6
4.0 DESCRIPTION OF COMBINED SEWER FACILITIES	4-1
4.1 Background	4-1
4.2 CSO Diversion Structures	4-1



	<u>Page</u>
4.2.1	Blacksnake Creek Diversion 4-1
4.2.2	Francis Street Diversion 4-2
4.2.3	Charles Street Diversion..... 4-2
4.2.4	Messanie Street Diversion..... 4-2
4.2.5	Patee Street Diversion 4-3
4.2.6	Olive Street Diversion..... 4-3
4.2.7	Mitchell Street Diversion 4-3
4.2.8	Duncan Street Diversion 4-3
4.2.9	Maple Street Diversion..... 4-4
4.2.10	Hickory Street Diversion..... 4-4
4.2.11	Walnut Street Diversion 4-4
4.2.12	Whitehead Creek Diversion 4-4
4.2.13	Missouri Avenue Diversion 4-5
4.2.14	Brown’s Branch Diversion..... 4-5
4.2.15	Roy’s Branch Diversion 4-5
4.3	Wastewater Collection System..... 4-6
4.4	Wastewater Treatment Plant 4-6
5.0	DESCRIPTION OF NINE MINIMUM OPEATIONAL CONTROLS..... 5-1
5.1	Existing Operational Controls..... 5-1
5.2	Operation and Maintenance of Collection System and Treatment Plant 5-1
5.3	Maximizing Collection System Storage..... 5-2
5.4	Review of Pretreatment Program 5-2
5.5	Maximization of Flow to the POTW for Treatment 5-3
5.6	Elimination of CSOs during Dry Weather 5-3
5.7	Control of Solid and Floatable Materials in CSOs..... 5-4
5.8	Pollution Prevention Programs to Reduce Contaminants in CSOs 5-4
5.9	Public Notification 5-5
5.10	Monitoring to Characterize CSO Impacts and Efficacy of CSO Controls 5-6



	<u>Page</u>
6.0 PUBLIC PARTICIPATION	6-1
6.1 Introduction	6-1
6.2 Existing Public Participation Programs.....	6-1
6.2.1 Clean Sweep.....	6-2
6.2.2 Clean St. Joseph	6-2
6.2.3 Community Appearance Plan.....	6-2
6.3 Public Participation for CSO LTCP	6-3
6.3.1 CSO Awareness.....	6-3
6.3.2 Public Education	6-3
6.3.3 Public Involvement	6-4
6.3.4 Results of Public Involvement	6-4
7.0 SENSITIVE AREAS	7-1
7.1 Introduction	7-1
7.2 Outstanding National Resource Waters	7-1
7.3 National Marine Sanctuaries	7-1
7.4 Waters with Primary Contact Recreation.....	7-2
7.5 Public Drinking Water Intakes.....	7-2
7.6 Shellfish Beds.....	7-2
7.7 Waters with Threatened or Endangered Species.....	7-2
7.7.1 Fish.....	7-3
7.7.2 Birds	7-6
7.7.3 Mammals.....	7-9
7.7.4 CSO Impacts on Threatened or Endangered Species.....	7-9
7.8 Conclusions	7-10
8.0 FLOW AND WATER QUALITY MONITORING	8-1
8.1 General	8-1
8.2 Flow Sampling and Monitoring Equipment.....	8-2
8.2.1 Sampling Equipment.....	8-2
8.2.2 Flow Monitoring Equipment.....	8-3
8.2.3 Rainfall Gauges	8-4
8.2.4 Equipment Installation	8-4



	<u>Page</u>
8.2.5 Equipment Maintenance.....	8-5
8.3 Station Descriptions	8-5
8.3.1 Monitoring Station SJ-1 – Blacksnake Creek Diversion	8-5
8.3.2 Monitoring Station SF-2 – Messanie Street Diversion	8-7
8.3.3 Monitoring Station SJ-3 – Mitchell Street Diversion	8-9
8.3.4 Monitoring Station SJ-4 – Whitehead Creek Diversion.....	8-11
8.3.5 Monitoring Station SJ-5 – Brown’s Branch Diversion	8-13
8.3.6 Monitoring Station SJ-6 – Francis Street Diversion	8-15
8.3.7 Monitoring Station SJ-7 – Charles Street Diversion.....	8-15
8.3.8 Monitoring Station SJ-8 – Olive Street Diversion	8-15
8.3.9 Monitoring Station SJ-9 – Patee Street Diversion	8-15
8.3.10 Monitoring Station SJ-10 – Missouri Avenue Diversion.....	8-16
8.4 Water Quality Data.....	8-16
8.4.1 Test Methods	8-16
8.4.2 Grab Samples	8-17
8.4.3 Composite Samples.....	8-17
8.4.4 pH Meters.....	8-18
8.4.5 Selection and Preparation of Sample Containers	8-18
8.4.6 Sample Volume	8-18
8.4.7 Sample Preservation and Holding Times	8-19
8.4.8 Quality Assurance	8-19
8.4.9 Chain of Custody Procedures	8-20
8.5 Results of Water Quality Monitoring.....	8-20
8.5.1 BOD ₅	8-21
8.5.2 TSS	8-22
8.5.3 TKN.....	8-23
8.5.4 Ammonia.....	8-24
8.5.5 Phosphates.....	8-25
8.5.6 <i>E. coli</i>	8-26
8.5.7 Fecal Coliforms.....	8-27
8.5.8 Metals	8-28
8.5.9 Toxic Organics	8-28



	<u>Page</u>
9.0 COLLECTION SYSTEM MODELING.....	9-1
9.1 Model Development.....	9-1
9.2 Addition of Dry Weather Flows to CSS.....	9-2
9.3 Flow and Rainfall Monitoring Data for Collection System Calibration	9-3
9.4 Model Calibration	9-4
9.5 Typical Year Rainfall	9-10
9.6 Typical Year Overflow for Existing Conditions.....	9-11
9.7 Typical Year Overflow for Proposed Alternatives	9-12
9.8 References	9-16
10. WATER QUALITY MODELING.....	10-1
10.1 Introduction.....	10-1
10.2 Hydraulic Model	10-2
10.3 Water Quality Model.....	10-4
10.3.1 Model Application.....	10-4
10.3.2 Model Inputs	10-6
10.3.3 Water Quality Model Calibration.....	10-16
10.3.4 Water Quality Standards	10-16
10.3.5 Model Results.....	10-17
10.4 Summary and Conclusions.....	10-23
10.4.1 Summary	10-23
10.4.2 Conclusions	10-25
11.0 COMBINED SEWER OVERFLOW CONTROL ALTERNATIVES.....	11-1
11.1 Introduction.....	11-1
11.2 Fundamental Projects	11-1
11.3 Proposed Alternatives	11-3
11.3.1 Alternative No. 1	11-3
11.3.2 Alternative No. 2.....	11-4
11.3.3 Alternative No. 3	11-5
11.3.4 Alternative No. 4.....	11-6
11.3.5 Summary of Alternatives	11-8
11.4 Present Worth Analysis.....	11-9



	<u>Page</u>
12.0 RECOMMENDED CSO CONTROL PLAN	12-1
12.1 Recommended Alternative	12-1
12.2 Implementation Schedule	12-4
12.3 Phase I Facility Plan	12-5

Appendices

- Appendix A – Future Land Use Maps
- Appendix B – CSO Annual Report
- Appendix C – Public Participation Information
- Appendix D – Sensitive Areas Correspondence
- Appendix E – Sampling and Flow Monitoring Data
- Appendix F – CSS Modeling Data
- Appendix G – Water Quality Modeling Data
- Appendix H – Affordability Analysis
- Appendix I – Abatement Order on Consent

Tables

	<u>Page</u>
Table 1.1 CSO Alternatives and Cost Summary	1-8
Table 1.2 Alternative No. 4 Cost Summary by Phases	1-10
Table 1.3 Alternative No. 4 Project Phasing	1-11
Table 3.1 Monthly Temperature Distribution	3-2
Table 3.2 Monthly Precipitation Distribution	3-3
Table 3.3 Summary of Future Land Use	3-5
Table 4.1 CSO Diversion Structures	4-1
Table 4.2 Design Capacity of Wastewater Treatment Plant Process Units	4-7
Table 8.1 Flow Sampling/Monitoring Locations and Equipment	8-1
Table 8.2 Test Methods	8-16
Table 8.3 Summary of Events from Flow Sampling/Monitoring Stations	8-21
Table 8.4 Summary of Events from Flow Monitoring Systems	8-21



	<u>Page</u>
Table 9.1	Dry Weather Flow by Watershed..... 9-2
Table 9.2	Wet Weather Events..... 9-3
Table 9.3	Stormwater Runoff to Rainfall Ratios for Observed Events 9-5
Table 9.4	Percent Difference of Runoff Volume Between Observed and Modeled Events..... 9-6
Table 9.5	Percent Difference of Peak Flow Between Observed And Modeled Events..... 9-6
Table 9.6	Typical Year Rainfall Event Characteristics..... 9-10
Table 9.7	Existing Condition – Typical Year Overflow Volume 9-12
Table 9.8	Alternative 4 Phase I – Typical Year Overflow Volume 9-14
Table 9.9	Alternative 4 Phase II – Typical Year Overflow Volume..... 9-15
Table 9.10	Alternative 4 Phase III – Typical Year Overflow Volume 9-16
Table 10.1	Constituent Concentrations Associated with Each Storm Event..... 10-11
Table 10.2	Model Input Locations 10-12
Table 10.3	Water Quality of Headwaters and Full Flow 10-13
Table 10.4	Peak CSO Flows for Storm Events and Improvement Alternatives 10-14
Table 10.5	WWTP and High Rate Treatment Loadings to the River..... 10-16
Table 10.6	Bacteria Water Quality Criteria for Missouri River at St. Joseph..... 10-17
Table 11.1	Fundamental Project Components and Costs..... 11-2
Table 11.2	Alternative No. 1 Project Components and Costs..... 11-4
Table 11.3	Alternative No. 2 Project Components and Costs..... 11-5
Table 11.4	Alternative No. 3 Project Components and Costs..... 11-6
Table 11.5	Alternative No. 4 Project Components and Costs..... 11-8
Table 11.6	CSO Alternatives and Cost Summary..... 11-9
Table 11.7	Present Worth Evaluation of Alternatives..... 11-10
Table 12.1	Present Worth Evaluation of Alternatives..... 12-1
Table 12.2	Alternative No. 4 Cost Summary by Phases 12-3
Table 12.3	Present Worth Evaluation of Phased Alternative No. 4..... 12-4
Table 12.4	Alternative No. 4 Project Phasing..... 12-5



Figures

	<u>Page</u>
Figure 1.1	Capital Costs Versus Overflow Events 1-9
Figure 1.2	Cost Indicators for Alternatives 1-10
Figure 3.1	Drainage Area Following Page 3-1
Figure 3.2	Watershed Map Following Page 3-1
Figure 3.3	Soils Map..... Following Page 3-3
Figure 4.1	Study Area..... Following Page 4-1
Figure 4.2	Blacksnake Creek Diversion Structure Following Page 4-2
Figure 4.3	Messanie Creek Diversion Structure..... Following Page 4-2
Figure 4.4	Mitchell Street Diversion Structure Following Page 4-3
Figure 4.5	Whitehead Creek Diversion Structure..... Following Page 4-5
Figure 4.6	Brown’s Branch Diversion Structure..... Following Page 4-5
Figure 4.7	Wastewater Treatment Plant Process Flow Schematic Following Page 4-7
Figure 8.1	CSO Monitoring Location Map Following Page 8-1
Figure 8.2	Installation of Blacksnake Creek Sampling Equipment 8-2
Figure 8.3	Monitoring Equipment at Blacksnake Creek Diversion 8-3
Figure 8.4	Flowmetering Equipment at Francis Street..... 8-4
Figure 8.5	Blacksnake Creek Monitoring Equipment 8-6
Figure 8.6	Messanie Street Monitoring Equipment..... 8-8
Figure 8.7	Mitchell Street Monitoring Equipment 8-10
Figure 8.8	Whitehead Creek Monitoring Equipment 8-12
Figure 8.9	Brown’s Branch Monitoring Equipment..... 8-14
Figure 8.10	2007 BOD Data..... 8-22
Figure 8.11	2007 TSS Data 8-23
Figure 8.12	2007 TKN Data 8-24
Figure 8.13	2007 Ammonia Data 8-25
Figure 8.14	2007 Phosphate Data..... 8-26
Figure 8.15	2007 <i>E. coli</i> Data..... 8-27
Figure 8.16	2007 Fecal Coliform Data..... 8-28



	<u>Page</u>
Figure 9.1	Observed Compared to Modeled Runoff Volume – Charles Watershed.....9-7
Figure 9.2	Observed Compared to Modeled Peak Flow - Charles Watershed.....9-7
Figure 9.3	Observed Compared to Modeled Runoff Volume – Mitchell Watershed9-8
Figure 9.4	Observed Compared to Modeled Peak Flow – Mitchell Watershed9-8
Figure 9.5	Observed Compared to Modeled Runoff Volume – Olive Watershed9-9
Figure 9.6	Observed Compared to Modeled Peak Flow9-9
Figure 10.1	St. Joseph CSS System..... 10-3
Figure 10.2	Rainfall Stations 10-7
Figure 10.3	Rainfall Versus CSO Pollutant Concentrations 10-8
Figure 10.4	Average Daily River Dissolved Oxygen for Existing CSS and Alternative 4 Phases for Maximum Loading Events – Navigation Season..... 10-18
Figure 10.5	River Dissolved Oxygen for Existing CSS and Alternative 4 Phases for Events E – Navigation Season..... 10-19
Figure 10.6	River CBOD Ultimate for Existing CSS and Alternative 4 Phases for Maximum Loading Events – Navigation Season..... 10-20
Figure 10.7	River Ammonia for Existing CSS and Alternative 4 Phases for Maximum Loading Events – Navigation Season..... 10-21
Figure 10.8	River <i>E. coli</i> for Existing CSS and Alternative 4 Phases for Maximum Loading Events 10-23
Figure 11.1	Alternative 1 – Deep Tunnel and High Rate Treatment at WWTPFollowing Page 11-4
Figure 11.2	Alternative 2 – Satellite High Rate TreatmentFollowing Page 11-5
Figure 11.3	Alternative 3 – Complete Sewer SeparationFollowing Page 11-5
Figure 11.4	Alternative 4 – Phased High Rate Treatment at WWTP and Deep TunnelFollowing Page 11-8



	<u>Page</u>
Figure 12.1 Capital Costs versus Overflow Events	12-2
Figure 12.2 Cost Indicators for Alternatives	12-3
Figure 12.3 Preliminary Project Implementation Schedule.....	Following Page 12-5



1.0 Executive Summary

1.1 Background and Scope

In December of 1992, the U.S. Environmental Protection Agency (EPA) signed the draft Combined Sewer Overflow (CSO) Control Policy. The main purpose of this policy is to expand on the National CSO Control Strategy published on September 8, 1989, and to expedite compliance with the Clean Water Act. The final CSO Control Policy was approved in April 1994 and requires communities with CSOs to develop and implement Long Term Control Plans (LTCPs) that will ultimately result in compliance with the Clean Water Act.

CSOs are mixtures of sanitary sewage, industrial wastewater, and stormwater runoff. CSOs often contain high concentrations of suspended solids, bacteria, heavy metals, floatables, nutrients, oxygen-demanding compounds, oil and grease, and other pollutants. Discharges of these materials can degrade water quality, pose risks to human health, threaten aquatic habitat, and impair the use and enjoyment of the nation's waterways.

The City of St. Joseph first submitted a LTCP to the Missouri Department of Natural Resources (MDNR) on December 19, 2002. The original LTCP demonstrated that the City's discharges to the Missouri River through its CSOs were compliant with the existing water quality standards. MDNR rejected the initial submittal stating that although the LTCP met the requirements of the Clean Water Act, it did not meet all aspects of the higher standards promulgated by the State of Missouri. In addition, MDNR has significantly revised the State's water quality standards since submission of the original LTCP.

To be in compliance with the EPA's initiative to set a specified date for completing the LTCP, the City of St. Joseph entered into an Abatement Order on Consent with MDNR on October 18, 2007. The abatement order is a voluntary agreement between the State regulatory agency and the City for the purpose of specifying the final completion date of the City's LTCP. The abatement order requires the City of St. Joseph to submit an updated LTCP to MDNR on or before February 15, 2008. The Abatement Order on Consent is included in Appendix I.



This LTCP update expands on the work and data collection previously completed by the City of St. Joseph and updates the results of modeling completed by Black & Veatch as part of the 1996 Combined Sewer Overflow Characterization Report and the 2002 Combined Sewer Overflow Long Term Control Plan. An updated Long Term Control Plan was developed that will assist the City in the reduction of pollutant loadings from CSO diversion structures. The Long Term Control Plan includes project costs and a preliminary implementation plan for the CSO program.

1.2 Watershed Description

The St. Joseph drainage area is located in the northwestern portion of Buchanan County, Missouri. The entire study area covers approximately 50 square miles or 32,400 acres. The contributing area outside of the City limits is 7,800 acres, of which 1,400 acres are in Andrew County.

The study area consists of 18 watersheds, eight of which drain to the Missouri River and the remaining 10 drain to the One Hundred and Two River on the east side of the City. The eight watersheds in the western portion of the City that drain to the Missouri River are Roy's Branch, Blacksnake, Frederick, Mitchell, Maple, Whitehead, Missouri Avenue, and Brown's Branch. The conveyance systems in these western watersheds are combined sewers which discharge to the Missouri River or watercourses tributary to the Missouri River during high flows caused by storm events. Five of the watersheds that drain to the Missouri River – Roy's Branch, Blacksnake, Mitchell, Whitehead, and Brown's Branch – also have separate storm sewer systems in their upper reaches. All of the separate systems drain directly into the combined sewer system. The majority of the combined sewer watersheds are fully developed, with the exception of the upper reaches of the Blacksnake and Whitehead watersheds, which are currently in agricultural use, but are designated for future residential development.

The 10 watersheds that discharge into the One Hundred and Two River on the eastern side of the City (A, B, C and D, E, F, G, H, J, K, and L) have separate sanitary and storm sewers. Flow from these separate sanitary sewers is pumped to the Mitchell combined sewer. Future land use for the One Hundred and Two drainage basin will consist



mainly of residential areas and parks, with some commercial and industrial development in its southern half. Similar to the watersheds draining to the Missouri River, the majority of the agricultural land has been designated for future residential development.

1.3 Description of Combined Sewer System Facilities

Fourteen locations have been identified where combined sewage is discharged from the combined sewer system through diversion structures to the Missouri River. CSO diversion structures and outfalls are shown on Figure 4.1.

The majority of sanitary sewage is transported through a series of combined sewers that extend across the City from east to west. Dry weather flow and a portion of the wet weather flow is diverted into a north-south interceptor along the Missouri River which flows to Whitehead Pump Station where it is conveyed to the wastewater treatment plant (WWTP). Based on a review of the interceptor capacity, the line has adequate size and grade to convey by gravity when flowing full 57 mgd to the Whitehead Pump Station. Sanitary sewage from the south part of St. Joseph is pumped from the Brown's Branch Pump Station to the Missouri Avenue watershed and is conveyed by gravity to the south end of the wastewater treatment plant and to the in-plant influent pump station.

The flow to the WWTP consists of the discharge from the Whitehead Pump Station, the in-plant pump station, Triumph Foods, Prime Tanning, and South St. Joseph Industrial Sewer District. The flow capacity of the primary treatment plant is limited to approximately 27 million gallons per day (mgd) due to hydraulic restrictions at the grit basins.

1.4 Description of Nine Minimum Operational Controls

The City of St. Joseph is required by their National Pollutant Discharge Elimination System (NPDES) permit to implement operating practices to reduce the strength and volume of CSO discharges to the receiving stream. These operating practices or nine minimum controls were implemented by the City in 1996. Each year, the City must submit a report to MDNR describing the controls which were completed during the previous year.



1.5 Public Participation

EPA CSO control policy requires that the City of St. Joseph conduct a public participation process that actively involves the affected public in the decision-making to select the long term CSO controls. During development of the long term control plan, three public meetings were conducted at City Hall on the following dates: 1) November 13, 2007, 2) January 9, 2008, and 3) February 6, 2008. In addition, City staff conducted several meetings with the City Council, community groups, and other stakeholders. The primary outcomes of the public meetings are that citizens are concerned about how the City will pay for the CSO program and the impact on individual sewer rates, how the proposed facilities may affect the community, and the desire of achieving multiple community benefits for stormwater detention basin projects.

1.6 Sensitive Areas

According to the CSO Control Policy, the Long Term Control Plan should give the highest priority to the prohibition of new or significantly increased overflows to designated sensitive areas. If sensitive areas are present, the plan should include provisions to eliminate or relocate overflows where possible, treat overflows where necessary, and reassess impacts each permit cycle where elimination or treatment is not achievable. Sensitive areas as determined by MDNR include outstanding national resource waters, national marine sanctuaries, waters with primary contact recreation, public drinking water intakes, shellfish beds, and waters with threatened or endangered species. Based on documentation collected for sensitive areas near St. Joseph and guidance provided in the CSO Control Policy, the vicinity of the St. Joseph CSOs is not considered a sensitive area. Therefore, CSO control improvements above and beyond those recommended in the Long Term Control Plan are not required for the City of St. Joseph.

1.7 Flow and Water Quality Monitoring

Five of the fourteen CSO diversion locations were selected for installation of sampling and flow monitoring equipment in the development of this LTCP, and five additional sites were selected for flow monitoring only. To ensure that sufficient data was



collected for the Long Term Control Plan, data was collected from 36 potential monitoring events in 2007. Data collected was used to verify and calibrate the collection system and water quality models. Comparisons were also made to sampling conducted for the 1996 Combined Sewer Overflow Characterization Report. Rainfall data collected during 2007 indicates longer duration, higher intensity rainfall than the previous study, resulting in near flooding events in April and May 2007. In comparison, the rainfall for the 1996 report appears to be shorter duration, lower intensity events. It appears that the 2007 rainfall events resulted in higher maximum concentrations and overall higher average concentrations for the measured constituents.

1.8 Collection System Modeling

The St. Joseph combined sewer system (CSS) was modeled using the XP-SWMM computer program, which was adapted from the XP-SWMM model previously developed by Black & Veatch for the 1999 Comprehensive Stormwater Management Plan. The CSS encompasses the eight major watersheds shown on Figure 4.1. The model developed for the stormwater management plan includes all of the CSS except the force mains and interceptors that convey dry weather flow and a portion of the wet weather flow to the WWTP, which is located in the Missouri Avenue watershed. Pipe segments representing these force mains and interceptors were added to the original stormwater model to provide a complete CSS model for the Long Term Control Plan. The CSS model was verified and calibrated using data collected in 2007 from the ten flow monitoring stations.

The CSS model was used to develop the frequency and volume of CSO events for a “typical year,” which was assumed to be representative of long-term average annual conditions. The frequency and volume of rainfall events that define the typical year were based on a similar methodology developed for the City of Kansas City, Missouri to support its CSO Long Term Control Plan. Rainfall data used to develop the typical year were based on continuous, long-term data available from the National Climatic Data Center (NCDC) for the Kansas City Downtown Airport (MKC) (November 1948 through October 1972) and the Kansas City International Airport (MCI) (November 1972 through December 2004). The combined airport data sets provide 56 continuous and complete years of hourly



precipitation data with a precision of 0.01 inch. As St. Joseph is located approximately 30 miles north of MCI and 50 miles north of MKC, it was assumed that the rainfall data used to develop the typical year for the Kansas City area would be representative of the St. Joseph area. The typical year was defined by eight design storm events (A through H), ranging in depth from 0.29 inches for Event A to 2.9 inches for Event H. There were a total of 78 storm events during the typical year. The CSS model was used to predict combined sewer overflow frequency and volume for the typical rainfall year for the existing CSS and for the proposed long term control plan improvements including high rate treatment, deep tunnel storage, and near surface storage.

1.9 Water Quality Modeling

The QUAL2K computer program was used to develop a water quality model of the Missouri River at St. Joseph. The model evaluated the effect of CSOs on water quality in the river for critical wet-weather flow conditions. Of primary interest to this study was the effect of the CSOs on dissolved oxygen (DO) and *E. coli* bacteria concentrations in the river. Carbonaceous biochemical oxygen demand (CBOD) and ammonia were also of interest because these constituents cause depletion of DO. The model study area included a 100 km (62 mile) reach of the Missouri River beginning just upstream of the most upstream CSO in St. Joseph. Sampling data collected from the monitored storm events in 2007 were used to determine CBOD, ammonia, and EC concentrations for the model.

The model was used to evaluate water quality in the river under current conditions and for the proposed CSO improvements. The critical condition for DO is during the navigation season months of July and August. For the non-navigation period, the minimum DO concentration will be above the DO water quality criterion for existing conditions and each of the proposed improvement phases.

The critical condition for EC is during April when water temperatures are the lowest of any the months of the recreation season. Because of the extremely high concentrations of *E. coli* in the combined sewer system, any untreated CSO event will cause an excursion of the *E. coli* water quality criterion for the Missouri River.



1.10 Combined Sewer Overflow Alternatives

Alternatives to reduce the volume and frequency of CSOs to the Missouri River were developed for evaluation as part of the Long Term Control Plan. A “presumptive approach” as accepted by the EPA was used to develop the alternatives and involves technological solutions that are presumed to meet the CSO Control Policy. The presumptive approach results in no more than four overflow events per year based on computer modeling of the CSS.

In developing potential alternatives for the Long Term Control Plan, several projects were identified as common to all alternatives, except sewer separation. These common or fundamental projects would include the stormwater detention basins proposed in the 1999 Comprehensive Stormwater Management Plan in the Blacksnake, Whitehead, and Brown’s Branch watersheds as well as stormwater separation conduits downstream from these basins. Other fundamental projects would include the addition of motor operated gates and fixed weirs at several of the diversion structures to increase storage capacity within the existing CSS and maximize flow conveyed to the wastewater treatment plant.

Four alternatives were developed to meet the EPA target of four overflow events per year. The alternatives were compared and evaluated based on the City’s financial capability to pay for the improvements as indicated by an Affordability Analysis conducted under EPA guidelines. The Affordability Analysis is included in Appendix H. The alternatives and estimated total project costs, in 2007 dollars, are summarized in Table 1.1 and shown on Figures 11.1 through 11.4.



Table 1.1 CSO Alternatives and Cost Summary		
Alternative	Facilities	Project Cost
1	<ul style="list-style-type: none"> • Fundamental projects • Whitehead Pump Station upgrade with new wet weather pump station • Headworks improvements at WWTP • High rate treatment facility at WWTP • Deep tunnel and pump station 	\$580 Million
2	<ul style="list-style-type: none"> • Fundamental projects • Four satellite high rate treatment facilities • Conveyance piping 	\$555 Million
3	<ul style="list-style-type: none"> • Complete sewer separation 	\$850 Million
4	<ul style="list-style-type: none"> • Fundamental projects • Whitehead Pump Station upgrade with new wet weather pump station • Headworks improvements at WWTP • High rate treatment facility at WWTP • Flow equalization basins at Patee and Missouri Avenue • Deep tunnel and pump station • Flow equalization basin at WWTP 	\$450 Million

1.11 Recommended Combined Sewer Overflow Control Plan

Based on an economic evaluation, Alternative No. 4 is the recommended alternative for the Long Term Control Plan. This alternative was further divided into three phases for implementation to meet an affordability target and EPA CSO goals. Phase I improvements will reduce overflow events to 12 per year and provide 65 percent basin-wide annual capture during precipitation events. Phase II will further reduce overflow events to six per year and provide 84 percent capture, and Phase III will result in meeting the EPA goal of four overflow events per year as well as provide 90 percent capture. For comparison purposes and to show a knee of the curve for diminishing benefits versus cost, Figure 1.1 presents a graph of the estimated capital costs versus overflow events for the three phases of Alternative No. 1 and also shows Alternative No. 3 – Complete Sewer Separation. It appears that the knee of the curve is between four to six overflow events per year.

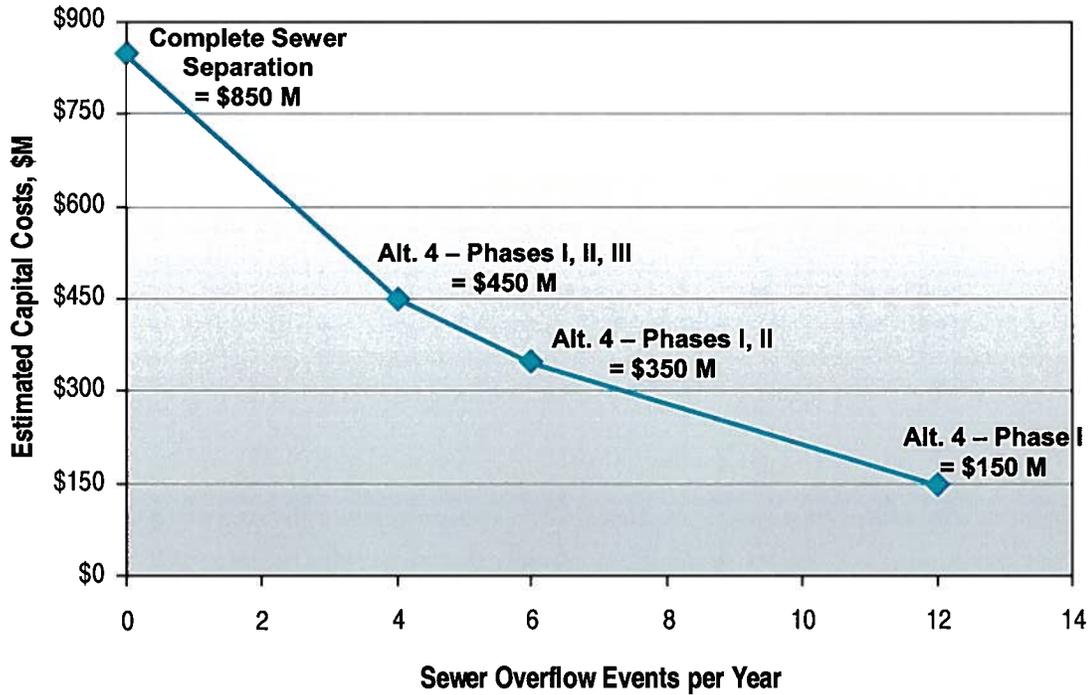


Figure 1.1 Capital Costs versus Overflow Events

Figure 1.2 presents a comparison of the cost indicators for each of the four alternatives based on the results of the Affordability Analysis. As shown in this figure, it is unrealistic and financially unfeasible to expect the City of St. Joseph to implement the CSO control improvement within a 20-year implementation schedule. Alternative No. 4 presents a phased implementation plan based on a wastewater cost burden of 2.07 percent of median household income (MHI). It is recommended that the wastewater burden for St. Joseph not exceed 2.07 percent of MHI in order to have a financially viable CSO program and maintain economic stability for the City.

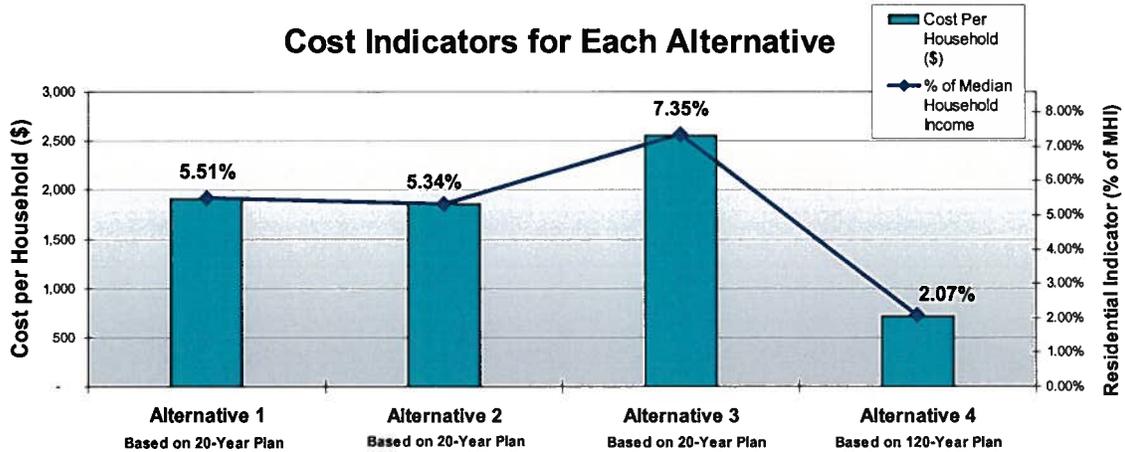


Figure 1.2 Cost Indicators for Alternatives

Table 1.2 summarizes the estimated project costs, in 2007 dollars, for the recommended phased alternative. A facility plan will be conducted during the first year of implementation to further refine the Phase I project elements and costs.

Table 1.2	
Alternative No. 4 Cost Summary by Phases	
Phase IA Projects	Project Cost
Phase 1 Facility Plan	To Be Determined
WWTP Headworks Improvements	\$1.8 Million
Whitehead Pump Station Improvements	\$18.5 Million
High Rate Treatment Facilities at WWTP	\$22.2 Million
Diversion Structure Modifications	\$2.4 Million
Blacksnake Stormwater Detention Basin	\$9.0 Million
Whitehead Stormwater Detention Basin	\$7.3 Million
Patee Flow Equalization Basin	\$13.8 Million
Phase IA TOTAL	\$75.0 Million
Phase IB Projects	
Blacksnake Stormwater Separation Conduit	\$22.0 Million
Whitehead Stormwater Separation Conduit	\$10.4 Million
Missouri Avenue Flow Equalization Basin	\$30.0 Million
Brown's Branch Stormwater Detention Basin	\$9.5 Million
Brown's Branch Stormwater Separation Conduit	\$3.1 Million
Phase IB TOTAL	\$75.0 Million
Phase II TOTAL (deep tunnel and pump station)	\$200.0 Million
Phase III TOTAL (high rate treatment expansion and flow equalization basin at WWTP)	\$100.0 Million



The proposed project costs for the CSO program will impose a significant financial burden on the City of St. Joseph. As indicated in the Affordability Analysis dated December 21, 2007, due to the high financial burden of the CSO program on St. Joseph sewer rate payers, it is recommended that the wastewater system capital projects burden not exceed 2.07 percent of the median household income for residents of St. Joseph. Based on this burden limit, the maximum amount of CSO program capital costs to be expended by the City during a 20-year period is \$75 million. A preliminary project implementation schedule was developed to maintain approximately \$75 million in CSO program expenditures during each 20-year period and is shown on Figure 12.3.

The implementation schedule for the recommended alternative was subdivided into major phases with associated levels of control, wet weather capture rates, and estimated project costs as shown in Table 1.3.

Phase	Time Period	Project Cost, \$	Level of Control, CSO events/yr	Annual Wet Weather Capture Rate, %
I	Years 1-40	\$150 Million	12	65
II	Years 41-93	\$200 Million	6	84
III	Years 94-120	\$100 Million	4	90



2.0 Introduction

2.1 Background

In 1972, the U.S. Congress enacted the Clean Water Act (Public Law 92-500) which amended the Water Pollution Control Act of 1952. As stated in the preamble to the Clean Water Act, the principal objective was to “restore and maintain the chemical, physical, and biological integrity of the nation’s waters.”

In December of 1992, the U.S. Environmental Protection Agency (EPA) signed the draft Combined Sewer Overflow (CSO) Control Policy. The main purpose of this policy is to expand on the National CSO Control Strategy published on September 8, 1989, and to expedite compliance with the Clean Water Act. The final CSO Control Policy was approved in April 1994 and requires communities with CSOs to develop and implement Long Term Control Plans (LTCPs) that will ultimately result in compliance with the Clean Water Act.

CSOs are mixtures of sanitary sewage, industrial wastewater, and stormwater runoff. CSOs often contain high concentrations of suspended solids, bacteria, heavy metals, floatables, nutrients, oxygen-demanding compounds, oil and grease, and other pollutants. Discharges of these materials can degrade water quality, pose risks to human health, threaten aquatic habitat, and impair the use and enjoyment of the nation’s waterways.

The City of St. Joseph first submitted a LTCP to the Missouri Department of Natural Resources (MDNR) on December 19, 2002. The original LTCP demonstrated that the City’s discharges to the Missouri River through its CSOs were compliant with the existing water quality standards. MDNR rejected the initial submittal stating that although the LTCP met the requirements of the Clean Water Act, it did not meet all aspects of the higher standards promulgated by the State of Missouri. In addition, MDNR has significantly revised the State’s water quality standards since submission of the original LTCP.

To be in compliance with the EPA’s initiative to set a specified date for completing the LTCP, the City of St. Joseph entered into an Abatement Order on Consent with MDNR on October 18, 2007. The abatement order is a voluntary agreement between the State regulatory agencies and the City for the purpose of specifying the final completion date of



the City's LTCP. The abatement order requires the City of St. Joseph to submit an updated LTCP to MDNR on or before February 15, 2008. The Abatement Order on Consent is included in Appendix I.

2.2 Long Term Control Plan Update

This LTCP update expands on the work and data collection previously completed by the City of St. Joseph and updates the results of modeling completed by Black & Veatch as part of the 1996 Combined Sewer Overflow Characterization Report and the 2002 Combined Sewer Overflow Long Term Control Plan. The City of St. Joseph submitted its nine minimum controls report to MDNR in 1997. To complete this LTCP update, available data sources were used to gather information on topography, land use, recreational areas, soil geology, vegetation, natural resources, precipitation, temperature (air and water), storm drainage systems, wastewater collection system mapping, population, zoning, point discharge locations, physiographic and bathymetric data, sediment data, and federal and state water quality standards.

Meetings with the local community were conducted to obtain public involvement and feedback. Additional educational materials were developed to inform the public about the CSO challenges faced by the City. The river was examined to determine the current uses and how that compares to designated uses in the water quality standards. Sensitive areas were identified and evaluated with respect to CSO discharges to the Missouri River. Modeling of the Missouri River was completed using the QUAL2K program and sampling data collected from 34 storm events from March through October 2007. Existing procedures used by the City to minimize CSOs were documented. Hydraulic and hydrologic modeling of the combined sewer system was conducted to determine the frequency and volume of CSOs and to predict the effectiveness of proposed CSO control alternatives. The capacity of the collection system (main interceptor) and treatment plant was verified to determine if treatment of CSOs can be provided at the treatment plant. All the information was evaluated and developed into a Long Term Control Plan Update that will assist the City in the reduction of pollutant loadings from CSO structures. Project costs and a preliminary implementation plan were also developed for the CSO program.



3.0 Watershed Description

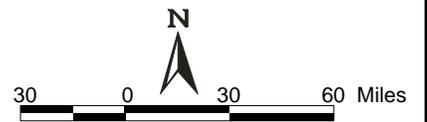
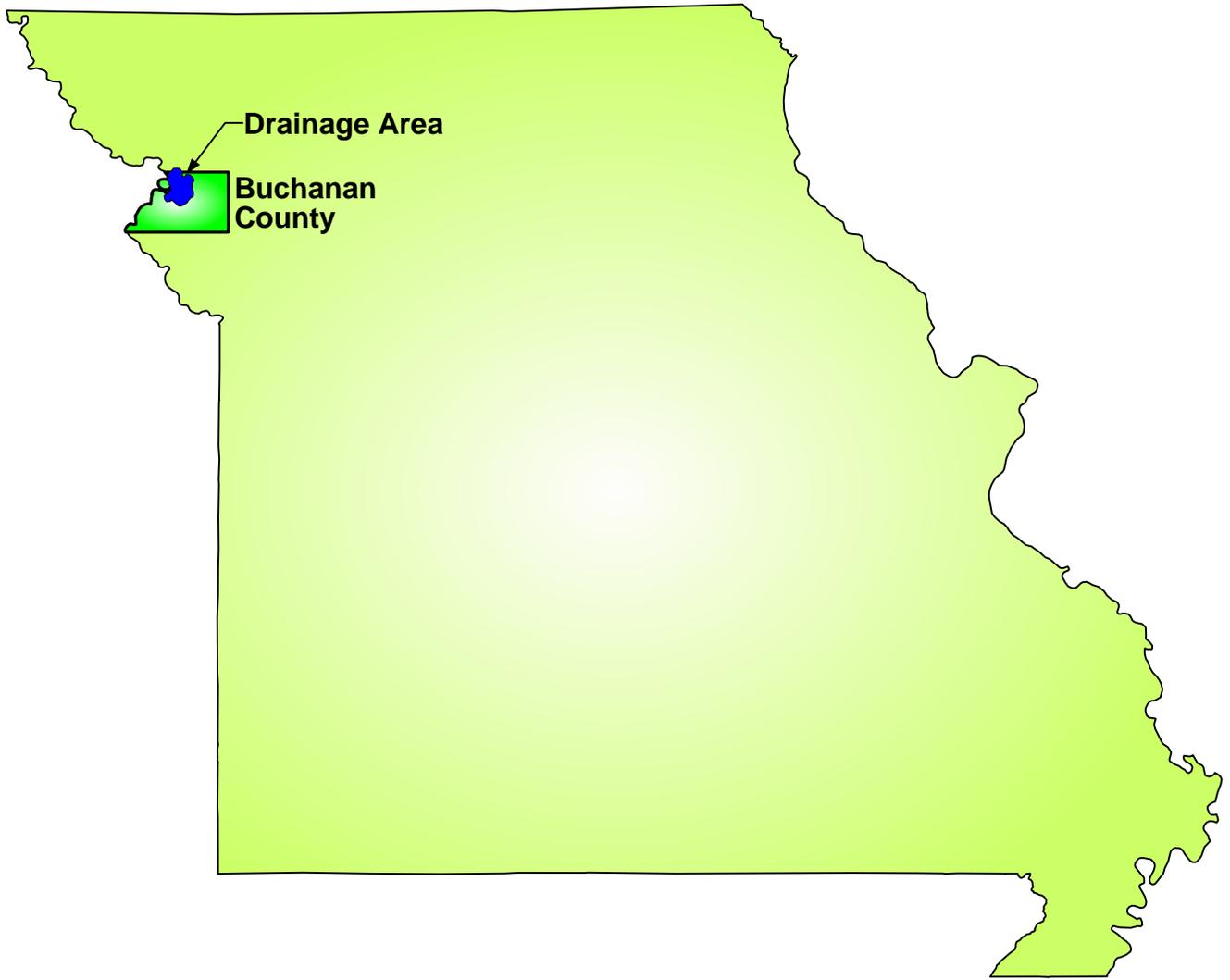
3.1 Area Description

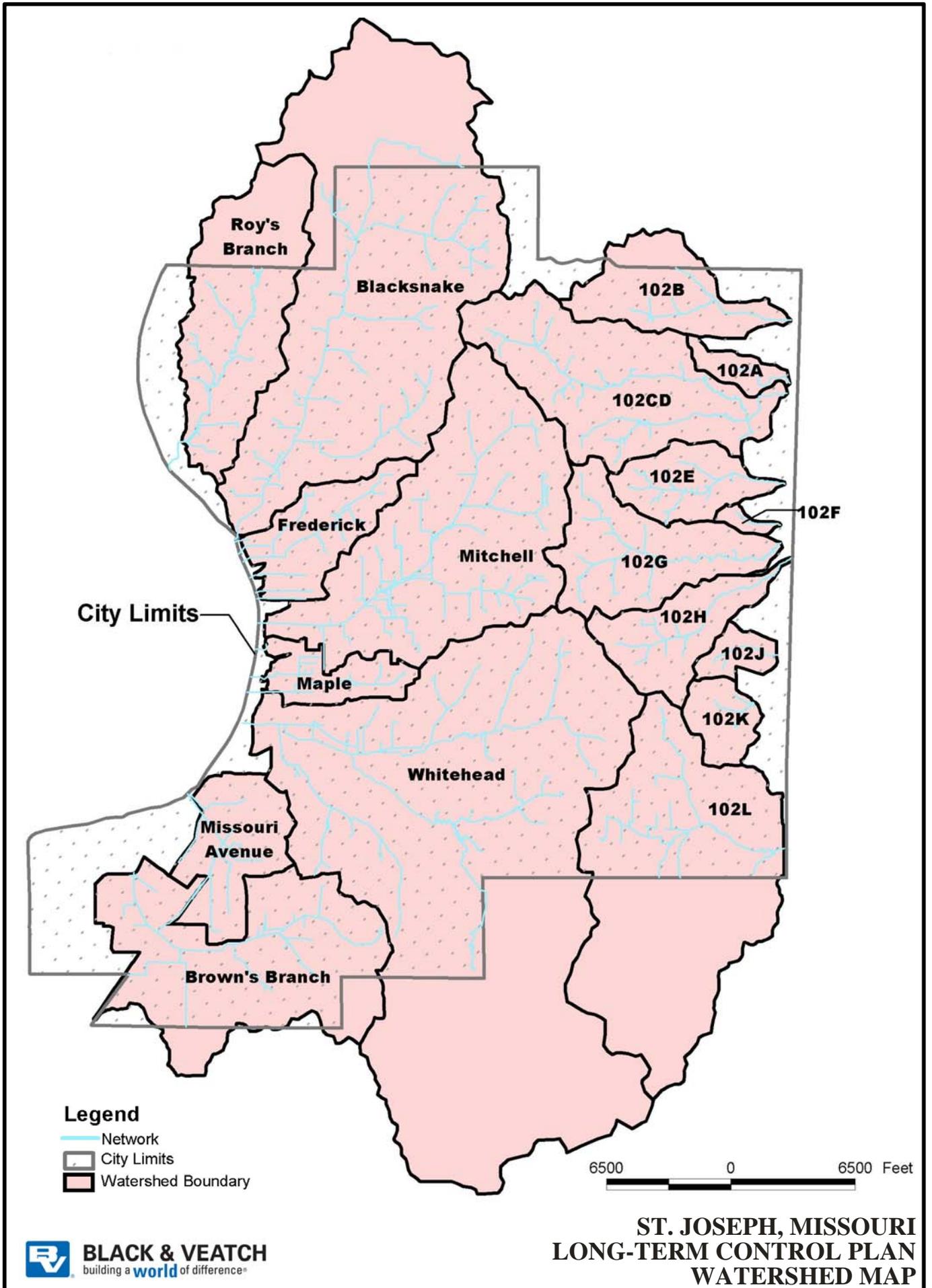
The St. Joseph drainage area is located in the northwestern portion of Buchanan County, Missouri, as shown on Figure 3.1. The entire study area covers approximately 50 square miles or 32,400 acres. The contributing area outside of the city limits is 7,800 acres, of which 1,400 acres are in Andrew County. The land is generally characterized by hills and uplands that rise 100 to 200 feet above the Missouri River floodplain.

The study area consists of 18 watersheds as shown on Figure 3.2. Eight of these watersheds drain to the Missouri River, the remaining 10 drain to the One Hundred and Two River on the east side of the City. The eight watersheds in the western portion of the City that drain to the Missouri River are Roy's Branch, Blacksnake, Frederick, Mitchell, Maple, Whitehead, Missouri Avenue, and Brown's Branch. The conveyance systems in these western watersheds are combined sewers. During high flows caused by storm events, the combined sewer overflows (CSOs) discharge directly to the Missouri River or to watercourses tributary to the Missouri River. The functional operation of the interceptors and overflow structures differ among the watersheds. The majority of the watersheds are fully developed, with the exception of the upper reaches of the Blacksnake and Whitehead watersheds, which are currently in agricultural use, but are designated for future residential development.

Five of the watersheds that drain to the Missouri River – Roy's Branch, Blacksnake, Mitchell, Whitehead, and Brown's Branch – also have separate storm sewer systems in their upper reaches. All of the separate systems drain directly into the combined sewer system.

The 10 watersheds that discharge into the One Hundred and Two River on the eastern side of the city, labeled A, B, C and D, E, F, G, H, J, K, and L, have separate sanitary and storm sewers. Flow from these separate sanitary sewers is pumped to the Mitchell combined sewer. Future land use for the One Hundred and Two drainage basin will consist mainly of residential areas and parks, with some commercial and industrial development in its southern half. Similar to the watersheds draining to the Missouri River, the majority of the agricultural land has been designated for future residential development.







3.2 Temperature

The climate of the area is characterized by wide fluctuations in temperature and precipitation, both daily and seasonal. The coldest month is normally January, with an average temperature of 24.9°F (-3.94°C). The warmest month is July, with an average temperature of 78.5°F (25.8°C). The monthly distribution of temperature is listed in Table 3.1.

Month	Ave High, °F	Ave Low, °F	Mean, °F	Record High, °F	Record Low, °F
January	34	14	25	68	-25
February	40	19	30	79	-23
March	53	31	42	90	-13
April	65	42	54	96	2
May	76	53	65	98	30
June	84	62	74	105	41
July	88	67	78	107	41
August	85	63	75	105	41
September	78	54	67	102	30
October	68	43	56	94	18
November	52	31	42	82	-5
December	38	19	29	70	-24

3.3 Precipitation

The annual average precipitation in the area is 34.06 inches. The monthly and seasonal distribution of precipitation is listed in Table 3.2. Summer precipitation is generally in the form of high intensity thunderstorms and short duration rains. Hourly rainfall in the range of 1 to 1.5 inches is common. The maximum 24-hour rainfall reported in St. Joseph was 7.12 inches in May 1962. As indicated in the table, the majority of rainfall occurs between April and September, with the greatest amount of moisture received during spring and summer.



Table 3.2
Monthly Precipitation Distribution

Month	Precipitation, inches	Seasonal Precipitation, %
December	1.40	Winter 9.5
January	1.00	
February	1.00	
March	2.40	Spring 28.7
April	3.00	
May	4.90	
June	4.80	Summer 35.9
July	3.80	
August	4.30	
September	4.50	Fall 25.9
October	3.00	
November	1.80	

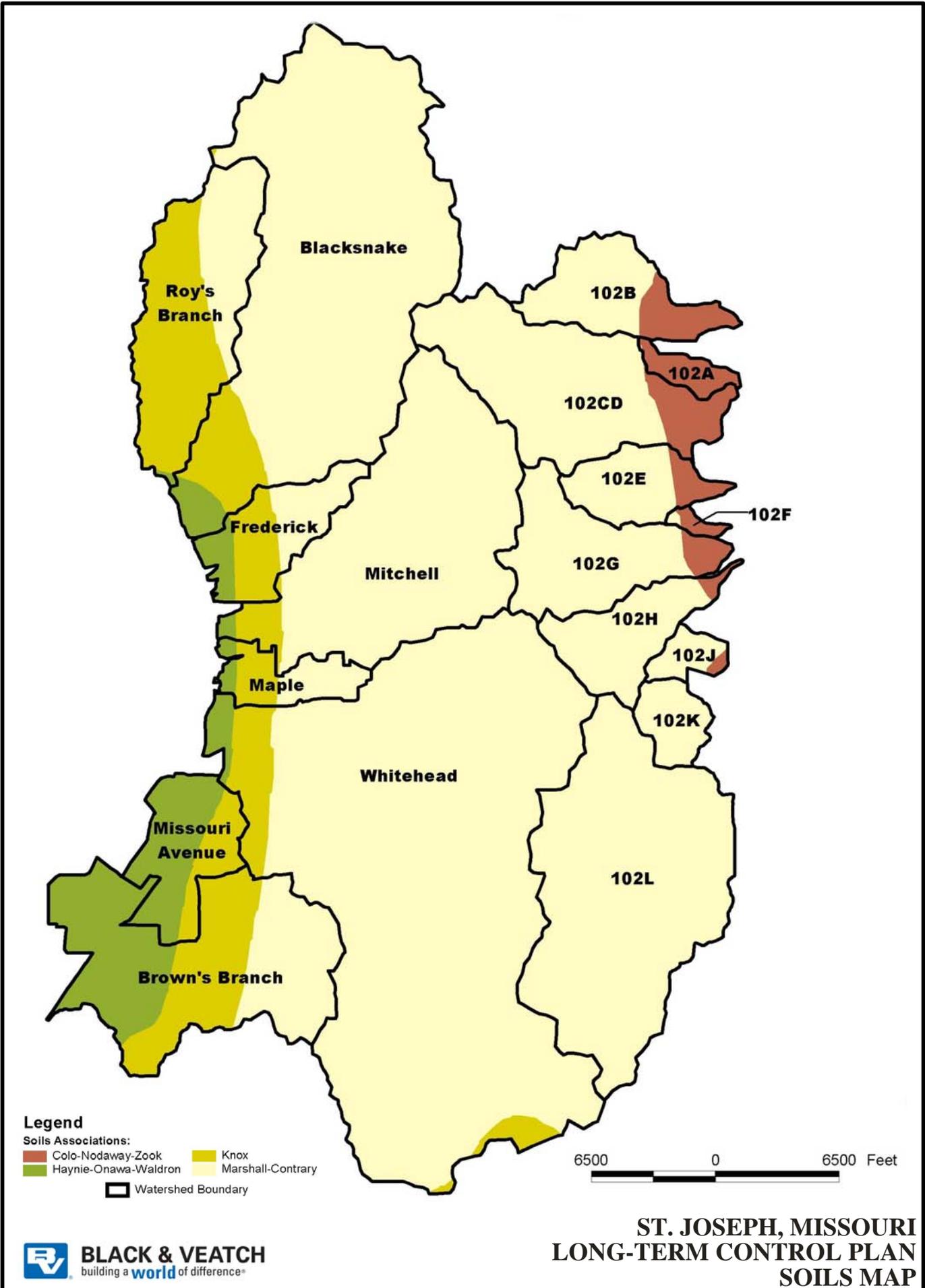
3.4 Vegetation

The density of vegetation varies throughout the area; it is heaviest primarily along the natural creek banks in undeveloped areas outside the city limits and light to moderate along the natural creek banks in developed areas within the city limits.

The effect of vegetation on water quality of stormwater runoff can be substantial. A significant degree of stormwater management can be achieved naturally by preserving buffer zones of vegetation around streams. The vegetation will stabilize stream banks and reduce erosion by slowing water velocities. Vegetation also acts as a natural filter for runoff by capturing sediment to which fertilizers and other pollutants are attached. Regular maintenance should be performed on the stream banks to prevent overgrowth of vegetation, which can inhibit stormwater flow and cause backwater effects.

3.5 Soils

The soils in the St. Joseph drainage basin are primarily the Marshall-Contrary soil association, which covers approximately 80 percent of the drainage area as shown on Figure 3.3. The remaining 20 percent consists of the Knox soil association (11 percent), the Haynie-Onawa Waldron soil association (6 percent) and the Colo-Nodaway-Zook soil association (3 percent).





The Marshall-Contrary soil association is characterized by gently to strongly sloping, well-drained soils formed in loess on uplands. Slopes range from 2 to 20 percent. The Knox soil association is moderately sloping to very steep, consisting of well drained soil formed in a thick layer of loess on uplands. Slopes range from 5 to 35 percent. The Haynie-Onawa-Waldron soil association is characterized by nearly level, moderately well drained and somewhat poorly drained soils formed in calcareous alluvium on flood plains. Slopes range from 0 to 2 percent. The Colo-Nodaway-Zook soil association consists of nearly level, poorly drained and moderately well drained soils formed in alluvium on floodplains. Slopes range from 0 to 2 percent.

3.6 Topography

St. Joseph area topography is characterized by rolling hills, open fertile plains, and well watered prairie next to the Missouri River. The elevation is 826 feet above sea level.

3.7 Natural Resources

Buchanan County is located within the Glaciated Plains Natural Division. Most of the state north of the Missouri River was covered by glaciers during two time periods. Besides having a leveling effect, the glaciers deposited silts, sand, gravels, and boulders, providing parent materials for soil development. The gentle terrain and deep, silty soils are ideal for agriculture use.

Buchanan County is rich in fish, forest and wildlife resources, some of which are available to the public. The Conservation Department manages over 100 conservation areas totaling just over 70,000 acres in Northwest Missouri, including many public access points on streams and the Missouri River.

3.8 Land Use

Buchanan County covers 410 square miles or nearly 263,000 acres. There are approximately 776 farms in Buchanan County with an average size of 234 acres (0.365 square miles) for a total of 181,500 acres (284 square miles). Vegetative coverage in the county is made up of 44 percent row and close grown crops; 23.85 percent non-native, cool-



season grasslands; 5.27 percent general grasslands; and 4.38 percent deciduous upland mixed oak forest.

All of the watersheds are proposed to be fully developed, with the exception of Roy’s Branch and Blacksnake (outside the city limits) and a portion of the One Hundred and Two watershed. Portions of these watersheds have future agricultural land use identified. Table 3.3 lists the percentages of future land use within each watershed. Future land use maps are included in Appendix A. Collection system and water quality modeling results are based on these percentages.

Watershed	Total Area, acres	Low Density Residential, %	Multi-Family Residential, %	Office, %	Commercial, %	Industrial, %	Historic Districts, %	Quasi Public, %	Public, %	Parks, %	Transition Areas, %	Agriculture, %
Roy’s Branch	1,667	43	0	0	0	2	0	0	1	32	0	22
Blacksnake	5,254	57	0	0	5	1	0	2	2	12	1	20
Frederick	733	24	0	0	25	14	9	6	6	2	14	0
Mitchell	3,143	52	1	1	13	2	0	2	14	9	6	0
Maple	429	49	0	0	0	24	0	0	0	0	27	0
Whitehead	8,637	66	4	0	4	5	0	0	1	20	0	0
Missouri Avenue	820	45	4	0	5	44	0	1	1	0	0	0
Brown’s Branch	2,470	69	0	0	2	14	0	0	3	12	0	0
102 System A	174	21	0	0	0	0	0	0	0	19	0	60
102 System B	829	59	0	0	0	0	0	0	0	37	0	4
102 System C & D	1,921	55	14	0	11	2	0	5	0	7	0	6
102 System E	561	79	0	0	8	0	0	4	0	7	0	2
102 System F	62	32	0	0	2	0	0	29	0	37	0	0
102 System G	1,153	19	14	0	12	0	0	0	51	4	0	0
102 System H	726	20	0	22	0	24	0	0	29	5	0	0
102 System J	189	16	0	17	13	25	0	5	0	24	0	0
102 System K	318	50	0	0	0	17	0	0	0	33	0	0
102 System L	3,349	50	1	0	0	47	0	0	2	0	0	0
Entire Study Area	32,435	55	3	1	5	10	0	1	5	13	1	5

3.9 Recreational Areas

Less than 2 percent of the land in Northwest Missouri is public land. The public has the opportunity to enjoy fishing on many ponds and lakes, target shooting, hiking, and



horseback riding. St. Joseph's park system encompasses over 1,500 acres of city parks connected by a 26 mile parkway system. Public recreational facilities include golf courses, baseball fields, ice skating rinks, swimming pools, and tennis courts.

The parkway system, developed in 1918, was one of the first comprehensive parkway plans implemented in the United States. The completed greenbelt of hiking and biking trails connects the principal parks and recreation facilities throughout the city.

Located at the northern end of the parkway, the 164 acre Krug Park contains an amphitheater, a lagoon, rose gardens, picnic areas, scenic walking trails, and playgrounds. The 93 acre Hyde Park Recreational Complex, located at the parkway's southern end, contains tennis courts, a swimming pool, horseshoe courts, a baseball complex, basketball goals, and picnic shelters.

3.10 River Uses

The Missouri Water Quality Standards are contained in 10 CSR 20-7.031. Table H of this standard lists the following use classifications for the Missouri River segment that includes St. Joseph.

- Irrigation
- Livestock and wildlife watering
- Protection of warm water aquatic life and human health (fish consumption)
- Whole body contact recreation
- Secondary contact recreation
- Drinking water supply
- Industrial process and cooling water

The Water Quality Standards indicate that the dissolved oxygen (DO) concentration cannot be lower than 5 mg/L at any time for protection of aquatic life (10 CSR 20-7.031 (4) (J), Table A). The standards also indicate that the *E. coli* bacteria count cannot exceed 548/100 mL as a geometric mean during the recreational season (April 1 to October 31) for



whole body contact (10 CSR 20-7.031 (4) (C), Table A). *E. coli* bacteria counts for secondary contact cannot exceed 1,134/100 mL as a geometric mean during the recreational season.

Discharges from the CSOs have the potential to adversely impact aquatic life by increasing organic material (biochemical oxygen demand or BOD) concentrations and reducing the DO concentration in the river. CSO discharges also have the potential to adversely impact public health by increasing bacteria counts. Water quality modeling is required to determine the impact of CSO discharges on the river and is summarized in Chapter 10.0.

On August 30, 2002, Black & Veatch conducted a preliminary recreational use attainability analysis of the river upstream and downstream of the city. This survey was conducted by boat from River Mile 451 to River Mile 436. Activities along the river were discussed with St. Joseph Yacht Club members and were found to be consistent with the secondary contact recreation use designated by the Missouri Department of Natural Resources (MDNR). Fishing and boating were among the activities observed. There also appears to be considerable industrial use along the river segments surveyed.



4.0 Description of Combined Sewer Facilities

4.1 Background

The St. Joseph combined sewer system is located in the western portion of the City and drains to the Missouri River. Flow into the combined sewer system consists of sanitary sewage, stormwater, and stream flow from Blacksnake Creek, Whitehead Creek, and Brown's Branch Creek. Dry weather flow and a portion of the wet weather flow is conveyed through a sewer interceptor to the wastewater treatment plant at the south end of town along the Missouri River. The interceptor collects combined sewage at various diversion structures along the Missouri River. During wet weather events, combined sewer overflow (CSO) discharges from the diversion structures to the Missouri River.

4.2 CSO Diversion Structures

Fourteen locations have been identified where combined sewage is discharged from the combined sewer system through diversion structures to the Missouri River. CSO diversion structures are summarized in Table 4.1 and shown on Figure 4.1.

Roy's Branch Diversion	Mitchell Street Diversion
Blacksnake Creek Diversion	Duncan Street Diversion
Francis Street Diversion	Maple Street Diversion
Charles Street Diversion	Hickory Street Diversion
Messanie Street Diversion	Whitehead Creek Diversion
Patee Street Diversion	Missouri Avenue Diversion
Olive Street Diversion	Brown's Branch Diversion
Note: The Walnut Street Diversion / CSO was closed in 2006.	

4.2.1 Blacksnake Creek Diversion

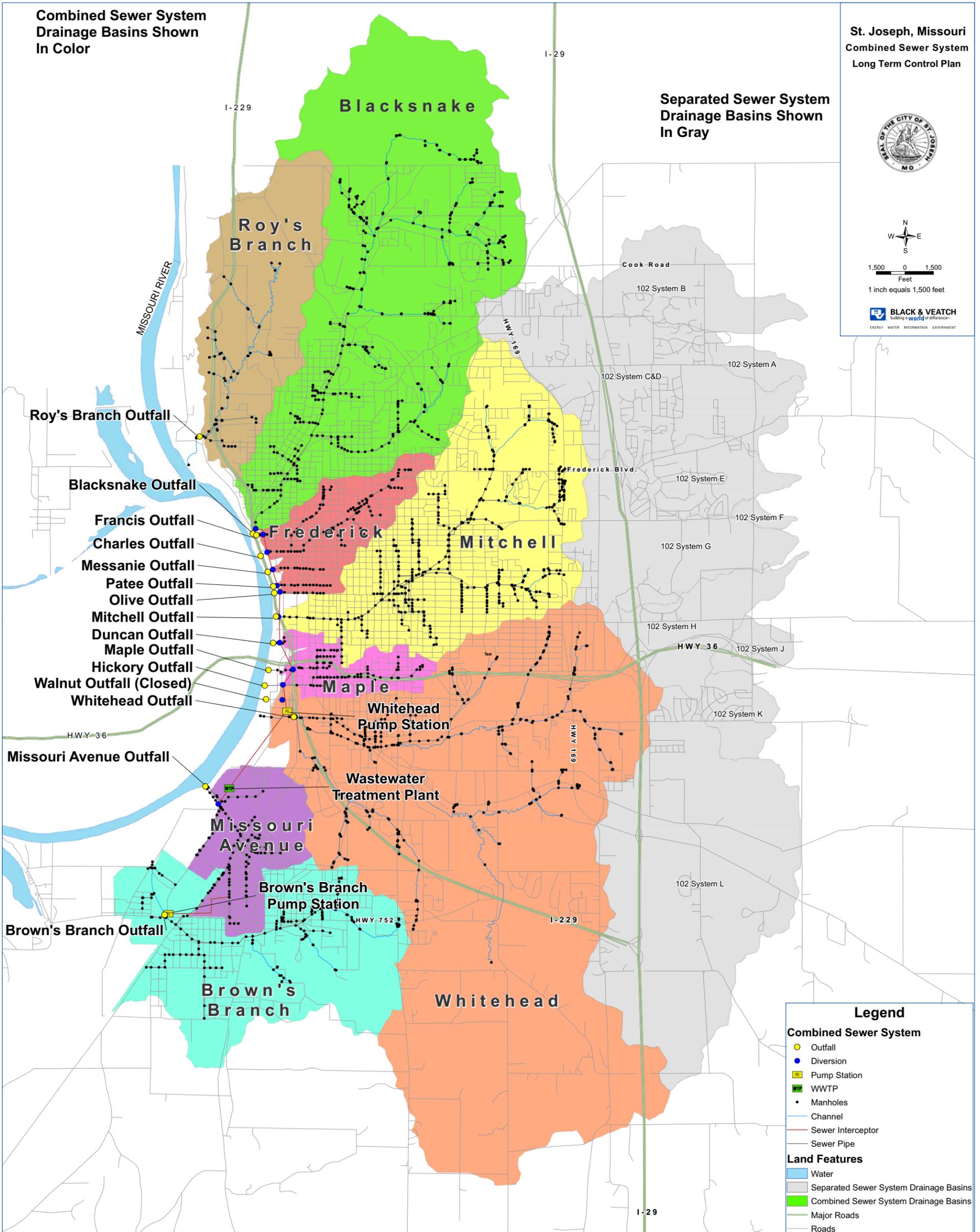
In addition to the base flow from Blacksnake Creek, the Blacksnake Creek diversion structure receives combined sewage from Roy's Branch Pump Station as well as from other residential and commercial sources. Approximately 30 percent of the City's wastewater drains through this diversion structure. Combined sewage enters through a 17 foot by

Combined Sewer System
Drainage Basins Shown
In Color

St. Joseph, Missouri
Combined Sewer System
Long Term Control Plan



1,500 0 1,500
Feet
1 inch equals 1,500 feet



Legend

Combined Sewer System

- Outfall
- Diversion
- Pump Station
- WWTP
- Manholes
- Channel
- Sewer Interceptor
- Sewer Pipe

Land Features

- Water
- Separated Sewer System Drainage Basins
- Combined Sewer System Drainage Basins
- Major Roads
- Roads

STUDY AREA

Figure 4.1



10 foot arched sewer and is diverted into a 36 inch interceptor with the use of a weir dam as shown on Figure 4.2. Discharges to the interceptor are controlled by a manually-operated 36 inch sluice gate at a downstream manhole where the diameter of the interceptor increases to 48 inches. When flows exceed the height of the overflow weir dam or when the sluice gate is closed, it overflows the weir dam and is discharged to the Missouri River through a 17 foot by 17 foot flap gate.

4.2.2 Francis Street Diversion

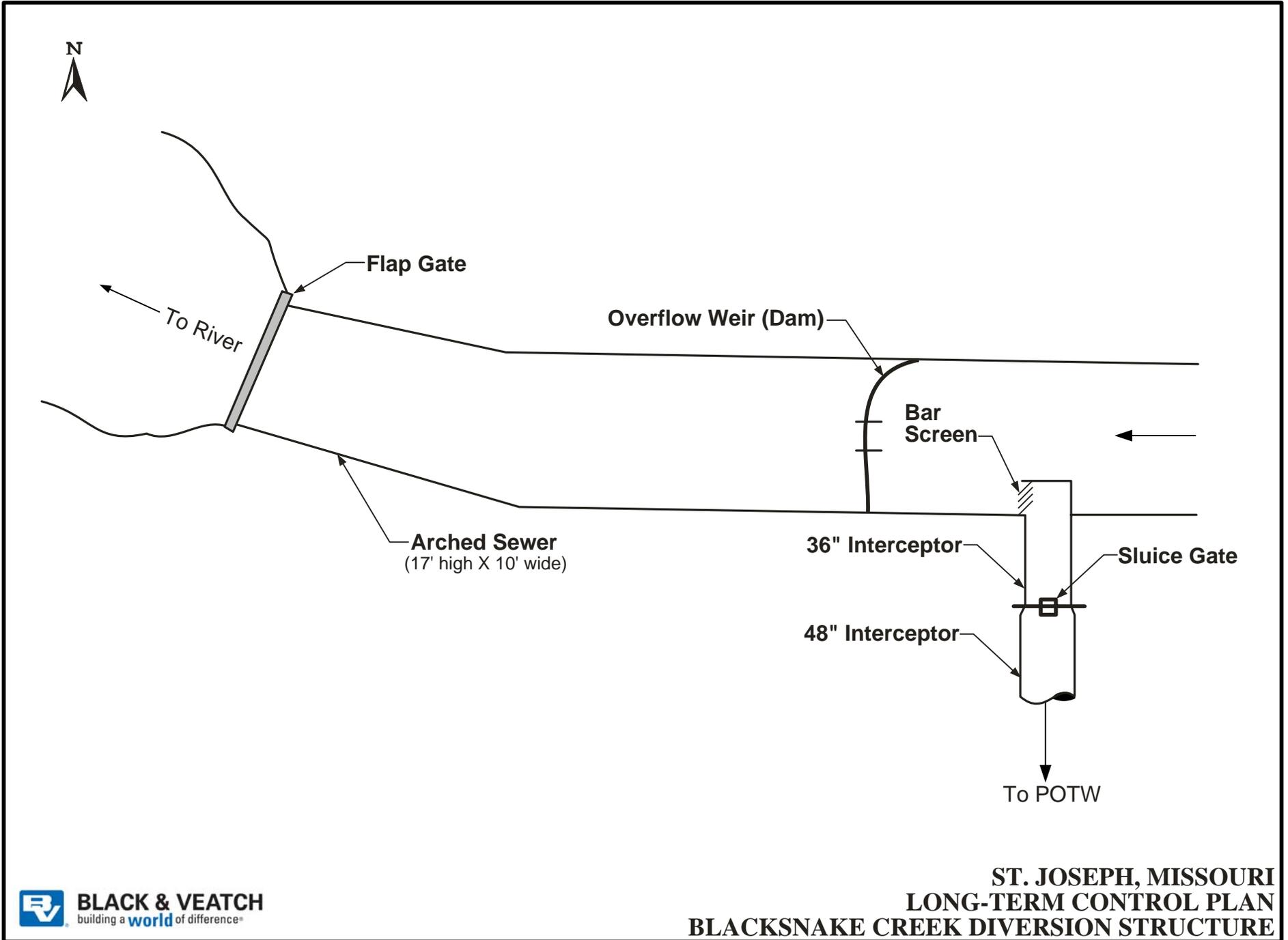
The Francis Street diversion structure receives flow from industries, offices, and multi-family dwellings through a 24 inch sewer. Combined sewage flows into a 4 foot by 4 foot diversion box and passes through a 12 inch opening controlled by a manually-operated sluice gate into the 48 inch main interceptor. When the capacity of the 12 inch opening is exceeded or when the gate is closed, excess flow is diverted through an 8 inch vitrified clay pipe to the Missouri River.

4.2.3 Charles Street Diversion

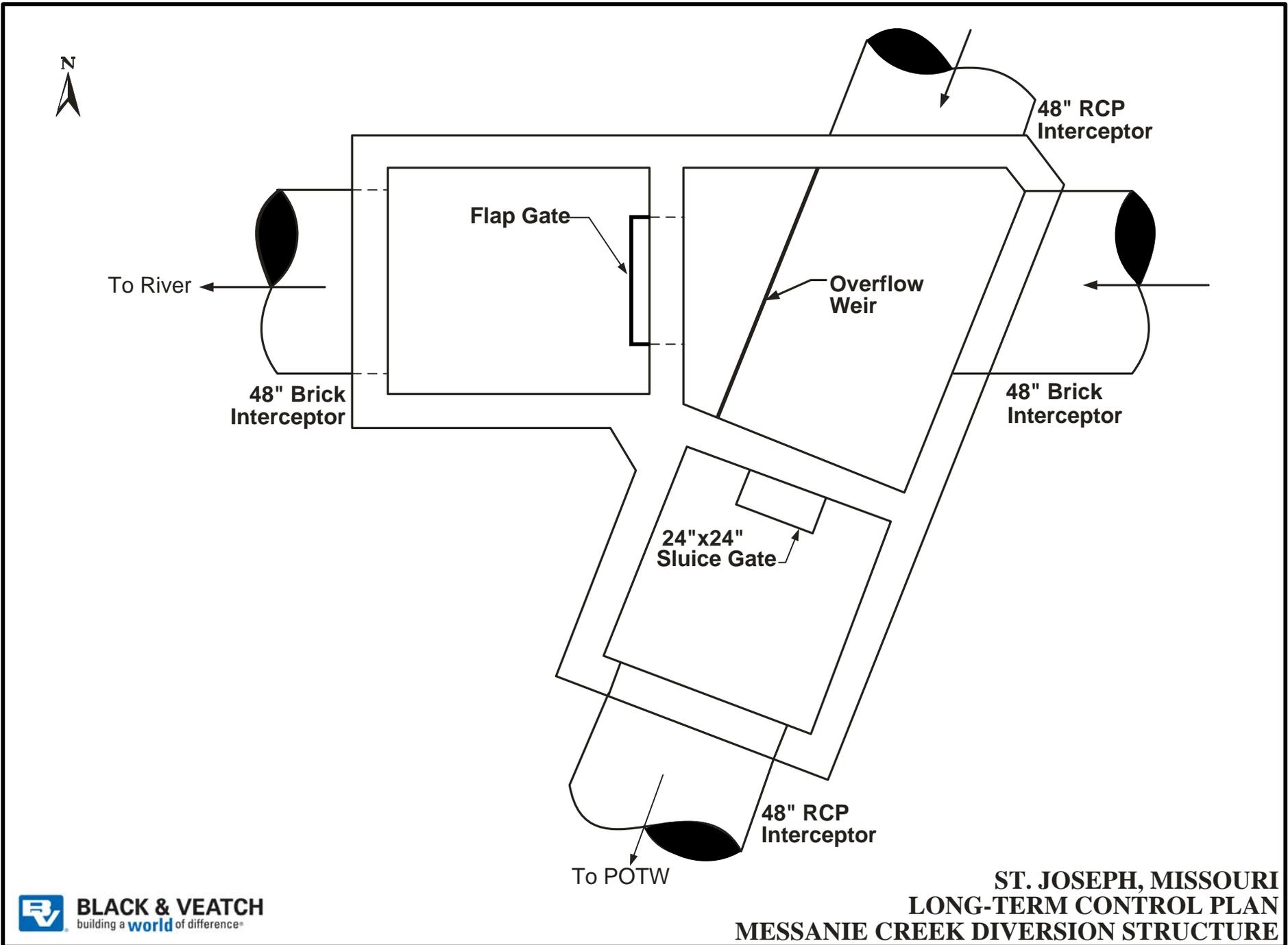
The Charles Street diversion structure receives flow from industry, offices, and multi-family dwellings. Combined sewage flows into the diversion box and exits through a 5 inch opening regulated by a manually-operated orifice plate into the 48 inch main interceptor. The orifice plate has been removed to increase flows to the interceptor. Excess flow is diverted to the river through a flap gate during storm events.

4.2.4 Messanie Street Diversion

The Messanie Street diversion structure receives flow from industry, offices, and multi-family dwellings. Combined sewage is discharged into a diversion box and passes through a 6 inch orifice regulated by a 24 inch manually-operated sluice gate into the 48 inch main interceptor. Excess flow is diverted through a flap gate into the river as shown on Figure 4.3.



**ST. JOSEPH, MISSOURI
LONG-TERM CONTROL PLAN
BLACKSNAKE CREEK DIVERSION STRUCTURE**





4.2.5 Patee Street Diversion

The Patee Street diversion structure receives flow from industry, offices, and multi-family dwellings through the 42 inch Patee Street interceptor in a fashion similar to the Messanie Street structure shown on Figure 4.3. The flow is discharged into a diversion box and exits through a 24 inch manually-operated sluice gate into the 48 inch main interceptor. Excess flow is diverted through a 48 inch by 48 inch flap gate to the river.

4.2.6 Olive Street Diversion

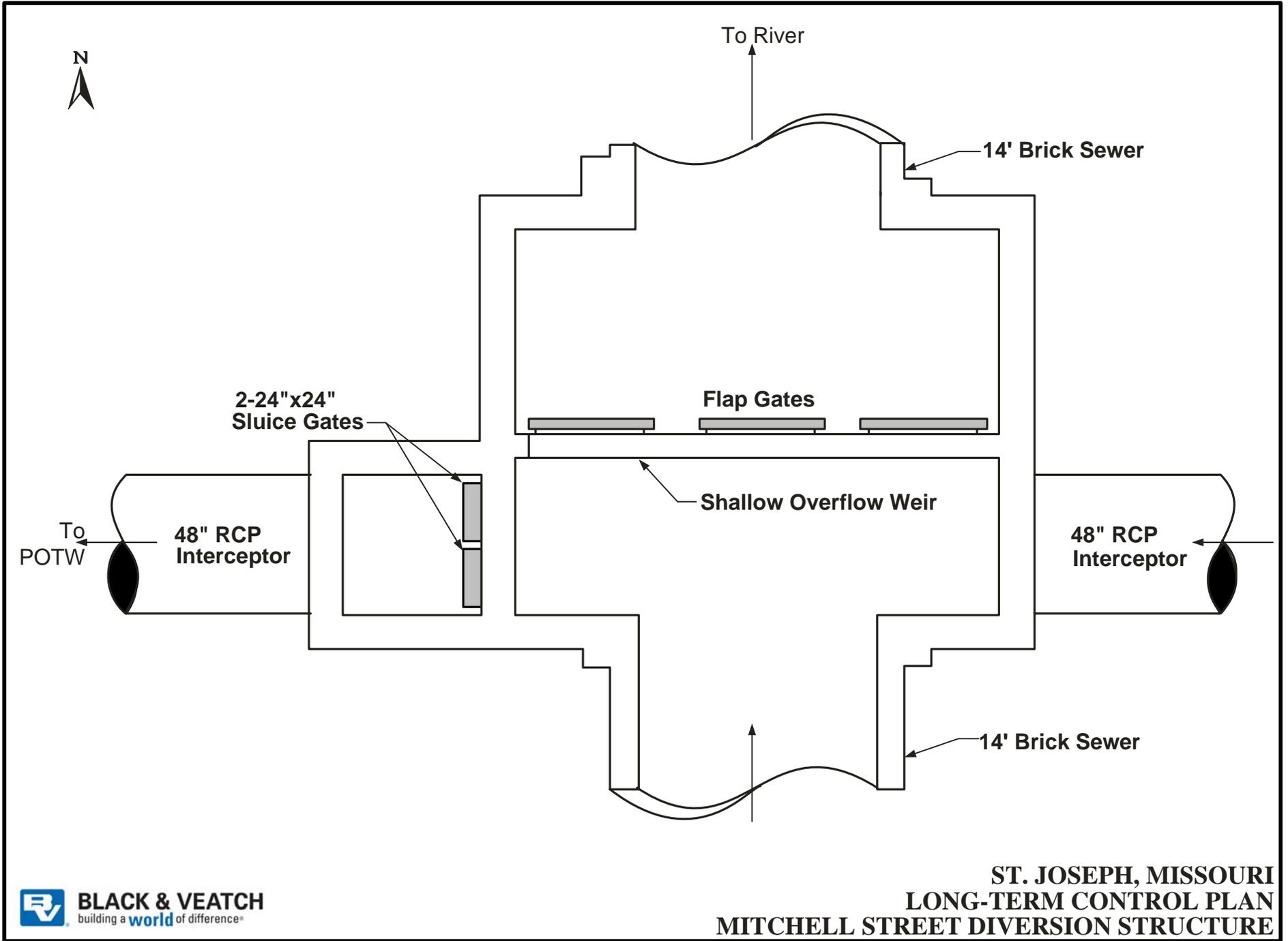
The Olive Street diversion structure receives flow from industry, offices, and multi-family dwellings through the 72 inch Olive Street interceptor. The flow passes through a 7-1/2 foot by 10 foot diversion box and a 24 inch manually-operated sluice gate into the 48 inch main interceptor. Excess flow is diverted through a 6 foot by 6 foot flap gate to the river. The configuration of this structure is similar to the Messanie Street structure shown on Figure 4.3.

4.2.7 Mitchell Street Diversion

The Mitchell Street diversion structure receives flow from industry, offices, and single- and multi-family dwellings through a 14 foot interceptor. Approximately 20 percent of the City's sanitary wastewater flow drains through this location. Combined sewage passes through a 7-1/2 foot by 33-3/4 foot diversion box, shown on Figure 4.4, and exits through two 24 inch by 24 inch manually-operated sluice gates into the 48 inch main interceptor. Excess flow is diverted over a shallow weir through three flap gates into a 14 foot culvert leading to the river. Two of these gates are 6 feet by 10 feet in size, and the third measures 10 feet by 10 feet.

4.2.8 Duncan Street Diversion

The Duncan Street diversion structure receives flow from industry, offices, and multi-family dwellings. The flow passes through a 5 foot by 6 foot diversion box and a 12 inch manually-operated sluice gate into the 48 inch main interceptor. Excess flow is





diverted through a 3 foot by 3 foot flap gate to the river. The configuration of this structure resembles that of the Messanie Street structure shown on Figure 4.3.

4.2.9 Maple Street Diversion

The Maple Street diversion structure receives flow from industry, offices, and multi-family dwellings through a 72 inch sewer. Combined sewage passes through a 6 foot by 10 foot diversion box and an 18 inch manually-operated sluice gate into the 54 inch main interceptor. Excess flow is diverted through a 6 foot by 6 foot flap gate to the river similar to the Messanie Street structure shown on Figure 4.3.

4.2.10 Hickory Street Diversion

The Hickory Street diversion structure receives flow from industry, offices, and multi-family dwellings through the 92 inch Hickory Street sewer. Combined sewage passes through a 6 foot by 10 foot diversion box and an 18 inch manually-operated sluice gate into the 54 inch main interceptor. Excess flow is diverted through a 6 foot by 6 foot flap gate to the river. The design of this structure is similar to that of the Messanie Street structure shown on Figure 4.3.

4.2.11 Walnut Street Diversion

The Walnut Street diversion structure receives flow from industry, offices, and multi-family dwellings through a 21 inch sewer. Combined sewage passes through a 5 foot by 6 foot diversion box and a 12 inch manually-operated sluice gate into a 12 inch cast iron pipe and is conveyed to a manhole connected to the 54 inch main interceptor. Excess flow is diverted through a 3 foot by 3 foot flap gate to the river. This diversion structure collapsed in 1990. In November 2006, the structure was further sealed by filling with concrete and closed.

4.2.12 Whitehead Creek Diversion

In addition to the base flow in Whitehead Creek, the Whitehead Pump Station diversion structure receives flow from industry, offices, and multi-family dwellings. This



diversion structure contributes between 25 to 30 percent of the City's CSOs. Combined sewage passes through a 20 foot by 20 foot channel and is diverted into a 36 inch pipe that increases to a 48 inch pipe and is conveyed to the Whitehead Pump Station. The flow is diverted with the use of a 20 foot wide by 3 foot high weir dam in the channel. When flows exceed the height of the weir dam, it overflows the dam and is diverted through an earthen channel and a box culvert to the river as shown on Figure 4.5.

4.2.13 Missouri Avenue Diversion

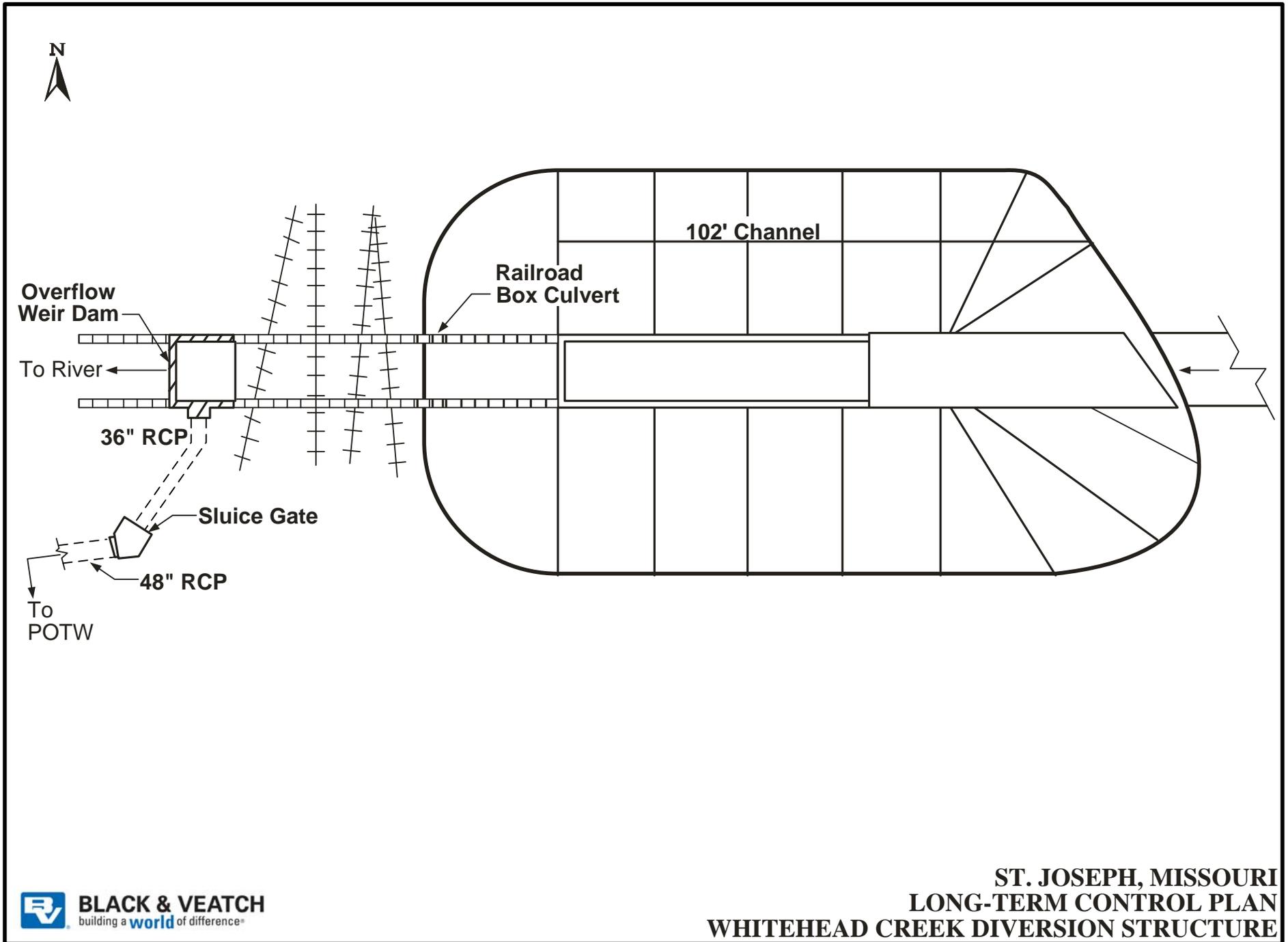
The Missouri Avenue diversion structure receives flow from industry, offices, and single- and multi-family dwellings. The majority of the flow to this location is residential/commercial. Combined sewage passes through a 6 inch orifice regulated by an 18 inch manually-operated sluice gate into a 30 inch interceptor leading to the treatment plant. Excess flow is diverted through a 10 foot by 10 foot flap gate through a 96 inch pipe to the river. The Missouri Avenue CSO facilities are similar to Messanie Street shown on Figure 4.3.

4.2.14 Brown's Branch Diversion

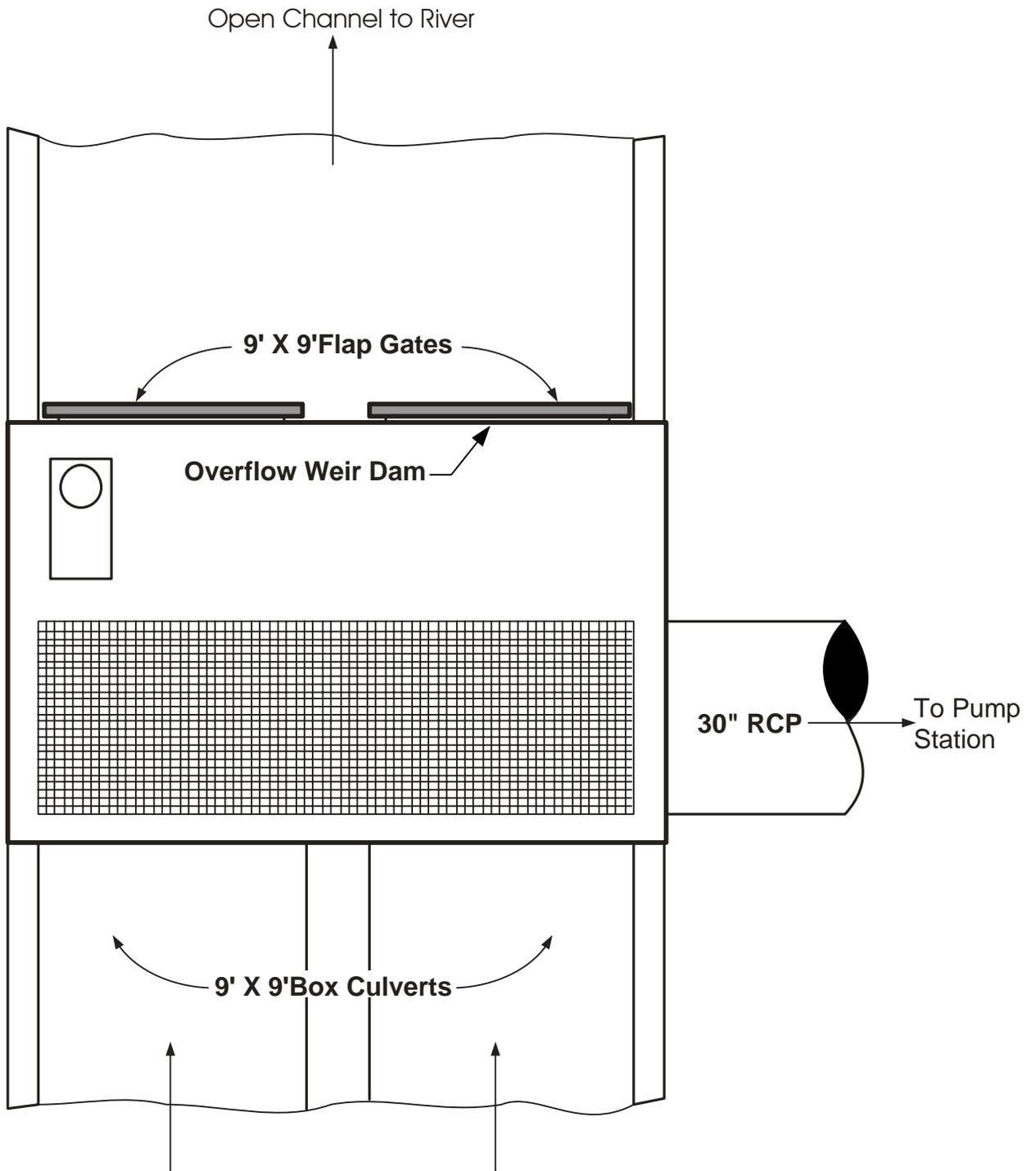
The Brown's Branch Pump Station diversion structure receives flow primarily from residential and rural sources, with some flow from industry and offices. CSOs from this location constitute almost 15 percent of the City's stormwater discharge to the river. Combined sewage is discharged through two 9 foot by 9 foot box culverts to the diversion structure and is diverted through a 30 inch pipe to the Brown's Branch Pump Station. The flow is diverted with the use of a 20 foot wide by 3 foot high overflow weir dam to the pump wetwell. When flows exceed the height of the weir dam, it overflows the dam and is diverted through an earthen bermed channel to the river. Diversion facilities at the Brown's Branch Pump Station are shown on Figure 4.6.

4.2.15 Roy's Branch Diversion

The Roy's Branch Pump Station receives flow primarily from residential and rural sources. CSOs from this location constitute almost 15 percent of the City's combined



**ST. JOSEPH, MISSOURI
LONG-TERM CONTROL PLAN
WHITEHEAD CREEK DIVERSION STRUCTURE**





sewage discharge to the river. Combined sewage is discharged through a reinforced concrete pipe to Roy's Branch Creek.

4.3 Wastewater Collection System

The majority of the sanitary sewage generated within St. Joseph is transported through a series of combined sewers that extend across the City from east to west and have outfalls that discharge directly to the Missouri River or to watercourses that are tributary to the Missouri River. Dry weather flow and a portion of the wet weather flow is diverted into a north-south interceptor sewer along the Missouri River which flows to Whitehead Pump Station. The Whitehead Pump Station conveys the dry weather flow and a portion of the wet weather flow to the wastewater treatment plant. The interceptor sewer was designed in 1960 to deliver a diverted peak flow of 45 mgd to the Whitehead Pump Station. As a part of the 2002 Combined Sewer Overflow Long Term Control Plan, the construction records were reviewed to verify the as-constructed capacity of the interceptor. According to the records, the interceptor capacity varies to match the estimated flows being diverted into the interceptor. This review indicated that the interceptor has adequate size and grade to convey by gravity when flowing full 57 mgd to the Whitehead Pump Station.

Sanitary sewage from the south part of St. Joseph is pumped from the Brown's Branch Pump Station to the Missouri Avenue watershed and is conveyed by gravity to the south end of the wastewater treatment plant and to the in-plant influent pump station.

4.4 Wastewater Treatment Plant

The flow to the wastewater treatment plant consists of the discharge from the Whitehead Pump Station, the in-plant pump station, Triumph Foods, Prime Tanning, and the South St. Joseph Industrial Sewer District. Prime Tanning is located directly north of the wastewater treatment plant and has the capability to either discharge to an industrial clarifier or downstream from the trickling filters ahead of the aeration basins. Triumph Foods enters the treatment plant at the same location as Prime Tanning. Flow from the South St. Joseph Industrial Sewer District enters the plant and combines with primary

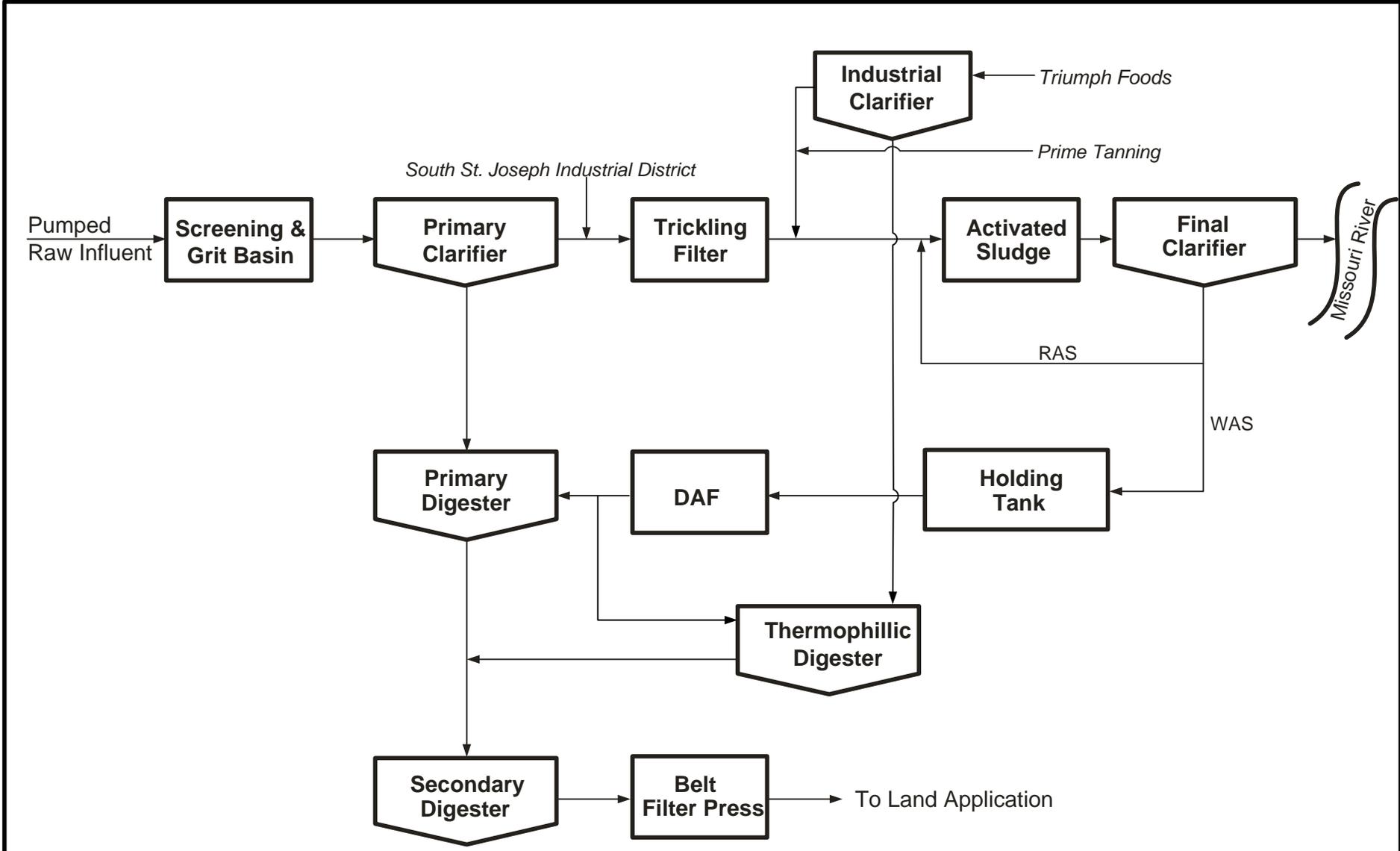


effluent upstream from the trickling filters as shown on Figure 4.7. The wastewater treatment plant process flow schematic is also shown on this figure.

Table 4.2 indicates the capacity of treatment plant process units based on the design guidelines developed by the Missouri Department of Natural Resources (MDNR) and published on February 28, 1999 as “Rules of Department of Natural Resources, Division 20 – Clean Water Commission, Chapter 8 - Design Guides, 10 CSR 20.” If the treatment facility fails to observe the limits established by these guidelines, it is at risk of noncompliance.

Treatment Unit	Design Criteria	Basis	Design Capacity
Grit Basins	Plant staff experience	Side water depth in channel	27 mgd
Primary Clarifiers	Surface overflow rate: 1,000 gpd/sq ft	Total surface area: 33,930 total sq ft	33.9 mgd
Trickling Filters	Wetting rate plus recycle: 1.5 gpm/sq ft	Total surface area: 24,270 sq ft	54.4 mgd
	BOD loading rate: 100 - 200 ppd/kcf	Total volume: 504.9 kcf	50,500 - 101,000 ppd BOD
Aeration Basins	BOD loading rate: 40 ppd/kcf	Total volume: 493.878 kcf	19,800 ppd BOD
	MLSS: 3,000 mg/L in aeration basin	--	--
Final Clarifiers	Surface overflow rate: 600 gpd/sq ft	Total surface area: 60,300 sq ft	36.2 mgd
	Solids loading rate: 50 ppd/sq ft (peak flow)	Total surface area: 60,300 sq ft	3,000,000 ppd
Anaerobic Digesters (Mesophilic)	Volatile solids loading rate: 80 ppd/kcf	Total volume: 518.063 kcf	41,400 ppd VSS
	Volatile solids destruction: 38 percent	--	--

Evaluation of the plant capacity was based on the plant’s current configuration and operating mode. The plant was designed with flexibility to operate in a less conventional mode when treating high-strength wastes in the portion of the plant downstream from the primary clarifiers. Although there is no practical reason for making a change at this time,



Note:

Raw influent is pumped from Whitehead pump station and in-plant pump station

**ST. JOSEPH, MISSOURI
LONG-TERM CONTROL PLAN
WASTEWATER TREATMENT PLANT
PROCESS FLOW SCHEMATIC**





Table 12.22 of “Design of Municipal Wastewater Treatment Plants, WEF Manual of Practice 8, Fourth Edition” indicates that this plant could treat much higher loads.



5.0 Description of Nine Minimum Operational Controls

5.1 Existing Operational Controls

The purpose of this chapter is to survey and document the existing operating practices (nine minimum controls or NMCs) used by the City of St. Joseph to reduce the strength and volume of combined sewer overflow (CSO) discharges to the receiving stream. The City implemented these practices in 1996, and the Missouri Department of Natural Resources (MDNR) includes them in the City's National Pollutant Discharge Elimination System (NPDES) permit. The NPDES permit requires the implementation of all the controls described in this chapter. Each year, the City must submit a report to MDNR describing the controls which were completed during the previous year. The City's 2006 implementation report is included in Appendix B.

5.2 Operation and Maintenance of Collection System and Treatment Plant

The City has established procedures for the operation and maintenance of its publicly owned treatment works (POTW), the collection system, and the CSO diversion structures. All CSO structures are inspected for damage weekly and after every significant storm event. Inspection reports are submitted to the Public Works Department for any needed follow-up. If cleaning or repairs are needed, they can often be completed by City staff. The City also performed major maintenance on many diversion structures and pumping stations in the past year.

Major capital construction projects were executed during the reporting period to increase flow to the POTW and improve handling of storm flows. The construction of a thermophilic digester was undertaken to increase the solids processing capabilities and thus influent capacity of the POTW. The construction of an industrial clarifier was also completed to equalize storm event flow.

The following additional maintenance activities were completed in 2006:

- Repaired 70 cave-ins
- Cleaned 4,699 inlets



- Repaired and/or replaced 189 storm sewer inlets
- Televised 85,690 lineal feet of sewer line
- Swept 5,952 miles of streets

POTW maintenance staff keeps the wastewater treatment plant, pump stations, and the CSO structures in proper working condition. Treatment plant operations are reviewed annually by MDNR.

5.3 Maximizing Collection System Storage

The storage capacity of the sewer system is maximized through regular cleaning of the interceptor sewer and diversion structures. The City utilizes vacuum and flushing trucks to clean the interior of the collection system on a routine maintenance schedule, as well as in response to performance issues observed by the staff. During 2006, City staff cleaned and root sawed over 163,400 lineal feet of sewer line.

Prior to submittal of the 2002 Long Term Control Plan, the overflow weirs at the Brown's Branch and Blacksnake CSO outfalls were raised approximately 18 inches to retain additional storm flows in the sewer. The City periodically evaluates the storage potential in other large diameter sewers directly upstream from the CSO outfalls. As part of the CSO control alternatives presented in Chapter 11.0, fixed weirs and sluice gates will be added to several of the diversion structures to increase storage within the collection system.

In addition, a U.S. Army Corps of Engineers (USACE) Section 205 flood control project to construct a detention basin upstream of the Blacksnake Creek combined sewer system is progressing. This project has the potential to reduce the frequency and volume of CSO discharges and is discussed in further detail later in this report. A feasibility phase study conducted by the Corps was completed in 2007.

5.4 Review of Pretreatment Program

The City of St. Joseph administers its own pretreatment program. Federal industrial pretreatment requirements and local individual discharge ordinances provide the



frame work for controlling the discharge of pollutants to the wastewater collection system. Each significant industrial user is sampled twice per year and inspected once per year as required by the Federal Pretreatment Regulations (40 CFR 403). Enforcement actions are taken by the City as needed to ensure permitted industrial users comply with the discharge requirements. Three additional staff members were hired in 2006 for administration and monitoring support of the pretreatment program. The efforts of staff regarding pretreatment issues have enabled the effluent from the treatment plant to meet NPDES requirements. In addition, the City received positive feedback on their program from the MDNR Pretreatment Coordinator following their Pretreatment Compliance Inspection in 2006.

5.5 Maximization of Flow to the POTW for Treatment

The POTW has increased the amount of flow it will accept during storm events to 27 mgd, the maximum amount hydraulically possible through the headworks facilities. In addition, replacement of aging equipment at pump stations aids in the maximization of flow to the POTW. Increasing the flow pumped to the treatment plant has shortened the duration of the overflow event and has allowed small events that would in the past have caused a CSO to be routed through the POTW. As part of the CSO alternatives presented later in this report, the capacity of the headworks will be increased to 34 mgd to match the capacity of the existing primary clarifiers.

In addition, the phased separation of sanitary sewer mains from stormwater runoff within the Roy's Branch watershed is currently underway. By reducing the volume of combined flow, this project will clearly reduce CSOs while maximizing the use of the POTW for treatment of sanitary flows.

5.6 Elimination of CSOs during Dry Weather

The St. Joseph sewer system does not experience routine dry weather overflows (DWOs) caused by inadequate sewers or system capacity. The DWOs that do occur are caused by mechanical malfunctions, power loss, or plugged collection system lines. All pump stations within the collection system are equipped with an alarm system in the event



of a mechanical malfunction or power loss. The City has an on-call system which assures a prompt response to the malfunction or power loss, thereby addressing the issue immediately and greatly reducing the chance of overflow. When a CSO or DWO occurs, a report listing the date, time, location, and amount of flow bypassed is completed and sent to the MDNR Regional Office.

5.7 Control of Solid and Floatable Materials in CSOs

Control of solids and floatables at or near the CSO outfalls is not practical for the City of St. Joseph. The large volume and high velocities, combined with the large size of some of the debris such as tree limbs, make it difficult, if not impossible, to capture floatables and solids before they enter the Missouri River. The use of booms or nets is not practical because of frequent changes in river levels and velocities as well as navigational considerations.

The City attempts to control solid and floatable materials before they enter the sewer system. The City has a street sweeping program that utilizes two sweepers, forty hours per week in all non-freezing weather. In addition, a third sweeper is maintained as a standby for any downtime of the two main sweepers. The street sweeping program reduces the amount of debris that can enter the combined sewer system as suspended solids. City staff indicate that the additional street sweeping appears to have reduced the quantity of solid and floatable material in CSO discharges based on visual observations. In addition, the City has been working with the public to assist in stream cleanup activities, further reducing the quantity of solid and floatable material in the CSOs.

5.8 Pollution Prevention Programs to Reduce Contaminants in CSOs

The City of St. Joseph utilizes several means to prevent floatables, solids, and pollutants from entering the sewer system. While these measures are mainly intended to keep out floatables and solids, they will also keep out other pollutants. All of the following measures are implemented through the Public Works and Transportation Department.



Street Sweeping – As discussed previously in this chapter, street sweeping is a regular program of the City’s Street Maintenance Division.

Upstream Channel Cleaning – Storm channels are regularly cleaned at the entrance to the Blacksnake, Whitehead, and Brown’s Branch systems.

Inlet Cleaning – The City has instituted an annual inlet cleaning program to inspect and clean all storm sewer inlets each year. In 2006, 4,699 inlets were cleaned as a result of this program. The addition of another vactor truck and additional sewer staff maintenance personnel will allow the cleaning rate of storm water inlets to increase even further in future years.

Blacksnake Retention Basin – The proposed USACE flood control project discussed previously in this chapter will provide a longer capture of the first flush due to additional retention volume. This results in the opportunity to settle solids ahead of the sewer system and to reduce the volume and velocity of CSO discharges thus reducing solids scouring.

5.9 Public Notification

All of the CSO outfalls in St. Joseph are located along the Missouri River. Access to the outfalls is generally restricted, and several of them are submerged during most of the year. Public use of the shoreline is usually confined to a limited number of fishermen on private property. All CSO outfalls and samplers have notification signs posted.

The City has implemented a number of public notification programs. The Community Appearance Plan, first implemented in 2002, utilizes zoning and code enforcement inspectors to keep private properties and right-of-ways clear of debris, thereby reducing the introduction of debris to the collection system. City Talk, a monthly forum, allows citizens to meet with the Mayor and City Council in a town meeting setting to discuss City programs and policies, including topics related to wastewater treatment and the collection system.



5.10 Monitoring to Characterize CSO Impacts and Efficacy of CSO Controls

In 1996, the City and Black & Veatch completed a CSO characterization report containing information on CSO names, locations, and sizes. This report also related CSO discharge quality to background contaminant levels in the receiving stream. In 2006, monitoring stations were established at the Blacksnake, Messanie, Mitchell, Whitehead, and Brown's Branch diversion structures. Each station is equipped with a flowmeter and sampler. The samplers alarm during a bypass event, notifying an on-call POTW staff member to pick-up the sample as well as make a visual inspection of the alarming site. In 2007, flow measurement stations were added at five locations: Francis, Charles, Olive, Patee, and Missouri Avenue.



6.0 Public Participation

6.1 Introduction

Establishing early communication with the public is an important first step in long term planning and is crucial to the success of a combined sewer overflow (CSO) control program. By informing the public early in the planning process about the scope and goals of the program and encouraging public involvement during the development, evaluation, and selection of the control strategy, potential conflicts can be identified and addressed more expeditiously, minimizing the likelihood of prolonged delay or additional expenses. In addition, multiple community benefits for certain projects can be identified and discussed early in the planning process. It is important to gain public support for increases in user charges that will be necessary to finance the CSO control program.

Citizen Advisory Committees (CACs) can serve as liaisons among municipal officials, National Pollutant Discharge Elimination System (NPDES) permitting agencies, and the general public. Public meetings and public hearings can serve as a forum for presenting technical information and obtaining input from interested individuals and organizations. Impacts on user fees and tax rates should also be communicated as early as possible in development of the Long Term Control Plan (LTCP). Particular attention should be given to informing residents and businesses of any construction associated with project implementation that would affect them.

This chapter presents the public participation elements used in developing the City's updated LTCP. It is anticipated that additional opportunities for public involvement will be available and utilized during the facility planning stages of the proposed CSO improvement projects.

6.2 Existing Public Participation Programs

The City has used or proposed a number of public participation efforts relating to the control of pollutants being discharged to the river. These efforts include:

- Clean Sweep
- Clean St. Joseph



- Community Appearance Plan

6.2.1 Clean Sweep

In 1990 the City established a program to minimize debris and material that was dumped into the wastewater collection system. This program, called “Clean Sweep”, allowed residents of the City to dispose of material free of charge at the landfill two Saturdays per year. In addition, the City staff would set up dumpsters at 13 locations around the City to make it easier for the disposal of unwanted material. The goal of the program was to stop illegal dumping of debris in the City. Observations from City staff over the years indicated that much of the illegally dumped material would end up in the wastewater collection system. This program has been very successful over the years.

6.2.2 Clean St. Joseph

The “Clean St. Joseph” program was a marketing campaign started in 1996 in conjunction with prison crew labor to clean public right-of-ways (ROW) and county-owned vacant lots. This program targeted schools, neighborhoods, groups, associations, and businesses. The program provided information handouts, public speaking, and coordination for help to interested parties. This program appeared to have a positive impact by reducing the amount of debris discharged to the collection system.

6.2.3 Community Appearance Plan

The City prepared a Community Appearance Plan that combines all of the City’s appearance and related compliance activities into one comprehensive program. As part of this plan, the City is implementing a recycling program for telephone books and tires, a City trash program, and Clean Sweep. The City trash program allows the citizens of St. Joseph to visit with the mayor in a town hall meeting. The Clean Sweep program has been modified to allow two free days each year for the disposal of material. The landfill is open 7 days per quarter, at no charge, to provide opportunity to dispose of material. Two tires (off rim) are allowed per day, and yard waste must be separated from trash.



6.3 Public Participation for CSO LTCP

The public participation program for the CSO LTCP combined elements from existing programs and new LTCP specific efforts. Recent LTCP efforts to engage the community involved three specific public participation elements: 1) CSO awareness, 2) public education, and 3) public involvement. A summary of recent activities associated with these three elements is provided in the following paragraphs.

6.3.1 CSO Awareness

The public is made aware of existing CSO problems through warning signs that were installed at each CSO outfall along the Missouri River. The signs advise the public about the existence of combined sewer overflows at each outfall and that swimming and fishing are not allowed. The City's telephone number is also posted so people can call to receive more information on the CSOs.

6.3.2 Public Education

Public education efforts about the St. Joseph CSO program have been ongoing during the LTCP study process and involved the following activities:

- Media Coverage. The City public access channel was used to broadcast information about the CSO program and about three public meetings conducted to present the CSO study efforts. In addition, several newspaper articles were published about the CSO program and are included in Appendix C.
- CSO Project Website. The City of St. Joseph has maintained a CSO project specific website for the past two years to publicize CSO program efforts, LTCP preparation, post public meeting presentations, and post photographs of the CSO outfalls. In addition "frequently asked questions" are summarized and other maps and documents are posted for viewing by the public. The website can be accessed at the following URL: http://www.ci.st-joseph.mo.us/publicworks/wpc_cso.cfm.



- Newsletters. The CSO program was publicized in the City newsletter “City Weekly” to provide news and information to City staff and the public.
- City Talk. City Talks provide an opportunity for the public to meet with City Council Members and discuss various City issues. The CSO program has been discussed during the past year at these meetings. Ten City Talks are held annually in various locations throughout the City.

6.3.3 Public Involvement

A priority was made to engage public involvement during the CSO LTCP study. Three public meetings were advertised and held at City Hall in the Council Chambers to inform the public about the combined sewer system and extent of the CSO problem, potential solutions and alternatives, proposed technologies and facilities, proposed level of control, and cost implications to rate payers. Public meetings were conducted on the following dates, and presentation handouts are included in Appendix C.

- Public Meeting No. 1 – November 13, 2007
- Public Meeting No. 2 – January 9, 2008
- Public Meeting No. 3 – February 6, 2008

In addition, City staff conducted other meetings with the City Council and other interest groups during development of the LTCP.

6.3.4 Results of Public Involvement

The primary feedback and results of the public meetings are that citizens are concerned about how the City will pay for the CSO program and the impact on individual sewer rates, how the proposed facilities may affect the community, and the desire of achieving multiple community benefits for stormwater detention basin projects. The overriding comment from the meetings is that the CSO program will put an incredible financial burden on the City and the only hope of keeping the City financially solvent is to provide an extended implementation schedule as presented in the LTCP.



7.0 Sensitive Areas

7.1 Introduction

In accordance with the Combined Sewer Overflow (CSO) Control Policy, the Long Term Control Plan (LTCP) should give the highest priority to the prohibition of new or significantly increased overflows to designated sensitive areas. If sensitive areas are present, the LTCP should include provisions to eliminate or relocate overflows where possible, treat overflows where necessary, and reassess impacts each permit cycle where elimination or treatment is not achievable. The Control Policy also states that sensitive areas are to be determined by the National Pollutant Discharge Elimination System (NPDES) permitting authority in coordination with State and Federal agencies. For St. Joseph, the NPDES permitting authority is the Missouri Department of Natural Resources (MDNR). This chapter summarizes the determination and evaluation of sensitive areas as defined by the Control Policy within the CSO receiving waters for St. Joseph, Missouri.

7.2 Outstanding National Resource Waters

Waters defined as an outstanding national resource have been designated by the state as high quality waters such as waters of national and state parks, wildlife refuges, and waters of exceptional recreational or ecological significance where water quality shall be maintained and protected. MDNR has not designated any outstanding national resource waters in the Missouri River.

7.3 National Marine Sanctuaries

The National Oceanic and Atmospheric Administration (NOAA) is the trustee for the nation's system of marine protected areas with the responsibility to conserve, protect, and enhance their biodiversity, ecological integrity, and cultural legacy. There are no national marine sanctuaries within the receiving waters for St. Joseph CSOs.



7.4 Waters with Primary Contact Recreation

All classified water bodies in Missouri are designated for whole body contact recreation unless otherwise designated through a Use Attainability Analysis (UAA). The designated use is the use specified for the water body in the water quality standards whether or not it is being attained. Although the Missouri River is designated for primary contact recreation, there are no known public or private swimming areas within the area of the St. Joseph CSOs. Fishing and boating were the primary activities observed during a survey conducted along the Missouri River in 2002. The absence of public swimming areas and the physical risks during and following wet weather events due to debris and current velocity in the river does not support the consideration of the St. Joseph CSO receiving water as a whole body contact recreation area.

7.5 Public Drinking Water Intakes

There are no public drinking water intakes within the area of the St. Joseph CSOs. Drinking water for the City of St. Joseph is provided by the Missouri American Water Company with intake wells along the Missouri River several miles north of town and upstream of all CSO locations.

7.6 Shellfish Beds

There are no known commercial shellfish beds nor is shellfish harvesting for consumption by private individuals known to occur within St. Joseph's CSO receiving waters.

7.7 Waters with Threatened or Endangered Species

Documentation on the occurrence of threatened or endangered species and their habitats within the vicinity of the St. Joseph CSOs was obtained from the U.S. Fish and Wildlife Service (USFWS) and the Missouri Department of Conservation (MDC). Correspondence with the USFWS and MDC is included in Appendix D. The following sections summarize information on threatened or endangered fish, birds, and mammals that are known or have the potential to occur within the study area.



7.7.1 Fish

Prior to 1900 the Missouri River was characterized by high turbidity, wide seasonal fluctuations in flow, and a wide meandering channel that was constantly changing. The river supported a relatively limited fauna comprised of species adapted for life in this environment. The most distinctive species were pallid sturgeon (*Scaphirhynchus albus*), sicklefin chub (*Macrhybopsis meeki*), sturgeon chub (*Macrhybopsis gelida*), flathead chub (*Platygobio gracilis*), western silvery minnow (*Hybognathus argyritis*), and plains minnow (*Hybognathus placitus*). Construction of an extensive system of dikes, revetments, levees, and upstream reservoirs since 1900 has reduced turbidity and sediment load and has modified the natural-flow regimen (Pflieger and Grace 1987).

Surveys since 1940 have shown an increase in the number of species and substantial changes in relative abundance. The native species adapted for life in the presettlement Missouri River have declined markedly in abundance. Species that have established themselves in the river or became more abundant are mostly pelagic planktivores and sight-feeding carnivores such as gizzard shad, white bass, bluegill, white crappie, emerald shiner, river shiner, and red shiner. These changes are related to decreased turbidity and changes in flow regimens following construction of the upstream reservoirs (Pflieger and Grace 1987).

The USFWS has identified the pallid sturgeon (*Scaphirhynchus albus*) as federally endangered in the Missouri River. The pallid sturgeon has also been identified by the MDC as a State of Missouri endangered species. Six other declining fish species in the Missouri River identified as a concern by the MDC are the blue sucker (*Cycleptus elongatus*), silver chub (*Macrhybopsis storeriana*), sicklefin chub (*Macrhybopsis meeki*), sturgeon chub (*Macrhybopsis gelida*), flathead chub (*Platygobio gracilis*), and plains minnow (*Hybognathus placitus*). These fish are big river, main channel/sandbar inhabitants.

The following sections briefly summarize the habitat requirements of the federal and state endangered, threatened, and ranked fish species identified by the USFWS and MDC as possibly occurring in the study area.



7.7.1.1 Pallid Sturgeon

The pallid sturgeon, both a federal and State of Missouri endangered species (State Rank S1 – critically imperiled), is found primarily in the Missouri River and the Mississippi River downstream of the confluence with the Missouri River. These fish inhabit bottom areas of open channels with strong currents and firm sandy substrate. They have also been found along sandbars and behind wing dikes. Pallid sturgeons feed on the bottom of the river and typically consume aquatic insects, crustaceans, mollusks, marine worms, fish, and the eggs of other fish. It prefers large, muddy rivers where it lives in strong current over a firm sand or gravel bottom. It is believed that spawning activities occur April through mid-June when water temperatures reach a range between 55 to 70°F.

Pallid sturgeons are threatened primarily by habitat modifications from dam construction, channelization, and navigation maintenance of major rivers. These changes destroy spawning areas, reduce food supply or access to food, and block the sturgeon's ability to move within the river. Dams slow flow rates and produce cooler water temperatures, making rivers less desirable for pallid sturgeon. Water pollution from rural and urban development along rivers may also be a problem for pallid sturgeons.

7.7.1.2 Blue Sucker

The blue sucker, State Rank S3 – rare and uncommon, typically inhabits large streams and rivers with deep, swift channels and sand, gravel, or rock bottoms. The blue sucker tolerates high turbidity if the current prevents silt deposition. Adults probably winter in deep pools and move upstream in spring to spawn on riffles (Cross 1967). Decline of this species is due to construction of lock and dam structures, impoundments, and channelization that reduced the occurrence of rapids and other shallow fast-water habitats (Vokoun Guerrant, and Rabini 2003).

7.7.1.3 Silver Chub

The silver chub, State Rank S3, occurs in the Missouri, Mississippi, Chariton, and Grand Rivers preferring reservoirs, pools, and backwaters with sand or gravel bottoms.



They are also known to inhabit riffles if the water is very silty (Davis and Miller 1967). The species is believed to spawn in April or May (Cross 1967). Adverse management practices affecting the silver chub include dredging and filling of rivers and drainage of wetlands, marshes, ponds, and lakes.

7.7.1.4 Sicklefin Chub

The sicklefin chub, State Rank S3, occurs in the Missouri River and the Mississippi River downstream of the confluence of these two rivers. It inhabits the main channels of these large, turbid rivers preferring areas of strong current flowing over a substrate of sand or fine gravel. Sicklefin chubs are likely bottom feeders locating food by external taste buds. Spawning occurs in the spring, likely between late March and May. The sicklefin chub has declined because the number and area of sand and gravel shoals and bars have been eliminated by channel training activities. Habitat has been degraded by changes in natural flow regimen and reduced turbidity due to mainstream reservoirs. Other likely factors which have reduced the population include point and non-point source pollution.

7.7.1.5 Sturgeon Chub

The sturgeon chub, State Rank S3, inhabits the Missouri River from Montana to Missouri and the Mississippi River downstream from the confluence of these rivers. They prefer swift current in large, silty rivers that have sand and fine gravel bottoms. Sturgeon chubs eat bottom-dwelling invertebrates and spawn from late spring to mid-summer. The sturgeon chub has declined for the same reasons as the sicklefin chub.

7.7.1.6 Flathead Chub

The flathead chub, a State of Missouri endangered species (State Rank S1), occurs in the entire length of the Missouri River and the Mississippi River from the mouth of the Missouri southward to the Arkansas state line. They also occur in small tributaries of the Missouri River in northwestern Missouri. The large river habitats consist of continuously turbid waters with swift current and substrates composed of sand and fine gravel. They can also be found in pools of small creeks with clear water, little current, and substrates



composed of coarse gravel and bedrock. Main food items are terrestrial insects that fall into the water, as well as small aquatic insects. Spawning occurs in July and August. Decline of the species coincides with the construction of large reservoirs on the Missouri River. Other factors likely include non-point source pollution and degradation of riparian areas.

7.7.1.7 Plains Minnow

The plains minnow, State Rank S2 – imperiled, inhabits permanent streams and backwaters with sandy bottoms and noticeable current. The species occurs in the northwest quarter of Missouri, in the Missouri River, and in the Mississippi River below the mouth of the Missouri River. In the Missouri River, the plains minnow colonizes the margins of the main channel where the current eddies and organic debris accumulates (Hesse 1994).

7.7.2 Birds

The USFWS has identified the bald eagle (*Haliaeetus leucocephalus*) as a federally threatened species within the study area. The bald eagle was reclassified by the USFWS from endangered to threatened in 1995 (Federal Register, Volume 60, Number 133). The MDC has identified the bald eagle as a State of Missouri endangered species. In addition, the MDC identified the following state endangered birds within the study area: the peregrine falcon (*Falco peregrinus*), American bittern (*Botaurus lentiginosus*), and king rail (*Rallus elegans*).

The following sections briefly summarize the habitat requirements of the federal and state endangered, threatened, and ranked bird species identified by the USFWS and MDC as possibly occurring in the study area.

7.7.2.1 Bald Eagle

The bald eagle, a federal threatened and a State of Missouri endangered species (State Rank S3), is a common migrant and winter resident throughout Missouri and an uncommon breeder along some of the major rivers and larger reservoirs in the state. During winter, bald eagles congregate near rivers and reservoirs with open water and often near large concentrations of waterfowl. Wintering eagles usually occupy river habitats between November 15 and March 1 where they use large diameter (greater than 12 inches at breast



height) cottonwoods, sycamores, and other riparian trees as daytime perches and night roosts. They usually perch within a riparian corridor or along lake shores where there is limited human activity.

In addition to feeding on fish, bald eagles also feed on dead or crippled waterfowl, small mammals, and carrion. During winter nights, bald eagles may congregate at communal roosts, sometimes traveling as far as 12 miles from feeding areas to the roost sites. Nesting activity is initiated from January 1 to March 1 with the critical time for incubation and yearling of young from March 1 to May 15.

Declines in the population of the species took place throughout the United States from the 1950s into the early 1970s. Population declines are due to loss of riparian habitat and human disturbances such as shooting, poisoning, and trapping. Pesticide-induced reproductive failure also caused a decline as bald eagles fed on fish that were contaminated with the pesticide DDT. Accumulation of the pesticide within the bald eagle resulted in thin-shelled eggs that broke under the weight of the incubating parent. Eagle populations stabilized and slowly increased with the ban of DDT in 1972. Current concerns include habitat loss due to land use changes and activities that adversely alter roost sites.

7.7.2.2 Peregrine Falcon

The peregrine falcon, a State of Missouri endangered species (State Rank S1), inhabits open areas usually associated with high cliffs and bluffs over rivers and coasts. In Missouri, these falcons are observed most often during spring and fall migration, especially in areas with high concentrations of shorebirds and waterfowl. Currently, the only known nesting pairs are using buildings, bridges, or power plants near Kansas City and St. Louis. Peregrine falcons mostly prey on birds, but will also eat amphibians, insects, and mammals.

Declines of peregrine falcons began in the 1940s when environmental contaminants were introduced. Contaminants such as DDT built up in the birds that preyed on contaminated insects resulting in thin-shelled eggs. Once DDT was banned in 1972, peregrine falcon populations increased with the help of captive rearing and release programs. Current threats include human disturbance of nesting birds, alteration of nesting and wintering habitat, and continued use of environmental contaminants.



7.7.2.3 American Bittern

The American bittern, a State of Missouri endangered species (State Rank S1), is a secretive bird found in wetlands in most parts of North America. In Missouri, American bitterns nest in permanent wetlands with tall, emergent vegetation such as bur reed and bulrush. Breeding occurs between April and July with females making nests in thick vegetation several inches above water. American bitterns prey on large insects, small fish and mammals, amphibians, and crayfish.

The American bittern population has experienced a significant decline since the 1970s due to loss and degradation of wetland habitat. Conversion of wetlands for urban and rural development and draw downs in spring and summer to promote migratory waterfowl habitat are the primary causes for decline. Siltation, chemical contamination from farms and factories, and human disturbance have also degraded existing habitat. In addition, wetland isolation affects the American bittern's ability to move between areas of quality habitat.

7.7.2.4 King Rail

King rails, a State of Missouri endangered species (State Rank S1), are permanent residents of the Atlantic and Gulf coast plains from South Carolina to Texas. During the breeding season, some king rails migrate north to inland marshes in the Midwest, Great Lake, and mid-Atlantic states. King rails inhabit fresh and brackish wetlands with abundant grasses, sedges, rushes, and cattails where they prey upon beetles, fish, mollusks, and crustaceans. In Missouri, breeding begins in April with males building nests in cover over shallow water in river floodplains.

Populations of the king rail have declined extensively since the early 1960s especially in the inland portion of their range. In Missouri, king rails were historically common in marshes along large rivers, but are now found primarily in wildlife refuges at fewer than five locations each year. Conversion of wetland habitat for development, spring and summer draw downs of wetland areas, and water impoundments on rivers have contributed to the decline. In addition, point and non-point source pollution also has degraded the water quality of the rail's habitat.



7.7.3 Mammals

Although not related to specific recorded occurrences, the MDC has identified the Indiana bat (*Myotis sodalis*) as a concern within the study area. Indiana bats, a federally endangered and State of Missouri endangered species (State Rank S1), roost and raise young under the bark of trees in riparian forests and upland forests near perennial streams. They mate in early October when they swarm at the entrances of hibernation caves in southern Missouri. In the spring, females fly north of their hibernation caves in search of large diameter trees with loose bark where they can roost. In general, most females raise their young in the northern half of the state.

Indiana bats have declined significantly over the last 20 years, particularly in Missouri. Biologists have not yet determined why the bats are declining, but speculation ranges from pesticide contamination through their insect prey to changes in the internal temperature of their hibernation caves brought on by several decades of higher average yearly temperatures. Other reasons could include habitat loss and human disturbance while bats are hibernating.

7.7.4 CSO Impacts on Threatened or Endangered Species

Recovery of the threatened or endangered species identified by the USFWS and the MDC is not anticipated to be dependent upon the presence or control of combined sewer overflows within the study area. Bacteria, the primary pollutant of concern in CSOs, has no known impact on the species of concern. In addition, as combined sewer overflows usually occur during wet weather events when receiving waters experience higher in-stream flows, the potential influence of other possible pollutants of concern is minimized.

Implementation of the CSO improvements described in this Long Term Control Plan will reduce the pollutant loadings to the Missouri River resulting in improved habitat conditions for all species. As the CSO improvements proceed into construction, best management practices as recommended by the MDC should be observed to protect all threatened or endangered species.



7.8 Conclusions

Based on documentation collected for sensitive areas near St. Joseph and guidance provided in the CSO Control Policy, the vicinity of the St. Joseph CSOs is not considered a sensitive area. Therefore, CSO control improvements above and beyond those recommended in this LTCP are not required for the City of St. Joseph.

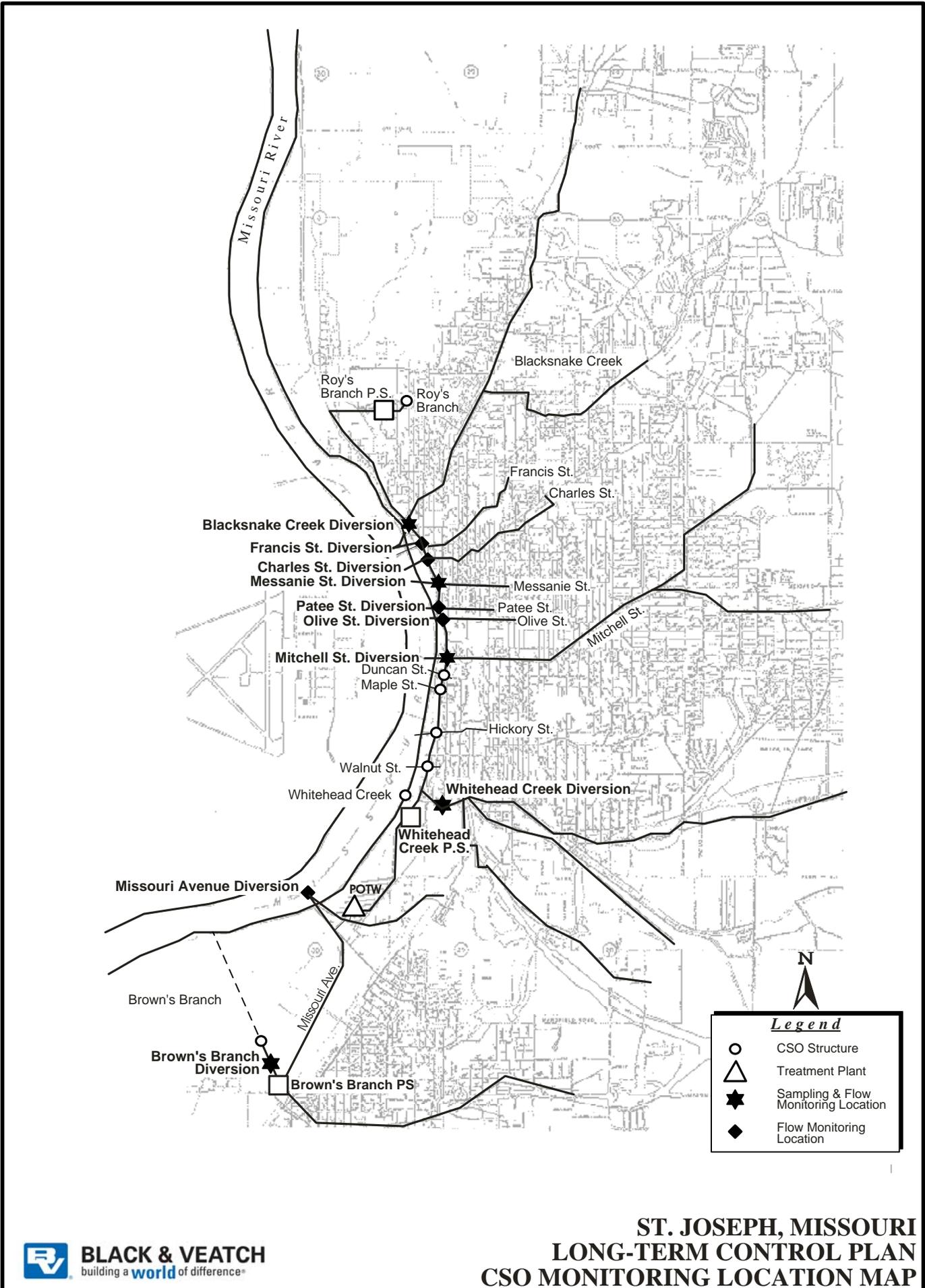


8.0 Flow and Water Quality Monitoring

8.1 General

Five of the fourteen combined sewer overflow (CSO) diversion locations were chosen for installation of sampling and flow monitoring equipment in development of this Long Term Control Plan (LTCP) (Table 8.1 and Figure 8.1), and five additional sites were selected for flow monitoring only. Criteria used to select the diversion sites were land use, drainage area, accessibility, potential for closure of location, and safety. The sampling/monitoring locations and equipment are described in Table 8.1.

Table 8.1 Flow Sampling/Monitoring Locations and Equipment		
Location Code	Location	Equipment
SJ-1	Blacksnake Creek Diversion	ISCO Avalanche refrigerated sampler with area-velocity sensor, wireless data retrieval module, and stainless steel shelter
SJ-2	Messanie Street Diversion	ISCO Avalanche refrigerated sampler with area-velocity sensor, wireless data retrieval module, and stainless steel shelter
SJ-3	Mitchell Street Diversion	ISCO Avalanche refrigerated sampler with area-velocity sensor, wireless data retrieval module, and stainless steel shelter
SJ-4	Whitehead Creek Diversion	ISCO Avalanche refrigerated sampler with ultrasonic sensor, wireless data retrieval module, and stainless steel shelter
SJ-5	Brown's Branch Diversion	ISCO Avalanche refrigerated sampler with ultrasonic sensor, wireless data retrieval module, and stainless steel shelter
SJ-6	Francis Street Diversion	ISCO area-velocity sensor and stainless steel shelter
SJ-7	Charles Street Diversion	ISCO area-velocity sensor and stainless steel shelter
SJ-8	Olive Street Diversion	ISCO area-velocity sensor and stainless steel shelter
SJ-9	Patee Street Diversion	ISCO area-velocity sensor and stainless steel shelter
SJ-10	Missouri Avenue Diversion	ISCO area-velocity sensor and stainless steel shelter





8.2 Flow Sampling and Monitoring Equipment

8.2.1 Sampling Equipment

ISCO Avalanche refrigerated samplers were installed at the five monitoring locations equipped with sampling equipment to collect composite samples of the overflows. Each sampler consisted of a peristaltic pump, four containers, a controller, and a power supply. Each sampler was housed in a corrosion-proof stainless steel shelter suitable for outdoor use.

Additionally, each monitoring location was equipped with an ISCO cellular modem to allow remote data retrieval. The modem also allows the sampler to transmit text message alarms to a text-enabled telephone or pager.

Figures 8.2 and 8.3 provide representative photographs of the sampling equipment installation at the Blacksnake Creek diversion structure. Photographs of installations at the other diversion structures are included in Appendix E.



Figure 8.2 Installation of Blacksnake Creek Sampling Equipment



Figure 8.3 Monitoring Equipment at Blacksnake Creek Diversion

8.2.2 Flow Monitoring Equipment

Area-velocity flow sensors (ISCO 700 Series) were installed at eight of the stations to measure liquid depth and average velocity in the flow stream. The flow modules were connected into the ISCO Avalanche samplers for flow measurement and data collection at three of the sampling locations. At the remaining five locations, the flow sensors were connected to flow recording equipment. Ultrasonic sensors were used at two of the sampling locations to measure liquid depth over a weir to convert the information to depth. The flow modules at these locations were connected into the ISCO Avalanche samplers.

Figure 8.4 provides a representative photograph of the flowmetering equipment installation at the Francis Street diversion structure. Photographs of installations at the other diversion structures are included in Appendix E.



Figure 8.4 Flowmetering Equipment at Francis Street

8.2.3 Rainfall Gauges

Three tipping bucket gauges were installed to collect rainfall data for this LTCP and were located at the wastewater treatment plant, Faraon Street Pump Station, and a location near the Frontier Casino in the north part of the City. The data from these gauges were added to data from two other tipping bucket rain gauges located at the Bishop and Easton Road Pump Stations.

Additionally, rainfall data was obtained from the Rosecrans Memorial Airport in St. Joseph. The rainfall data obtained from all sources was extrapolated across the service areas.

8.2.4 Equipment Installation

The refrigerated automatic samplers, flow monitors, and accessories were installed according to manufacturer's recommendations by plant staff under the supervision of Black & Veatch. The automatic samplers, flow monitors, power sources, and accessories were secured in stainless steel housings for protection against the elements and vandalism. The equipment housings were located above grade near the diversion structures.



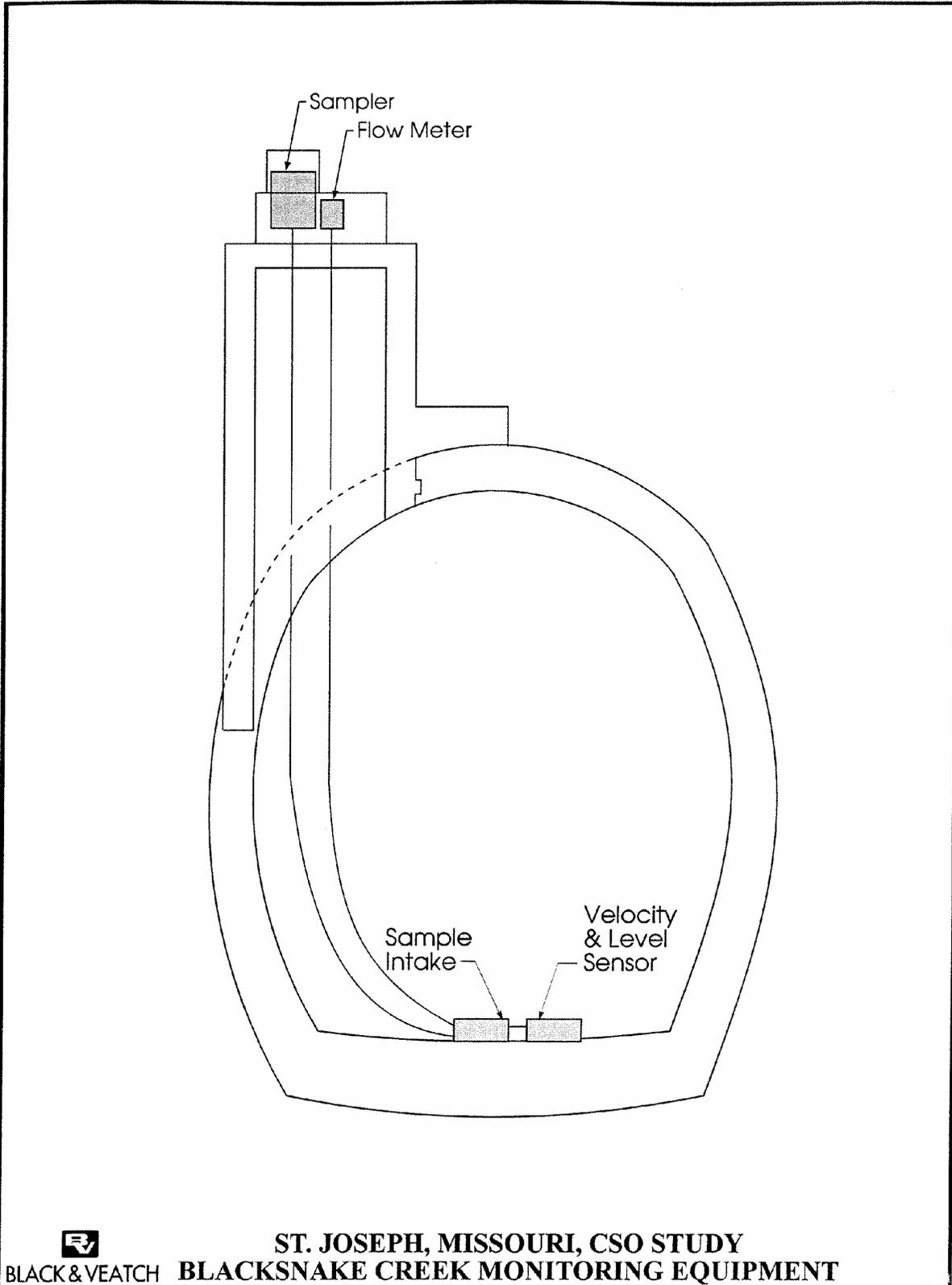
8.2.5 Equipment Maintenance

Routine maintenance of the samplers and flowmeters is conducted by City staff to keep the equipment in proper operating condition. A maintenance log is kept to ensure that all the equipment manufacturer's recommendations are followed.

8.3 Station Descriptions

8.3.1 Monitoring Station SJ-1 – Blacksnake Creek Diversion

The Blacksnake Creek Diversion structure is located at the intersection of Jules Street and McArthur Drive. This location was chosen because results of previous studies of the geographic drainage area indicate that it discharges approximately 30 percent of the total CSO volume to the river, making it a major contributor during storm events. The diversion structure is accessible through a locked 2 foot by 4 foot manhole. An illustration of the Blacksnake monitoring equipment installation is shown on Figure 8.5.




BLACK & VEATCH

**ST. JOSEPH, MISSOURI, CSO STUDY
BLACKSNAKE CREEK MONITORING EQUIPMENT**

23487.134-6 ADI 10/18/96

Figure 8.5 Blacksake Creek Monitoring Equipment



8.3.2 Monitoring Station SJ-2 – Messanie Street Diversion

The Messanie Street Diversion structure is located at the end of Messanie Street, at the back entrance to the HPI Company. Based on geographic drainage area, the CSO contribution from this location is relatively small. This location was chosen, however, because the flow through this diversion is approximately 80 percent commercial and industrial, as evidenced by the volatile organic compounds (VOCs) detected during the inspection of this structure in 1995. Access to the diversion structure is through a 30 inch by 30 inch manhole cover and down approximately two dozen manhole rungs. An illustration of the below grade installation of the equipment at the Messanie Street Diversion is shown on Figure 8.6.

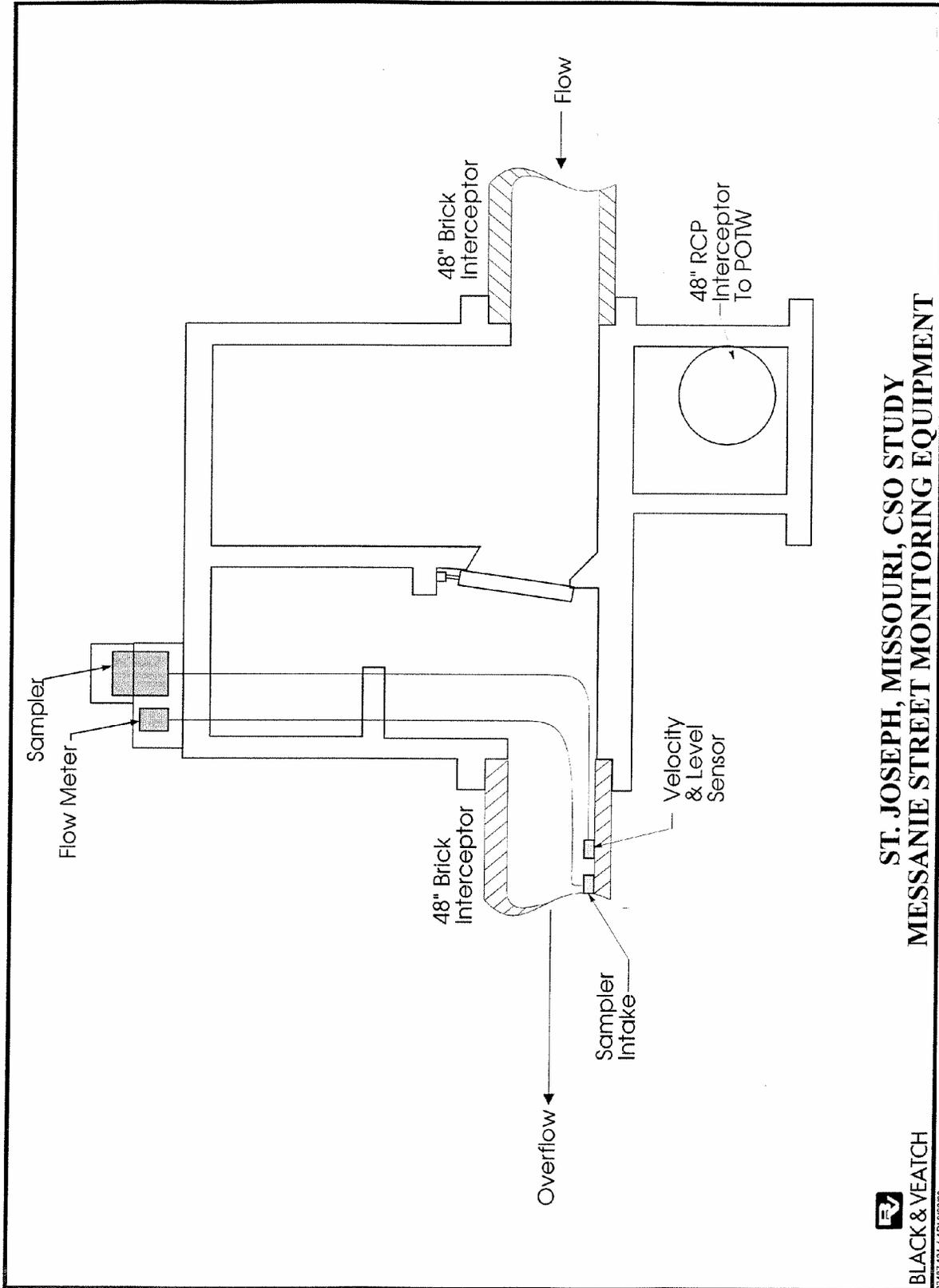


Figure 8.6 Messanie Street Monitoring Equipment

 BLACK & VEATCH
23487.1344.4 ADI 6/26/06



8.3.3 Monitoring Station SJ-3 – Mitchell Street Diversion

The Mitchell Street Diversion structure is located at the end of Mitchell Street, approximately 30 feet west of the Missouri River. Based on a review of drainage area maps, 20 percent of the City’s wastewater and stormwater drains through this location. Access to the diversion structure is through a 4 foot by 4 foot manhole cover and down approximately two dozen manhole rungs. Figure 8.7 presents an illustration of the below grade installation of the equipment at Mitchell Street.

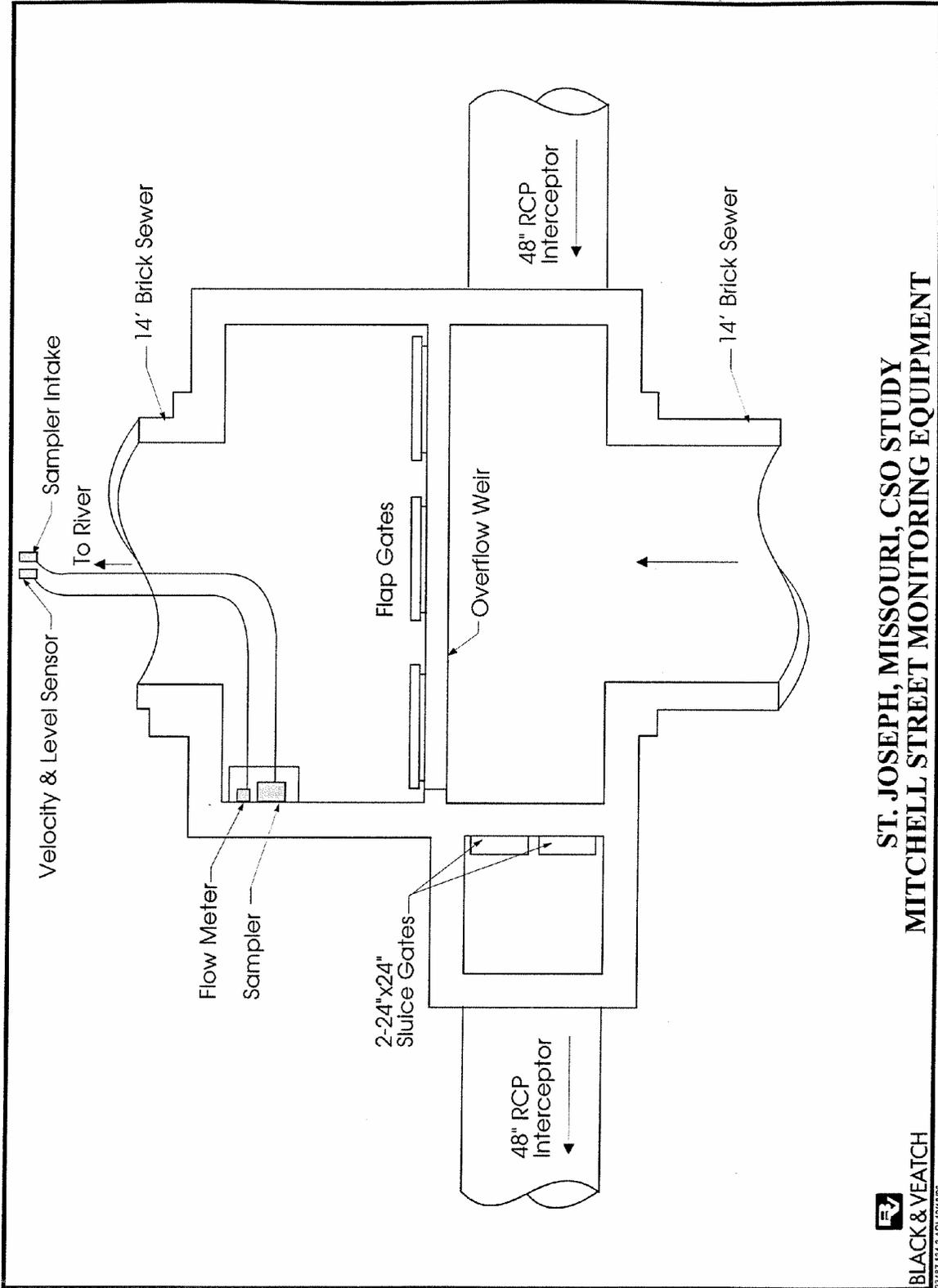
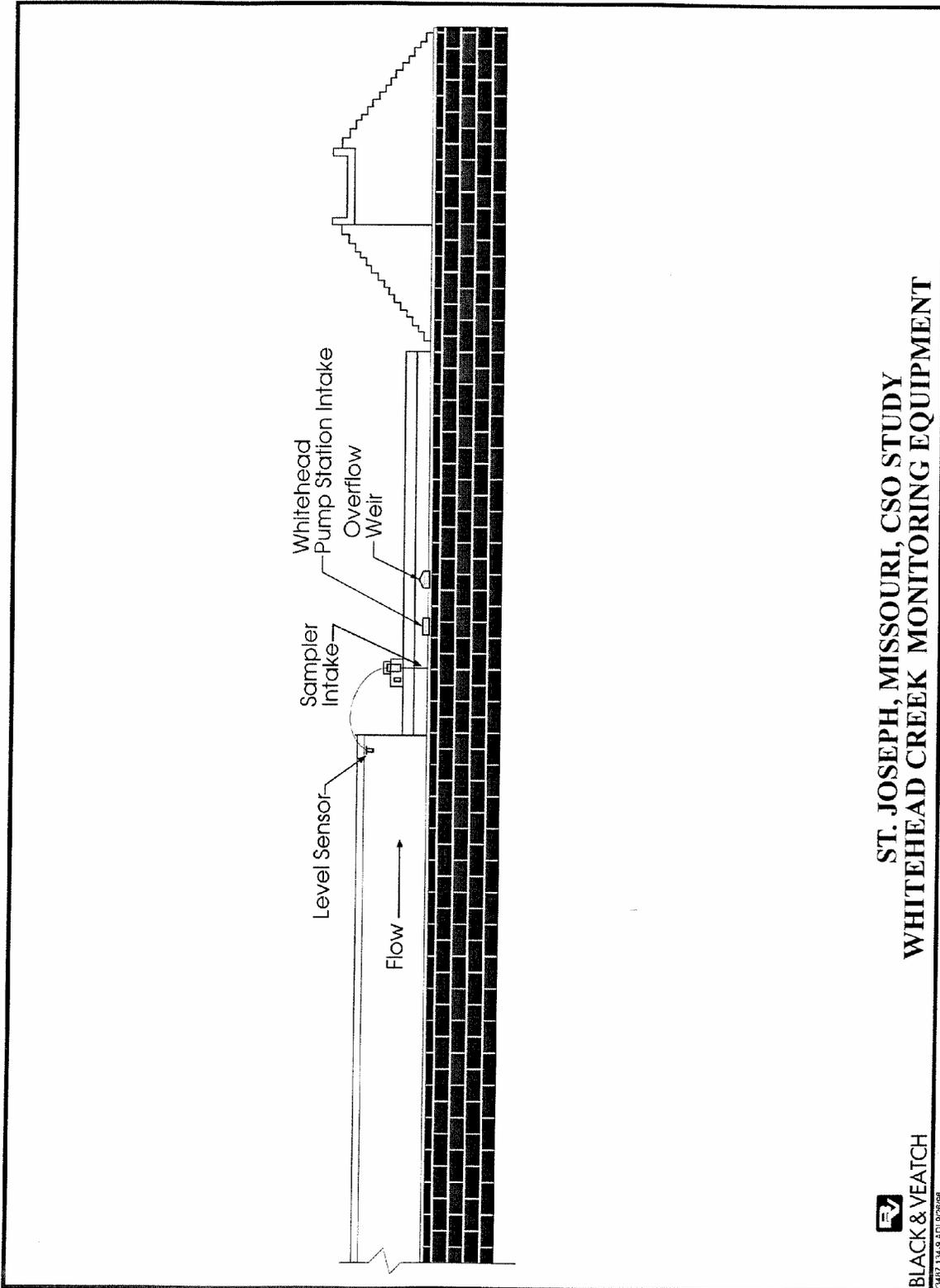


Figure 8.7 Mitchell Street Monitoring Equipment



8.3.4 Monitoring Station SJ-4 – Whitehead Creek Diversion

The Whitehead Creek Pump Station Diversion structure is located approximately 100 feet east of the intersection of Atchison and Sixth Street at the I-29 exit ramp. Results of previous studies of the geographic drainage area indicate that between 25 to 30 percent of the City's wastewater and stormwater flows drain through this diversion structure. Due to the large amount of debris that has been observed in this diversion structure, an ultrasonic flow sensor was used for flow measurement. Even with the use of an ultrasonic sensor, the sensor was damaged during flooding events in 2007. Equipment was repaired and re-installed after the flood waters receded to ensure that the sensor would not be damaged during subsequent storms. An illustration of the installation of the equipment is shown on Figure 8.8.



**ST. JOSEPH, MISSOURI, CSO STUDY
WHITEHEAD CREEK MONITORING EQUIPMENT**

Figure 8.8 Whitehead Creek Monitoring Equipment


BLACK & VEATCH
23407134-9-201 9/26/08



8.3.5 Monitoring Station SJ-5 – Brown’s Branch Diversion

The Brown’s Branch Diversion structure is located approximately 75 feet west of the Brown’s Branch Pump Station on the opposite side of the railroad tracks. Results of previous studies indicate that this watershed constitutes about 15 percent of the City’s wastewater and stormwater flows.

The monitoring equipment was installed downstream on a 32 inch high overflow dam which serves as a broad-crested weir. During installation, the flow sensor was changed from an area-velocity sensor to an ultrasonic sensor as a means of protecting the sensor from debris. An illustration of the installation of the equipment is shown on Figure 8.9.

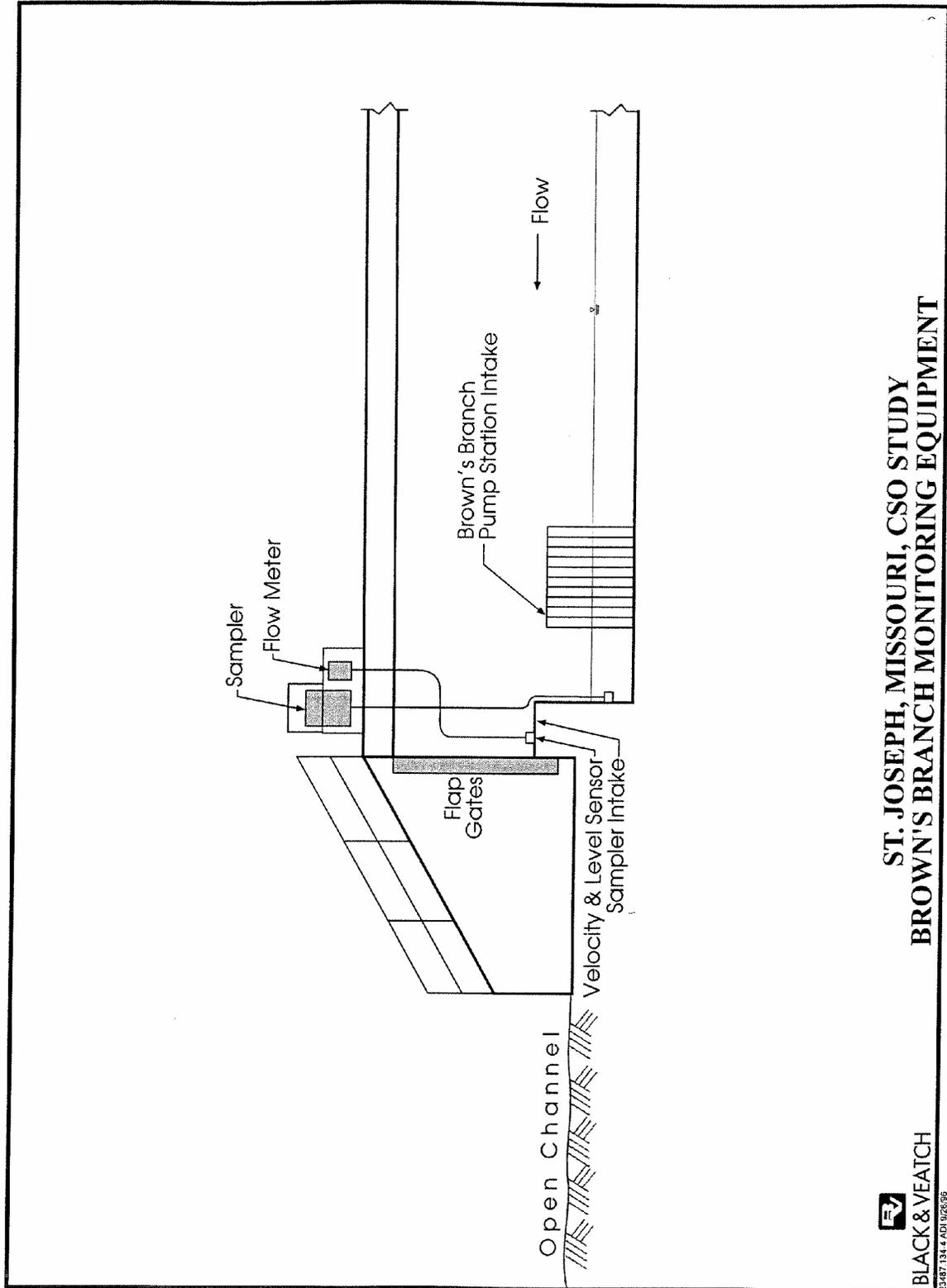


Figure 8.9 Brown's Branch Monitoring Equipment



8.3.6 Monitoring Station SJ-6 – Francis Street Diversion

Flow monitoring equipment was installed at selected diversion structures to collect additional information on locations to better calibrate the model and evaluate the potential for future closure. Francis Street diversion was identified as a potential for closure. Sanitary and storm flows are diverted at the Francis Street location into a 24 inch pipe that flows to the Missouri River. The flow monitoring equipment was installed in a manhole located approximately 150 feet downstream of the diversion. This location was selected based on its accessibility (fenced area). An area-velocity sensor (ISCO 700 Series) was installed at this location to collect flow information and evaluate the possibility of closing this diversion structure.

8.3.7 Monitoring Station SJ-7 – Charles Street Diversion

The Charles Street diversion was identified as a potential diversion structure for future closure. In order to confirm this possibility, monitoring equipment was installed downstream of the overflow structure in the discharge pipe. An area-velocity sensor (ISCO 700 Series) was installed at this location to collect flow information and evaluate the possibility for closing this diversion structure.

8.3.8 Monitoring Station SJ-8 – Olive Street Diversion

The Olive overflow structure was identified as a potential diversion structure for future closure. The flow monitoring equipment was installed in the discharge pipe downstream of the overflow structure. An area-velocity sensor (ISCO 700 Series) was installed at this location to collect flow information and evaluate the possibility of closing this diversion structure.

8.3.9 Monitoring Station SJ-9 – Patee Street Diversion

The Patee overflow structure was identified as a potential diversion structure for future closure because it handles one of the smallest watersheds in the City. The flow monitoring equipment was installed in the discharge pipe downstream of the overflow



structure. An area-velocity sensor (ISCO 700 Series) was installed at this location to collect flow information and evaluate the possibility of closing this diversion structure.

8.3.10 Monitoring Station SJ-10 – Missouri Avenue Diversion

The Missouri Avenue is located at the south end of the wastewater treatment plant. This location receives sanitary and storm flow from the sewershed between Brown’s Branch sewershed and the treatment plant. Flow monitoring equipment was installed downstream of the overflow structure. This location was selected based on its accessibility (fenced area). An area-velocity sensor (ISCO 700 Series) was installed at this location to collect flow information.

8.4 Water Quality Data

This section summarizes the water quality data from 36 storm events that were sampled and monitored in 2007 during development of this LTCP. Appendix E provides a summary of the data collected at the five monitoring locations. All monitoring data collected as part of this study was analyzed by the City of St. Joseph’s wastewater treatment plant laboratory. All internal quality assurance/quality control (QA/QC) procedures established by the laboratory were followed during this study.

8.4.1 Test Methods

The recommended test methods for the pollutants are summarized in Table 8.2.

Test Parameters	Type	Test Method
BOD ₅	Composite	EPA 405.1
COD	Composite	EPA 410.4
TSS	Composite	EPA 160.2
TDS	Composite	EPA 160.1
TKN	Composite	EPA 351.2
Ammonia-N	Composite	EPA 350.1
Nitrate-N	Composite	EPA 353.1
Total Phosphorus	Composite	EPA 365.3



Test Parameters	Type	Test Method
pH	Grab	EPA 150.1
Temperature	Grab	EPA 170.1
Oil and Grease	Grab	EPA 413.1
Fecal Coliform	Grab	SM 9222D
E. coli	Grab	EPA 1103/1603
Antimony	Composite	EPA 204.2
Arsenic	Composite	EPA 206.2
Beryllium	Composite	EPA 210.1
Cadmium	Composite	EPA 213.1
Chromium	Composite	EPA 218.1
Copper	Composite	EPA 220.1
Lead	Composite	EPA 239.1
Mercury	Composite	EPA 245.1
Nickel	Composite	EPA 249.1
Selenium	Composite	EPA 270.1
Silver	Composite	EPA 272.1
Thallium	Composite	EPA 279.2
Zinc	Composite	EPA 289.1
Total Phenol	Composite	EPA 420.1
Total Cyanide	Composite	EPA 335.3
Pesticide and PCB	Composite	EPA 608
Priority Pollutants – Base/Neutrals and Acids	Composite	EPA 625
Priority Pollutants – Volatile Organics	Composite	EPA 602
TTO	Composite	EPA 624

8.4.2 Grab Samples

Field crews obtained the required grab sample volume from each monitoring location using proper field sampling and sample preservative procedures. The pH and the temperature of the samples were measured in the field and recorded.

8.4.3 Composite Samples

Automatic samplers were used to collect time-weighted composite samples at each of the monitoring locations. Each composite sampler was programmed to collect a time-



weighted composite by taking an appropriate sample every 15 minutes during a 24 hour period. Time increments were adjusted at each location based on the amount of volume that was collected during an event. For instance at the Messanie location, sample frequency was decreased to 5 minutes to collect sufficient volume for the analytical testing. Samples were cooled to 4°C during collection using the ISCO Avalanche equipment.

8.4.4 pH Meters

Samples were analyzed using a portable pH meter in the field. A two point calibration process was employed using two fresh buffer solutions. The buffers used to perform the calibration bracketed the expected pH range of the sample and measured at least 3 standard units (SU) apart. A log book with calibration information for the pH meters was maintained during the study. The temperature of the sample was collected at the same time as pH.

8.4.5 Selection and Preparation of Sample Containers

The selection and preparation of sample containers was made prior to beginning the field work. Sample containers must be made of chemically resistant material that does not interact to affect the concentration of pollutants to be measured. Containers used for this study were either new or certified as new. Sample containers, preservatives, and holding times are specified in 40 CFR Part 136. These requirements were used by field sampling crews during the collection of data in this study.

8.4.6 Sample Volume

The volume of samples collected depended on the type and number of analyses needed. This was determined by the parameters to be measured and the requirements of the analytical laboratory being used. Sample volume must be sufficient for all analyses, including QA/QC and any repeat analyses used for verification. The laboratory recommended the sample volume required to complete all analyses. Programming of the



composite samplers was completed in graduations of 100 mLs, with a total composite volume of two to four gallons.

Volume requirements for individual analyses ranged from 40 mL for pH and volatile organic determinations to 1,000 mL or more for biochemical oxygen demand (BOD), oil and grease, and suspended solids. The sampling crews collected more than the minimum sample volume to allow for spillage and laboratory reruns.

8.4.7 Sample Preservation and Holding Times

Preservation techniques ensure that the sample remains representative of the waste stream at the time of collection. Since most pollutants in the samples collected are unstable to some extent, this instability requires that the sample be analyzed immediately or that it be preserved or fixed to minimize changes in the pollutant concentration or characteristics between the times of collection and analysis. Because immediate analysis is not usually possible, most samples are preserved regardless of the time of planned analysis. Preservation is to take place as soon as possible after collecting the sample. Sample preservation took place in the field (40 CFR part 136.3) and was performed by the sampling crews. The most common procedures used for preserving samples include icing, refrigeration, pH adjustment, and chemical fixation. When chemical fixation is used, the chemical preservative must be added before the samples are transferred to the laboratory. Likewise, refrigeration will be supplied immediately upon taking the sample. For many samples, if preservatives are not appropriately used, bacteria can quickly degrade certain pollutant constituents (phenols and phosphorous). Other constituents may volatilize (cyanide and sulfides) or may react to form different chemical species (hexavalent chromium). Proper preservation and holding time for each parameter is essential for the integrity of the monitoring program and was followed according to 40 CFR Part 136, which provides proper holding times and preservation requirements.

8.4.8 Quality Assurance

The quality assurance procedures were designed to assure that the information obtained is accurate, complete, and reliable. Elements of the program included written



procedures for the field crews and standard reporting procedures for data collection. The value of the data collected from the sampling program is only as reliable as the representative quality of the sample itself so quality assurance is an important aspect of the program. Automatic samplers can reduce human errors in sampling and improve overall reliability.

Clean sampling containers were used at all times and each container was labeled in indelible ink on a waterproof label. New or certified as new containers were used during the study.

8.4.9 Chain of Custody Procedures

To ensure sample integrity from collection to data reporting, it is important to trace possession and handling of the sample from time of collection through analysis and to final disposition. This process is referred to as the chain of custody, and is useful for routine control of sample flow.

Chain of custody procedures begin with proper labeling of the sample as previously discussed. Sample containers were tightly sealed to prevent loss of sample or degradation from exposure to the atmosphere or contamination. Both composite and grab samples were chained together on one form.

8.5 Results of Water Quality Monitoring

To ensure that sufficient data was collected for the long term control program, data was collected from 36 potential monitoring events in 2007. Data, however, was not collected during a number of events at specific locations due to the fact that sufficient rainfall did not occur at that location to cause an overflow or due to equipment failures (dead batteries, programming, automatic control system non-functional). Table 8.3 details the number of events and actual number of times data was collected for a given location.



Table 8.3
Summary of Events from Flow Sampling/Monitoring Stations

Diversion Location	No. of Events	No. of Events with No Data	No. of Events Where No Discharge Occurred at Diversion Structure	No. of Events Where Equipment Did Not Activate Due to Malfunction
Blacksnake Creek	36	6	3	3
Messanie	36	12	10	2
Mitchell	36	9	4	5
Whitehead Creek	36	7	3	4
Brown's Branch	36	18	12	6

In addition to the five sampling stations, additional flow monitoring stations were established at Charles, Francis, Olive, Patee, and Missouri Avenue as discussed previously in this chapter. These stations were placed into operation in August 2007. Table 8.4 presents the number of events in which data was recorded by these stations. Flow data from all locations were used in the modeling of the collection system.

Table 8.4
Summary of Events from Flow Monitoring Stations

Station	Sept 2007	Oct 2007	Nov 2007	Dec 2007	Total
Charles	2	0	2	2	6
Francis	2	0	2	1	5
Olive	2	0	0	0	2
Patee	3	1	2	1	7
Missouri Ave	1	0	1	2	4

8.5.1 BOD₅

BOD₅ data was collected at each of the monitoring stations. Figure 8.10 presents a summary of the data. The results of the monitoring indicated an average concentration from all storms of 74 mg/L. This was higher than the average value of 20 mg/L reported during monitoring for the 1996 Combined Sewer Overflow Characterization Report. Multiple results from the Mitchell station appeared to be the highest with five results over 200 mg/L. During the 1996 study, results from the Mitchell station during the nine sampled storms reported no value over 120 mg/L. The highest reported result from the Blacksnake station was 808 mg/L, which was also the highest reported BOD



concentration from all samples tested during the 2007 study. This was considerably higher than the data collected from 1995 to 1996 when the highest value reported at the Blacksnake location was 76 mg/L. Overall the BOD concentrations reported from the 2007 study were higher than the data collected during 1995 to 1996.

Rainfall data collected during 2007 indicates longer duration, higher intensity rainfall than the previous study, resulting in near flooding events in April and May 2007. In comparison, the rainfall during 1995 to 1996 appears to be shorter duration, lower intensity events. It appears that these longer duration, higher intensity rainfall events resulted in higher maximum concentrations and overall higher average concentrations.

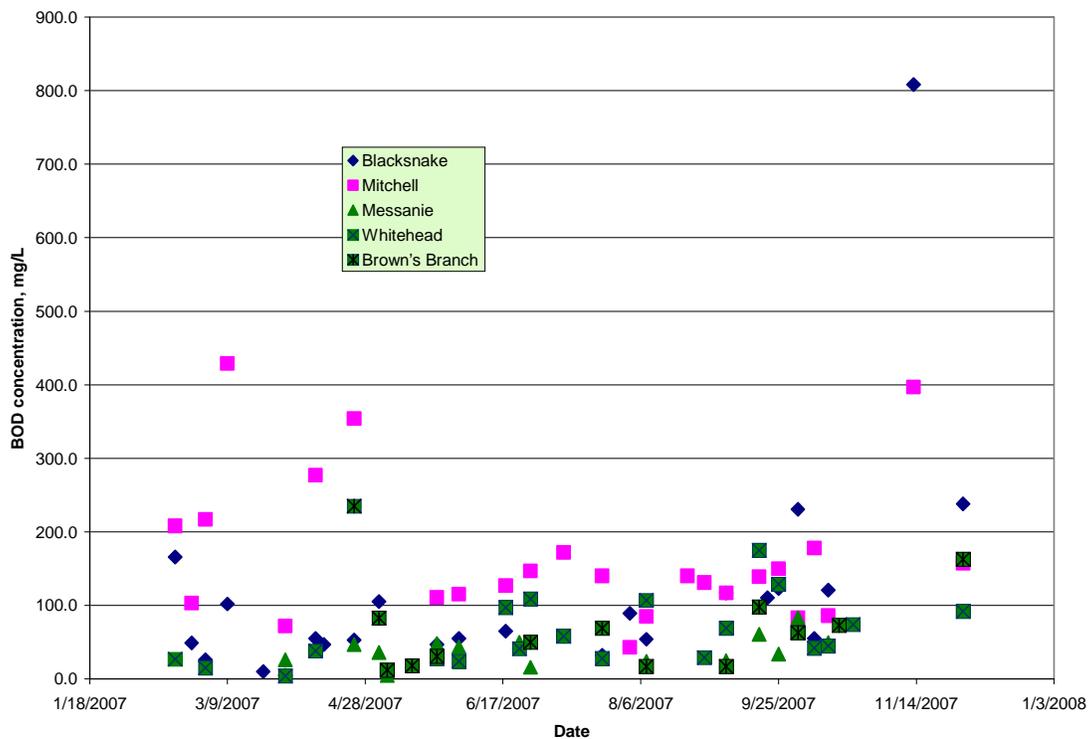


Figure 8.10 2007 BOD Data

8.5.2 TSS

Total suspended solids (TSS) data was collected at each of the monitoring stations and is presented on Figure 8.11. The results of the monitoring indicated an average



concentration from all storms of 780 mg/L. Results from the Mitchell and Blacksnake stations appeared to be the highest with over 30 percent of the data exceeding 1,000 mg/L. The highest TSS concentrations reported during this study were approximately 7,700 mg/L at both the Mitchell and Blacksnake locations. Most of these higher values were reported during the flooding events of 2007. During 1995 to 1996, the maximum TSS reported at any of the locations was at the Whitehead location with a value of approximately 8,000 mg/L.

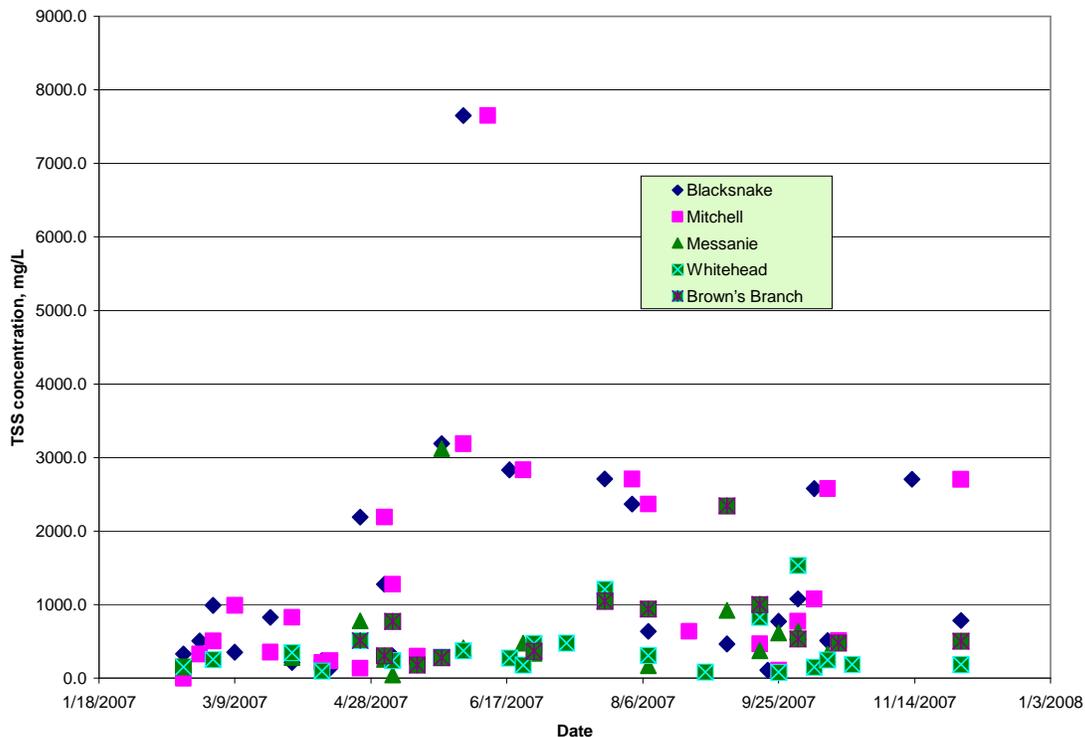


Figure 8.11 2007 TSS Data

8.5.3 TKN

Total Kjeldahl nitrogen (TKN) data was collected to examine nitrogen loadings to the river during wet weather events. Figure 8.12 presents a summary of the data. The results of the monitoring indicated an average concentration from all storms of 10 mg/L which is relatively weak in comparison to typical wastewater. TKN results from the



1996 study indicated results of approximately one half of what was found during 2007. In 2007, results from the Mitchell Street location appeared to be the highest TKN values with over 50 percent of the data exceeding 10 mg/L. The 2007 results were higher due to higher levels in the Missouri River as well as higher intensity rain events. Results of the 1996 study also found the highest TKN concentrations at the Mitchell location.

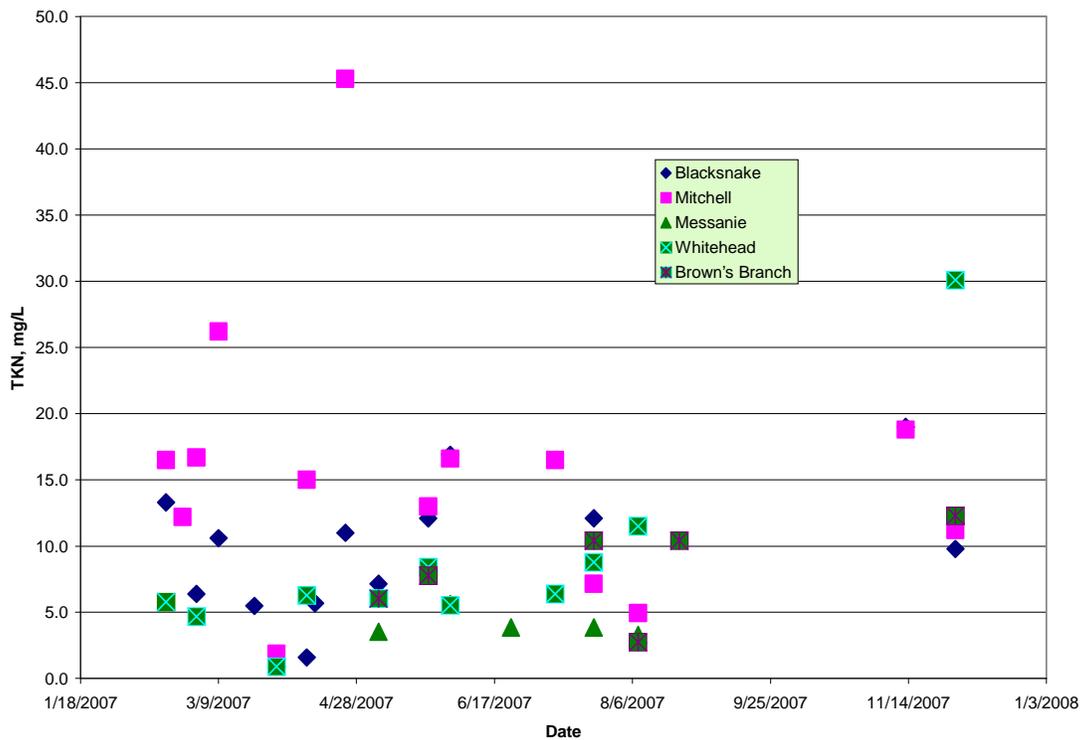


Figure 8.12 2007 TKN Data

8.5.4 Ammonia

Ammonia data was also collected to examine nitrogen loadings to the river during wet weather events. Figure 8.13 presents a summary of the ammonia data. The results of the monitoring indicated an average concentration from all storms of 2.5 mg/L which is relatively weak in comparison to typical wastewater. During 1996, ammonia results were generally below 0.5 mg/L. In 2007, results from the Mitchell station appeared to be the



highest with six values over 5 mg/L. Most of these higher values were reported during the flooding events of 2007.

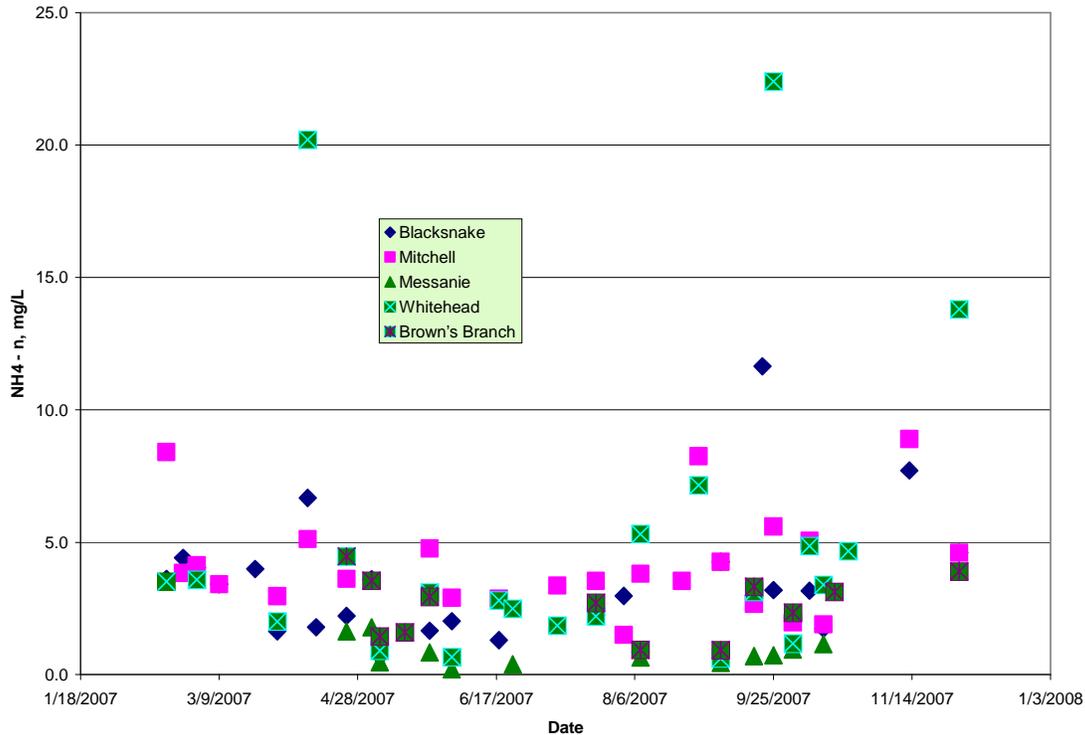


Figure 8.13 2007 Ammonia Data

8.5.5 Phosphates

Phosphate data was also collected to examine nutrient loadings to the river during wet weather events. A summary of the data is presented on Figure 8.14. The results of the monitoring indicated an average concentration from all storms of 5 mg/L, which is in the typical range of domestic wastewater. During the 1996 study, the maximum reported phosphate concentration was 1.5 mg/L. Overall, the 2007 results appear to be the highest during the spring storms with concentrations decreasing after these events. The results from the Mitchell station appeared to be the highest with nine values over 10 mg/L.

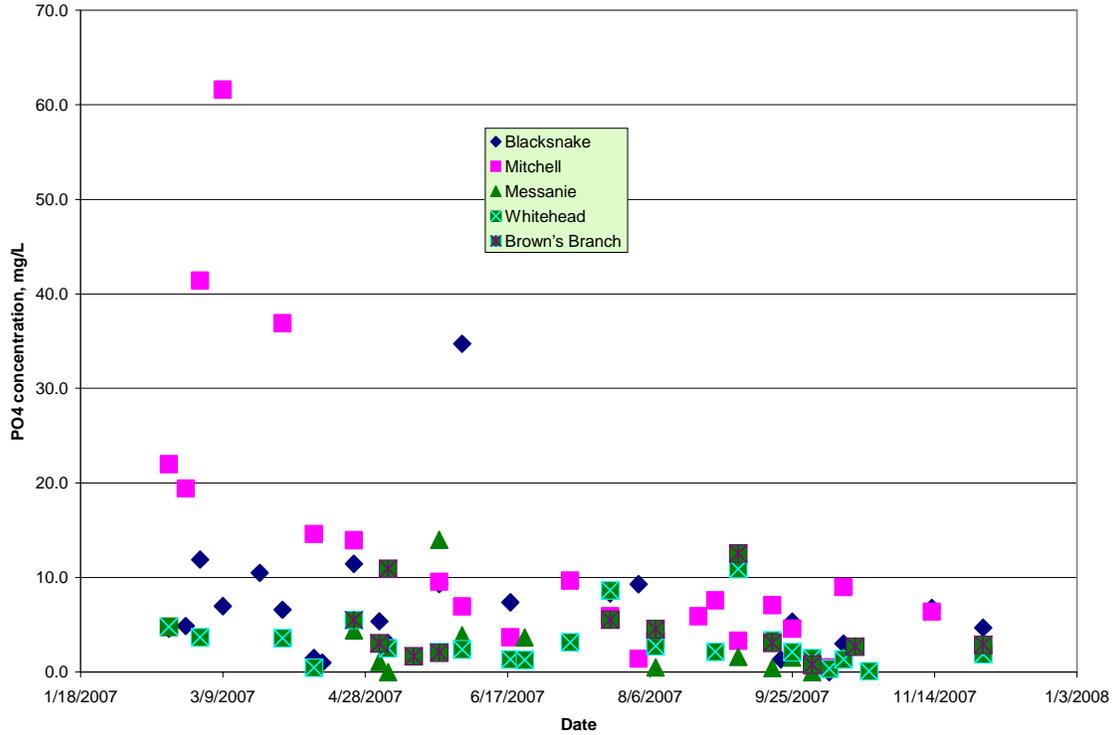


Figure 8.14 2007 Phosphate Data

8.5.6 *E. coli*

E. coli data was collected from each of the five monitoring stations as shown on Figure 8.15. This data was collected as the Missouri Department of Natural Resources (MDNR) is in the process of modifying the water quality standard from fecal coliforms to *E. coli*. It is anticipated that the maximum *E. coli* concentration will be above 500 mpn/100 mL, indicating that all data collected during this study would exceed the proposed water quality standard.

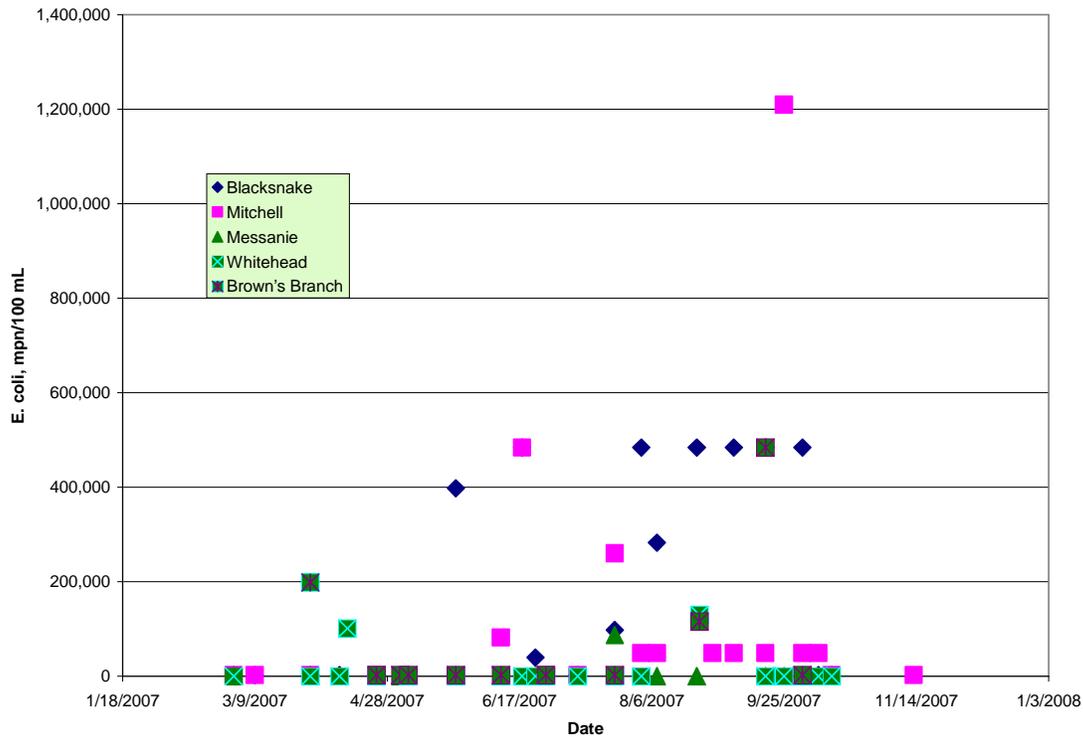


Figure 8.15 2007 *E. coli* Data

8.5.7 Fecal Coliforms

Fecal coliforms were measured during both the 1996 study as well as the monitoring conducted during 2007. During the 1996 study, fecal coliform results from 1,000 mpn/100 mL to a maximum concentration of 2,000,000 mpn/100 mL were reported. Results of fecal coliform testing conducted during 2007 ranged from 2,420 mpn/100 mL to 1,200,000 mpn/100 mL as shown on Figure 8.16. It should be noted that all fecal coliform results collected exceeded the daily maximum of 1,000 mpn/100 mL.

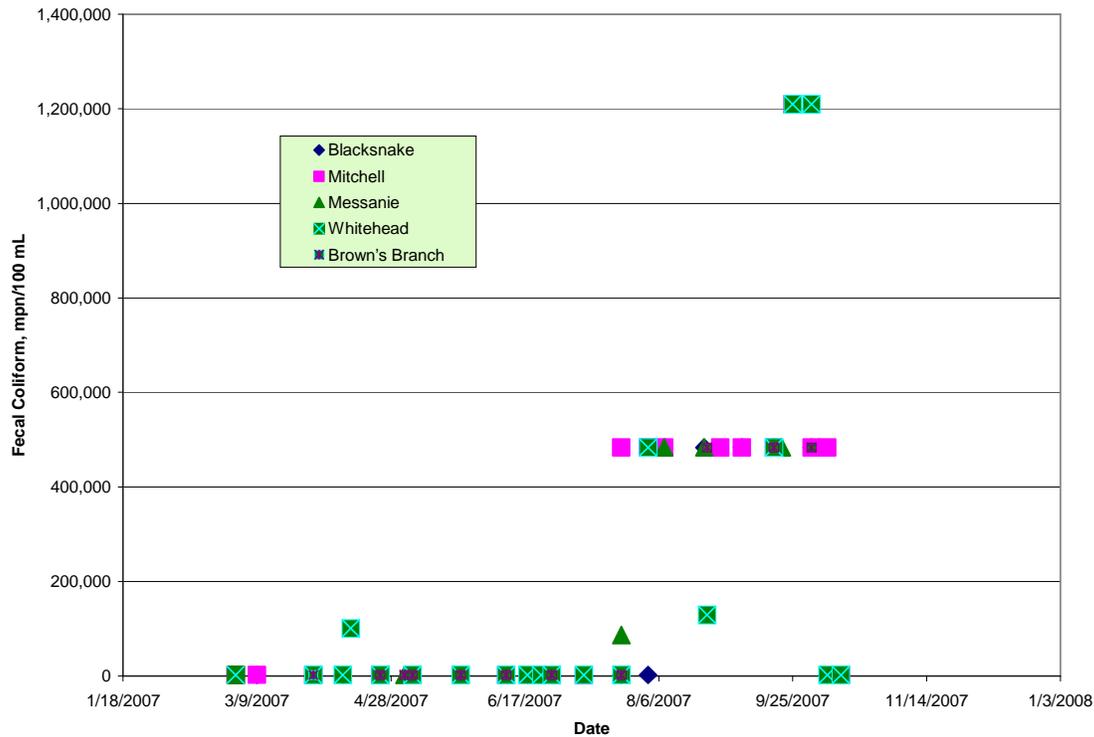


Figure 8.16 2007 Fecal Coliform Data

8.5.8 Metals

Fifteen metal compounds were measured during both the 1996 and 2007 studies. Overall, metal results during both studies were at or below detection limits with a few exceptions. When concentrations were above detection, values reported during the 1996 study were higher than those reported in 2007. For example during the 1996 study, the highest zinc concentration was 2.62 mg/L at the Whitehead location. During the 2007 study, the highest zinc concentration was 0.4 mg/L at the Mitchell location.

8.5.9 Toxic Organics

Toxic organic compounds (EPA 608/624/625) were measured during both the 1996 and 2007 studies. During the 1996 study, 1,1-dichloroethane, Gamma BHC, tetrachloromethane, toluene, trichloromethane, and vinyl chloride were all detected above the detection limit. During the 2007 study, only Bis (2-ethylhexyl) phthalate was



identified at one location. All other toxic organic compounds were reported below the detection limits. Results of the 2007 study indicate that the City has implemented effective methods for reducing the discharge of toxic organics.



9.0 Collection System Modeling

9.1 Model Development

The St. Joseph combined sewer system (CSS) was modeled using the XP-SWMM program, which was adapted from the XP-SWMM model previously developed by Black & Veatch for the 1999 Comprehensive Stormwater Management Plan. Hydraulic and hydrologic modeling was completed for the CSS which encompasses the eight major watersheds shown on Figure 4.1. The model developed for the stormwater management plan includes all of the CSS except the force mains and interceptors that convey flows to the City's Wastewater Treatment Plant (WWTP), which is located in the Missouri Avenue watershed. To incorporate the force mains and interceptors into the CSS model, the following pipe segments were added:

- Blacksnake interceptor, which extends from the Blacksnake diversion structure to the Whitehead Pump Station.
- Whitehead interceptor, which extends from the Whitehead diversion structure to the Whitehead Pump Station.
- Brown's Branch force main and interceptor, which extends from the Brown's Branch diversion structure into the Missouri Avenue collection system.
- Missouri Avenue interceptor, which extends from the Missouri Avenue diversion structure to the WWTP.

The combined sewer overflows (CSOs) discharge to the Missouri River at the following fourteen diversion structures as indicated on Figure 4.1: Roy's Branch, Blacksnake, Francis, Charles, Messanie, Patee, Olive, Mitchell, Duncan, Maple, Hickory, Whitehead, Missouri Avenue, and Brown's Branch. The Walnut CSO outfall has been closed and was not included as an outfall in the model. A sewer separation project is currently being implemented in the Roy's Branch watershed to separate all known combined sewer connections. The City will be evaluating infiltration and inflow at the



completion of the project to determine if the capacity of the Roy’s Branch Pump Station needs to be increased or if a holding basin is needed in this watershed to eliminate the CSO diversion structure. For modeling purposes, the Roy’s Branch CSO outfall will not be included in the alternatives evaluation.

9.2 Addition of Dry Weather Flows to CSS

In addition to incorporating the interceptors and force mains to the stormwater master plan model, dry weather sanitary flows were also added to the model. To do this, the current average wastewater treatment plant flow of 17 million gallons per day (mgd) was allocated by a population-weighted average of the CSS service area. The population data came from the U.S. Census Bureau data for census year 2000. Based on the intersection of the CSS system subbasins with the census block group populations, the population of each subbasin could be determined. For example, if 100 people were counted in census block Group A and 50 percent of the area of census block Group A was in Subbasin 1, then 50 people were assumed to be in Subbasin 1 (plus the population from any other census block groups that intersected Subbasin 1). The dry weather flow analysis did not evaluate diurnal flow variation, and as a result, the model simulates the dry weather flow as a constant inflow into the CSS. The results of the dry weather flow allocation for each watershed within the CSS service area are presented in Table 9.1.

Watershed	Dry Weather Flow, mgd
Blacksnake*	4.36
Francis	0.001
Charles	1.18
Messanie	0.12
Patee	0.08
Olive	0.03
Mitchell	4.99
Duncan	0.004
Maple	0.57
Hickory	0.52
Whitehead	3.1



Watershed	Dry Weather Flow, mgd
Missouri Avenue	0.64
Brown's Branch	1.36
* Includes dry weather flow from Roy's Branch.	

9.3 Flow and Rainfall Monitoring Data for Collection System Calibration

The City of St. Joseph was responsible for collecting and providing rainfall and flow data for the monitoring period of March 1 through October 1, 2007. Rainfall data was collected from five rain gauge locations, and flow data was collected from nine flow monitoring stations (the tenth flowmeter, Missouri Avenue, did not provide any data during the flow monitoring period). The data was evaluated to determine the number of significant wet weather events that occurred during the monitoring period.

Table 9.2 lists the dates and times of the wet weather events that occurred during the monitoring period.

Event Number	Start Date and Time	End Date and Time	Average Precipitation, in	Number of Meters with Data
1	03/22/07, 00:00	03/22/07, 08:00	0.3	5
2	03/26/07, 00:00	03/28/07, 00:00	0.3	2
3	03/29/07, 16:00	03/30/07, 12:00	1.3	4
4	04/10/07, 12:00	04/11/07, 12:00	0.8	2
5	04/13/07, 00:00	04/15/07, 00:00	0.3	1
6	04/25/07, 12:00	04/26/07, 00:00	0.3	1
7	05/03/07, 00:00	05/04/07, 00:00	0.4	0
8	05/06/07, 04:00	05/07/07, 14:00	5.7	1
9	05/15/07, 00:00	05/15/07, 12:00	0.7	1
10	05/24/07, 06:00	05/24/07, 18:00	0.6	1
11	06/01/07, 00:00	06/01/07, 12:00	0.6	1
12	06/10/07, 06:00	06/10/07, 14:00	0.7	1
13	06/18/07, 09:00	06/18/07, 21:00	0.6	1
14	06/22/07, 21:00	06/23/07, 10:00	0.3	3
15	06/27/07, 15:00	06/27/07, 23:30	0.2	4
16	07/09/07, 13:00	07/09/07, 23:00	1.0	3
17	07/23/07, 07:00	07/23/07, 17:00	0.7	5
18	08/02/07, 08:00	08/02/07, 20:00	0.2	4



Event Number	Start Date and Time	End Date and Time	Average Precipitation, in	Number of Meters with Data
19	08/08/07, 06:00	08/09/07, 04:00	1.1	5
20	09/06/07, 22:00	09/07/07, 18:00	1.8	6
21	09/18/07, 12:00	09/19/07, 08:00	0.7	7

Event start and end times were determined graphically by examining rainfall hyetographs and flowmeter hydrographs. Generally, the event start time is two hours ahead of the rainfall event and the event end time is two hours after the last flowmeter returns to low flow. Graphs of the rainfall and flowmeter data for the events are provided in Appendix F.

9.4 Model Calibration

The *Combined Sewer Overflow Control Manual* (U.S. EPA, 1993) states that “an adequate number of storm events (usually five to ten) should be monitored and used in calibration.” However; *Combined Sewer Overflows – Guidance for Monitoring and Modeling* (U.S. EPA, 1999) states that calibration and verification are often done with two to three storms each.

For calibration, it is desirable to have a range of events that cover the range that will be seen in a typical year; however, it is generally accepted that during the system monitoring period, it is unlikely that the entire range of typical year events will occur.

Based on review and evaluation of the 2007 data for the St. Joseph CSO model, events 17, 19, 20 and 21 were chosen for calibration. These events were selected for the following reasons:

- A majority of the meters (at least five of the nine meters) were reporting data.
- The rainfall events had precipitation from 0.7 to 1.8 inches, whereas a typical year has events that range from 0.29 to 2.88 inches, so the events covered a good portion of the typical year events.



- Flow responses for the flowmeters visually appeared appropriate based on a review of the data in graphical form.

Stormwater runoff to rainfall ratios for observed events are shown in Table 9.3.

Meter	Event 17 Runoff Depth*	Event 19 Runoff Depth*	Event 20 Runoff Depth*	Event 21 Runoff Depth*
Blacksnake				
Brown's Branch				0.89 (133%)
Charles	0.07 (10%)	0.25 (23%)	0.43 (24%)	0.10 (14%)
Francis	0.69 (96%)	0.88 (82%)	2.06 (118%)	0.13 (20%)
Messanie	0.86 (118%)		0.93 (52%)	0.09 (13%)
Mitchell	0.07 (10%)	0.11 (10%)		0.05 (7%)
Olive	0.42 (59%)	0.44 (41%)	1.03 (58%)	
Patee		1.00 (94%)	1.22 (69%)	0.37 (55%)
Whitehead			0.59 (33%)	0.23 (34%)

* Runoff depth units are inches with the percent of rain that flowed past the meter site in parentheses.

Based on the data presented in Table 9.3, the following three meters had at least three events reporting relatively constant runoff percentages allowing calibration: Charles, Mitchell, and Olive. The other meters that reported at least three events had the following significant problems:

- Francis significantly overproduced runoff, which may indicate a flowmeter issue.
- The runoff to rainfall ratio for Messanie was too variable (13 to 118 percent). The flowmeter location should be evaluated.
- The monitored hydrographs for Patee were significantly different than the monitored rainfall with two of the three events showing an unusual flow response that did not appear in the third. Additional monitoring is needed at this location before it can be calibrated.



For the three flowmeters where calibration could be performed, the hydrology parameters for the CSS subbasins were adjusted to simulate the monitored hydrographs. The original stormwater model hydrology utilized the Soil Conservation Service (SCS) method so the subbasin variables adjusted were the runoff curve number and subbasin lag time. Tables 9.4 and 9.5 and Figures 9.1 through 9.6 present the results of the calibration for the three flowmeters that could be calibrated.

Table 9.4
Percent Difference of Runoff Volume Between Observed and Modeled Events*

		Charles	Mitchell	Olive
Event 17	Before		34%	-27%
	After		7%	-14%
Event 19	Before	127%	209%	-8%
	After	19%	-28%	1%
Event 20	Before	138%		22%
	After	59%		25%
Event 21	Before	201%	433%	
	After	-14%	108%	
Range	Before	127 to 201%	34 to 433%	-27 to 22%
	After	-14 to 59%	-28 to 108%	-14 to 25%

* Percent Difference calculated as (Modeled – Observed) / Observed (i.e. positive values indicate model over-estimation)

Table 9.5
Percent Difference of Peak Flow Between Observed and Modeled Events*

		Charles	Mitchell	Olive
Event 17	Before		103%	-46%
	After		-62%	-33%
Event 19	Before	60%	105%	-17%
	After	21%	-28%	-7%
Event 20	Before	73%		-43%
	After	36%		-36%
Event 21	Before	89%	23%	
	After	-45%	50%	
Range	Before	60 to 89%	23 to 105%	-46 to -17%
	After	-45 to 36%	-62 to 50%	-36 to -7%

* Percent Difference calculated as (Modeled – Observed) / Observed (i.e. positive values indicate model over-estimation)

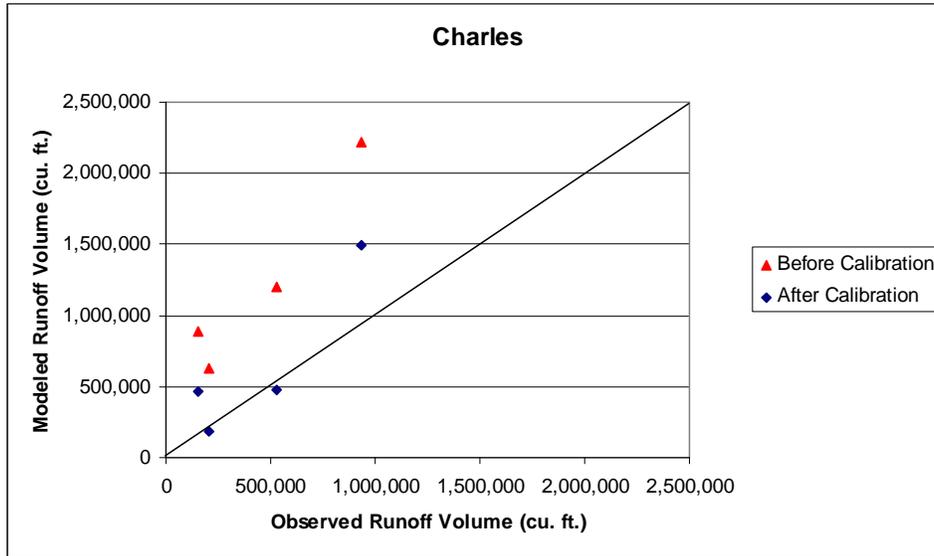


Figure 9.1 Observed Compared to Modeled Runoff Volume - Charles Watershed

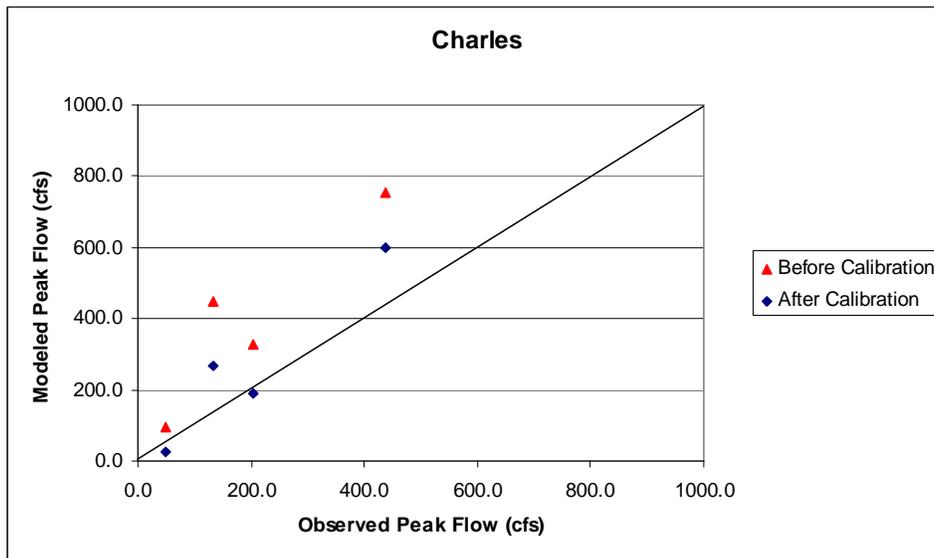


Figure 9.2 Observed Compared to Modeled Peak Flow - Charles Watershed

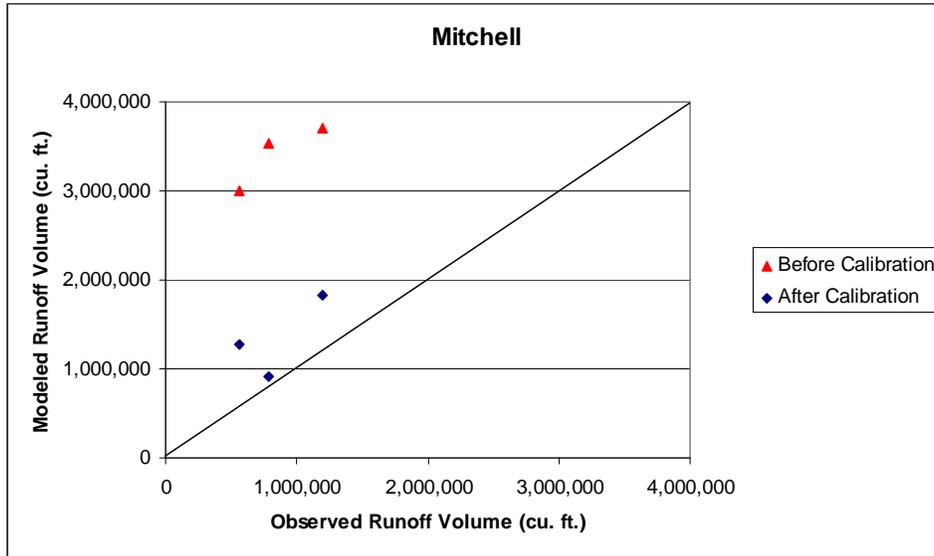


Figure 9.3 Observed Compared to Modeled Runoff Volume - Mitchell Watershed

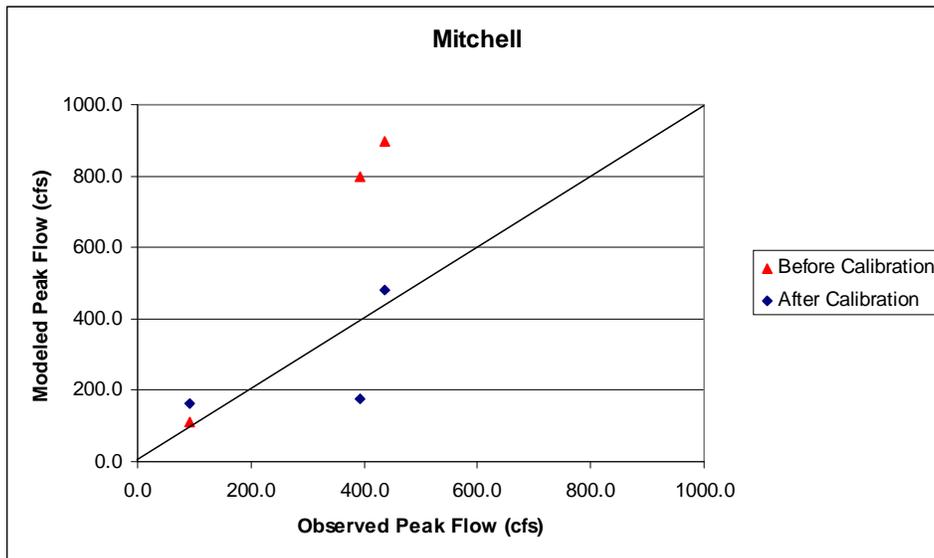


Figure 9.4 Observed Compared to Modeled Peak Flow - Mitchell Watershed

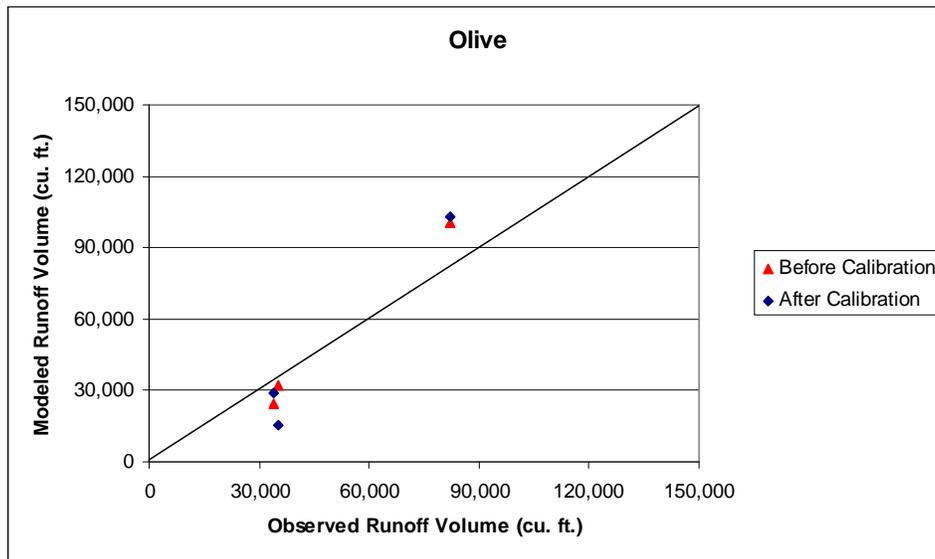


Figure 9.5 Observed Compared to Modeled Runoff Volume - Olive Watershed

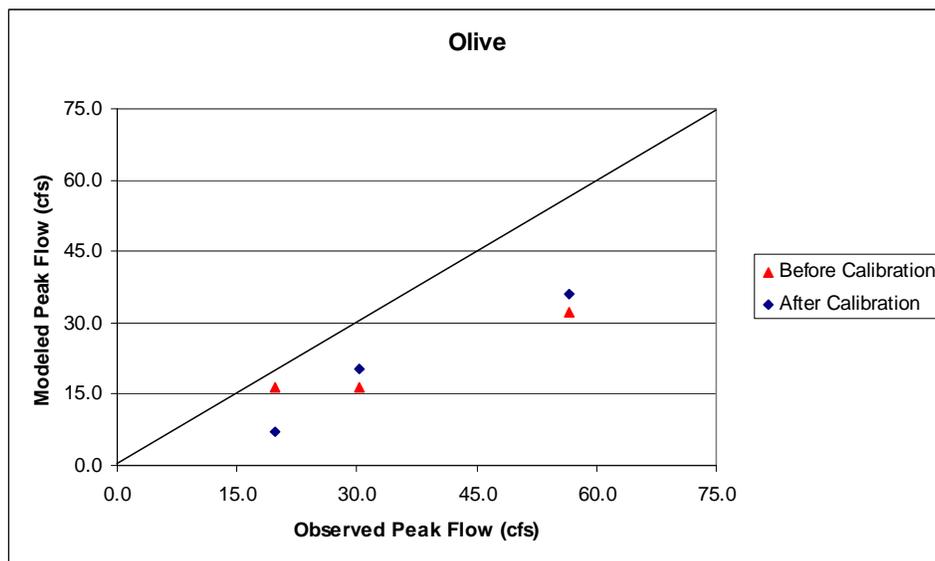


Figure 9.6 Observed Compared to Modeled Peak Flow - Olive Watershed

In summary, based on the 2007 data, three of the nine flowmeter locations could be calibrated. For the remaining six locations, either monitoring gauges are producing inaccurate results or data is not being reported. Some of the locations that could not be calibrated contribute only a small volume of the estimated annual CSS overflow. However, Blacksnake, Whitehead, Missouri Avenue, and Brown's Branch do produce



significant overflow so future model calibrations will be completed for these flowmeters at these locations to provide better estimates of overflow volume.

9.5 Typical Year Rainfall

The CSS model was used to develop the frequency and volume of CSO events for a “typical year,” which was assumed to be representative of long-term average annual conditions. The frequency and volume of rainfall events that define the typical year were based on a similar methodology developed for Kansas City, Missouri to support its CSO Long Term Control Plan.

Rainfall data used to develop the typical year were based on continuous, long-term data available from the National Climatic Data Center (NCDC) for the Kansas City Downtown Airport (MKC) (November 1948 through October 1972) and the Kansas City International Airport (MCI) (November 1972 through December 2004). The combined airport data sets provide 56 continuous and complete years of hourly precipitation data with a precision of 0.01 inch. As St. Joseph is located approximately 30 miles north of MCI and 50 miles north of MKC, it was assumed that the rainfall data used to develop the typical year for the Kansas City area would be representative of the St. Joseph area.

Typical year rainfall was defined by eight design storm events (A through H) ranging in depth from 0.29 inches for Event A to 2.9 inches for Event H. In a typical year, it was determined that there were a total of 78 rainfall events. Table 9.6 presents the typical year event characteristics.

Event	Return Period, months	No. of Events Greater Than or Equal To	Precipitation Depth, in	Peak Intensity, in/hr	Duration, hr
A	0.33	36	0.28	0.16	6
B	0.67	18	0.52	0.25	8.75
C	1	12	0.86	0.38	12.25
D	2	6	1.4	0.60	16.75
E	3	4	1.8	0.73	19.75
F	4	3	2	0.82	21
G	6	2	2.4	0.95	23.75
H	12	1	2.9	1.2	26.75



9.6 Typical Year Overflow for Existing Conditions

The purpose of determining the design storms that comprise a typical year is to determine the typical year combined sewer overflow volume. To do this, the CSS model for St. Joseph is run for each of the design events (A through H) to determine the overflow volume at each diversion structure. The total overflow volume is the sum of all diversion structure overflows, which results in the total overflow volume for each of the design events. Table 9.7 shows the results of the typical year overflow volume calculation for existing conditions.

As shown in the tables, the overflow for each event is determined from the CSS model. However, in determining the typical year overflow volume the event overflow volume must be multiplied by the number of times a particular event occurs during a typical year. A typical year will have events that are within ranges, not exactly the same size as the design events. To explain, in a typical year, there are 36 events equal to or larger than Event A and there are 18 events equal to or larger than Event B. Therefore, there are 18 individual events in between Events A and B ($36 - 18 = 18$), so to account for this, the overflow volume of A and B are averaged, then that average volume is multiplied by the number of events between Events A and B. Appendix F includes the complete results of the typical year overflow by diversion structure for existing and improved conditions.



Table 9.7					
Existing Condition – Typical Year Overflow Volume					
Event	Events Equal to or Greater Than	Overflow Volume, MG	Average Overflow Volume, MG	Events in this Range	Overflow Volume for Range, MG
Less than A	78	0			
			0.015	42	0.63
A	36	0.03			
			1.14	18	20.52
B	18	2.24			
			13.16	6	76.96
C	12	24.07			
			75.58	6	453.48
D	6	127.08			
			179.76	2	359.52
E	4	232.44			
			260.28	1	260.28
F	3	288.11			
			349.67	1	349.67
G	2	411.23			
			497.17	1	497.17
H	1	583.11			
			583.11	1	583.11
			Total	78	2,601.34

MG – Million Gallons

9.7 Typical Year Overflow for Proposed Alternatives

Alternatives were developed to provide solutions to meet the presumptive level of control for the U.S. Environmental Protection Agency (EPA) CSO Control Policy. Four alternatives were developed, including sewer separation. CSS modeling was performed for the design storm events A through H for all alternatives except sewer separation. The following four proposed alternatives are described in detail in Chapter 11.0:

- Alternative 1 – Deep Storage Tunnel
- Alternative 2 – Satellite High Rate Treatment
- Alternative 3 – Sewer Separation
- Alternative 4 – Phased High Rate Treatment and Deep Storage Tunnel

After evaluating the potential alternatives, it was determined that Alternative 4 was the most cost effective solution and best approach for the City of St. Joseph.



However, as initially conceived, Alternative 4 still allowed 18 overflows per year so additional phases for Alternative 4 were developed to provide for additional overflow control. The final phase of Alternative 4 was developed to meet the presumptive level of control for the EPA CSO Control Policy or four overflow events per year. Alternative 4 with the following additional phases are described in detail in Chapter 11.0:

- Alternative 4 Phase I – fundamental projects, WWTP headworks improvements, Whitehead Pump Station improvements, high rate treatment facility at WWTP, flow equalization basins at Patee and Missouri Avenue.
- Alternative 4 Phase II – Alternative 4 with deep tunnel addition.
- Alternative 4 Phase III – Alternative 4 Phase II with high rate clarification addition.

To quantify the benefits of Alternative 4 and the additional phases, CSS modeling was performed for the design storm events A through H. Phase I of Alternative 4 reduces the volume of CSS overflows to approximately 1.2 billion gallons and the number of overflow events to 18 per year. After evaluating the results of this phase, an option was discussed to reduce the number of overflow events to 12 per year by adding storage at Patee and Missouri Avenue. However, detailed modeling was not done to quantify the reduction of overflow as it is uncertain if this is needed at this time. The deep tunnel in Phase II of Alternative 4 was designed to limit the number of overflow events to six per year, while Alternative 4 Phase III was designed to limit the number of overflow events to four per year. Results of the detailed modeling of Alternative 4 with additional phases are provided in Tables 9.8 through 9.10.



Table 9.8
Alternative 4 Phase I – Typical Year Overflow Volume

Event	Events Equal to or Greater Than	Overflow Volume, MG	Average Overflow Volume, MG	Events in this Range	Overflow Volume for Range, MG
Less than A	78	0			
			0	42	0
A	36	0			
			0	18	0
B	18	0			
			2.45	6	14.71
C	12	4.90			
			29.37	6	176.19
D	6	53.83			
			81.36	2	162.72
E	4	108.89			
			123.45	1	123.45
F	3	138.01			
			170.28	1	170.28
G	2	202.54			
			252.88	1	252.88
H	1	303.23			
			303.23	1	303.22
			Total	18	1,203.45

Note: Additional flow equalization basin storage at both Patee (1 MG) and Missouri Avenue (5 MG) was evaluated. If these storage basins were added to this proposed scenario, the system overflow event frequency would be reduced to 12 overflow events per year and the overflow volume would be reduced to ~1,150 MG, which equates to ~65% estimated basin-wide annual capture during precipitation events.
 MG – Million Gallons



Table 9.9
Alternative 4 Phase II – Typical Year Overflow Volume

Event	Events Equal to or Greater Than	Overflow Volume, MG	Average Overflow Volume, MG	Events in this Range	Overflow Volume for Range, MG
Less than A	78	0			
			0	42	0
A	36	0			
			0	18	0
B	18	0			
			0	6	0
C	12	0			
			0	6	0
D	6	0			
			14.18	2	28.36
E	4	28.36			
			40.77	1	40.77
F	3	53.17			
			84.12	1	84.12
G	2	115.07			
			161.01	1	161.01
H	1	206.94			
			206.94	1	206.94
			Total	6	521.19

MG – Million Gallons



Table 9.10
Alternative 4 Phase III – Typical Year Overflow Volume

Event	Events Equal to or Greater Than	Overflow Volume, MG	Average Overflow Volume, MG	Events in this Range	Overflow Volume for Range, MG
Less than A	78	0			
			0	42	0
A	36	0			
			0	18	0
B	18	0			
			0	6	0
C	12	0			
			0	6	0
D	6	0			
			0	2	0
E	4	0			
			7.85	1	7.85
F	3	15.71			
			43.73	1	43.73
G	2	71.75			
			118.40	1	118.40
H	1	165.06			
			165.06	1	165.06
			Total	4	335.04

MG – Million Gallons

9.8 References

USEPA (1993) *Combined Sewer Overflow Manual*

USEPA (1999) *Combined Sewer Overflow – Guidance for Monitoring and Modeling*



10.0 Water Quality Modeling

10.1 Introduction

The QUAL2K program was used to develop a water quality model of the Missouri River at St. Joseph. The model evaluated the effect of combined sewer overflows (CSOs) on water quality in the river for critical wet-weather flow conditions. QUAL2K is intended to represent a modernized version of the QUAL2E model (Brown and Barnwell 1987). The model is packaged as a Microsoft Excel Workbook with the program written in Excel's macro language Visual Basic for Applications.

The critical wet-weather flow condition was defined as the river flowing at a 7Q10 low flow while at the same time localized rainfall events cause the CSOs to discharge to the river. The 7Q10 flow is the average of the lowest seven consecutive days of flow expected to occur once every 10 years. The U.S. Army Corps of Engineers (COE) manages flows on the Missouri River as described in the Missouri River Master Water Control Manual. The Master Water Control Manual establishes a navigation season of April through November and a non-navigation season of December through March. The 7Q10 flow at St. Joseph for the navigation period is substantially higher than the 7Q10 flow for the non-navigation period. The model was run for both flow conditions to predict the impact on water quality for each season. For each season, the model was used to simulate four cases: the existing combined sewer system (CSS) and the CSS with improvements described as Alternative 4 – Phases I, II, and III. The alternatives considered as part of this study are presented in Chapter 11.0.

Of primary interest to this study was the effect of the CSOs on dissolved oxygen (DO) and *E. coli* (EC) concentrations in the river. Carbonaceous biochemical oxygen demand (CBOD) and ammonia were also of interest because these constituents cause depletion of dissolved oxygen. The model study area included a 100 km (62 mile) reach of the Missouri River beginning just upstream of the most upstream CSO in St. Joseph.



10.2 Hydraulic Model

The CSS was hydraulically modeled using XP-SWMM, which was adapted from the XP-SWMM model previously developed by Black & Veatch for the 1999 Comprehensive Stormwater Management Plan. The CSS encompasses the eight major watersheds shown on Figure 10.1.

The water quality model was based on CSO discharges to the Missouri River at the following 13 diversion structures (outfalls) as indicated on Figure 10.1 in order from north to south: Blacksnake Creek, Francis, Charles, Messanie, Patee, Olive, Mitchell, Duncan, Maple, Hickory, Whitehead Creek, Missouri Avenue, and Brown's Branch. The Roy's Branch CSO was not included since this watershed is being sewer separated, and the Walnut CSO has been closed by the City.

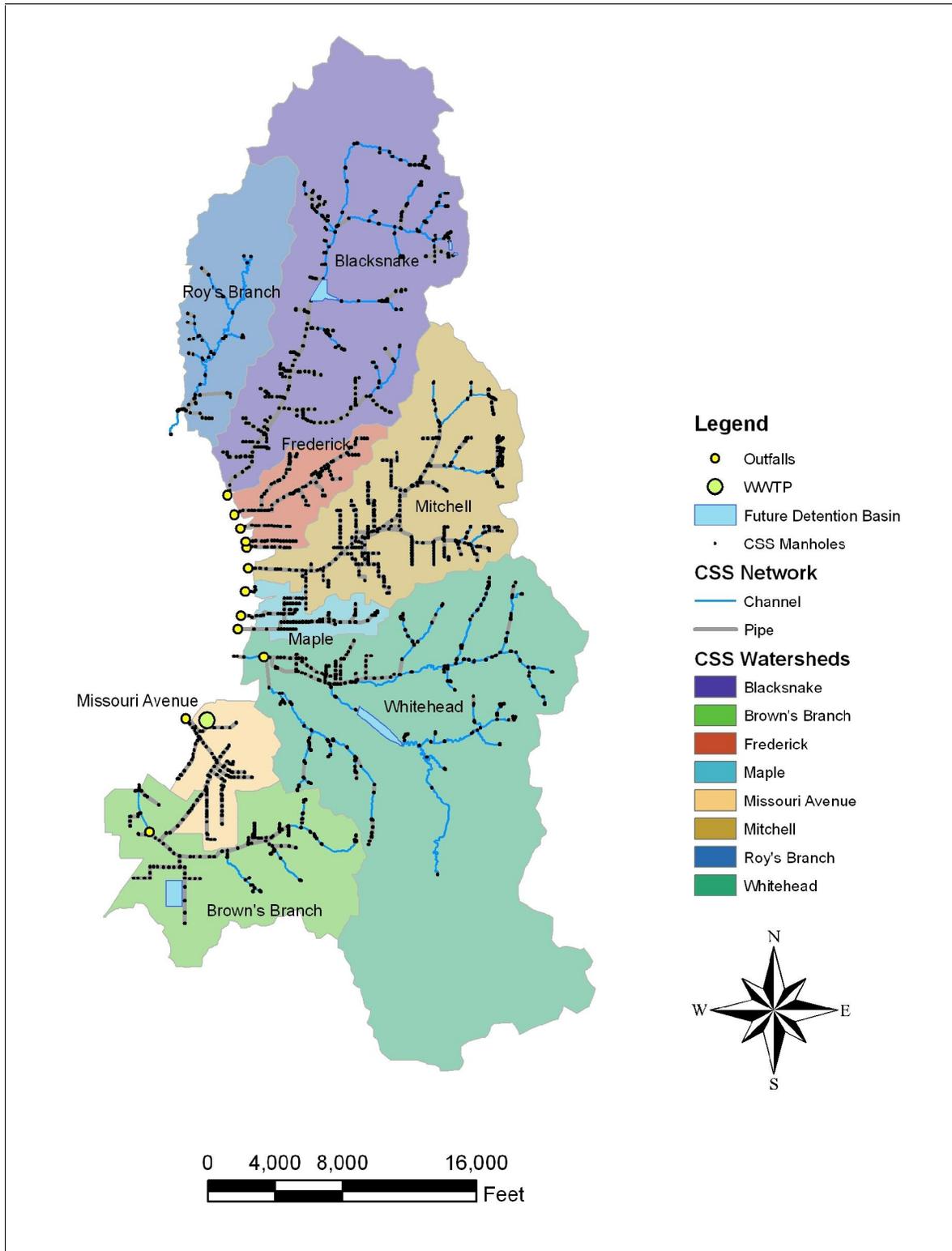


Figure 10.1 St. Joseph CSS System



10.3 Water Quality Model

10.3.1 Model Application

QUAL2K is a one-dimensional, steady-state program, which is similar to QUAL2E in that the program has the capability to simulate carbonaceous, nitrogenous, and benthic oxygen demands, atmospheric reaeration, and the effects of these processes on the dissolved oxygen in the receiving stream. The program also has the capability to simulate other non-conservative substances, such as *E. coli* (EC), which along with the decay of ammonia and CBOD, is assumed to undergo first-order decay in the receiving stream.

The QUAL2K model was developed to simulate dissolved oxygen and EC concentrations in the river from discharges of CBOD, ammonia, and EC in the CSOs. Chlorophyll *a*, a constituent of the algae cell, was not simulated because the algal contribution to dissolved oxygen on an average daily basis was considered negligible. Water temperature was included as a conservative constituent, which was affected only by assumed river temperatures and CSO inputs to the model. Water temperature is important because CBOD and ammonia decay rates and other model parameters are based on temperature.

The headwaters is defined as the most upstream river location in the model. For purposes of this study, the headwaters corresponds to the Missouri River Mile 451, which was set to a reference point of 100 km. The headwaters is located 1.6 km (1 mile) upstream from the most upstream CSO, Blacksnake Creek. It was necessary for the model reach to be at least 100 km (62 miles) in length in order to identify the location of the DO sag (minimum downstream DO concentration).

Application of the QUAL2K model involved dividing the entire 100 km study reach into 36 computational reaches. Each reach was assumed to have uniform hydraulic characteristics. COE cross-sections of the river channel were only available for the most upstream 25.6 km (16 miles) of the river, so it was assumed that the most downstream cross-section available was representative of the next 74.4 km.



QUAL2K calculates velocities and depths for any river flow using the following equations:

$$V = aQ^b$$

where: V = River velocity, ft/sec
Q = Discharge, cfs
a, b = Empirical constants

$$D = cQ^d$$

where: D = River average depth, ft
Q = Discharge, cfs
c, d = Empirical constants

Based on the COE cross sections, a HEC-RAS hydraulic model of the study reach was constructed, and the model was used to calculate the information needed to develop the velocity and depth coefficients and exponents defined in the above equations for each computational reach.

The width of the Missouri River channel in the study area is approximately 180 to 200 meters (600 to 700 feet). Given the great width of the river, it was not considered appropriate to assume that the CSOs would mix completely across the entire width of the channel at their points of discharge. The channel cross-sections indicate that a deeper navigation channel exists along the east bank, where all of the CSOs and wastewater treatment plant (WWTP) are located. At a point 15.8 km (9.8 miles) downstream of the model headwaters, the navigation channel crosses the river and continues downstream along the west bank. For purposes of configuring the model, it was assumed that mixing of the CSOs and WWTP would be limited to the navigation channel or 25 percent of the channel cross sectional area of river flow. At 15.8 km, it was assumed that the river becomes completely mixed with the remaining 75 percent of the river flow.



10.3.2 Model Inputs

Inputs to the QUAL2K model consist of the following flows and their associated concentrations of CBOD, ammonia, and EC:

- 25 percent river headwaters
- 75 percent river downstream
- Peak CSOs
- WWTP

It was assumed that the peak flows from the hydrographs generated by the CSS model would result in the maximum constituent loadings and therefore the maximum constituent concentrations in the river. The combined loadings of CBOD and ammonia would result in the minimum downstream DO concentration (sag).

10.3.2.1 CSO Water Quality

Concentrations of CBOD, ammonia, and EC in the CSOs were based on sampling data collected from 34 storm events from March to October 2007 at the following CSO locations:

- Blacksnake Creek
- Mitchell
- Messanie
- Whitehead Creek
- Brown's Branch

Rainfall data concurrent with the sampling data were obtained at the five locations indicated with stars on Figure 10.2.

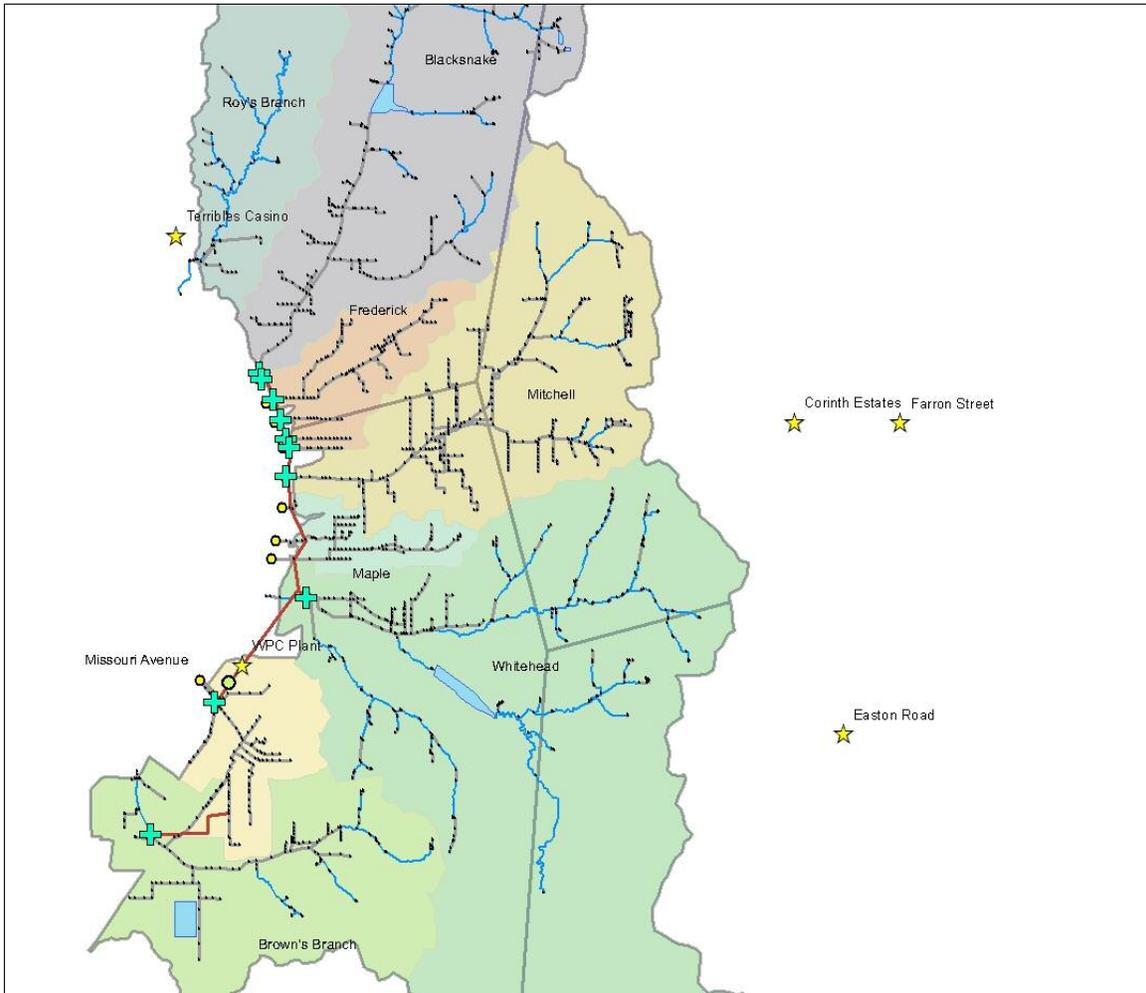
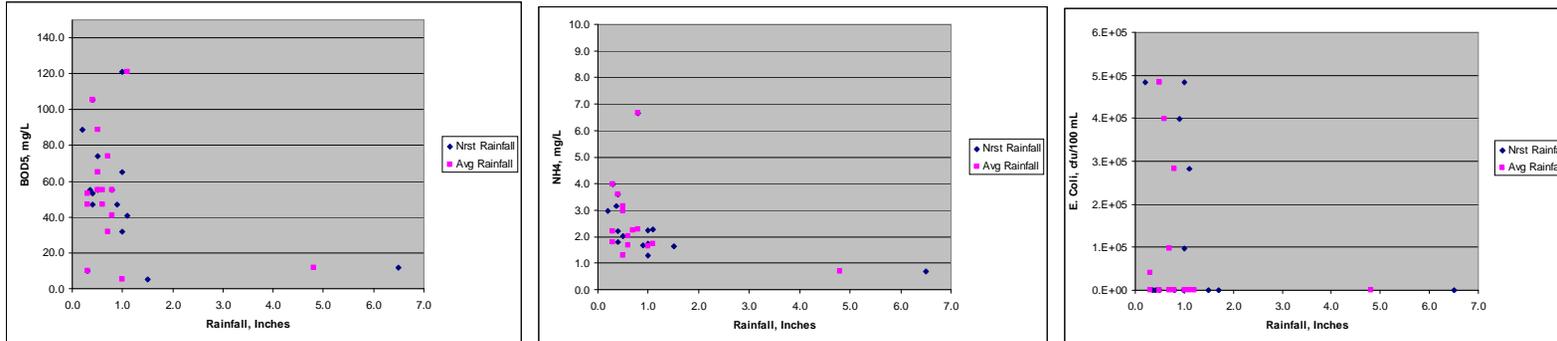


Figure 10.2 Rainfall Stations

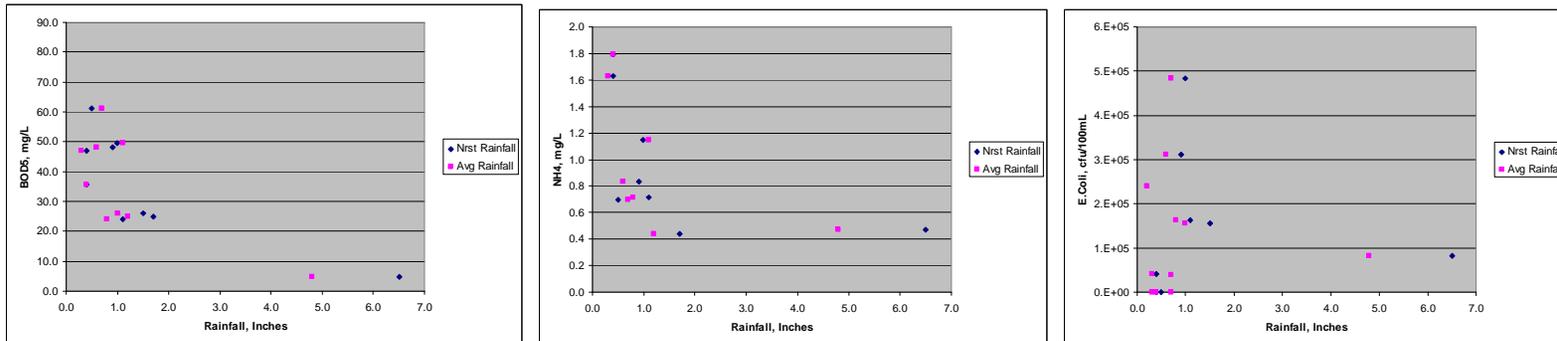
Over the course of the 34 sampling events, the 24-hour total rainfall depths ranged from 0.1 inch to 6.5 inches. For each CSO sampling station, CBOD, ammonia, and EC concentrations were plotted with respect to the concurrent rainfall depths using both the average depth measured at the rainfall station nearest the sampling station and the average depth measured at all the rainfall stations. The samples were also analyzed for fecal coliform, but the concentrations for each of the samples exceeded the detection limit because the colony forming units (cfu) were too numerous to count. Figure 10.3 includes the plots of CBOD₅, ammonia, and EC versus rainfall depth for each sampling station.



Blacksnake Creek



Messanie



Mitchell

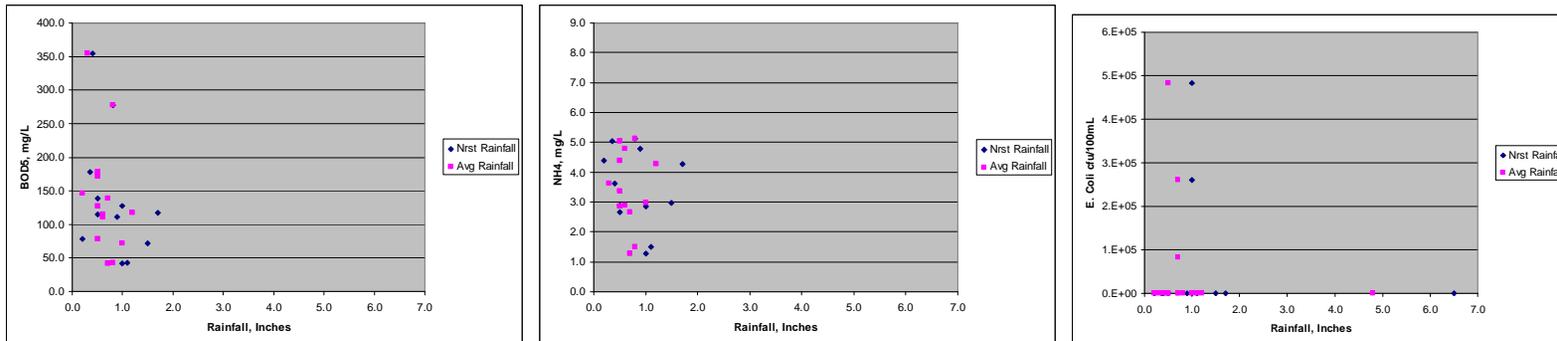
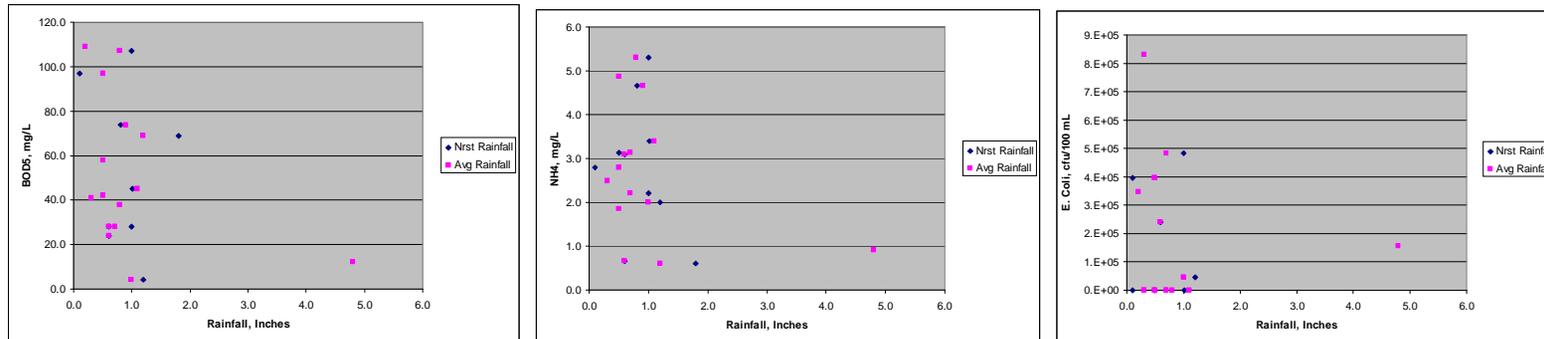


Figure 10.3 Rainfall Versus CSO Pollutant Concentrations



Whitehead Creek



Brown's Branch

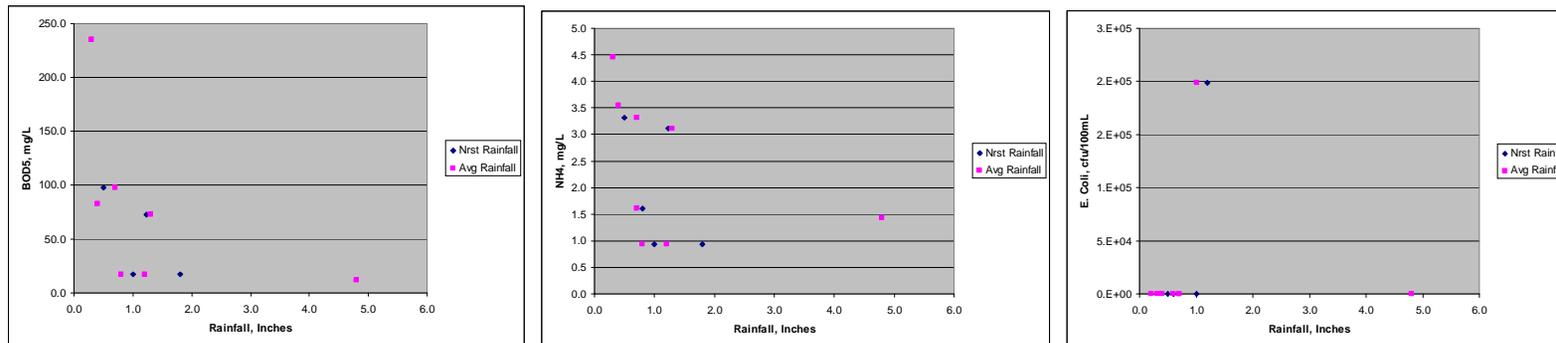


Figure 10.3 Rainfall Versus CSO Pollutant Concentrations (Continued)



The plots suggest trends of decreasing constituent concentrations with increasing rainfall depths for each constituent. EC concentrations too numerous to count were plotted as zero and therefore not noted as part of the trend. Generally, the CBOD₅ and ammonia concentrations for the Mitchell CSO were the highest, while these concentrations for the Messanie CSO were the lowest. EC concentrations were the highest for Whitehead Creek and lowest for Brown's Branch.

The plots were used to estimate event mean concentrations for each of the typical year storm event depths, A through H. The typical storm events are described in Chapter 9.0. It was assumed that the Blacksnake Creek constituent concentrations were representative of the nearby Frances and Charles CSOs; Messanie was representative of Patee and Olive; Mitchell was representative of Duncan; Whitehead Creek was representative of Hickory and Maple; and Brown's Branch was representative of Missouri Avenue. Based on the trends observed in Figure 10.3, CSO constituent concentrations associated with each storm event, A through H, are presented in Table 10.1.



Table 10.1
Constituent Concentrations Associated with Each Storm Event

	Event A = 0.29 inch			Event B = 0.51 inch			Event C = 0.86 inch			Event D = 1.41 inch		
	CBOD ₅	Ammonia	<i>E. coli</i>									
	mg/L	mg/L	cfu/100mL									
Basin												
Blacksnake	120	5	5.5E+05	110	3.5	5.0E+05	80	2.5	3.0E+05	25	1.5	1.5E+05
Frances	120	5	5.5E+05	110	3.5	5.0E+05	80	2.5	3.0E+05	25	1.5	1.5E+05
Charles	120	5	5.5E+05	110	3.5	5.0E+05	80	2.5	3.0E+05	25	1.5	1.5E+05
Messanie	65	1.7	6.0E+05	55	1.4	5.0E+05	50	1.2	5.0E+05	40	0.5	3.0E+05
Patee	65	1.7	6.0E+05	55	1.4	5.0E+05	50	1.2	5.0E+05	40	0.5	3.0E+05
Olive	65	1.7	6.0E+05	55	1.4	5.0E+05	50	1.2	5.0E+05	40	0.5	3.0E+05
Mitchell	375	5.5	5.5E+05	350	5.0	5.0E+05	275	3.5	3.0E+05	125	2.0	2.0E+05
Duncan	375	5.5	5.5E+05	350	5.0	5.0E+05	275	3.5	3.0E+05	125	2.0	2.0E+05
Maple	190	5.5	8.5E+05	170	5.0	8.0E+05	150	4.0	5.0E+05	80	2.0	2.0E+05
Hickory	190	5.5	8.5E+05	170	5.0	8.0E+05	150	4.0	5.0E+05	80	2.0	2.0E+05
Whitehead	190	5.5	8.5E+05	170	5.0	8.0E+05	150	4.0	5.0E+05	80	2.0	2.0E+05
MO Ave	250	4.5	2.5E+05	200	3.5	2.0E+05	100	2.0	1.5E+05	75	1.0	1.0E+05
Brown's Br	250	4.5	2.5E+05	200	3.5	2.0E+05	100	2.0	1.5E+05	75	1.0	1.0E+05
	Event E = 1.82 inch			Event F = 2.00 inch			Event G = 2.37 inch			Event H = 2.88 inch		
	CBOD ₅	Ammonia	<i>E. coli</i>									
	mg/L	mg/L	cfu/100mL									
Basin												
Blacksnake	20	1.2	1.0E+05	15	0.6	5.0E+05	10	0.5	5.0E+05	7	0.4	5.0E+05
Frances	20	1.2	1.0E+05	15	0.6	5.0E+05	10	0.5	5.0E+05	7	0.4	5.0E+05
Charles	20	1.2	1.0E+05	15	0.6	5.0E+05	10	0.5	5.0E+05	7	0.4	5.0E+05
Messanie	25	0.4	1.5E+05	18	1.0	8.0E+04	15	0.8	7.5E+04	10	0.7	5.0E+04
Patee	25	0.4	1.5E+05	18	1.0	8.0E+04	15	0.8	7.5E+04	10	0.7	5.0E+04
Olive	25	0.4	1.5E+05	18	1.0	8.0E+04	15	0.8	7.5E+04	10	0.7	5.0E+04
Mitchell	110	1.9	1.8E+05	100	1.8	1.5E+05	50	1.0	5.0E+04	25	0.5	2.5E+04
Duncan	110	1.9	1.8E+05	100	1.8	1.5E+05	50	1.0	5.0E+04	25	0.5	2.5E+04
Maple	50	1.0	1.5E+05	40	0.8	1.0E+05	30	0.7	1.0E+05	20	0.5	5.0E+04
Hickory	50	1.0	1.5E+05	40	0.8	1.0E+05	30	0.7	1.0E+05	20	0.5	5.0E+04
Whitehead	50	1.0	1.5E+05	40	0.8	1.0E+05	30	0.7	1.0E+05	20	0.5	5.0E+04
MO Ave	50	0.8	5.0E+04	40	0.6	4.0E+04	25	0.5	3.0E+04	10	0.4	2.0E+04
Brown's Br	50	0.8	5.0E+04	40	0.6	4.0E+04	25	0.5	3.0E+04	10	0.4	2.0E+04



10.3.2.2 CSO Flows and Constituent Loadings to River

Table 10.2 summarizes the locations of each of the inputs to the model relative to the reference headwaters location of 100 km. The most downstream location in the model was at km 0.0. The river flows were based on the 7Q10 low flows in the river, which is 303 cms (10,700 cfs) for the non-navigation season and 683 cms (24,100 cfs) for the navigation season. These flows were provided by the Kansas City District COE. Since the first 15.8 km of the model was based on 25 percent of the channel, the model headwater flows were set at 76 cms (2,675 cfs) and 171 cms (6,025 cfs) for non-navigation and navigation flows, respectively. The remaining 75 percent of the flows, 227 cms (8,025 cfs) and 512 cms (18,075 cfs) for non-navigation and navigation flows, respectively, were input to the model as point sources at km 84.2, which is indicated in Table 10.2 as “Full Flow.”

Input	km
Blacksnake Creek	96.8
Francis	96.3
Charles	96.5
Messanie	96.1
Patee	96.0
Olive	95.7
Mitchell	95.3
Duncan	94.9
Maple	94.5
Hickory	94.2
Whitehead Creek	93.9
Wastewater Treatment Plant	92.8
Missouri Avenue	91.7
Brown’s Branch	91.6
Full Flow	84.2

Table 10.3 presents the water quality assumptions for the model headwaters and full flow inputs. Water temperature is an important input to the model because the DO saturation concentrations decrease with increasing water temperature, and BOD and ammonia decay rates increase with increasing water temperature. Therefore, the lowest DO



concentrations usually occur during the warmest months. The warmest months in the navigation season were July and August, and 25°C (77°F) was also assumed for the CSOs and WWTP water temperature inputs. For the non-navigation season, March was assumed to be the warmest month, and a water temperature of 4.8 °C was also assumed for the CSOs and WWTP temperature inputs. The values in Table 10.3 are based on the USGS monitoring station at St. Joseph (Station Number 06818000).

	CBOD₅	NH₄⁺	EC	Temp.
	mg/L	mg/L-N	cfu/100mL	°C
Navigation	2.5	0.16	500	25
Non-Navigation	2.5	0.16	500	4.8

Table 10.4 presents the peak CSO flows for the existing CSS and Alternative 4 – Phases I, II, and III for each of the storm events A through H. The CSS model used to develop these flows is described in Chapter 9.0. The flows were multiplied by their respective CBOD, ammonia, and EC concentrations in Table 10.1 to determine which of the events would result in the maximum loadings to the river for each of the existing CSS and the three improvement phases. The CBOD₅ concentrations in Table 10.1 were multiplied by 2.0 to convert the values to ultimate CBOD, which is required by the model.

Based on water quality modeling for the existing CSS and proposed Phase I improvements, the maximum total CBOD, ammonia, and EC loadings from all the CSOs are associated with Event F. This assumes that the peak flows for each of the CSOs occur at approximately the same time. For Phase II improvements, Event G resulted in the maximum loadings, and for Phase III improvements, Event H produced the maximum loadings, although less than the maximum loadings for Phase II. The storm event associated with the maximum CBOD and ammonia loadings for each case resulted in the lowest DO concentrations in the river, and the event associated with the maximum EC loadings for each case resulted in the highest EC concentrations in the river compared to any of the lesser events.



Table 10.4
Peak CSO Flows for Storm Events and Improvement Alternatives

	Event A				Event B				Event C				Event D			
	Existing	Alt 4-P1	Alt 4-P2	Alt 4-P3	Existing	Alt 4-P1	Alt 4-P2	Alt 4-P3	Existing	Alt 4-P1	Alt 4-P2	Alt 4-P3	Existing	Alt 4-P1	Alt 4-P2	Alt 4-P3
Basin	mgd															
Blacksnake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.26	0.00	0.00	0.00	126.14	49.09	0.00	0.00
Frances	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Charles	0.10	0.00	0.00	0.00	9.56	0.00	0.00	0.00	28.59	0.00	0.00	0.00	86.30	160.24	0.00	0.00
Messanie	0.60	0.00	0.00	0.00	2.29	0.00	0.00	0.00	5.60	0.02	0.00	0.00	13.00	16.58	0.00	0.00
Patee	0.00	0.00	0.00	0.00	1.35	0.00	0.00	0.00	3.79	7.62	0.00	0.00	11.59	18.47	0.00	0.00
Olive	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	2.44	0.00	0.00	0.00	6.01	0.00	0.00	0.00
Mitchell	0.00	0.00	0.00	0.00	18.86	0.00	0.00	0.00	41.10	0.00	0.00	0.00	158.55	164.32	0.00	0.00
Duncan	0.68	0.00	0.00	0.00	1.91	0.00	0.00	0.00	4.61	1.80	0.00	0.00	9.07	9.89	0.00	0.00
Maple	0.00	0.00	0.00	0.00	2.13	0.00	0.00	0.00	7.51	0.63	0.00	0.00	27.57	20.07	0.00	0.00
Hickory	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	4.89	0.00	0.00	0.00	13.91	10.51	0.00	0.00
Whitehead	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.93	0.00	0.00	0.00	312.86	99.50	0.00	0.00
MO Ave	0.00	0.00	0.00	0.00	10.83	0.00	0.00	0.00	34.12	52.05	0.00	0.00	104.62	127.00	0.00	0.00
Brown's Br	0.00	0.00	0.00	0.00	2.21	0.00	0.00	0.00	30.54	0.00	0.00	0.00	128.80	410.74	0.00	0.00
	Event E				Event F				Event G				Event H			
	Existing	Alt 4-P1	Alt 4-P2	Alt 4-P3	Existing	Alt 4-P1	Alt 4-P2	Alt 4-P3	Existing	Alt 4-P1	Alt 4-P2	Alt 4-P3	Existing	Alt 4-P1	Alt 4-P2	Alt 4-P3
Basin	mgd															
Blacksnake	284.46	110.12	0.00	0.00	373.47	177.25	56.90	8.53	613.04	278.50	42.79	28.73	854.41	489.27	292.08	67.65
Frances	0.17	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.59	0.00	0.00	0.00	1.02	0.00	0.00	0.00
Charles	143.12	142.35	0.00	0.00	196.51	193.76	0.00	0.00	237.82	235.51	0.00	0.00	330.60	331.02	319.85	0.00
Messanie	19.90	26.30	47.10	0.00	29.14	30.39	104.99	23.97	30.54	30.95	93.91	94.17	40.58	44.01	142.99	97.09
Patee	18.02	26.57	100.71	0.00	23.41	30.31	111.82	6.25	28.44	35.38	108.26	8.25	38.37	45.82	125.74	7.92
Olive	8.18	0.75	0.00	0.00	10.10	2.38	0.65	0.00	11.90	4.13	0.00	0.00	16.26	6.89	4.84	0.00
Mitchell	288.09	291.01	0.00	0.00	396.43	407.84	0.00	0.00	606.97	613.19	766.70	0.00	1022.15	984.22	1385.34	1162.49
Duncan	12.71	14.99	18.44	0.00	15.45	16.85	20.04	16.25	17.72	16.47	20.28	20.31	22.06	18.84	22.17	20.60
Maple	46.00	37.56	20.84	0.00	62.53	50.51	55.31	2.79	79.29	66.14	26.58	55.55	112.86	98.47	88.11	72.60
Hickory	24.68	20.19	79.18	0.00	34.53	25.83	115.28	33.90	44.98	37.67	89.29	113.84	65.97	69.18	148.27	135.88
Whitehead	623.15	228.51	197.81	0.00	822.91	293.84	340.64	110.07	1258.47	500.21	361.98	343.48	2082.82	860.21	524.71	555.14
MO Ave	157.78	159.00	3.84	0.00	202.20	200.17	245.47	19.55	242.27	272.86	457.01	239.92	316.52	321.14	443.16	431.23
Brown's Br	210.19	555.08	0.00	0.00	283.79	542.23	0.00	0.00	388.19	434.13	517.03	366.87	576.30	548.66	462.36	407.89



10.3.2.3 WWTP and Proposed High Rate Treatment Constituent Loadings to River

Each of the three Alternative 4 improvement phases includes CSO treatment with high rate treatment (HRT) to increase the wet weather treatment capacity at the WWTP. Table 10.5 summarizes the influent and effluent flows and associated constituent concentrations for the existing WWTP and proposed HRT facility. For example, for the existing CSS loading condition, the maximum allowable flow to the WWTP is 27 mgd. As discussed in the previous section, the maximum load for the existing CSS occurs with Event F, as indicated in the table. The flow-weighted average CBOD₅, NH₄, and EC concentrations of all the CSOs for storm event F is approximately 66 mg/L, 1.4 mg/L, and 300,000 cfu/100 mL, respectively. It was assumed that these concentrations represent the average influent concentrations to the WWTP during wet weather events.

For the existing condition, it was assumed that the WWTP would reduce influent CBOD₅ to an event average of 25 mg/L; the effluent ammonia would not change from the influent ammonia since the concentration is already very low, and it is expected that the WWTP would provide negligible additional treatment of ammonia. EC would not change since the WWTP currently does not disinfect the plant effluent. However, disinfection would be required for the WWTP and high rate treatment unit for the three Alternative 4 phases. Following disinfection, EC would be treated to an average effluent concentration of 230 cfu per 100 mL, which is the expected discharge permit concentration. The combined WWTP and high rate treatment effluent flows and associated constituent concentrations indicated in Table 10.5 were inputs to the river model for each of the loading conditions. No additional point source loadings from other possible WWTPs or tributaries to the Missouri River in the 100 km study reach were included in the model.



**Table 10.5
 WWTP and High Rate Treatment Loadings to the River**

Loading Condition	Influent						Combined Effluent		
	WWTP mgd	HRT mgd	CBOD ₅ mg/L	NH ₄ mg/L	<i>E. coli</i> cfu/100mL	Flow mgd	CBOD ₅ mg/L	NH ₄ mg/L	<i>E. coli</i> cfu/100mL
Existing CSS (Event F)	27	0	66	1.4	300,000	27	25	1.4	300,000
Alt 4 - Phase 1 (Event F)	34	54	66	1.4	300,000	88	25	1.4	230
Alt 4 - Phase 2 (Event G)	34	54	60	1.5	400,000	88	25	1.5	230
Alt 4 - Phase 3 (Event H)	34	189	55	1.6	500,000	223	25	1.6	230

10.3.3 Water Quality Model Calibration

Water quality sampling in the river concurrent with the sampling of the CSOs described in Section 10.3.2.1 was not conducted. Therefore, the model was calibrated based on commonly used model variables provided in *Rates, Constants, and Kinetic Formulations in Surface Water Quality Modeling* (EPA/600/3-85/040, June 1985). Important model calibration variables include the dissolved oxygen reaeration equation and CBOD, ammonia, and EC decay rates.

The QUAL2K program allows the user to select from three reaeration model options. Given expected velocities and depths in the river, the Churchill model was considered to be the most appropriate. Decay rates for CBOD, ammonia, and fecal coliform were assumed at 0.4 per day, 0.2 per day, and 2.0 per day respectively. A complete list of model calibration variables is included in Appendix G.

10.3.4 Water Quality Standards

Discharges from the CSOs and the WWTP have the potential for adversely affecting the aquatic life use by increasing organic material (CBOD and ammonia) and reducing the dissolved oxygen concentration in the river. 10-CSR-20-7.031 indicates water contaminants shall not cause the dissolved oxygen to be lower than 5 mg/L for warm water fisheries, which is one of the designated uses for the river.

When the 2002 Long Term Control Plan was submitted, the recreational designation of the Missouri River in the study area was Secondary Contact Recreation (SCR). The current designation also includes Whole Body Contact – Category B (WBC-B). Table 10.6 indicates that the EC criterion for the WBC-B classification is 548 cfu/100ml, which is the



geometric mean of all river samples obtained during the recreational season of April 1 through October 31. The EC criterion for WBC-B is substantially less than the SCR criterion. There is no fecal coliform criterion for WBC-B.

	Fecal Coliform	<i>E. coli</i>
Classification	cfu/100 mL	cfu/100 mL
WBC-B	NC	548
SCR	1,800	1,134

10.3.5 Model Results

10.3.5.1 Dissolved Oxygen

Figure 10.4 presents a plot of the average daily DO model results for the existing CSS and the three Alternative 4 phases for the storm events associated with the maximum CBOD and ammonia loadings to the river for the navigation season. The most upstream point in the model reach is at 100 km. Because of the high organic loading from the combined CSOs, the DO concentration decreases sharply down to a point (km 85) where the remaining river flow with relatively high DO causes a sharp increase in DO. However, the remaining CBOD and ammonia concentrations downstream of km 85 are sufficient to cause a steady, significant decline in DO concentration. The minimum DO concentrations (sag) for each of the cases occurred at the most downstream location, km 0.

As expected, the lowest DO concentration of 3.8 mg/L is associated with the existing CSS, Event F. Since the improvement phases reduce the CSO loadings, the DO concentrations increase with each phase. Only Phase III, Event H would result in a minimum DO concentration of more than 5 mg/L, the water quality criterion. Therefore, only the Phase III improvements would provide enough control of the CSOs to keep the DO concentration in the river above 5 mg/L during a typical year.

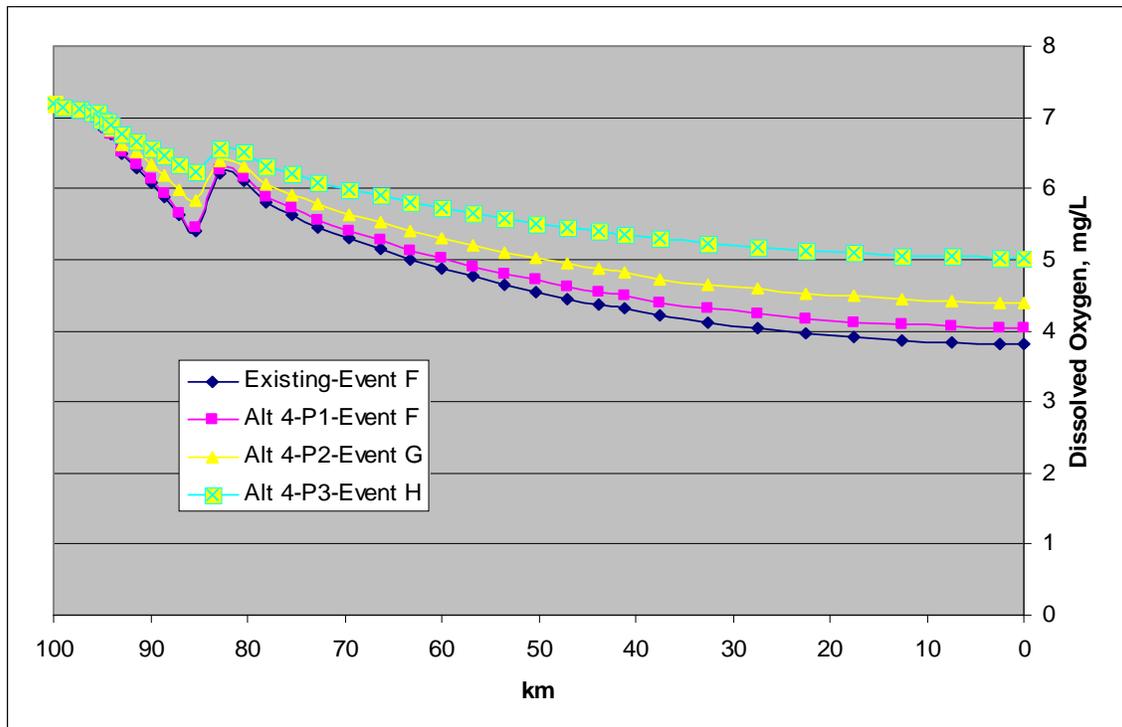


Figure 10.4 Average Daily River Dissolved Oxygen for Existing CSS and Alternative 4 Phases for Maximum Loading Events – Navigation Season

Water quality modeling was performed for Alternative 4 – Phase I, II, and III for Event E flows to demonstrate river water quality for the presumptive approach improvements. It is assumed that CSO improvements for Event E flows will meet the presumptive approach requirements. Figure 10.5 is a plot of the model results for each case for Event E only. There are significant increases in DO concentration for Phases II and III compared to the phases in Figure 10.4, and the minimum DO for the Phase II alternative is now well above 5 mg/L. However, the difference in DO between the two figures for the existing CSS and Phase I is not as significant. The difference in DO shown in Figure 10.5 between the existing CSS and Phase I is minimal. As expected, the model also indicated that the DO concentrations in the river for the lower-loading Events A through D were even higher than Event E, which is expected to occur only one time during a typical year. Event G is also expected to occur only once per year out of a total of 78 events per year, so the exposure of the river to DO below the water quality criterion for Phase II is infrequent.



Therefore, the Phase II improvements would provide sufficient treatment of CBOD and ammonia to keep the DO concentration in the river above the water quality criterion for all but one storm event during a typical year. In addition, Phase II improvements are expected to provide capture and treatment of 84 percent of the total CSS volume during a typical year.

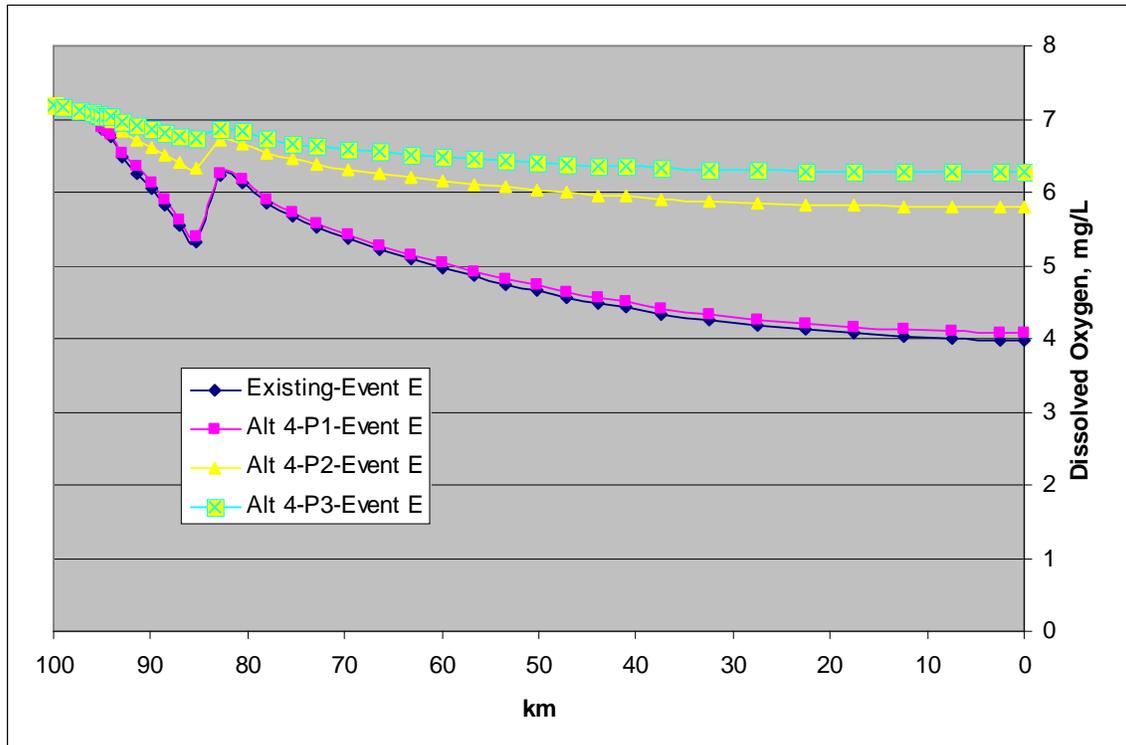


Figure 10.5 River Dissolved Oxygen for Existing CSS and Alternative 4 Phases for Events E – Navigation Season

DO concentrations in the river are most directly impacted by the decay of CBOD and ammonia. Figures 10.6 and 10.7 are the CBOD ultimate and ammonia profiles for the existing CSS and the three Alternative 4 phases at the maximum loading events. The maximum CBOD and ammonia concentrations occur at km 91.5, which is just downstream of the Brown’s Branch CSO and near the WWTP. The relatively low concentrations CBOD and ammonia of the remaining flow entering at km 85 cause a sharp decrease in concentrations.



The DO concentrations in the river were determined to be most sensitive to the decay rate of CBOD, which was assumed at 0.4 per day without the benefit of calibration data. To check the sensitivity of the CBOD of the decay rate, two additional runs for the existing CSS, Event F case were conducted:

- For a decay rate of 0.2 per day, which is a 50 percent reduction, the minimum DO concentrations increased from 3.8 mg/L to 5.3 mg/L.
- For a decay rate of 0.6 per day, which is a 50 percent increase, the minimum DO concentrations decreased to 3.0 mg/L.

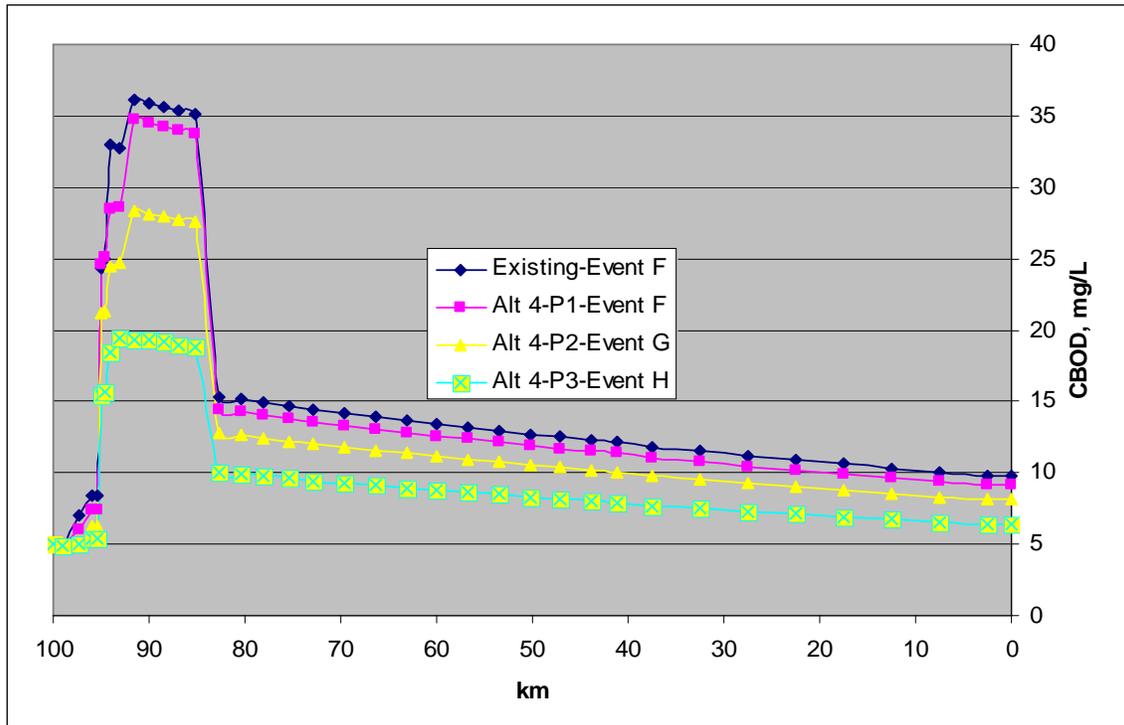


Figure 10.6 River CBOD Ultimate for Existing CSS and Alternative 4 Phases for Maximum Loading Events – Navigation Season

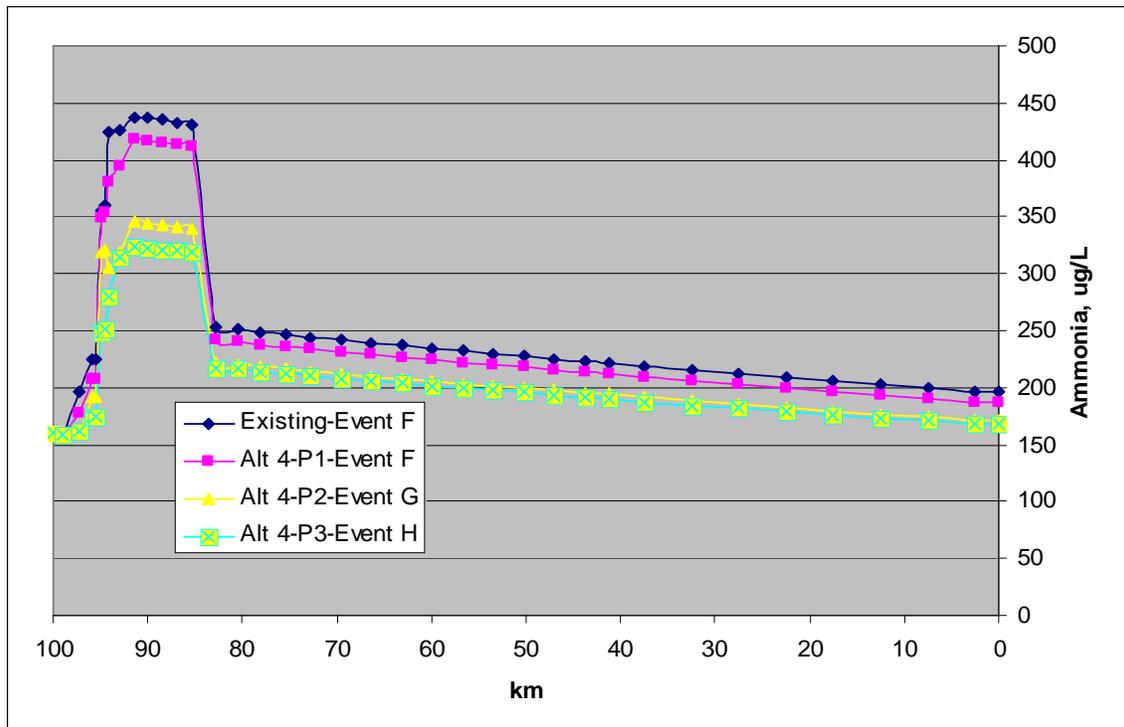


Figure 10.7 River Ammonia for Existing CSS and Alternative 4 Phases for Maximum Loading Events – Navigation Season

Based on Black & Veatch experience with other similar applications with a calibrated model, it is expected that a calibrated decay rate would fall somewhere between 0.2 and 0.6 per day; the decay rate is more likely to be lower rather than higher than the modeled 0.4 per day. Therefore, the model results for each of the cases may be conservative in that the model may have under predicted the DO concentrations. However, the relative differences in DO concentrations among the loading cases are more significant than the absolute concentrations.

The model was also run for the non-navigation period for the existing CSS Event F case assuming the non-navigation flows previously discussed and the water quality in Table 10.3. The minimum DO concentrations increased from 3.8 to 6.6 mg/L. Although the non-navigation flow in the river was lower, providing less dilution of the CSOs, the primary reason for the increase in DO was the decrease in assumed water temperature which reduced the decay rates for CBOD and ammonia and increased the DO saturation



concentration. Therefore, the minimum DO concentrations for the existing CSS and the three Alternative 4 phases would be expected to be above the DO water quality criterion. The critical condition for DO is during the navigation season months of July and August.

10.3.5.2 *E. coli*

Figure 10.8 shows the river *E. coli* (EC) profile for the existing CSS and Alternative 4 phases for the maximum loading events. Since the coldest month in the recreation season is April, all of the EC runs assumed a water temperature of 15 °C to account for the temperature adjusted EC decay rate, which would result in the lowest EC decay and highest EC concentrations in the river of any of the recreation season months.

The figure shows the immediate impact of the EC loadings on concentrations in the river, reaching a maximum concentration of over 70,000 per 100 mL for the existing CSS at about km 95, which is just downstream of the Whitehead Creek CSO. At this point, all of the CSOs except Brown's Branch are contributing to the EC concentration in the river. The dilution from the "Full Flow" input flow outside of the navigation channel at km 85 causes a significant reduction in EC, which continues to drop rapidly to km 0. Phases II and III would result in a significant reduction in EC, although the maximum concentrations are significantly higher than the recreation season water quality criterion of 548 cfu per 100 mL. Only Phase II, Event D and Phase III, Event E (not shown) and all lesser events for these phases would result in concentrations of EC below the criterion because all of the CSO inputs are eliminated for these cases. Because of the extremely high concentrations of EC in the CSS, any untreated CSO would cause an excursion of the EC water quality criterion.

It should be noted that the water quality criterion is based on the geometric average concentration of EC during the recreation season. Therefore, the high EC concentrations in the river during CSO events should be averaged with relatively low EC concentrations in the river when the CSOs are not discharging during wet weather, resulting in a much lower average concentration.

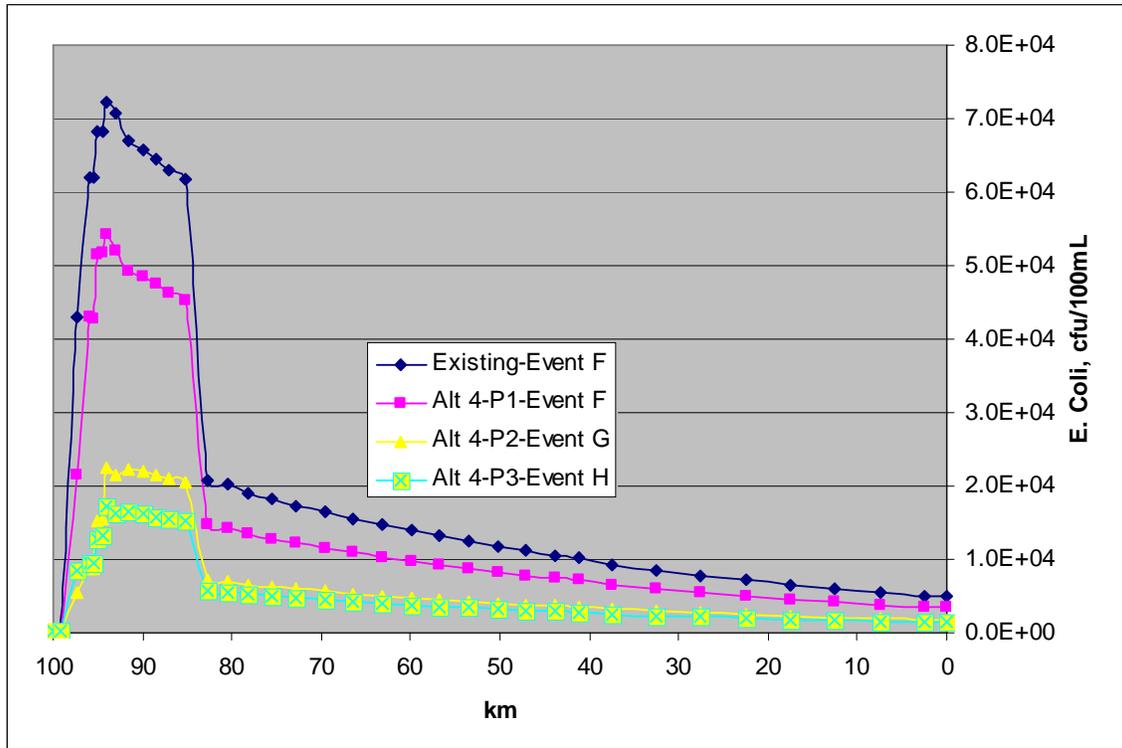


Figure 10.8 River *E. coli* for Existing CSS and Alternative 4 Phases for Maximum Loading Events

10.4 Summary and Conclusions

10.4.1 Summary

A water quality model based on the QUAL2K program was developed to assess the impacts of the City's proposed remaining 13 combined sewer overflows (CSOs) on dissolved oxygen (DO) and *E. coli* (EC) concentrations in the river for four loading cases: existing combined sewer system (CSS) and three Alternative 4 improvement phases. CBOD and ammonia were also modeled because the decay of these constituents consumes DO.

Concentrations of CBOD, ammonia, and EC in the CSOs were based on sampling data collected from 34 storm events from March to October 2007. CSO flows were based on XP-SWMM modeling of the CSS for Storm Events A through H.



For the existing CSS and Phase I improvements, the maximum total CBOD and ammonia loading from all the CSOs is associated with Event F. This assumes that the peak flows for each of the CSOs occur at approximately the same time. For Phase II improvements, Event G resulted in the maximum loadings, and for Phase III improvements, Event H produced the maximum loadings, although less than the maximum loadings for Phase II.

The lowest DO concentration of 3.8 mg/L is associated with the existing CSS, Event F. Since each of the improvement phases reduce CSO loadings, the DO concentrations in the river increase with each phase. Only Phase III, Event H would result in a minimum DO concentration of more than 5 mg/L, the water quality criterion. The minimum DO concentrations for Phase I, Event F, and Phase II, Event G were 4.0 mg/L and 4.4 mg/L, respectively. However, the minimum DO for the Phase II, Event E was well above 5 mg/L. Event E is expected to occur only one time during a typical year. Event G is also expected to occur only once per year out of a total of 78 events per year, so the exposure of the river to DO below the water quality criterion for Phase II is infrequent. Phase II improvements are expected to provide capture and treatment of 84 percent of the total CSS volume during a typical year.

Water quality modeling was performed for Alternative 4 – Phase I, II, and III for Event E flows to demonstrate river water quality for the presumptive approach improvements. It is assumed that CSO improvements for Event E flows will meet the presumptive approach requirements.

For the non-navigation season the minimum DO concentrations for the Existing CSS Event F increased from 3.8 to 6.6 mg/L because of the effect of lower water temperatures during the non-navigation months.

The maximum EC concentration in the river was over 70,000 per 100 mL for the existing CSS, located just downstream of the Whitehead Creek CSO. Phases II and III would result in a significant reduction in EC, although the maximum concentrations remain significantly higher than the recreation season water quality criterion of 548 cfu per 100 mL. Only Phase II, Event D and Phase III, Event E and all lesser events for these phases would



result in concentrations of EC below the criterion because all of the CSO inputs are eliminated for these cases. Because of the extremely high concentrations of *E. coli* in the CSS, any untreated CSO would cause an excursion of the EC water quality criterion. However, the water quality criterion is based on the geometric average concentration of EC during the recreation season. Therefore, the high EC concentrations in the river during CSO events should be averaged with relatively low EC concentrations in the river when the CSOs are not discharging during wet weather, resulting in a much lower average concentration.

10.4.2 Conclusions

Only Alternative 4 Phase III improvements would provide enough control of the CSOs to keep the DO concentration in the river above the water quality criterion of 5 mg/L during a typical year. However, Alternative 4, Phase II improvements would provide sufficient treatment of CBOD and ammonia to keep the DO concentration in the river above the water quality criterion for all but two of the largest storm events during a typical year.

The difference in DO concentrations between the existing CSS and Alternative 4, Phase I is minimal because the difference in constituent loadings is not significant. DO model results for each of the cases may be conservative in that the model may have under-predicted the DO concentrations. However, the relative differences in DO concentrations among the loading cases are more significant than the absolute concentrations. The critical condition for DO is during the navigation season months of July and August. For the non-navigation period, the minimum DO concentration will be above the DO water quality criterion for the existing CSS and each of the three Alternative 4 phases.

The critical condition for EC is during April when water temperatures are the lowest of any of the months of the recreation season. Because of the extremely high concentrations of EC in the CSS, any untreated CSO event will cause an excursion of the EC water quality criterion for Category B, Whole Body Contact Recreation.



11.0 Combined Sewer Overflow Control Alternatives

11.1 Introduction

Alternatives to reduce the volume and frequency of combined sewer overflows (CSOs) to the Missouri River were developed for evaluation as part of the Long Term Control Plan for St. Joseph. A “presumptive approach” as accepted by the U.S. Environmental Protection Agency (EPA) was used to develop the alternatives and involves technological solutions that are presumed to meet the CSO Control Policy. The presumptive approach results in no more than four overflow events per year based on computer modeling of the combined sewer system (CSS).

11.2 Fundamental Projects

In developing potential alternatives for the Long Term Control Plan, several projects were identified as common to all alternatives, except complete sewer separation. These common or fundamental projects would include the stormwater detention basins proposed in the 1999 Comprehensive Stormwater Management Plan in the Blacksnake, Whitehead, and Brown’s Branch watersheds. These detention basins along with downstream stormwater separation conduits would remove a large portion of the creek flow from the sewer system in these watersheds. Construction of a pipe within the existing combined sewer is proposed to separate the stormwater flow for a portion of these three watersheds. As these projects proceed into the facility planning stage, additional methods for stormwater separation including overland channels will be evaluated. The detention basins will be constructed in conjunction with the flood control projects funded in part by the U.S. Army Corps of Engineers (USACE).

Other fundamental projects include the addition of motor operated gates with level sensors and supervisory control and data acquisition (SCADA) as well as fixed weir modifications at several of the CSO diversion structures to increase storage capacity within the existing CSS and maximize flow conveyed to the wastewater treatment plant (WWTP). The hydraulics of the CSS will be reviewed during the facility planning stage of these facilities to fully utilize existing storage capacity and confirm the hydraulic design of this



fundamental project. Motor operated gates are proposed at the following four diversion structures: Charles, Mitchell, Missouri Avenue, and Brown’s Branch. The gates would typically be in the closed position. During storm events when the water reaches a designated level in each diversion structure, the gates would raise and allow some overflow to the river to prevent basement backups in the collection system. Additional fixed weir plate height is recommended at the following seven diversion structures to maximize flow to the WWTP: Francis, Messanie, Patee, Olive, Duncan, Maple, and Hickory.

Table 11.1 lists the project components and estimated total project costs, in 2007 dollars, for each of the fundamental projects. Costs for the stormwater detention basins from the 1999 Comprehensive Stormwater Management Plan have been escalated for inflation. Costs for the Blacksnake detention basin reflect partial funding by the USACE. It is anticipated that the Whitehead detention basin will also be partially funded by USACE with the Brown’s Branch detention basin receiving no funding. For purposes of this study, the costs for the Whitehead and Brown’s Branch basins have been escalated from the Stormwater Management Plan which did not reflect funding from USACE. The Brown’s Branch basin cost also includes separation of the combined sewer system upstream of the proposed stormwater detention basin.

Table 11.1 Fundamental Project Components and Costs		
Project	Size	Project Cost, \$
Blacksnake Detention Basin	351 acre-ft	\$9.0 Million
Blacksnake Stormwater Separation Conduit	5 ft dia	\$22.0 Million
Whitehead Detention Basin	675 acre-ft	\$7.3 Million
Whitehead Stormwater Separation Conduit	5 ft dia	\$10.4 Million
Brown’s Branch Detention Basin	97 acre-ft	\$9.5 Million
Brown’s Branch Stormwater Separation Conduit	3 ft dia	\$3.1 Million
Diversion Structure Modifications (gates and fixed weirs)	---	\$2.4 Million
TOTAL		\$63.7 Million
Notes:		
1. Project costs include 25% for contingency and 20% for engineering, legal, and administrative costs.		
2. Detention basin sizes are from the 1999 Stormwater Management Plan.		



11.3 Proposed Alternatives

Four alternatives were developed to meet the EPA presumptive target of four overflow events per year. The alternatives were compared and evaluated based on the City's financial capability to pay for the improvements as indicated by an Affordability Analysis completed in 2007 under EPA guidelines. The Affordability Analysis is included in Appendix H.

11.3.1 Alternative No. 1

Alternative No. 1 would consist of the fundamental projects as well as other improvements to achieve a level of control of four overflow events per year. Alternative 1 would involve improvements to the Whitehead Pump Station to maximize flow to the wastewater treatment plant. Pump station improvements would include increasing the firm capacity of the existing station to 26 million gallons per day (mgd) and providing a new 54 mgd wet weather pump station with coarse screening. This would result in the capability to pump 80 mgd from the Whitehead Pump Station which would fully utilize the two existing force mains to the plant. Modeling of the interceptor to the Whitehead Pump Station indicates that 80 mgd of flow can be conveyed to the station by surcharging flow in the interceptor.

To treat 80 mgd of combined sewage from the Whitehead Pump Station as well as approximately 8 mgd from the south via the in-plant pump station (total flow to WWTP of 88 mgd), a 54 mgd high rate treatment (HRT) system would be needed at the WWTP. The high rate treatment system would consist of fine screens, a high rate clarification system (such as ballasted flocculation), and disinfection to treat the flows pumped to the high rate system. The current capacity of the primary WWTP is limited to approximately 27 mgd due to hydraulic constrictions at the headworks facility. In this alternative, headworks/grit removal capacity at the WWTP would be increased to 34 mgd to match the treatment capacity of the existing primary clarifiers. Therefore, a total treatment capacity of 88 mgd would be provided at the WWTP, including the high rate facilities.



A deep tunnel and associated pump station would also be provided along the main interceptor to the plant collecting additional peak flows and limiting overflow events to four per year. This tunnel would have a diameter of 30 feet and would be 26,000 feet long for a total storage volume of 137 million gallons. The tunnel would extend from the Brown's Branch CSO to the Blacksnake CSO.

Table 11.2 lists the project components, including land acquisition, and estimated total project costs, in 2007 dollars, for Alternative No. 1. Estimated costs are based on project experience and cost manuals developed for similar CSO control programs. Figure 11.1 presents the location of project components for Alternative No. 1 throughout the CSS.

Project	Size	Project Cost, \$
Fundamental Projects	---	\$63.7 Million
Whitehead Pump Station Upgrade	26 mgd firm	\$2.4 Million
Whitehead Wet Weather Pump Station	54 mgd firm	\$16.1 Million
Headworks Improvements at WWTP	7 mgd	\$1.8 Million
HRT Facility at WWTP	54 mgd	\$22.2 Million
Deep Tunnel and Pump Station	30 ft dia, 26,000 ft, 137 MG	\$473.8 Million
TOTAL		\$580.0 Million
Note: Project costs include 25% for contingency and 20% for engineering, legal, and administrative costs.		

11.3.2 Alternative No. 2

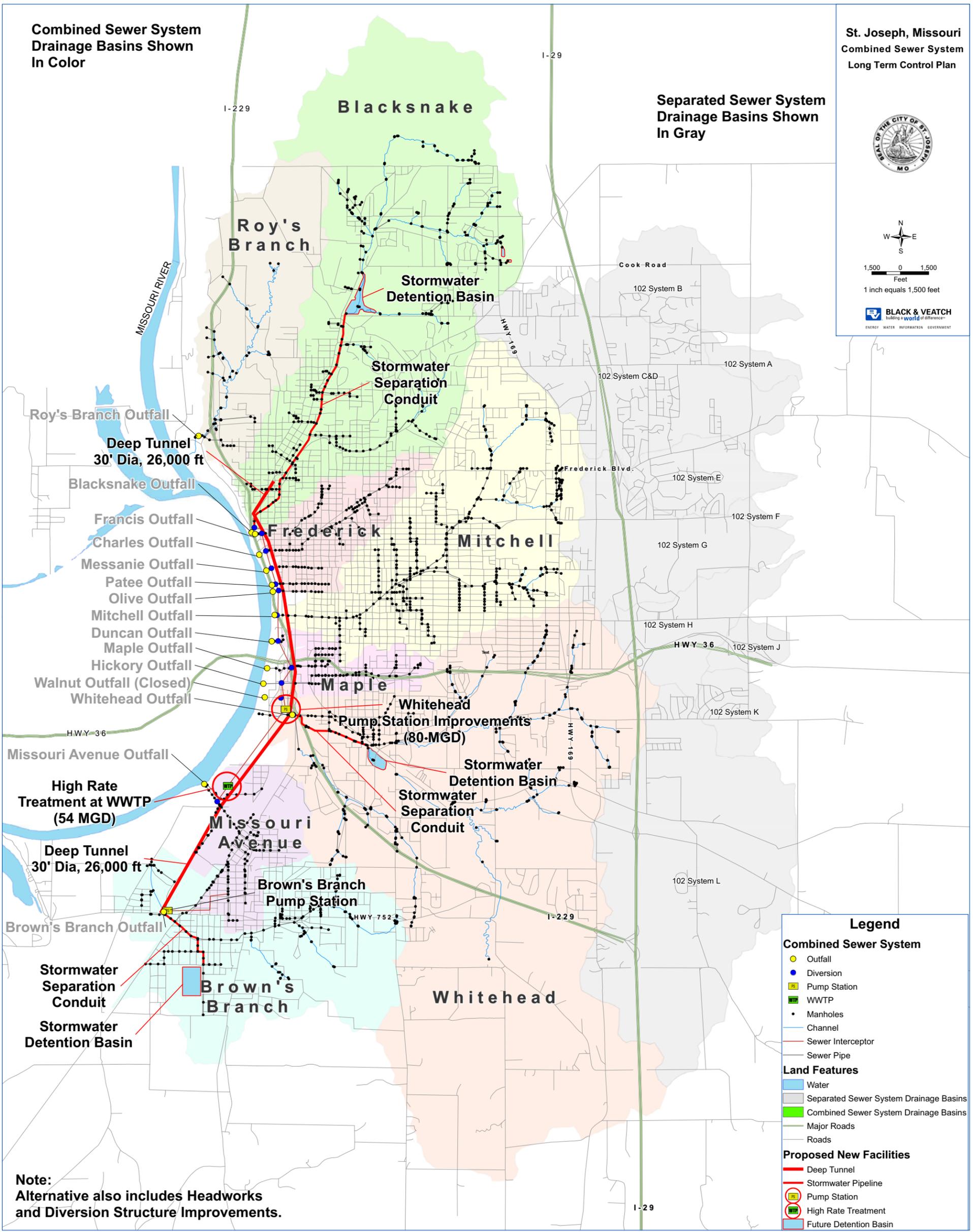
Alternative No. 2 would achieve a level of control of four overflow events per year and consists of the fundamental projects as well as satellite high rate treatment facilities in the Blacksnake, Mitchell, Whitehead, and Missouri Avenue watersheds. Each satellite facility would consist of coarse and fine screens, a high rate clarification system (such as ballasted flocculation), a pump station, a flow equalization basin (FEB), and disinfection to treat the flows pumped to the high rate systems. To divert flow to these satellite facilities, conveyance tunnels would be needed between the diversions at Blacksnake and Whitehead and between the diversions at Brown's Branch and Missouri Avenue. The wastewater treatment plant would continue to treat 27 mgd in this alternative.

Combined Sewer System
Drainage Basins Shown
In Color

St. Joseph, Missouri
Combined Sewer System
Long Term Control Plan



1,500 0 1,500
Feet
1 inch equals 1,500 feet



Note:
Alternative also includes Headworks
and Diversion Structure Improvements.

**Alternative 1 - Deep Tunnel and High Rate
Treatment at WWTP**

Figure 11.1



Table 11.3 lists the project components, including land acquisition, and estimated total project costs, in 2007 dollars, for Alternative No. 2. Estimated costs are based on project experience and cost manuals developed for similar CSO control programs. Figure 11.2 presents the location of project components for Alternative No. 2 throughout the CSS.

Table 11.3		
Alternative No. 2 Project Components and Costs		
Project	Size	Project Cost, \$
Fundamental Projects	---	\$63.7 Million
Blacksnake Satellite HRT Facility	60 mgd	\$86.3 Million
Mitchell Satellite HRT Facility	85 mgd	\$111.1 Million
Whitehead Satellite HRT Facility	125 mgd	\$148.8 Million
Missouri Avenue Satellite HRT Facility	75 mgd	\$88.2 Million
Conveyance Tunnels	---	\$56.9 Million
TOTAL		\$555.0 Million

Note: Project costs include 25% for contingency and 20% for engineering, legal, and administrative costs.

11.3.3 Alternative No. 3

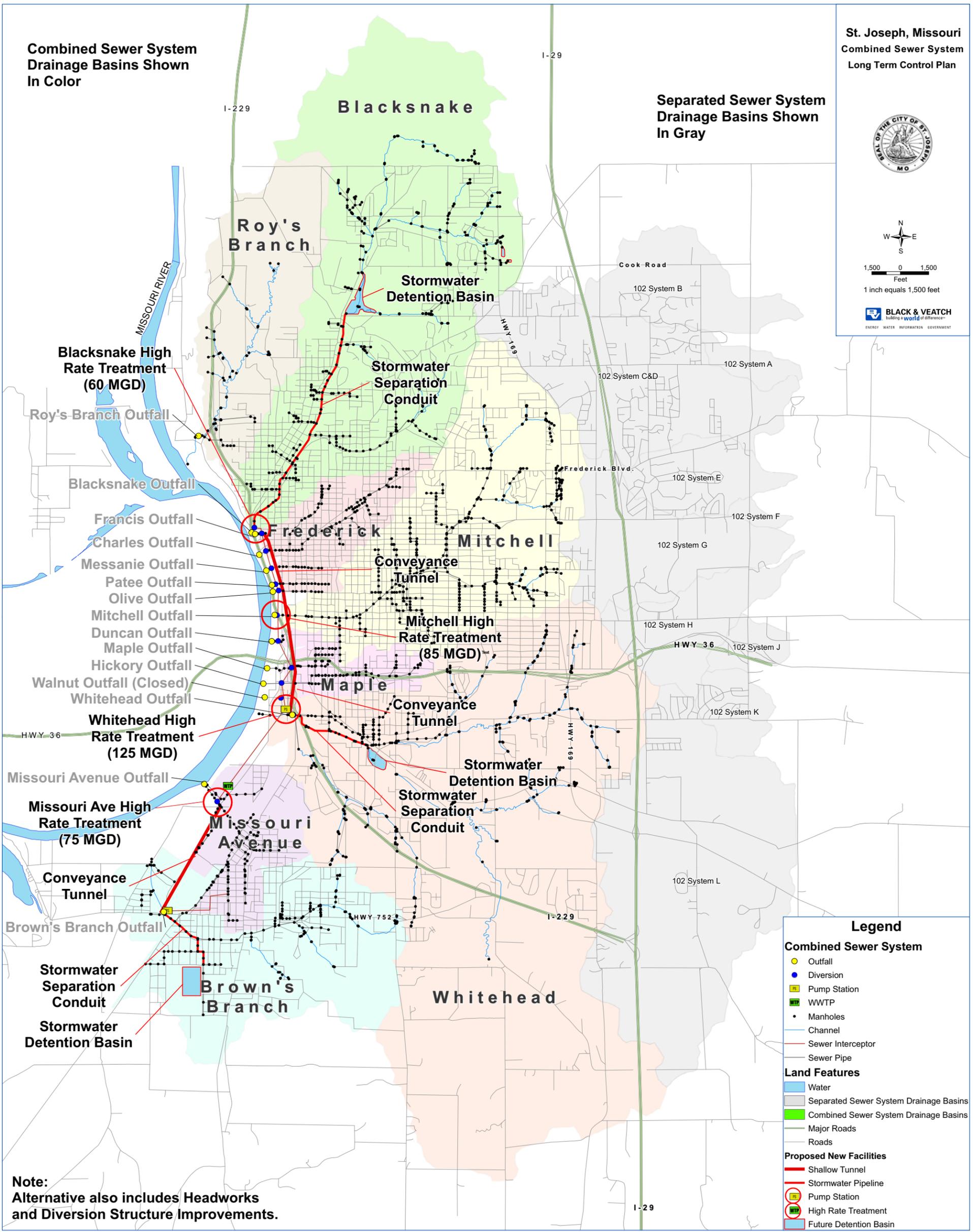
Alternative No. 3 would consist of complete separation of all sanitary and stormwater flows in the combined sewer system, and therefore, would achieve a level of control of zero overflow events per year. The sewer separation alternative would require disconnection of all buildings in the western portion of the City from the existing collection system and construction of a new system for sanitary flows. In a 2004 study conducted by Black & Veatch, order of magnitude costs were developed based on new trunk lines and wastewater collection systems for each overflow structure. Each house/building would need to be individually connected to the new system. A connection fee of \$5,000 per house was included in the estimated costs. Based on information from the Missouri American Water Company (water supplier), there are approximately 18,000 connections in the combined sewer area. The existing CSO outfalls would be converted to stormwater outfalls in this alternative. Table 11.4 and Figure 11.3 present the project components and costs for Alternative No. 3. Costs have been escalated from the 2004 study to 2007 dollars.

Combined Sewer System
Drainage Basins Shown
In Color

St. Joseph, Missouri
Combined Sewer System
Long Term Control Plan



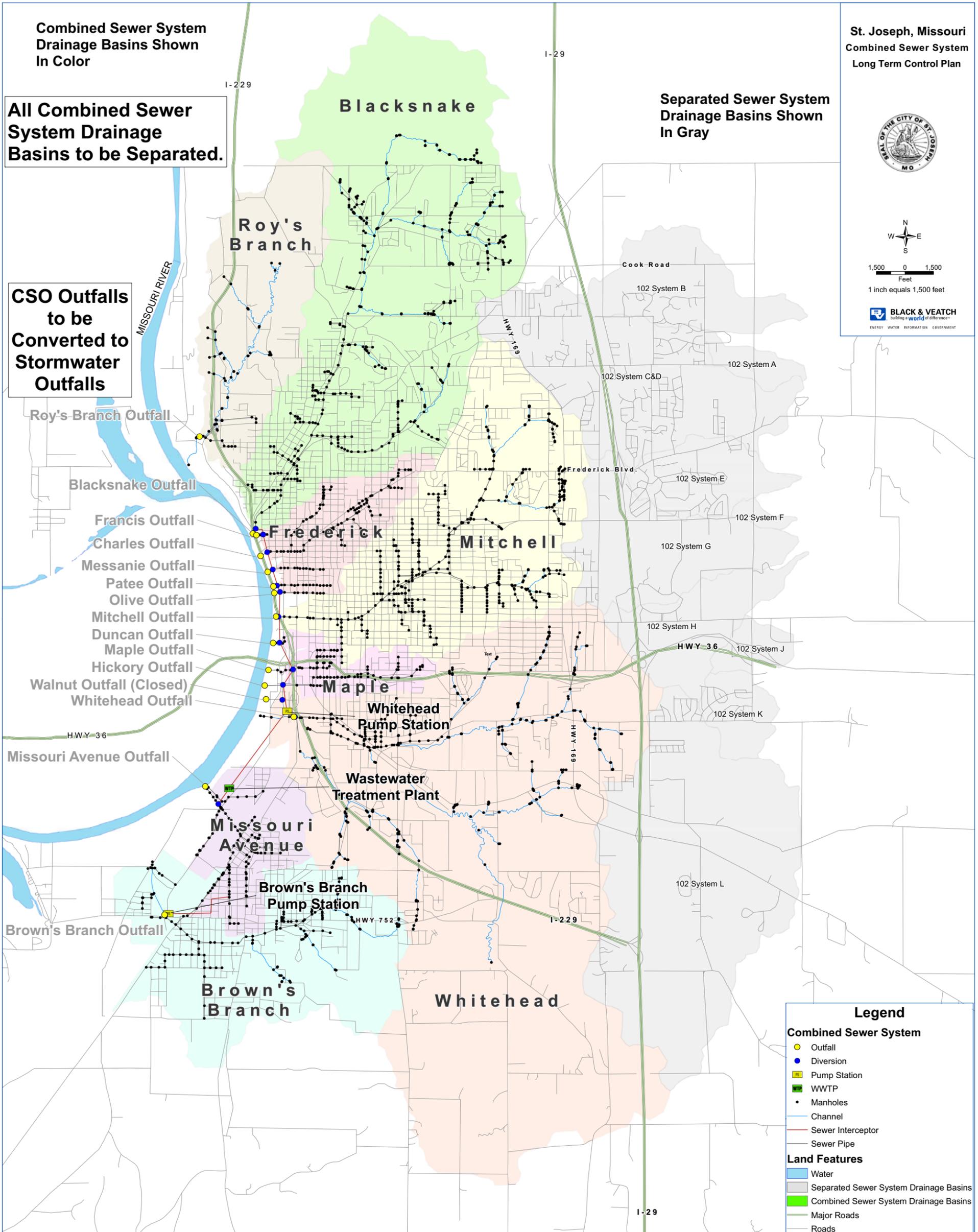
1,500 0 1,500
Feet
1 inch equals 1,500 feet



Note:
Alternative also includes Headworks
and Diversion Structure Improvements.

Alternative 2 - Satellite High Rate Treatment

Figure 11.2



Alternative 3 - Complete Sewer Separation

Figure 11.3



Table 11.4
Alternative No. 3 Project Components and Costs

CSO Structure	Trunk Line, \$	Collection System, \$	Project Cost, \$
Blacksnake	47,400,000	72,000,000	119,400,000
Francis	3,900,000	7,100,000	11,000,000
Charles	22,800,000	17,200,000	40,000,000
Messanie	7,300,000	3,400,000	10,700,000
Patee	6,500,000	7,800,000	14,300,000
Olive	6,000,000	7,800,000	13,800,000
Mitchell	82,300,000	78,700,000	161,000,000
Duncan	4,000,000	1,600,000	5,600,000
Maple	21,000,000	13,600,000	34,600,000
Hickory	11,200,000	3,900,000	15,100,000
Whitehead	32,700,000	50,500,000	83,200,000
Missouri Avenue	26,100,000	25,400,000	51,500,000
Brown's Branch	52,900,000	25,700,000	78,600,000
<i>Subtotal</i>	<i>324,100,000</i>	<i>314,700,000</i>	<i>638,800,000</i>
Contingency, ELA, 33%	107,000,000	103,900,000	210,900,000
TOTAL	\$431,100,000	\$418,600,000	\$850,000,000
ELA – Engineering, Legal, and Administrative			

11.3.4 Alternative No. 4

Alternative No. 4 would consist of the fundamental projects as well as other phased implementation improvements to achieve a level of control of four overflow events per year. Alternative No. 4 Phase I would involve improvements to the Whitehead Pump Station to maximize flow to the wastewater treatment plant. Pump station improvements would include increasing the firm capacity of the existing station to 26 mgd and constructing a new 54 mgd wet weather pump station with coarse screening. This would result in the capability to pump 80 mgd from the Whitehead Pump Station which would fully utilize the two existing force mains to the plant. Modeling of the interceptor to the Whitehead Pump Station indicates that 80 mgd of flow can be conveyed to this pump station by surcharging the interceptor.



To treat 80 mgd of combined sewage from the Whitehead Pump Station as well as approximately 8 mgd from the south via the in-plant pump station (total flow to WWTP of 88 mgd) for Phase I, a 54 mgd high rate treatment system would be needed at the WWTP. The HRT system would consist of fine screens, a high rate clarification system (such as ballasted flocculation), and disinfection to treat the flows pumped to the high rate system. The current capacity of the primary WWTP is limited to approximately 27 mgd due to hydraulic constrictions at the headworks facility. In this alternative, headworks/grit removal capacity at the WWTP would be increased to 34 mgd to match the treatment capacity of the existing primary clarifiers. Therefore, a total treatment capacity of 88 mgd would be provided at the WWTP, including the high rate facilities.

To capture and treat additional combined sewer overflows to achieve a level of control of 12 overflow events per year and provide 65 percent basin-wide annual capture during precipitation events for Phase I, a 5 million gallon flow equalization basin would be constructed at the Missouri Avenue diversion structure and a 1 million gallon flow equalization basin would be constructed at the Patee diversion structure. For planning purposes, it was assumed the flow equalization basins would be completely covered with full odor control facilities.

Phase II would achieve a level of control of six overflow events per year and provide 84 percent basin-wide annual capture during precipitation events. A deep tunnel would be constructed along the main interceptor for this phase to collect and store additional peak flows. The tunnel would have a diameter of 17 feet and would be 23,100 feet long for a total storage volume of 39 million gallons. The tunnel would extend from the Brown's Branch CSO to the Blacksnake CSO. The stored flow would be pumped out of the tunnel with a deep pump station located at the wastewater treatment plant after peak flows have receded. The tunnel pump-out flows would be conveyed to the high rate treatment facility for treatment before discharge to the river.

To reduce the overflow events to four per year and provide 90 percent basin-wide annual capture during precipitation events, Phase III would involve a high rate treatment expansion of 135 mgd at the wastewater treatment plant and include a 13.5 million gallon flow equalization basin with associated intermediate pump station. This expansion would



then provide a total high rate treatment capacity of 189 mgd. Additional pumps would also be added to the deep pump station and the deep tunnel would function as a conveyance tunnel for Phase III overflow events.

Table 11.5 lists the project components, including land acquisition, and estimated total project costs, in 2007 dollars, for Alternative No. 4. Estimated costs are based on project experience and cost manuals developed for similar CSO control programs. Figure 11.4 presents the location of project components for Alternative No. 4 throughout the CSS.

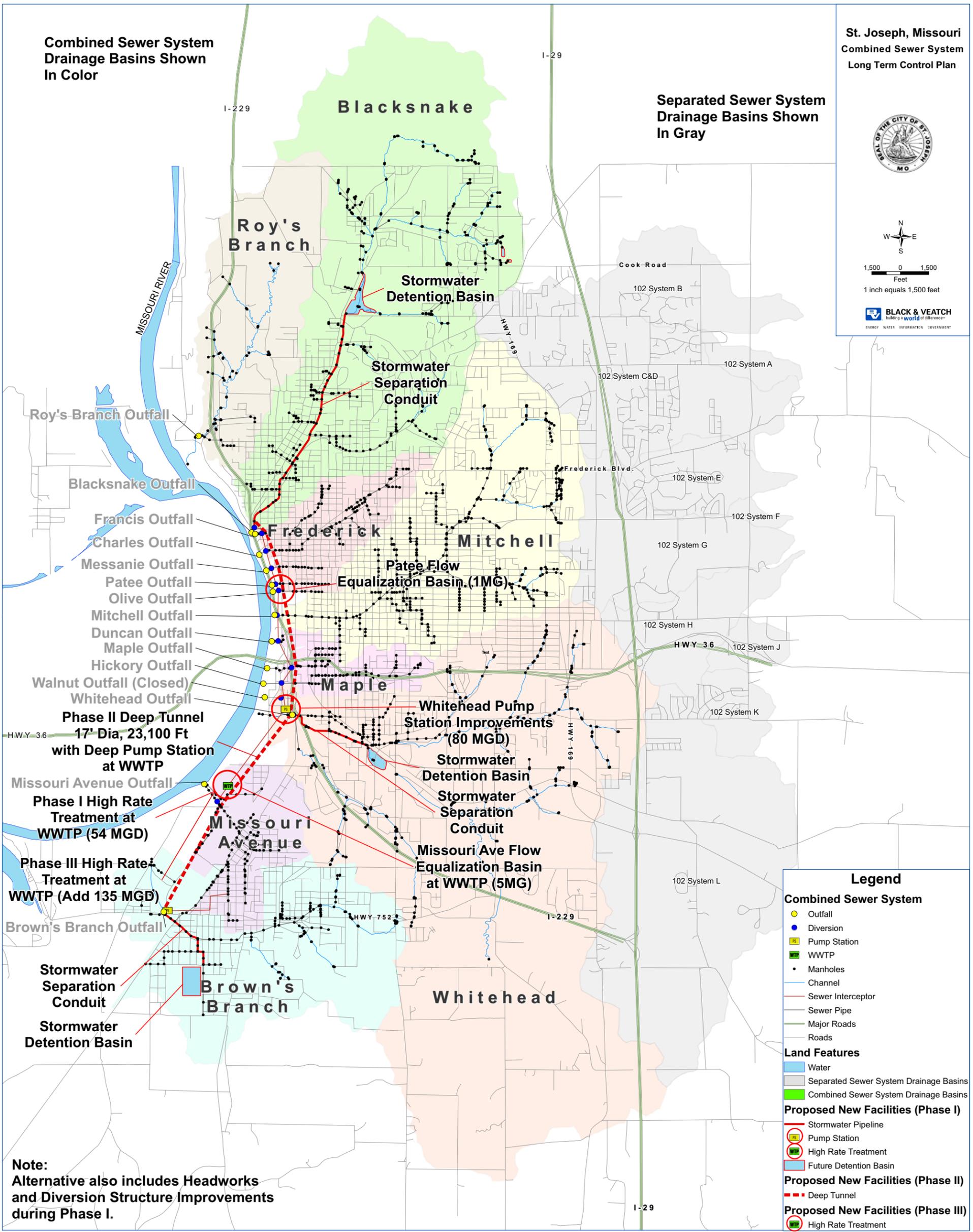
Project	Size	Project Cost, \$
Fundamental Projects	---	\$63.7 Million
Whitehead Pump Station Upgrade	26 mgd firm	\$2.4 Million
Whitehead Wet Weather Pump Station	54 mgd firm	\$16.1 Million
Headworks Improvements at WWTP	7 mgd	\$1.8 Million
High Rate Treatment Facility at WWTP	54 mgd	\$22.2 Million
Patee Flow Equalization Basin	1 MG	\$13.8 Million
Missouri Avenue Flow Equalization Basin	5 MG	\$30.0 Million
Deep Tunnel and Pump Station	17 ft dia, 23,100 ft, 39 MG	\$200.0 Million
High Rate Treatment Facility Expansion and Flow Equalization Basin at WWTP	135 mgd	\$100.0 Million
TOTAL		\$450.0 Million
Note: Project costs include 25% for contingency and 20% for engineering, legal, and administrative costs.		

11.3.5 Summary of Alternatives

The four alternatives and estimated project costs, in 2007 dollars, are summarized in Table 11.6.



1,500 0 1,500
 Feet
 1 inch equals 1,500 feet



Note:
 Alternative also includes Headworks
 and Diversion Structure Improvements
 during Phase I.

**Alternative 4 - Phased High Rate Treatment at WWTP
 and Deep Tunnel**

Figure 11.4



Alternative	Facilities	Project Cost, \$
1	<ul style="list-style-type: none">• Fundamental projects• Whitehead Pump Station upgrade with new wet weather pump station• Headworks improvements at WWTP• High rate treatment facility at WWTP• Deep tunnel and pump station	\$580 Million
2	<ul style="list-style-type: none">• Fundamental projects• Four satellite high rate treatment facilities• Conveyance piping	\$555 Million
3	<ul style="list-style-type: none">• Complete sewer separation	\$850 Million
4	<ul style="list-style-type: none">• Fundamental projects• Whitehead Pump Station upgrade with new wet weather pump station• Headworks improvements at WWTP• High rate treatment facility at WWTP• Flow equalization basins at Patee and Missouri Avenue• Deep tunnel and pump station• Flow equalization basin at WWTP	\$450 Million

11.4 Present Worth Analysis

A present worth analysis was conducted to estimate the total monetary value of the proposed facilities. Present worth is the equivalent amount of money that must be invested at a given interest rate at the start of the project to provide all funds necessary to construct, operate, and maintain the required facilities and equipment throughout the design life of the project. The total present worth of an alternative includes capital costs, annual operations and maintenance (O&M) costs, and the present worth of any remaining value.

The analysis was conducted for a 50-year study period beginning in the year 2008. The present worth of future costs over the study period was calculated using a 4.75 percent interest rate. At the end of the 50-year period, those items which still had assumed useful



life were given a discounted salvage value. A service life of 50 years was used for structures, and a 10-year service life was used for equipment. Capital and annual O&M costs were calculated based on project experience and cost manuals developed for similar CSO control programs. For comparison, a summary of the present worth evaluation is presented in Table 11.7 assuming all projects are constructed in 2008.

Alternative	Capital Present Worth, \$	O&M Present Worth, \$	Total Present Worth, \$
1	\$640.0 Million	\$72.1 Million	\$712.1 Million
2	\$672.3 Million	\$59.7 Million	\$732.0 Million
3	\$1,001.8 Million	---	\$1,001.8 Million
4	\$524.6 Million	\$64.2 Million	\$588.8 Million



12.0 Recommended CSO Control Plan

12.1 Recommended Alternative

As presented in Chapter 11.0, a present worth analysis was conducted to estimate the total monetary value of the proposed facilities. The analysis was conducted for a 50-year study period beginning in the year 2008. The present worth of future costs over the study period was calculated using a 4.75 percent interest rate. At the end of the 50-year period, those items which still had assumed useful life were given a discounted salvage value. A service life of 50 years was used for structures, and a 10-year service life was used for equipment. Capital and annual operations and maintenance (O&M) costs were calculated based on project experience and cost manuals developed for similar combined sewer overflow (CSO) control programs. For comparison, a summary of the present worth evaluation is presented in Table 12.1 assuming all projects are constructed in 2008.

Alternative	Capital Present Worth, \$	O&M Present Worth, \$	Total Present Worth, \$
1	\$640.0 Million	\$72.1 Million	\$712.1 Million
2	\$672.3 Million	\$59.7 Million	\$732.0 Million
3	\$1,001.8 Million	---	\$1,001.8 Million
4	\$524.6 Million	\$64.2 Million	\$588.8 Million

Based on the economic present worth evaluation, Alternative No. 4 is the recommended alternative for the Long Term Control Plan (LTCP). This alternative was divided into three phases for implementation to meet an affordability target and U.S. Environmental Protection Agency (EPA) CSO goals. Each phase or sub-phase equates to \$75 million over a 20-year period which is the maximum amount of CSO program capital costs that can be expended by the City based on the results of an Affordability Analysis conducted as part of this LTCP. The Affordability Analysis is included in Appendix H.

Phase I improvements will reduce overflow events to 12 per year and provide 65 percent basin-wide annual capture during precipitation events. Phase II will further reduce



overflow events to six per year and provide 84 percent capture, and Phase III will result in meeting the EPA goal of four overflow events per year as well as provide 90 percent capture. For comparison purposes and to show a knee of the curve for diminishing benefits versus cost, Figure 12.1 presents a graph of the estimated capital costs versus overflow events for the three phases of Alternative No. 1 and also shows Alternative No. 3 – Complete Sewer Separation. It appears that the knee of the curve is between four to six overflow events per year.

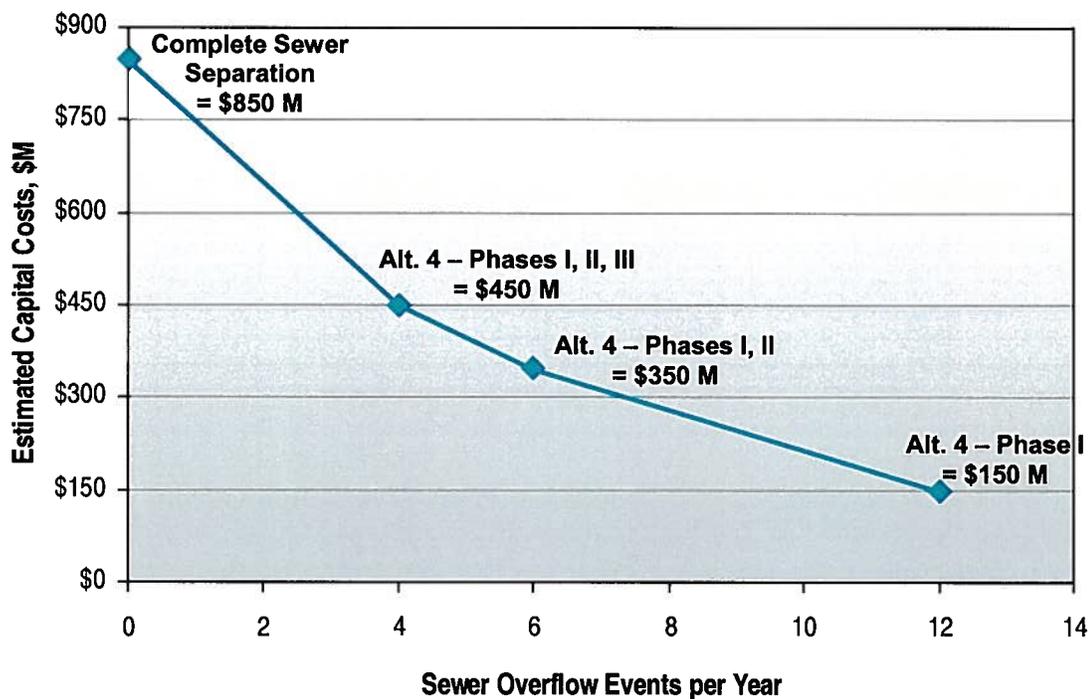


Figure 12.1 Capital Costs versus Overflow Events

Figure 12.2 presents a comparison of the cost indicators for each of the four alternatives based on the results of the Affordability Analysis. As shown in this figure, it is unrealistic and financially unfeasible to expect the City of St. Joseph to implement the CSO control improvement within a 20-year implementation schedule. Alternative No. 4 presents a phased implementation plan based on a wastewater cost burden of 2.07 percent of median household income (MHI). It is recommended that the wastewater burden for St. Joseph not



exceed 2.07 percent of MHI in order to have a financially viable CSO program and maintain economic stability for the City.

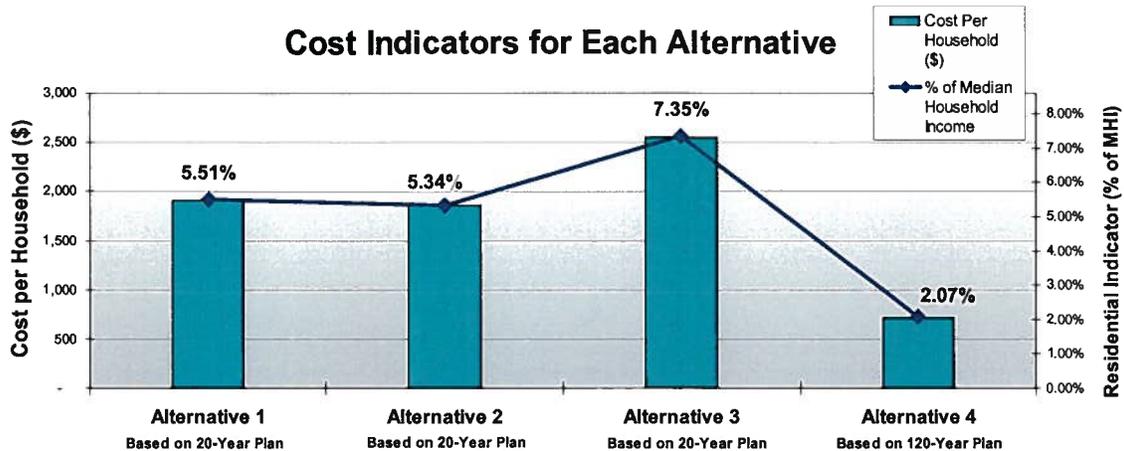


Figure 12.2 Cost Indicators for Alternatives

Table 12.2 summarizes the components and the estimated project costs, in 2007 dollars, for the three phases of Alternative No. 4. A facility plan will be conducted during the first year of implementation to further refine the project elements and costs for Phase I.

Table 12.2	
Alternative No. 4 Cost Summary by Phases	
Phase IA Projects	Project Cost
Phase 1 Facility Plan	To Be Determined
WWTP Headworks Improvements	\$1.8 Million
Whitehead Pump Station Improvements	\$18.5 Million
High Rate Treatment Facilities at WWTP	\$22.2 Million
Diversion Structure Modifications	\$2.4 Million
Blacksnake Stormwater Detention Basin	\$9.0 Million
Whitehead Stormwater Detention Basin	\$7.3 Million
Patee Flow Equalization Basin	\$13.8 Million
Phase IA TOTAL	\$75.0 Million
Phase IB Projects	
Blacksnake Stormwater Separation Conduit	\$22.0 Million
Whitehead Stormwater Separation Conduit	\$10.4 Million
Missouri Avenue Flow Equalization Basin	\$30.0 Million
Brown's Branch Stormwater Detention Basin	\$9.5 Million
Brown's Branch Stormwater Separation Conduit	\$3.1 Million
Phase IB TOTAL	\$75.0 Million



Phase II TOTAL (deep tunnel and pump station)	\$200.0 Million
Phase III TOTAL (high rate treatment expansion and flow equalization basin at WWTP)	\$100.0 Million

A present worth evaluation was conducted for Alternative No. 4 using the phased approach to implementing the various projects. The costs for each phase were input into the implementation year associated with each phase. The results of this evaluation are presented in Table 12.3 and reflect a much lower present worth cost for the City based on the phased implementation approach.

Capital Present Worth	\$195.0 Million
O&M Present Worth	\$28.7 Million
Total Present Worth	\$223.7 Million

12.2 Implementation Schedule

The proposed project costs for the CSO program will impose a significant financial burden on the City of St. Joseph. As indicated in the Black & Veatch Affordability Analysis dated December 21, 2007, due to the high financial burden of the CSO program on St. Joseph sewer rate payers, it is recommended that the wastewater system capital projects burden not exceed 2.07 percent of the MHI for residents of St. Joseph. The Affordability Analysis is included in Appendix H and, at 2.07 percent of MHI, documents a maximum wastewater burden amount of \$180 million over a 20-year period for the City. Of that amount, \$105 million is attributed to non-CSO related wastewater capital improvements such as treatment plant upgrades and collection system improvements. Based on this burden limit, the maximum amount of CSO program capital costs to be expended by the City during a 20-year period is \$75 million. The Affordability Analysis recognizes future regulatory requirements that will likely impact the City for wastewater treatment plant (WWTP) ammonia removal and effluent disinfection. In addition, the Affordability



Analysis identifies other project costs required for treatment plant upgrades and collection system improvements.

A preliminary project implementation schedule was developed for the recommended alternative to maintain approximately \$75 million in CSO program expenditures during each 20-year period. The preliminary implementation schedule is shown on Figure 12.3.

The implementation schedule for the recommended alternative was subdivided into major phases with associated levels of control, wet weather capture rates, and estimated project costs as shown in Table 12.4.

Phase	Time Period	Project Cost, \$	Level of Control, CSO events/yr	Annual Wet Weather Capture Rate, %
I	Years 1-40	\$150 Million	12	65
II	Years 41-93	\$200 Million	6	84
III	Years 94-120	\$100 Million	4	90

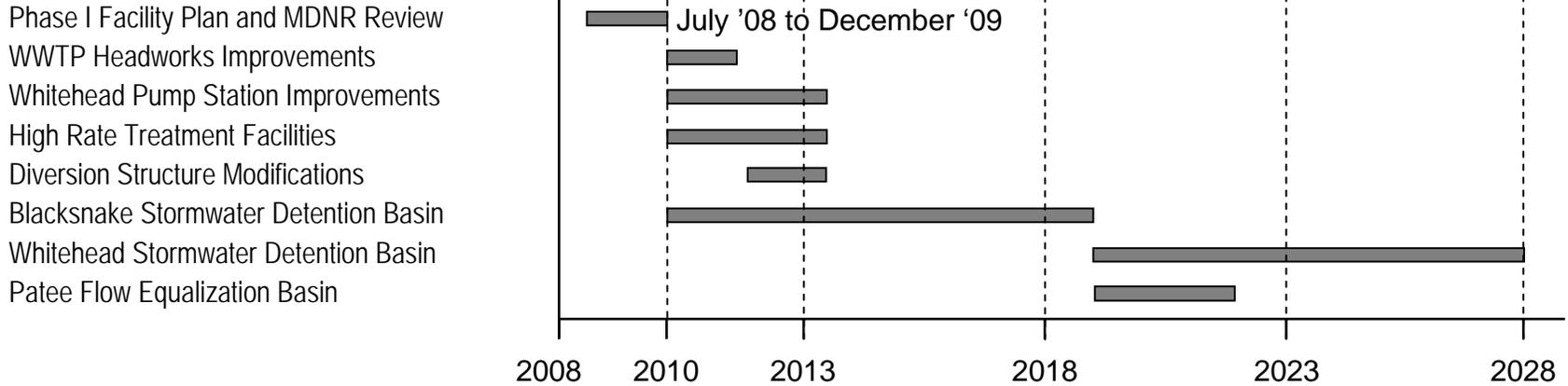
A CSO control Facility Plan will be completed for the Phase I improvements to incorporate the Missouri Department of Natural Resources (MDNR) and EPA comments, perform refinements for the Phase I plan, and complete conceptual facility planning and definition for the Phase I facilities. Primary work elements for the Facility Plan are described in Section 12.3. A sewer rate study will also be completed in 2008 to evaluate and identify financing methods and sewer rate increases necessary to fund the Phase I CSO control plan.

12.3 Phase I Facility Plan

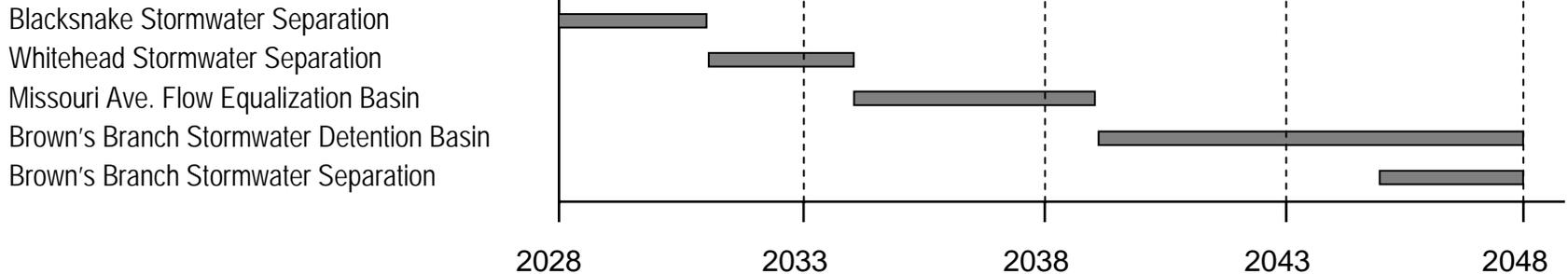
A conceptual Facility Plan study for Phase I CSO control improvements will be completed from approximately July 2008 through the end of 2009. Facility planning and refinement is necessary for Phase I improvements to provide adequate facility definition, site selection, and cost detail to set the path forward prior to design activities. Major elements of the Phase I Facility Plan will include the following:

St. Joseph CSO Control Program Preliminary Project Implementation Schedule

PHASE IA PROJECTS



PHASE IB PROJECTS



PHASE II – Deep Storage Tunnel and Pump Station ➡ 2049 to 2101

PHASE III – High Rate Treatment Expansion and Flow Equalization at WWTP ➡ 2102 to 2128

Figure 12.3
Preliminary Project Implementation Schedule



- Incorporation of MDNR/EPA comments relating to the Phase I plan.
- Evaluation and consideration of potential refinements for Phase I improvements as identified by City staff, Black & Veatch, and MDNR/EPA.
- Evaluation of 2008 flowmetering and sampling data and re-calibrate the computer model based on current data. Update CSO frequency and volumes based on re-calibrated model.
- Hydraulics evaluation of diversion structures, interceptors, and WWTP headworks to confirm plan of maximizing flow to the WWTP.
- Site selection evaluation to identify best locations for Phase I facilities.
- High rate treatment technology pilot study (ballasted flocculation and disinfection).
- Conceptual facility planning and layouts for Phase I facilities.
- Investigation of green infrastructure opportunities to detain or retain additional stormwater within each watershed.
- Facility planning cost estimate and detailed implementation schedule.
- Cash flow expenditures by year for Phase I improvements.
- Operational plan for Phase I improvements.



**APPENDIX A
FUTURE LAND
USE MAPS**

- Legend**
- Low Density Residential
 - Multi-Family
 - Office
 - Commercial
 - Industrial
 - Historic Districts
 - Quasi-Public
 - Public
 - Parks
 - Transition
 - Agriculture
 - Watershed Boundaries

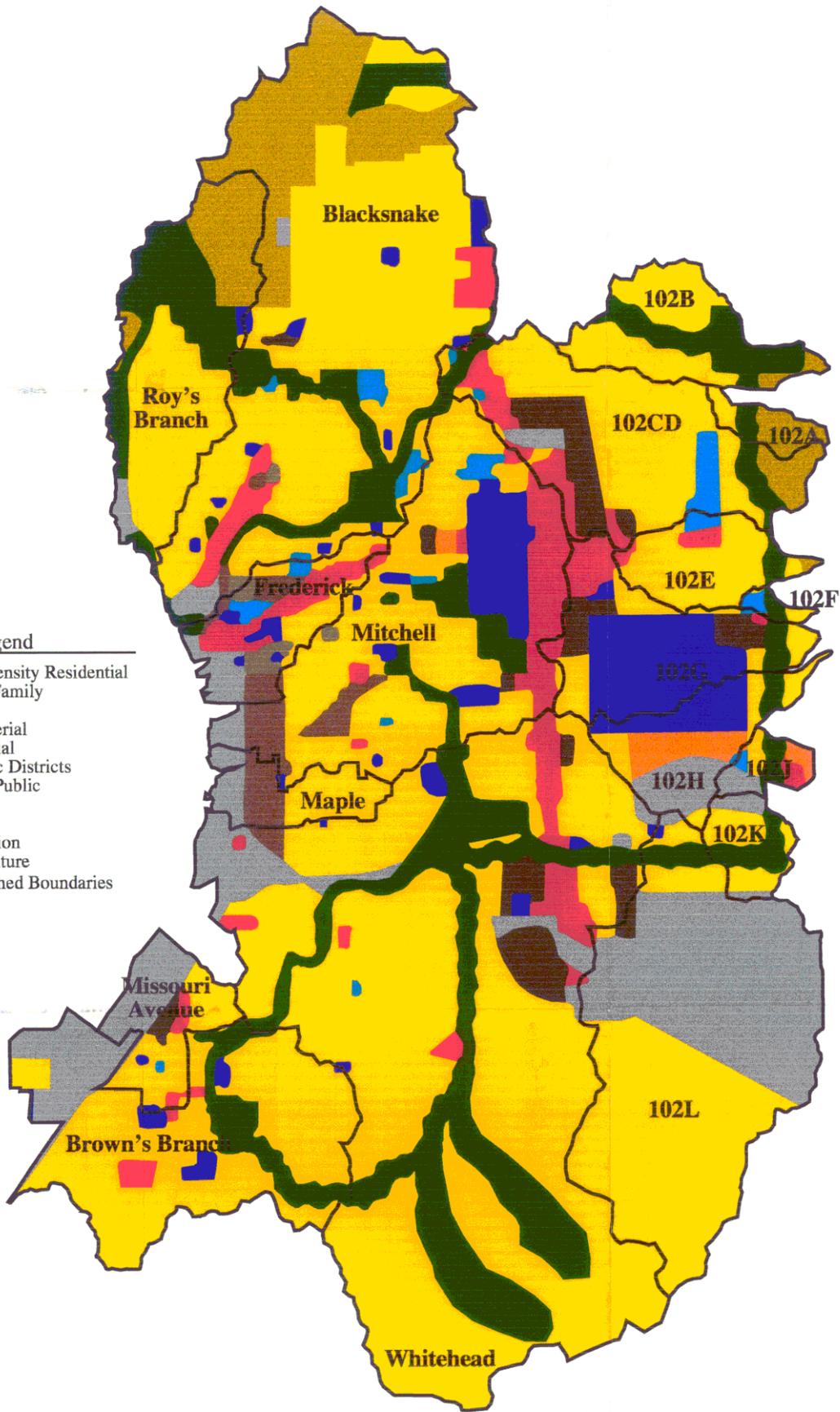
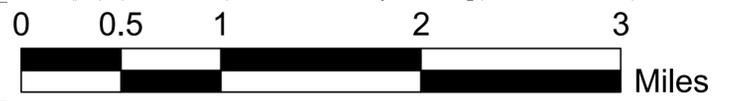


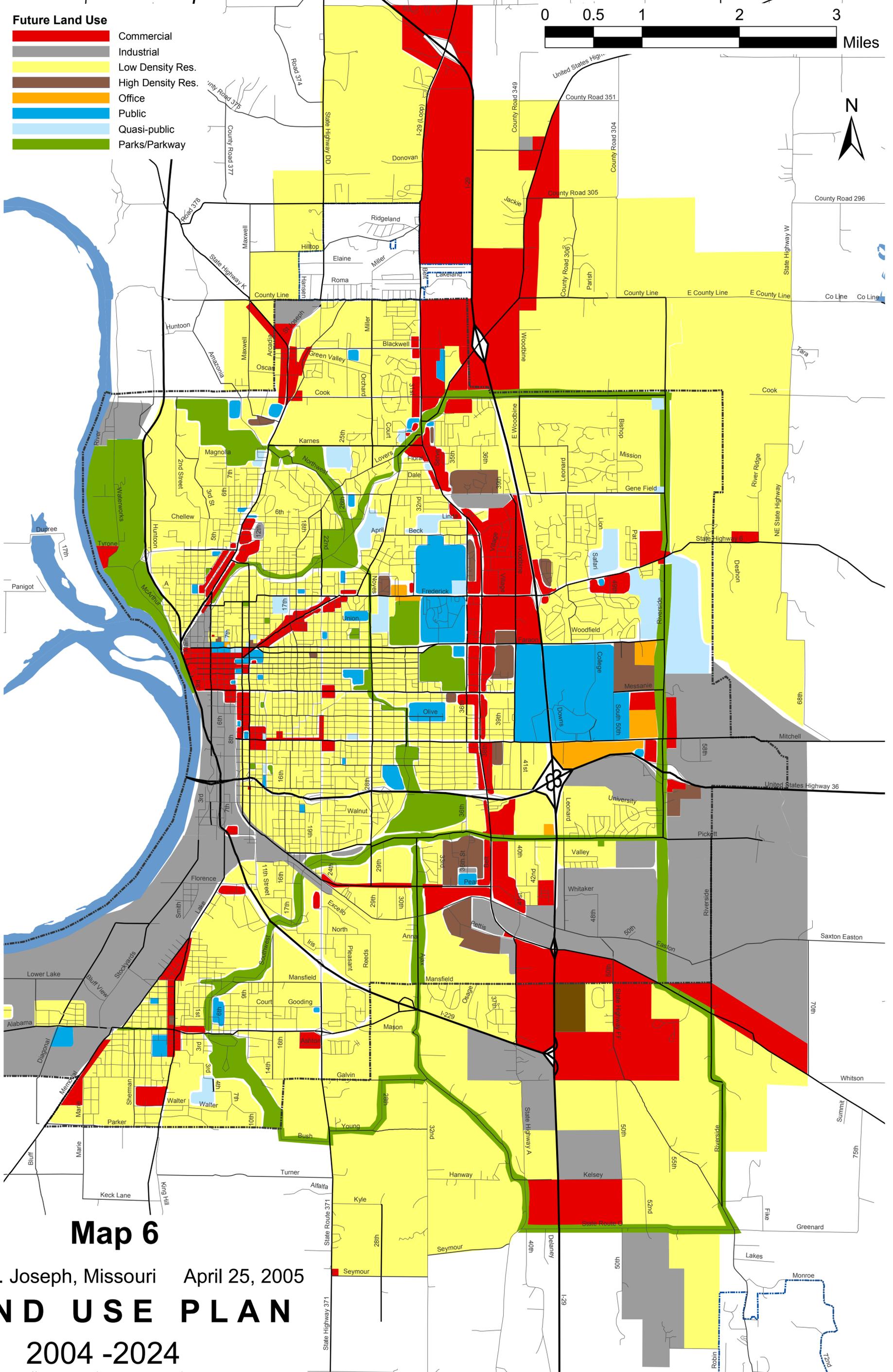
Figure III-5: Future Land Use
 Comprehensive Stormwater Management Plan
 St. Joseph, Missouri
 November 1998

Future Land Use

- Commercial
- Industrial
- Low Density Res.
- High Density Res.
- Office
- Public
- Quasi-public
- Parks/Parkway



Miles



Map 6

City of St. Joseph, Missouri April 25, 2005

LAND USE PLAN

2004 -2024



**APPENDIX B
CSO ANNUAL
REPORT**



COMBINED SEWER OVERFLOW

2006 ANNUAL REPORT

FOR

THE CITY OF ST. JOSEPH, MISSOURI

Minimum Control 8 – Public Notification..... 14
Photo 6 – CSO No Fishing/Swimming Sign
Photo 7 – CSO Sampler Biohazard Sign

**Minimum Control 9 – Monitoring to Characterize CSO
Impacts and The Efficacy of CSO
Controls.....15-16**

- Photo 8 – Blacksnake Diversion CSO Sampling Site
- Photo 9 – Messanie Diversion CSO Sampling Site
- Photo 10 – Mitchell Diversion CSO Sampling Site
- Photo 11 – Whitehead Diversion CSO Sampling Site
- Photo 12 – Brown’s Branch Diversion CSO Sampling Site
- Photo 13 – Teledyne Isco Avalanche Remote Sampler

Appendix A

- Figure 7 – Sample TV Inspection Report
- Figure 8 – Copy Manhole Inspection Form

Combined Sewer Overflow 2006 Annual Report City of St. Joseph, Missouri

Executive Summary

This report documents the various activities conducted and the projects in progress by the City of St. Joseph to implement the nine minimum controls (NMC) and help reduce the frequency of combined sewer overflows in the City.

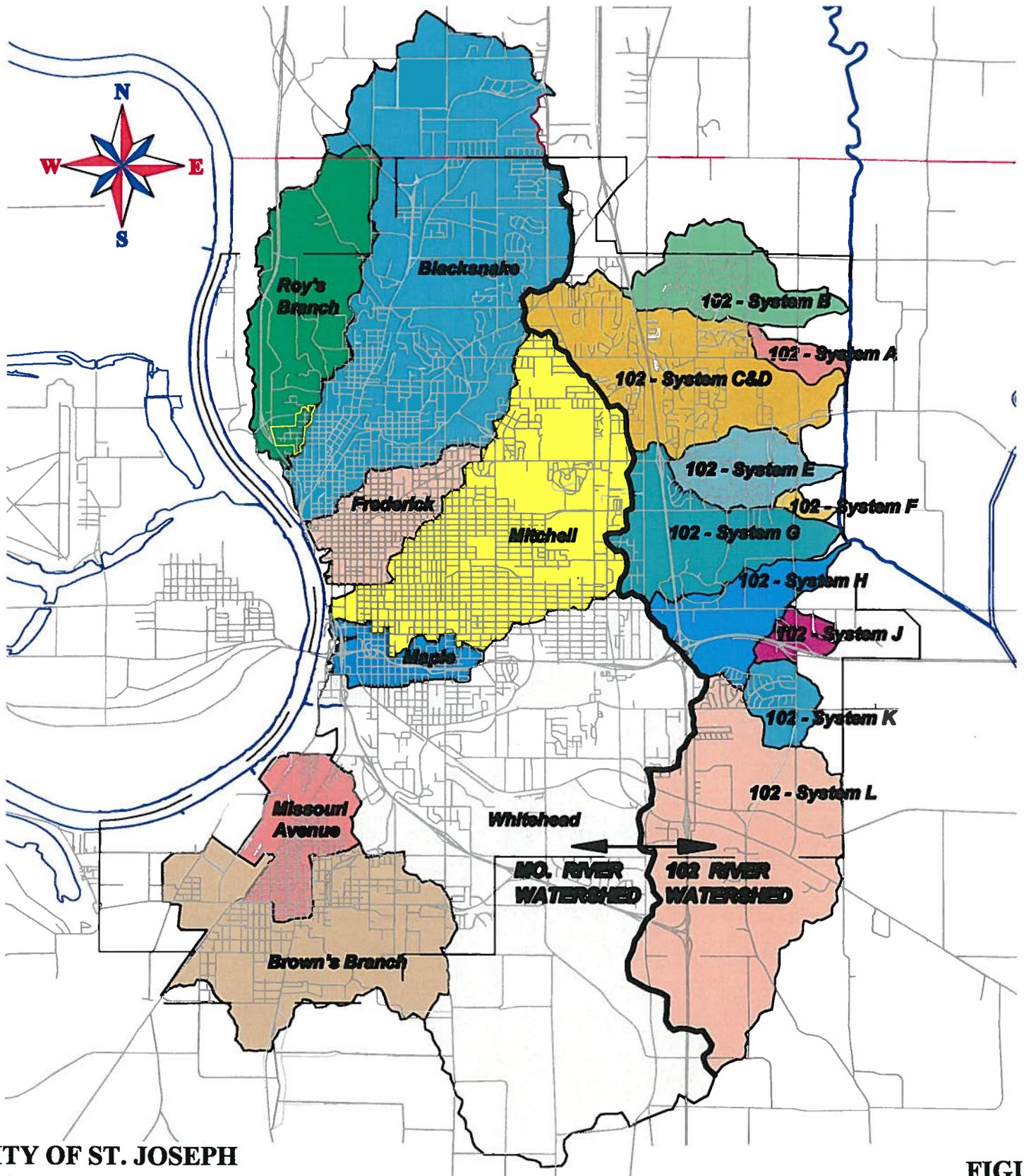
The City first implemented these practices in 1996, and the Missouri Department of Natural Resources (MDNR) included them in the City's NPDES permit. In addition, during 2002, the City submitted its combined sewer overflow (CSO) long term control plan (LTCP) to MDNR by December 21, 2002 as required by the NPDES permit.

The St. Joseph, Missouri CSO system consists of several Missouri River watersheds (see Figure 1) and CSO locations (see Figure 2). Flow into the CSO system consists of sanitary sewage, stormwater, and stream flow from Blacksnake Creek, Whitehead Creek, and Brown's Branch Creek.

A preliminary CSO Long-Term Control Plan (LTCP) was submitted in May 2006 to Missouri Department of Natural Resources (MDNR) and the Environmental Protection Agency (EPA). An updated CSO long term control plan is due January 31, 2007 per an extension letter from EPA date December 14, 2006. In the updated LTCP, the City is to provide pollutant analyses, CSO locations, land use, sampling procedures from five storm events, water quality modeling and alternatives for the reduction of CSO events.

The City of St. Joseph is working toward minimizing the frequency, duration, and severity of CSO events by installing remote, on-site samplers and analyzing the data from rain events. The City of St. Joseph has tentatively budgeted \$275,000 in fiscal year 2007 (FY07) for additional professional services to garner information and to analyze the data gathered from the CSO sites. The City can, therefore, make sound engineering and scientific recommendations to the City Council on ways to move toward reducing the number of CSO events within the City and to enhance the best management practices being implemented.

CITY OF ST. JOSEPH, MO. WATERSHED MAP

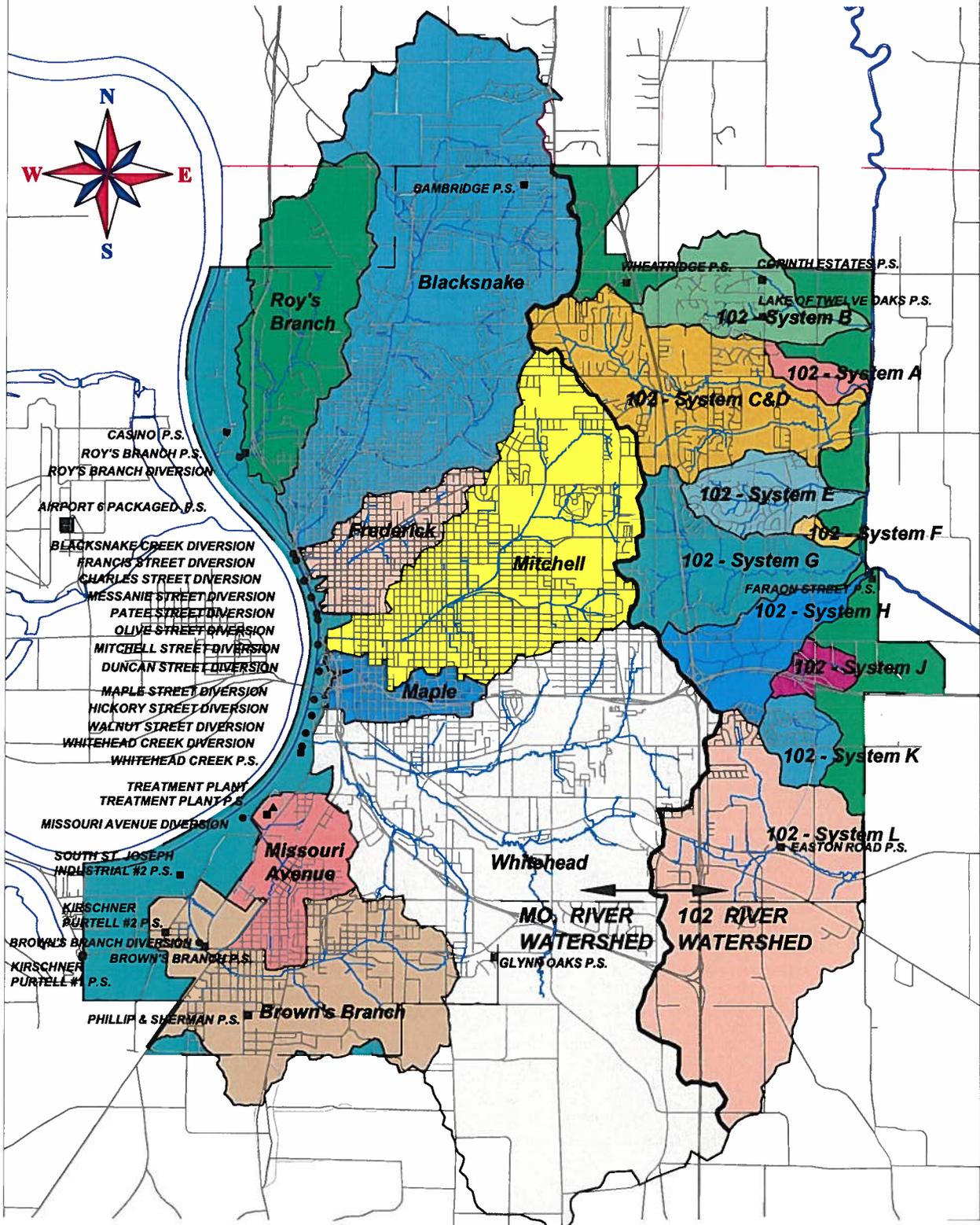


CITY OF ST. JOSEPH
WATERSHED MAP

FIGURE 1

CITY OF ST. JOSEPH, MO.

WATERSHED MAP



CSO LOCATION MAP

FIGURE 2

Minimum Control 1

Operation and Maintenance of the Collection System and Treatment Plant

The City has established procedures for the operation and maintenance of its Public-Owned Treatment Works (POTW), wastewater collection system, and CSO diversion structures. The Public Works Administration oversees the combined efforts of three divisions that operate and manage the City's wastewater utility. The maintenance of the collection system is performed by the Street and Sewer Maintenance Divisions while staff in the Water Pollution Control Division is responsible for the operation and maintenance of the POTW, the wastewater pumping stations, and the CSO diversion structures.

During 2006, the following maintenance activities were completed by the Sewer Maintenance Division personnel:

- **Repaired 70 Cave-Ins** - This activity includes point repairs to the combined sewer collection system, manhole replacements, storm sewer line repair, and related major maintenance. In 2006, the City purchased a new Strong Seal machine that was utilized to reinforce the structural integrity of sewer inlets by spraying a cementacious, gunite lining on weakened areas of brick manholes. The areas of concern were identified by resident call-in and by the televising of sewer lines by the sewer maintenance crew. After spray application of the cementacious lining, the compound was troweled smooth to also reduce inflow and infiltration.
- **Cleaned 4,699 Inlets** - The Sewer Maintenance Division operates a 2100 series Vactor, 10 cubic yard capacity, with a two-person crew. This crew has the annual responsibility of cleaning all of the curb inlets in town (both combined and separated systems). This crew removes any vegetative growth from the mouth of the inlet, cleans out any sand, rock or other debris from the mouth of the inlet, then vacuums out any accumulated deposits in the bottom of the inlet. Accumulated deposits can include floatables, trash, leaves, sand, silt, salt, mud, and other items. A photo of the 2100 series Vactor and its crew cleaning an inlet is attached (See Photo 1).
- **Repaired or Replaced 189 Storm Sewer Inlets** - A six-person crew repairs or replaces inlets throughout our system when they fail, are damaged, or are otherwise in need of replacement. The Strong Seal machine mentioned above was also used in this program for quicker response and repair time. A list is attached of the 189 repairs completed in 2006 with the address and completion date identified (See Table 1).
- **Televised 85,640 Feet of Sewer Line** - A two-person crew conducts closed circuit television inspection of the sewer system using a Cobra Technologies Optical Robotics unit. This equipment is mounted in a 2003 Freightliner Sprinter van and consists of a 3 lux, multi-color pan and tilt camera, computerized digital

recording system, 1,000 feet of cable and a smaller push camera, for an investment of \$119,000. The camera is self-propelled and designed for inspection of 8-inch through 48-inch diameter sewers. Our larger diameter sewers are manually inspected by the staff. See Appendix A for a sample TV inspection report (Figure 7) and a copy of a manhole inspection form (Figure 8). Inspection of each section of sewer generally includes a thorough cleaning using a flusher truck. Inspection results are reviewed by supervisors for prioritizing maintenance and repair needs. Some work is done in-house using City staff, while other repairs are done by contractors, depending on the complexity and severity of the problem. Contracted work includes heavy cleaning and heavy root sawing, lining (e.g. Insituform), and line replacement. In 2006, \$380,601.13 was spent on outside contractor services for repairs (See Table 2).

During 2006, the following maintenance activities were completed by the Street Maintenance Division personnel:

- **Swept 5,952 Miles of Streets** - The City of St. Joseph owns and maintains 426 miles of streets inside its corporate City limits. Street cleaning is an important public service to keep undesirable elements out of the combined sewer system as well as to keep our streets clean and attractive.

The street cleaning schedule is divided into nine work districts for routine sweeping city wide. Twenty-seven priority streets are a part of that schedule and receive either weekly or bi-weekly cleaning. Priority streets include streets in industrial areas where truck traffic is frequent, the downtown central business district, and the major arterial and collector roadways. The roads in the nine districts are cleaned as often as possible, usually once or twice per year at a minimum, except during below freezing temperatures. Last year 5,952 miles of streets were swept and 3,854 cubic yards of debris were disposed of.

During 2006 the following major maintenance of diversion structures, pump stations and treatment plant equipment was completed by the Water Pollution Control Division staff:

- **All Diversion Structures** - All 15 diversion structures were visually inspected for debris and gate operation. The operations staff checks the diversion structures weekly and after every rain over 4 inches, noting any repairs or defects on their weekly inspection checklist (See attached Table 3 for sample checklist). Maintenance and cleaning are done accordingly with each inspection. The sluice gates are lubricated and exercised on a semi-annual basis.
- **Roy's Branch Diversion Structure** - This structure is cleaned by hand after every rain event due to the amount of rock and other debris that washes into it.

- **5th & Atchison Diversion Structure** – Maintenance at this diversion site included cleaning done by a 17-ton crane with a clamshell bucket to remove sand and silt before it was washed to the POTW.
- **Blacksnake Creek Diversion Structure** – Maintenance at this diversion site included cleaning the bar screen 29 times during 2006.
- **Walnut Diversion Structure** – This diversion site was officially closed on November 17, 2006, by filling the collapsed overflow line with concrete and forcing any future bypasses through other diversion sites.
- **Missouri Avenue Diversion Structure** – Maintenance at this diversion site consisted of cleaning bar screen 7 times during 2006.
- **Mitchell Diversion Structure** – Maintenance at this diversion site in 2005 and 2006 consisted of re-building the three gates on the structure. The hangars on the south gate were rebuilt, the middle gate was welded for better support, and new plates were added to the north gate.
- **Brown's Branch Pump Station and Diversion Structure** – Maintenance at this diversion site consisted of cleaning the bar screen approximately 8 times during 2006, greasing the sluice gate, and removing debris from the overflow flap in November 2006. This diversion structure is cleaned with a backhoe, at least semi-annually, utilizing POTW and sewer maintenance staff due to the large amount of silt and debris that washes into it during rain events.
- **Thermophilic Digester Construction** – The City of St. Joseph, in an effort to improve and expand the capabilities of solids processing and increase influent capacity at the POTW, retained the services of CDM and DRG Engineering firms. The firms were to recommend a feasible and economical alternative to the four existing mesophilic digesters, two from the original plant construction in 1965 and two added to the plant site in the 1970's.

Construction of a thermophilic digester was begun in 2005 to produce Class A biosolids. The cost of producing Class A versus Class B biosolids was not much greater, and Class A biosolids are a more environmentally friendly product. Class A biosolids will reduce pathogenic bacteria content and the low metal concentration will allow for application in almost any situation. The POTW produces approximately 3500 dry tons of biosolids per year.

The 1.9 million-gallon thermophilic digester is slated for start-up in March 2007. The cost for design and construction was approximately \$6 million, and according to regulatory agencies within the State of Missouri, is the first anaerobic thermophilic digester in the state. Photos of the nearly-completed

thermophilic digester (See Photo 2) and POTW road improvements are attached (See Photo 3).

- **Industrial Clarifier** - Construction of a 500,000-gallon industrial clarifier was completed and the unit was put into service in 2006. This unit will allow the plant to equalize storm event flow and act as a cushion during rain events. Its main purpose of operation at this time is to handle flow from a pork processing plant to equalize their concentration of waste prior to entering the secondary treatment system at the POTW. The design and construction were budgeted at a total cost of \$1.9 million, a photo of the completed clarifier filled to capacity is attached (See Photo 4).

All wastewater treatment plant operations are reviewed annually by MDNR and the POTW met all the NPDES requirements in 2006.



VACTOR CREW AND TRUCK

PHOTO 1

Inlets Repaired 2006

NUM	DATE RCVD.	WORK DIST.	STREET NAME	ADDRESS/CROSS ST.	BARRI (Y/N)	CORNER	ADA RAMPS	ENTITY	DATE COMP.	Days	Status	Days
1	7/29/2005	2	26TH ST. N	FARAON TO JULES	YES	W SIDE	0	SMNT	1/3/2006	158.00	Done	893.70
2	8/2/2004	3	30TH ST. S	MESSAINE	YES	NE COR	0	SMNT	1/4/2006	520.00	Done	1254.70
3	5/28/2004	1	11TH ST. S	2335	YES	E SIDE	0	SMNT	1/6/2006	588.00	Done	1320.70
4	9/16/2004	2	ANGELIQUE	9TH ST. S TO 10TH ST. S	YES	N SIDE	1	SMNT	1/6/2006	477.00	Done	1209.70
5	12/10/2004	1	11TH ST. S	GARFIELD	YES	NE COR	0	SMNT	1/6/2006	392.00	Done	1124.70
6	4/21/2005	2	OLIVE	3409	YES	N SIDE	0	SMNT	1/11/2006	265.00	Done	992.70
7	8/24/2005	6	MICHEL	PROSPECT	YES	SW COR	0	SMNT	1/18/2006	147.00	Done	867.70
8	8/24/2005	6	FRANKLIN	315	YES	SW COR	0	SMNT	1/19/2006	148.00	Done	867.70
9	8/24/2005	6	FRANKLIN	314	YES	NW COR	0	SMNT	1/19/2006	148.00	Done	867.70
10	8/24/2005	6	MICHEL	PROSPECT	YES	NW COR	0	SMNT	1/19/2006	148.00	Done	867.70
11	12/27/2005	2	FREDERICK	KEMPER	YES	SW COR	1	SMNT	1/24/2006	28.00	Done	742.70
12	12/29/2004	6	HIGHLAND	SAVANNAH AVE	YES	SW COR	0	SMNT	2/1/2006	399.00	Done	1105.70
13	2/18/2005	2	9TH ST. N	FELIX	YES	NE COR	0	SMNT	2/1/2006	348.00	Done	1054.70
14	4/26/2005	2	5TH ST. N	ROBIDOUX	YES	NW COR	1	SMNT	2/1/2006	281.00	Done	987.70
15	2/9/2006	1	5TH ST. S	EDMOND	YES	NW COR	0	MADIGRAW	2/16/2006	7.00	Done	698.70
16	2/9/2006	1	8TH ST. S	EDMOND	YES	NE COR	0	MADIGRAW	2/24/2006	15.00	Done	698.70
17	2/9/2006	1	4TH ST. N	FELIX	YES	NE COR	0	MADIGRAW	2/15/2006	6.00	Done	698.70
18	2/9/2006	7	OAKLAND	VILLAGE DRIVE	YES	S SIDE	1	SMR	2/15/2006	6.00	Done	698.70
19	5/13/2005	6	11TH ST. N	RANDOLPH	YES	NE COR	1	SMNT	2/3/2006	266.00	Done	970.70
20	11/9/2005	5	11TH ST. N	RANDOLPH	YES	SW COR	1	SMNT	2/3/2006	86.00	Done	790.70
21	8/11/2005	2	FARAON	3RD ST. N TO 4TH ST. N	YES	S SIDE	0	SMNT	2/10/2006	183.00	Done	880.70
22	5/12/2005	2	3RD ST. N	ROBIDOUX	YES	NE COR	0	SMNT	2/15/2006	279.00	Done	971.70
23	8/24/2005	2	15TH ST. S	2110	YES	W SIDE	0	SMNT	2/21/2006	181.00	Done	867.70
24	1/1/2006	1	OLIVE	WARSAW	YES	NW COR	0	SMNT	2/24/2006	54.00	Done	737.70
25	1/10/2006	1	6TH ST. S	CHARLES	YES	NW COR	1	SMNT	2/24/2006	45.00	Done	728.70
26	12/30/2004	1	6TH ST. S	MITCHEL	YES	NW COR	2	SMNT	3/7/2006	432.00	Done	1104.70
27	1/11/2006	6	3RD ST. N	LINN	YES	SW COR	0	SMNT	3/8/2006	56.00	Done	727.70
28	2/27/2006	6	BLACKWELL	GREENCREST	YES	NE COR	0	SMNT	3/8/2006	9.00	Done	680.70
29	8/30/2004	3	27TH ST. N	MONTEREY	YES	SE COR	0	SMNT	3/10/2006	557.00	Done	1226.70
30	8/10/2005	3	30TH ST. S	PARKWAY A	YES	SE COR	0	SMNT	3/13/2006	215.00	Done	881.70
31	6/11/2004	2	16TH ST. S	JULES	YES	SE COR	2	SMNT	3/16/2006	643.00	Done	1306.70
32	1/4/2006	2	27TH ST. N	FARAON TO JULES	YES	W SIDE	0	SMNT	3/20/2006	75.00	Done	734.70
33	5/4/2005	2	POWELL	615	YES	N SIDE	0	SMNT	3/24/2006	324.00	Done	979.70
34	11/7/2005	1	PACIFIC	1401	YES	ALLEY	0	SMNT	3/28/2006	141.00	Done	792.70
35	3/17/2005	1	11TH ST. S	ANGELIQUE	YES	SE COR	0	SMNT	3/31/2006	379.00	Done	1027.70
36	2/28/2006	1	11TH ST. S	ANGELIQUE	YES	NE COR	2	SMNT	3/31/2006	31.00	Done	679.70
37	3/18/2005	1	HICKORY	11TH ST. S TO 12TH ST. S	YES	S SIDE	0	SMNT	1/25/2006	313.00	Done	1026.70
38	7/11/2005	2	12TH ST. S	MONTEREY	YES	NE COR	0	SMNT	4/3/2006	266.00	Done	911.70
39	2/14/2006	1	DONIPHAN	11TH ST. S TO 12TH ST. S	YES	N SIDE	0	SMNT	4/7/2006	52.00	Done	693.70
40	4/13/2005	3	FARLEIGH TERR	2737	YES	NW COR	0	SMNT	4/10/2006	362.00	Done	1000.70
41	12/12/2005	2	25TH ST. N	CALHOUN	YES	NE COR	0	SMNT	4/10/2006	119.00	Done	757.70
42	4/25/2005	2	LAFAYETTE	VINE	YES	NE COR	0	SMNT	4/13/2006	353.00	Done	988.70
43	2/1/2006	1	LOCUST	VINE	YES	NW COR	2	SMNT	4/14/2006	72.00	Done	706.70
44	1/26/2005	3	31ST ST. N	JULES	YES	SW COR	1	SMNT	4/20/2006	449.00	Done	1077.70
45	2/11/2005	1	7TH ST. S	WALNUT	YES	NW COR	0	SMNT	4/21/2006	434.00	Done	1061.70
46	4/10/2006	1	7TH ST. S	HICKORY TO WALNUT	YES	E SIDE	0	SMNT	4/24/2006	14.00	Done	638.70
47	4/6/2006	2	27TH ST. S	CLAY	YES	SE COR	0	SMNT	4/20/2006	14.00	Done	642.70
48	4/10/2006	1	7TH ST. S	HICKORY TO WALNUT	YES	W SIDE	0	SMNT	4/21/2006	11.00	Done	638.70
49	4/17/2006	1	10TH ST. N	1600	YES	W SIDE	0	STRONG	4/27/2006	10.00	Done	631.70
50	4/20/2006	1	5TH ST. S	FRAMCIS	YES	SE COR	0	PARADE	4/27/2006	7.00	Done	628.70
51	4/26/2006	5	KINGHILL AVE	PARK WOOD	YES	W SIDE	0	SMNT	4/27/2006	1.00	Done	622.70
52	2/11/2005	1	7TH ST. S	HICKORY	YES	W SIDE	0	SMNT	4/27/2006	440.00	Done	1061.70
53	1/10/2006	6	5TH ST. N	INDEPENDENCE	YES	NE COR	0	SMNT	5/3/2006	113.00	Done	728.70
54	2/3/2006	2	20TH ST. S	JACKSON	YES	NW COR	0	SMNT	5/5/2006	91.00	Done	704.70
55	12/14/2005	3	MORINGSIDE	GRANDVIEW	YES	NE COR	0	SMNT	5/8/2006	145.00	Done	755.70
56	2/10/2006	2	20TH ST. S	ANGELIQUE TO MESSAINE	YES	E SIDE	0	SMNT	5/10/2006	89.00	Done	697.70
57	2/24/2006	6	WEST HIGHLAND	124	YES	ALLEY	0	SMNT	5/10/2006	75.00	Done	683.70
58	10/31/2005	5	16TH ST. S	PACIFIC	YES	ALLEY	0	SMNT	5/12/2006	193.00	Done	799.70
59	1/12/2006	6	7TH ST. N	MADISON	YES	NE COR	0	SMNT	5/15/2006	123.00	Done	726.70
60	3/1/2005	1	7TH ST. S	PATEE	YES	SW COR	0	SMNT	5/16/2006	441.00	Done	1043.70
61	3/15/2006	2	16TH ST. S	2108	YES	W SIDE	0	SMNT	5/16/2006	62.00	Done	664.70
62	1/23/2006	5	BRIARWOOD	MOCKINGBIRD LANE	YES	NE COR	0	SMNT	5/18/2006	115.00	Done	715.70
63	3/31/2006	5	FLEEMAN	LOOKOUT	YES	NE COR	0	SMNT	5/22/2006	52.00	Done	648.70
64	5/27/2005	6	DEWEY	ST. PAUL	YES	NE COR	2	SMNT	5/23/2006	361.00	Done	956.70
65	3/27/2006	5	HARVARD	209	YES	N SIDE	0	SMNT	5/23/2006	57.00	Done	652.70
66	3/29/2005	6	ST. PAUL	DEWEY	YES	SE COR	2	SMNT	5/26/2006	423.00	Done	1015.70
67	11/7/2005	4	LOOKOUT	FLEEMAN	YES	SE COR	0	SMNT	5/26/2006	200.00	Done	792.70
68	2/15/2006	1	17TH ST. S	MITCHEL	YES	NE COR	0	SMNT	5/26/2006	100.00	Done	692.70
69	4/28/2006	4	CARNEIGE	RHUDY	YES	SW COR	1	SMNT	5/10/2006	12.00	Done	620.70

Inlets Repaired 2006

NUM	DATE RCVD.	WORK DIST.	STREET NAME	ADDRESS/CROSS ST.	BARRI (Y/N)	CORNER	ADA RAMPS	ENTITY	DATE COMP.	Days	Status	Days
70	5/1/2006	6	DEWEY	ST. PAUL	YES	MIDDLE	0	SMNT	5/23/2006	22.00	Done	617.70
71	5/18/2006	5	EAST CLIFF	214	YES	S SIDE	0	SMNT	5/26/2006	8.00	Done	600.70
72	3/9/2006	3	EUGENE FIELD	FORSEE	YES	NW COR	0	SMNT	5/31/2006	83.00	Done	670.70
73	4/10/2006	5	YALE	CUMBURLIN	YES	SE COR	0	SMNT	5/31/2006	51.00	Done	638.70
74	6/3/2005	6	DEWEY	ST. PAUL	YES	NW COR	2	SMNT	6/1/2006	363.00	Done	949.70
75	2/23/2006	2	JONES	2513	YES	N SIDE	0	SMNT	6/1/2006	98.00	Done	684.70
76	3/22/2006	5	IOWA	228	YES	S SIDE	0	SMNT	6/1/2006	71.00	Done	657.70
77	5/5/2006	2	SENECA	3316	YES	ALLEY	0	SMNT	6/2/2006	28.00	Done	613.70
78	4/29/2005	6	DEWEY	ST. PAUL	YES	SW COR	2	SMNT	6/5/2006	402.00	Done	984.70
79	3/4/2005	6	PROSPECT	ROSINE	YES	NW COR	2	SMNT	6/8/2006	461.00	Done	1040.70
80	5/18/2005	4	GRANT	MICHIGAN	YES	SW COR	0	SMNT	6/13/2006	391.00	Done	965.70
81	4/13/2006	1	19TH ST. N	FREDERICK	YES	NE COR	0	SMNT	6/13/2006	61.00	Done	635.70
82	5/16/2006	3	ASHLAND	DOUGLAS	YES	SE COR	0	SMNT	6/13/2006	28.00	Done	602.70
83	3/22/2005	6	3RD ST. N	ROSINE	YES	NW COR	0	SMNT	6/14/2006	449.00	Done	1022.70
84	9/19/2005	5	MORRIS	EAST VALLEY	YES	SE COR	2	SMNT	6/14/2006	268.00	Done	841.70
85	5/24/2006	6	SAVANNA AVE	RICHARDSON	YES	NE COR	0	SMNT	6/14/2006	21.00	Done	594.70
86	5/30/2006	6	MAIN	MICHEL	YES	NW COR	0	SMNT	6/14/2006	15.00	Done	588.70
87	5/11/2004	2	22ND ST. S	FARAON	YES	NW COR	1	SMNT	6/19/2006	769.00	Done	1337.70
88	11/2/2004	2	22ND ST N	MULLBERRY	YES	SW COR	1	SMNT	6/29/2006	604.00	Done	1162.70
89	6/1/2006	7	GENEFIRLD ROAD	PEMBROKE	YES	S SIDE	1	SIMR	6/20/2006	19.00	Done	586.70
90	6/23/2006	1	SACRAMENTO	8TH ST. S TO 9TH ST. S	YES	N SIDE	0	SMNT	6/29/2006	6.00	Done	564.70
91	6/23/2006	6	MONROE	9TH ST. N	YES	NE COR	0	SMNT	6/29/2006	6.00	Done	564.70
92	1/17/2006	3	25TH ST. S	SYLVAIN	YES	NE COR	2	SMNT	6/22/2006	156.00	Done	721.70
93	6/26/2006	3	25TH ST S	SYLVAIN	YES	SE COR	2	SMNT	6/26/2006	0.00	Done	561.70
94	1/26/2006	3	27TH ST N	DELEWARE	YES	SE COR	1	SMNT	6/28/2006	153.00	Done	712.70
95	5/30/2006	3	30TH ST S	MESSAINE	YES	SE COR	0	SMNT	7/6/2006	37.00	Done	588.70
96	4/27/2006	2	22ND ST. S	BELLE	YES	SW COR	0	SMNT	7/10/2006	74.00	Done	621.70
97	3/14/2005	2	19TH ST. N	1203	YES	E SIDE	0	SMNT	7/11/2006	484.00	Done	1030.70
98	1/31/2006	1	18TH ST. S	SACRAMENTO	YES	SW COR	0	SMNT	7/12/2006	162.00	Done	707.70
99	9/19/2005	8	ARIZONA	300	YES	S SIDE	0	SMNT	7/14/2006	298.00	Done	841.70
100	4/1/2006	3	31ST ST. S	PARKWAY A	YES	SW COR	0	SMNT	7/17/2006	107.00	Done	647.70
101	5/1/2006	3	CRESTVIEW LANE	SHURMAN AVE	YES	SE COR	0	SMNT	7/17/2006	77.00	Done	617.70
102	6/10/2005	3	30TH ST. S	MESSAINE	YES	SE COR	2	SMNT	7/19/2006	404.00	Done	942.70
103	7/28/2005	2	12TH ST. N	6TH AVE	YES	SE COR	0	SMNT	7/20/2006	357.00	Done	894.70
104	10/27/2005	2	9TH ST. N	3121	YES	W SIDE	0	SMNT	7/21/2006	267.00	Done	803.70
105	6/21/2006	3	NOYES	EDMOUND TO FELIX	YES	E SIDE	0	SMNT	7/24/2006	33.00	Done	566.70
106	4/13/2005	6	MAIN	ISABELLE	YES	NE COR	0	SMNT	7/25/2006	468.00	Done	1000.70
107	1/10/2006	1	4TH ST. S	MITCHELL	YES	NE COR	0	SMNT	7/31/2006	202.00	Done	728.70
108	7/24/2006	1	11TH ST. S	521	YES	ALLEY	0	SMNT	7/25/2006	1.00	Done	533.70
109	7/25/2006	1	6TH ST. S	OLIVE	YES	SW COR	0	EL CRAFTORD	8/7/2006	13.00	Done	532.70
110	7/25/2006	1	7TH ST. S	OLIVE	YES	SE COR	0	EL CRAFTORD	8/7/2006	13.00	Done	532.70
111	7/25/2006	1	OLIVE	6TH ST. S TO 7TH ST. S	YES	S SIDE	0	EL CRAFTORD	7/28/2006	3.00	Done	532.70
112	8/10/2006	1	13TH ST. S	CHARLES	YES	SE COR	0	DBUTERFIELD	8/29/2006	19.00	Done	516.70
113	8/23/2006	2	24TH ST. S	DUNCAN	YES	SE COR	0	S BRUNE	8/28/2006	5.00	Done	503.70
114	7/26/2006	1	8TH ST. S	DUNCAN	YES	SW COR	0	SMNT	8/1/2006	6.00	Done	531.70
115	12/1/2004	6	13TH ST. N	DOUGLAS	YES	NW COR	0	SMNT	8/2/2006	609.00	Done	1133.70
116	7/28/2006	3	28TH ST. S	DONIPHAN TO DUNCAN	YES	E SIDE	0	SMNT	8/7/2006	10.00	Done	529.70
117	3/6/2006	2	ATCHISON	14TH ST. S TO 15TH ST. S	YES	S SIDE	0	SMNT	8/11/2006	158.00	Done	673.70
118	4/27/2006	2	28TH ST. S	SENECA TO LAFAYETTE	YES	E SIDE	0	SMNT	8/11/2006	106.00	Done	621.70
119	6/16/2006	1	14TH ST. N	FREDERICK	YES	NE COR	0	SMNT	8/15/2006	60.00	Done	571.70
120	8/27/2005	1	13TH ST. N	FARAON	YES	SE COR	0	SMNT	8/17/2006	355.00	Done	864.70
121	9/19/2005	6	ST. JOSEPH AVE	MCDONALD	YES	NW COR	0	SMNT	8/21/2006	336.00	Done	841.70
122	6/29/2005	6	4TH ST. N	HIGHLAND	YES	SE COR	1	SMNT	8/24/2006	421.00	Done	923.70
123	7/28/2005	2	14TH ST. S	ATCHISON TO GARFIELD	YES	N SIDE	0	SMNT	9/1/2006	400.00	Done	894.70
124	8/3/2006	4	TEXAS WEST	300	YES	S SIDE	0	SMNT	9/1/2006	29.00	Done	523.70
125	8/24/2006	2	11TH ST. N	POWELL	YES	NW COR	0	SMNT	9/7/2006	14.00	Done	502.70
126	6/14/2005	2	11TH ST. N	POWELL	YES	SW COR	2	SMNT	9/13/2006	456.00	Done	938.70
127	12/5/2005	1	PACIFIC	11TH ST. S TO 12TH ST. S	YES	W SIDE	0	SMNT	9/14/2006	283.00	Done	764.70
128	5/18/2006	5	EAST VALLEY	BELDING	YES	NW COR	0	SMNT	9/15/2006	120.00	Done	600.70
129	7/26/2005	2	10TH ST. N	RIDENBAUGH	YES	SW COR	2	SMNT	9/19/2006	420.00	Done	896.70
130	5/11/2006	6	PARKER	110	YES	S SIDE	0	SMNT	9/26/2006	138.00	Done	607.70
131	7/12/2005	6	11TH ST. N	LINCOLN	YES	SW COR	0	SMNT	9/27/2006	442.00	Done	910.70
132	7/12/2005	6	11TH ST. N	LINCOLN	YES	NW COR	2	SMNT	9/27/2006	442.00	Done	910.70
133	7/12/2005	6	11TH ST. N	LINCOLN	YES	NE COR	2	SMNT	9/27/2006	442.00	Done	910.70
134	1/11/2006	4	LAKE AVE	ALABAMMA	YES	NE COR	0	SMNT	9/29/2006	261.00	Done	727.70
135	6/29/2005	6	4TH ST. N	HIGHLAND	YES	SW COR	1	SMNT	8/28/2006	425.00	Done	923.70
136	6/23/2006	6	9TH ST. N	MONROE	YES	S SIDE	0	SMNT	8/30/2006	68.00	Done	564.70
137	11/18/2005	2	24HT ST. N	FRANCES	YES	NE COR	2	SMNT	6/30/2006	224.00	Done	781.70
138	2/11/2005	1	7TH ST. S	WALNUT	YES	NE COR	0	SMNT	4/27/2006	440.00	Done	1061.70

Inlets Repaired 2006

NUM	DATE RCVD.	WORK DIST.	STREET NAME	ADDRESS/CROSS ST.	BARRI (Y/N)	CORNER	ADA RAMP	ENTITY	DATE COMP.	Days	Status	Days
139	8/31/2006	4	4TH ST S	HARMON TO THOMPSON	YES	E SIDE	0	SMNT	9/1/2006	1.00	Done	495.70
140	8/31/2006	4	4TH ST. S	BENTON DR TO HARMON	YES	E SIDE	0	SMNT	9/1/2006	1.00	Done	495.70
141	8/24/2006	4	GRANT	ELIZABETH	YES	SE COR	0	SMNT	9/28/2006	35.00	Done	502.70
142	5/25/2006	2	21ST ST. S	ANGELIQUE TO MESSAINE	YES	E SIDE	0	SMNT	10/2/2006	130.00	Done	593.70
143	5/25/2006	2	23RD ST S	2827	YES	NE COR	0	SMNT	10/2/2006	130.00	Done	593.70
144	9/15/2005	5	6TH ST. N	POULIN	YES	SW COR	0	SMNT	10/4/2006	384.00	Done	845.70
145	11/18/2005	1	GARFIELD	1329	YES	ALLEY	0	SMNT	10/5/2006	321.00	Done	781.70
146	8/17/2006	6	3RD ST. N	HIGHLAND	YES	SE COR	0	SMNT	10/10/2006	54.00	Done	509.70
147	6/14/2005	4	COLORADO	515	YES	N SIDE	0	SMNT	10/20/2006	493.00	Done	938.70
148	9/14/2005	5	GORDON	VIRGINA	YES	NW COR	0	SMNT	10/20/2006	401.00	Done	846.70
149	8/2/2006	4	BROWN	6408	YES	W SIDE	0	SMNT	10/24/2006	83.00	Done	524.70
150	7/12/2005	4	RUDY	BROWN	YES	NE COR	2	SMNT	10/30/2006	475.00	Done	910.70
151	9/15/2006	1	6TH ST. S	SYLVAINE	YES	NE COR	1	SIMR	10/16/2006	31.00	Done	480.70
152	9/22/2006	5	GRANT	WEST VALLEY	YES	NW COR	0	OSBORN	9/28/2006	14.00	Done	473.70
153	10/2/2006	1	MESSAINE	16TH ST. S TO 17TH ST. S	YES	N SIDE	0	BRUNE	10/17/2006	15.00	Done	463.70
154	12/1/2005	4	CARNEIGIE	ELIZABETH	YES	SE COR	1	SMNT	10/30/2006	333.00	Done	768.70
155	2/15/2006	4	BROWN	WEST VALLEY	YES	NE COR	0	SMNT	10/30/2006	257.00	Done	692.70
156	9/8/2006	2	28TH ST S	LAFAYETTE	YES	SW COR	0	SMNT	9/28/2006	20.00	Done	487.70
157	4/25/2005	6	ALBERMARLE	6TH ST. N TO 7TH ST. N	YES	N SIDE	0	SMNT	10/4/2006	527.00	Done	988.70
158	3/1/2005	3	12TH ST S	ATCHISON	YES	SW COR	0	SMNT	10/6/2006	584.00	Done	1043.70
159	10/31/2005	8	5TH ST S	COLORADO	YES	SW COR	0	SMNT	11/2/2006	367.00	Done	799.70
160	6/23/2006	4	OHIO	PRYOR	YES	NE COR	0	SMNT	11/2/2006	132.00	Done	564.70
161	10/31/2005	4	NEW PORT	3302	YES	W SIDE	0	SMNT	11/6/2006	371.00	Done	799.70
162	10/10/2006	6	NEWPORT	ESSEX	YES	NW COR	0	SMNT	11/6/2006	27.00	Done	455.70
163	5/2/2006	1	10TH ST S	MITCHELL	YES	SE COR	0	SMNT	11/16/2006	198.00	Done	616.70
164	8/8/2005	1	15TH ST S	MITCHELL	YES	NW COR	0	SMNT	11/20/2006	469.00	Done	883.70
165	8/10/2006	3	26TH ST N	516	YES	W SIDE	0	SMNT	11/21/2006	103.00	Done	516.70
166	8/21/2006	3	MULBERRY	BIRCH	YES	NW COR	0	SMNT	11/21/2006	92.00	Done	505.70
167	10/31/2006	1	10TH ST S	MITCHELL	YES	SW COR	2	SMNT	11/21/2006	21.00	Done	434.70
168	10/18/2006	3	32ND ST S	SENECA	YES	SW COR	0	SMNT	11/27/2006	40.00	Done	447.70
169	11/8/2006	2	18TH ST. N	FREDERICK	YES	NW COR	1	SIMR	11/20/2006	12.00	Done	426.70
170	11/9/2006	6	MAIN	LINN	YES	SW COR	0	SMNT	11/15/2006	6.00	Done	425.70
171	11/14/2006	3	ASHLAND	LOVERS LANE	YES	SE COR	0	SMNT	11/15/2006	1.00	Done	420.70
172	8/15/2006	4	8TH ST S	GARDEN	YES	ALLEY	0	SMNT	11/30/2006	107.00	Done	511.70
173	10/10/2006	3	32ND ST S	SENECA	YES	SW COR	0	SMNT	11/30/2006	51.00	Done	455.70
174	8/21/2006	4	WASHINGTON	WEST VALLEY	YES	NW COR	0	SMNT	12/1/2006	102.00	Done	505.70
175	8/21/2006	4	WASHINGTON	WEST VALLEY	YES	NE COR	0	SMNT	12/1/2006	102.00	Done	505.70
176	10/23/2006	3	MONTEREY	SNELSON	YES	NE COR	0	SMNT	12/1/2006	39.00	Done	442.70
177	11/22/2006	4	CARNEGIE	OHIO TO VIRGINA	YES	W SIDE	0	SMNT	12/1/2006	9.00	Done	412.70
178	10/6/2005	2	PENN	1412	YES	S SIDE	0	SMNT	12/4/2006	424.00	Done	824.70
179	10/11/2005	1	19TH ST. S	MITCHELL	YES	SW COR	0	SMNT	12/4/2006	419.00	Done	819.70
180	10/23/2006	3	MONTEREY	SNELSON	YES	NW COR	0	SMNT	12/4/2006	42.00	Done	442.70
181	11/13/2006	2	15TH ST. N	FELIX	YES	SE COR	0	SMNT	12/7/2006	24.00	Done	421.70
182	8/15/2006	6	7TH ST. N	SHADY	YES	SW COR	0	SMNT	12/11/2006	118.00	Done	511.70
183	8/23/2005	2	19TH ST. S	MITCHELL	YES	NW COR	0	SMNT	12/18/2006	482.00	Done	868.70
184	10/20/2005	1	MITCHELL	2209	YES	N SIDE	0	SMNT	12/18/2006	424.00	Done	810.70
185	9/29/2006	3	ASHLAND	DOUGLAS	YES	W SIDE	0	SMNT	12/18/2006	80.00	Done	466.70
186	10/31/2006	1	19TH ST. S	MITCHELL	YES	NE COR	2	SMNT	12/18/2006	48.00	Done	434.70
187	9/15/2006	3	NOYES	SYLVAINE	YES	NW COR	1	SIMR	9/20/2006	5.00	Done	480.70
188	9/15/2006	3	NOYES	SYLVAINE	YES	SW COR	1	SIMR	9/20/2006	5.00	Done	480.70
189	4/18/2005	2	PARK LANE	140	YES	S SIDE	0	SMNT	4/25/2006	372.00	Done	995.70

Sewer Repairs 2006

Contractor	Street, Alley or Easement	Location	Description	PO Date	Type of Work	Status	Total
Duke's	(blank)	Leonard Rd Acres (Cheyenne, Shawnee & Valley Ln)	Roots in Line	9/22/2006	Foam	Paid	\$ 9,770.46
Duke's Total							\$ 9,770.46
Insituform	Easement	Pickett Rd Sewer	Line Pipe	3/16/2006	CIPP line	Paid	\$ 111,804.00
	Street	200 Yale St	Pipe is broken & disconnected Wyes	2/23/2006	CIPP Line, Reconnect Wyes	Paid	\$ 10,098.00
		2500 Kent	Line has Holes in it	10/4/2006	Install CIPP Liner	Need Bill	
		4814 Stonecrest Terr	Line has Holes in it	10/4/2006	Install CIPP Liner	Need Bill	
		E of Claremont -Allen Ct to Cronkite	20' Wall built over line	10/4/2006	Install CIPP Liner	Need Bill	
Insituform Total							\$ 121,902.00
Sprague	Alley	Alley 4/5 Felix/Edmond	Alley is caved in	4/20/2006	Replace Line	Paid	\$ 18,603.77
		Alley Angelique /Sylvanie W of 11th St	Alley is caved in	4/21/2006	Replace Line	Paid	\$ 9,657.87
	Easement	Cronkite & Claremont	Low spot in line causing backups	6/12/2006	Rebuild Line	Paid	\$ 50,872.26
		E of Leonard-Eastwood Dr & Brookwood Terr	Line is off set	6/29/2006	Rebuild Line	Paid	\$ 18,971.17
	Street	22nd & Locust	Street is undermined	10/12/2006	Gunitite Main & Reconnect service line	Paid	\$ 12,138.49
		Cronkite & Claremont	Additonal Costs	6/12/2006	Rebuild Line	Paid	
		Essex St	Additonal Costs	8/14/2006	Rebuild Line	Paid	
			Line is broken and has several low spots	8/14/2006	Rebuild Line	Paid	\$ 83,485.70
		Harvard at Lookout	Additonal Costs	4/12/2006	Replace Line	Paid	
			Street is caved in	4/12/2006	Replace Line	Paid	\$ 32,861.23
		SD #294 East of Shawnee Main Line exposed	Creek has washed out mainline sewer	11/3/2006	Put Rip Rap in Creek, Encase Line & build cutoff wall	Paid	\$ 13,378.39
	(blank)	Wayne & Junior Dr	Line is Collapsed	8/14/2006	Repair Line	Paid	\$ 8,959.79
Sprague Total							\$ 248,928.67
2006 Total Costs							\$ 380,601.13

54" INTERCEPTOR DIVERSION
STRUCTURES
INSPECTION CHECKLIST

The following diversion structures are to be inspected weekly and after any significant wet weather bypass event. Indicate any problems you find and any corrective action that was taken.

DATE: 8-30-06

CONDITION/COMMENTS

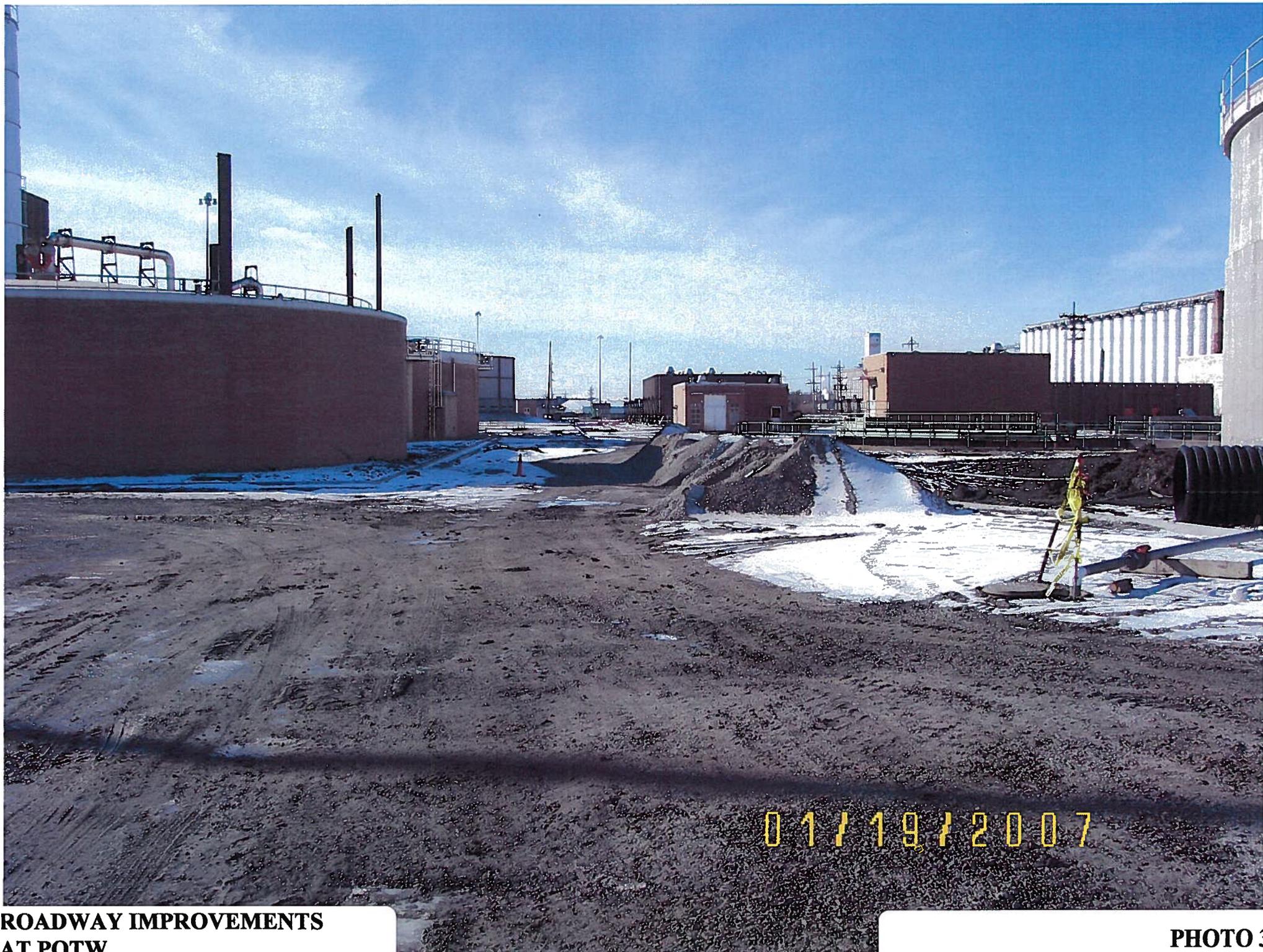
- | | |
|-----------------------|-------------------------------------|
| 1. Francis Diversion | <u>OK</u> |
| 2. Charles Diversion | <u>OK</u> |
| 3. Messanie Diversion | <u>OK - Change lock on dry side</u> |
| 4. Patee Diversion | <u>OK</u> |
| 5. Olive Diversion | <u>OK</u> |
| 6. Mitchell Diversion | <u>MR^d door - OK</u> |
| 7. Duncan Diversion | <u>OK</u> |
| 8. Maple Diversion | <u>OK</u> |
| 9. Hickory Diversion | <u>OK</u> |
| 10. Walnut Diversion | <u>OK</u> |

NAME: Tim Gasj



THERMOPHILIC DIGESTER

PHOTO 2



01/19/2007

**ROADWAY IMPROVEMENTS
AT POTW**

PHOTO 3



01/22/2007

INDUSTRIAL CLARIFIER

PHOTO 4

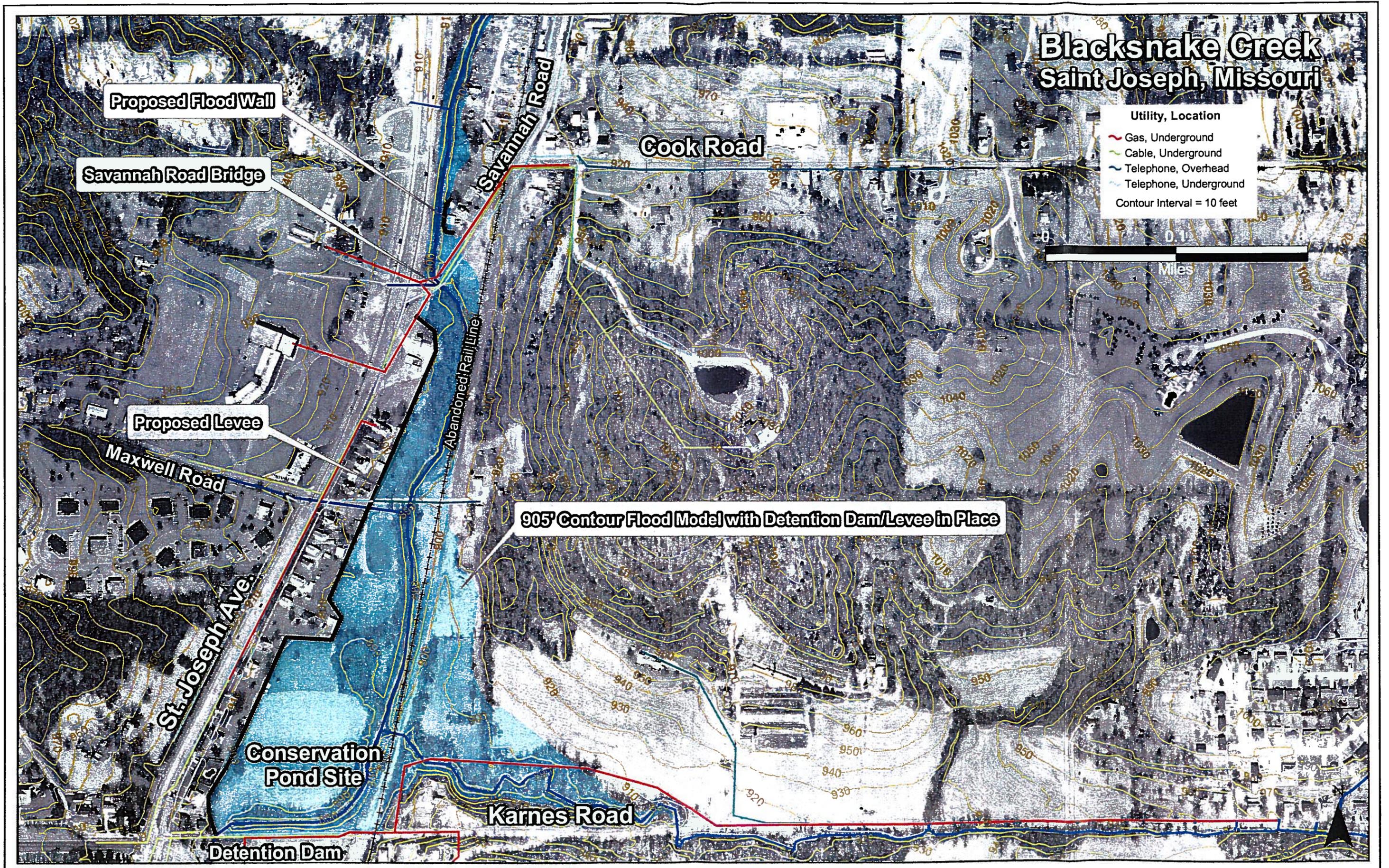
Minimum Control 2

Maximize Collection System Storage

The storage capacity of the sewer system is maximized through regular cleaning of the collection system and diversion structures. The City utilizes vacuum and flushing trucks to clean the interior of the collection system on a routine maintenance schedule, as well as in response to performance issues observed by or reported to staff. During 2006, City staff cleaned and root sawed over 163,407 lineal feet of sewer line. In the Blacksnake, Whitehead and Brown's Branch systems, there are upstream creeks that drain directly into the combined sewer system. A routine program of cleaning dead limbs and collecting accumulated trash and debris from the openings of these systems helps to preserve the most capacity available to the enclosed conveyance system.

An Army Corps of Engineers section 205 flood control project that includes a detention basin, upstream of the Blacksnake Creek combined sewer system is still progressing. This project has the potential to reduce the frequency and volume of CSO discharges in two different ways. It would first reduce the release rate, so that in small storm events the entire volume of stormwater can be treated. Secondly, in larger events, it would reduce the volume to be treated by utilizing the detention basin and extending the release time. A preliminary layout of the proposed detention basin for 100-year flood protection is attached (See Figure 3). The final feasibility phase study is being conducted by the Corps and is scheduled to be complete in 2007.

The diversion structures that are designed with barscreens were cleaned on a regular basis by POTW maintenance personnel. Collection system staff and heavy equipment from outside contractors are also involved during some cleaning activities.



PRELIMINARY LAYOUT OF
BLACKSNAKE FLOOD CONTROL

FIGURE 3

Minimum Control 3

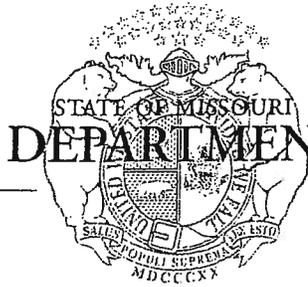
Review of Pretreatment Program

The City of St. Joseph administers its own pretreatment program according to Federal Pretreatment Regulations 40 CFR 403. Federal industrial pretreatment requirements and the local individual discharge ordinances provide the framework for controlling the discharge of pollutants to the wastewater collection system through a permit system.

The City added three new staff members during 2006 for administration and monitoring support of its pretreatment program. Each of those staff members has received specific pretreatment training from Water Environment Federation (WEF) approved seminars in 2006. The training provided detailed training in federal regulations and CIU credits to support the wastewater accreditation of each staff member. Additional WEF pretreatment training for advanced administration is scheduled for 2007.

Significant industrial users are sampled on a semi-annual basis and inspected once per year as required by federal regulation. Categorical industrial users are monitored similarly, with some industries being monitored on a daily basis. Enforcement actions taken by the City in 2006 were in the form of Notice of Violation (NOV) letters to three separate industries. Each of those industries is working to bring their operations into compliance to meet their specific permit limits.

The City of St. Joseph underwent a Pretreatment Compliance Inspection in 2006 by the MDNR Pretreatment Coordinator. The City received a positive review of its program and the resulting letter and summary are attached (See Figure 4).



Matt Blunt, Governor • Doyle Childers, Director

DEPARTMENT OF NATURAL RESOURCES

www.dnr.mo.gov

DEC 5 2006

Mr. Don Gilpin, Superintendent
Water Pollution Control
City of St. Joseph
3500 S. 759 Highway
St. Joseph, MO 64504

Dear Mr. Gilpin:

Enclosed is a summary of the Pretreatment Compliance Inspection (PCI) I conducted on November 21, 2006. I appreciate the time Ms. Nelson and Mr. Fitzpatrick spent with me and commend the Cities staff and consultants on-going efforts with St. Joseph's pretreatment program.

Should you have any questions or concerns regarding the report or any other issues you are dealing with, please contact me by phone at (573) 751-6982 or P.O. Box 176, Jefferson City, MO 65102-0176. Thank you again for your staff's time and efforts.

Sincerely,

WATER PROTECTION PROGRAM

Richard J. Laux, R.G.
Pretreatment Coordinator

RJL:an

c: Kansas City Regional Office
Mr. Paul Marshall, EPA Region 7
Ms. Kendra Nelson
Mr. James Fitzpatrick P.E. Black and Veatch

Enclosure

**PRETREATMENT COMPLIANCE INSPECTION
CITY OF ST. JOSEPH**

On November 21, 2006 a Pretreatment Compliance Inspection (PCI) was performed on the City of St. Joseph's approved program. Ms. Kendra Nelson represented the City; also attending was Mr. James Fitzpatrick P.E. with Black and Veatch who assists the City with pretreatment efforts. The previous review of the program was a PCI conducted in 2003. Mr. Richard J. Laux, R.G. conducted this PCI for the department.

FINDINGS:

1. The City appears to have reviewed industrial user reports and it's own monitoring data on the industrial users within thirty days. With minor exceptions, records indicate compliance with categorical standards and with local limits during the last year.
2. There have been a number of plant closures, name changes and new facilities since the last PCI. The City is providing an updated CIU/SIU list. The Cities' files appear well organized and up-to-date.
3. The City appears to be conducting industrial inspections and successfully implementing their pretreatment program.

RECOMMENDATIONS:

1. The City should continue to review reports in a timely manner and follow up on any non-compliance reported or detected by the City's sampling program.

Minimum Control 4

Maximization of Flow to the POTW for Treatment

The POTW typically receives 14-16 million gallons per day (MGD) of influent at the headworks of the plant during dry weather. During a wet weather event, staff increases the pumped flow volume from the interceptor to the maximum flow rate of 27 MGD allowed by the City's NPDES permit. Short duration peaks in excess of 27 MGD are achieved at the discretion of the Operations Manager, if operation conditions allow. Increasing the flow pumped to the treatment plant during wet weather events has shortened the duration of the overflow events and has allowed small events to be captured and routed through the POTW. The POTW has established procedures to maintain and document the maximization of flow during wet weather events.

Two options to maximize combined sewer flow to the POTW are being evaluated at this time. One option under consideration, is a pipe-in-pipe system to divert sanitary sewer from creek flow at Whitehead and Mitchell diversions directly to the POTW. Problems with this option include balancing the 1-2 year storms and the 50-100 year storm events that occur without overloading the POTW plant. A feasibility study for the pipe-in-pipe system is being developed at this time by Black and Veatch Engineering firm.

The second option to maximize combined sewer flow to the POTW is the removal of the stormwater component where possible. The City has initiated a multiphase project to separate the combined sewer system in Roy's Branch watershed.

Roy's Branch Diversion - Roy's Branch Watershed and Diversion, since it is the least developed area of the City, was deemed in FY05 as being the most cost-effective area to separate sanitary sewer mains from stormwater run-off. This project is being completed by Bartlett & West Engineering firm. Phases 1 and 2 involve the separation of public sewer mains primarily located in the public right-of-way and will be completed in 2007.

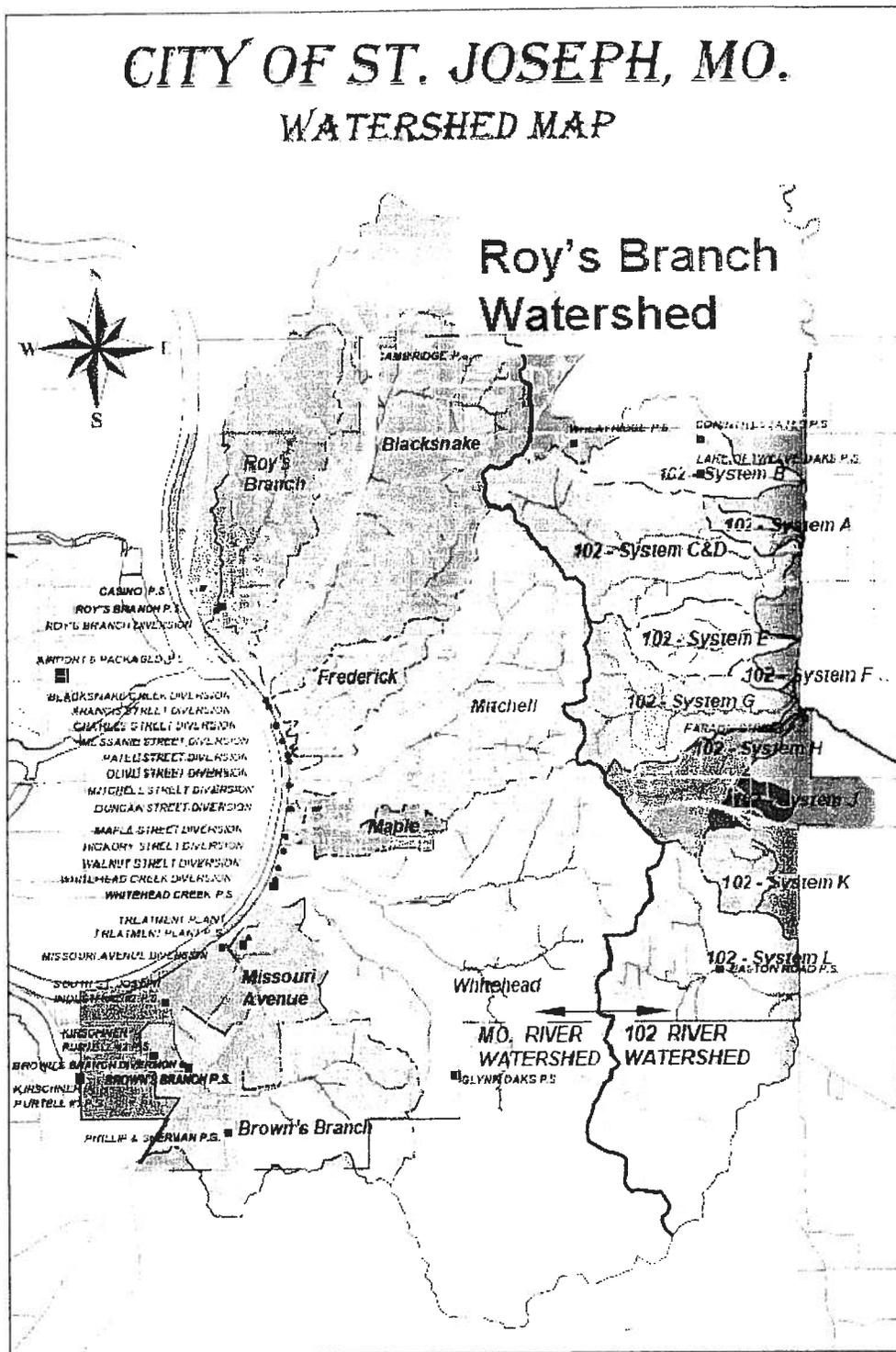
The Roy's Branch Watershed has an area of approximately 1700 acres total, but approximately 60 acres are served by a combined sewer system. The construction consists of installing new, stormwater-only pipes that discharge to existing waterways. The existing stormwater inlets will be connected to the new piping. The existing combined storm and sanitary sewers will be used for sanitary sewage only. Phase 1 and two represent forty percent of the construction, or inflow of sanitary sewer from 24 acres, is scheduled to be separated during 2007. Phase 3 and 4 represent the remaining sixty percent of construction, or inflow of sanitary sewer from 36 acres, is scheduled to be separated in 2008. The year 2008 is projected for final completion, with a total cost to the City for design and construction of \$1.75 million.

After the public mains are separated, the reduction and/or elimination of CSO frequency and volume from Roy's Branch will be assessed. If the overflows are still occurring, the

City will begin investigating the line for other sources of stormwater; such as gutter downspouts, defective or damaged pipe, and leaking manholes. In 2006, City staff smoke tested the Roy's Branch sanitary sewer system and did not see evidence of smoke from any downspouts. Yet, upon further inspection, several downspouts were noted to be discharging their contents underground. A map outlining the area known as Roy's Branch Watershed (See Figure 5) and a map outlining the schematic location of each phase are attached (See Figure 6).

Replacement of Aging Equipment – A three-year project by Black & Veatch and RS Electric to replace equipment originally installed in 1979 was completed in 2006 at a cost of \$594,000. The project consisted of the installation of new variable speed drives and bubbler systems at both the Whitehead Pump Station and at the South St. Joseph Industrial Sewer District Pump Station. This equipment is necessary to assist in controlling the wet well level at each pump station and therefore the flow to the POTW.

CITY OF ST. JOSEPH, MO. WATERSHED MAP



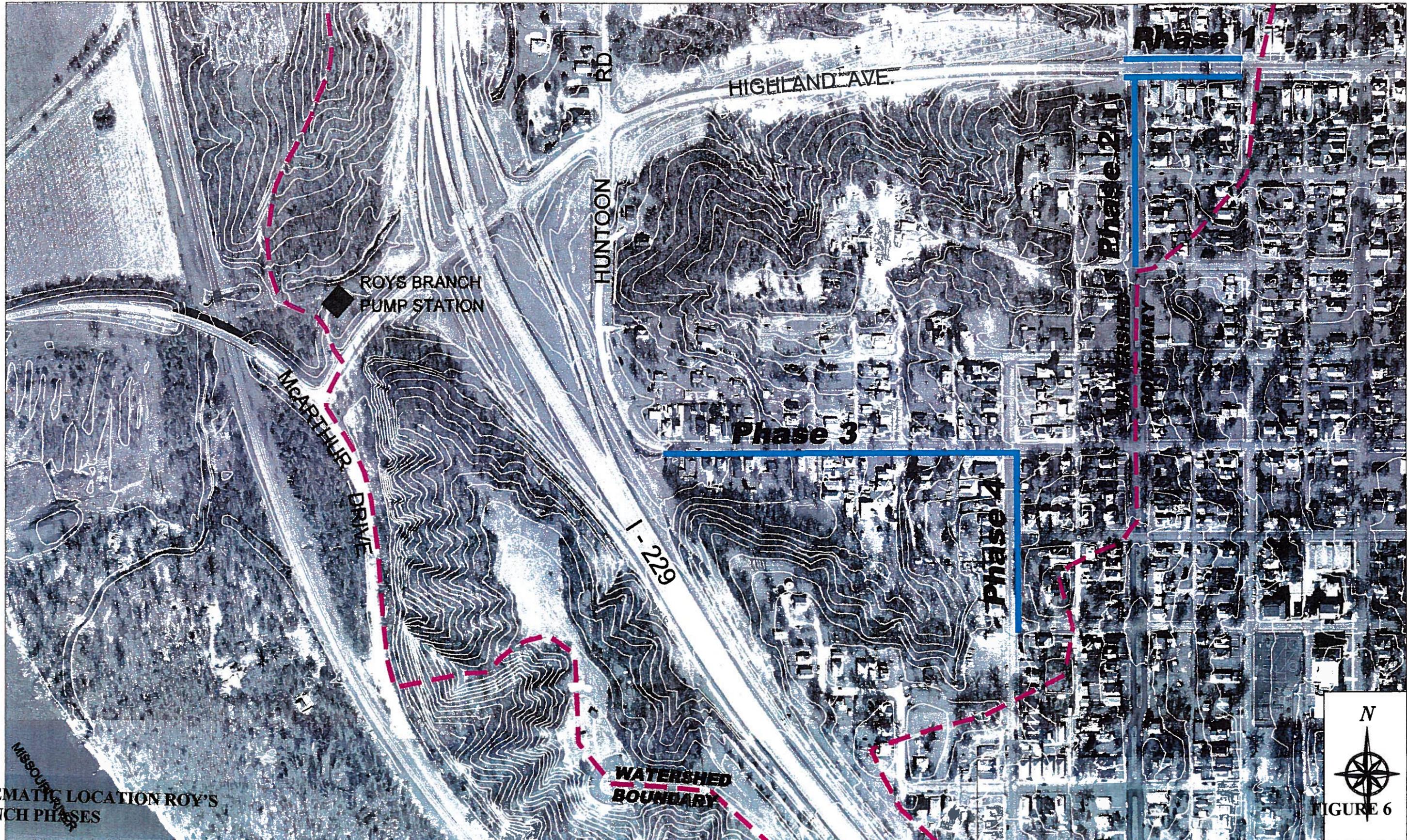
ROY'S BRANCH WATERSHED
MAP

FIGURE 5

ROY'S BRANCH SEWER SEPARATION PROJECT

--- WATERSHED BOUNDARY

— REPLACEMENT CORRIDORS



SCHEMATIC LOCATION ROY'S BRANCH PHASES

N
FIGURE 6

Minimum Control 5

Elimination of CSO's During Dry Weather

The City of St. Joseph sewer system does not experience routine dry weather overflows (DWO) caused by inadequate sewers or system capacity. The DWOs that do occur are caused by mechanical malfunctions, power loss, or plugged collection system lines. All wastewater pumping stations in the collection system are equipped with an alarm system which will transmit a radio message to POTW personnel in the event of a major mechanical malfunction or power loss. Procedures are in place that cause a prompt response 24 hours a day, seven days a week, including holidays. Therefore, any problems that do occur are addressed immediately so that any chance of overflow is greatly reduced. If such overflows do occur, they are of very short duration. If a CSO or DWO does occur, a report listing the date, time, location and amount of flow bypassed is completed and sent to the MDNR Regional Office.

Minimum Control 6

Control of Solid and Floatable Materials in CSOs

Control of solids and floatables at or near the CSO outfalls is not practical for the City of St. Joseph given that the CSO discharges are mostly at the bank of the Missouri River. The river varies greatly in level, contains ice floes in winter, and is near the navigation channel along most of its length. The large volume and high velocities of some of the discharges, combined with the large size of debris, make it difficult, if not impossible, to capture floatables and solids before they enter the Missouri River. The large debris in past history has consisted of tree limbs, entire trees, or even small cars. The use of booms or nets is not practicable because of frequent changes in the river level and velocity, and for navigational considerations. However, the FY07 budget contains funds for further CSO management study and will again review the technical merits of available options for better control of these substances.

A more efficient method of removal of floatables is to capture them prior to entering the sewer system. The City has a street sweeping program that utilizes two sweepers operating eight hours per day, five days per week during all non-freezing weather, which is approximately ten months per year. A third sweeper is utilized as a back-up sweeper to cover for maintenance and repairs of the two main sweepers. A new Elgin Eagle sweeper with 4.5 cubic yard (CY) capacity, budgeted at \$180,000, will be received in early 2007. An Elgin Eagle sweeper similarly sized is the second sweeper in the daily program. An Athey Mobile sweeper with a 5.0 CY capacity will be moved to the back-up unit designation.

Streets in each year's micro surface overlay program (May to September) are swept prior to receiving an overlay. The area scheduled for FY06 is 54 miles of streets with a total budget of \$533,800. Sweepers are also used during enforcement clean up of violations of the City's erosion control measures on private property, if it leads to mud in the street. The contractor or individual are billed for man-hours and equipment usage if the City is forced to clean the street itself. There were approximately eight enforcement actions taken during 2006 that required billing for street clean-up by City personnel.

A listing of priority streets that receive weekly or bi-weekly sweeping is attached (See Tables 4 and 5). In addition to the priority street list, the balance of the City is broken into nine work districts, and the remaining streets within those districts are swept one to two times per year.

Sweeper one, Priority Streets

Week 1

Monday

Jules St.-----Frederick Ave. to 32nd St.
Faraon St.-----Riverside Rd. to Frederick Ave.

Tuesday

04th St.-----Robidoux St. to St. Joseph Ave.
06th St.-----Robidoux St. to St. Joseph Ave.

Wednesday

Noyes Blvd.-----Messanie St. to Ashland Ave.
Ashland Ave.-----Frederick Ave. to Belt Hwy.

Thursday

36th St.----- Belt Hwy. to Mitchell Ave.

Friday

Down Town-----Messanie St. to Robidoux St. / Main St. to 12th St.

Week 2

Monday

Woodbine Rd.-----Mitchell Ave. to Genefield Rd.

Tuesday

Messanie St.-----10th St. to Belt Hwy.

Wednesday

10th St.-----Garfield Ave. to Messanie St.
09th St.-----Messanie St. to Garfield Ave.

Thursday

Kinghill Ave.-----06th St. to Parker Rd.
Lake Ave.-----Kinghill Ave. to Alabama
Illinois Ave.-----Kinghill Ave. to Cherokee St.
Packers Ave.-----759 Hwy. to Alabama

Friday

Down Town-----Messanie St. to Robidoux St. / Main St. to 12th St.

Sweeper two, Priority Sweeping

Week 1

Monday

Jules St.-----Frederick Ave. to 32nd St.
Faraon St.-----Riverside Rd. to Frederick Ave.

Tuesday

St. Joseph Ave.-----04th St. to Karnes Rd.

Wednesday

22nd St.-----Lovers Lane to Garfield Ave.
28th St.-----Walnut St. to Messanie St.

Thursday

Lovers Lane-----Ashland Ave. to 18th St.

Friday

Frederick Ave.-----10th St. to Belt Hwy.

Week 2

Monday

Leonard Rd.-----Faraon St. to Genefield Rd.

Tuesday

Genefield Rd.-----N/W Parkway to Leonard Rd.

Wednesday

Mitchell Ave.-----08th St. to Belt Hwy.

Thursday

Garfield Ave.-----08th St. to 22nd St.
06th St.-----Messanie St. to Kinghill Ave.
Atchison St.-----06th St. to 11th St.

Friday

Frederick Ave. 10th St. to Belt Hwy.

Minimum Control 7

Pollution Prevention Programs to Reduce Contaminants in CSOs

The City of St. Joseph utilizes several means to protect its sewer system against floatables, solids and pollutants. While these measures are mainly intended to keep out floatables and solids, they will also keep out other pollutants. The follow programs are in place to mitigate or otherwise reduce the introduction of contaminants into the combined sewer system.

Inlet Cleaning – The City instituted an annual inlet cleaning program to inspect and clean all storm sewer inlets each year. Staff conducts this program utilizing quarter-section maps (120 total) to track their progress. In 2006, 4,699 inlets were cleaned as a result of this inspection program. During each visit the throat of the inlet is thoroughly cleaned of all vegetative material and debris. The inlet box itself is inspected for accumulation of debris and the need for any additional vacuum cleaning necessary. The gutter line is also cleaned 10 feet on either side of the inlet as needed.

This inspection and cleaning work is performed throughout the year from January 1 through December 31, except during freezing weather, or until completed. See attached photo series for reference of a typical inlet cleaning operation (Photo 5).

A 1% sewer rate increase was approved in 2006 for the purpose of purchasing another 2100 Series Vector truck and adding two full-time sewer maintenance staff to operate it. These additions are aimed at doubling the number of sewer inlets cleaned during an annual period and thereby reducing the amount of debris in the sewer system. The new Vector truck will be received in first quarter 2007, at a cost of \$261,000. The additional sewer maintenance staff will also be hired in first quarter 2007.

Upstream Channel Cleaning – Storm channels carrying vegetative matter, dead limbs, and other debris are regularly cleaned at the entrance to the Blacksnake, Whitehead, and Brown's Branch systems. Blacksnake and Whitehead are maintained by the Street Maintenance Division, and the Brown's Branch system is cleaned by the Parks and Recreation Department due to its location in Hyde Park.

Street Sweeping – As discussed in other sections, street sweeping is a regular program of the City's Street Maintenance Division.

Blacksnake Retention Basin – An Army Corps of Engineers section 205 flood control project that includes a detention basin, upstream of the Blacksnake Creek combined sewer system is still progressing. This proposed detention basin to be located immediately above the combined sewer system will reduce the pollution discharged through the CSO by:

- 1 Allowing for a longer capture of the first flush due to the reduce stormwater flow entering the system at the start of the rain event.
- 2 Settling out many solids in the detention basin ahead of the sewer system
- 3 Reducing the volume and therefore the velocity of the CSO discharge which will result in less solids scouring.

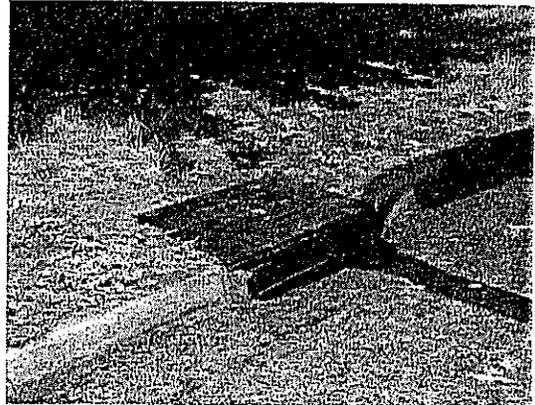
This project is in the feasibility stage with the Corps of Engineers. Construction will not occur until at least 2008.

CSO Monitoring – Five remote, on-site sampling points were installed and set up in 2006 at CSO diversion points along the Missouri River. The five sampler sites along the Missouri River are located at Blacksnake diversion, Mitchell diversion, Messanie diversion, Whitehead Creek diversion, and Brown's Branch diversion. These sites were chosen due to the volume of flow at these points during bypass events and due to the industrial waste content of the flow during bypass. Total toxic organics (TTO), metals, and priority pollutants outlined in the 40 CFR 403 regulations will be monitored at these sites as directed by the LTCP agreement with the EPA. Dissolved pollutants will be identified and upstream contamination tracked to locate the source of pollutants. The five CSO sampling sites put into place in 2006 will be expanded in the future to include all CSO diversion sites.

CSO Diversion Closing – Walnut Diversion Structure was closed in 2006. This diversion site was officially closed on November 17, 2006, by filling the collapsed entrance to the sluice gate with concrete and forcing any future bypasses through other diversion sites. Pollutant prevention by closing inoperative or low-flow diversion structures like Walnut Street will be evaluated in the future.

Eight diversion structures are under consideration for closure at this time, as part of the LTCP. These structures are Francis, Charles, Messanie, Patee, Olive, Duncan, Maple and Hickory. CSO analysis and analysis of bypass events are based on typical-year storms and reducing the number of overflows during those typical-year storms. Diversion structure closing will be evaluated to ensure that flooding does not occur in the service area if the structure is closed. Visual monitoring of bypass events at the diversion structures under consideration during 2007 will assist in the evaluation to close.

Representative Cleaning a Sewer Inlet



Minimum Control 8

Public Notification

All of the CSO outfalls in St. Joseph are located along the Missouri River. Access to the outfalls is generally restricted, and several of them are submerged during part of the year. Public use of the shoreline is usually confined to a limited number of fishermen. All CSO outfalls have notification signs posted on the shoreline. A picture of the typical signage currently in place at each CSO location is attached (See attached Photo 6).

The five CSO samplers along the Missouri River are enclosed in locked stainless steel enclosures with biohazard signs posted on each enclosure. Access to each of these sites is also limited due to their location. A picture of the biohazard "Raw Sewage" signs posted on the CSO sampler enclosures is attached (See attached Photo 7).

The City has used a number of public notification programs throughout the years. During October 2002 the City implemented a Community Appearance Plan that is still going strong in 2006. Zoning and code enforcement inspectors keep private properties clear of debris in the right-of-way as well as on private property. This program helps to reduce the introduction of debris in the collection system and is used as a public education program about the importance of keeping private and public areas clean.

A monthly forum called City Talk allows the citizens of St. Joseph the opportunity to visit with the Mayor and members of the City Council in a town meeting setting to discuss City programs and policies. These are good forums for discussion about our wastewater utility and its programs.

**COMBINED
SEWER
OVERFLOW
NO
SWIMMING
/ FISHING**

**FOR INFORMATION
CALL 271-4746**



CSO SAMPLER BIOHAZARD SIGN

Minimum Control 9

Monitoring to Characterize CSO Impacts and The Efficacy of CSO Controls

Characterize CSO Impacts - The City of St. Joseph had 15 diversion structures along the Missouri River in its CSO system as of January 1, 2006. Walnut Street Diversion was permanently closed in November 2006, reducing the active diversion structures to 14. Of those 14 remaining structures, 5 sites were chosen based on volume of flow at wet-weather bypass and possible industrial content of wastewater to have remote samplers installed. A budget of \$265,000 was allocated for design and implementation of the sample plan (See attached photos 8-12 for Blacksnake, Messanie, Mitchell, Whitehead, and Brown's Branch CSO sampling sites).

The remote samplers are Teledyne Isco Avalanche Models with flow measurement modules, flow activation software, and modem modules installed (See attached photo 13 of the Avalanche Model sampler). The modem modules will allow the samplers to alarm upon a bypass event and notify the on-call personnel via text message that a bypass is occurring. A responding text message will terminate the alarm and the on-call personnel will be dispatched to pick up the initial grab sample within a 6-hour window. The flow activation software will also activate upon a bypass event and take an initial grab sample for E. coli and fecal coliform testing. As the bypass continues, three additional composite samples will be taken over a 24-hour time period to determine the content of total toxic organics (TTO), priority pollutants, and metals as required in the City's LTCP. Flow measurement will continue from the beginning to the end of each bypass event. A hand-held computer system was purchased to download data from each sampler and analyze the flow data. As flow and pollutant content data are compiled, impact of CSO events upon the Missouri River can be determined.

Three diversions chosen for their volume of flow from open streams are Blacksnake, Whitehead, and Brown's Branch. The fourth diversion, Mitchell, receives flow from an open channel sewer system named Brookside Creek. Each of these four creeks are slated to have similar Avalanche samplers installed well upstream of the diversion sites in 2007. From the samples gathered upstream of the diversion sites, pollutant analysis can determine exactly what is being discharged to the Missouri River from the combined sewer system of the City.

During bypass events and sample pick-up, visual determinations of flow from all the remaining diversion sites will be made. Based upon those records, decisions to install additional samplers or to close the diversion sites will be made during FY07.

Efficacy of CSO Controls - The efficacy of all CSO controls outlined in this report such as routine maintenance, pollutant reduction, flow control, reduction of bypass events, and

evaluation of pollutants in the waste stream during bypass can only be determined through future analysis.

- Street maintenance, sewer repairs, and POTW structural and mechanical maintenance will continue as budgeted, with the addition of new systems and equipment as funds are made available.
- Collection system storage will continue to be maximized through regular cleaning and additional long-range project planning.
- The pretreatment program will continue to monitor industries and their wastestreams to reduce pollutants being released to the POTW, as outlined in federal regulations.
- Maximization of flow to the POTW will continue to be a major focus to replace aging equipment and to continue to implement projects that will control overflows.
- Dry weather CSO occurrences will continue to be controlled through management of the current sewer systems and POTW.
- The control of solid and floatable materials will continue to be addressed through the efforts of the sewer maintenance and streets department for the City of St. Joseph. Equipment needs will continue to be evaluated for future addition to the sewer cleaning regimen.
- Pollution prevention remains a high priority to reduce contaminants to the Missouri River as federal and state regulations on pollutants continue to tighten.
- In many cases, the public is unaware of how wastewater is delivered to the Missouri River and of the sampling procedures of the POTW. Signage will continue to be posted at any locations where public awareness of water quality is reduced.
- Additional CSO monitoring and impact on the Missouri River will continue to be evaluated for how to proceed in the future. In 2007, data and visual references will be used to determine how to proceed.



**BLACKSNAKE DIVERSION CSO
SAMPLING SITE**

PHOTO 8



**MESSANIE DIVERSION CSO
SAMPLING SITE**



**MITCHELL DIVERSION CSO
SAMPLING SITE**



01/23/2007

**WHITEHEAD DIVERSION CSO
SAMPLING SITE**



**BROWN'S BRANCH DIVERSION
CSO SAMPLING SITE**

PHOTO 12



**TELEDYNE ISCO AVALANCHE
REMOTE SAMPLER**

PHOTO 13

TV Inspection Report

MH UPPER 52-6 to MH LOWER 52-5

Televised Thursday, August 3, 2006

CITY OF ST.JOSEPH 2316 S.3RD 64501

<u>PACP PSR</u>	<u>Date</u>	<u>Cert.#</u>	<u>Status</u>					
080306A 52	8/3/2006	03 1149	COMP					
<u>Street</u>	<u>Drainage Area</u>							
1412 N.10TH.								
<u>City Name</u>	<u>Material</u>							
ST.JOE	VCP							
<u>Owner</u>	<u>Surveyor</u>	<u>Dir</u>						
CITY	JASON	DOWNSTREAM						
<u>Shape</u>	<u>Lin Mthd</u>	<u>JTL</u>	<u>Use</u>	<u>Prcln</u>	<u>Loc Code</u>	<u>Size</u>	<u>Up Dp</u>	<u>Dwn Dp</u>
C		3	CB	J	C	12	10.9	11.8
<u>USMH</u>	<u>DWNMH</u>	<u>Video Volume</u>						
UPPER 52-6	LOWER 52-5							
<u>Video File</u>								
E:\								
<u>Tape #</u>						<u>Weather</u>		
54D						1		
<u>Location Details</u>								
TVING ON N.10TH FROM PENDLETON TO RICHARDSON.								
<u>Addl. Info</u>								
DYING HOLE AT 1406 & 1412 N.10TH.								
<u>Addl. Info</u>								

Footage	SF	PACP	Observation	Modifier	Image File	Str Grd	OM Grd
0.0		ST	<START INSPECTION>	09:47:10			
6.0		AMH	"AMH"				
6.0		MWL	"MWL 05%"				
28.3		TFC	"TFC AT 02 DIA 06"				
30.3		TFC	"TFC AT 10 DIA 06"				
32.2		TBI	"TBI AT 10 DIA 06 INT 02 00%"				2
65.2		TFC	"TFC AT 02 DIA 06"				
80.0		MYV	"MYV"				5
80.1		IG	"IG AT 07 TO 10"				5
82.1		TFD	"TFD AT 10 DIA 06"				2
83.6		HSV	"HSV AT 02 TO 03"			5	
83.8		TBD	"TBD AT 02 DIA 06"				3
103.9		TFC	"TFC AT 10 DIA 06"				
80.2		MYV	"MYV"				5
81.8		MYV	"MYV"				5
131.0		TFA	"TFA AT 02 DIA 06"				
155.5		TFC	"TFC AT 02 DIA 06"				
167.5		TFA	"TFA AT 10 DIA 06"				
184.6		TFA	"TFA AT 02 DIA 06"				
199.8		TBA	"TBA AT 10 DIA 06"				
221.7		TFC	"TFC AT 10 DIA 06"				
223.7		TFA	"TFA AT 02 DIA 06"				
255.8		TFC	"TFC AT 02 DIA 06"				
267.3		TBD	"TBD AT 10 DIA 06"				
267.3		HSV	"HSV AT 09 TO 10"				
281.2		AMH	"AMH"			5	3

**SAMPLE TV INSPECTION
REPORT**

FIGURE 7

TV Inspection Report

MH UPPER 52-6 to MH LOWER 52-5

Televised Thursday, August 3, 2006

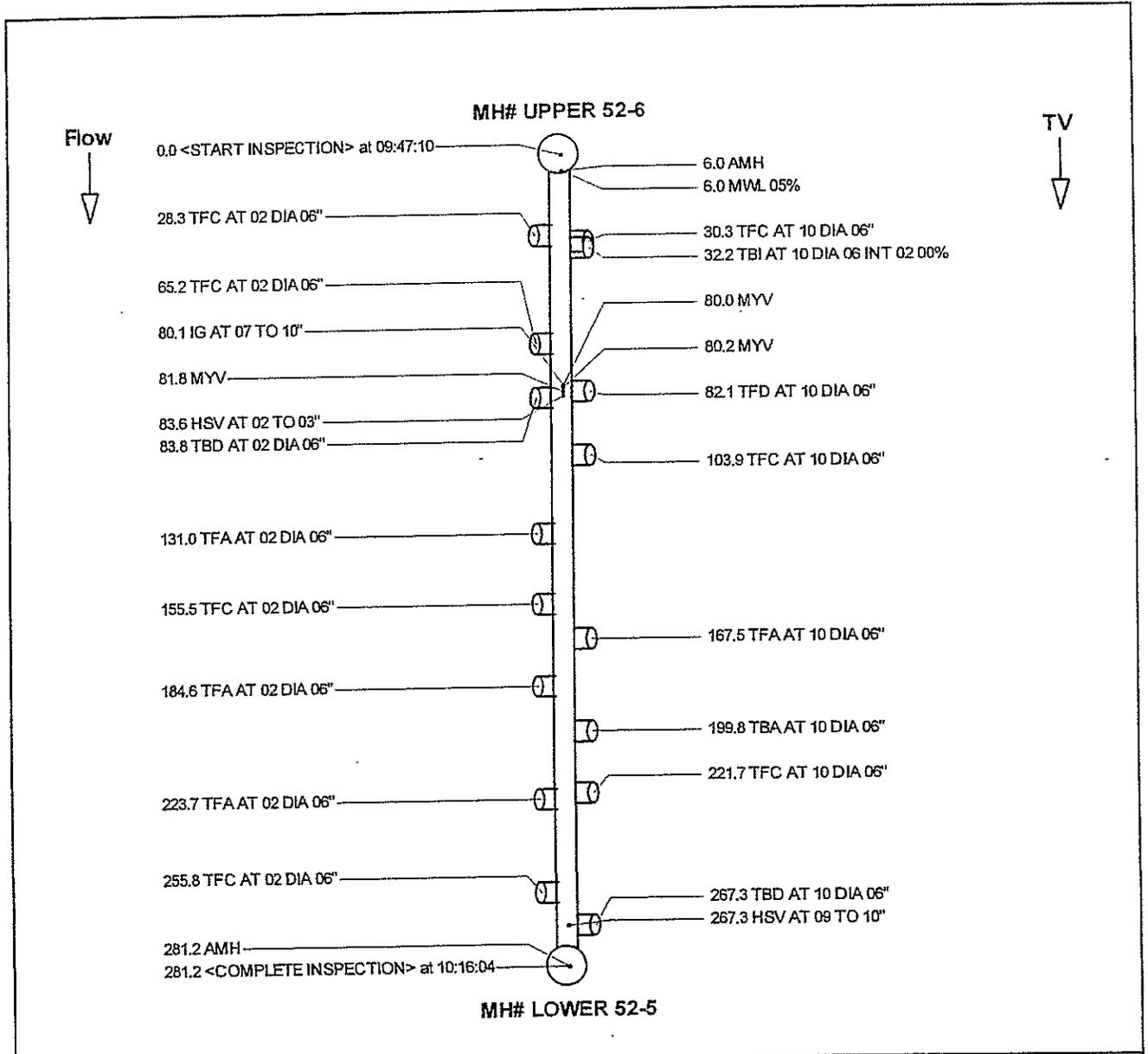
CITY OF ST. JOSEPH 2316 S.3RD 64501

Footage	SF	PACP	Observation	Modifier	Image File	Str Grd	OM Grd
281.2		FH	<COMPLETE INSPECTION>	10:16:04			

Total Length of Line	281.2
Total Length Inspected	281.2
Total Upstream Footage	0.0
Total Downstream Footage	281.2
Number of Observations	27

CITY OF ST. JOSEPH

2316 S.3RD 64501 --



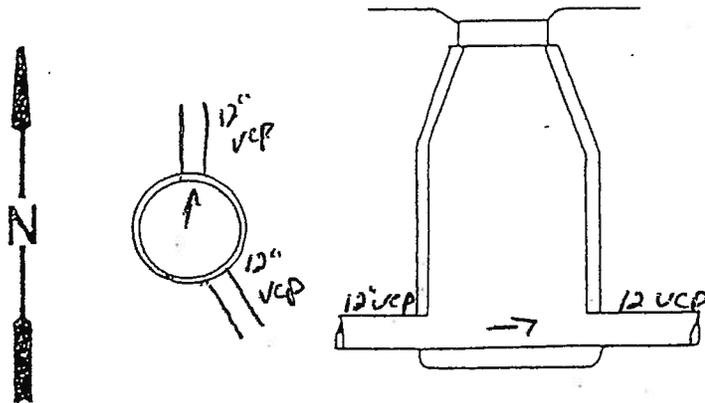
Street:	1412 N.10TH.	City Name: ST.JOE
MH:	UPPER 52-6 to LOWER 52-5	
Cert.#:	03 1149	Material: VCP
PACP PSR:	080306A 52	Size: 12
Date:	8/3/2006	Status: COMP
Length:	281.20 Feet	<input type="checkbox"/> =Image Attached
Dir:	DOWNSTREAM	<input checked="" type="checkbox"/> =Video Clip Attached
Use:	CB	
Insp/Oper:	CITY, JASON	
Loc Code:	C	
Tape #/Weather:	54D/1	
Location Details: TVING ON N.10TH FROM PENDLETON TO RICHARDSON.		
Cobra Information Management System © 2004 Cobra Technologies/Optical Robotics, LLC. For Information Call 1-800-443-3761		

MANHOLE INSPECTION LOG

Section No.: 52 Node No.: 52.6 Date: 8-3-06

Manhole Location: 1402 N. 10th

SKETCH (include pipe diameter and direction of flow):



MANHOLE PARTICULARS

CONSTRUCTION: Brick Block, Precast Concrete, Cast in Place Other _____

DROP MANHOLE: Yes No

OUTSIDE DROP: Yes No

STEPS: Iron, Steel, Plastic, None
No.:

SEWER PIPE MATERIAL: VCP

DEPTH OF MANHOLE: 10' 9"

	CONDITION			INDICATION OF INFILTRATION		DESCRIPTION
	GOOD	FAIR	POOR	NO	YES	
Cover		X		X		
Ring/Collar		X		X		
Leveling Bricks		X		X		
Cap or Cone		X		X		
Steps		X		X		
Iron		X		X		
Inverts		X		X		

Evidence of Surge and Maximum Height: None

Appearance of Flow: Normal Sewage Muddy, Clear Other: _____

Depth of Flow: _____

Notes: _____

Inspected By: R. GARRETT Recorded By: _____ Entered M.H.: Yes No

Inspection ID: 161	Project ID: 1	Surveyor Name: Jason
Cert Number: 03 1149	Owner: City	Customer:
Drainage Area:	PO Number: 54d	Pipe Segment Reference: 080306a 52
Date Created: 8/3/2006	Time Created:	Street: 1412 N.10th.
City: St.Joe	Location Details: Tving on N.10th from Pendleton to Richardson.	Upstream MH: Upper 52-6
Rim To Invert (U): 10.9	Grade To Invert (U):	Rim To Grade (U):
Downstream MH: Lower 52-5	Rim To Invert (D): 11.8	Grade To Invert (D):
Rim To Grade (D):	Sewer Use: Combined	Direction: Downstream
Flow Control:	Height: 12	Width:
Shape: Circular	Material: Vitrified Clay Pipe	Lining Method:
Pipe Joint Length: 3.0	Total Length:	Length Surveyed: 281.2
Year Laid:	Year Renewed:	Media Label: 54d
Purpose: Infiltration/Inflow Investigation	Sewer Category:	Pre-Cleaning: Jetting
Date Cleaned:	Weather: Dry	Location Code: Light Highway
Additional Info: Dying hole at 1406 & 1412 N.10th.	Video Location: E:\	Status: Completed
CT_Optional1:	CT_Optional2:	CT_Optional3:
CT_Optional4:	CT_Optional5:	CT_Optional6:
CT_Optional7:	CT_Optional8:	CT_Optional9:
CT_Optional10:		

Observations Table										
Distance	Code	Cont	S/M/L	Val1	Val2	Percent	Joint	At/From	Click To	Remarks
6.0	AMH						No			MH 52-6.
6.0	MWL					5	No			
28.3	TFC			6.0			No	2		
30.3	TFC			6.0			No	10		
32.2	TBI			6.0	2.0		No	10		
65.2	TFC			6.0			No	2		
80.0	MYV						No			Dyed hole red.
80.1	IG						No	7	10	
82.1	TFD			6.0			No	10		
83.6	HSV						No	2	3	
83.8	TBD			6.0			No	2		
103.9	TFC			6.0			No	10		
80.2	MYV						No			Dyed 1406 N.10th blue.
81.8	MYV						No			Dyed 1412 N.10th red.1406 & 1412 both connected to same TFD.
131.0	TFA			6.0			No	2		
155.5	TFC			6.0			No	2		

167.5	TFA		6.0		No	10		
184.6	TFA		6.0		No	2		
199.8	TBA		6.0		No	10		
221.7	TFC		6.0		No	10		
223.7	TFA		6.0		No	2		
255.8	TFC		6.0		No	2		
267.3	TBD		6.0		No	10		
267.3	HSV				No	9	10	
281.2	AMH				No			MH 52-5.

RICHARDSON ST.

5-25-57 HLU

(115)

68

9-26-67 HLU

PENDLETON ST.

PLACE

ADDITION

NIELSON'S

PLACE

WILLIAM'S
SUB
DIV.

BURMAN

(48)

ST. JOSEPH

LINCOLN ST.

IMPROVEMENT

AD

11

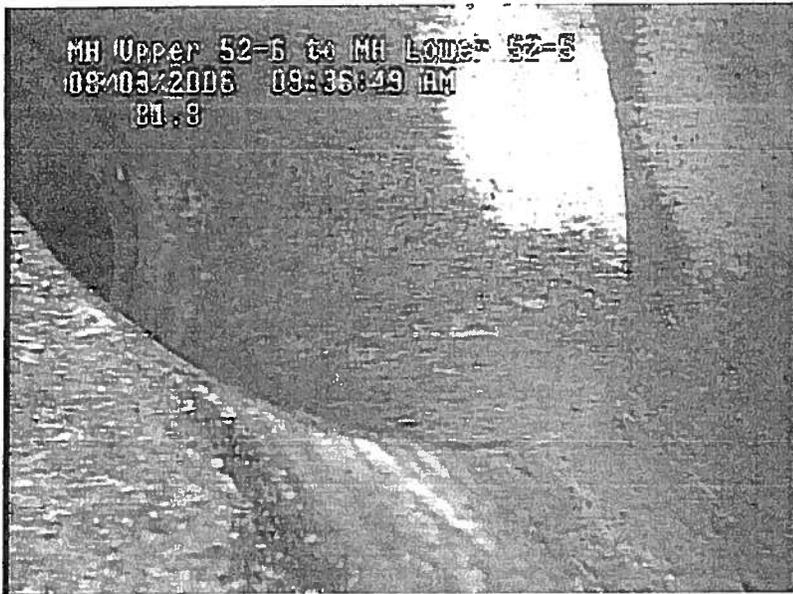
SMERP
GENERAL ORDINANCE

ARTICLE 5

10TH ST.

11TH ST.

N



Still Image Info:

JPEG Path: E:\080306a 52_161_2.jpg

Current Footage: 81.8

*Dyed 1412 10.10th Red.
1406 & 1412 both connected to same TFD.*

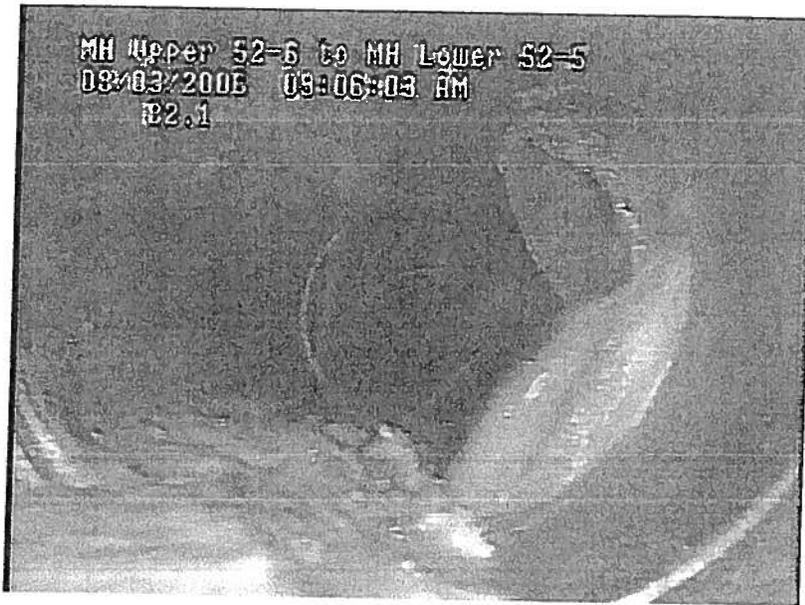


Still Image Info:

JPEG Path: E:\080306a 52_161_2.jpg

Current Footage: 80.2

Dyed 1406 Blue



MH Upper 52-6 to MH Lower 52-5
08/03/2006 09:06:03 AM
82.1

Still Image Info:

JPEG Path: E:\080306a 52_161_2.jpg

Current Footage: 82.1



MH Upper 52-6 to MH Lower 52-5
08/03/2006 09:01:34 AM
79.3

Still Image Info:

JPEG Path: E:\080306a 52_161_2.jpg

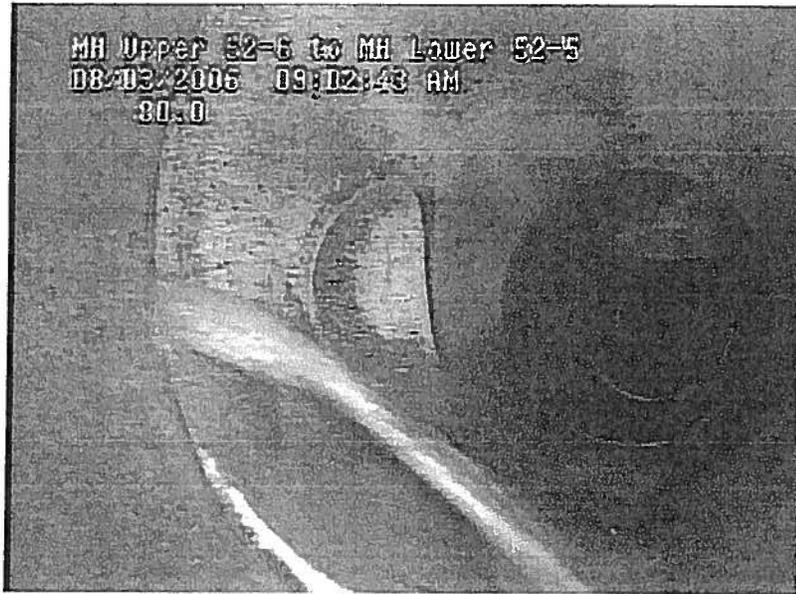
Current Footage: 79.3



Still Image Info:

JPEG Path: E:\080306a 52_161_2.jpg

Current Footage: 79.3



Still Image Info:

JPEG Path: E:\080306a 52_161_2.jpg

Current Footage: 80:0



Still Image Info:

JPEG Path: E:\080306a 52_161_2.jpg

Current Footage: 80.1



**APPENDIX C
PUBLIC
PARTICIPATION
INFORMATION**

**CSO Program
Press Releases / Newspaper Articles**



NEWS RELEASE

Public Meeting to Discuss Combined Sewer Overflows

**FOR MORE INFORMATION CONTACT:
CITY MANAGER'S OFFICE
816/271-4610**

ST. JOSEPH, MISSOURI (November 9, 2007.....FOR IMMEDIATE RELEASE.....)

A public meeting to discuss combined sewer overflows will be held on Tuesday, November 13, 4:00pm, in the Council Chamber, on the third floor of City Hall, 1100 Frederick Avenue.

Via the Clean Water Act, the Environmental Protection Agency requires communities with combined sanitary sewer and storm water collection systems to produce a document called a Long Term Control Plan (LTCP). St. Joseph has the third largest combined sewer system in Missouri, following St. Louis and Kansas City.

The LTCP is required to set forth a strategy to reduce combined sewer overflow discharges over time and to maximize existing treatment capabilities during wet weather. The goal is to greatly improve water quality in the receiving streams throughout the nation, and in St. Joseph's case, the Missouri River. The result is anticipated to have positive effects upon plant and animal life within the Missouri River ecosystem. According to Bruce Woody, Director of Public Works & Transportation, "The LTCP is required to outline a dramatic shift in St. Joseph's approach to managing its combined sewer system for many decades to come."

Black and Veatch Corporation, an engineering consultant with national experience on this issue, will be presenting the preliminary results of its study to the public. The many faceted approaches outlined will reflect the largest civic projects undertaken by the city of St. Joseph in the last several generations.

To learn more about the scope of the civic projects proposed, the options, and the costs of the proposals, the public is encouraged to attend this very important meeting. For questions, or for those individuals requiring special accommodations (at least 24 hours in advance), please contact the Public Works & Transportation Department at 271-4653.

###

MEETING NOTICE

TO: The Honorable Mayor and Members of the City Council
FROM: Councilmember Mike A. Bozarth, Chairman
DATE: December 18, 2007
SUBJECT: Council Landfill & Water Pollution Control Committee Meeting

The Council Landfill & Water Pollution Control Committee will hold a meeting on Wednesday, January 9, 2008, at 4:00 p.m., in the 4th Floor Conference Room at City Hall, to discuss the following issues:

1. Update on development of the Long Term Control Plan; and
2. Other landfill and water pollution control related issues.

Committee members:

Mike Bozarth, Chairman
Mike Hirter
Gary Roach

cc: Vincent J. Capell, City Manager
Department Directors
Don Gilpin, Supt. of Wastewater Treatment
Bill Blacketer, Landfill Supt.

MEETING NOTICE

TO: The Honorable Mayor and Members of the City Council

FROM: Councilmember Mike A. Bozarth, Chairman

DATE: January 18, 2008

SUBJECT: Council Landfill & Water Pollution Control Committee Meeting

The Council Landfill & Water Pollution Control Committee will hold a meeting on **Wednesday, February 6, 2008, at 4:30 p.m.** in the Council Chamber at City Hall, to discuss the following issues:

1. Final review of the CSO Long Term Control Plan (due to the Missouri Department of Natural Resources on February 15, 2008); and
2. Other landfill and water pollution control related issues.

Committee members:

Mike Bozarth, Chairman
Mike Hirter
Gary Roach

cc: Vincent J. Capell, City Manager
Department Directors
Andrew Clements, Asst. Public Works & Transportation Director
Roger Sparks, City Engineer
Don Gilpin, Supt. of Wastewater Treatment
Bill Blacketer, Landfill Supt.

By: JOE BLUMBERG

joeblumberg@jppgco.com

St. Joseph News-Press

St. Joseph sewer customers might spend more money this offseason than the Kansas City Royals.

The city has learned that it will have to pay an estimated \$6 million for a new ammonia-removal process at its wastewater treatment plant.

That only adds to a list of repairs and upgrades in the next five years that will cost untold tens of millions of dollars. Depending on the city's plans to address sewer overflows, which it will disclose next week, sewer needs could swell into New York Yankees territory.

The sewer plant's new five-year federal permit will effectively force it to remove nitrogen in the form of ammonia from its sewage, said city Public Works Director Bruce Woody.

The city must comply with the new ammonia-nitrogen limits by early 2011, which means it immediately must start construction planning.

Ammonia-nitrogen can be toxic to aquatic life, deplete the oxygen in water and cause excessive algae growth — in the Missouri River, as St. Joseph is concerned — according to the federal Environmental Protection Agency.

The city will need to spend about \$6 million to convert four existing 1.1 million-gallon tanks into huge grounds for nitrogen-eating bacteria, Mr. Woody said.

The new permit's ammonia-nitrogen levels will only require the city to perform the treatment from November to April, Mr. Woody said.

ing the overflows, which dump St. Joseph's permit renewal raw sewage into the river during even moderate rains. The sewer plant's five-year permit is set to be renewed in early 2008 by the Missouri Department of Natural Resources, Water Protection Program, P.O. Box 176, Jefferson City, MO 65102, ATTN: NPDES Permits and Engineering Section/Permit Comments. For more details on wastewater treatment processes, go to www.epa.gov/npdes/pubs/primr.pdf

But the equipment is needed

nonetheless.

The city had hoped the new

winter levels would be high

enough to avoid the construc-

tion cost.

While the ammonia-nitrogen

costs are somewhat unexpected,

the city already had planned

to spend \$6 million for another

new treatment — disinfection.

Disinfection will have to be in

place by 2013, Mr. Woody said.

The city last week finalized

issuing \$20.7 million in sewer

revenue bonds. That includes

\$6 million for disinfection, but it

has none for ammonia-nitrogen.

"We'll have to address how

we're going to (pay for) that,"

Mr. Woody said. "Maybe we'll

postpone a couple projects."

The biggest regulatory cost

has yet to be publicized.

Next week, St. Joseph will

get its first estimate for cor-

recting combined sewer over-

flows. The City Council will

hear from its sewer consultant,

Black & Veatch, about address-



ERIC KEITH/St. Joseph News-Press

Superintendent of the St. Joseph Wastewater Treatment Plant Donald Gilpin poses with the aerobic digesters that will be converted to remove nitrogen in the form of ammonia to meet lagging state regulations.

Sewer needs swell by \$6M

Sewer needs swell by \$6M

CONTINUED FROM Page A1

Sewer tab may grow

11-18-07



After a brief, heavy rain in the St. Joseph area, water rolls out of Black-snake Creek into the Missouri River Monday morning.

TODD WEDDLE
St. Joseph News-Press

City Council will meet today to discuss options

By **JOE BLUMBERG**

joelblumberg@npgco.com
St. Joseph News-Press

Prepare for sticker shock.

The city of St. Joseph hinted at the enormity of the expense to fix combined sewer overflows in a public invitation to today's City Council meeting on the subject.

"The many faceted approaches outlined will reflect the largest civic projects undertaken by the city of St. Joseph in the last several generations," the city said in a news release.

Also, it's extremely rare for

the city to issue a news release for what is technically only a council committee meeting.

The "very important meeting" is at 4 p.m. in the fourth floor conference room at City Hall, 1100 Frederick Ave. For questions or for people requiring special accommodations, please contact the public works department at 271-4653.

Generally west of Belt Highway, St. Joseph has combined storm and sanitary sewers. During even moderate rains,

Please see SEWER/Page A6

Sewer tab: How high will it go?

A6 St. Joseph (Mo.) News-Press

11-11-07

FROM PAGE ONE/NATION/WORLD

CONTINUED FROM Page A1

the sewers can become full and overflow directly into the Missouri River.

State and federal regulators have been working to eliminate overflows in about 770 cities in the country.

Today, St. Joseph will get its first estimate for correcting the overflows.

The council will hear from sewer consultant Black & Veatch about a multi-faceted approach. The city must submit a long-term control plan for overflows by Feb. 18.

Completely separating the storm and sanitary sewers likely would cost hundreds of millions of dollars, which is not seen as a reasonable option.

Instead, the city will try to

minimize overflows. Some options include closing some of the 15 overflow points along the river and slowing down storm water with upstream detention ponds.

But if the city can't stop the overflows, it likely will have to install disinfection equipment at the overflow points along the river.

Most likely, all of that means

rate increases for sewer customers.

How much and how soon are the big questions.

The city recently issued \$20.7 million in sewer revenue bonds. None of that money was for overflows or for ammonia-nitrogen removal equipment, which the city recently learned it will have to install for about \$6 million.

\$120 million

11-14-07

Sewer requirements force city of St. Joseph to undertake its largest public works project ever

By **JOE BLUMBERG** | joelblumberg@npgco.com | *St. Joseph News-Press*

St. Joseph's best-case scenario for addressing its combined sewer overflows will cost an estimated \$120 million, its consultant told the City Council on Tuesday.

"Shell-shocked," is how Councilman Bill Falkner described his reaction to the figures.

But even \$120 million wouldn't completely eliminate the overflows, which currently dump raw sewage into the Missouri River during moderate rains.

erate rains.

If state and federal regulators aren't satisfied with the plan, the next alternative could cost about \$480 million, said Matt Schultze, project manager for sewer consultant Black & Veatch.

Over the next 32 years, it's likely that sewer bills will gradually triple to about \$60 for the average household.

The rates shouldn't rise above about \$60 a month because St. Joseph will

have maxed out its ability to pay for sewers under federal income guidelines, Black & Veatch consultants said.

The city will submit its \$120 million plan to the Missouri Department of Natural Resources next week. It includes a combination of three detention basins (basically ponds that would only fill during rains) to hold storm water and a sewer treatment facility that can process sewage faster.

The next alternative is much more daunting and expensive, at a possible \$480 million.

Under that scenario, the city would build a 5-mile-long "deep tunnel" to hold sewage during rains, after which the sewage would be pumped up to the treatment plant. The concrete tunnel would be 30 feet in diameter and would have to be built in bedrock some 200 feet below ground, Mr. Schultze said.

Please see **SEWER/Page A10**

Sewer upgrade tab put at \$120 million

CONTINUED FROM Page A1

Generally west of the Belt Highway, St. Joseph has combined storm and sanitary sewers. When rain fills the sewers, they overflow from 15 points along the river.

That typically happens about 78 times a year, Black & Veatch said. Bacteria levels in overflows have measured at 480 times the amount allowed by the state.

The Council got an up-close look at overflow samples Tuesday. A consultant passed around glass jars from Monday's overflow after a very brief rainfall.

Council members were about as excited to handle the jars as they were to have no choice in committing St. Joseph to its most expensive public project ever.

About 770 cities in the country have similar problems.

Kansas City and Omaha recently said they could spend \$3 billion and \$1.5 billion, respectively, on overflows.

St. Joseph recently issued \$20.7 million in sewer revenue bonds for sewer extensions and other improvements. None of that money was for overflows or for ammonia-nitrogen removal equipment, which the city recently learned it will have to install for about \$6 million.

V
I
C
A
V
E
I

Sewer bill will challenge the city

11-18-07 Council must make sure federal mandate doesn't turn into a blank check for City Hall

You don't have to be H. Ross Perot to hate unfunded federal mandates. Shucks, you don't even have to remember that firebrand, third-party presidential hopeful.

Unfunded federal mandates became the battle cry of political independents tired of a wasteful Congress that was anxious to force local spending on grand federal programs.

But as Mr. Perot would tell you (you might want to squint your eyes here

and read the rest of this line in a high-pitched voice), "The devil is in the details."

IN OUR VIEW

St. Joseph's problem is that its sewers carry off

both sanitary waste and storm water. That means that even during moderate rains (almost 80 times a year) the storm water carries the sanitary waste into the Missouri River.

City officials found out this week that they likely will be spending \$120 million to solve the problem of combined sewer overflows — thanks to an unfunded federal mandate. The money would be used to install three detention basins to hold storm water and a sewer treatment facility that can process sewage faster. That's the good news.



The final bill could explode to \$480 million if state regulators decide the city's more modest plan fails to meet federal clean-water standards. The \$480 million plan would build a five-mile-long "deep tunnel" to hold sewage during rains, after which the sewage would be pumped up to the treatment plant. The concrete tunnel would be 30 feet in diameter and would have to

be built in bedrock some 200 feet below ground.

Neither option is that attractive for this City Council. But it can take some steps to answer this challenge with the support of voters.

The first step already has been taken. This council quickly made upgrading the city's sewer system its top priority. It inherited a sewer system that

needed major improvements even before the feds dropped this bombshell last week.

Now the council needs a comprehensive plan to guide the city's effort. We said that when this council began talking about sewers shortly after taking office.

Since then, the council agreed to issue, without a vote of the people, more than \$20

million worth of bonds for sewer extensions and improvements. The council later learned that it would need to spend another \$6 million for ammonia-nitrogen removal equipment. And now the council is looking at spending another \$100 million to \$500 million on the sewers.

Without a plan, voters (and rate payers) are going to get the feeling that they are at the mercy of a used-car dealer who keeps adding one undercoating fee and another setup charge to a price tag that is always changing.

This council also has a responsibility to keep City Hall from turning this federal mandate into a blank check. Sewer rates are projected to triple to \$60 a month for the average household over the next 32 years. Without a fiscally responsible council, we could see that number ballooning.

Finally, the council needs to understand there are only so many tax dollars floating around this community. The school district is laying the foundation for a major tax package soon. The county has big plans of its own.

The high cost of this sewer works will force city, county and school leaders to work together on a plan that will turn our finite tax resources into a plan for growth for this community.

Competing Priorities *by J. Bruce Woody, P.E., Director of Public Works & Transportation*



The city of St. Joseph, state and federal environmental regulators, elected officials, and the general public are facing some tough decisions in the next several months concerning the city's combined sewer system.

At the heart of the decisions is how to reconcile the competing priorities of meeting the full intent of the Clean Water Act regarding the operation of our combined sewer system, and also abide by the financial capability guidelines of the Environmental Protection Agency (EPA) regarding our community's ability to raise funding for sewer improvements.

What improvements are we talking about? Specifically, the Missouri Department of Natural Resources (MDNR) and the EPA are looking for improvements that reduce the frequency of combined sewer overflows to the Missouri River to no more than four times per year (they currently overflow about 78 times per year). The city's consultant, Black & Veatch Corporation, has estimated that the least costly alternative for reaching that goal costs \$480 million dollars and consists of deep tunnels to store these flows during a rain storm so that they can later be pumped out and the water treated through high-rate clarifiers and then disinfected prior to discharging the water to the Missouri River. However, to do so would require sewer user rates to rise more than seven times higher than what EPA guidance indicates should be the limiting amount of 2% of the city's median household income (MHI). Two percent of the MHI for St. Joseph is \$720/year, or \$60/month.

Black & Veatch has estimated that rates at 2.07% of MHI would produce \$120 million in 32 years and has proposed a series of projects for this cost that would capture 59% of combined sewer overflows. However, twenty years is the generally accepted length of time that regulators will approve for completion of these projects. Further, these 32 years worth of projects still won't meet the four overflows per year goal of the Clean Water Act. So where does that leave St. Joseph?

State and federal regulations have been provided detailed information about various alternatives the city could take to reach the four overflows per year goal, as well as what amount of work could be done within the limitations of the EPA's financial capability analysis guidelines of 2% of MHI. In the next one to two months, we hope to obtain some additional guidance in reconciling these two competing priorities. In the end, it is hoped that 1) The benefits derived from all costs incurred are reasonably high, and 2) The scope of projects the city is required to make are chosen based upon good science, and 3) Regulators limit our costs to not exceed the point beyond which the diminishing returns become unreasonable.

We also encourage the public to contact Public Works & Transportation Department with their questions, concerns, and suggestions regarding our various construction alternatives. You can also visit the city's website at www.stjoemo.info/publicworks/wpc_cso.cfm to learn more about the city's combined sewer system.



LIMITED OPTIONS | Bills may rise quickly

City sewer plan falls short of guidelines

By **JOE BLUMBERG**

joelumberg@npgco.com

St. Joseph News-Press

St. Joseph's proposed \$120 million plan for combined sewer overflows would only stop about 59 percent of the overflows into the Missouri River.

That doesn't meet state and federal requirements, and neither does the project's 32-year timeline.

But St. Joseph's options are limited. It has far less money and fewer people compared with other cities dealing with similar-sized issues.

St. Joseph officials "fully expect" regulators to require a ramped-up schedule for raising sewer bills to St. Joseph's \$60-a-month threshold. The city hoped to gradually increase the bills in the next 20 years or more.

The city also is concerned that it could be forced to postpone its other sewer projects — such as extending sewers to unserved areas — and redirect that money toward overflows.

St. Joseph's combined sewers cover about 30 square miles,

The problem

City sewers often overflow into the Missouri River, on average 78 times a year, according to a recent study. State and federal agencies want no more than four overflows per year.

The plan

The city would spend \$120 million to minimize overflows, and residential sewer bills would increase to a threshold of \$60 a month over 30 years.

The problem with the plan

The city's plan would eliminate only 59 percent of the current number of overflows, far below state and federal requirements.

Please see **CITY'S/Page A8**

City's \$120M sewer plan falls short of state, federal guidelines

CONTINUED FROM Page A1

compared with 27, 51 and 56 square miles respectively in Louisville, Ky., Omaha, Neb., and Kansas City. St. Joseph has about 74,000 residents, while those cities have between 340,000 and 700,000 residents.

Those factors "absolutely" are being taken into consideration, said Kevin Mohammadi, the state's chief of water pollution compliance and enforcement.

"St. Joseph is a very unique situation," Mr. Mohammadi agreed.

St. Joseph's sewers generally west of the Belt Highway are "combined," meaning they carry both stormwater and sanitary sewage.

During even light rains, they can overflow into the Missouri

River. This happens 78 times a year on average, according to a recent study.

The Missouri Department of Natural Resources and U.S. Environmental Protection Agency want no more than four overflows per year. The city and its sewer consultant, Black & Veatch, met Nov. 21 with DNR and EPA to discuss the city's proposed plan for the overflows.

For \$120 million, the city still would have about 30 overflows a year. And the 32-year schedule to get to that point "will probably not be able to be approved" and "(if acceptable) would be precedent-setting," the regulators told the city, according to city notes from the meeting.

However, regulators also seemed uncomfortable asking St. Joseph residents to pay

more given St. Joseph's relatively low household incomes. An EPA guideline caps sewer rates at 2 percent of the median household income — about \$60 per month in St. Joseph.

Numerous cities have lobbied regulators to consider how expensive it is to limit overflows to four per year.

In St. Joseph, capturing 59 percent of overflows would cost about \$2 million per percentage point. But St. Joseph would have to spend another \$360 million to meet the four-per-year limit — more than \$10 million for each of those last 25 to 35 percentage points — including a half-mile-long underground storage tunnel to catch overflows.

"At some point in time, there's diminishing returns," said Bruce Woody, St. Joseph's public works director.



SEWER REALITY STARTS TO SINK IN

Council deals with five stages of grief when dealing with overflow issues

\$150M

Projected city cost over 40 years to drastically reduce overflows.

\$300M

Projected city cost over the next 80 years to reduce overflows to four per year.

\$60

Monthly amount city residents' bills are expected to reach.

By JOE BLUMBERG
St. Joseph News-Press

Amateur psychologists can note that the St. Joseph City Council has touched on all five stages of grief — denial, anger, bargaining, depression and acceptance — as it prepares to confront the most expensive, longest public project in the city's history.

But council members also seem to be preparing themselves for a little post-traumatic stress disorder when sewer bills hit home over the next several years.

Council members on Wednesday night agreed for the city to submit its long-term control plan to deal with combined sewer overflows, which send raw sewage into the Missouri

River an average of 78 times per year. A court order requires the plan be submitted to the Missouri Department of Natural Resources by Feb. 15.

St. Joseph plans to pay \$150 million over 40 years to drastically reduce overflows, and another \$300 million over the next 80 years to reduce overflows to four per year. The average household sewer bill likely will triple from about \$20 to \$60 a month sometime in the next several years, according to sewer consultant Black & Veatch (Depression).

Some major questions haven't yet been answered by DNR and the U.S. Environmental Protection Agency, namely whether they'll accept St. Joseph's time frame, and when St. Joseph's sewer bills must be ramped up.

The meeting was held off until Wednesday because Mayor Ken Shearin didn't want to have the figures again publicized as voters decided whether to increase the sales tax for city buses (Denial).

On Wednesday, Mr. Shearin complimented the city's staff for the work that went into the plans. But he also was frustrated that the local and federal governments have avoided the problem until now.

"I still can't get over how irritating it is to have to do it on this time frame instead of over the last 50 years," Mr. Shearin said. (Anger).

Mr. Shearin has called on Congress to provide money for St. Joseph (Bargaining).

Chad Higdon, a field representative

for U.S. Rep. Sam Graves, R-Tarkio, attended the meeting to say that Mr. Graves is "very interested" and will write a letter to the EPA asking for leniency. He noted that Mr. Graves secured \$1 million of Homeland Security funds to help pay for a stormwater project.

Councilmen Gary Roach and Bill Falkner said they didn't want to again put off the problem to another council (Acceptance).

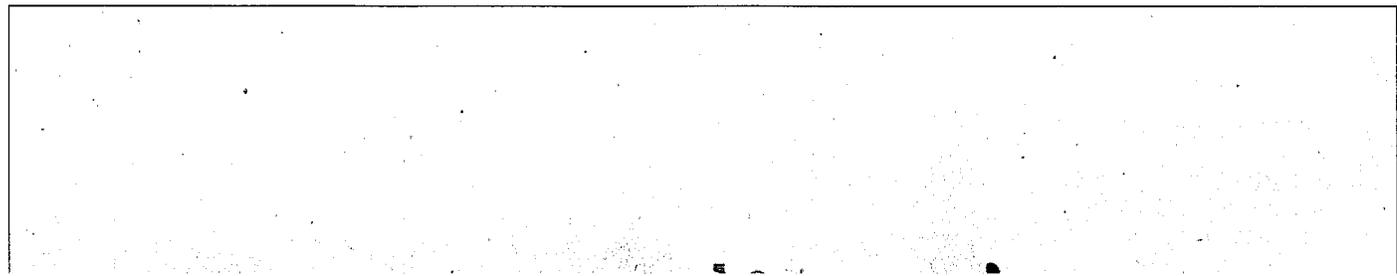
At the end of the meeting, Mr. Falkner told Public Works Director Bruce Woody, "Bruce, I'm glad you're the one leading this ship."

"Uh," Mr. Woody replied, hesitating. "OK."

Joe Blumberg can be reached at joelblumberg@npgco.com.

Schaaf pushes nuisance

ROSECRANS MEMORIAL AIRPORT | Retired Air Force Reservist takes over as manager



PING
OUR online p...
and YOUR ans...



How soon plan to eat Garden after opens Mo...

This week, \$... the salad.

11

This month, worth the li...

33

This lifetime Olive Garden... ian what Vel... fresh chees...

55

You can answer questi... stoener



Local

Snow d...

Presentation Handouts From Public Meetings

ST. JOSEPH, MISSOURI

Combined Sewer System Long Term Control Plan

Public Meeting - November 13, 2007 - 4:00 pm

Why Are We Here?

- St. Joseph must develop a Long Term Control Plan to control combined sewer overflows in accordance with the requirements of the Federal Clean Water Act

Whitehead Overflow to Missouri River Spring 2007

11/13/2007 2

Combined Sewer Overflow (CSO) Solutions Must Balance the Challenges Facing St. Joseph

WE NEED YOUR INPUT!

11/13/2007 3

Where We Were, Where We Are, and Where We Are Going

- Overview of Our Combined Sewer System & Deficiencies
- Potential **Solutions** / Alternatives to Minimize Overflows to Acceptable Levels
- Planning Level **Costs** & Affordability Analysis
- Action **Plan** / Next Steps

WE NEED YOUR INPUT!

11/13/2007 4

Combined vs. Separate Sewers

Combined Sewer System

Day: 80% of the flow

Night: 1% of the flow

Separate Sewer System

To Treatment Plant

11/13/2007 5

What are the Problems When It Rains?

Existing pipes are undersized to carry both sewage and rain water, resulting in untreated combined sewage overflows into the Missouri River

Combined Sewer Outfall at Patee

11/13/2007

What are Other Problems When It Rains?

- Existing pump stations do not have the capacity to pump all flows to the treatment plant
- Existing treatment plant does not have the capacity to treat all flows
- Potential sewer backups due to undersized system capacity

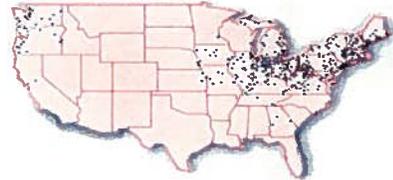


11/13/2007

7

We Have Many Challenges, But We are Not Alone!

- EPA has placed a priority on Cities to reduce overflows from their combined sewer systems - **772 other CSO communities**



11/13/2007

8

We Have Many Challenges, but it's an Opportunity to Improve our Community and It Provides Other Benefits

- Reduce Overflows of Sewage to the Missouri River, thereby **Improving Water Quality**
- **Replace Aging Sewer Infrastructure** in Some Locations
- **Address Odor Issues** in Some Locations
- Improve Drainage and **Reduce Flooding**
- Increase Service Area and **Treatment Capacity**

11/13/2007

9

We Have Already Made Some Progress!

- **Sewer Separation Projects**
 - Roy's Branch initiated in 2005 to install new storm sewer to remove wet weather flows from combined system (\$1.5 M)
- **Regional Detention Basins - U.S. Army Corps of Engineers (USACE)**
 - Blacksake Creek currently in Feasibility Study
 - Brown's Branch Funding Not Approved by the USACE After Reconnaissance Study
 - Whitehead Creek on hold pending USACE moratorium on "new starts"

11/13/2007

10

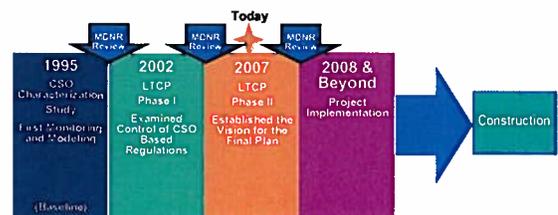
We Have Many Challenges, but We Have the Right Team

- **Black & Veatch Corp. is Preparing the City's Long Term Control Plan**
 - Coordinate a comprehensive plan
 - Provide computer modeling
 - Evaluation of alternatives
 - Assist in public education and participation process
- **Long Term Control Plan to be Submitted to MDNR by February 15, 2008. It will outline how the City plans to reduce the number of overflows and deficiencies in our combined sewer system.**

11/13/2007

11

Where We Are in St. Joseph's Long Term Control Plan (LTCP) Process



11/13/2007

12

City Council Questions at This Point?

11/13/2007 13

St. Joseph Watershed

11/13/2007 14

What Does Our Combined Sewer System Look Like?

- 8 Drainage Basins Covering 30 Sq. Miles Are Served by Combined Sewers
- 15 Combined Sewer Overflow Discharge Locations (All Along Missouri River)
- One Main Wastewater Treatment Plant
- Sizes Range from 18-inch Sewer Pipes to 19-foot Arch Sewers, Some Over 100 Years Old

11/13/2007

Anatomy of Our Combined Sewer System

- Main sewers
- Wastewater treatment plant
- Diversion structure
- Interceptor Sewer
- Pump Station
- Force Main

City Staff and Black & Veatch Conducted Extensive Sampling and Modeling

- **Collection System Assessment**
 - Sampling to Assess Water Quality
 - Flow Monitoring to Determine CSO Volumes For Each Rain Event
 - Detailed Modeling of System
- **2007 Efforts Alone**
 - 10 Flow Monitoring Locations
 - 3 Rain Gage Stations (for a total of 6)
 - 5 Samplers Installed Feb 2007
 - 34 Rain Events Recorded Since Feb
 - Over 2,000 Separate Analyses

11/13/2007 17

Comparison of 1995 and 2007 End of Pipe CSO Water Quality Data to KCMO and State Limits

Parameter	1995 St. Joseph	2007 St. Joseph	2006 Kansas City	Missouri Limit
BOD, mg/L	3 – 682	5 – 231	3 – 400	45
TSS, mg/L	36 – 5,000	109 – 8,000	11 – 1,400	45
E.Coli, mpm/100 mL	NA	39,000 – 480,000	50,000 – 3,000,000	~ 500 Daily Max ~ 200 Mo. Ave.
Fecal Coliform, mpm/100 mL	76,100 – 298,000	>39,000 – >480,000	100,000 – 3,000,000	1,000 Daily Max 400 Mo. Ave.
Ammonia, mg/L	0.4 – 4.7	0.7 – 12	0.2 – 11	–

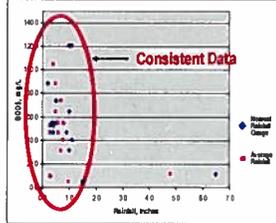
- 1995 to 2007 St Joseph Water Quality Data is Consistent
- St Joseph Data is Comparable to KCMO Data
- Bacteria Levels are up to **480 Times Higher** Than State Limits

11/13/2007 18

Staff Efforts Resulted in Good Data to Assess Water Quality Impacts from CSOs through Modeling

- B&V conducted modeling 1995, 2002, 2006, 2007 to examine impact of CSOs on the environment

- 2007 data shows strong relationship between rainfall and CSO constituents such as BOD5, ammonia, and bacteria



- Modeling results predict that:
 - dissolved oxygen levels in stream won't meet State Standards.
 - high levels of bacteria are a concern in the receiving stream.

11/13/2007

19

Modeling Predicts That Overflow Frequencies and Volumes Are Significant!

- St. Joseph Typical Year:**
 - 78 Rainfall Events
 - 2.9 Billion Gallons of Sewage spilled into the receiving streams
 - Largest Storm discharges 605 million gallons of sewage to the rivers
- St. Joseph Overflow Volumes are Larger Than Other Comparable Cities**



11/13/2007

St. Joseph Has Big Drainage Area vs. Small Population

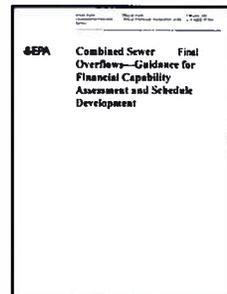
City	CSO Drainage Area Sq. Mi.	Population	Population Density Persons/Sq. Mile
Atlanta, GA	19	5,100,000	268,000
Cincinnati, OH	74	332,000	4,500
Cleveland, OH	75	478,000	6,400
Louisville, KY	27	701,000	26,000
Nashville, TN	15	607,000	40,500
Kansas City, MO	56	440,000	7,900
Omaha, NE	51	339,000	6,600
St. Joseph, MO	30	73,000	2,400

11/13/2007

21

How is Affordability Taken into Consideration?

- EPA Considers Affordability When Negotiating with CSO Cities
- Uses a Standardized Approach
- Considers Costs to Residents (**2% Median Household Income**) and Financial Capability of Community



11/13/2007

22

Using a 2% Affordability Index Results in a "High" Burden for Citizens of St. Joseph

CSO Financial Burden Level			
City of St. Joseph Financial Capability	RESIDENTIAL INDICATOR (COSTS)		
	Low	Medium	High
Weak	Medium	High	High
Mid-range	Low	Medium	High
Strong	Low	Low	Medium

11/13/2007

23

A "High" Burden Will Factor into Negotiations with EPA

- "High" burdens will typically not result in relaxed CSO controls
- However, it should give St. Joseph a strong stance for negotiating an **extended implementation** time to make it more affordable for ratepayers.

11/13/2007

24

Based on a 2% Affordability Index, EPA Defines Your Burden As...

- St. Joseph's wastewater system burden as calculated by EPA guidance is \$180 million over a 20-year period
- Of that amount, your CSO burden is \$75 million
- Alternatives to meet MDNR water quality standards will exceed your 20-year burden amounts

11/13/2007

25

How Do We Fix the Overflow Problems?

• Our Challenges:

- Meet Regulatory Requirements
- Focus on Community Needs
- Make It Affordable

• We Must Evaluate Cost-Effective Technologies:

- ✓ Storage Basins
- ✓ Storage Tunnels
- ✓ Sewer Separation
- ✓ High Rate Treatment



11/13/2007

26

Stormwater Detention



Low-Cost Strategy

11/13/2007

27

Sewer Separation

Highly Disruptive and Expensive!



11/13/2007

Deep Tunnel Storage

Least Disruptive to the Community!



High Rate Treatment Facility

Lawrence, KS



CONCEPT PICTURE

COMPLETED PROJECT



11/13/2007

30

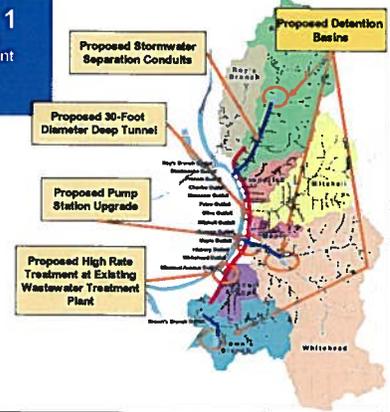
Alternatives to Meet EPA Target of Four Overflow Events Per Year

- Three Alternatives Will Meet EPA Target:
Alt. 1 – Storage and Treatment
Alt. 2 – Satellite Treatment
Alt. 3 – Sewer Separation
- A 4th Alternative Costs Less and Meets Your Affordability Target, But Does Not Solve All CSO Problems

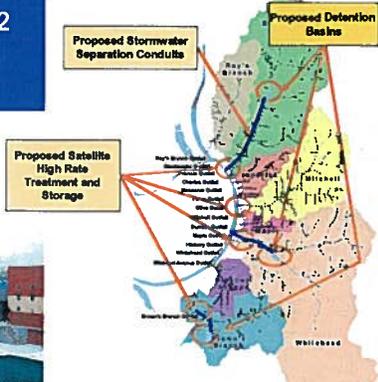
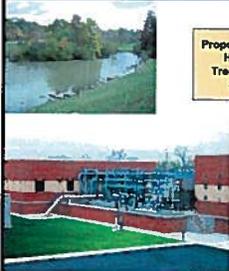
11/13/2007

37

Alternative 1 Deep Tunnel and High Rate Treatment at Wastewater Treatment Plant



Alternative 2 Satellite High Rate Treatment



11/13/2007

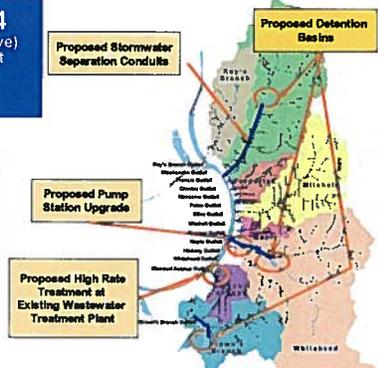
Alternative 3 Complete Sewer Separation

All Areas to Be Separated



11/13/2007

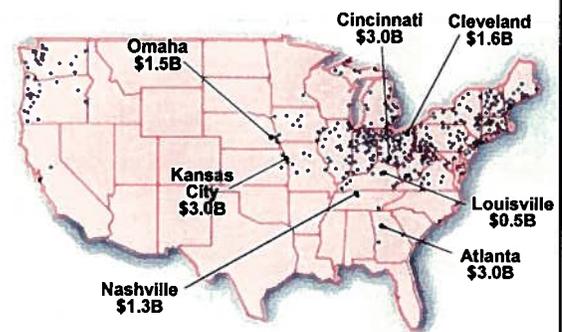
Alternative 4 (Lower Cost Alternative) High Rate Treatment at Wastewater Treatment Plant



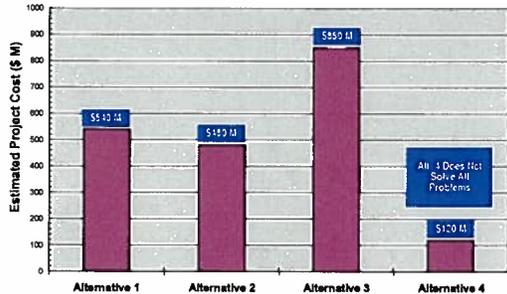
11/13/2007

Alt. 4 Does Not Solve All Problems

Representative CSO Program Costs



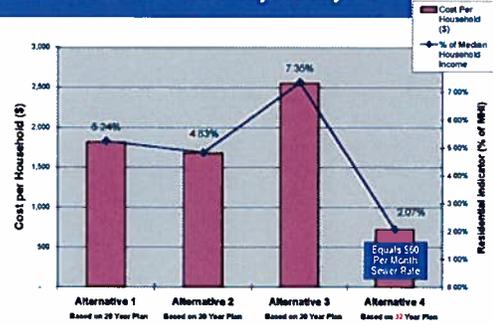
What are the Estimated Costs for the Alternatives?



11/13/2007

43

Alternative 4 is the Best Approach Based On Affordability Analysis



11/13/2007

44

Proposed CSO Plan Based on Affordability Analysis

- 32 year implementation schedule using Alternative 4 (\$120 million)
- \$75 million in expenditures over first 20 years
- \$45 million in years 21 – 32
- City and MDNR would re-evaluate the CSO Program during and after the 32 year plan is complete and decide what CSO controls may be required in the future

11/13/2007

45

What are the Next Steps?

Nov. '07 to Early Jan. '08

- Meet with MDNR on Nov 21 to Discuss Alternatives, Affordability, and Proposed Plan
- Complete Alternatives, Evaluations, and Cost Estimates
- Increase Public Participation and Stakeholder Input in Process (e.g., Public Meetings, City Talk, Web Site, Public Access Channel, Direct Mail)
- Conduct Public Meetings in December and Early January

Late Jan. to June '08

- Make Final Selection of Project Approach by End of Jan. 2008
- Submit Plan to MDNR and EPA by Required Deadline, February 15, 2008
- Conduct Annual Sewer Rate Study in Spring 2008, including Proposed CSO Plan Costs
- Begin Study and Design for Year 1 Projects in 2008
- Meetings with MDNR/EPA Throughout the Process

11/13/2007

46

Learn More... Visit St. Joseph's and Other Cities' Project Websites

- St. Joseph: http://www.ci.st-joseph.mo.us/publicworks/wpc_csos.cfm
- KCMO: <http://www.kcmo.org/water.nsf/web/homeww?openDocument>
- Omaha: <http://www.omahacso.com/>
- Toledo: <http://www.toledowaterwaysinitiative.com/>
- Indianapolis: www.indycleanstreams.org

11/13/2007

47

City Council Discussion

Public Comment

11/13/2007

48

ST. JOSEPH, MISSOURI

Combined Sewer System - Long Term Control Plan



Public Meeting No. 2

January 9, 2008 - 4:00 pm

Why Are We Here?

- St. Joseph must develop a Long Term Control Plan to control combined sewer overflows in accordance with the requirements of the Federal Clean Water Act



Whitehead Overflow to Missouri River Spring 2007

1/9/2008 2

Combined Sewer Overflow (CSO) Solutions Must Balance the Challenges Facing St. Joseph



WE NEED YOUR INPUT!

1/9/2008 3

Previous Public Meeting

November 13, 2007



- Overview of our combined sewer system and deficiencies
- Potential solutions / alternatives to minimize overflows to acceptable levels
- Planning level costs and affordability analysis
- Action plan / next steps

WE NEED YOUR INPUT!

1/9/2008 4

Where We Are in St. Joseph's Long Term Control Plan (LTCP) Process



TODAY
Feb. 15, 2008

- 1995 CSO Characterization Study, Data Monitoring and Modeling (Eveline)
- 2002 LTCP Phase I: Examined Control of CSO Based Regulations
- 2007 LTCP Phase II: Established the Vision for the Final Plan
- 2008 & Beyond: Submit Final LTCP, Project Implementation
- Construction

1/9/2008 5

What Does Our Combined Sewer System Look Like?

- 8 drainage basins covering 30 sq. miles are served by combined sewers
- 15 combined sewer overflow discharge locations (all along Missouri River)
- One main wastewater treatment plant
- Sizes range from 18-inch sewer pipes to 20-foot box sewers, some over 100 years old



1/9/2008

How is Affordability Taken into Consideration?

- EPA considers affordability when negotiating with CSO cities
- Uses a standardized approach
- Considers costs to residents (**2% median household income**) and financial capability of community

EPA Combined Sewer Flow Overflows—Guidance for Financial Capability Assessment and Schedule Development

1/9/2008 7

Using a 2% Affordability Index Results in a "High" Burden for Citizens of St. Joseph

CSO Financial Burden Level			
City of St. Joseph Financial Capability	RESIDENTIAL INDICATOR (COSTS)		
	Low	Medium	High
Weak	Medium	High	High
Mid-range	Low	Medium	High
Strong	Low	Low	Medium

1/9/2008 8

A "High" Burden Will Factor into Negotiations with EPA

- "High" burdens will typically not result in relaxed CSO controls
- However, it should give St. Joseph a strong stance for negotiating an **extended implementation time** to make it more affordable for ratepayers.

1/9/2008 9

Based on a 2% Affordability Index, EPA Defines Your Burden As...

- St. Joseph's wastewater system burden as calculated by EPA guidance is \$180 million over a 20-year period
- Of that amount:
 - CSO burden is \$75 million
 - Non-CSO-related Capital Improvement Plan (CIP) projects burden is \$105 million
- Alternatives to meet MDNR water quality standards will exceed your 20-year burden amounts

1/9/2008 10

Review of Preliminary Results with MDNR and EPA

- MDNR/EPA comments from November 21, 2007 meeting:
 - For the Long Term Control Plan to be accepted, modeling results must show either
 - Attainment of water quality standards
 - or
 - No more than four overflow events per year
- Wastewater system affordability will be taken into consideration by MDNR/EPA

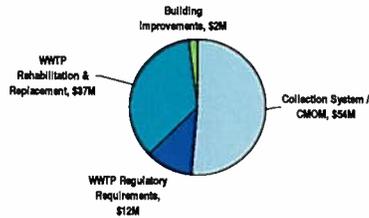
1/9/2008 11

Outcomes of Discussions with MDNR and EPA

- EPA requires a detailed breakdown of \$105 million in non-CSO related CIP
- \$75 million alone for CSO projects will not achieve EPA's requirement of meeting four overflows per year or water quality standards
- City must present a phased implementation plan to meet EPA requirements, regardless of the amount of time needed

1/9/2008 12

Non-CSO Related CIP Projects Total During 20-Year Period is \$105M



1/9/2008

13

Preliminary Alternatives Were Refined Based on MDNR/EPA Meeting

- **Basis of refinement:**
 - Focused on EPA goal to reduce CSOs to no more than four events per year
 - Optimized conveying maximum amount of flow to wastewater treatment plant (WWTP)
 - Developed phased CSO control approach for best alternative (Alt. 4)
 - Phase I – 12 overflow events per year
 - Phase II – 6 overflow events per year
 - Phase III – 4 overflow events per year
 - Conducted site visits

1/9/2008

14

Fundamental Projects

Projects Common to all Alternatives (Except Sewer Separation)

Stormwater Detention Is a Common (Fundamental) Element to Alternatives

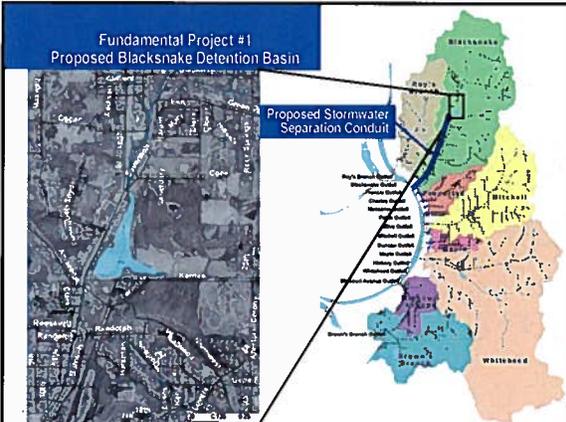
- Concept to remove Blacksnake, Whitehead, and Brown's Branch Creeks from collection system
- Build in conjunction with U.S. Army Corps of Engineers' (USACE) flood control facilities



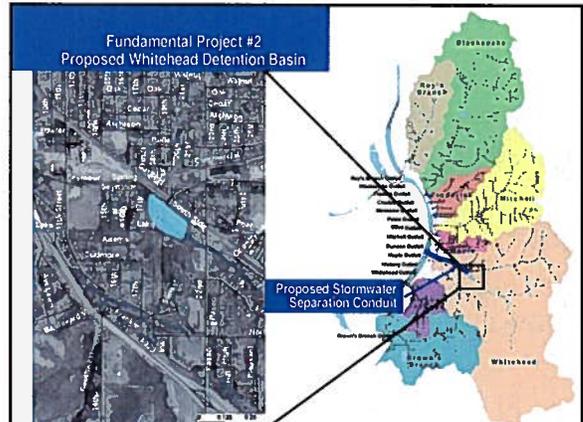
1/9/2008

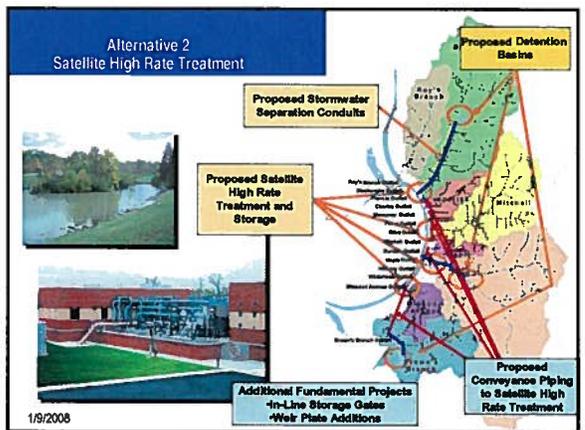
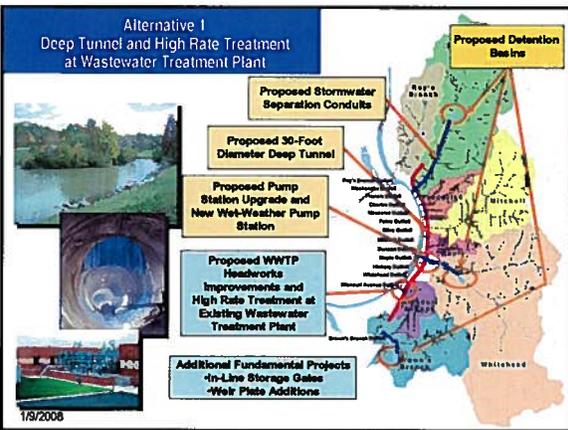
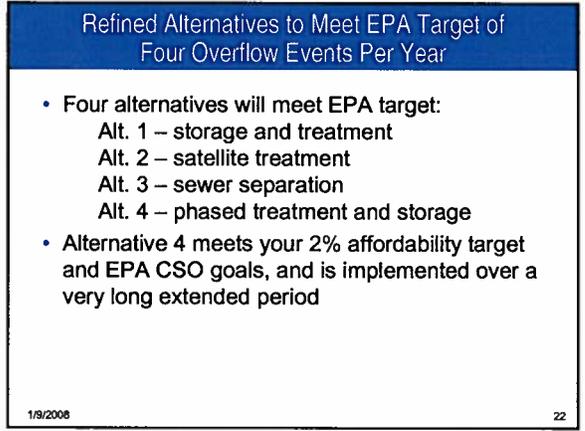
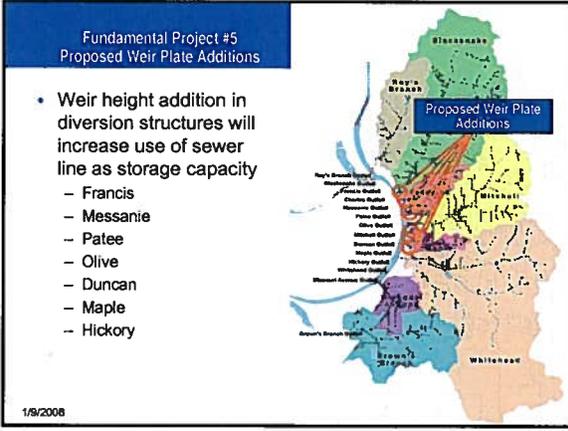
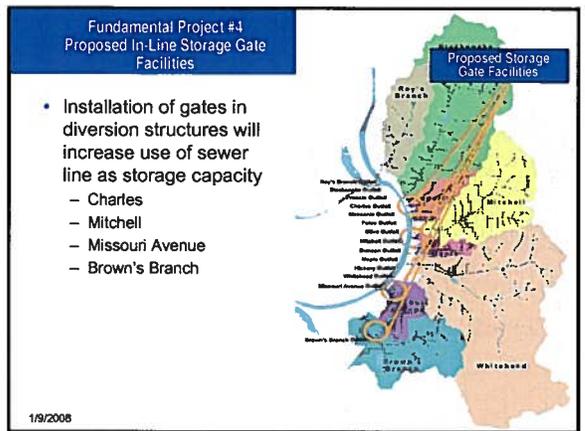
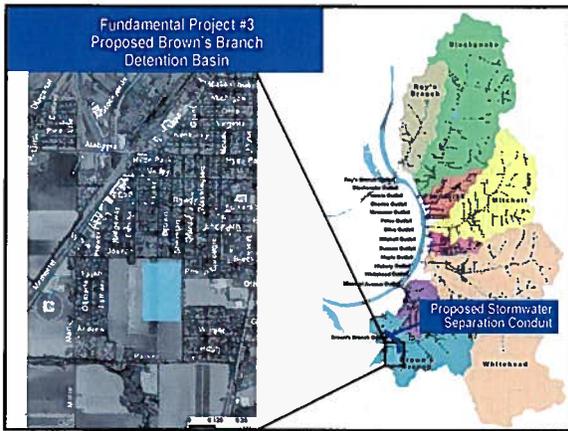
16

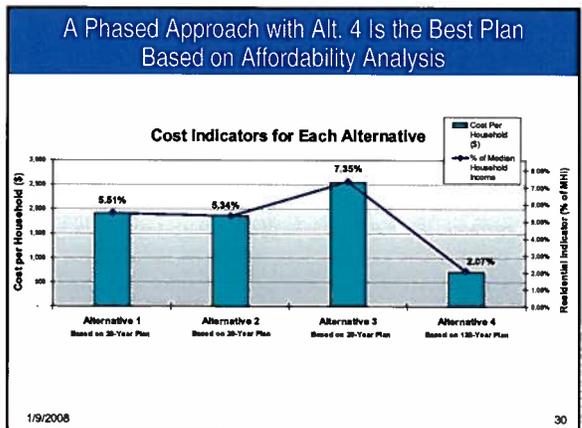
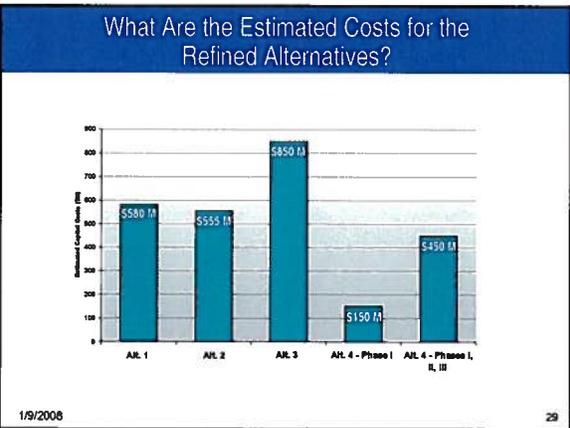
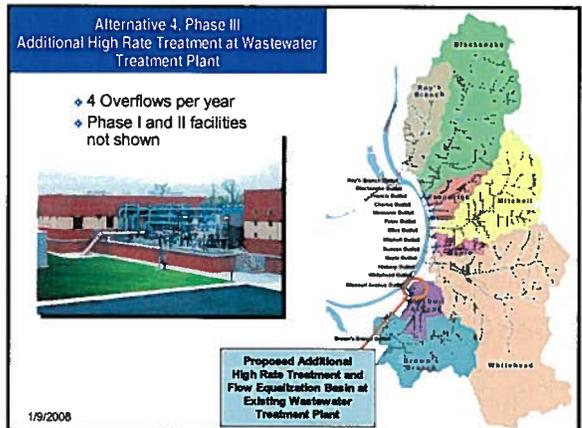
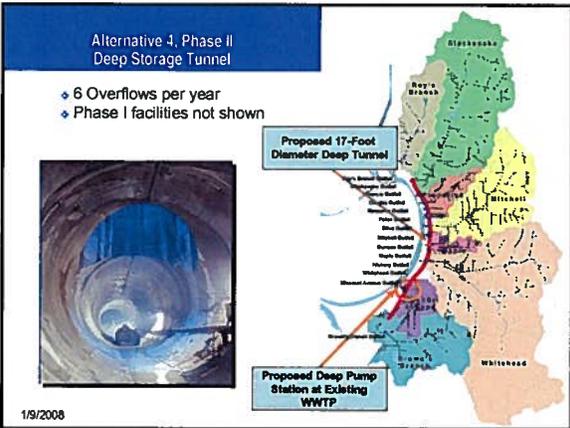
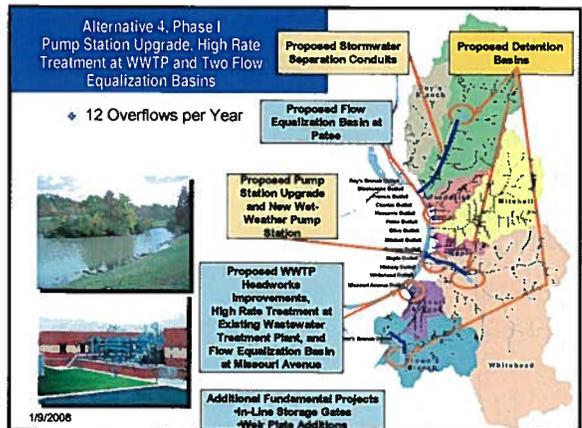
Fundamental Project #1
Proposed Blacksnake Detention Basin



Fundamental Project #2
Proposed Whitehead Detention Basin







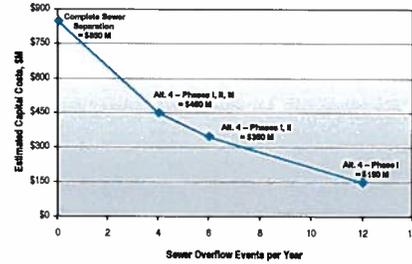
Recommended CSO Control Plan Based on Affordability Analysis

- 120-Year implementation schedule using recommended Alternative 4
 - \$75 Million in CSO control expenditures during each 20-year period
 - Phase I Years 1-40 \$150 M
 - Phase II Years 41-93 \$200 M
 - Phase III Years 94-120 \$100 M
- Total = \$450 M**
(costs in 2007 dollars)

1/9/2008

31

Costs Increase Significantly with Tighter Control of Sewer Overflows



1/9/2008

32

What Are the Next Steps?

- Late January to July 2008
- Increase public participation and stakeholder input in process (e.g., public meetings, city talk, web site, public access channel, direct mail)
 - Make final selection of project approach by end of Jan. 2008
 - Develop Phase I implementation schedule
 - Conduct public meeting in late January
 - Submit plan to MDNR and EPA by required deadline, February 15, 2008
 - Conduct annual sewer rate study in Spring 2008, including proposed CSO plan costs
 - Begin study and design for Year 1 projects in 2008
 - Meetings with MDNR/EPA throughout the process

1/9/2008

33

Learn More... Visit St. Joseph's and Other Cities' Project Websites

- St. Joseph: http://www.ci.st-joseph.mo.us/publicworks/wpc_cso.cfm
- KCMO: <http://www.kcmo.org/water.nsf/web/homeww?opendocument>
- Omaha: <http://www.omahacso.com/>
- Toledo: <http://www.toledowaterwaysinitiative.com/>
- Indianapolis: www.indycleanstreams.org

1/9/2008

34

City Council Discussion

Public Comment

ST. JOSEPH, MISSOURI

Combined Sewer System - Long Term Control Plan

Public Meeting No. 3

February 6, 2008 - 6:30 pm

Why Are We Here?

- St. Joseph must develop a Long Term Control Plan to control combined sewer overflows in accordance with the requirements of the Federal Clean Water Act

Whitehead Overflow to Missouri River Spring 2007

2/6/2008 2

Combined Sewer Overflow (CSO) Solutions Must Balance the Challenges Facing St. Joseph

WE NEED YOUR INPUT!

2/6/2008 3

Previous Public Meeting

January 9, 2008

- Wastewater Affordability Analysis and burden to the City
- Potential solutions / alternatives to minimize overflows to acceptable levels
- Planning level costs and phased approach
- Action plan / next steps

WE NEED YOUR INPUT!

2/6/2008 4

Where We Are in St. Joseph's Long Term Control Plan (LTCP) Process

TODAY
Feb. 15, 2008

- 1995 CSO Characterization Study, First Monitoring and Modeling (Baseline)
- 2002 LTCP Phase I: Examined Control of CSO Based Regulations (MCMR Review)
- 2007 LTCP Phase II: Established the Vision for the Final Plan (MCMR Review)
- 2008 & Beyond: Submit Final LTCP, Phase I Facility Plan, Project Implementation (MCMR Review)
- Construction

2/6/2008 5

What Does Our Combined Sewer System Look Like?

- 8 drainage basins covering 30 sq. miles are served by combined sewers
- 15 combined sewer overflow discharge locations (all along Missouri River)
- One main wastewater treatment plant
- Sizes range from 18-inch sewer pipes to 20-foot box sewers, some over 100 years old

2/6/2008

How is Affordability Taken into Consideration?

- EPA considers affordability when negotiating with CSO cities
- Uses a standardized approach
- Considers costs to residents (**2% median household income**) and financial capability of community

EPA Combined Sewer First Overflows—Guidance for Financial Capability Assessment and Schedule Development

2/6/2008 7

Using a 2% Affordability Index Results in a "High" Burden for Citizens of St. Joseph

CSO Financial Burden Level			
City of St. Joseph Financial Capability	RESIDENTIAL INDICATOR (COSTS)		
	Low	Medium	High
Weak	Medium	High	High
Mid-range	Low	Medium	High
Strong	Low	Low	Medium

2/6/2008 8

A "High" Burden Will Factor into Negotiations with EPA

- "High" burdens will typically not result in relaxed CSO controls
- However, it should give St. Joseph a strong stance for negotiating an **extended implementation time** to make it more affordable for ratepayers.

2/6/2008 9

Based on a 2% Affordability Index, EPA Defines Your Burden As...

- St. Joseph's wastewater system burden as calculated by EPA guidance is \$180 million over a 20-year period
- Of that amount:
 - CSO burden is \$75 million
 - Non-CSO-related Capital Improvement Plan (CIP) projects burden is \$105 million
- Alternatives to meet MDNR water quality standards will exceed your 20-year burden amounts

2/6/2008 10

Review of Preliminary Results with MDNR and EPA

- MDNR/EPA comments from November 21, 2007 meeting:
 - For the Long Term Control Plan to be accepted, modeling results must show either
 - Attainment of water quality standards
 - or
 - No more than four overflow events per year
- Wastewater system affordability will be taken into consideration by MDNR/EPA

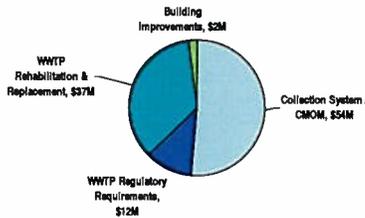
2/6/2008 11

Outcomes of Discussions with MDNR and EPA

- EPA requires a detailed breakdown of \$105 million in non-CSO related CIP
- \$75 million alone for CSO projects will not achieve EPA's requirement of meeting four overflows per year or water quality standards
- City must present a phased implementation plan to meet EPA requirements, regardless of the amount of time needed

2/6/2008 12

Non-CSO Related CIP Projects Total During 20-Year Period is \$105M



2/6/2008

13

Preliminary Alternatives Were Refined Based on MDNR/EPA Meeting

- **Basis of refinement:**
 - Focused on EPA goal to reduce CSOs to no more than four events per year
 - Optimized conveying maximum amount of flow to wastewater treatment plant (WWTP)
 - Developed phased CSO control approach for best alternative (Alt. 4)
 - Phase I – 12 overflow events per year
 - Phase II – 6 overflow events per year
 - Phase III – 4 overflow events per year

2/6/2008

14

Water Quality Standards are only Achieved with All Three Phases of Improvements

- CSOs to Missouri River cause problems in meeting water quality standards for dissolved oxygen and E. Coli bacteria.
- Water quality modeling indicates all three phases of improvements must be implemented to meet water quality standards.

2/6/2008

15

Fundamental Projects

Projects Common to all Alternatives (Except Sewer Separation)

Stormwater Detention Is a Common (Fundamental) Element to Alternatives

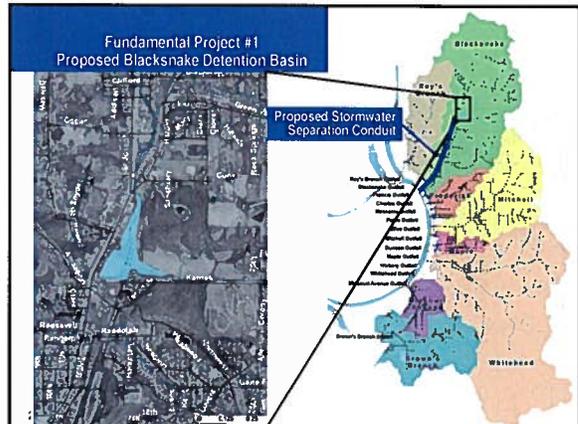
- Concept to remove Blacksnake, Whitehead, and Brown's Branch Creeks from collection system
- Build in conjunction with U.S. Army Corps of Engineers' (USACE) flood control facilities

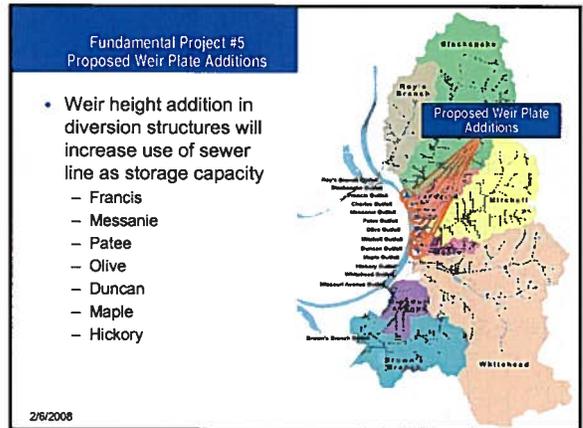
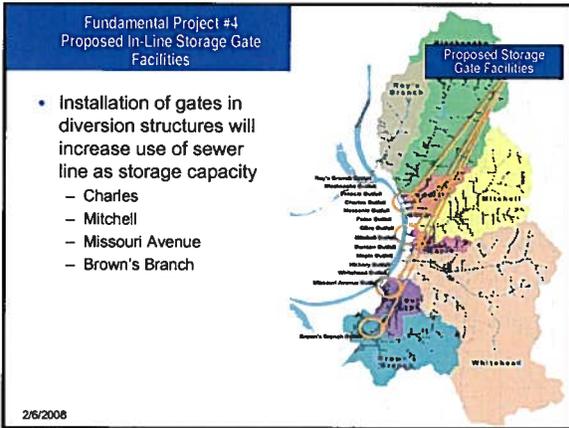
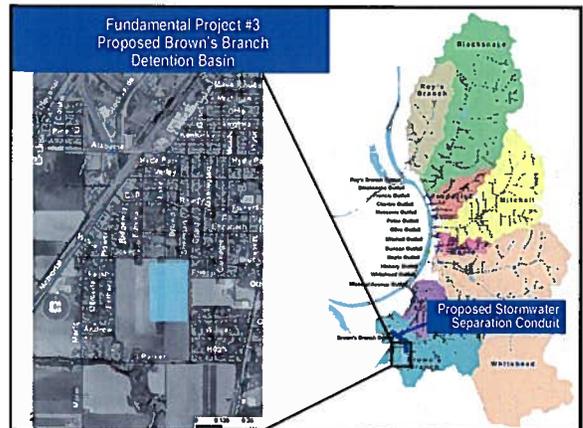
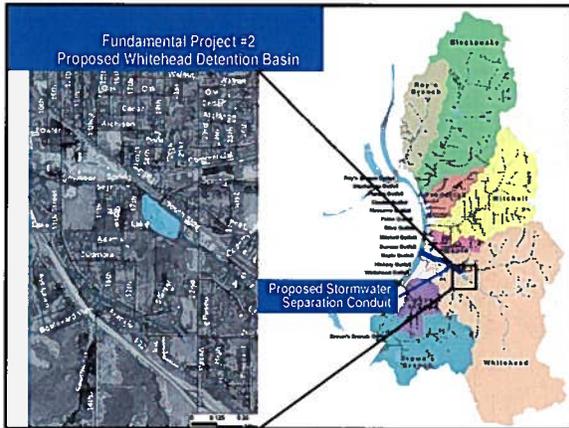


2/6/2008

17

Fundamental Project #1
Proposed Blacksnake Detention Basin





Final Alternatives will Meet EPA Target of Four Overflow Events Per Year

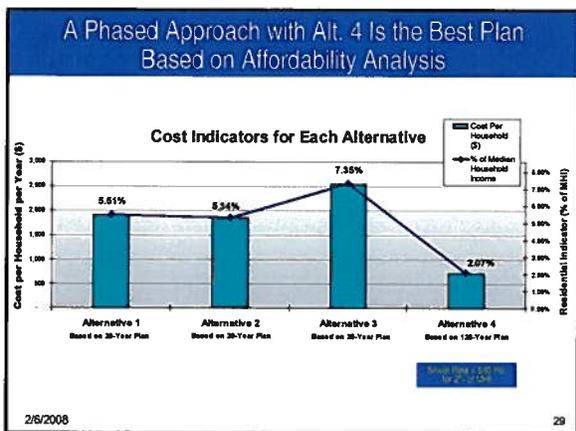
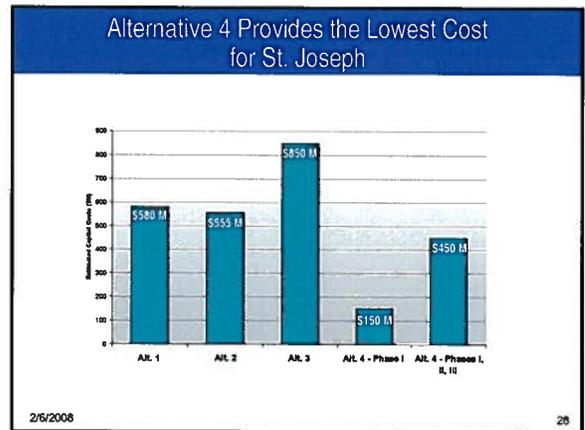
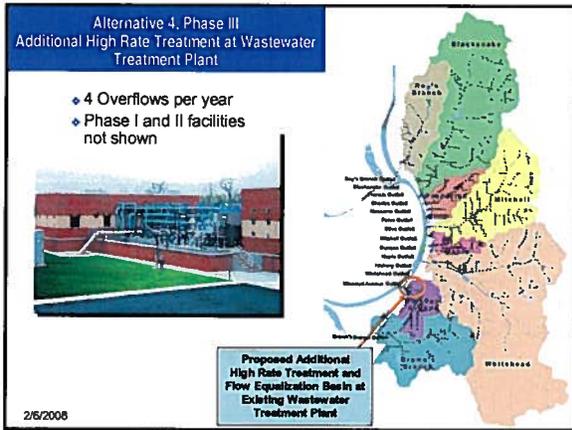
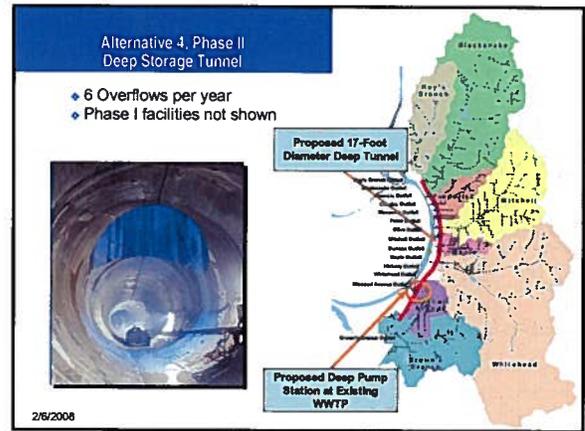
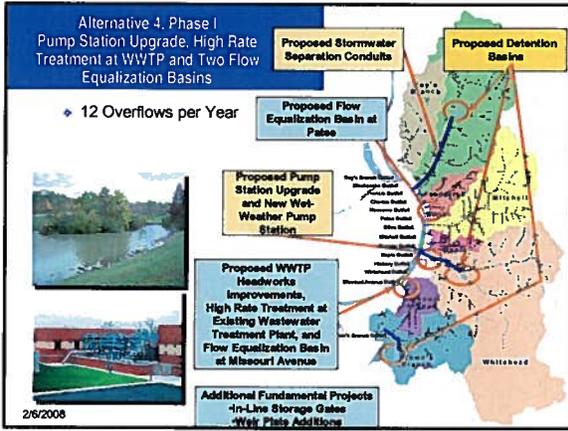
- Four alternatives will meet EPA target:
 - Alt. 1 – storage and treatment
 - Alt. 2 – satellite treatment
 - Alt. 3 – sewer separation
 - Alt. 4 – phased treatment and storage
- Alternative 4 meets your 2% affordability target and EPA CSO goals, and is implemented over a very long extended period

2/6/2008 23

Alternative 4 – Phased Treatment and Storage is the Best Plan for St. Joseph

- Phased implementation spreads costs out over time to reduce impact to rate payers
- Phased implementation provides milestone points to confirm improvements effectiveness
- Maximizing flow to treatment plant fully utilizes existing infrastructure
- Multiple community benefits can be achieved with stormwater detention basins

2/6/2008 24



Recommended CSO Control Plan Based on Affordability Analysis

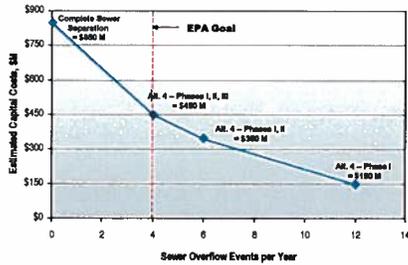
- 120-Year implementation schedule using recommended Alternative 4
- \$75 Million in CSO control expenditures during each 20-year period
- Phase I Years 1-40 \$150 M
- Phase II Years 41-93 \$200 M
- Phase III Years 94-120 \$100 M

Total = \$450 M
(costs in 2007 dollars)

Subject to Negotiation with MDNR / EPA

2/6/2008

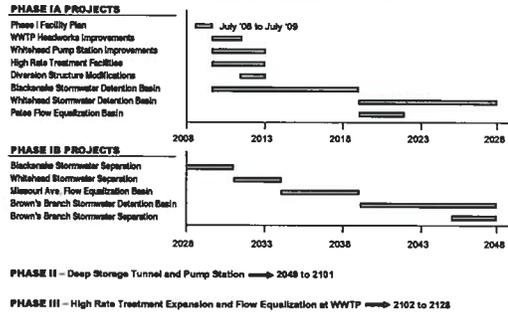
Costs Increase Significantly with Tighter Control of Sewer Overflows



2/6/2008

31

St. Joseph CSO Control Program Preliminary Project Implementation Schedule



2/6/2008

32

What Are the Next Steps?

Late February to December 2008

- Submit long term control plan to MDNR and EPA by required deadline, February 15, 2008
- Increase public participation and stakeholder input in process (e.g., public meetings, city talk, web site, public access channel, direct mail)
- Conduct annual sewer rate study in Spring 2008, including proposed CSO plan costs
- Begin Phase I Facility Planning Study in July 2008
- Meetings with MDNR/EPA throughout the process to obtain comments and refine the plan

2/6/2008

33

Legal Perspective on CSO Long Term Control Plans

Legal Discussion by The Session Law Firm

2/6/2008

34

Learn More... Visit St. Joseph's and Other Cities' Project Websites

- St. Joseph: http://www.ci-st-joseph.mo.us/publicworks/wpc_cso.cfm
- KCMO: <http://www.kcmo.org/water.nsf/web/homeww?opendocument>
- Omaha: <http://www.omahacso.com/>
- Toledo: <http://www.toledowaterwaysinitiative.com/>
- Indianapolis: www.indycleanstreams.org

2/6/2008

35

City Council Discussion Public Comment



**APPENDIX D
SENSITIVE AREAS
CORRESPONDENCE**



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Columbia Ecological Services Field Office
101 Park DeVille Drive, Suite A
Columbia, Missouri 65203-0057
Phone: (573) 234-2132 Fax: (573) 234-2181



November 30, 2006

Ms. Dianne Honomichl
Black and Veatch
8400 Ward Parkway
P.O. Box 8405
Kansas City, Missouri 64114

Dear Ms. Honomichl:

Please refer to your October 26, 2006, letter, requesting information on federally listed species in the vicinity of St. Joseph, Buchanan County, Missouri. That information will be used in development of a Combined Sewer Overflow Long Term Plan for the city. The U.S. Fish and Wildlife Service (Service) offers the following comments pursuant the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

The following federally listed species may occur in the project area.

Pallid Sturgeon (*Scaphirhynchus albus*), Endangered - The pallid sturgeon is found primarily in the Missouri River and the Mississippi River downstream of its confluence with the Missouri River. Limited data is available concerning preferred habitats in the Missouri but adults of the species have been captured across many river habitats, including tributary mouths, sandbars, along main channel borders, deep holes (winter) and along revetments. Small sturgeons have been captured in areas with shoals, island tips, and secondary channels.

Bald eagle (*Haliaeetus leucocephalus*), Threatened - Bald eagles are common migrants and winter residents throughout the state and are uncommon breeders along some of the major rivers and larger reservoirs in the state. During winter, they congregate near rivers and reservoirs with open water and often near large concentrations of waterfowl. Wintering eagles usually occupy river habitats between November 15 and March 1, and use large diameter riparian tree species as daytime perches and night roosts. They usually perch within a riparian corridor or along lake shores and prefer areas with limited human activity. At night, wintering bald eagles may congregate at communal roosts and

will travel as much as 20 kilometers (12 miles) from feeding areas to a roost site. The period January 1 to March 1 is important for initiating nesting activity; March 1 to May 15 is the most critical time for incubation and rearing of young.

Bald eagles are known to prefer trees greater than 11 inches dbh and within 100 to 600 feet of water for perching sites. Eagles also tend to roost on the tallest trees (greater than 63 feet above ground level). Cottonwood (*Populus deltoides*) and sycamore (*Platanus occidentalis*) are often selected over other trees for perching and roosting. We recommend the project be designed to avoid the loss of trees matching these criteria.

If you have questions regarding our comments, please contact Ms. Jane Ledwin (573) 234-2132, extension 109.

Sincerely,

A handwritten signature in black ink, appearing to read "Charles M. Scott". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

Charles M. Scott
Field Supervisor

cc: MDC, Jefferson City, MO (Miller)

O:\Ledwin\Letters\2007006St. JoeCSOlistltr.doc



BLACK & VEATCH
building a world of difference™

ENERGY WATER INFORMATION GOVERNMENT

City of St. Joseph, Missouri
Combined Sewer Overflow Long Term Control Plan

B&V Project 140176.0204
B&V File F
October 23, 2006

Mr. Charlie Scott
Field Supervisor
Department of the Interior
U.S. Fish and Wildlife Service
101 Park DeVille Drive, Suite A
Columbia, Missouri 65203-0057

Subject: Endangered Species

Dear Mr. Scott:

Black & Veatch has been retained by the City of St. Joseph to prepare a Combined Sewer Overflow (CSO) Long Term Control Plan to be submitted to the Missouri Department of Natural Resources and the United States Environmental Protection Agency. As part of the control plan, Black & Veatch will be conducting an environmental review of the stretch of the Missouri River as shown on the attached figure.

A portion of the environmental review process includes examining the study area for the occurrence or potential occurrence of state and federally protected plants and animals. Please review the study area for known or potential occurrences of protected plants and animals and their habitats. Comments can be mailed to my attention at the letterhead address. If you have any questions regarding the project or this request, please call me at (913) 458-3438.

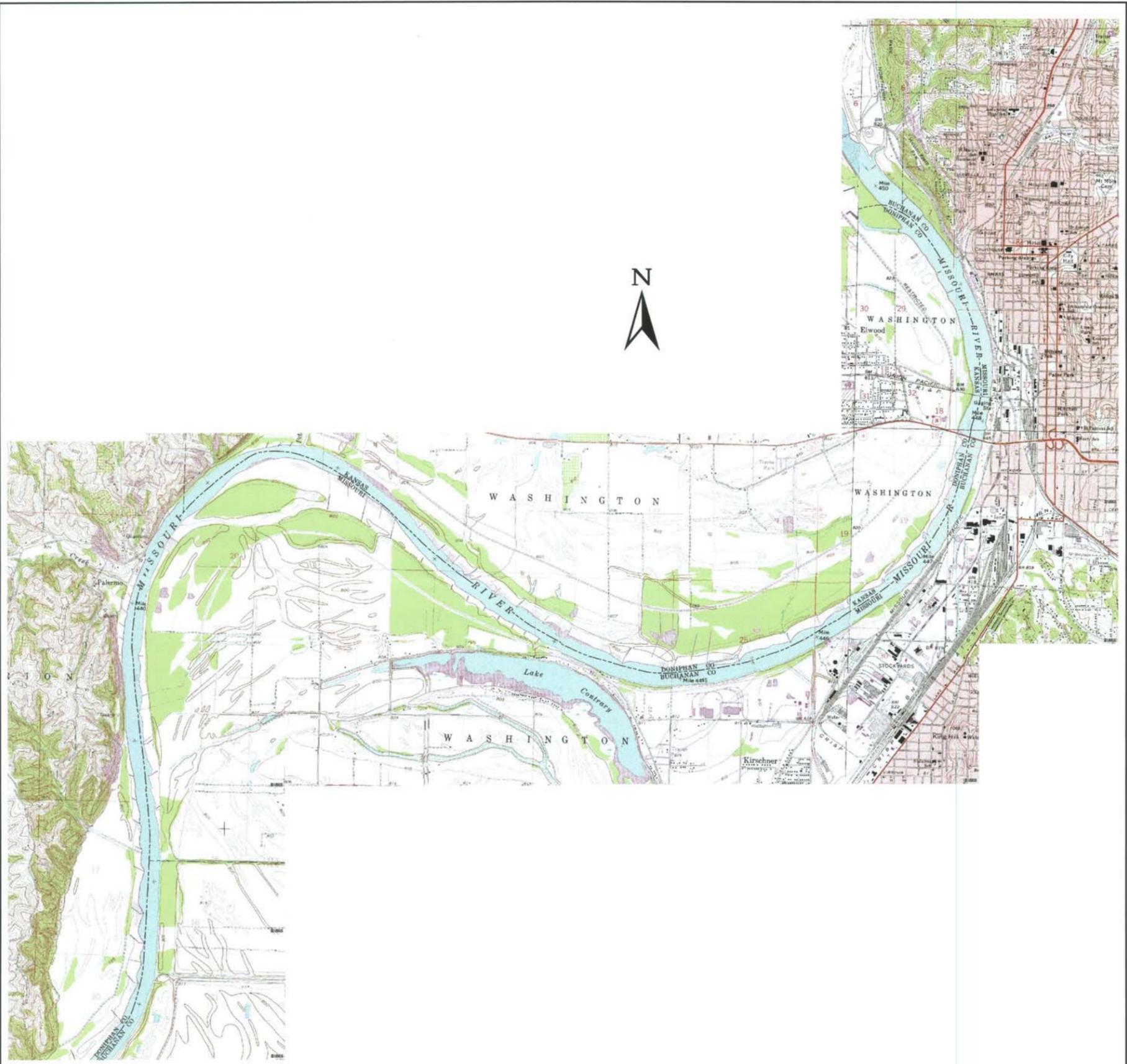
Very truly yours,

BLACK & VEATCH CORPORATION

Dianne S. Honomichl

Dianne S. Honomichl
Engineering Manager

dsh
Enclosure





Missouri Department of Conservation
 Policy Coordination Unit
 P. O. Box 180
 Jefferson City, MO 65102
 573-522-4115 X 3250 -- Shannon.Cave@mdc.mo.gov

Heritage Review Report

Dianne S. Honomichi, Engineering Manager
 Black & Veatch Corporation
 8400 Ward Parkway
 P.O. Box 8405
 Kansas City, MO 64114

Project type: Combined Sewer Overflow
Location/Scope: City of St. Joseph
County: Buchanan
Described in query as: B & V Project 140176.0204
Query received: November 1, 2006

This is not a site clearance letter, but a report of Missouri Department of Conservation records concerning public lands and sensitive resources known to be near and possibly affected by the proposed project. Please note that our records cover Missouri only, and you may need to consult with the state of Kansas for information about issues on its side of the border.

Prepared by:

November 6, 2006

Records found of species/habitats with federal or state concerns:

Species	Common Name	Federal Status	State Status	State Rank	Twp/Rng	Section	Last record
Scaphirhynchus albus	Pallid Sturgeon	E	E	S1	T57N R36W	25	1979
Scaphirhynchus albus	Pallid Sturgeon	E	E	S1			2004-07-20
Dry loess/glacial till prairie				S2	T57N R35W	7	1999-10-21
Hybognathus placitus	Plains Minnow			S2			2004-09-13
Lygodesmia juncea	Skeleton Plant			S3	T57N R35W	7	1988
Lygodesmia juncea	Skeleton Plant			S3	T57N R35W	29	1988-07-23
Macrhybopsis storeriana	Silver Chub			S3			2004-10-05
Cycleptus elongatus	Blue Sucker			S3			1997
Macrhybopsis meeki	Sicklefin Chub			S3			2004-10-05
Macrhybopsis gelida	Sturgeon Chub			S3			2004-10-05
Cycleptus elongatus	Blue Sucker			S3			2004-10-05

FEDERAL STATUS is coded E = Endangered, T = Threatened, C = Candidate, or PE = Proposed Endangered based on the federal Endangered Species Act

STATE STATUS is coded E = endangered or blank, as defined and protected by the Wildlife Code of Missouri and Missouri State Law.

STATE RANK is coded S1 = Critically imperiled, S2 = Imperiled, S3 = Rare & uncommon. These are tracked only, and are protected by general provisions of the Wildlife Code.

The Missouri River and its floodplain are home to a number of species of state and federal concern, including federal/state endangered pallid sturgeon, gray bats, Indiana bats, bald eagles and others. All these travel considerable distances from points they have been recorded, upstream or down, and important species like the following should be considered in appropriate habitats in this part of the Missouri River, its floodplain and

tributary mouths. Terrestrial projects that manage construction and include operation plans to avoid runoff of sediment or pollutants are unlikely to affect the aquatic species. Projects that place fill in or discharge water to the river are subject to federal permits, and strict observance of conditions required in those permit is important to minimize risk of damage to endangered species.

Species Mo. River N. of Kaw	Common name	Federal Status	State Status	State Rank	BMP available at http://www.mdc.mo.gov/documents/...
<i>Haliaeetus leucocephalus</i>	Bald Eagle	T	E	S3	...nathis/endangered/baldeagle.pdf
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	E	E	S1	...nathis/endangered/p_sturgeon.pdf
<i>Falco peregrinus</i>	Peregrine Falcon	none	E	S1	...nathis/endangered/peregrinefalcon.pdf
<i>Rallus elegans</i>	King Rail	none	E	S1	...nathis/endangered/kingrail.pdf
<i>Platygobio gracilis</i>	Flathead Chub	none	E	S1	...nathis/endangered/chub.pdf
<i>Botaurus lentiginosus</i>	American Bittern	none	E	S1	...nathis/endangered/americanbittern.pdf

Conservation concerns not related to specific heritage records (based on project type or species range):

Indiana bats (*myotis sodalis*, Federally endangered, State endangered) roost and raise young under the bark of trees in riparian forests and upland forests near perennial streams. During project activities, avoid degrading stream quality and where possible leave snags standing and preserve mature forest canopy. Additional information to incorporate in planning documents is available at <http://www.mdc.mo.gov/documents/nathis/endangered/indianabat.pdf>.

Clean Water Act permits issued by other agencies regulate both construction and operation of wastewater and stormwater systems, and provide many important protections for fish and wildlife resources throughout the project area and at some distance downstream. Fish and wildlife almost always benefit when unnatural pollutants are removed from water, and concerns are minimal if (a) the project area includes no protected species or restricted habitat identified in this report, and (b) construction is managed to minimize erosion and sedimentation/runoff to nearby streams and lakes, including adherence to any "Clean Water Permit" conditions.

Revegetation of disturbed areas is recommended to minimize erosion, as is restoration with of native plant species compatible with the local landscape and for wildlife needs. Annual ryegrass may be combined with native perennials for quicker green-up. Avoid aggressive exotic perennials such as crown vetch and sericea lespedeza.

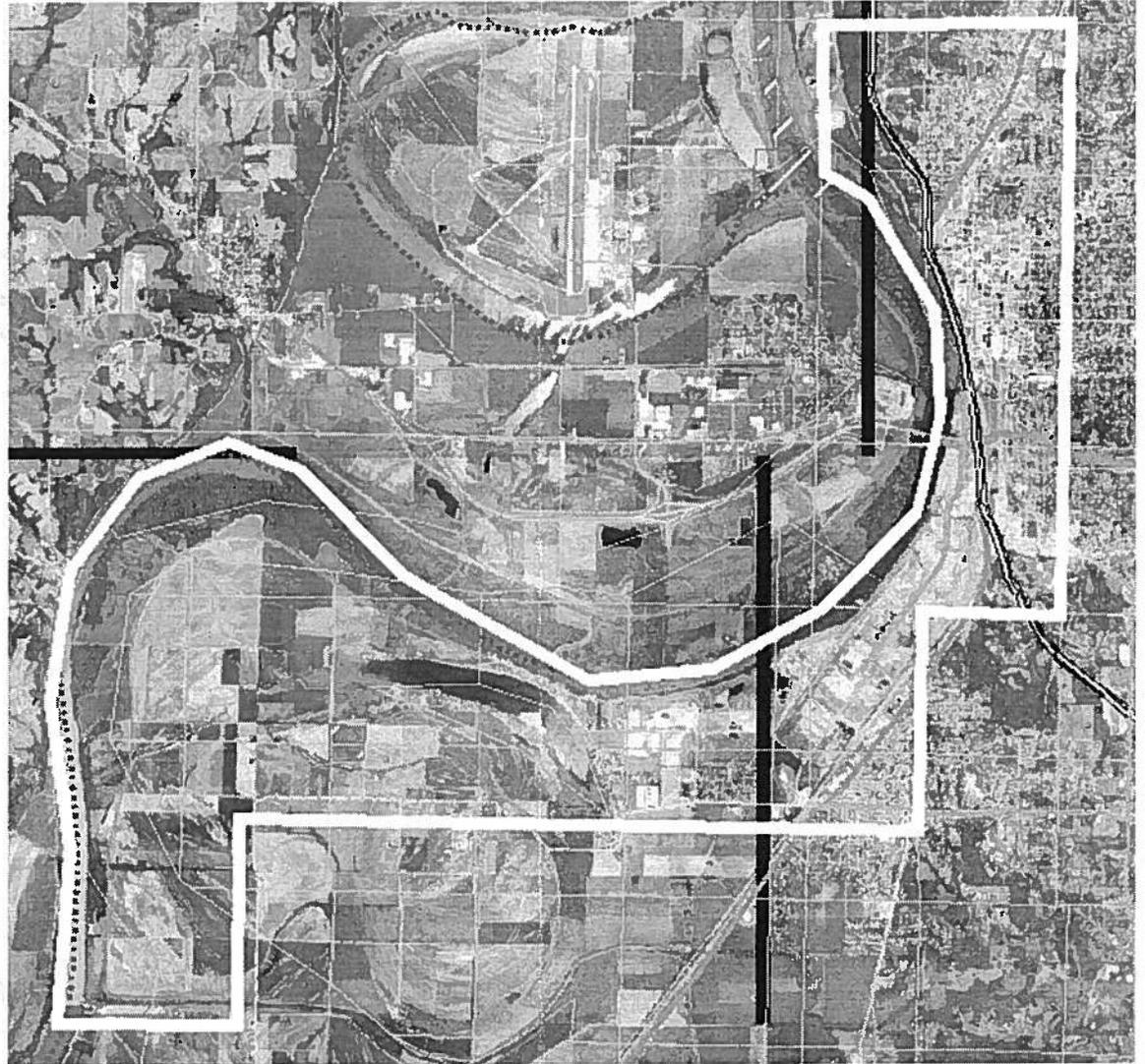
Management Recommendations for Construction Projects Affecting Missouri Streams and Rivers is a Conservation Department publication available at <http://www.mdc.mo.gov/documents/nathis/endangered/streams.pdf>.

A HERITAGE REVIEW provides information about species and habitats of concern that could be affected by the project. Heritage records note things that were positively identified at some date and time, marked at a location that may be more or less precise. Animals move quickly but plant communities can move also. To say "there is a record" does not mean the species/habitat is still there. To say that "there is no record" does not mean the project may not encounter something. Because of this, reports include information about records near but not necessarily on the project site. Three different kinds of information are provided.

- *FEDERAL Concerns are species/habitats protected under the Federal Endangered Species Act and that have been known near enough to the project site to warrant consideration. For these, project managers must contact the U.S. Fish and Wildlife Service Ecological Services (101 Park Deville Drive Suite A, Columbia, Missouri 65203-0007; Phone 573-234-2132; Fax 573-234-2181) for consultation.*
- *STATE Concerns are species/habitats known to exist near enough to the project site to warrant concern and protected under the Wildlife Code of Missouri (RSMo 3 CSR 10). "State Endangered Status" is determined by the Missouri Conservation Commission under constitutional authority, with requirements expressed in the Missouri Wildlife Code, rule 3CSR10-4.111. "State Rank" is numeric rank of relative rarity, protected under general provisions of the Wildlife Code but not endangered.*
- *"Concerns & management recommendations" are things for which one might prudently look. There is no specific heritage record, but our knowledge of the surrounding landscape suggests consideration. 93% of Missouri's land is in private ownership, so most sites have never been carefully inspected by conservation professionals*

This report is not a site clearance letter. Rather, it provides an indication of whether or not public lands and sensitive resources are known to be (or are likely to be) located close to the proposed project. Incorporating information from our Heritage Database into project plans is an important step that can help reduce unnecessary impacts to Missouri's sensitive natural resources. However, the Heritage Database is only one reference that should be used to evaluate potential adverse impacts. Other types of information, such as wetland and soils maps and on-site inspections or surveys, should be considered. Reviewing current landscape and habitat information and species biological characteristics would additionally ensure that species of conservation concern are appropriately identified and addressed.

Additional information on rare, endangered and watched species may be found at <http://www.mdc.mo.gov/nathis/endangered/>. Detailed information about species mentioned may be accessed at http://mdc4.mdc.mo.gov/applications/mofwis/mofwis_search1.aspx. If you would like printed copies of best management practices cited as internet URLs, please contact us.





BLACK & VEATCH
building a world of difference™

ENERGY WATER INFORMATION GOVERNMENT

City of St. Joseph, Missouri
Combined Sewer Overflow Long Term Control Plan

B&V Project 140176.0204
B&V File F
October 30, 2006

Mr. Shannon Cave
Missouri Department of Conservation
Public Involvement Coordinator
P.O. Box 180
Jefferson City, Missouri 65102

Subject: Endangered Species

Dear Mr. Cave:

Black & Veatch has been retained by the City of St. Joseph to prepare a Combined Sewer Overflow (CSO) Long Term Control Plan to be submitted to the Missouri Department of Natural Resources and the United States Environmental Protection Agency. As part of the control plan, Black & Veatch will be conducting an environmental review of the stretch of the Missouri River as shown on the attached figure.

A portion of the environmental review process includes examining the study area for the occurrence or potential occurrence of state and federally protected plants and animals. Please review the study area for known or potential occurrences of protected plants and animals and their habitats. Comments can be mailed to my attention at the letterhead address. If you have any questions regarding the project or this request, please call me at (913) 458-3438.

Very truly yours,

BLACK & VEATCH CORPORATION

Dianne S. Honomichl
Engineering Manager

dsh
Enclosure



BLACK & VEATCH
building a world of difference™

ENERGY WATER INFORMATION GOVERNMENT

City of St. Joseph, Missouri
Combined Sewer Overflow Long Term Control Plan

B&V Project 140176.0204
B&V File F
October 23, 2006

Mr. Tom Nagel
Missouri Department of Conservation
Northwest Regional Office
701 James McCarthy Drive
St. Joseph, Missouri 64507

Subject: Endangered Species

Dear Mr. Nagel:

Black & Veatch has been retained by the City of St. Joseph to prepare a Combined Sewer Overflow (CSO) Long Term Control Plan to be submitted to the Missouri Department of Natural Resources and the United States Environmental Protection Agency. As part of the control plan, Black & Veatch will be conducting an environmental review of the stretch of the Missouri River as shown on the attached figure.

A portion of the environmental review process includes examining the study area for the occurrence or potential occurrence of state and federally protected plants and animals. Please review the study area for known or potential occurrences of protected plants and animals and their habitats. Comments can be mailed to my attention at the letterhead address. If you have any questions regarding the project or this request, please call me at (913) 458-3438.

Very truly yours,

BLACK & VEATCH CORPORATION

Dianne S. Honomichl

Dianne S. Honomichl
Engineering Manager

dsh
Enclosure



**APPENDIX E
SAMPLING AND
FLOW MONITORING
DATA**

Photographs of Diversion Structure Monitoring Equipment

Appendix E
Photographs of Diversion Structure Monitoring Equipment

Figure E.1 Messanie Diversion Monitoring Equipment



Figure E.2 Mitchell Street Diversion Monitoring Equipment



Figure E.3 Whitehead Creek Diversion Monitoring Equipment



Figure E.4 Brown's Branch Diversion Monitoring Equipment



Figure E.5 Charles Street Diversion Monitoring Equipment



Figure E.6 Olive Street Diversion Monitoring Equipment



Figure E.7 Patee Street Diversion Monitoring Equipment



Figure E.8 Missouri Avenue Diversion Monitoring Equipment



Sampling and Monitoring Data

BLACKSNAKE CSO EVENTS 2007

TIME IN EVENT NO.	2/18/2007 3:15 p.m.	2/24/2007 4:02 a.m.	3/1/2007 2:14 a.m.	3/9/2007 8:50 a.m.	3/22/2007 7:00 a.m.	3/30/2007 12:41 a.m.	4/10/2007 7:32 p.m.	4/13/2007 3:31 a.m.	4/24/2007 6:35 p.m.	5/3/2007 10:45 p.m.	5/6/2007 8:50 a.m.	5/15/2007 8:30 a.m.	5/24/2007 9:24 a.m.	6/1/2007 8:30 a.m.	6/10/2007 12:45 p.m.	6/18/2007 11:15 a.m.	6/23/2007 1:07 a.m.	6/27/2007 5:35 p.m.	7/9/2007 10:30 p.m.	7/23/2007 9:00 a.m.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Rainfall Recorded (Inches)					0.3	1.3	0.8	0.3	0.3	0.3	5.0	0.8	0.6	0.6	0.6	0.4	0.2	0.2	0.2	0.9
Peak Depth																				
Peak cfs																				
Flow Volume																				
E. coli (cfu)			>2419.6	>2419.6		>2419.6	>2419.6		>2419.6		>2419.6		398,000			483,920	39,800		>2419.6	97,680
Fecal Coliform (cfu)			2420.0	2420.0		2420.0	2420.0		2420.0		2420.0		398,000			483,900	39,800		2420.0	97,700
BOD ₅ (mg/L)	166.0	49.0	26.0	102.0	10.2	5.0	55.0	47.0	53.0	105.4	12.0		47.0	55.2		65				32
TSS (mg/L)	330.0	508.0	989.0	354.0	829.0	213.0	239.0	136.0	2190.0	1277.0	299.0		3188.0	7651.0		2833.0				2710
TKN (mg/L)	13.3		6.4	10.6	5.5	0.9	1.6	5.7	11.0		7.1		12.1	16.9						12.1
NH ₄ -N (mg/L)	3.6	4.4	4.0	3.4	4.0	1.6	6.7	1.8	2.2	3.6	0.7		1.7	2.0		1.3				2.25
NO ₃ (mg/L)	5.3	5.7	11.2	0.2	5.9	2.8	6.0	4.5	8.1	7.9	2.8		6.1	19.1		5.7				7.04
PO ₄ (mg/L)	4.6	4.9	11.9	7.0	10.5	6.6	1.5	1.0	11.5	5.4	3.1		9.3	34.7		7.4				8.32
FOG (mg/L)		30.0	42.4	-	18.8	54.8	22.8		64.0		14.0		100.4			50	4.4			6
Total Phenol (mg/L)							0.08													
pH		8.3	8.5	7.0		8.4	8.0	8.1	7.8	-	8.2		7.3	7.9						
Temperature C°		7.3	17.2	6.7		8.7	10.9	10.0	10.8	-	9.2		7.9	13.1		22.4	20.5		7.1	8
Antimony (mg/L) (total)							0.0006													
Arsenic (mg/L) (total)						ND	0.0020													
Beryllium (mg/L) (total)							ND													
Cadmium (mg/L) (total)						ND	ND													
Chromium (mg/L) (total)						0.02	ND													
Copper (mg/L) (total)						0.02	0.0100													
Lead (mg/L) (total)						ND	0.0124													
Mercury (mg/L) (total)						ND	ND													
Nickel (mg/L) (total)						0.01	ND													
Selenium (mg/L) (total)							ND													
Silver (mg/L) (total)							ND													
Thallium (mg/L) (total)							ND													
Zinc (mg/L) (total)						0.09	0.1000													
Cyanide (Total) (mg/L)							ND													
Benzene							ND													
Bromodichloromethane							ND													
Bromofom							ND													
Bromomethane							ND													
Carbon Tetrachloride							ND													
Chlorobenzene							ND													
Chloroethane							ND													
2-Chloroethyl Vinyl ether							ND													
Chloroform							ND													
Chloromethane							ND													
Chlorodibromomethane							ND													
1,1-Dichloroethane							ND													
1,2-Dichloroethane							ND													
1,1-Dichloroethene							ND													
Trans 1,2-Dichloroethene							ND													
1,2-Dichloropropane							ND													
cis-1,3-Dichloropropene							ND													
trans-1,3-Dichloropropene							ND													
Ethylbenzene							ND													
Methylene Chloride							ND													
1,1,2,2-Tetrachloroethane							ND													
Tetrachloroethene							ND													
Toluene							ND													
1,1,1-Trichloroethane							ND													
1,1,2-Trichloroethane							ND													
Trichloroethene							ND													
Trichlorofluoromethane							ND													
Vinyl Chloride							ND													
Acrylonitrile							ND													
Acrolein							ND													

BLACKSNAKE CSO EVENTS 2007

TIME IN EVENT NO.	2/18/2007 3:15 p.m. 1	2/24/2007 4:02 a.m. 2	3/1/2007 2:14 a.m. 3	3/9/2007 8:50 a.m. 4	3/22/2007 7:00 a.m. 5	3/30/2007 12:41 a.m. 6	4/10/2007 7:32 p.m. 7	4/13/2007 3:31 a.m. 8	4/24/2007 6:35 p.m. 9	5/3/2007 10:45 p.m. 10	5/6/2007 8:50 a.m. 11	5/15/2007 8:30 a.m. 12	5/24/2007 9:24 a.m. 13	6/1/2007 8:30 a.m. 14	6/10/2007 12:45 p.m. 15	6/18/2007 11:15 a.m. 16	6/23/2007 1:07 a.m. 17	6/27/2007 5:35 p.m. 18	7/9/2007 10:30 p.m. 19	7/23/2007 9:00 a.m. 20
Phenol							ND													
bis(2-Chloroethyl) Ether							ND													
2-Chlorophenol							ND													
1,2-Dichlorobenzene							ND													
1,4-Dichlorobenzene							ND													
1,2-Dichlorobenzene							ND													
2-Methylphenol							ND													
bis(2-Chloroisopropyl) Ether							ND													
4-Methylphenol							ND													
N-Nitroso-di-n-propylamine							ND													
Hexachloroethane							ND													
Nitrobenzene							ND													
Isophorone							ND													
2-Nitrophenol							ND													
2,4-Dimethylphenol							ND													
bis(2-Chloroethoxy) Methane							ND													
2,4-Dichlorophenol							ND													
1,2,4-Trichlorobenzene							ND													
Naphthalene							ND													
4-Chloroaniline							ND													
Hexachlorobutadiene							ND													
4-Chloro-3-methylphenol							ND													
2-Methylnaphthalene							ND													
Hexachlorocyclopentadiene							ND													
2,4,6-Trichlorophenol							ND													
2,4,5-Trichlorophenol							ND													
2-Chloronaphthalene							ND													
2-Nitroaniline							ND													
Dimethyl Phthalate							ND													
Acenaphthylene							ND													
3-Nitroaniline							ND													
2,4-Dinitrophenol							ND													
4-Nitrophenol							ND													
Dibenzofuran							ND													
2,4-Dinitrotoluene							ND													
2,6-Dinitrotoluene							ND													
Diethyl Phthalate							ND													
4-Chlorophenyl Phenyl Ether							ND													
Fluorene							ND													
4-Nitroaniline							ND													
4,6-Dinitro-2-methylphenol							ND													
N-Nitrosodiphenylamine							ND													
4-Bromophenyl Phenyl Ether							ND													
Hexachlorobenzene							ND													
Pentachlorophenol							ND													
Phenanthrene							ND													
Carbazole							ND													
Anthracene							ND													
Di-n-butyl Phthalate							ND													
Fluoranthene							ND													
Pyrene							ND													
Butyl Benzyl Phthalate							ND													
3,3'-Dichlorobenzidine							ND													
Benzo (a) Anthracene							ND													
Bis(2-ethylhexyl) Phthalate							17.00													
Chrysene							ND													
Di-n-octyl Phthalate							ND													
Benzo (b) Fluoranthene							ND													
Benzo (k) Fluoranthene							ND													
Benzo (a) Pyrene							ND													
Indeno(1,2,3-cd) Pyrene							ND													
Dibenz (a,h) Anthracene							ND													
4,4'-DDE							ND													
4,4'-DDD							ND													
4,4'-DDT							ND													
4,4'-Methoxychlor							ND													
Aldrin							ND													
Aroclor 1016							ND													

BLACKSNAKE CSO EVENTS 2007

	2/18/2007	2/24/2007	3/1/2007	3/9/2007	3/22/2007	3/30/2007	4/10/2007	4/13/2007	4/24/2007	5/3/2007	5/6/2007	5/15/2007	5/24/2007	6/1/2007	6/10/2007	6/18/2007	6/23/2007	6/27/2007	7/9/2007	7/23/2007	
TIME IN	3:15 p.m.	4:02 a.m.	2:14 a.m.	8:50 a.m.	7:00 a.m.	12:41 a.m.	7:32 p.m.	3:31 a.m.	6:35 p.m.	10:45 p.m.	8:50 a.m.	8:30 a.m.	9:24 a.m.	8:30 a.m.	12:45 p.m.	11:15 a.m.	1:07 a.m.	5:35 p.m.	10:30 p.m.	9:00 a.m.	
EVENT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Aroclor 1221							ND														
Aroclor 1232							ND														
Aroclor 1242							ND														
Aroclor 1248							ND														
Aroclor 1254							ND														
Aroclor 1260							ND														
Dieldrin							ND														
Endosulfan I							ND														
Endosulfan II							ND														
Endosulfan sulfate							ND														
Endrin							ND														
Endrin aldehyde							ND														
Endrin ketone							ND														
Heptachlor							ND														
Heptachlor epoxide							ND														
Toxaphene							ND														
alpha-Chlordane							ND														
alpha-BHC							ND														
beta-BHC							ND														
delta-BHC							ND														
gamma-BHC (Lindane)							ND														
gamma-Chlordane							ND														

BLACKSNAKE CSO EVENTS 2007

TIME IN EVENT NO.	8/2/2007 10:45 a.m.	8/8/2007 9:20 a.m.	8/23/2007 8:47 a.m.	8/24/2007 3:56 a.m.	8/29/2007 11:15 a.m.	9/6/2007 7:30 a.m.	9/18/2007 3:10 p.m.	9/21/2007 7:50 a.m.	9/25/2007 9:05 a.m.	10/2/2007 12:10 p.m.	10/8/2007 7:30 a.m.	10/13/2007 6:10 a.m.	10/17/2007 12:40 p.m.	10/22/2007 7:45 a.m.	11/13/2007	12/1/2007				
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum
Rainfall Recorded (Inches)	1.0	1.0				1.8	0.6													
Peak Depth																				
Peak cfs																				
Flow Volume																				
E. coli (cfu)	483,920	282,720	>483,920			>483,920	>483,920			>483,920	>2419.6	>2419.6						297,673	483,920	39,800
Fecal Coliform (cfu)	483,900	282,700	483,900			483,900	483,900			483,900	2420	2420						197,020	483,900	2,420
	>2419.6	>483,920	>483,920			>483,920	>483,920			>483,920	>2419.6	>2419.6								
	2420.0	483900.0	483900.0			483900.0	483900.0			483900	2420	2420						129,125	483,900	2,420
BOD ₅ (mg/L)	89	54				117		110.6	123	231	55	121			808	238		111.06	808.00	5.00
TSS (mg/L)	2370	638				465		109	773	1078	2578	510			2703	785		1,430.20	7,651.00	109.00
TKN (mg/L)															19	9.78		9.43	19.00	0.90
NH ₄ -N (mg/L)	2.97	0.85				4.26		11.65	3.19	2.14	3.17	1.74			7.71	4.6		3.42	11.65	0.70
NO ₃ (mg/L)	9.11	3.72				55.78		71.3	74.8	24.48	25.63	42.06			84.11	43.3		21.30	84.11	0.16
PO ₄ (mg/L)	9.29	4.06				3.3		1.35	5.33	0.29	-	3.01			6.78	4.7		6.91	34.73	0.29
FOG (mg/L)	26.8			93.2		13.2	78	26.8		156		20.4						45.67	156.00	4.40
Total Phenol (mg/L)																		0.08	0.08	0.08
pH	7.9	8.48		7.63		8.01	8.5	8.08	7.63	7.7	8	7.91						7.90	8.52	7.01
Temperature C°	22.0	22.8		22.6		14.0	20.4	23.5	17.8	22.7	18.5	19.4						16.58	28.00	6.70
Antimony (mg/L) (total)																			0.00000	0.00000
Arsenic (mg/L) (total)																		0.00060	0.00060	0.00060
Beryllium (mg/L) (total)																		0.00200	0.00200	0.00200
Cadmium (mg/L) (total)																			0.00000	0.00000
Chromium (mg/L) (total)																		0.00000	0.00000	0.00000
Copper (mg/L) (total)																		0.02000	0.02000	0.02000
Lead (mg/L) (total)																		0.01500	0.02000	0.01000
Mercury (mg/L) (total)																		0.01240	0.01240	0.01240
Nickel (mg/L) (total)																			0.00000	0.00000
Selenium (mg/L) (total)																		0.01000	0.01000	0.01000
Silver (mg/L) (total)																			0.00000	0.00000
Thallium (mg/L) (total)																			0.00000	0.00000
Zinc (mg/L) (total)																		0.09500	0.10000	0.09000
Cyanide (Total) (mg/L)																			0.00000	0.00000
Benzene																				
Bromodichloromethane																				
Bromoform																				
Bromomethane																				
Carbon Tetrachloride																				
Chlorobenzene																				
Chloroethane																				
2-Chloroethyl Vinyl ether																				
Chloroform																				
Chloromethane																				
Chlorodibromomethane																				
1,1-Dichloroethane																				
1,2-Dichloroethane																				
1,1-Dichloroethene																				
Trans 1,2-Dichloroethene																				
1,2-Dichloropropane																				
cis-1,3-Dichloropropene																				
trans-1,3-Dichloropropene																				
Ethylbenzene																				
Methylene Chloride																				
1,1,2,2-Tetrachloroethane																				
Tetrachloroethene																				
Toluene																				
1,1,1-Trichloroethane																				
1,1,2-Trichloroethane																				
Trichloroethene																				
Trichlorofluoromethane																				
Vinyl Chloride																				
Acrylonitrile																				
Acrolein																				

BLACKSNAKE CSO EVENTS 2007

	8/2/2007	8/8/2007	8/23/2007	8/24/2007	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007					
TIME IN	10:45 a.m.	9:20 a.m.	8:47 a.m.	3:56 a.m.	11:15 a.m.	7:30 a.m.	3:10 p.m.	7:50 a.m.	9:05 a.m.	12:10 p.m.	7:30 a.m.	6:10 a.m.	12:40 p.m.	7:45 a.m.							
EVENT NO.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum	
Phenol																					
bis(2-Chloroethyl) Ether																					
2-Chlorophenol																					
1,2-Dichlorobenzene																					
1,4-Dichlorobenzene																					
1,2-Dichlorobenzene																					
2-Methylphenol																					
bis(2-Chloroisopropyl) Ether																					
4-Methylphenol																					
N-Nitroso-di-n-propylamine																					
Hexachloroethane																					
Nitrobenzene																					
Isophorone																					
2-Nitrophenol																					
2,4-Dimethylphenol																					
bis(2-Chloroethoxy) Methane																					
2,4-Dichlorophenol																					
1,2,4-Trichlorobenzene																					
Naphthalene																					
4-Chloroaniline																					
Hexachlorobutadiene																					
4-Chloro-3-methylphenol																					
2-Methylnaphthalene																					
Hexachlorocyclopentadiene																					
2,4,6-Trichlorophenol																					
2,4,5-Trichlorophenol																					
2-Chloronaphthalene																					
2-Nitroaniline																					
Dimethyl Phthalate																					
Acenaphthylene																					
3-Nitroaniline																					
2,4-Dinitrophenol																					
4-Nitrophenol																					
Dibenzofuran																					
2,4-Dinitrotoluene																					
2,6-Dinitrotoluene																					
Diethyl Phthalate																					
4-Chlorophenyl Phenyl Ether																					
Fluorene																					
4-Nitroaniline																					
4,6-Dinitro-2-methylphenol																					
N-Nitrosodiphenylamine																					
4-Bromophenyl Phenyl Ether																					
Hexachlorobenzene																					
Pentachlorophenol																					
Phenanthrene																					
Carbazole																					
Anthracene																					
Di-n-butyl Phthalate																					
Fluoranthene																					
Pyrene																					
Butyl Benzyl Phthalate																					
3,3'-Dichlorobenzidine																					
Benzo (a) Anthracene																					
Bis(2-ethylhexyl) Phthalate																					
Chrysene																					
Di-n-octyl Phthalate																					
Benzo (b) Fluoranthene																					
Benzo (k) Fluoranthene																					
Benzo (a) Pyrene																					
Indeno(1,2,3-cd) Pyrene																					
Dibenz (a,h) Athracene																					
4,4'-DDE																					
4,4'-DDD																					
4,4'-DDT																					
4,4'-Methoxychlor																					
Aldrin																					
Aroclor 1016																					

BLACKSNAKE CSO EVENTS 2007

	8/2/2007	8/8/2007	8/23/2007	8/24/2007	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007				
TIME IN	10:45 a.m.	9:20 a.m.	8:47 a.m.	3:56 a.m.	11:15 a.m.	7:30 a.m.	3:10 p.m.	7:50 a.m.	9:05 a.m.	12:10 p.m.	7:30 a.m.	6:10 a.m.	12:40 p.m.	7:45 a.m.						
EVENT NO.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum
Aroclor 1221																				
Aroclor 1232																				
Aroclor 1242																				
Aroclor 1248																				
Aroclor 1254																				
Aroclor 1260																				
Dieldrin																				
Endosulfan I																				
Endosulfan II																				
Endosulfan sulfate																				
Endrin																				
Endrin aldehyde																				
Endrin ketone																				
Heptachlor																				
Heptachlor epoxide																				
Toxaphene																				
alpha-Chlordane																				
alpha-BHC																				
beta-BHC																				
delta-BHC																				
gamma-BHC (Lindane)																				
gamma-Chlordane																				

MESSANIE CSO EVENTS 2007

TIME IN EVENT NO.	2/18/2007 3:15 p.m.	2/24/2007 4:02 a.m.	3/1/2007 2:14 a.m.	3/9/2007 8:50 a.m.	3/22/2007 7:00 a.m.	3/30/2007 12:41 a.m.	4/10/2007 7:32 p.m.	4/13/2007 3:31 a.m.	4/24/2007 6:35 p.m.	5/3/2007 10:45 p.m.	5/6/2007 8:50 a.m.	5/15/2007 8:00 a.m.	5/24/2007 9:24 a.m.	6/1/2007 8:30 a.m.	6/10/2007 12:45 p.m.	6/18/2007 11:15 a.m.	6/23/2007 1:07 a.m.	6/27/2007 5:35 p.m.	7/9/2007 10:30 p.m.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Rainfall Recorded (Inches)					0.3	1.3	0.8	0.3	0.3	0.3	5.0	0.8	0.6	0.6	0.6	0.4	0.2	0.2	0.2
Peak Depth																			
Peak cfs																			
Flow Volume																			
E. coll (cfu)			79452.0			155310.0			41060.0	>2419.6	81640.0		310600		39120.0		>2419.6	240660	
Fecal Coliform (cfu)			79500.0			155300.0			41000.0	2420.0	81640.0		310600.0		39120.0		2420.0	240660	
			>2419.6			>2419.6			>2419.6	>2419.6	>2419.6		>2419.6		>2419.6		>2419.6	>2419.6	
			2420.0			2420.0			2420.0	2420.0	2420.0		2420.0		2420.0		2420.0	2420.0	
BOD ₅ (mg/L)						26.0			47.0	35.8	4.86		48.0	43.6			50	16	
TSS (mg/L)						282.0			778.0	258.0	43		3120.0	412.0			478	338	
TKN (mg/L)											3.53			5.6			3.85		
NH ₄ N- (mg/L)									1.6	1.8	0.47		0.8	0.2			0.39		
NO ₃ (mg/L)									129.3	27.4	1.08		16.5	6.7			17.4		
PO ₄ (mg/L)									4.4	1.1	0		14.0	3.9			3.67		
FOG (mg/L)			3.4	18.4		7.2	16.0		30.8	12.8			24.0					4.4	
Total Phenol (mg/L)													4.7						
pH			8.6			8.5			8.6	7.1	8.9		8.0	7.7	7.9		8.25	7.4	
Temperature C°			14.3			7.1			9.7	11.3	8.0		10.0	10.9	6.8		21.3	25.0	
Antimony (mg/L) (total)													nd						
Arsenic (mg/L) (total)													0.002						
Beryllium (mg/L) (total)													nd						
Cadmium (mg/L) (total)													nd						
Chromium (mg/L) (total)													nd						
Copper (mg/L) (total)													nd						
Lead (mg/L) (total)													0.02						
Mercury (mg/L) (total)													0.0175						
Nickel (mg/L) (total)													nd						
Selenium (mg/L) (total)													nd						
Silver (mg/L) (total)													nd						
Thallium (mg/L) (total)													nd						
Zinc (mg/L) (total)													0.07						
Cyanide (Total) (mg/L)													nd						
Benzene													nd						
Bromodichloromethane													nd						
Bromoform													nd						
Bromomethane													nd						
Carbon Tetrachloride													nd						
Chlorobenzene													nd						
Chloroethane													nd						
2-Chloroethyl Vinyl ether													nd						
Chloroform													nd						
Chloromethane													nd						
Chlorodibromomethane													nd						
1,1-Dichloroethane													nd						
1,2-Dichloroethane													nd						
1,1-Dichloroethene													nd						
Trans 1,2-Dichloroethene													nd						
1,2-Dichloropropane													nd						
cis-1,3-Dichloropropene													nd						
trans-1,3-Dichloropropene													nd						
Ethylbenzene													nd						
Methylene Chloride													nd						
1,1,2,2-Tetrachloroethane													nd						
Tetrachloroethene													nd						
Toluene													nd						
1,1,1-Trichloroethane													nd						
1,1,2-Trichloroethane													nd						
Trichloroethene													nd						
Trichlorofluoromethane													nd						
Vinyl Chloride													nd						

MESSANIE CSO EVENTS 2007

	2/18/2007	2/24/2007	3/1/2007	3/9/2007	3/22/2007	3/30/2007	4/10/2007	4/13/2007	4/24/2007	5/3/2007	5/6/2007	5/15/2007	5/24/2007	6/1/2007	6/10/2007	6/18/2007	6/23/2007	6/27/2007	7/9/2007	
TIME IN	3:15 p.m.	4:02 a.m.	2:14 a.m.	8:50 a.m.	7:00 a.m.	12:41 a.m.	7:32 p.m.	3:31 a.m.	6:35 p.m.	10:45 p.m.	8:50 a.m.	8:00 a.m.	9:24 a.m.	8:30 a.m.	12:45 p.m.	11:15 a.m.	1:07 a.m.	5:35 p.m.	10:30 p.m.	
EVENT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Acrylonitrile													nd							
Acrolein													nd							
Phenol																				
bis(2-Chloroethyl) Ether																				
2-Chlorophenol																				
1,2-Dichlorobenzene																				
1,4-Dichlorobenzene													nd							
1,2-Dichlorobenzene													nd							
2-Methylphenol													nd							
bis(2-Chloroisopropyl) Ether																				
4-Methylphenol																				
N-Nitroso-di-n-propylamine																				
Hexachloroethane																				
Nitrobenzene																				
Isophorone																				
2-Nitrophenol																				
2,4-Dimethylphenol																				
bis(2-Chloroethoxy) Methane																				
2,4-Dichlorophenol																				
1,2,4-Trichlorobenzene																				
Naphthalene																				
4-Chloroaniline																				
Hexachlorobutadiene																				
4-Chloro-3-methylphenol																				
2-Methylnaphthalene																				
Hexachlorocyclopentadiene																				
2,4,6-Trichlorophenol																				
2,4,5-Trichlorophenol																				
2-Chloronaphthalene																				
2-Nitroaniline																				
Dimethyl Phthalate																				
Acenaphthylene																				
3-Nitroaniline																				
2,4-Dinitrophenol																				
4-Nitrophenol																				
Dibenzofuran																				
2,4-Dinitrotoluene																				
2,6-Dinitrotoluene																				
Diethyl Phthalate																				
4-Chlorophenyl Phenyl Ether																				
Fluorene																				
4-Nitroaniline																				
4,6-Dinitro-2-methylphenol																				
N-Nitrosodiphenylamine																				
4-Bromophenyl Phenyl Ether																				
Hexachlorobenzene																				
Pentachlorophenol																				
Phenanthrene																				
Carbazole																				
Anthracene																				
Di-n-butyl Phthalate																				
Fluoranthene																				
Pyrene																				
Butyl Benzyl Phthalate																				
3,3'-Dichlorobenzidine																				
Benzo (a) Anthracene																				
Bis(2-ethylhexyl) Phthalate																				
Chrysene																				
Di-n-octyl Phthalate																				
Benzo (b) Fluoranthene																				
Benzo (k) Fluoranthene																				
Benzo (a) Pyrene																				
Indeno(1,2,3-cd) Pyrene																				
Dibenz (a,h) Anthracene																				
4,4'-DDE																				
4,4'-DDD																				
4,4'-DDT																				

MESSANIE CSO EVENTS 2007

	2/18/2007	2/24/2007	3/1/2007	3/9/2007	3/22/2007	3/30/2007	4/10/2007	4/13/2007	4/24/2007	5/3/2007	5/6/2007	5/15/2007	5/24/2007	6/1/2007	6/10/2007	6/18/2007	6/23/2007	6/27/2007	7/9/2007	
TIME IN	3:15 p.m.	4:02 a.m.	2:14 a.m.	8:50 a.m.	7:00 a.m.	12:41 a.m.	7:32 p.m.	3:31 a.m.	6:35 p.m.	10:45 p.m.	8:50 a.m.	8:00 a.m.	9:24 a.m.	8:30 a.m.	12:45 p.m.	11:15 a.m.	1:07 a.m.	5:35 p.m.	10:30 p.m.	
EVENT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
4,4'-Methoxychlor																				
Aldrin																				
Aroclor 1016																				
Aroclor 1221																				
Aroclor 1232																				
Aroclor 1242																				
Aroclor 1248																				
Aroclor 1254																				
Aroclor 1260																				
Dieldrin																				
Endosulfan I																				
Endosulfan II																				
Endosulfan sulfate																				
Endrin																				
Endrin aldehyde																				
Endrin ketone																				
Heptachlor																				
Heptachlor epoxide																				
Toxaphene																				
alpha-Chlordane																				
alpha-BHC																				
beta-BHC																				
delta-BHC																				
gamma-BHC (Lindane)																				
gamma-Chlordane																				

MESSANIE CSO EVENTS 2007

TIME IN	7/23/2007	8/2/2007	8/8/2007	8/23/2007	8/24/2007	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007				
EVENT NO.	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum
Rainfall Recorded (inches)	0.9	1.0	1.0				1.8	0.6													
Peak Depth																					
Peak cfs																					
Flow Volume																					
E. coll (cfu)	483920		163,280	>483,920				>483,920	>483,920	172,400	282,720								186,378	483,920	39,120
	483920		163,280	483900				483900	483900	172,400	282,720								219,168	483,920	2,420
Fecal Coliform (cfu)	87040		>483,920	>483,920				>483,920	>483,920	>1209800	>1209800								87,040	87,040	87,040
	87040.0		483900.0	483900				483900	483900	1,209,800	1,209,800								279,001	1,209,800	2,420
BOD ₅ (mg/L)			24				25	61		34	83			49.6					39.13	83.00	4.86
TSS (mg/L)			170				925	374		613	632			324					624.79	3,120.00	43.00
TKN (mg/L)	3.85		3.29																4.02	5.60	3.29
NH ₄ -N (mg/L)			0.65				0.44	0.698		0.733	0.945			1.15					0.83	1.79	0.20
NO ₃ (mg/L)			2.88				16.65	22		29.97	11.29			17.84					24.92	129.27	1.08
PO ₄ (mg/L)			0.5				1.6	0.43		1.54	0			1.59					2.73	14.00	0.00
FOG (mg/L)	27				13.2			21.6		17.2									16.33	30.80	3.40
Total Phenol (mg/L)																			4.72	4.72	4.72
pH	8.25		8.01		7.97			8.08		8.38	8								8.10	8.93	7.09
Temperature C°	21.3		24		22.1			25		18.3	22.5								16.10	25.00	6.80
Antimony (mg/L) (total)																				0.00000	0.00000
Arsenic (mg/L) (total)																			0.00200	0.00000	0.00000
Beryllium (mg/L) (total)																				0.00200	0.00200
Cadmium (mg/L) (total)																				0.00000	0.00000
Chromium (mg/L) (total)																				0.00000	0.00000
Copper (mg/L) (total)																			0.02000	0.02000	0.02000
Lead (mg/L) (total)																			0.01750	0.01750	0.01750
Mercury (mg/L) (total)																				0.00000	0.00000
Nickel (mg/L) (total)																				0.00000	0.00000
Selenium (mg/L) (total)																				0.00000	0.00000
Silver (mg/L) (total)																				0.00000	0.00000
Thallium (mg/L) (total)																				0.00000	0.00000
Zinc (mg/L) (total)																			0.07000	0.07000	0.07000
Cyanide (Total) (mg/L)																				0.00000	0.00000
Benzene																					
Bromodichloromethane																					
Bromoform																					
Bromomethane																					
Carbon Tetrachloride																					
Chlorobenzene																					
Chloroethane																					
2-Chloroethyl Vinyl ether																					
Chloroform																					
Chloromethane																					
Chlorodibromomethane																					
1,1-Dichloroethane																					
1,2-Dichloroethane																					
1,1-Dichloroethene																					
Trans 1,2-Dichloroethene																					
1,2-Dichloropropane																					
cis-1,3-Dichloropropene																					
trans-1,3-Dichloropropene																					
Ethylbenzene																					
Methylene Chloride																					
1,1,2,2-Tetrachloroethane																					
Tetrachloroethene																					
Toluene																					
1,1,1-Trichloroethane																					
1,1,2-Trichloroethane																					
Trichloroethene																					
Trichlorofluoromethane																					
Vinyl Chloride																					

MESSANIE CSO EVENTS 2007

	7/23/2007	8/2/2007	8/8/2007	8/23/2007	8/24/2007	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007					
TIME IN	9:00 a.m.	10:45 a.m.	9:20 a.m.	8:47 a.m.	3:56 a.m.	11:16 a.m.	7:30 a.m.	3:10 p.m.	7:50 a.m.	9:05 a.m.	12:10 p.m.	7:30 a.m.	6:10 a.m.	12:40 p.m.	7:45 a.m.							
EVENT NO.	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum	
Acrylonitrile																						
Acrolein																						
Phenol																						
bis(2-Chloroethyl) Ether																						
2-Chlorophenol																						
1,2-Dichlorobenzene																						
1,4-Dichlorobenzene																						
1,2-Dichlorobenzene																						
2-Methylphenol																						
bis(2-Chloroisopropyl) Ether																						
4-Methylphenol																						
N-Nitroso-d-n-propylamine																						
Hexachloroethane																						
Nitrobenzene																						
Isophorone																						
2-Nitrophenol																						
2,4-Dimethylphenol																						
bis(2-Chloroethoxy) Methane																						
2,4-Dichlorophenol																						
1,2,4-Trichlorobenzene																						
Naphthalene																						
4-Chloroaniline																						
Hexachlorobutadiene																						
4-Chloro-3-methylphenol																						
2-Methylnaphthalene																						
Hexachlorocyclopentadiene																						
2,4,6-Trichlorophenol																						
2,4,5-Trichlorophenol																						
2-Chloronaphthalene																						
2-Nitroaniline																						
Dimethyl Phthalate																						
Acenaphthylene																						
3-Nitroaniline																						
2,4-Dinitrophenol																						
4-Nitrophenol																						
Dibenzofuran																						
2,4-Dinitrotoluene																						
2,6-Dinitrotoluene																						
Diethyl Phthalate																						
4-Chlorophenyl Phenyl Ether																						
Fluorene																						
4-Nitroaniline																						
4,6-Dinitro-2-methylphenol																						
N-Nitrosodiphenylamine																						
4-Bromophenyl Phenyl Ether																						
Hexachlorobenzene																						
Pentachlorophenol																						
Phenanthrene																						
Carbazole																						
Anthracene																						
Di-n-butyl Phthalate																						
Fluoranthene																						
Pyrene																						
Butyl Benzyl Phthalate																						
3,3'-Dichlorobenzidine																						
Benzo (a) Anthracene																						
Bis(2-ethylhexyl) Phthalate																						
Chrysene																						
Di-n-octyl Phthalate																						
Benzo (b) Fluoranthene																						
Benzo (k) Fluoranthene																						
Benzo (a) Pyrene																						
Indeno(1,2,3-cd) Pyrene																						
Dibenz (a,h) Anthracene																						
4,4'-DDE																						
4,4'-DDD																						
4,4'-DDT																						

MESSANIE CSO EVENTS 2007

	7/23/2007	8/2/2007	8/8/2007	8/23/2007	8/24/2007	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007					
TIME IN	9:00 a.m.	10:45 a.m.	9:20 a.m.	8:47 a.m.	3:56 a.m.	11:16 a.m.	7:30 a.m.	3:10 p.m.	7:50 a.m.	9:05 a.m.	12:10 p.m.	7:30 a.m.	6:10 a.m.	12:40 p.m.	7:45 a.m.							
EVENT NO.	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum	
4,4'-Methoxychlor																						
Aldrin																						
Aroclor 1016																						
Aroclor 1221																						
Aroclor 1232																						
Aroclor 1242																						
Aroclor 1248																						
Aroclor 1254																						
Aroclor 1260																						
Dieldrin																						
Endosulfan I																						
Endosulfan II																						
Endosulfan sulfate																						
Endrin																						
Endrin aldehyde																						
Endrin ketone																						
Heptachlor																						
Heptachlor epoxide																						
Toxaphene																						
alpha-Chlordane																						
alpha-BHC																						
beta-BHC																						
delta-BHC																						
gamma-BHC (Lindane)																						
gamma-Chlordane																						

MITCHELL CSO EVENTS 2007

	2/18/2007	2/24/2007	3/1/2007	3/9/2007	3/22/2007	3/30/2007	4/10/2007	4/13/2007	4/24/2007	5/3/2007	5/6/2007	5/15/2007	5/24/2007	6/1/2007	6/10/2007	6/18/2007	6/23/2007	6/27/2007	7/9/2007	7/23/2007	8/2/2007	8/8/2007	8/23/2007	8/24/2007
TIME IN	3:15 p.m.	4:02 a.m.	2:14 a.m.	8:50 a.m.	7:00 a.m.	12:41 a.m.	7:32 p.m.	3:31 a.m.	6:35 p.m.	10:45 p.m.	8:50 a.m.	8:00 a.m.	9:24 a.m.	8:30 a.m.	12:45 p.m.	11:15 a.m.	1:07 a.m.	5:35 p.m.	10:30 p.m.	9:00 a.m.	10:45 a.m.	9:20 a.m.	8:47 a.m.	3:56 a.m.
EVENT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Rainfall Recorded (Inches)					0.3	1.3	0.8	0.3	0.3	0.3	5.0	0.8	0.6	0.6	0.6	0.4	0.2	0.2	0.2	0.9	1.0	1.0		
Peak Depth																								
Peak cfs																								
Flow Volume																								
E. coli (cfu)			>2419.6	>2419.6		>2419.6			>2419.6	O/S	O/S	O/S			82,120.0	483,920.0		>2419.6	>2419.6	259,920.0	>483920	>483920		
Fecal Coliform (cfu)			>2419.6	>2419.6		>2419.6			>2419.6						82,120.0	483,900.0		2420.0	2420.0	259,900.0	48,900	48,900		
BOD ₅ (mg/L)	208.0	103.0	217.0	429.0		72.0	277.0		354.0				111	115.1		127		147	172	140	43	85	140	
TSS (mg/L)	348.0	1204.0	5560.0	1750.0		1225.0	1467.0		4158.0				6495	2110		515		488	1980	540	740	420	540	
TKN (mg/L)	16.5	12.2	16.7	26.2		1.9	15.0		45.3				13	16.6		5				16.5	7.14	1.5	3.81	3.54
NH ₄ -N (mg/L)	8.4	3.8	4.1	3.4		3.0	5.1		3.6				4.77	2.9		2.87			3.37	3.54	1.5	3.81	3.54	
NO ₃ (mg/L)	7.2	8.2	11.0	7.3		6.9	16.8		5.3				11.68	164.24		147.86			9.32	7.55	5.44	7.06	158.5	
PO ₄ (mg/L)	22.0	19.4	41.4	61.6		36.9	14.6		13.9				9.56	6.95		3.7			9.68	5.9	1.41	3.43	5.9	
FOG (mg/L)		65.6			64.4	14.8	8.4		45.2							54		31.2		20	32			
Total Phenol (mg/L)													5.97											
pH	8.0	7.5	7.7	7.2		7.2	7.6		7.7				7.22											
Temperature C°	25.0	4.5	10.7	6.0		19.0	11.8		19.5				19.2											
Antimony (mg/L) (total)													0.0013											
Arsenic (mg/L) (total)						nd							0.008											
Beryllium (mg/L) (total)													nd											
Cadmium (mg/L) (total)						nd							nd											
Chromium (mg/L) (total)						0.0							0.01											
Copper (mg/L) (total)						0.1							0.02											
Lead (mg/L) (total)						0.1							0.019											
Mercury (mg/L) (total)						nd							nd											
Nickel (mg/L) (total)						0.0							0.02											
Selenium (mg/L) (total)													0.001											
Silver (mg/L) (total)													0.01											
Thallium (mg/L) (total)													nd											
Zinc (mg/L) (total)						0.4							0.07											
Cyanide (Total) (mg/L)													nd											
Benzene													ND											
Bromodichloromethane													ND											
Bromoform													ND											
Bromomethane													ND											
Carbon Tetrachloride													ND											
Chlorobenzene													ND											
Chloroethane													ND											
2-Chloroethyl Vinyl ether													ND											
Chloroform													ND											
Chloromethane													ND											
Chlorodibromomethane													ND											
1,1-Dichloroethane													ND											
1,2-Dichloroethane													ND											
1,1-Dichloroethene													ND											
Trans 1,2-Dichloroethene													ND											
1,2-Dichloropropane													ND											
cis-1,3-Dichloropropene													ND											
trans-1,3-Dichloropropene													ND											
Ethylbenzene													ND											
Methylene Chloride													ND											
1,1,2,2-Tetrachloroethane													ND											
Tetrachloroethene													ND											
Toluene													ND											
1,1,1-Trichloroethane													ND											
1,1,2-Trichloroethane													ND											
Trichloroethene													ND											
Trichlorofluoromethane													ND											
Vinyl Chloride													ND											
Acrylonitrile													ND											
Acrolein													ND											
Phenol													ND											

MITCHELL CSO EVENTS 2007

TIME IN	2/18/2007	2/24/2007	3/1/2007	3/9/2007	3/22/2007	3/30/2007	4/10/2007	4/13/2007	4/24/2007	5/3/2007	5/6/2007	5/15/2007	5/24/2007	6/1/2007	6/10/2007	6/18/2007	6/23/2007	6/27/2007	7/9/2007	7/23/2007	8/2/2007	8/8/2007	8/23/2007	8/24/2007	
EVENT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
bis(2-Chloroethyl) Ether													ND												
2-Chlorophenol													ND												
1,2-Dichlorobenzene													ND												
1,4-Dichlorobenzene													ND												
1,2-Dichlorobenzene													ND												
2-Methylphenol													ND												
bis(2-Chloroisopropyl) Ether													ND												
4-Methylphenol													ND												
N-Nitroso-di-n-propylamine													ND												
Hexachloroethane													ND												
Nitrobenzene													ND												
Isophorone													ND												
2-Nitrophenol													ND												
2,4-Dimethylphenol													ND												
bis(2-Chloroethoxy) Methane													ND												
2,4-Dichlorophenol													ND												
1,2,4-Trichlorobenzene													ND												
Naphthalene													ND												
4-Chloroaniline													ND												
Hexachlorobutadiene													ND												
4-Chloro-3-methylphenol													ND												
2-Methylnaphthalene													ND												
Hexachlorocyclopentadiene													ND												
2,4,6-Trichlorophenol													ND												
2,4,5-Trichlorophenol													ND												
2-Chloronaphthalene													ND												
2-Nitroaniline													ND												
Dimethyl Phthalate													ND												
Acenaphthylene													ND												
3-Nitroaniline													ND												
2,4-Dinitrophenol													ND												
4-Nitrophenol													ND												
Dibenzofuran													ND												
2,4-Dinitrotoluene													ND												
2,6-Dinitrotoluene													ND												
Diethyl Phthalate													ND												
4-Chlorophenyl Phenyl Ether													ND												
Fluorene													ND												
4-Nitroaniline													ND												
4,6-Dinitro-2-methylphenol													ND												
N-Nitrosodiphenylamine													ND												
4-Bromophenyl Phenyl Ether													ND												
Hexachlorobenzene													ND												
Pentachlorophenol													ND												
Phenanthrene													ND												
Carbazole													ND												
Anthracene													ND												
Di-n-butyl Phthalate													ND												
Fluoranthene													ND												
Pyrene													ND												
Butyl Benzyl Phthalate													ND												
3,3'-Dichlorobenzidine													ND												
Benzo (a) Anthracene													ND												
Bis(2-ethylhexyl) Phthalate													ND												
Chrysene													ND												
Di-n-octyl Phthalate													ND												
Benzo (b) Fluoranthene													ND												
Benzo (k) Fluoranthene													ND												
Benzo (a) Pyrene													ND												
Indeno(1,2,3-cd) Pyrene													ND												
Dibenz (a,h) Athracene													ND												
4,4'-DDE													ND												
4,4'-DDD													ND												
4,4'-DDT													ND												
4,4'-Methoxychlor													ND												
Aldrin													ND												
Aroclor 1016													ND												
Aroclor 1221													ND												
Aroclor 1232													ND												
Aroclor 1242													ND												

MITCHELL CSO EVENTS 2007

	2/18/2007	2/24/2007	3/1/2007	3/9/2007	3/22/2007	3/30/2007	4/10/2007	4/13/2007	4/24/2007	5/3/2007	5/6/2007	5/15/2007	5/24/2007	6/1/2007	6/10/2007	6/18/2007	6/23/2007	6/27/2007	7/9/2007	7/23/2007	8/2/2007	8/8/2007	8/23/2007	8/24/2007		
TIME IN	3:15 p.m.	4:02 a.m.	2:14 a.m.	8:50 a.m.	7:00 a.m.	12:41 a.m.	7:32 p.m.	3:31 a.m.	6:35 p.m.	10:45 p.m.	8:50 a.m.	8:00 a.m.	9:24 a.m.	8:30 a.m.	12:45 p.m.	11:15 a.m.	1:07 a.m.	5:35 p.m.	10:30 p.m.	9:00 a.m.	10:45 a.m.	9:20 a.m.	8:47 a.m.	3:56 a.m.		
EVENT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
Aroclor 1248													ND													
Aroclor 1254													ND													
Aroclor 1260													ND													
Dieldrin													ND													
Endosulfan I													ND													
Endosulfan II													ND													
Endosulfan sulfate													ND													
Endrin													ND													
Endrin aldehyde													ND													
Endrin ketone													ND													
Heptachlor													ND													
Heptachlor epoxide													ND													
Toxaphene													ND													
alpha-Chlordane													ND													
alpha-BHC													ND													
beta-BHC													ND													
delta-BHC													ND													
gamma-BHC (Lindane)													ND													
gamma-Chlordane													ND													

MITCHELL CSO EVENTS 2007

	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007					
TIME IN	11:15 a.m.	7:30 a.m.	3:10 p.m.	7:50 a.m.	9:05 a.m.	12:10 p.m.	7:30 a.m.	6:10 a.m.	12:40 p.m.	7:45 a.m.							
EVENT NO.	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum	
Rainfall Recorded (Inches)		1.8	0.6														
Peak Depth																	
Peak cfs																	
Flow Volume																	
E. coli (cfu)	>483920	>483920	>483920		>1,209,800	>483920	>483920	>2419.6			>2419.6			275,320	483,920	82,120	
	48,900	48,900	48,900		1,209,800	48,900	48,900	2,420			2,420			126,173	1,209,800	2,320	
Fecal Coliform (cfu)	>483920	>483920	>483920		>1,209,800	>483920	>483920	>2419.6						483,920	483,920	483,920	
	483,900	483,900	483,900		1,209,800	483,900	483,900	2,420						283,432	1,209,800	1,420	
BOD ₅ (mg/L)	131	117	139		150	83	178	86			397	157		167.12	429.00	43.00	
TSS (mg/L)	450	465	19.5		670	970	538	245			1048	445		1,375.62	6,495.00	19.50	
TKN (mg/L)											18.8	11.2		15.85	45.30	1.88	
NH ₄ -N (mg/L)	8.25	4.26	2.67		5.59	1.97	5.05	1.9			8.9	4.6		4.21	8.90	1.50	
NO ₃ (mg/L)	248.79	55.78	41.13		67.29	17.97	43.56	31.7			83.23	49.58		50.55	248.79	5.29	
PO ₄ (mg/L)	7.6	3.3	7.09		4.58	0.685	0.489	8.99			6.4	1.9		12.39	61.60	0.49	
FOG (mg/L)	19.2	18	22		32.4	44	28.4	37.6			64.8			35.41	65.60	8.40	
Total Phenol (mg/L)														5.97	5.97	5.97	
pH	7.64		7.5		7.56	7.5		8.34						7.49	8.34	6.84	
Temperature C°	23.4		24.6		19.2	22.2		17.3						17.36	25.00	4.50	
Antimony (mg/L) (total)															0.00000	0.00000	
Arsenic (mg/L) (total)														0.00130	0.00130	0.00130	
Beryllium (mg/L) (total)														0.00800	0.00800	0.00800	
Cadmium (mg/L) (total)															0.00000	0.00000	
Chromium (mg/L) (total)														0.02000	0.03000	0.01000	
Copper (mg/L) (total)														0.03500	0.05000	0.02000	
Lead (mg/L) (total)														0.04950	0.08000	0.01900	
Mercury (mg/L) (total)															0.00000	0.00000	
Nickel (mg/L) (total)														0.02000	0.02000	0.02000	
Selenium (mg/L) (total)														0.00100	0.00100	0.00100	
Silver (mg/L) (total)														0.01000	0.01000	0.01000	
Thallium (mg/L) (total)															0.00000	0.00000	
Zinc (mg/L) (total)														0.24000	0.41000	0.07000	
Cyanide (Total) (mg/L)															0.00000	0.00000	
Benzene																	
Bromodichloromethane																	
Bromoform																	
Bromomethane																	
Carbon Tetrachloride																	
Chlorobenzene																	
Chloroethane																	
2-Chloroethyl Vinyl ether																	
Chloroform																	
Chloromethane																	
Chlorodibromomethane																	
1,1-Dichloroethane																	
1,2-Dichloroethane																	
1,1-Dichloroethene																	
Trans 1,2-Dichloroethene																	
1,2-Dichloropropane																	
cis-1,3-Dichloropropene																	
trans-1,3-Dichloropropene																	
Ethylbenzene																	
Methylene Chloride																	
1,1,2,2-Tetrachloroethane																	
Tetrachloroethene																	
Toluene																	
1,1,1-Trichloroethane																	
1,1,2-Trichloroethane																	
Trichloroethene																	
Trichlorofluoromethane																	
Vinyl Chloride																	
Acrylonitrile																	
Acrolein																	
Phenol																	

MITCHELL CSO EVENTS 2007

TIME IN	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007				
EVENT NO.	11:15 a.m.	7:30 a.m.	3:10 p.m.	7:50 a.m.	9:05 a.m.	12:10 p.m.	7:30 a.m.	6:10 a.m.	12:40 p.m.	7:45 a.m.						
	25	26	27	28	29	30	31	32	33	34	35	36	Average	Maximum	Minimum	
bis(2-Chloroethyl) Ether																
2-Chlorophenol																
1,2-Dichlorobenzene																
1,4-Dichlorobenzene																
1,2-Dichlorobenzene																
2-Methylphenol																
bis(2-Chloroisopropyl) Ether																
4-Methylphenol																
N-Nitroso-di-n-propylamine																
Hexachloroethane																
Nitrobenzene																
Isophorone																
2-Nitrophenol																
2,4-Dimethylphenol																
bis(2-Chloroethoxy) Methane																
2,4-Dichlorophenol																
1,2,4-Trichlorobenzene																
Naphthalene																
4-Chloroaniline																
Hexachlorobutadiene																
4-Chloro-3-methylphenol																
2-Methylnaphthalene																
Hexachlorocyclopentadiene																
2,4,6-Trichlorophenol																
2,4,5-Trichlorophenol																
2-Chloronaphthalene																
2-Nitroaniline																
Dimethyl Phthalate																
Acenaphthylene																
3-Nitroaniline																
2,4-Dinitrophenol																
4-Nitrophenol																
Dibenzofuran																
2,4-Dinitrotoluene																
2,6-Dinitrotoluene																
Diethyl Phthalate																
4-Chlorophenyl Phenyl Ether																
Fluorene																
4-Nitroaniline																
4,6-Dinitro-2-methylphenol																
N-Nitrosodiphenylamine																
4-Bromophenyl Phenyl Ether																
Hexachlorobenzene																
Pentachlorophenol																
Phenanthrene																
Carbazole																
Anthracene																
Di-n-butyl Phthalate																
Fluoranthene																
Pyrene																
Butyl Benzyl Phthalate																
3,3'-Dichlorobenzidine																
Benzo (a) Anthracene																
Bis(2-ethylhexyl) Phthalate																
Chrysene																
Di-n-octyl Phthalate																
Benzo (b) Fluoranthene																
Benzo (k) Fluoranthene																
Benzo (a) Pyrene																
Indeno(1,2,3-cd) Pyrene																
Dibenz (a,h) Athracene																
4,4'-DDE																
4,4'-DDD																
4,4'-DDT																
4,4'-Methoxychlor																
Aldrin																
Aroclor 1016																
Aroclor 1221																
Aroclor 1232																
Aroclor 1242																

MITCHELL CSO EVENTS 2007

	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007				
TIME IN	11:15 a.m.	7:30 a.m.	3:10 p.m.	7:50 a.m.	9:05 a.m.	12:10 p.m.	7:30 a.m.	6:10 a.m.	12:40 p.m.	7:45 a.m.						
EVENT NO.	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum
Aroclor 1248																
Aroclor 1254																
Aroclor 1260																
Dieldrin																
Endosulfan I																
Endosulfan II																
Endosulfan sulfate																
Endrin																
Endrin aldehyde																
Endrin ketone																
Heptachlor																
Heptachlor epoxide																
Toxaphene																
alpha-Chlordane																
alpha-BHC																
beta-BHC																
delta-BHC																
gamma-BHC (Lindane)																
gamma-Chlordane																

WHITEHEAD CSO EVENTS 2007

	2/18/2007	2/24/2007	3/1/2007	3/9/2007	3/22/2007	3/30/2007	4/10/2007	4/13/2007	4/24/2007	5/3/2007	5/6/2007	5/15/2007	5/24/2007	6/1/2007	6/10/2007	6/18/2007	6/23/2007	6/27/2007	7/9/2007
TIME IN	3:15 p.m.	4:02 a.m.	2:14 a.m.	8:50 a.m.	7:00 a.m.	12:41 a.m.	7:32 p.m.	3:31 a.m.	6:35 p.m.	10:46 p.m.	8:50 a.m.	8:00 a.m.	9:24 a.m.	8:30 a.m.	12:45 p.m.	11:16 a.m.	1:07 a.m.	5:35 p.m.	10:30 p.m.
EVENT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Rainfall Recorded (Inches)					0.3	1.3	0.8	0.3	0.3	0.3	5.0	0.8	0.6	0.6	0.6	0.4	0.2	0.2	0.2
Peak Depth																			
Peak cfs																			
Flow Volume																			
E. coli (cfu)			>2419.6			46110.0	>2419.6	829700.0	>2419.6		155315.0		240660.0		>2419.6	397260.0	>2419.6	346580.0	397260.0
Fecal Coliform (cfu)			2420.0			46110.0	2420.0	829700.0	2420.0		155315.0		240660.0		2420.0	397260.0	2420.0	346580.0	397260.0
BOD ₅ (mg/L)	27.0		15.0			4.0	38.0				12.0		28.0	24.0		97.0	41.0	109.0	58.0
TSS (mg/L)	153.0		255.0			347.0	97.0				242.0		287.0	372.0		274.0	179.0	475.0	478.0
TKN (mg/L)	5.8		4.7			0.9	6.3				6.0		8.4	5.5					6.4
NH ₄ -N (mg/L)	3.5		3.6			2.0	20.2				0.9		3.1	0.7		2.8	2.5		1.9
NO ₃ (mg/L)	4.0		5.7			3.4	4.3				3.0		5.6	3.4		5.6	5.5		5.0
PO ₄ (mg/L)	4.8		3.7			3.6	0.5				2.5		2.1	2.4		1.3	1.3		3.2
FOG (mg/L)		12.4	15.0				9.2	11.6	38.8		8.8		12.4			43.6	32.0	14.8	
Total Phenol (mg/L)							ND												
pH	8.0		8.4			8.0	7.9	7.4	7.7		7.9		7.7	8.1	8.0	7.5	7.6	7.5	7.9
Temperature C°	9.2		14.8			16.6	7.7	5.8	17.5		5.4		18.8	13.6	4.4	19.8	8.7	14.2	11.0
Antimony (mg/L) (total)							0.0007												
Arsenic (mg/L) (total)						ND	0.0020												
Beryllium (mg/L) (total)							ND												
Cadmium (mg/L) (total)						ND	ND												
Chromium (mg/L) (total)						0.02	ND												
Copper (mg/L) (total)						0.03	0.01												
Lead (mg/L) (total)						ND	0.0069												
Mercury (mg/L) (total)						ND	ND												
Nickel (mg/L) (total)						0.02	0.01												
Selenium (mg/L) (total)							ND												
Silver (mg/L) (total)							ND												
Thallium (mg/L) (total)							ND												
Zinc (mg/L) (total)						0.09	0.05												
Cyanide (Total) (mg/L)							ND												
Benzene							ND												
Bromodichloromethane							ND												
Bromoform							ND												
Bromomethane							ND												
Carbon Tetrachloride							ND												
Chlorobenzene							ND												
Chloroethane							ND												
2-Chloroethyl Vinyl ether							ND												
Chloroform							ND												
Chloromethane							ND												
Chlorodibromomethane							ND												
1,1-Dichloroethane							ND												
1,2-Dichloroethane							ND												
1,1-Dichloroethene							ND												
Trans 1,2-Dichloroethene							ND												
1,2-Dichloropropane							ND												
cis-1,3-Dichloropropene							ND												
trans-1,3-Dichloropropene							ND												
Ethylbenzene							ND												
Methylene Chloride							ND												
1,1,2,2-Tetrachloroethane							ND												
Tetrachloroethene							ND												
Toluene							ND												
1,1,1-Trichloroethane							ND												
1,1,2-Trichloroethane							ND												
Trichloroethene							ND												
Trichlorofluoromethane							ND												
Vinyl Chloride							ND												

WHITEHEAD CSO EVENTS 2007

TIME IN	2/18/2007	2/24/2007	3/1/2007	3/9/2007	3/22/2007	3/30/2007	4/10/2007	4/13/2007	4/24/2007	5/3/2007	5/6/2007	5/15/2007	5/24/2007	6/1/2007	6/10/2007	6/18/2007	6/23/2007	6/27/2007	7/9/2007	
EVENT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Acrylonitrile							ND													
Acrolein							ND													
Phenol							ND													
bis(2-Chloroethyl) Ether							ND													
2-Chlorophenol							ND													
1,2-Dichlorobenzene							ND													
1,4-Dichlorobenzene							ND													
1,2-Dichlorobenzene							ND													
2-Methylphenol							ND													
bis(2-Chloroisopropyl) Ether							ND													
4-Methylphenol							ND													
N-Nitroso-di-n-propylamine							ND													
Hexachloroethane							ND													
Nitrobenzene							ND													
Isophorone							ND													
2-Nitrophenol							ND													
2,4-Dimethylphenol							ND													
bis(2-Chloroethoxy) Methane							ND													
2,4-Dichlorophenol							ND													
1,2,4-Trichlorobenzene							ND													
Naphthalene							ND													
4-Chloroaniline							ND													
Hexachlorobutadiene							ND													
4-Chloro-3-methylphenol							ND													
2-Methylnaphthalene							ND													
Hexachlorocyclopentadiene							ND													
2,4,6-Trichlorophenol							ND													
2,4,5-Trichlorophenol							ND													
2-Chloronaphthalene							ND													
2-Nitroaniline							ND													
Dimethyl Phthalate							ND													
Acenaphthylene							ND													
3-Nitroaniline							ND													
2,4-Dinitrophenol							ND													
4-Nitrophenol							ND													
Dibenzofuran							ND													
2,4-Dinitrotoluene							ND													
2,6-Dinitrotoluene							ND													
Diethyl Phthalate							ND													
4-Chlorophenyl Phenyl Ether							ND													
Fluorene							ND													
4-Nitroaniline							ND													
4,6-Dinitro-2-methylphenol							ND													
N-Nitrosodiphenylamine							ND													
4-Bromophenyl Phenyl Ether							ND													
Hexachlorobenzene							ND													
Pentachlorophenol							ND													
Phenanthrene							ND													
Carbazole							ND													
Anthracene							ND													
Di-n-butyl Phthalate							ND													
Fluoranthene							ND													
Pyrene							ND													
Butyl Benzyl Phthalate							ND													
3,3'-Dichlorobenzidine							ND													
Benzo (a) Anthracene							ND													
Bis(2-ethylhexyl) Phthalate							ND													
Chrysene							ND													
Di-n-octyl Phthalate							ND													
Benzo (b) Fluoranthene							ND													
Benzo (k) Fluoranthene							ND													
Benzo (a) Pyrene							ND													
Indeno(1,2,3-cd) Pyrene							ND													
Dibenz (a,h) Athracene							ND													
4,4'-DDE							ND													
4,4'-DDD							ND													
4,4'-DDT							ND													

WHITEHEAD CSO EVENTS 2007

	2/18/2007	2/24/2007	3/1/2007	3/9/2007	3/22/2007	3/30/2007	4/10/2007	4/13/2007	4/24/2007	5/3/2007	5/6/2007	5/15/2007	5/24/2007	6/1/2007	6/10/2007	6/18/2007	6/23/2007	6/27/2007	7/9/2007	
TIME IN	3:15 p.m.	4:02 a.m.	2:14 a.m.	8:50 a.m.	7:00 a.m.	12:41 a.m.	7:32 p.m.	3:31 a.m.	6:35 p.m.	10:46 p.m.	8:50 a.m.	8:00 a.m.	9:24 a.m.	8:30 a.m.	12:46 p.m.	11:16 a.m.	1:07 a.m.	5:35 p.m.	10:30 p.m.	
EVENT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
4,4'-Methoxychlor							ND													
Aldrin							ND													
Aroclor 1016							ND													
Aroclor 1221							ND													
Aroclor 1232							ND													
Aroclor 1242							ND													
Aroclor 1248							ND													
Aroclor 1254							ND													
Aroclor 1260							ND													
Dieldrin							ND													
Endosulfan I							ND													
Endosulfan II							ND													
Endosulfan sulfate							ND													
Endrin							ND													
Endrin aldehyde							ND													
Endrin ketone							ND													
Heptachlor							ND													
Heptachlor epoxide							ND													
Toxaphene							ND													
alpha-Chlordane							ND													
alpha-BHC							ND													
beta-BHC							ND													
delta-BHC							ND													
gamma-BHC (Lindane)							ND													
gamma-Chlordane							ND													

WHITEHEAD CSO EVENTS 2007

	7/23/2007	8/2/2007	8/8/2007	8/23/2007	8/24/2007	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007					
TIME IN	9:00 a.m.	10:45 a.m.	9:20 a.m.	8:47 a.m.	3:56 a.m.	11:15 a.m.	7:30 a.m.	3:10 p.m.	7:50 a.m.	9:05 a.m.	12:10 p.m.	7:30 a.m.	6:10 a.m.	12:40 p.m.	7:45 a.m.							
EVENT NO.	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum	
Rainfall Recorded (Inches)	0.9	1.0	1.0				1.8	0.6														
Peak Depth																						
Peak cfs																						
Flow Volume																						
E. coli (cfu)	483920.0	>483,920			>483,920			>483,920		>1,209,800	310,620	>2419.6	>2419.6						356,381	829,700	46,110	
	483920.0	483920.0			483900.0			483900		1209800	310,620	2420	2420						294,294	1,209,800	2,420	
Fecal Coliform (cfu)	>2419.6	>483,920			129,760			>483,920		>1,209,800	>1,209,800	>2419.6	>2419.6						115,440	129,760	101,120	
	2420.0	483920.0			129,760			483900		1209800	1209800	2420	2420						182,609	1,209,800	2,420	
BOD ₅ (mg/L)	28.0		107.0			29	69	175		129	63	42	45		74		92		59.36	175.00	4.00	
TSS (mg/L)	1210.0		310.0			86	5310	828		82	1532	150	249		190		187		604.23	5,310.00	82.00	
TKN (mg/L)	8.78		11.5														30.1		8.58	30.10	0.90	
NH ₄ -N (mg/L)	2.2		5.3			7.15	0.612	3.13		22.4	1.17	4.86	3.39		4.66		13.8		5.23	22.40	0.61	
NO ₃ (mg/L)	129.3		9.3			8.4	1.58	36.43		5.12	4.96	37.81	36.3		52.24		133.25		23.81	133.25	1.58	
PO ₄ (mg/L)	8.7		2.8			2.15	10.9	3.38		2.13	1.47	0.391	1.35		0.097		1.9		2.89	10.90	0.10	
FOG (mg/L)	13.0				5			44.4		18	57.2	16	24.4						22.15	57.20	5.00	
Total Phenol (mg/L)																				0.00	0.00	
pH			9.8		6.85			7.3		7.79	9.2	7.95			8.5				7.95	9.82	6.85	
Temperature C°			22.0		23.7			23.9		21.5	22.1	17.8			11.4				14.76	23.90	4.40	
Antimony (mg/L) (total)																			0.00070	0.00070	0.00070	
Arsenic (mg/L) (total)																			0.00200	0.00200	0.00200	
Beryllium (mg/L) (total)																				0.00000	0.00000	
Cadmium (mg/L) (total)																				0.00000	0.00000	
Chromium (mg/L) (total)																				0.02000	0.02000	
Copper (mg/L) (total)																				0.02000	0.03000	
Lead (mg/L) (total)																				0.00690	0.00690	
Mercury (mg/L) (total)																				0.00000	0.00000	
Nickel (mg/L) (total)																				0.01500	0.02000	
Selenium (mg/L) (total)																				0.00000	0.00000	
Silver (mg/L) (total)																				0.00000	0.00000	
Thallium (mg/L) (total)																				0.00000	0.00000	
Zinc (mg/L) (total)																				0.07000	0.09000	
Cyanide (Total) (mg/L)																				0.00000	0.00000	
Benzene																						
Bromodichloromethane																						
Bromoform																						
Bromomethane																						
Carbon Tetrachloride																						
Chlorobenzene																						
Chloroethane																						
2-Chloroethyl Vinyl ether																						
Chloroform																						
Chloromethane																						
Chlorodibromomethane																						
1,1-Dichloroethane																						
1,2-Dichloroethane																						
1,1-Dichloroethene																						
Trans 1,2-Dichloroethene																						
1,2-Dichloropropane																						
cis-1,3-Dichloropropene																						
trans-1,3-Dichloropropene																						
Ethylbenzene																						
Methylene Chloride																						
1,1,2,2-Tetrachloroethane																						
Tetrachloroethene																						
Toluene																						
1,1,1-Trichloroethane																						
1,1,2-Trichloroethane																						
Trichloroethene																						
Trichlorofluoromethane																						
Vinyl Chloride																						

WHITEHEAD CSO EVENTS 2007

TIME IN	7/23/2007	8/2/2007	8/8/2007	8/23/2007	8/24/2007	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007					
EVENT NO.	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum	
Acrylonitrile																						
Acrolein																						
Phenol																						
bis(2-Chloroethyl) Ether																						
2-Chlorophenol																						
1,2-Dichlorobenzene																						
1,4-Dichlorobenzene																						
1,2-Dichlorobenzene																						
2-Methylphenol																						
bis(2-Chloroisopropyl) Ether																						
4-Methylphenol																						
N-Nitroso-di-n-propylamine																						
Hexachloroethane																						
Nitrobenzene																						
Isophorone																						
2-Nitrophenol																						
2,4-Dimethylphenol																						
bis(2-Chloroethoxy) Methane																						
2,4-Dichlorophenol																						
1,2,4-Trichlorobenzene																						
Naphthalene																						
4-Chloroaniline																						
Hexachlorobutadiene																						
4-Chloro-3-methylphenol																						
2-Methylnaphthalene																						
Hexachlorocyclopentadiene																						
2,4,6-Trichlorophenol																						
2,4,5-Trichlorophenol																						
2-Chloronaphthalene																						
2-Nitroaniline																						
Dimethyl Phthalate																						
Acenaphthylene																						
3-Nitroaniline																						
2,4-Dinitrophenol																						
4-Nitrophenol																						
Dibenzofuran																						
2,4-Dinitrotoluene																						
2,6-Dinitrotoluene																						
Diethyl Phthalate																						
4-Chlorophenyl Phenyl Ether																						
Fluorene																						
4-Nitroaniline																						
4,6-Dinitro-2-methylphenol																						
N-Nitrosodiphenylamine																						
4-Bromophenyl Phenyl Ether																						
Hexachlorobenzene																						
Pentachlorophenol																						
Phenanthrene																						
Carbazole																						
Anthracene																						
Di-n-butyl Phthalate																						
Fluoranthene																						
Pyrene																						
Butyl Benzyl Phthalate																						
3,3'-Dichlorobenzidine																						
Benzo (a) Anthracene																						
Bis(2-ethylhexyl) Phthalate																						
Chrysene																						
Di-n-octyl Phthalate																						
Benzo (b) Fluoranthene																						
Benzo (k) Fluoranthene																						
Benzo (a) Pyrene																						
Indeno(1,2,3-cd) Pyrene																						
Dibenz (a,h) Anthracene																						
4,4'-DDE																						
4,4'-DDD																						
4,4'-DDT																						

WHITEHEAD CSO EVENTS 2007

TIME IN	7/23/2007	8/2/2007	8/8/2007	8/23/2007	8/24/2007	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007					
EVENT NO.	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum	
4,4'-Methoxychlor																						
Aldrin																						
Aroclor 1016																						
Aroclor 1221																						
Aroclor 1232																						
Aroclor 1242																						
Aroclor 1248																						
Aroclor 1254																						
Aroclor 1260																						
Dieldrin																						
Endosulfan I																						
Endosulfan II																						
Endosulfan sulfate																						
Endrin																						
Endrin aldehyde																						
Endrin ketone																						
Heptachlor																						
Heptachlor epoxide																						
Toxaphene																						
alpha-Chlordane																						
alpha-BHC																						
beta-BHC																						
delta-BHC																						
gamma-BHC (Lindane)																						
gamma-Chlordane																						

BROWN'S BRANCH CSO EVENTS 2007

	2/18/2007	2/24/2007	3/1/2007	3/9/2007	3/22/2007	3/30/2007	4/10/2007	4/13/2007	4/24/2007	5/3/2007	5/6/2007	5/15/2007	5/24/2007	6/1/2007	6/10/2007	6/18/2007	6/23/2007	6/27/2007	7/9/2007	7/23/2007	8/2/2007
TIME IN	3:15 p.m.	4:02 a.m.	2:14 a.m.	8:50 a.m.	7:00 a.m.	12:41 a.m.	7:32 p.m.	3:31 a.m.	6:35 p.m.	10:45 p.m.	8:50 a.m.	8:00 a.m.	9:24 a.m.	8:30 a.m.	12:45 p.m.	11:15 a.m.	1:07 a.m.	5:35 p.m.	10:30 p.m.	9:00 a.m.	10:45 a.m.
EVENT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Rainfall Recorded (Inches)					0.3	1.3	0.8	0.3	0.3	0.3	5.0	0.8	0.6	0.6	0.6	0.4	0.2	0.2	0.2	0.9	1.0
Peak Depth																					
Peak cfs																					
Flow Volume																					
E. coli (cfu)						198630.0			>2419.6	>2419.6	>2419.6		>2419.6		>2419.6			>2419.6		>2419.6	
Fecal Coliform (cfu)						198630.0			2420.0	2420.0	2420.0		2420.0		2420.0			2420.0		2420.0	
BOD ₅ (mg/L)						>2419.6			2420.0	2420.0	2420.0		2420.0		2420.0			2420.0		2420.0	
TSS (mg/L)						235.0			82.9	12	18.0		31.0					50		69	
TKN (mg/L)						514.0			305.0	774	180.0		279.0					368		1048	
NH ₄ -N (mg/L)									6.03				7.77							10.4	
NO ₃ (mg/L)									4.5	3.6	1.44	1.6	2.9							2.71	
PO ₄ (mg/L)									10.4	6.7	5.63	4.4	5.6							7.69	
FOG (mg/L)		12.8					3.2		5.5	3.1	10.94	1.7	2.1							5.54	
Total Phenol (mg/L)									45.6	22.0	52.4	2.8	121.6					101		218	
pH							7.8		7.7	7.5	8.03		7.5		7.45			6.9		7.3	
Temperature C°							15.6		13.0	8.7	7.4		13.8		5.9			15.3		22.3	
Antimony (mg/L) (total)												0.0006									
Arsenic (mg/L) (total)												0.005									
Beryllium (mg/L) (total)												0.001									
Cadmium (mg/L) (total)												nd									
Chromium (mg/L) (total)												nd									
Copper (mg/L) (total)												0.01									
Lead (mg/L) (total)												0.0121									
Mercury (mg/L) (total)												nd									
Nickel (mg/L) (total)												nd									
Selenium (mg/L) (total)												0.002									
Silver (mg/L) (total)												nd									
Thallium (mg/L) (total)												nd									
Zinc (mg/L) (total)												0.06									
Cyanide (Total) (mg/L)												nd									
Benzene												nd									
Bromodichloromethane												nd									
Bromoform												nd									
Bromomethane												nd									
Carbon Tetrachloride												nd									
Chlorobenzene												nd									
Chloroethane												nd									
2-Chloroethyl Vinyl ether												nd									
Chloroform												nd									
Chloromethane												nd									
Chlorodibromomethane												nd									
1,1-Dichloroethane												nd									
1,2-Dichloroethane												nd									
1,1-Dichloroethene												nd									
Trans 1,2-Dichloroethene												nd									
1,2-Dichloropropane												nd									
cis-1,3-Dichloropropene												nd									
trans-1,3-Dichloropropene												nd									
Ethylbenzene												nd									
Methylene Chloride												nd									
1,1,2,2-Tetrachloroethane												nd									
Tetrachloroethene												nd									
Toluene												nd									
1,1,1-Trichloroethane												nd									

BROWN'S BRANCH CSO EVENTS 2007

	2/18/2007	2/24/2007	3/1/2007	3/9/2007	3/22/2007	3/30/2007	4/10/2007	4/13/2007	4/24/2007	5/3/2007	5/6/2007	5/15/2007	5/24/2007	6/1/2007	6/10/2007	6/18/2007	6/23/2007	6/27/2007	7/9/2007	7/23/2007	8/2/2007	
TIME IN	3:15 p.m.	4:02 a.m.	2:14 a.m.	8:50 a.m.	7:00 a.m.	12:41 a.m.	7:32 p.m.	3:31 a.m.	6:35 p.m.	10:45 p.m.	8:50 a.m.	8:00 a.m.	9:24 a.m.	8:30 a.m.	12:45 p.m.	11:15 a.m.	1:07 a.m.	5:35 p.m.	10:30 p.m.	9:00 a.m.	10:45 a.m.	
EVENT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1,1,2-Trichloroethane												nd										
Trichloroethene												nd										
Trichlorofluoromethane												nd										
Vinyl Chloride												nd										
Acrylonitrile												nd										
Acrolein												nd										
Phenol												nd										
bis(2-Chloroethyl) Ether												nd										
2-Chlorophenol												nd										
1,2-Dichlorobenzene												nd										
1,4-Dichlorobenzene												nd										
1,2-Dichlorobenzene												nd										
2-Methylphenol												nd										
bis(2-Chloroisopropyl) Ether												nd										
4-Methylphenol												nd										
N-Nitroso-di-n-propylamine												nd										
Hexachloroethane												nd										
Nitrobenzene												nd										
Isophorone												nd										
2-Nitrophenol												nd										
2,4-Dimethylphenol												nd										
bis(2-Chloroethoxy) Methane												nd										
2,4-Dichlorophenol												nd										
1,2,4-Trichlorobenzene												nd										
Naphthalene												nd										
4-Chloroaniline												nd										
Hexachlorobutadiene												nd										
4-Chloro-3-methylphenol												nd										
2-Methylnaphthalene												nd										
Hexachlorocyclopentadiene												nd										
2,4,6-Trichlorophenol												nd										
2,4,5-Trichlorophenol												nd										
2-Chloronaphthalene												nd										
2-Nitroaniline												nd										
Dimethyl Phthalate												nd										
Acenaphthylene												nd										
3-Nitroaniline												nd										
2,4-Dinitrophenol												nd										
4-Nitrophenol												nd										
Dibenzofuran												nd										
2,4-Dinitrotoluene												nd										
2,6-Dinitrotoluene												nd										
Diethyl Phthalate												nd										
4-Chlorophenyl Phenyl Ether												nd										
Fluorene												nd										
4-Nitroaniline												nd										
4,6-Dinitro-2-methylphenol												nd										
N-Nitrosodiphenylamine												nd										
4-Bromophenyl Phenyl Ether												nd										
Hexachlorobenzene												nd										
Pentachlorophenol												nd										
Phenanthrene												nd										
Carbazole												nd										
Anthracene												nd										
Di-n-butyl Phthalate												nd										
Fluoranthene												nd										
Pyrene												nd										
Butyl Benzyl Phthalate												nd										
3,3'-Dichlorobenzidine												nd										
Benzo (a) Anthracene												nd										
Bis(2-ethylhexyl) Phthalate												nd										
Chrysene												nd										
Di-n-octyl Phthalate												nd										

BROWN'S BRANCH CSO EVENTS 2007

	2/18/2007	2/24/2007	3/1/2007	3/9/2007	3/22/2007	3/30/2007	4/10/2007	4/13/2007	4/24/2007	5/3/2007	5/6/2007	5/15/2007	5/24/2007	6/1/2007	6/10/2007	6/18/2007	6/23/2007	6/27/2007	7/9/2007	7/23/2007	8/2/2007	
TIME IN	3:15 p.m.	4:02 a.m.	2:14 a.m.	8:50 a.m.	7:00 a.m.	12:41 a.m.	7:32 p.m.	3:31 a.m.	6:35 p.m.	10:45 p.m.	8:50 a.m.	8:00 a.m.	9:24 a.m.	8:30 a.m.	12:45 p.m.	11:15 a.m.	1:07 a.m.	5:35 p.m.	10:30 p.m.	9:00 a.m.	10:45 a.m.	
EVENT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
Benzo (b) Fluoranthene												nd										
Benzo (k) Fluoranthene												nd										
Benzo (a) Pyrene												nd										
Indeno(1,2,3-cd) Pyrene												nd										
Dibenz (a,h) Athracene												nd										
4,4'-DDE												nd										
4,4'-DDD												nd										
4,4'-DDT												nd										
4,4'-Methoxychlor												nd										
Aldrin												nd										
Aroclor 1016												nd										
Aroclor 1221												nd										
Aroclor 1232												nd										
Aroclor 1242												nd										
Aroclor 1248												nd										
Aroclor 1254												nd										
Aroclor 1260												nd										
Dieldrin												nd										
Endosulfan I												nd										
Endosulfan II												nd										
Endosulfan sulfate												nd										
Endrin												nd										
Endrin aldehyde												nd										
Endrin ketone												nd										
Heptachlor												nd										
Heptachlor epoxide												nd										
Toxaphene												nd										
alpha-Chlordane												nd										
alpha-BHC												nd										
beta-BHC												nd										
delta-BHC												nd										
gamma-BHC (Lindane)												nd										
gamma-Chlordane												nd										

BROWN'S BRANCH CSO EVENTS 2007

	8/8/2007	8/23/2007	8/24/2007	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007				
TIME IN	9:20 a.m.	8:47 a.m.	3:56 a.m.	11:15 a.m.	7:30 a.m.	3:10 p.m.	7:50 a.m.	9:05 a.m.	12:10 p.m.	7:30 a.m.	6:10 a.m.	12:40 p.m.	7:45 a.m.						
EVENT NO.	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum
Rainfall Recorded (Inches)	1.0				1.8	0.6													
Peak Depth																			
Peak cfs																			
Flow Volume																			
E. coli (cfu)			115,880			>483,920			>2419.6								157,255	198,630	115,880
Fecal Coliform (cfu)			>483,920			>483,920			2420								74,343	483,900	2,420
BOD ₅ (mg/L)	17		483900			483900			483900								133,733	483,900	2,420
TSS (mg/L)	940				17	98			63			73			163		71.5	235.0	12.0
TKN (mg/L)	2.74	10.4			2345	1003			534			480			505		713.5	2345.0	180.0
NH ₄ -N (mg/L)	0.935				0.932	3.32			2.34			3.12			12.3		8.3	12.3	2.7
NO ₃ (mg/L)	4				30.19	29.79			23.33			35.73			54		18.1	54.0	4.0
PO ₄ (mg/L)	4.56				12.54	3.12			0.815			2.7			2.9		4.6	12.5	0.8
FOG (mg/L)		218	1			46.4			28.4								67.2	218.0	1.0
Total Phenol (mg/L)																		0.0	0.0
pH			8.5			7.3			7.9			-			-		7.6	8.5	6.9
Temperature C°			22.3			20.1			23.8								15.3	23.8	5.9
Antimony (mg/L) (total)																		0.0	0.0
Arsenic (mg/L) (total)																		0.0	0.0
Beryllium (mg/L) (total)																		0.0	0.0
Cadmium (mg/L) (total)																		0.0	0.0
Chromium (mg/L) (total)																		0.0	0.0
Copper (mg/L) (total)																		0.0	0.0
Lead (mg/L) (total)																		0.0	0.0
Mercury (mg/L) (total)																		0.0	0.0
Nickel (mg/L) (total)																		0.0	0.0
Selenium (mg/L) (total)																		0.0	0.0
Silver (mg/L) (total)																		0.0	0.0
Thallium (mg/L) (total)																		0.0	0.0
Zinc (mg/L) (total)																		0.1	0.1
Cyanide (Total) (mg/L)																		0.0	0.0
Benzene																			
Bromodichloromethane																			
Bromoform																			
Bromomethane																			
Carbon Tetrachloride																			
Chlorobenzene																			
Chloroethane																			
2-Chloroethyl Vinyl ether																			
Chloroform																			
Chloromethane																			
Chlorodibromomethane																			
1,1-Dichloroethane																			
1,2-Dichloroethane																			
1,1-Dichloroethene																			
Trans 1,2-Dichloroethene																			
1,2-Dichloropropane																			
cis-1,3-Dichloropropene																			
trans-1,3-Dichloropropene																			
Ethylbenzene																			
Methylene Chloride																			
1,1,2,2-Tetrachloroethane																			
Tetrachloroethene																			
Toluene																			
1,1,1-Trichloroethane																			

BROWN'S BRANCH CSO EVENTS 2007

	8/8/2007	8/23/2007	8/24/2007	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007				
TIME IN	9:20 a.m.	8:47 a.m.	3:56 a.m.	11:15 a.m.	7:30 a.m.	3:10 p.m.	7:50 a.m.	9:05 a.m.	12:10 p.m.	7:30 a.m.	6:10 a.m.	12:40 p.m.	7:45 a.m.						
EVENT NO.	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		Average	Maximum	Minimum
1,1,2-Trichloroethane																			
Trichloroethene																			
Trichlorofluoromethane																			
Vinyl Chloride																			
Acrylonitrile																			
Acrolein																			
Phenol																			
bis(2-Chloroethyl) Ether																			
2-Chlorophenol																			
1,2-Dichlorobenzene																			
1,4-Dichlorobenzene																			
1,2-Dichlorobenzene																			
2-Methylphenol																			
bis(2-Chloroisopropyl) Ether																			
4-Methylphenol																			
N-Nitroso-di-n-propylamine																			
Hexachloroethane																			
Nitrobenzene																			
Isophorone																			
2-Nitrophenol																			
2,4-Dimethylphenol																			
bis(2-Chloroethoxy) Methane																			
2,4-Dichlorophenol																			
1,2,4-Trichlorobenzene																			
Naphthalene																			
4-Chloroaniline																			
Hexachlorobutadiene																			
4-Chloro-3-methylphenol																			
2-Methylnaphthalene																			
Hexachlorocyclopentadiene																			
2,4,6-Trichlorophenol																			
2,4,5-Trichlorophenol																			
2-Chloronaphthalene																			
2-Nitroaniline																			
Dimethyl Phthalate																			
Acenaphthylene																			
3-Nitroaniline																			
2,4-Dinitrophenol																			
4-Nitrophenol																			
Dibenzofuran																			
2,4-Dinitrotoluene																			
2,6-Dinitrotoluene																			
Diethyl Phthalate																			
4-Chlorophenyl Phenyl Ether																			
Fluorene																			
4-Nitroaniline																			
4,6-Dinitro-2-methylphenol																			
N-Nitrosodiphenylamine																			
4-Bromophenyl Phenyl Ether																			
Hexachlorobenzene																			
Pentachlorophenol																			
Phenanthrene																			
Carbazole																			
Anthracene																			
Di-n-butyl Phthalate																			
Fluoranthene																			
Pyrene																			
Butyl Benzyl Phthalate																			
3,3'-Dichlorobenzidine																			
Benzo (a) Anthracene																			
Bis(2-ethylhexyl) Phthalate																			
Chrysene																			
Di-n-octyl Phthalate																			

BROWN'S BRANCH CSO EVENTS 2007

	8/8/2007	8/23/2007	8/24/2007	8/29/2007	9/6/2007	9/18/2007	9/21/2007	9/25/2007	10/2/2007	10/8/2007	10/13/2007	10/17/2007	10/22/2007	11/13/2007	12/1/2007				
TIME IN	9:20 a.m.	8:47 a.m.	3:56 a.m.	11:15 a.m.	7:30 a.m.	3:10 p.m.	7:50 a.m.	9:05 a.m.	12:10 p.m.	7:30 a.m.	6:10 a.m.	12:40 p.m.	7:45 a.m.						
EVENT NO.	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36				
																	Average	Maximum	Minimum
Benzo (b) Fluoranthene																			
Benzo (k) Fluoranthene																			
Benzo (a) Pyrene																			
Indeno(1,2,3-cd) Pyrene																			
Dibenz (a,h) Athracene																			
4,4'-DDE																			
4,4'-DDD																			
4,4'-DDT																			
4,4'-Methoxychlor																			
Aldrin																			
Aroclor 1016																			
Aroclor 1221																			
Aroclor 1232																			
Aroclor 1242																			
Aroclor 1248																			
Aroclor 1254																			
Aroclor 1260																			
Dieldrin																			
Endosulfan I																			
Endosulfan II																			
Endosulfan sulfate																			
Endrin																			
Endrin aldehyde																			
Endrin ketone																			
Heptachlor																			
Heptachlor epoxide																			
Toxaphene																			
alpha-Chlordane																			
alpha-BHC																			
beta-BHC																			
delta-BHC																			
gamma-BHC (Lindane)																			
gamma-Chlordane																			

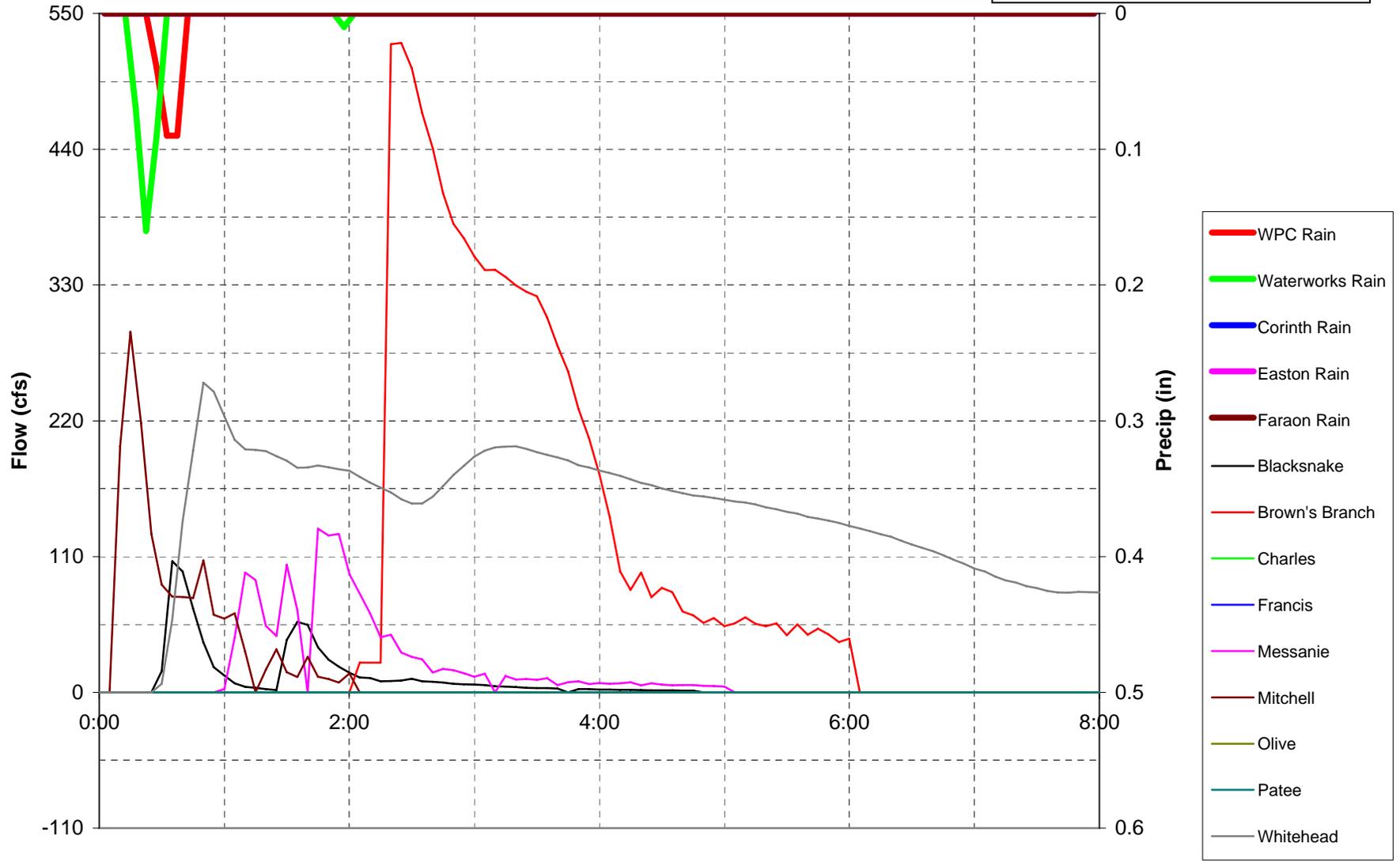


**APPENDIX F
CSS MODELING
DATA**

Rainfall and Flowmeter Data

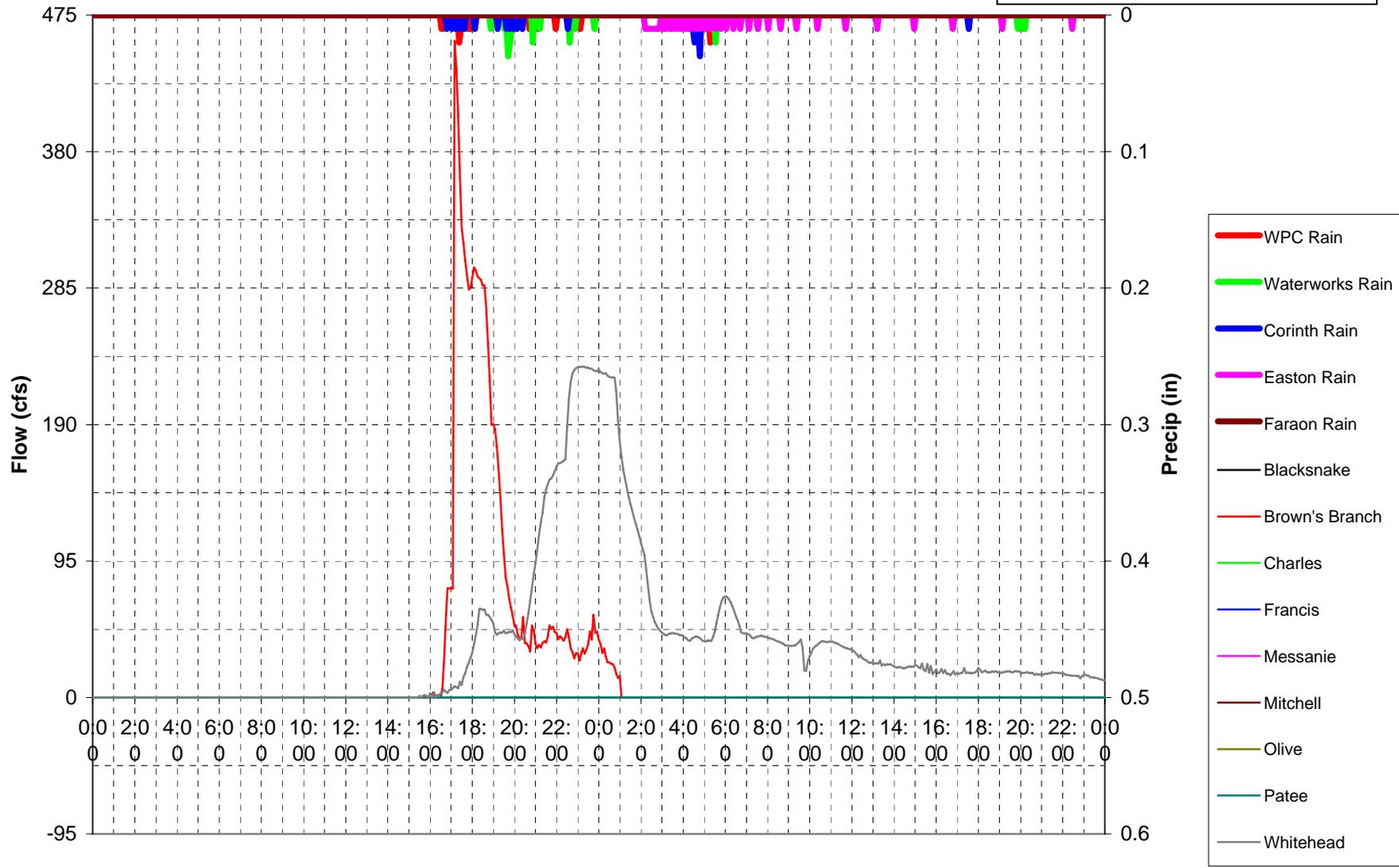
St. Joseph, MO CSO Basins - Event 1

Dates Reporting:
Start Date: 3/22/2007 00:00
End Date: 3/22/2007 08:00



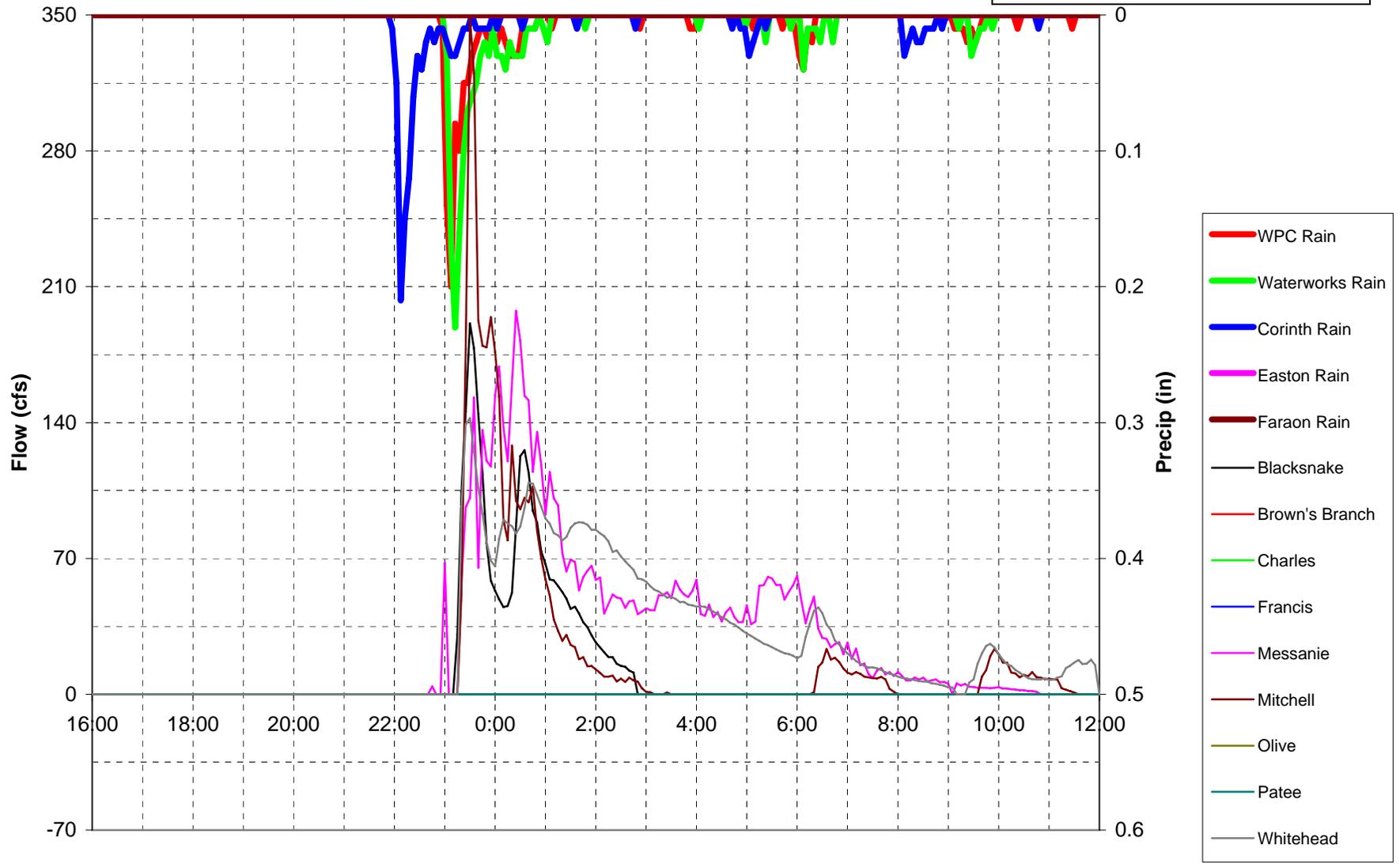
St. Joseph, MO CSO Basins - Event 2

Dates Reporting:
Start Date: 3/26/2007 00:00
End Date: 3/28/2007 00:00



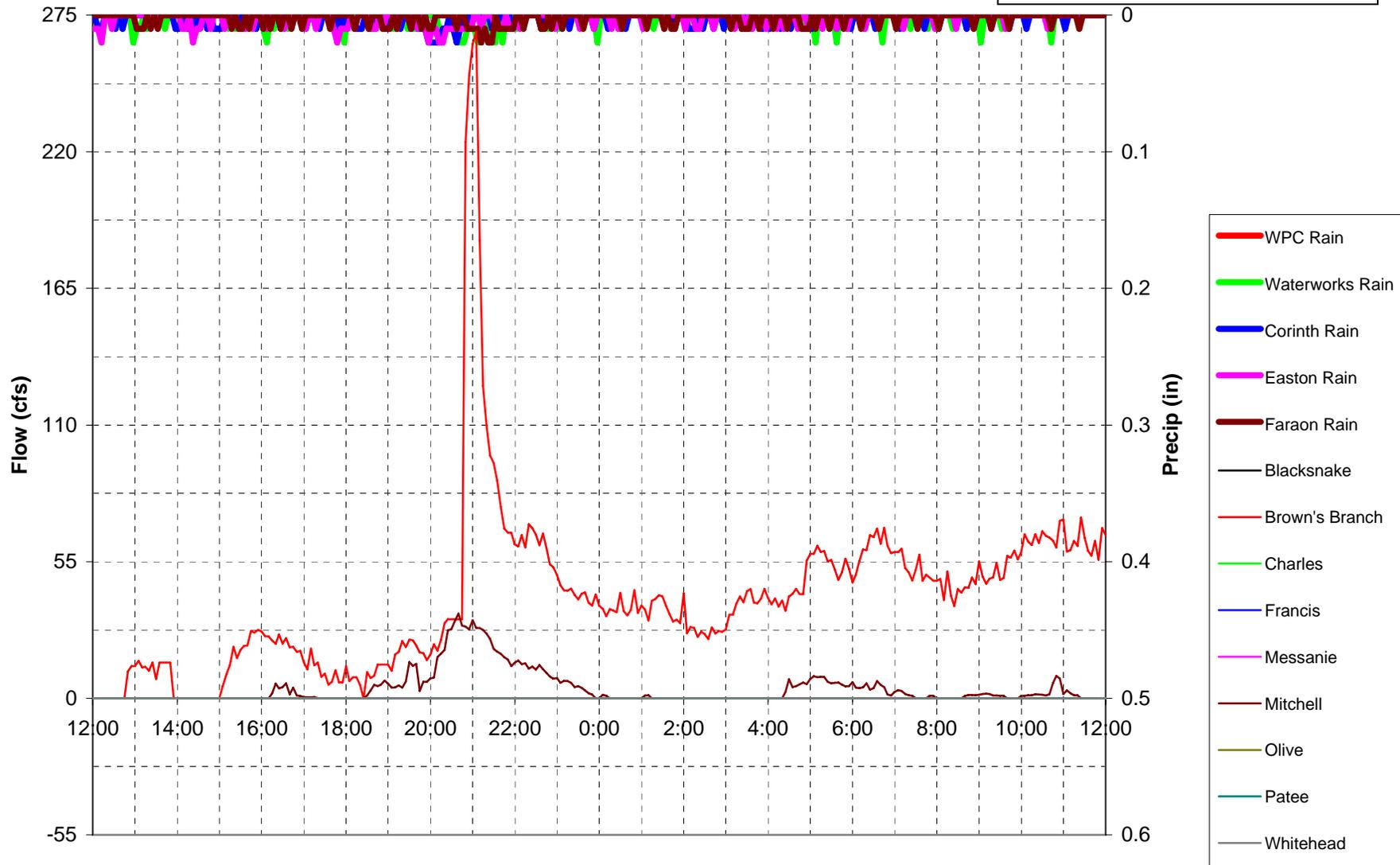
St. Joseph, MO CSO Basins - Event 3

Dates Reporting:
Start Date: 3/29/2007 16:00
End Date: 3/30/2007 12:00



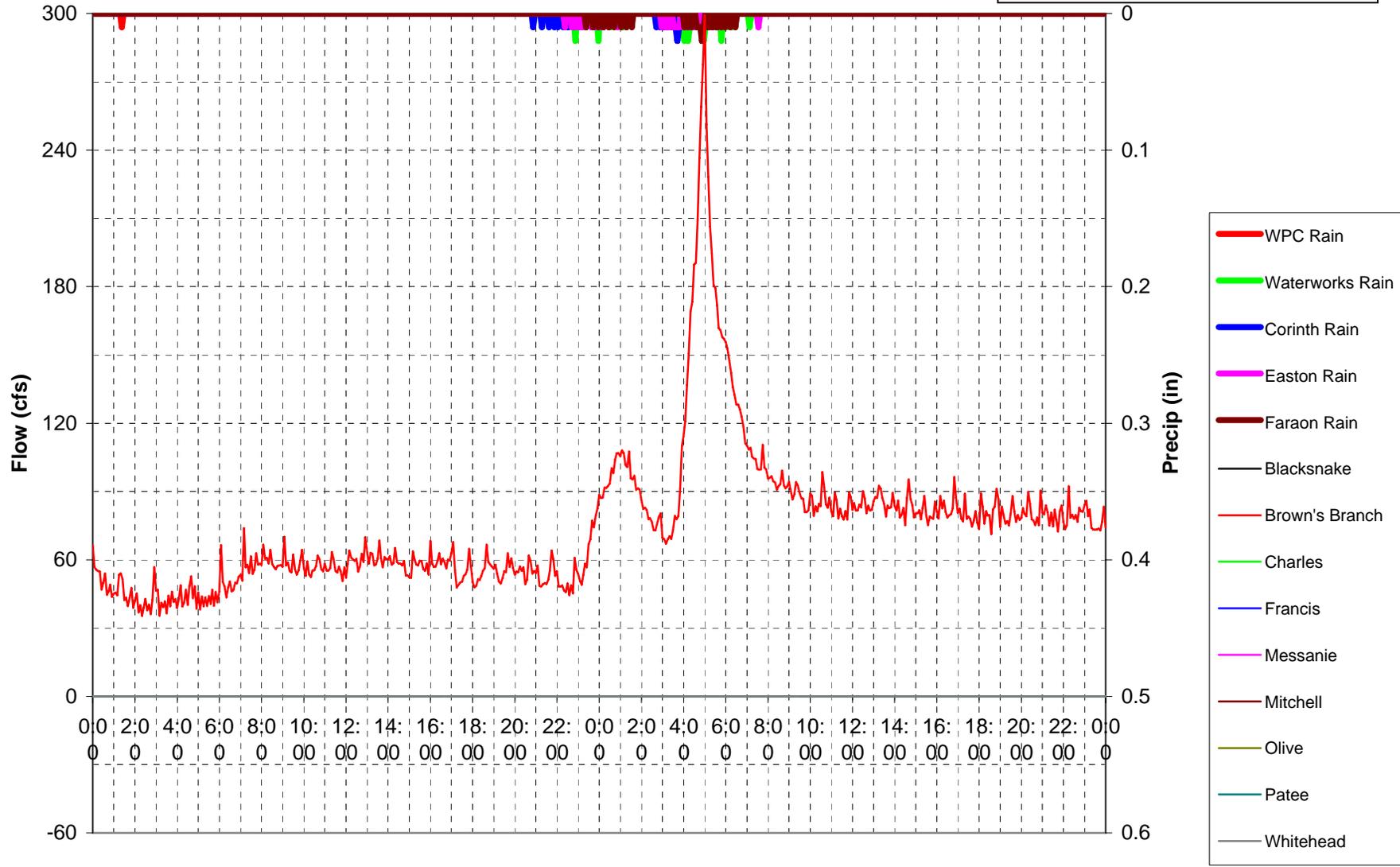
St. Joseph, MO CSO Basins - Event 4

Dates Reporting:
Start Date: 4/10/2007 12:00
End Date: 4/11/2007 12:00



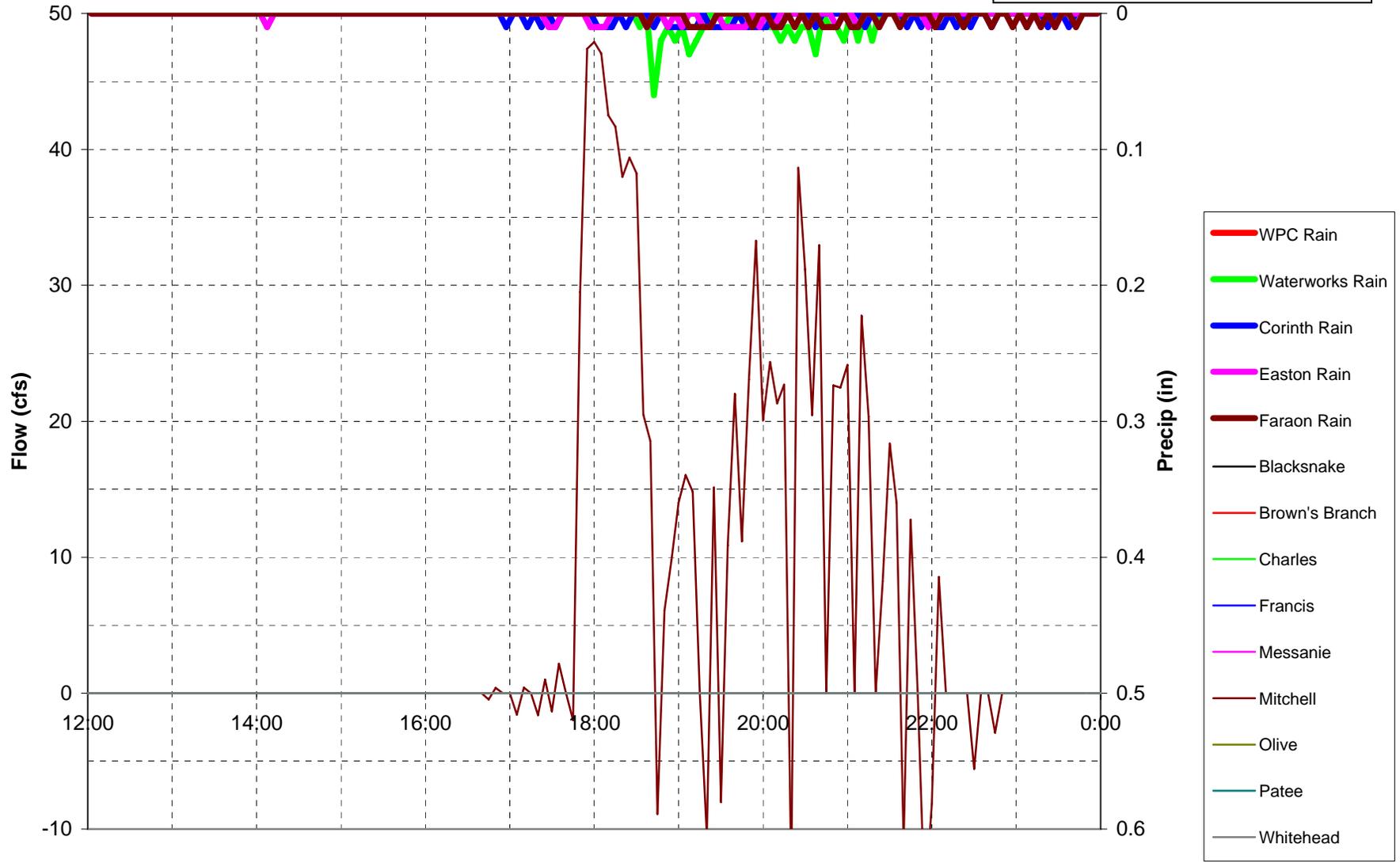
St. Joseph, MO CSO Basins - Event 5

Dates Reporting:
Start Date: 4/13/2007 00:00
End Date: 4/15/2007 00:00



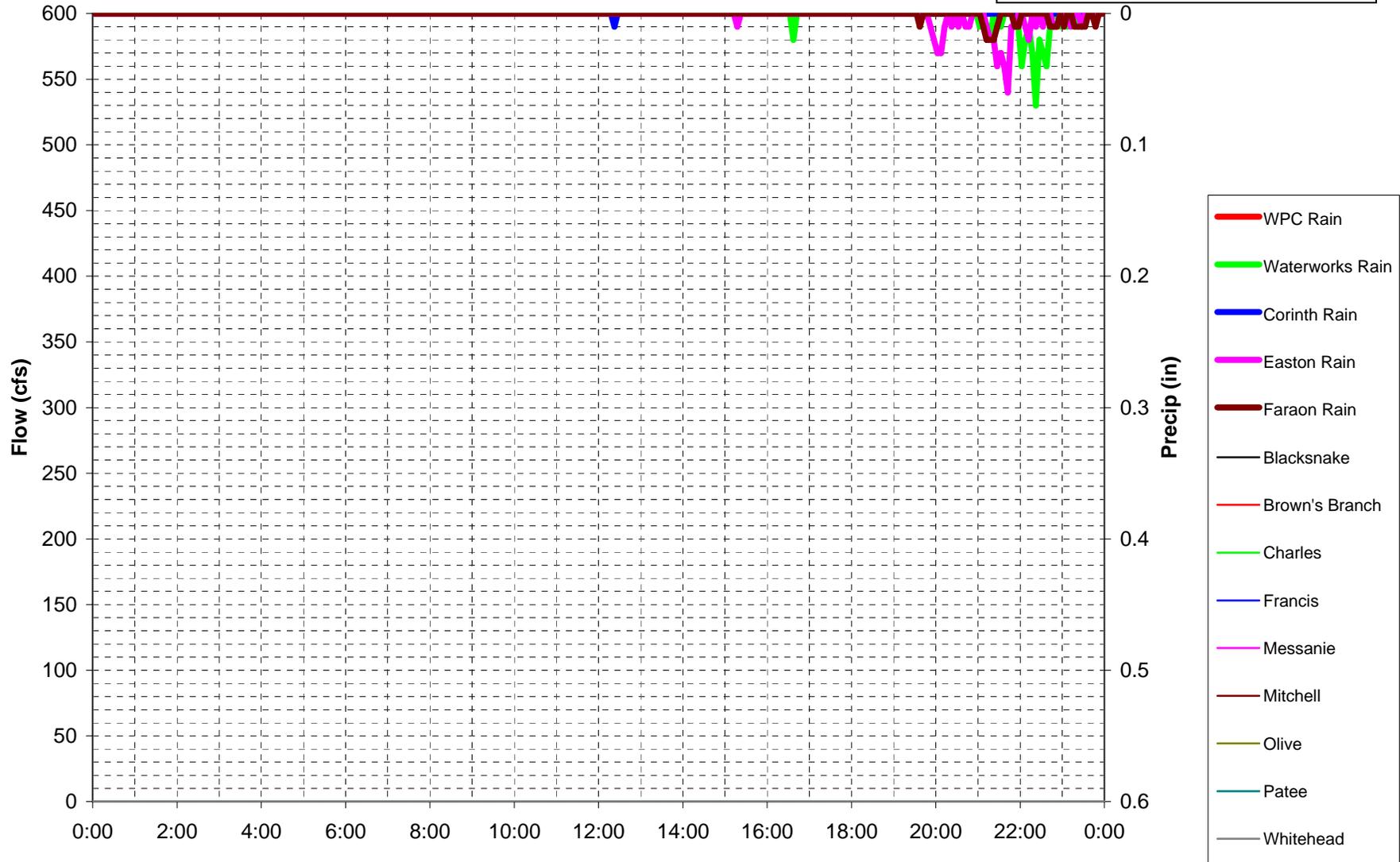
St. Joseph, MO CSO Basins - Event 6

Dates Reporting:
Start Date: 4/25/2007 12:00
End Date: 4/26/2007 00:00



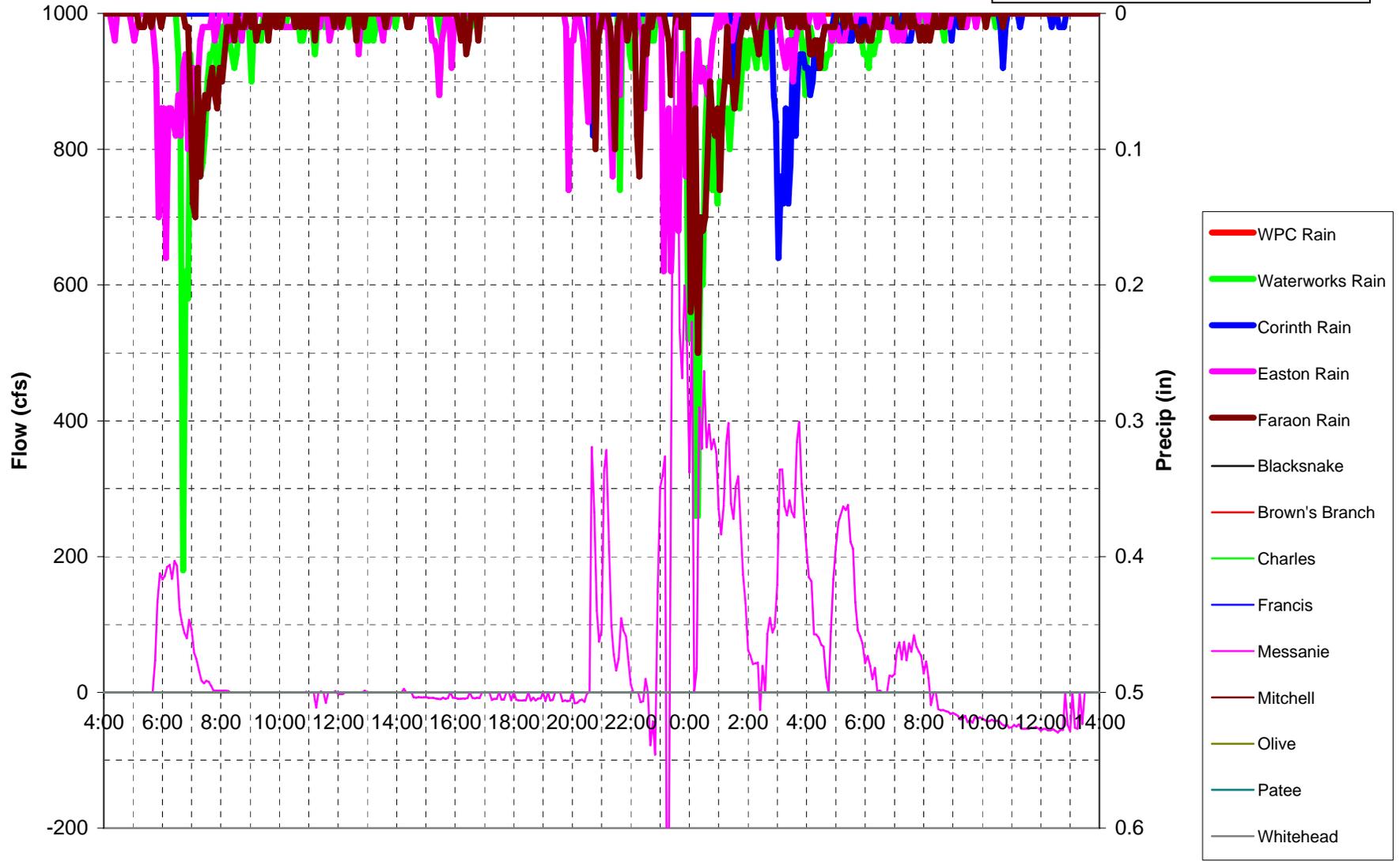
St. Joseph, MO CSO Basins - Event 7

Dates Reporting:
Start Date: 5/3/2007 00:00
End Date: 5/4/2007 00:00



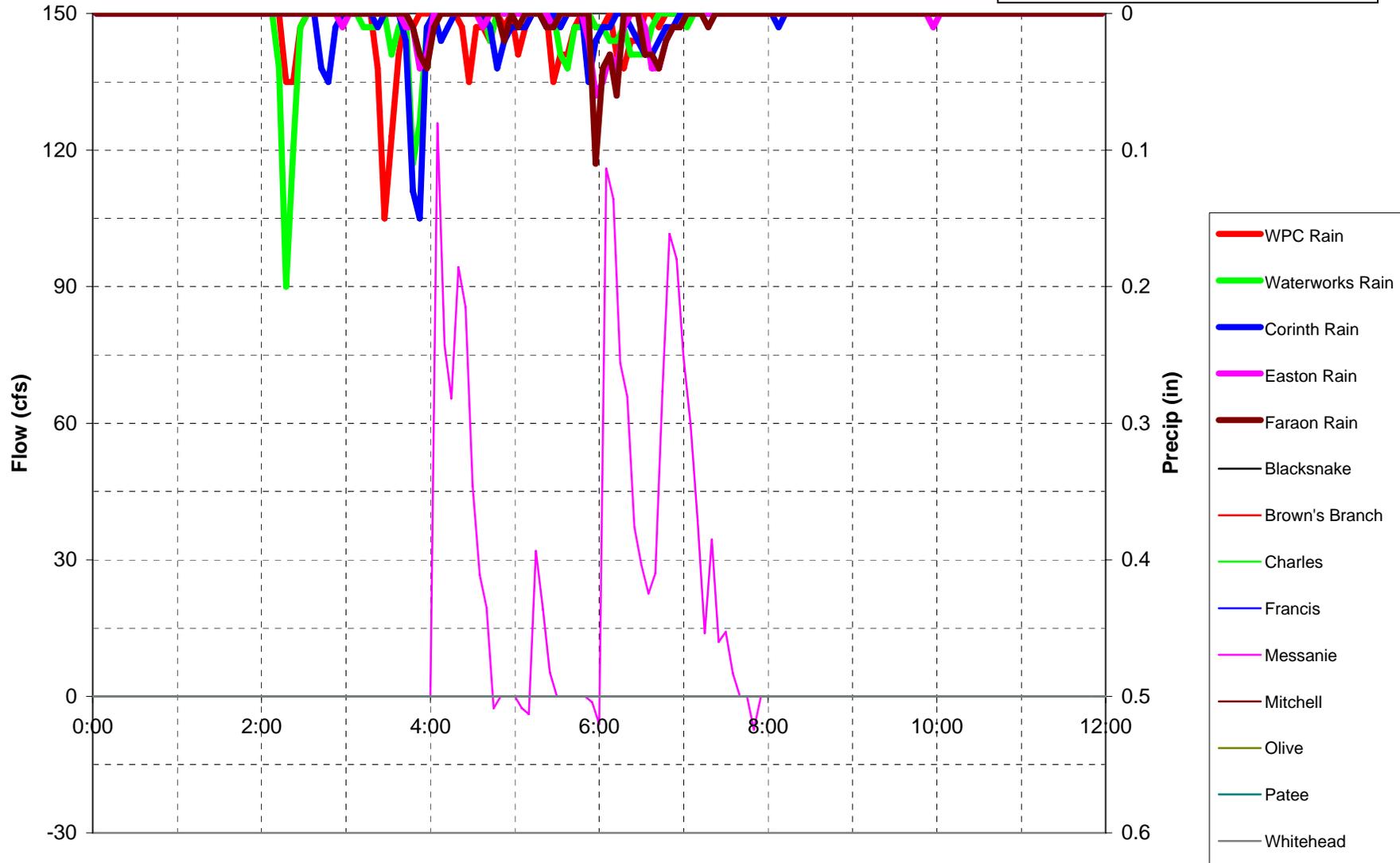
St. Joseph, MO CSO Basins - Event 8

Dates Reporting:
Start Date: 5/6/2007 04:00
End Date: 5/7/2007 14:00



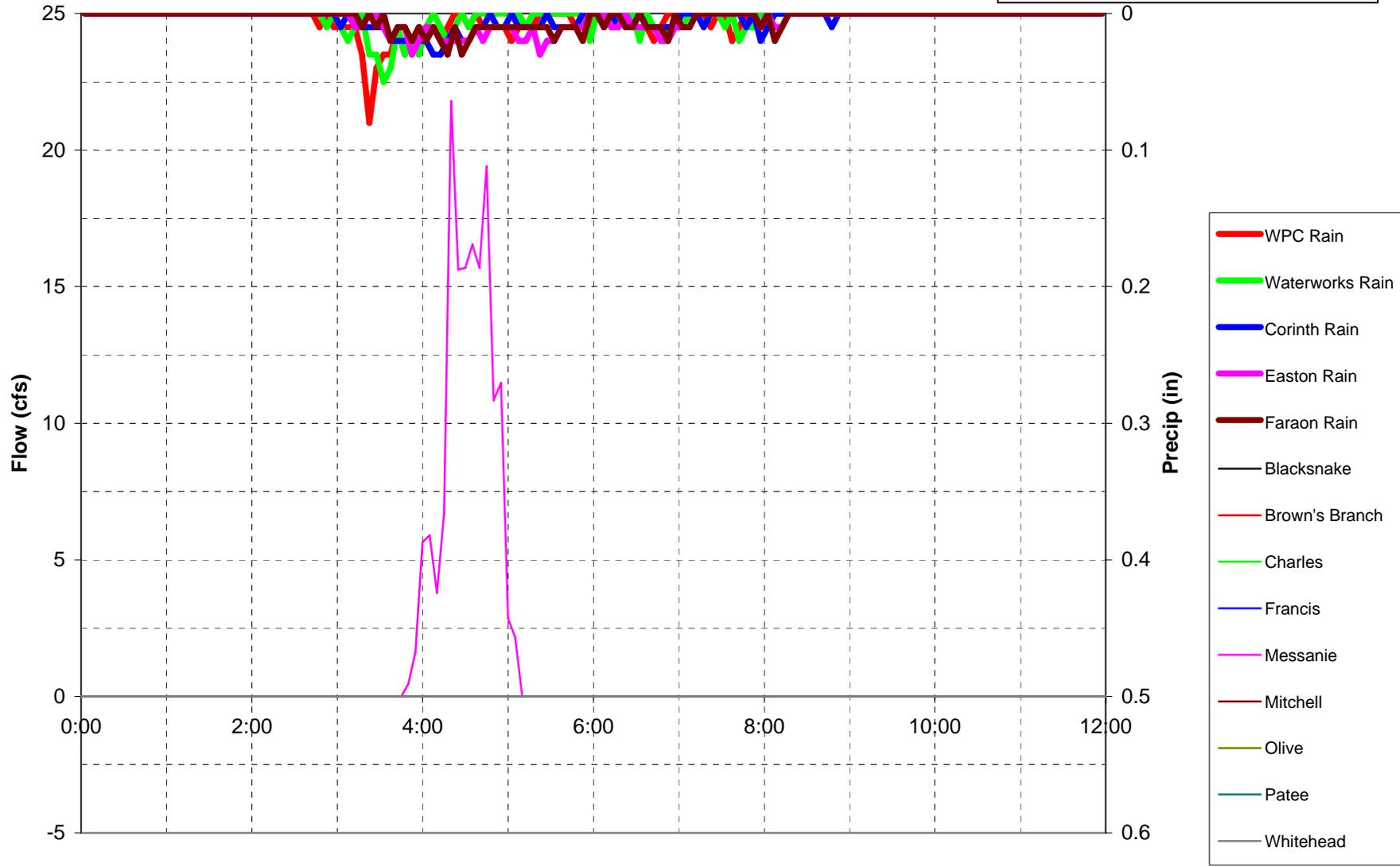
St. Joseph, MO CSO Basins - Event 9

Dates Reporting:
Start Date: 5/15/2007 00:00
End Date: 5/15/2007 12:00



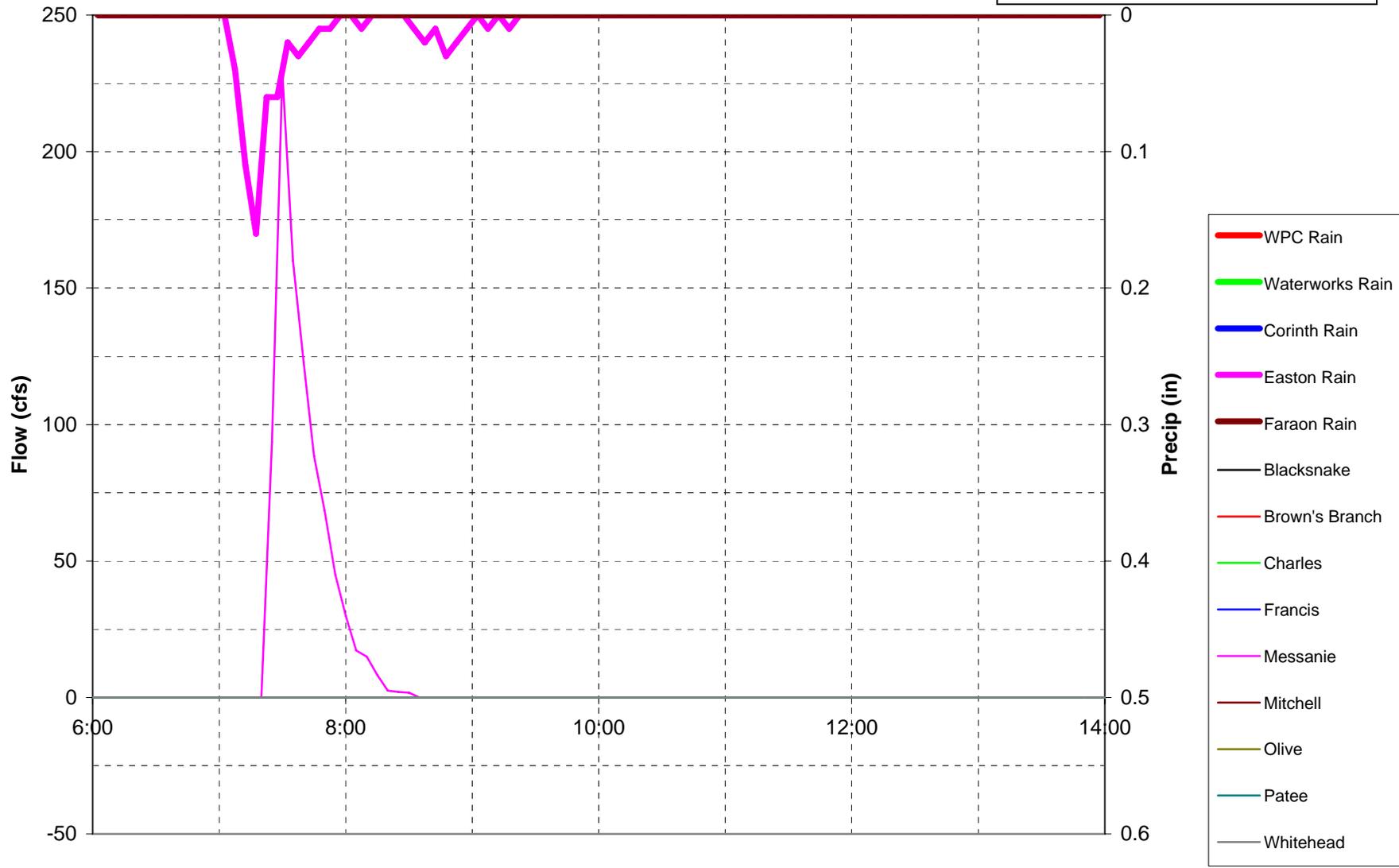
St. Joseph, MO CSO Basins - Event 11

Dates Reporting:
Start Date: 6/1/2007 00:00
End Date: 6/1/2007 12:00



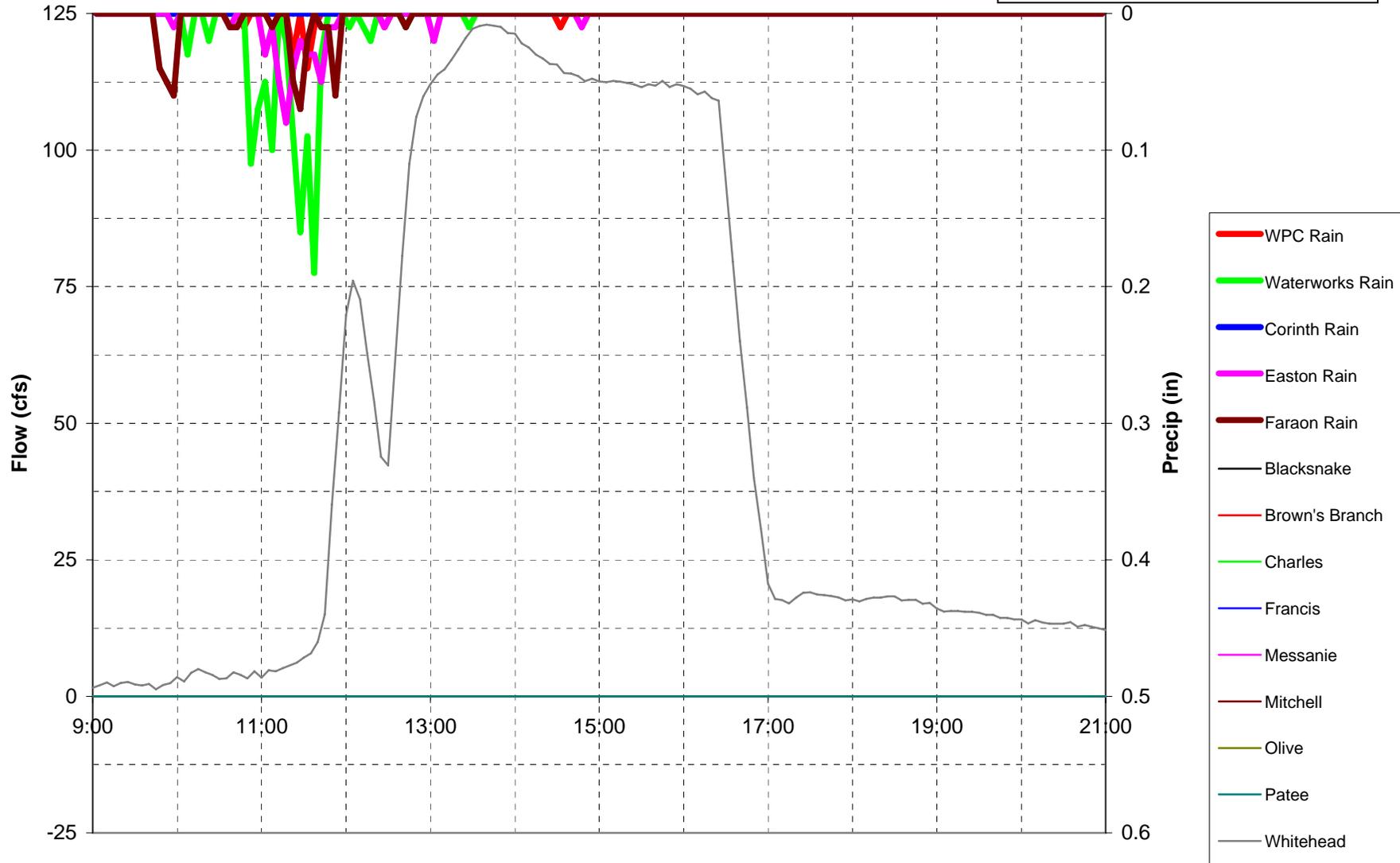
St. Joseph, MO CSO Basins - Event 12

Dates Reporting:
Start Date: 6/10/2007 06:00
End Date: 6/10/2007 14:00



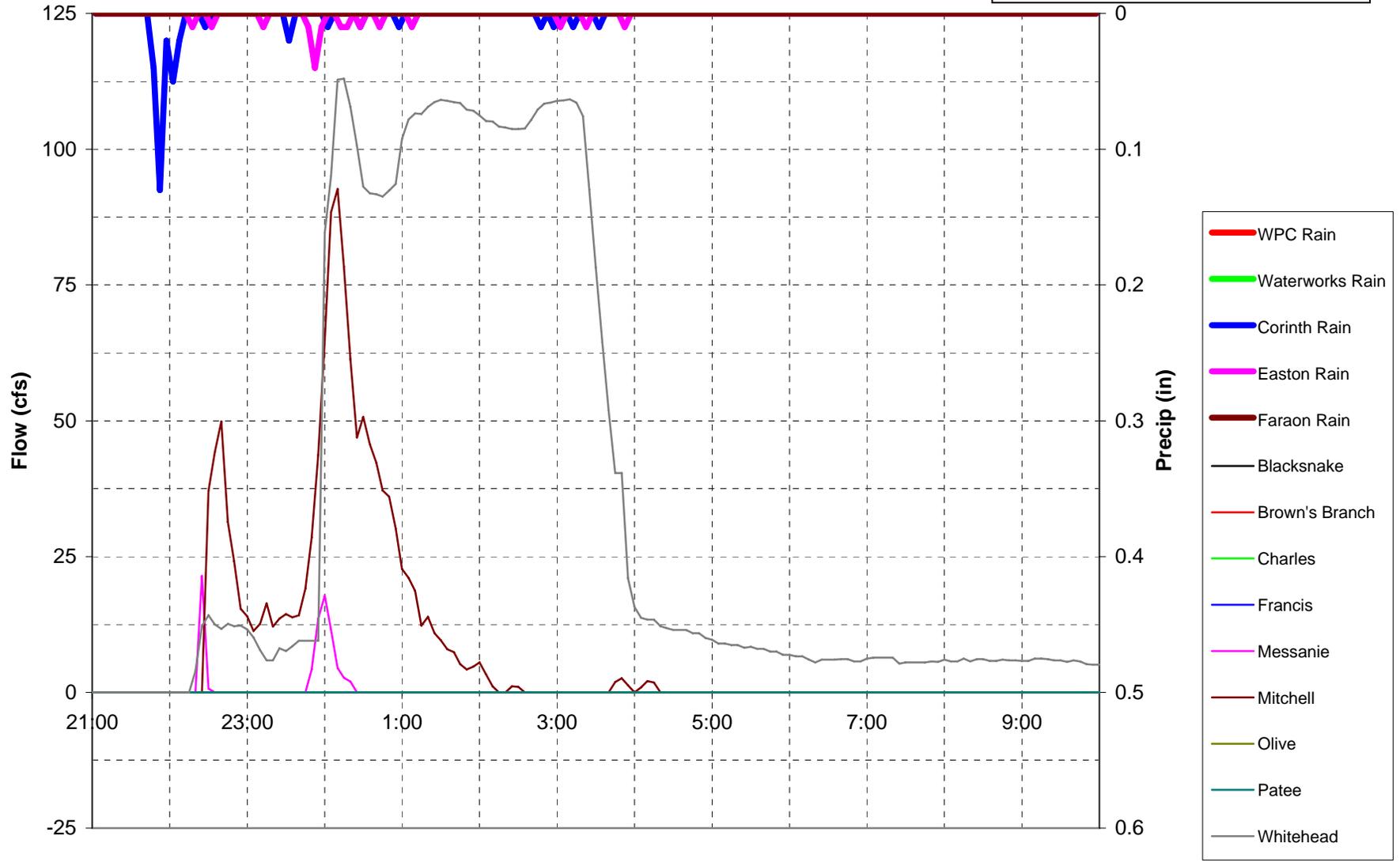
St. Joseph, MO CSO Basins - Event 13

Dates Reporting:
Start Date: 6/18/2007 09:00
End Date: 6/18/2007 21:00



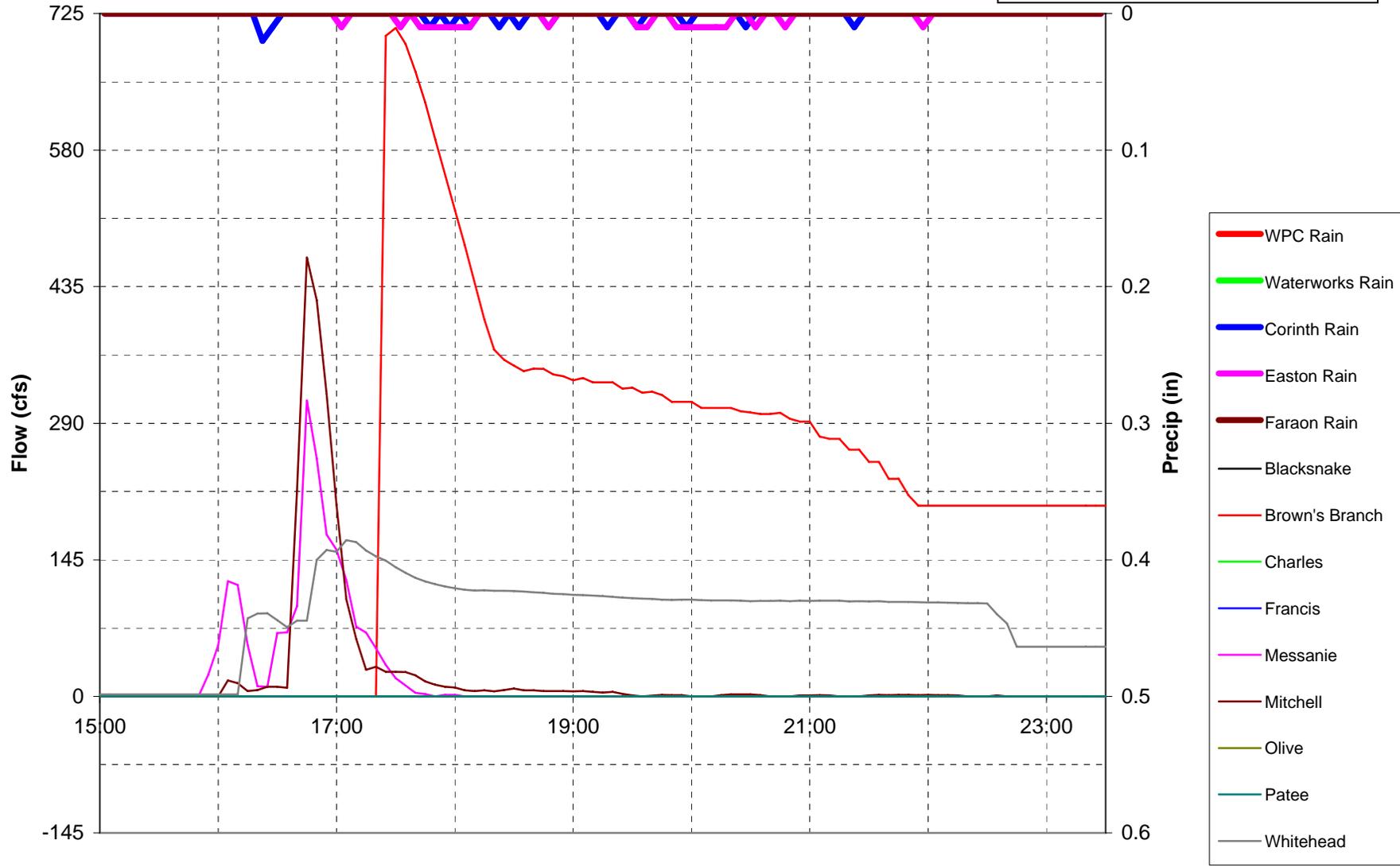
St. Joseph, MO CSO Basins - Event 14

Dates Reporting:
Start Date: 6/22/2007 21:00
End Date: 6/23/2007 10:00



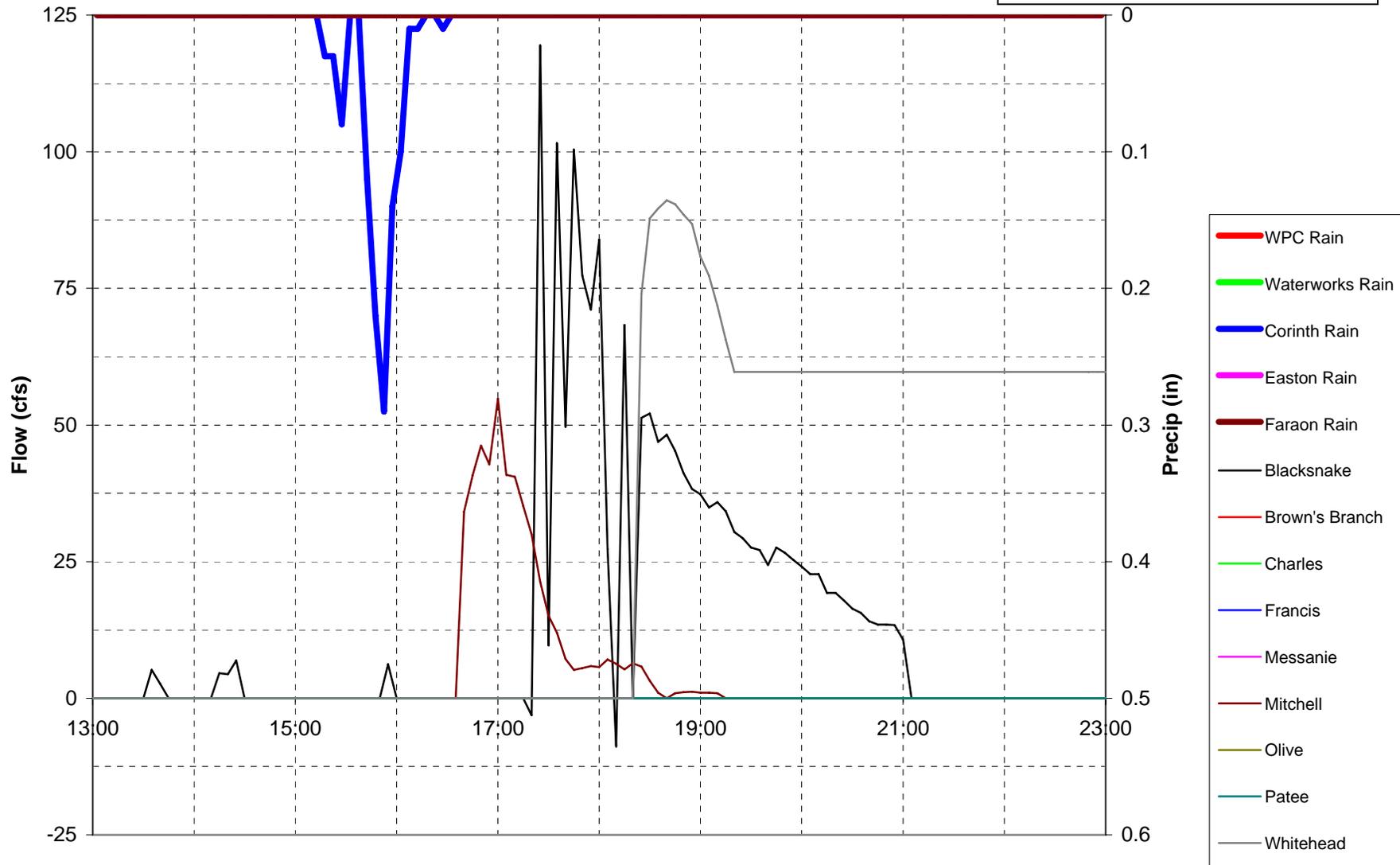
St. Joseph, MO CSO Basins - Event 15

Dates Reporting:
Start Date: 6/27/2007 15:00
End Date: 6/27/2007 23:30



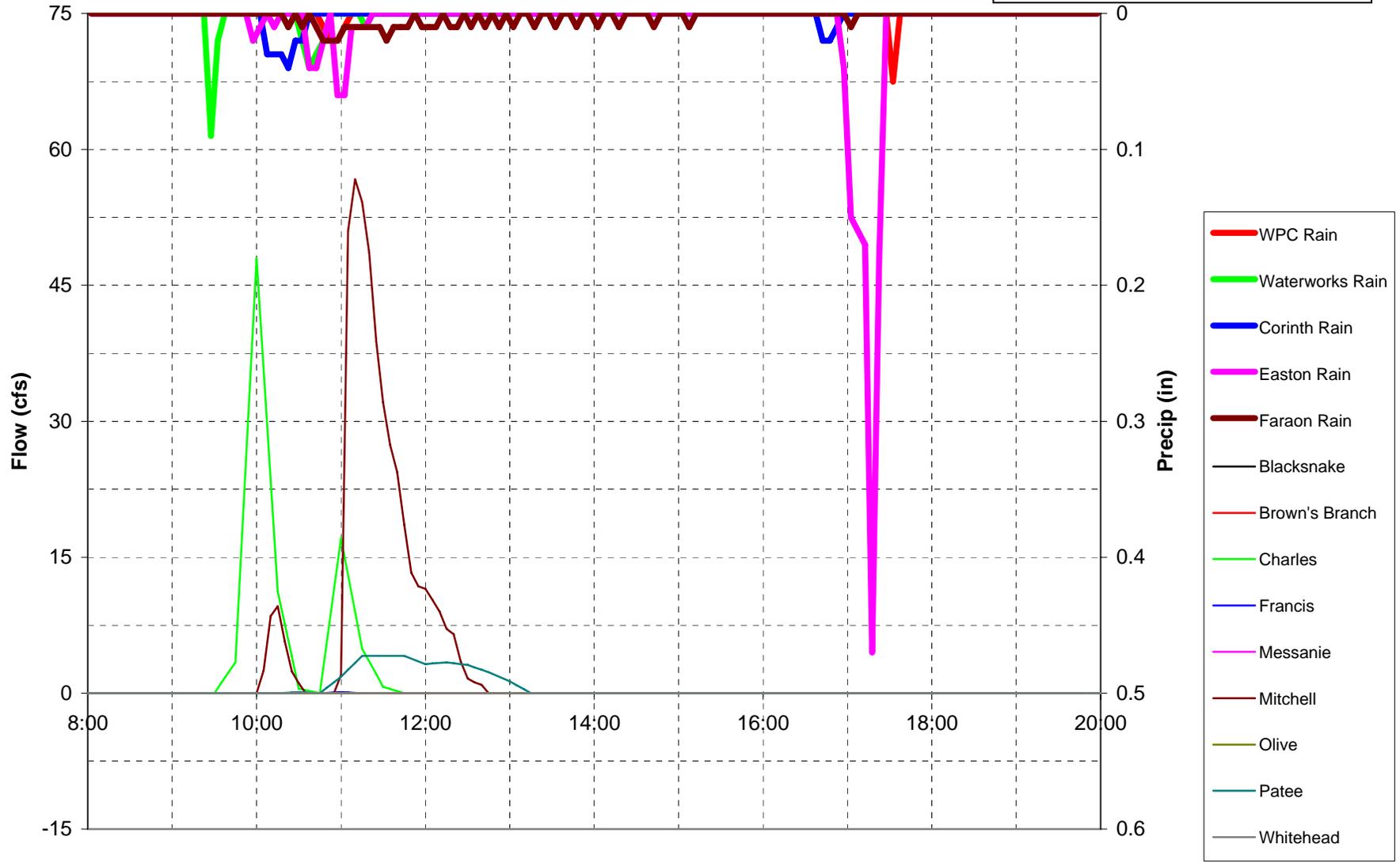
St. Joseph, MO CSO Basins - Event 16

Dates Reporting:
Start Date: 7/9/2007 13:00
End Date: 7/9/2007 23:00



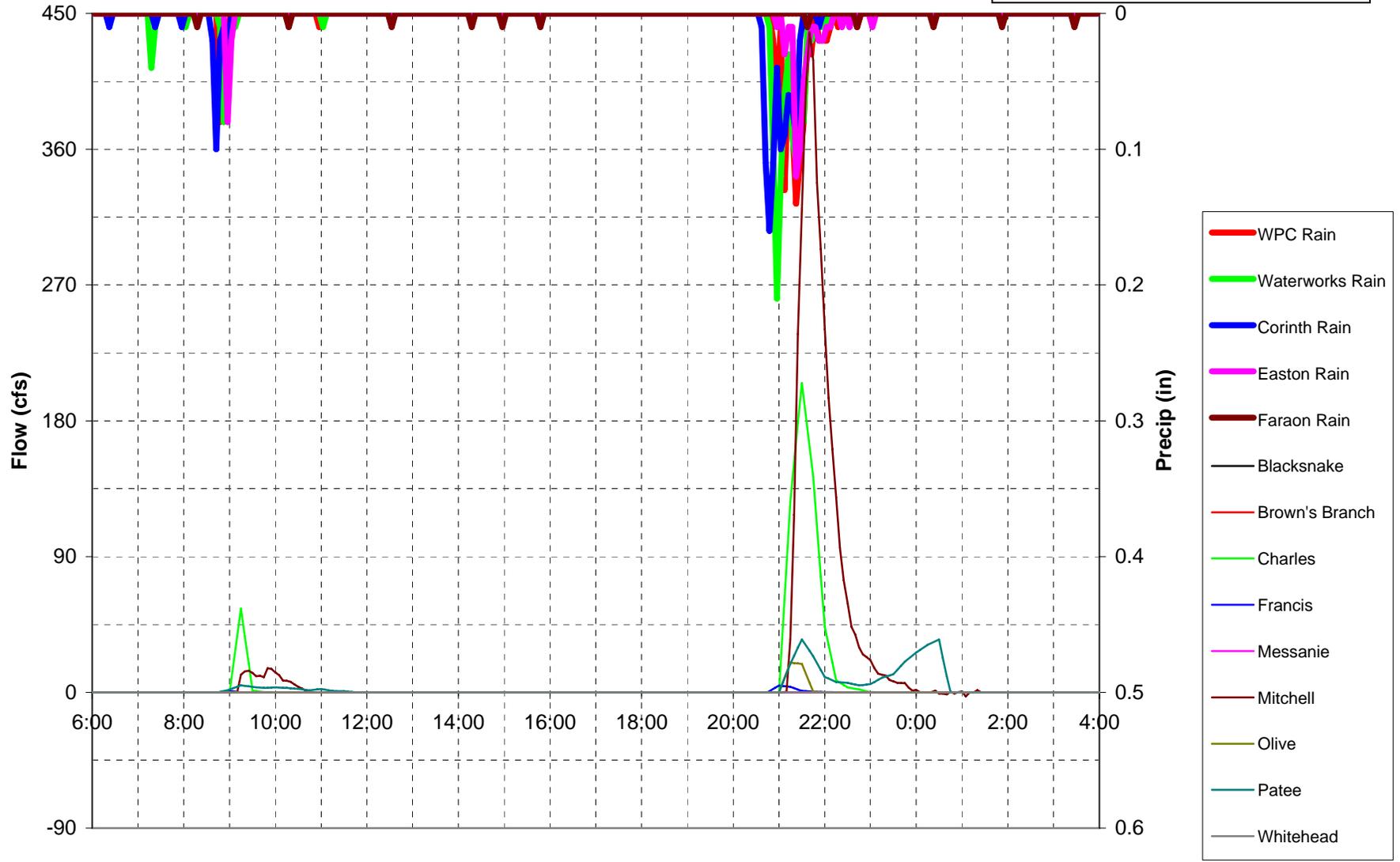
St. Joseph, MO CSO Basins - Event 18

Dates Reporting:
Start Date: 8/2/2007 08:00
End Date: 8/2/2007 20:00



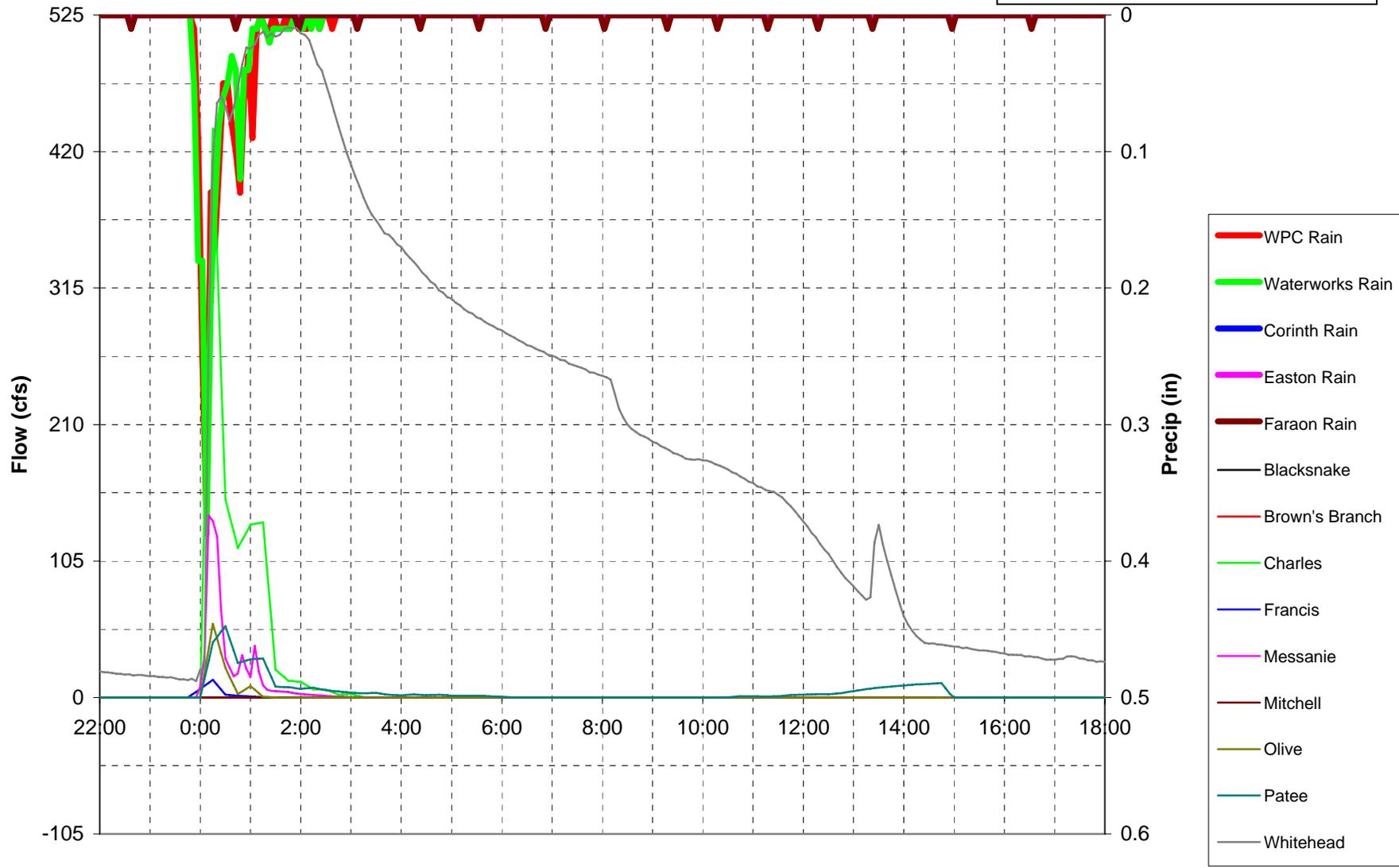
St. Joseph, MO CSO Basins - Event 19

Dates Reporting:
Start Date: 8/8/2007 06:00
End Date: 8/9/2007 04:00



St. Joseph, MO CSO Basins - Event 20

Dates Reporting:
Start Date: 9/6/2007 22:00
End Date: 9/7/2007 18:00



**Diversion Structure Discharge
Characteristics
Existing Conditions**

St. Joseph, MO

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Basin Summary

Basin:
 Diversion Structure No.:
 Design Condition/Alt.:
 Average Dry Weather Flow (ADWF), mgd:

St. Joseph CSO
 All
 Existing
 17.417

Rainfall Characteristics						Summary Data during Precipitation Events			
Design Storm ID	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Design Storm Summary		Estimated Annual Totals	
						Total Volume to Diversion Structures (mg)	Total Overflow Volume (mg)	Total Volume to Diversion Structures (mg)	Total Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.000	0.00	559.76	0.62
A	0.29	0.20	6.00	36	18	26.655	0.02965	524.19	20.40
B	0.51	0.26	8.75	18	6	31.589	2.24	261.38	78.91
C	0.86	0.58	12.25	12	6	55.537	24.07	648.27	453.45
D	1.41	0.75	16.75	6	2	160.551	127.08	427.89	359.52
E	1.82	0.87	19.75	4	1	267.341	232.44	295.48	260.28
F	2.00	0.95	21.00	3	1	323.621	288.11	385.83	349.67
G	2.37	1.06	23.75	2	1	448.045	411.23	542.05	497.17
H	2.88	1.25	26.75	1	1	636.057	583.11	636.06	583.11
Totals					78			4280.91	2603.13
Long-Term Mean Annual Rainfall (inches)					36.5				
Long-Term Median Annual Rainfall (inches)					35.0				
Total Rainfall Depth Represented Above (inches)					37.04				
Estimated Total Annual Inflow to Diversion Structures (mg)						10197.78			
Estimated Annual Volume Retained in System (mg)						7771.27			
ESTIMATED BASIN-WIDE ANNUAL CAPTURE DURING PRECIPITATION EVENTS						39%			
ESTIMATED BASIN-WIDE OVERALL CAPTURE						74%			

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Roys_Branch

Basin: **St. Joseph CSO**
 Diversion Structure No.: **BSS-30**
 Discharges to Outfall No.: **BSS-RIVER**
 Design Condition/Alt.: **Existing**

Or to: At:

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics				Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)	
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.00	0.00	
A	0.29	0.20	6.00	36	18	0.00	0.00	0.00	0.00	0.00	0.00	15.25	0.07	0.07	
B	0.51	0.26	8.75	18	6	30.50	0.01	0.04	0.01	0.04	30.50	30.08	2.06	2.06	
C	0.86	0.58	12.25	12	6	29.67	0.68	1.22	0.68	1.22	29.67	28.79	37.54	37.54	
D	1.41	0.75	16.75	6	2	27.92	11.84	34.52	11.84	34.52	27.92	27.29	28.51	28.51	
E	1.82	0.87	19.75	4	1	26.67	16.67	70.38	16.67	70.38	26.67	26.54	18.15	18.15	
F	2.00	0.95	21.00	3	1	26.42	19.63	93.79	19.63	93.79	26.42	26.17	22.98	22.98	
G	2.37	1.06	23.75	2	1	25.92	26.33	143.46	26.33	143.46	25.92	25.79	31.22	31.22	
H	2.88	1.25	26.75	1	1	25.67	36.11	243.33	36.11	243.33	25.67	25.67	36.11	36.11	
					78								176.63	176.63	
Estimated Annual Time During Runoff Events (hours)											787				
Estimated Annual Time Between Runoff Events											7,974				
Estimated Annual Inflow at ADWF Between Runoff Events (mg)											0				
Estimated Total Annual Inflow to Diversion Structure (mg)												176.63			
Estimated Annual Volume Retained in System (mg)												0.00			
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS													0%		
ESTIMATED OVERALL CAPTURE													0%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Blacksnake

Basin: **St. Joseph CSO**
 Diversion Structure No.: **BSS-30**
 Discharges to Outfall No.: **BSS-RIVER**
 Design Condition/Alt.: **Existing**

Or to: _____ At: _____

Average Dry Weather Flow (mgd):

4.6 (ADWF)

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	2.38	142.78	0.00
A	0.29	0.20	6.00	36	18	4.75	6.80	6.85	0.00	0.00	0.00	5.79	126.99	0.00
B	0.51	0.26	8.75	18	6	6.83	7.31	11.66	0.00	0.00	0.00	8.13	51.30	1.93
C	0.86	0.58	12.25	12	6	9.42	9.79	28.05	0.64	13.26	3.58	11.67	104.97	44.37
D	1.41	0.75	16.75	6	2	13.92	25.20	140.32	14.15	126.14	10.25	15.50	69.57	46.57
E	1.82	0.87	19.75	4	1	17.08	44.37	299.61	32.43	284.46	12.17	17.79	49.58	37.41
F	2.00	0.95	21.00	3	1	18.50	54.80	389.45	42.40	373.47	12.92	19.83	66.62	53.76
G	2.37	1.06	23.75	2	1	21.17	78.43	631.85	65.13	613.04	14.58	23.42	96.33	75.29
H	2.88	1.25	26.75	1	1	25.67	114.23	1125.03	85.45	854.41	16.50	25.67	114.23	85.45
					78								822.37	344.78
											Estimated Annual Time During Runoff Events (hours)	440		
											Estimated Annual Time Between Runoff Events	8,320		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	1594.578819		
											Estimated Total Annual Inflow to Diversion Structure (mg)	2416.94		
											Estimated Annual Volume Retained in System (mg)	2072.16		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS	58%		
											ESTIMATED OVERALL CAPTURE	86%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Francis

Basin: **St. Joseph CSO**
 Diversion Structure No.: **16-37**
 Discharges to Outfall No.: **16-River1**
 Design Condition/Alt.: **Existing**

Or to: _____ At: _____

Average Dry Weather Flow (mgd):

0.0 (ADWF)

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.02	0.00
A	0.29	0.20	6.00	36	18	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.02	0.00
B	0.51	0.26	8.75	18	6	4.00	0.00	0.00	0.00	0.00	0.00	5.38	0.03	0.00
C	0.86	0.58	12.25	12	6	6.75	0.01	0.07	0.00	0.00	0.00	8.13	0.11	0.00
D	1.41	0.75	16.75	6	2	9.50	0.03	0.33	0.00	0.00	0.08	10.50	0.08	0.00
E	1.82	0.87	19.75	4	1	11.50	0.05	0.59	0.00	0.17	0.67	12.04	0.05	0.00
F	2.00	0.95	21.00	3	1	12.58	0.06	0.82	0.01	0.39	0.75	13.63	0.07	0.01
G	2.37	1.06	23.75	2	1	14.67	0.08	1.02	0.02	0.59	1.08	16.71	0.09	0.02
H	2.88	1.25	26.75	1	1	18.75	0.11	1.47	0.03	1.02	1.33	18.75	0.11	0.03
					78								0.58	0.08
Estimated Annual Time During Runoff Events (hours)											199			
Estimated Annual Time Between Runoff Events											8,561			
Estimated Annual Inflow at ADWF Between Runoff Events (mg)											0			
Estimated Total Annual Inflow to Diversion Structure (mg)												0.58		
Estimated Annual Volume Retained in System (mg)												0.51		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS													87%	
ESTIMATED OVERALL CAPTURE													87%	

Basin: **St. Joseph CSO**
 Diversion Structure No.: **SBS-33**
 Discharges to Outfall No.: **SBS-RIVER**
 Design Condition/Alt.: **Existing**

Or to: _____

At: _____

Average Dry Weather Flow (mgd):

1.2 (ADWF)

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.42	1.78	2.19	0.00	0.10	1.50	1.71	37.31	0.03
B	0.51	0.26	8.75	18	6	5.42	2.33	12.10	0.40	9.56	5.50	4.42	36.94	3.59
C	0.86	0.58	12.25	12	6	7.67	4.19	31.13	2.12	28.59	8.00	6.54	19.56	7.54
D	1.41	0.75	16.75	6	2	11.75	8.85	88.32	6.69	86.30	11.42	9.71	39.11	26.42
E	1.82	0.87	19.75	4	1	14.75	13.04	143.64	10.99	143.12	14.33	13.25	21.89	17.68
F	2.00	0.95	21.00	3	1	16.08	15.18	195.18	13.26	196.51	15.50	15.42	14.11	12.13
G	2.37	1.06	23.75	2	1	18.58	19.59	235.18	17.84	237.82	18.00	17.33	17.39	15.55
H	2.88	1.25	26.75	1	1	21.58	26.09	324.04	24.58	330.60	21.25	20.08	22.84	21.21
					78							21.58	26.09	24.58
												235.24	128.74	
Estimated Annual Time During Runoff Events (hours)												350		
Estimated Annual Time Between Runoff Events												8,410		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												420.5166667		
Estimated Total Annual Inflow to Diversion Structure (mg)												655.76		
Estimated Annual Volume Retained in System (mg)												527.02		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												45%		
ESTIMATED OVERALL CAPTURE												80%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Messanie

Basin: **St. Joseph CSO**
 Diversion Structure No.: **9-75**
 Discharges to Outfall No.: **9-RIVER** Or to:
 Design Condition/Alt.: **Existing**
 Average Dry Weather Flow (mgd): **0.1 (ADWF)**

At:

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.75	0.23	1.19	0.01	0.60	1.25	1.88	4.79	0.22
B	0.51	0.26	8.75	18	6	6.08	0.34	2.73	0.09	2.29	3.25	4.92	5.12	0.88
C	0.86	0.58	12.25	12	6	9.50	0.60	5.76	0.59	5.60	7.67	7.79	2.81	2.02
D	1.41	0.75	16.75	6	6	14.25	1.16	11.99	1.45	13.00	12.17	11.88	5.27	6.11
E	1.82	0.87	19.75	4	2	17.33	1.65	17.57	2.10	19.90	15.17	15.79	2.81	3.55
F	2.00	0.95	21.00	3	1	18.67	1.90	22.29	2.44	29.14	16.17	18.00	1.78	2.27
G	2.37	1.06	23.75	2	1	21.42	2.41	27.00	3.04	30.54	18.67	20.04	2.15	2.74
H	2.88	1.25	26.75	1	1	26.00	3.15	36.15	4.00	40.58	22.50	23.71	2.78	3.52
					78							26.00	3.15	4.00
												30.66	25.31	
Estimated Annual Time During Runoff Events (hours)												405		
Estimated Annual Time Between Runoff Events												8,355		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												41.77708333		
Estimated Total Annual Inflow to Diversion Structure (mg)												72.44		
Estimated Annual Volume Retained in System (mg)												47.13		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												17%		
ESTIMATED OVERALL CAPTURE												65%		

Basin: **St. Joseph CSO**
 Diversion Structure No.: **9-76**
 Discharges to Outfall No.: **9-R2** Or to: _____
 Design Condition/Alt.: **Existing** At: _____
 Average Dry Weather Flow (mgd): **0.0 (ADWF)**

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.75	0.05	0.32	0.00	0.00	0.00	1.88	1.09	0.00
B	0.51	0.26	8.75	18	6	6.08	0.10	1.05	0.02	0.80	2.08	4.92	1.39	0.21
C	0.86	0.58	12.25	12	6	9.42	0.22	2.50	0.11	2.44	3.92	7.75	0.97	0.41
D	1.41	0.75	16.75	6	6	13.92	0.45	5.65	0.31	6.01	6.58	11.67	2.01	1.25
E	1.82	0.87	19.75	4	2	16.83	0.63	7.65	0.51	8.18	9.67	15.38	1.08	0.81
F	2.00	0.95	21.00	3	1	18.33	0.72	9.32	0.61	10.10	10.42	17.58	0.68	0.56
G	2.37	1.06	23.75	2	1	21.17	0.90	10.76	0.81	11.90	12.17	19.75	0.81	0.71
H	2.88	1.25	26.75	1	1	24.50	1.14	13.66	1.08	16.26	14.67	22.83	1.02	0.94
					78							24.50	1.14	1.08
												10.20	5.97	
												399		
												8,361		
												8,012,465,278		
												18.21		
												12.24		
												41%		
												67%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Mitchell

Basin: **St. Joseph CSO**
 Diversion Structure No.: **N7**
 Discharges to Outfall No.: **BDCS-RIVER** Or to:
 Design Condition/Alt.: **Existing**
 Average Dry Weather Flow (mgd): **4.7 (ADWF)**

At:

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	0.00	7.06	4.69	0.00	0.00	0.00	0.00	148.17	0.00
B	0.51	0.26	8.75	18	6	0.00	7.14	5.00	0.98	18.86	3.58	0.00	127.74	8.84
C	0.86	0.58	12.25	12	6	7.50	9.00	18.29	8.74	41.10	7.75	3.75	48.41	29.16
D	1.41	0.75	16.75	6	6	10.75	21.02	133.59	26.03	158.55	11.25	9.13	90.05	104.32
E	1.82	0.87	19.75	4	2	12.50	35.47	262.90	43.13	288.09	13.17	11.63	56.48	69.17
F	2.00	0.95	21.00	3	1	13.42	43.25	372.96	52.12	396.43	14.08	12.96	39.36	47.63
G	2.37	1.06	23.75	2	1	15.08	60.75	585.03	72.04	606.97	16.00	14.25	52.00	62.08
H	2.88	1.25	26.75	1	1	18.25	87.73	996.33	103.05	1022.15	19.75	16.67	74.24	87.54
					78							18.25	87.73	103.05
												724.17	511.80	
Estimated Annual Time During Runoff Events (hours)												163		
Estimated Annual Time Between Runoff Events												8,597		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												1683.652604		
Estimated Total Annual Inflow to Diversion Structure (mg)												2407.83		
Estimated Annual Volume Retained in System (mg)												1896.03		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS													29%	
ESTIMATED OVERALL CAPTURE													79%	

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Duncan

Basin: **St. Joseph CSO**
 Diversion Structure No.: **83-18**
 Discharges to Outfall No.: **83-RIVER** Or to:
 Design Condition/Alt.: **Existing**
 Average Dry Weather Flow (mgd): **0.0 (ADWF)**

At:

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range				
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)		
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00					
A	0.29	0.20	6.00	36	18	4.08	0.07	1.14	0.02	0.68	1.83	2.04	1.37	0.38		
B	0.51	0.26	8.75	18	6	6.50	0.16	2.40	0.08	1.91	2.92	5.29	2.06	0.85		
C	0.86	0.58	12.25	12	6	9.75	0.36	5.19	0.36	4.61	7.75	8.13	1.58	1.30		
D	1.41	0.75	16.75	6	6	14.67	0.73	9.76	0.88	9.07	12.50	12.21	3.28	3.72		
E	1.82	0.87	19.75	4	2	17.50	1.02	12.66	1.25	12.71	15.50	16.08	1.76	2.13		
F	2.00	0.95	21.00	3	1	18.83	1.16	15.10	1.41	15.45	16.42	18.17	1.09	1.33		
G	2.37	1.06	23.75	2	1	22.00	1.45	17.33	1.75	17.72	18.58	20.42	1.31	1.58		
H	2.88	1.25	26.75	1	1	24.92	1.85	21.71	2.21	22.06	22.67	23.46	1.65	1.98		
					78							24.92	1.85	2.21		
												15.95	15.48			
												Estimated Annual Time During Runoff Events (hours)		422		
												Estimated Annual Time Between Runoff Events		8,338		
												Estimated Annual Inflow at ADWF Between Runoff Events (mg)		1,389645833		
												Estimated Total Annual Inflow to Diversion Structure (mg)		17.34		
												Estimated Annual Volume Retained in System (mg)		1.86		
												ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS		3%		
												ESTIMATED OVERALL CAPTURE		11%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Maple

Basin: **St. Joseph CSO**
 Diversion Structure No.: **84-8**
 Discharges to Outfall No.: **84-RIVER** Or to:
 Design Condition/Alt.: **Existing**
 Average Dry Weather Flow (mgd): **0.3 (ADWF)**

At:

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.67	0.50	0.96	0.00	0.00	0.00	1.83	10.49	0.00
B	0.51	0.26	8.75	18	6	5.83	0.68	3.55	0.06	2.13	4.42	4.75	10.60	0.58
C	0.86	0.58	12.25	12	6	8.92	1.31	9.21	0.54	7.51	9.50	7.38	5.98	1.83
D	1.41	0.75	16.75	6	6	13.42	2.97	29.64	2.31	27.57	12.42	11.17	12.85	8.56
E	1.82	0.87	19.75	4	2	16.33	4.51	47.52	4.02	46.00	14.58	14.88	7.48	6.33
F	2.00	0.95	21.00	3	1	17.50	5.28	64.14	4.86	62.53	15.58	16.92	4.89	4.44
G	2.37	1.06	23.75	2	1	20.00	6.92	79.14	6.66	79.29	17.75	18.75	6.10	5.76
H	2.88	1.25	26.75	1	1	25.25	9.32	111.85	9.27	112.86	20.42	22.63	8.12	7.97
					78							25.25	9.32	9.27
												75.83	44.74	
Estimated Annual Time During Runoff Events (hours)												387		
Estimated Annual Time Between Runoff Events												8,373		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												90.70704861		
Estimated Total Annual Inflow to Diversion Structure (mg)												166.54		
Estimated Annual Volume Retained in System (mg)												121.80		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												41%		
ESTIMATED OVERALL CAPTURE												73%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Hickory

Basin: St. Joseph CSO
 Diversion Structure No.: 33-1
 Discharges to Outfall No.: 33-RIVER
 Design Condition/Alt.: Existing

Or to: [Redacted]

At: [Redacted]

Average Dry Weather Flow (mgd): 0.3 (ADWF)

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	0.00	0.41	0.32	0.00	0.00	0.00	0.00	8.54	0.00
B	0.51	0.26	8.75	18	6	4.58	0.44	0.67	0.00	0.08	5.67	2.29	7.58	0.03
C	0.86	0.58	12.25	12	6	7.17	0.68	2.62	0.54	4.89	11.17	5.88	3.35	1.63
D	1.41	0.75	16.75	6	2	10.00	1.54	12.63	1.74	13.91	14.92	8.58	6.65	6.85
E	1.82	0.87	19.75	4	1	12.33	2.41	23.20	2.80	24.68	16.83	11.17	3.94	4.54
F	2.00	0.95	21.00	3	1	13.50	2.86	33.19	3.32	34.53	17.75	12.92	2.63	3.06
G	2.37	1.06	23.75	2	1	15.67	3.83	42.73	4.45	44.98	19.75	14.58	3.34	3.88
H	2.88	1.25	26.75	1	1	19.58	5.28	63.99	6.11	65.97	22.83	17.63	4.56	5.28
					78							19.58	5.28	6.11
												45.89	31.38	
Estimated Annual Time During Runoff Events (hours)												215		
Estimated Annual Time Between Runoff Events												8,545		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												96.13078125		
Estimated Total Annual Inflow to Diversion Structure (mg)												142.02		
Estimated Annual Volume Retained in System (mg)												110.64		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS													32%	
ESTIMATED OVERALL CAPTURE													78%	

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Whitehead

Basin: **St. Joseph CSO**
 Diversion Structure No.: **WMS-19**
 Discharges to Outfall No.: **WMS-RIVER** Or to: _____ At: _____
 Design Condition/Alt.: **Existing**
 Average Dry Weather Flow (mgd): **2.8 (ADWF)**

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	2.38	95.98	0.00
A	0.29	0.20	6.00	36	18	4.75	4.57	6.66	0.00	0.00	0.00	5.88	95.66	0.00
B	0.51	0.26	8.75	18	6	7.00	6.06	23.30	0.00	0.00	0.00	8.46	63.84	12.39
C	0.86	0.58	12.25	12	6	9.92	15.22	67.33	4.13	40.93	13.33	12.33	213.11	131.69
D	1.41	0.75	16.75	6	2	14.75	55.81	348.50	39.77	312.86	18.17	16.25	156.15	121.05
E	1.82	0.87	19.75	4	1	17.75	100.33	662.92	81.28	623.15	20.08	18.38	112.02	92.31
F	2.00	0.95	21.00	3	1	19.00	123.71	863.44	103.34	822.91	21.00	20.54	149.52	127.83
G	2.37	1.06	23.75	2	1	22.08	175.33	1305.04	152.32	1258.47	22.75	24.21	215.04	189.84
H	2.88	1.25	26.75	1	1	26.33	254.75	2149.51	227.35	2082.82	24.00	26.33	254.75	227.35
					78								1356.09	902.47
Estimated Annual Time During Runoff Events (hours)											452			
Estimated Annual Time Between Runoff Events											8,308			
Estimated Annual Inflow at ADWF Between Runoff Events (mg)											969,242,361			
Estimated Total Annual Inflow to Diversion Structure (mg)											2325.33			
Estimated Annual Volume Retained in System (mg)											1422.86			
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS											33%			
ESTIMATED OVERALL CAPTURE											61%			

Combined Sewer System
 Diversion Structure Discharge Characteristics
 MOAV

Basin: **St. Joseph CSO**

Diversion Structure No.:

Discharges to Outfall No.:

Design Condition/Alt.:

Existing

Or to:

At:

Average Dry Weather Flow (mgd):

2.1 (ADWF)

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	2.33	65.22	0.00
A	0.29	0.20	6.00	36	18	4.67	3.11	4.39	0.00	0.00	0.00	6.04	67.35	3.61
B	0.51	0.26	8.75	18	6	7.42	4.38	18.70	0.40	10.83	4.50	9.21	35.71	8.98
C	0.86	0.58	12.25	12	6	11.00	7.53	42.20	2.59	34.12	8.25	13.54	63.09	30.77
D	1.41	0.75	16.75	6	2	16.08	13.50	112.93	7.66	104.62	11.25	17.38	32.14	19.80
E	1.82	0.87	19.75	4	1	18.67	18.64	166.99	12.14	157.78	13.42	19.42	19.88	13.23
F	2.00	0.95	21.00	3	1	20.17	21.12	211.61	14.31	202.20	14.50	23.13	23.74	16.61
G	2.37	1.06	23.75	2	1	26.08	26.36	250.32	18.90	242.27	16.58	26.29	29.99	22.09
H	2.88	1.25	26.75	1	1	26.50	33.62	325.36	25.28	316.52	19.42	26.50	33.62	25.28
					78								370.74	140.37
											Estimated Annual Time During Runoff Events (hours)	473		
											Estimated Annual Time Between Runoff Events	8,287		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	725,083,333		
											Estimated Total Annual Inflow to Diversion Structure (mg)	1095.83		
											Estimated Annual Volume Retained in System (mg)	955.46		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS		62%	
											ESTIMATED OVERALL CAPTURE		87%	

Basin: **St. Joseph CSO**
 Diversion Structure No.: **BNB-24**
 Discharges to Outfall No.: **BNB-28**
 Design Condition/Alt.: **Existing**
 Average Dry Weather Flow (mgd): **1.3 (ADWF)**

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	2.29	41.35	0.00
A	0.29	0.20	6.00	36	18	4.58	1.97	2.33	0.00	0.00	0.00	5.63	39.68	0.34
B	0.51	0.26	8.75	18	6	7.08	2.44	10.77	0.04	2.21	0.75	9.54	23.83	7.32
C	0.86	0.58	12.25	12	6	12.00	5.50	36.78	2.40	30.54	7.33	15.25	65.91	45.74
D	1.41	0.75	16.75	6	2	18.50	16.47	134.15	12.84	128.80	10.33	19.04	43.50	35.91
E	1.82	0.87	19.75	4	1	19.58	27.04	216.91	23.07	210.19	12.17	20.21	29.62	25.58
F	2.00	0.95	21.00	3	1	20.83	32.21	289.32	28.08	283.79	13.08	22.13	37.81	33.53
G	2.37	1.06	23.75	2	1	23.42	43.42	394.75	38.98	388.19	15.00	26.67	51.53	46.82
H	2.88	1.25	26.75	1	1	29.92	59.65	581.65	54.66	576.30	17.67	29.92	59.65	54.66
					78								392.89	249.89
											Estimated Annual Time During Runoff Events (hours)	487		
											Estimated Annual Time Between Runoff Events (hours)	8,273		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	434,3325		
											Estimated Total Annual Inflow to Diversion Structure (mg)	827.22		
											Estimated Annual Volume Retained in System (mg)	577.33		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS	36%		
											ESTIMATED OVERALL CAPTURE	70%		

**Diversion Structure Discharge
Characteristics
Alternative 4 Phase I**

St. Joseph, MO

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Basin Summary

Basin:
 Diversion Structure No.:
 Design Condition/Alt.:
 Average Dry Weather Flow (ADWF), mgd:

St. Joseph CSO
 All
 ALT 4 - Phase 1
 17.417

Design Storm ID	Rainfall Characteristics					Summary Data during Precipitation Events			
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Total Volume to Diversion Structures (mg)	Total Overflow Volume (mg)	Total Volume to Diversion Structures (mg)	Total Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.000	0.00	554.67	0.00
A	0.29	0.20	6.00	36	18	26.413	0.00	509.93	0.00
B	0.51	0.26	8.75	18	6	30.246	0.00	234.73	14.71
C	0.86	0.58	12.25	12	6	47.997	4.90	488.82	176.19
D	1.41	0.75	16.75	6	2	114.941	53.83	295.08	162.72
E	1.82	0.87	19.75	4	1	180.143	108.89	197.99	123.45
F	2.00	0.95	21.00	3	1	215.833	138.01	254.14	170.28
G	2.37	1.06	23.75	2	1	292.451	202.54	350.87	252.88
H	2.88	1.25	26.75	1	1	409.289	303.23	409.29	303.23
Totals				78				3295.51	1203.45
Long-Term Mean Annual Rainfall (inches)					36.5				
Long-Term Median Annual Rainfall (inches)					35.0				
Total Rainfall Depth Represented Above (inches)					37.04				
Estimated Total Annual Inflow to Diversion Structures (mg)						9184.32			
Estimated Annual Volume Retained in System (mg)						7980.87			
ESTIMATED BASIN-WIDE ANNUAL CAPTURE DURING PRECIPITATION EVENTS						63%			
ESTIMATED BASIN-WIDE OVERALL CAPTURE						87%			

NOTE:
 Additional flow equalization basin storage at both Patee and Missouri Avenue was discussed, 1 MG and 5 MG storage, respectively. If these storage basins were to be added to this proposed scenario, the system overflow event frequency would be reduced to 12 overflow events per year and the overflow volume would be reduced to ~1150 MG, which equates to ~65% estimated basin-wide annual capture during precipitation events.

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Roys_Branch

Basin: **St. Joseph CSO**
 Diversion Structure No.: **BSS-30**
 Discharges to Outfall No.: **BSS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 1**

Or to: _____ At: _____

Average Dry Weather Flow (mgd): **0.0 (ADWF)**

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.00	0.00
A	0.29	0.20	6.00	36	18	0.00	0.00	0.00	0.00	0.00	0.00	15.25	0.07	0.00
B	0.51	0.26	8.75	18	6	30.50	0.01	0.04	0.00	0.00	0.00	30.08	2.06	0.00
C	0.86	0.58	12.25	12	6	29.67	0.68	1.22	0.00	0.00	0.00	28.79	37.54	0.00
D	1.41	0.75	16.75	6	2	27.92	11.84	34.52	0.00	0.00	0.00	27.29	28.51	0.00
E	1.82	0.87	19.75	4	1	26.67	16.67	70.38	0.00	0.00	0.00	26.54	18.15	0.00
F	2.00	0.95	21.00	3	1	26.42	19.63	93.79	0.00	0.00	0.00	26.17	22.98	0.00
G	2.37	1.06	23.75	2	1	25.92	26.33	143.46	0.00	0.00	0.00	25.79	31.22	0.00
H	2.88	1.25	26.75	1	1	25.67	36.11	243.33	0.00	0.00	0.00	25.67	36.11	0.00
					78								176.63	0.00
											Estimated Annual Time During Runoff Events (hours)	787		
											Estimated Annual Time Between Runoff Events	7,974		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	0		
											Estimated Total Annual Inflow to Diversion Structure (mg)	176.63		
											Estimated Annual Volume Retained in System (mg)	176.63		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS	100%		
											ESTIMATED OVERALL CAPTURE	100%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Blacksake

Basin: **St. Joseph CSO**
 Diversion Structure No.: **BSS-30**
 Discharges to Outfall No.: **BSS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 1**

Or to: _____ At: _____

Average Dry Weather Flow (mgd):

4.6 (ADWF)

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	0.00	141.80	0.00
A	0.29	0.20	6.00	36	18	0.00	6.75	4.87	0.00	0.00	0.00	1.25	122.94	0.00
B	0.51	0.26	8.75	18	6	2.50	6.91	7.18	0.00	0.00	0.00	4.83	44.48	0.00
C	0.86	0.58	12.25	12	6	7.17	7.92	12.35	0.00	0.00	0.00	8.88	65.90	10.07
D	1.41	0.75	16.75	6	2	10.58	14.05	66.55	3.36	49.09	8.92	11.79	35.65	13.11
E	1.82	0.87	19.75	4	1	13.00	21.60	127.39	9.75	110.12	11.33	13.54	23.64	11.55
F	2.00	0.95	21.00	3	1	14.08	25.68	194.38	13.34	177.25	12.17	15.13	30.30	17.43
G	2.37	1.06	23.75	2	1	16.17	34.91	297.54	21.52	278.50	13.83	18.08	42.13	28.07
H	2.88	1.25	26.75	1	1	20.00	49.34	512.17	34.62	489.27	15.50	20.00	49.34	34.62
					78								556.17	114.85
Estimated Annual Time During Runoff Events (hours)											195			
Estimated Annual Time Between Runoff Events											8,565			
Estimated Annual Inflow at ADWF Between Runoff Events (mg)											1641,609028			
Estimated Total Annual Inflow to Diversion Structure (mg)											2197.78			
Estimated Annual Volume Retained in System (mg)											2082.92			
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS											79%			
ESTIMATED OVERALL CAPTURE											95%			

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Francis

Basin: **St. Joseph CSO**
 Diversion Structure No.: **16-37**
 Discharges to Outfall No.: **16-River1**
 Design Condition/Alt.: **ALT 4 - Phase 1**

Or to: _____ At: _____

Average Dry Weather Flow (mgd):

0.0 (ADWF)

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.02	0.00
A	0.29	0.20	6.00	36	18	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.02	0.00
B	0.51	0.26	8.75	18	6	4.00	0.00	0.00	0.00	0.00	0.00	5.38	0.03	0.00
C	0.86	0.58	12.25	12	6	6.75	0.01	0.07	0.00	0.00	0.00	8.13	0.11	0.00
D	1.41	0.75	16.75	6	2	9.50	0.03	0.33	0.00	0.00	0.00	10.50	0.08	0.00
E	1.82	0.87	19.75	4	1	11.50	0.05	0.59	0.00	0.00	0.00	12.04	0.05	0.00
F	2.00	0.95	21.00	3	1	12.58	0.06	0.82	0.00	0.00	0.00	13.63	0.07	0.00
G	2.37	1.06	23.75	2	1	14.67	0.08	1.02	0.00	0.00	0.00	16.71	0.09	0.00
H	2.88	1.25	26.75	1	1	18.75	0.11	1.47	0.00	0.00	0.00	18.75	0.11	0.00
					78								0.58	0.00
Estimated Annual Time During Runoff Events (hours)											199			
Estimated Annual Time Between Runoff Events											8,561			
Estimated Annual Inflow at ADWF Between Runoff Events (mg)											0			
Estimated Total Annual Inflow to Diversion Structure (mg)											0.58			
Estimated Annual Volume Retained in System (mg)											0.58			
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS											100%			
ESTIMATED OVERALL CAPTURE											100%			

Basin: **St. Joseph CSO**
 Diversion Structure No.: **SBS-33**
 Discharges to Outfall No.: **SBS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 1**
 Average Dry Weather Flow (mgd): **1.2 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.42	1.78	2.19	0.00	0.00	0.00	1.71	37.31	0.00
B	0.51	0.26	8.75	18	6	5.42	2.33	12.10	0.00	0.00	0.00	4.42	36.94	0.00
C	0.86	0.58	12.25	12	6	7.67	4.19	31.13	0.00	0.00	0.00	6.54	19.55	0.00
D	1.41	0.75	16.75	6	6	11.75	9.05	139.24	7.95	160.24	27.92	9.71	39.73	23.86
E	1.82	0.87	19.75	4	2	14.75	12.97	143.45	11.37	142.35	26.58	13.25	22.02	19.33
F	2.00	0.95	21.00	3	1	16.08	15.08	195.04	13.42	193.76	26.08	15.42	14.03	12.40
G	2.37	1.06	23.75	2	1	18.58	19.55	235.05	17.68	235.51	24.83	17.33	17.32	15.55
H	2.88	1.25	26.75	1	1	21.58	25.38	323.96	22.90	331.02	23.58	20.08	22.47	20.29
					78							21.58	25.38	22.90
												234.76	114.32	
Estimated Annual Time During Runoff Events (hours)												350		
Estimated Annual Time Between Runoff Events												8,410		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												420.5166667		
Estimated Total Annual Inflow to Diversion Structure (mg)												655.27		
Estimated Annual Volume Retained in System (mg)												540.95		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												51%		
ESTIMATED OVERALL CAPTURE												83%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Messanie

Basin: **St. Joseph CSO**
 Diversion Structure No.: **9-75**
 Discharges to Outfall No.: **9-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 1**
 Average Dry Weather Flow (mgd): **0.1 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.75	0.23	1.19	0.00	0.00	0.00	1.88	4.79	0.00
B	0.51	0.26	8.75	18	6	6.08	0.34	2.73	0.00	0.00	0.00	4.92	5.11	0.00
C	0.86	0.58	12.25	12	6	9.50	0.60	5.76	0.00	0.02	1.42	7.79	2.81	0.00
D	1.41	0.75	16.75	6	2	14.17	1.16	11.99	0.39	16.58	2.92	11.83	5.27	1.17
E	1.82	0.87	19.75	4	1	17.33	1.65	17.57	0.83	26.30	3.58	15.75	2.81	1.22
F	2.00	0.95	21.00	3	1	18.67	1.90	22.27	1.11	30.39	3.92	18.00	1.77	0.97
G	2.37	1.06	23.75	2	1	21.42	2.41	26.98	1.61	30.95	4.42	20.04	2.15	1.36
H	2.88	1.25	26.75	1	1	26.00	3.15	36.15	2.32	44.01	5.08	23.71	2.78	1.96
					78							26.00	3.15	2.32
												30.66	9.00	
Estimated Annual Time During Runoff Events (hours)												404		
Estimated Annual Time Between Runoff Events												8,356		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												41,77875		
Estimated Total Annual Inflow to Diversion Structure (mg)												72.44		
Estimated Annual Volume Retained in System (mg)												63.44		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												71%		
ESTIMATED OVERALL CAPTURE												88%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Patee

Basin: **St. Joseph CSO**
 Diversion Structure No.: **9-76**
 Discharges to Outfall No.: **9-R2**
 Design Condition/Alt.: **ALT 4 - Phase 1**
 Average Dry Weather Flow (mgd): **0.1 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.08	0.13	0.36	0.00	0.00	0.00	1.54	2.65	0.00
B	0.51	0.26	8.75	18	6	5.08	0.21	1.75	0.00	0.00	0.00	4.08	2.99	0.00
C	0.86	0.58	12.25	12	6	7.58	0.44	4.20	0.46	7.62	4.58	6.33	1.94	1.39
D	1.41	0.75	16.75	6	6	11.75	1.00	10.55	1.50	18.47	7.83	9.67	4.31	5.90
E	1.82	0.87	19.75	4	2	14.92	1.50	16.65	2.78	26.57	11.42	13.33	2.49	4.28
F	2.00	0.95	21.00	3	1	16.17	1.74	21.71	3.28	30.31	12.25	15.54	1.62	3.03
G	2.37	1.06	23.75	2	1	18.75	2.26	26.61	4.36	35.38	15.17	17.46	2.00	3.82
H	2.88	1.25	26.75	1	1	23.17	3.02	36.09	5.88	45.82	16.92	20.96	2.64	5.12
					78							23.17	3.02	5.88
												23.66	29.42	
Estimated Annual Time During Runoff Events (hours)												338		
Estimated Annual Time Between Runoff Events												8,422		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												28.07319444		
Estimated Total Annual Inflow to Diversion Structure (mg)												51.74		
Estimated Annual Volume Retained in System (mg)												22.31		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												-24%		
ESTIMATED OVERALL CAPTURE												43%		

Basin: **St. Joseph CSO**
 Diversion Structure No.: **9-76**
 Discharges to Outfall No.: **9-R2**
 Design Condition/Alt.: **ALT 4 - Phase 1**
 Average Dry Weather Flow (mgd): **0.0 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.58	0.05	0.42	0.00	0.00	0.00	1.79	1.09	0.00
B	0.51	0.26	8.75	18	6	6.00	0.10	1.05	0.00	0.00	0.00	4.79	1.39	0.00
C	0.86	0.58	12.25	12	6	9.25	0.22	2.49	0.00	0.00	0.00	7.63	0.97	0.00
D	1.41	0.75	16.75	6	6	13.75	0.45	5.43	0.00	0.00	0.00	11.50	2.01	0.00
E	1.82	0.87	19.75	4	2	16.67	0.63	7.80	0.01	0.75	2.50	15.21	1.08	0.01
F	2.00	0.95	21.00	3	1	18.08	0.72	9.34	0.03	2.38	2.75	17.38	0.68	0.02
G	2.37	1.06	23.75	2	1	21.00	0.90	10.75	0.09	4.13	3.08	19.54	0.81	0.06
H	2.88	1.25	26.75	1	1	24.25	1.15	13.59	0.19	6.89	3.17	22.63	1.03	0.14
					1							24.25	1.15	0.19
					78								10.21	0.42
											Estimated Annual Time During Runoff Events (hours)	390		
											Estimated Annual Time Between Runoff Events	8,370		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	8.020810764		
											Estimated Total Annual Inflow to Diversion Structure (mg)	18.23		
											Estimated Annual Volume Retained in System (mg)	17.80		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS	96%		
											ESTIMATED OVERALL CAPTURE	98%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Mitchell

Basin: **St. Joseph CSO**
 Diversion Structure No.: **N7**
 Discharges to Outfall No.: **BDCS-RIVER** Or to:
 Design Condition/Alt.: **ALT 4 - Phase 1** At:
 Average Dry Weather Flow (mgd): **4.7 (ADWF)**

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	0.00	7.03	4.68	0.00	0.00	0.00	0.00	147.67	0.00
B	0.51	0.26	8.75	18	6	0.00	7.09	4.95	0.00	0.00	0.00	0.00	127.07	0.00
C	0.86	0.58	12.25	12	6	7.33	8.94	18.18	0.00	0.00	0.00	3.67	48.07	0.00
D	1.41	0.75	16.75	6	6	10.42	20.37	136.23	12.37	164.32	9.25	8.88	87.91	37.11
E	1.82	0.87	19.75	4	2	12.33	35.17	264.25	29.72	291.01	11.17	11.38	55.53	42.09
F	2.00	0.95	21.00	3	1	13.25	43.04	382.92	38.59	407.84	12.08	12.79	39.10	34.16
G	2.37	1.06	23.75	2	1	15.00	60.53	590.58	58.08	613.19	13.75	14.13	51.78	48.34
H	2.88	1.25	26.75	1	1	18.25	88.79	970.53	89.58	984.22	15.75	16.63	74.66	73.83
					78							18.25	88.79	89.58
												720.58	325.11	
Estimated Annual Time During Runoff Events (hours)												160		
Estimated Annual Time Between Runoff Events												8,600		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												1684.207465		
Estimated Total Annual Inflow to Diversion Structure (mg)												2404.79		
Estimated Annual Volume Retained in System (mg)												2079.68		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												55%		
ESTIMATED OVERALL CAPTURE												86%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Duncan

Basin: **St. Joseph CSO**
 Diversion Structure No.: **83-18**
 Discharges to Outfall No.: **83-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 1**
 Average Dry Weather Flow (mgd): **0.0 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	6.42	0.07	1.14	0.00	0.00	0.00	3.21	1.37	0.00
B	0.51	0.26	8.75	18	6	9.25	0.16	2.41	0.00	0.00	0.00	7.83	2.06	0.00
C	0.86	0.58	12.25	12	6	12.83	0.36	5.19	0.03	1.80	6.42	11.04	1.58	0.10
D	1.41	0.75	16.75	6	2	17.50	0.73	9.76	0.29	9.89	7.08	15.17	3.28	0.97
E	1.82	0.87	19.75	4	1	20.50	1.02	12.65	0.50	14.99	7.83	19.00	1.75	0.79
F	2.00	0.95	21.00	3	1	21.83	1.16	15.10	0.66	16.85	8.08	21.17	1.09	0.58
G	2.37	1.06	23.75	2	1	24.58	1.45	17.33	0.90	16.47	8.58	23.21	1.30	0.78
H	2.88	1.25	26.75	1	1	29.08	1.84	21.72	1.16	18.84	9.17	26.83	1.65	1.03
					78							29.08	1.84	1.16
												15.94	5.41	
Estimated Annual Time During Runoff Events (hours)												571		
Estimated Annual Time Between Runoff Events												8,189		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												1,364784722		
Estimated Total Annual Inflow to Diversion Structure (mg)												17.30		
Estimated Annual Volume Retained in System (mg)												11.89		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												66%		
ESTIMATED OVERALL CAPTURE												69%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Maple

Basin: **St. Joseph CSO**
 Diversion Structure No.: **84-8**
 Discharges to Outfall No.: **84-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 1**
 Average Dry Weather Flow (mgd): **0.3 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	36.00	0.50	0.96	0.00	0.00	0.00	18.00	10.49	0.00
B	0.51	0.26	8.75	18	6	36.00	0.68	3.55	0.00	0.00	0.00	36.00	10.60	0.00
C	0.86	0.58	12.25	12	6	36.00	1.31	9.21	0.01	0.63	6.17	36.00	5.98	0.03
D	1.41	0.75	16.75	6	2	36.00	2.97	29.51	0.78	20.07	7.50	36.00	12.85	2.37
E	1.82	0.87	19.75	4	1	36.00	4.51	47.38	1.63	37.56	8.17	36.00	7.48	2.41
F	2.00	0.95	21.00	3	1	36.00	5.28	64.27	2.06	50.51	8.50	36.00	4.89	1.84
G	2.37	1.06	23.75	2	1	36.00	6.91	79.11	3.05	66.14	9.08	36.00	6.10	2.56
H	2.88	1.25	26.75	1	1	36.00	9.32	111.76	4.61	98.47	11.50	36.00	8.12	3.83
					78							36.00	9.32	4.61
												75.82	17.65	
Estimated Annual Time During Runoff Events (hours)												2,052		
Estimated Annual Time Between Runoff Events												6,708		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												72.67		
Estimated Total Annual Inflow to Diversion Structure (mg)												148.49		
Estimated Annual Volume Retained in System (mg)												130.84		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												77%		
ESTIMATED OVERALL CAPTURE												88%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Hickory

Basin: **St. Joseph CSO**
 Diversion Structure No.: **33-1**
 Discharges to Outfall No.: **33-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 1**
 Average Dry Weather Flow (mgd): **0.3 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	36.00	0.41	0.31	0.00	0.00	0.00	18.00	8.54	0.00
B	0.51	0.26	8.75	18	6	36.00	0.44	0.67	0.00	0.00	0.00	36.00	7.58	0.00
C	0.86	0.58	12.25	12	6	36.00	0.68	2.61	0.00	0.00	0.00	36.00	3.35	0.00
D	1.41	0.75	16.75	6	6	36.00	1.53	12.62	0.18	10.51	15.83	36.00	6.64	0.55
E	1.82	0.87	19.75	4	2	36.00	2.41	23.20	0.64	20.19	16.67	36.00	3.94	0.83
F	2.00	0.95	21.00	3	1	36.00	2.85	33.18	0.97	25.83	17.00	36.00	2.63	0.81
G	2.37	1.06	23.75	2	1	36.00	3.83	42.73	1.69	37.67	17.58	36.00	3.34	1.33
H	2.88	1.25	26.75	1	1	36.00	5.29	63.88	3.02	69.18	18.17	36.00	4.56	2.36
					78							36.00	5.29	3.02
												45.88	8.90	
Estimated Annual Time During Runoff Events (hours)												2,052		
Estimated Annual Time Between Runoff Events												6,708		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												75,465		
Estimated Total Annual Inflow to Diversion Structure (mg)												121.34		
Estimated Annual Volume Retained in System (mg)												112.45		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												81%		
ESTIMATED OVERALL CAPTURE												93%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Whitehead

Basin: **St. Joseph CSO**
 Diversion Structure No.: **WMS-19**
 Discharges to Outfall No.: **WMS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 1**
 Average Dry Weather Flow (mgd): **2.8 (ADWF)**

Or to: _____ At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	0.00	90.38	0.00
A	0.29	0.20	6.00	36	18	0.00	4.30	3.88	0.00	0.00	0.00	2.54	84.11	0.00
B	0.51	0.26	8.75	18	6	5.08	5.04	10.98	0.00	0.00	0.00	6.67	43.34	0.00
C	0.86	0.58	12.25	12	6	8.25	9.41	37.98	0.00	0.00	0.00	9.75	106.84	16.60
D	1.41	0.75	16.75	6	2	11.25	26.21	168.39	5.53	99.50	27.42	12.46	70.37	21.64
E	1.82	0.87	19.75	4	1	13.67	44.17	301.48	16.11	228.51	26.33	14.29	48.85	19.38
F	2.00	0.95	21.00	3	1	14.92	53.53	369.10	22.65	293.84	25.83	16.08	63.83	30.20
G	2.37	1.06	23.75	2	1	17.25	74.13	578.67	37.74	500.21	24.67	19.13	89.81	49.74
H	2.88	1.25	26.75	1	1	21.00	105.49	946.36	61.73	860.21	23.42	21.00	105.49	61.73
					78								703.02	199.29
Estimated Annual Time During Runoff Events (hours)											240			
Estimated Annual Time Between Runoff Events											8,520			
Estimated Annual Inflow at ADWF Between Runoff Events (mg)											994,038,889			
Estimated Total Annual Inflow to Diversion Structure (mg)											1697.06			
Estimated Annual Volume Retained in System (mg)											1497.77			
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS											72%			
ESTIMATED OVERALL CAPTURE											88%			

Combined Sewer System
 Diversion Structure Discharge Characteristics
 MOAV

Basin: **St. Joseph CSO**

Diversion Structure No.:

Discharges to Outfall No.:

Design Condition/Alt.:

ALT 4 - Phase 1

Or to:

At:

Average Dry Weather Flow (mgd):

2.1 (ADWF)

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	9.46	67.24	0.00
A	0.29	0.20	6.00	36	18	18.92	3.20	4.53	0.00	0.00	0.00	18.96	69.42	0.00
B	0.51	0.26	8.75	18	6	19.00	4.51	12.14	0.00	0.00	0.00	22.00	40.22	13.19
C	0.86	0.58	12.25	12	6	25.00	8.90	45.73	4.40	52.05	8.50	25.29	67.33	52.09
D	1.41	0.75	16.75	6	2	25.58	13.55	118.69	12.97	127.00	11.50	23.50	32.09	31.74
E	1.82	0.87	19.75	4	1	21.42	18.54	170.45	18.77	159.00	13.25	22.67	19.95	20.09
F	2.00	0.95	21.00	3	1	23.92	21.37	247.05	21.40	200.17	14.08	27.29	23.98	24.63
G	2.37	1.06	23.75	2	1	30.67	26.60	286.19	27.86	272.86	15.75	30.75	30.26	31.43
H	2.88	1.25	26.75	1	1	30.83	33.92	350.63	35.01	321.14	17.67	30.83	33.92	35.01
					78								384.40	208.18
Estimated Annual Time During Runoff Events (hours)											1,181			
Estimated Annual Time Between Runoff Events											7,579			
Estimated Annual Inflow at ADWF Between Runoff Events (mg)											663,180,729			
Estimated Total Annual Inflow to Diversion Structure (mg)											1047,58			
Estimated Annual Volume Retained in System (mg)											839,40			
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS											46%			
ESTIMATED OVERALL CAPTURE											80%			

Basin: **St. Joseph CSO**
 Diversion Structure No.: **BNB-24**
 Discharges to Outfall No.: **BNB-28** Or to: **[REDACTED]** At: **[REDACTED]**
 Design Condition/Alt.: **ALT 4 - Phase 1**
 Average Dry Weather Flow (mgd): **1.3 (ADWF)**

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	2.25	41.33	0.00
A	0.29	0.20	6.00	36	18	4.50	1.97	2.33	0.00	0.00	0.00	5.71	39.62	0.00
B	0.51	0.26	8.75	18	6	6.92	2.43	11.24	0.00	0.00	0.00	12.08	20.33	0.00
C	0.86	0.58	12.25	12	6	17.25	4.34	10.31	0.00	0.00	0.00	15.83	49.10	25.49
D	1.41	0.75	16.75	6	2	14.42	12.02	309.97	8.50	410.74	8.58	15.88	31.27	25.28
E	1.82	0.87	19.75	4	1	17.33	19.25	301.39	16.78	555.08	10.92	17.96	21.52	18.63
F	2.00	0.95	21.00	3	1	18.58	23.79	391.60	20.49	542.23	11.83	19.88	28.18	24.22
G	2.37	1.06	23.75	2	1	21.17	32.56	435.87	27.96	434.13	13.42	23.50	39.47	35.08
H	2.88	1.25	26.75	1	1	25.83	46.38	532.78	42.19	548.66	15.42	25.83	46.38	42.19
					78								317.21	170.89
											Estimated Annual Time During Runoff Events (hours)	484		
											Estimated Annual Time Between Runoff Events (hours)	8,276		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	434,507.5		
											Estimated Total Annual Inflow to Diversion Structure (mg)	751.72		
											Estimated Annual Volume Retained in System (mg)	580.83		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS	46%		
											ESTIMATED OVERALL CAPTURE	77%		

**Diversion Structure Discharge
Characteristics
Alternative 4 Phase II**

St. Joseph, MO

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Basin Summary

Basin:
 Diversion Structure No.:
 Design Condition/Alt.:
 Average Dry Weather Flow (ADWF), mgd:

St. Joseph CSO
 All
 ALT 4 - Phase 2
 17.417

Rainfall Characteristics						Summary Data during Precipitation Events			
Design Storm ID	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Design Storm Summary		Estimated Annual Totals	
						Total Volume to Diversion Structures (mg)	Total Overflow Volume (mg)	Total Volume to Diversion Structures (mg)	Total Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.000	0.00	553.83	0.00
A	0.29	0.20	6.00	36	18	26.373	0.00	509.38	0.00
B	0.51	0.26	8.75	18	6	30.225	0.00	230.93	0.00
C	0.86	0.58	12.25	12	6	46.750	0.00	485.55	0.00
D	1.41	0.75	16.75	6	2	115.101	0.00	295.88	28.36
E	1.82	0.87	19.75	4	1	180.775	28.36	198.44	40.77
F	2.00	0.95	21.00	3	1	216.107	53.17	254.22	84.12
G	2.37	1.06	23.75	2	1	292.333	115.07	349.57	161.01
H	2.88	1.25	26.75	1	1	406.816	206.94	406.82	206.94
Totals					78			3284.62	521.19
Long-Term Mean Annual Rainfall (inches)					36.5				
Long-Term Median Annual Rainfall (inches)					35.0				
Total Rainfall Depth Represented Above (inches)					37.04				
Estimated Total Annual Inflow to Diversion Structures (mg)						9211.94			
Estimated Annual Volume Retained in System (mg)						8690.74			
ESTIMATED BASIN-WIDE ANNUAL CAPTURE DURING PRECIPITATION EVENTS						84%			
ESTIMATED BASIN-WIDE OVERALL CAPTURE						94%			

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Roys_Branch

Basin: **St. Joseph CSO**
 Diversion Structure No.: **BSS-30**
 Discharges to Outfall No.: **BSS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 2**

Or to: At:

Average Dry Weather Flow (mgd):		0.0 (ADWF)				Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
Design Storm ID	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.00	0.00
A	0.29	0.20	6.00	36	18	0.00	0.00	0.00	0.00	0.00	0.00	15.25	0.07	0.00
B	0.51	0.26	8.75	18	6	30.50	0.01	0.04	0.00	0.00	0.00	30.08	2.06	0.00
C	0.86	0.58	12.25	12	6	29.67	0.68	1.22	0.00	0.00	0.00	28.79	37.54	0.00
D	1.41	0.75	16.75	6	2	27.92	11.84	34.52	0.00	0.00	0.00	27.29	28.51	0.00
E	1.82	0.87	19.75	4	1	26.67	16.67	70.38	0.00	0.00	0.00	26.54	18.15	0.00
F	2.00	0.95	21.00	3	1	26.42	19.63	93.79	0.00	0.00	0.00	26.17	22.98	0.00
G	2.37	1.06	23.75	2	1	25.92	26.33	143.46	0.00	0.00	0.00	25.79	31.22	0.00
H	2.88	1.25	26.75	1	1	25.67	36.11	243.33	0.00	0.00	0.00	25.67	36.11	0.00
					78								176.63	0.00
Estimated Annual Time During Runoff Events (hours)												787		
Estimated Annual Time Between Runoff Events												7,974		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												0		
Estimated Total Annual Inflow to Diversion Structure (mg)												176.63		
Estimated Annual Volume Retained in System (mg)												176.63		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												100%		
ESTIMATED OVERALL CAPTURE												100%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Blacksake

Basin: **St. Joseph CSO**
 Diversion Structure No.: **BSS-30**
 Discharges to Outfall No.: **BSS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 2**

Or to: _____ At: _____

Average Dry Weather Flow (mgd): 4.6 (ADWF)														
Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	1.67	141.80	0.00
A	0.29	0.20	6.00	36	18	3.33	6.75	4.87	0.00	0.00	0.00	4.38	122.94	0.00
B	0.51	0.26	8.75	18	6	5.42	6.91	7.24	0.00	0.00	0.00	7.29	44.48	0.00
C	0.86	0.58	12.25	12	6	9.17	7.92	12.84	0.00	0.00	0.00	11.58	65.92	0.00
D	1.41	0.75	16.75	6	2	14.00	14.05	66.63	0.00	0.00	0.00	15.54	35.66	0.00
E	1.82	0.87	19.75	4	1	17.08	21.61	127.68	0.00	0.00	0.00	17.71	23.66	0.21
F	2.00	0.95	21.00	3	1	18.33	25.71	195.51	0.42	56.90	1.67	19.42	30.31	0.60
G	2.37	1.06	23.75	2	1	20.50	34.92	297.80	0.77	42.79	1.83	22.50	42.19	1.92
H	2.88	1.25	26.75	1	1	24.50	49.46	549.57	3.06	292.08	1.92	24.50	49.46	3.06
					78								556.42	5.79
Estimated Annual Time During Runoff Events (hours)												377		
Estimated Annual Time Between Runoff Events												8,383		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												1606,701736		
Estimated Total Annual Inflow to Diversion Structure (mg)												2163.13		
Estimated Annual Volume Retained in System (mg)												2157.34		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												99%		
ESTIMATED OVERALL CAPTURE												100%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Francis

Basin: **St. Joseph CSO**
 Diversion Structure No.: **16-37**
 Discharges to Outfall No.: **16-River1**
 Design Condition/Alt.: **ALT 4 - Phase 2**

Or to: _____ At: _____

Average Dry Weather Flow (mgd):

0.0 (ADWF)

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.02	0.00
A	0.29	0.20	6.00	36	18	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.02	0.00
B	0.51	0.26	8.75	18	6	4.00	0.00	0.00	0.00	0.00	0.00	5.38	0.03	0.00
C	0.86	0.58	12.25	12	6	6.75	0.01	0.07	0.00	0.00	0.00	8.13	0.11	0.00
D	1.41	0.75	16.75	6	2	9.50	0.03	0.33	0.00	0.00	0.00	10.50	0.08	0.00
E	1.82	0.87	19.75	4	1	11.50	0.05	0.59	0.00	0.00	0.00	12.04	0.05	0.00
F	2.00	0.95	21.00	3	1	12.58	0.06	0.82	0.00	0.00	0.00	13.63	0.07	0.00
G	2.37	1.06	23.75	2	1	14.67	0.08	1.02	0.00	0.00	0.00	16.71	0.09	0.00
H	2.88	1.25	26.75	1	1	18.75	0.11	1.47	0.00	0.00	0.00	18.75	0.11	0.00
					78								0.58	0.00
Estimated Annual Time During Runoff Events (hours)											199			
Estimated Annual Time Between Runoff Events											8,561			
Estimated Annual Inflow at ADWF Between Runoff Events (mg)											0			
Estimated Total Annual Inflow to Diversion Structure (mg)												0.58		
Estimated Annual Volume Retained in System (mg)												0.58		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS													100%	
ESTIMATED OVERALL CAPTURE													100%	

Basin: **St. Joseph CSO**
 Diversion Structure No.: **SBS-33**
 Discharges to Outfall No.: **SBS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 2**
 Average Dry Weather Flow (mgd): **1.2 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.42	1.78	2.19	0.00	0.00	0.00	1.71	37.31	0.00
B	0.51	0.26	8.75	18	6	5.42	2.33	12.10	0.00	0.00	0.00	4.42	36.94	0.00
C	0.86	0.58	12.25	12	6	7.67	4.19	31.13	0.00	0.00	0.00	6.54	19.55	0.00
D	1.41	0.75	16.75	6	6	11.75	8.84	88.30	0.00	0.00	0.00	9.71	39.10	0.00
E	1.82	0.87	19.75	4	2	14.75	13.12	143.50	0.00	0.00	0.00	13.25	21.96	0.00
F	2.00	0.95	21.00	3	1	16.08	15.23	195.03	0.00	0.00	0.00	15.42	14.18	0.00
G	2.37	1.06	23.75	2	1	18.58	19.71	235.01	0.00	0.00	0.00	17.33	17.47	0.00
H	2.88	1.25	26.75	1	1	21.58	24.61	323.96	16.80	319.85	22.83	20.08	22.16	8.40
					78							21.58	24.61	16.80
												233.27	25.20	
Estimated Annual Time During Runoff Events (hours)												350		
Estimated Annual Time Between Runoff Events												8,410		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												420.5166667		
Estimated Total Annual Inflow to Diversion Structure (mg)												653.79		
Estimated Annual Volume Retained in System (mg)												628.59		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												89%		
ESTIMATED OVERALL CAPTURE												96%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Messanie

Basin: **St. Joseph CSO**
 Diversion Structure No.: **9-75**
 Discharges to Outfall No.: **9-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 2**
 Average Dry Weather Flow (mgd): **0.1 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.75	0.23	1.19	0.00	0.00	0.00	1.88	4.79	0.00
B	0.51	0.26	8.75	18	6	6.08	0.34	2.73	0.00	0.00	0.00	4.92	5.12	0.00
C	0.86	0.58	12.25	12	6	9.50	0.60	5.76	0.00	0.00	0.00	7.79	2.81	0.00
D	1.41	0.75	16.75	6	6	14.17	1.16	11.99	0.00	0.00	0.00	11.83	5.27	0.00
E	1.82	0.87	19.75	4	2	17.33	1.65	17.57	1.57	47.10	3.75	15.75	2.81	1.57
F	2.00	0.95	21.00	3	1	18.67	1.90	22.29	4.02	104.99	6.92	18.00	1.78	2.80
G	2.37	1.06	23.75	2	1	21.42	2.41	27.00	1.91	93.91	3.17	20.04	2.15	2.97
H	2.88	1.25	26.75	1	1	26.00	3.15	36.15	3.25	142.99	3.75	23.71	2.78	2.58
					78							26.00	3.15	3.25
												30.65	13.16	
Estimated Annual Time During Runoff Events (hours)												404		
Estimated Annual Time Between Runoff Events												8,356		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												41,77875		
Estimated Total Annual Inflow to Diversion Structure (mg)												72.43		
Estimated Annual Volume Retained in System (mg)												59.27		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												57%		
ESTIMATED OVERALL CAPTURE												82%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Patee

Basin: **St. Joseph CSO**
 Diversion Structure No.: **9-76**
 Discharges to Outfall No.: **9-R2**
 Design Condition/Alt.: **ALT 4 - Phase 2**
 Average Dry Weather Flow (mgd): **0.1 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.08	0.13	0.36	0.00	0.00	0.00	1.54	2.65	0.00
B	0.51	0.26	8.75	18	6	5.08	0.21	1.75	0.00	0.00	0.00	4.08	2.99	0.00
C	0.86	0.58	12.25	12	6	7.58	0.44	4.20	0.00	0.00	0.00	6.33	1.94	0.00
D	1.41	0.75	16.75	6	6	11.75	1.00	10.56	0.00	0.00	0.00	9.67	4.31	0.00
E	1.82	0.87	19.75	4	2	14.92	1.50	16.70	15.04	100.71	7.08	13.33	2.50	15.04
F	2.00	0.95	21.00	3	1	16.08	1.64	21.72	20.19	111.82	9.58	15.50	1.57	17.61
G	2.37	1.06	23.75	2	1	18.67	2.27	26.62	12.26	108.26	8.50	17.38	1.96	16.22
H	2.88	1.25	26.75	1	1	22.75	3.24	94.91	16.95	125.74	11.67	20.71	2.75	14.61
					1							22.75	3.24	16.95
					78								23.91	80.44
Estimated Annual Time During Runoff Events (hours)												337		
Estimated Annual Time Between Runoff Events												8,423		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												28.07583333		
Estimated Total Annual Inflow to Diversion Structure (mg)												51.99		
Estimated Annual Volume Retained in System (mg)												-28.46		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS														-236%
ESTIMATED OVERALL CAPTURE														-55%

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Olive

Basin: **St. Joseph CSO**
 Diversion Structure No.: **9-76**
 Discharges to Outfall No.: **9-R2**
 Design Condition/Alt.: **ALT 4 - Phase 2**
 Average Dry Weather Flow (mgd): **0.0 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.58	0.05	0.42	0.00	0.00	0.00	1.79	1.09	0.00
B	0.51	0.26	8.75	18	6	6.00	0.10	1.05	0.00	0.00	0.00	4.79	1.39	0.00
C	0.86	0.58	12.25	12	6	9.25	0.22	2.49	0.00	0.00	0.00	7.63	0.97	0.00
D	1.41	0.75	16.75	6	6	13.75	0.45	5.65	0.00	0.00	0.00	11.50	2.01	0.00
E	1.82	0.87	19.75	4	2	16.67	0.63	7.66	0.00	0.00	0.00	15.21	1.08	0.00
F	2.00	0.95	21.00	3	1	18.08	0.78	18.80	0.00	0.65	0.83	17.38	0.70	0.00
G	2.37	1.06	23.75	2	1	20.92	0.88	10.76	0.00	0.00	0.00	19.50	0.83	0.00
H	2.88	1.25	26.75	1	1	24.25	1.16	13.72	0.03	4.84	1.00	22.58	1.02	0.01
					1							24.25	1.16	0.03
					78								10.25	0.04
											Estimated Annual Time During Runoff Events (hours)	390		
											Estimated Annual Time Between Runoff Events	8,370		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	8.020890625		
											Estimated Total Annual Inflow to Diversion Structure (mg)	18.27		
											Estimated Annual Volume Retained in System (mg)	18.23		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS	100%		
											ESTIMATED OVERALL CAPTURE	100%		

Basin: **St. Joseph CSO**
 Diversion Structure No.: **N7**
 Discharges to Outfall No.: **BDCS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 2**
 Average Dry Weather Flow (mgd): **4.7 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	0.00	7.03	4.68	0.00	0.00	0.00	0.00	147.66	0.00
B	0.51	0.26	8.75	18	6	0.00	7.09	4.95	0.00	0.00	0.00	0.00	127.06	0.00
C	0.86	0.58	12.25	12	6	7.33	8.94	18.17	0.00	0.00	0.00	3.67	48.07	0.00
D	1.41	0.75	16.75	6	6	10.67	20.92	136.28	0.00	0.00	0.00	9.00	89.58	0.00
E	1.82	0.87	19.75	4	2	12.42	35.28	264.25	0.00	0.00	0.00	11.54	56.20	0.00
F	2.00	0.95	21.00	3	1	13.33	43.19	382.66	0.00	0.00	0.00	12.88	39.23	0.00
G	2.37	1.06	23.75	2	1	15.00	60.55	589.84	61.85	766.70	13.00	14.17	51.87	30.92
H	2.88	1.25	26.75	1	1	18.25	87.68	981.23	101.29	1385.34	15.25	16.63	74.11	81.57
					78							18.25	87.68	101.29
												721.47	213.78	
Estimated Annual Time During Runoff Events (hours)												161		
Estimated Annual Time Between Runoff Events												8,599		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												1683.970833		
Estimated Total Annual Inflow to Diversion Structure (mg)												2405.44		
Estimated Annual Volume Retained in System (mg)												2191.66		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												70%		
ESTIMATED OVERALL CAPTURE												91%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Duncan

Basin: **St. Joseph CSO**
 Diversion Structure No.: **83-18**
 Discharges to Outfall No.: **83-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 2**
 Average Dry Weather Flow (mgd): **0.0 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	4.08	0.07	1.14	0.00	0.00	0.00	2.04	1.37	0.00
B	0.51	0.26	8.75	18	6	6.50	0.16	2.41	0.00	0.00	0.00	5.29	2.06	0.00
C	0.86	0.58	12.25	12	6	9.75	0.36	5.16	0.00	0.00	0.00	8.13	1.58	0.00
D	1.41	0.75	16.75	6	2	14.67	0.73	9.75	0.00	0.00	0.00	12.21	3.28	0.00
E	1.82	0.87	19.75	4	1	17.50	1.02	12.64	1.30	18.44	5.42	16.08	1.75	1.30
F	2.00	0.95	21.00	3	1	18.83	1.16	15.11	2.15	20.04	7.67	18.17	1.09	1.72
G	2.37	1.06	23.75	2	1	22.00	1.45	17.33	1.17	20.28	3.83	20.42	1.30	1.66
H	2.88	1.25	26.75	1	1	24.92	1.84	21.72	1.47	22.17	4.42	23.46	1.64	1.32
					78							24.92	1.84	1.47
												15.93	7.48	
Estimated Annual Time During Runoff Events (hours)												422		
Estimated Annual Time Between Runoff Events												8,338		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												1,389,645,833		
Estimated Total Annual Inflow to Diversion Structure (mg)												17.32		
Estimated Annual Volume Retained in System (mg)												9.84		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS														53%
ESTIMATED OVERALL CAPTURE														57%

Basin: **St. Joseph CSO**
 Diversion Structure No.: **84-8**
 Discharges to Outfall No.: **84-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 2**
 Average Dry Weather Flow (mgd): **0.3 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.67	0.50	0.96	0.00	0.00	0.00	1.83	10.49	0.00
B	0.51	0.26	8.75	18	6	5.92	0.68	3.55	0.00	0.00	0.00	4.79	10.60	0.00
C	0.86	0.58	12.25	12	6	8.92	1.31	9.22	0.00	0.00	0.00	7.42	5.98	0.00
D	1.41	0.75	16.75	6	6	13.42	2.97	29.65	0.00	0.00	0.00	11.17	12.85	0.00
E	1.82	0.87	19.75	4	2	16.33	4.52	47.58	0.42	20.84	4.00	14.88	7.48	0.42
F	2.00	0.95	21.00	3	1	17.50	5.38	64.25	1.48	55.31	5.42	16.92	4.95	0.95
G	2.37	1.06	23.75	2	1	20.00	6.90	79.34	0.70	26.58	4.83	18.75	6.14	1.09
H	2.88	1.25	26.75	1	1	25.25	9.29	111.87	1.67	88.11	5.08	22.63	8.09	1.19
					78							25.25	9.29	1.67
												75.86	5.32	
Estimated Annual Time During Runoff Events (hours)												388		
Estimated Annual Time Between Runoff Events												8,372		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												90.69621528		
Estimated Total Annual Inflow to Diversion Structure (mg)												166.56		
Estimated Annual Volume Retained in System (mg)												161.24		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												93%		
ESTIMATED OVERALL CAPTURE												97%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Hickory

Basin: **St. Joseph CSO**
 Diversion Structure No.: **33-1**
 Discharges to Outfall No.: **33-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 2**
 Average Dry Weather Flow (mgd): **0.3 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	0.00	0.41	0.31	0.00	0.00	0.00	0.00	8.54	0.00
B	0.51	0.26	8.75	18	6	4.58	0.44	0.67	0.00	0.00	0.00	2.29	7.58	0.00
C	0.86	0.58	12.25	12	6	7.17	0.68	2.61	0.00	0.00	0.00	5.88	3.35	0.00
D	1.41	0.75	16.75	6	6	10.00	1.53	12.63	0.00	0.00	0.00	8.58	6.65	0.00
E	1.82	0.87	19.75	4	2	12.25	2.41	23.20	2.70	79.18	7.08	11.13	3.94	2.70
F	2.00	0.95	21.00	3	1	13.42	2.87	33.19	5.67	115.28	9.58	12.83	2.64	4.18
G	2.37	1.06	23.75	2	1	15.67	3.82	42.72	3.58	89.29	6.75	14.54	3.34	4.62
H	2.88	1.25	26.75	1	1	19.58	5.28	63.91	5.10	148.27	7.33	17.63	4.55	4.34
					78							19.58	5.28	5.10
												45.88	20.95	
Estimated Annual Time During Runoff Events (hours)												215		
Estimated Annual Time Between Runoff Events												8,545		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												96.133125		
Estimated Total Annual Inflow to Diversion Structure (mg)												142.01		
Estimated Annual Volume Retained in System (mg)												121.06		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												54%		
ESTIMATED OVERALL CAPTURE												85%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Whitehead

Basin: **St. Joseph CSO**
 Diversion Structure No.: **WMS-19**
 Discharges to Outfall No.: **WMS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 2**
 Average Dry Weather Flow (mgd): **2.8 (ADWF)**

Or to: _____ At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	2.29	90.37	0.00
A	0.29	0.20	6.00	36	18	4.58	4.30	3.88	0.00	0.00	0.00	5.71	84.11	0.00
B	0.51	0.26	8.75	18	6	6.83	5.04	10.98	0.00	0.00	0.00	8.04	43.34	0.00
C	0.86	0.58	12.25	12	6	9.25	9.41	37.98	0.00	0.00	0.00	11.25	106.83	0.00
D	1.41	0.75	16.75	6	2	13.25	26.20	168.44	0.00	0.00	0.00	14.67	70.32	7.29
E	1.82	0.87	19.75	4	1	16.08	44.12	301.75	7.29	197.81	11.92	16.75	48.86	11.24
F	2.00	0.95	21.00	3	1	17.42	53.61	369.08	15.18	340.64	13.75	18.71	63.80	13.09
G	2.37	1.06	23.75	2	1	20.00	74.00	579.13	11.00	361.98	10.58	22.13	89.74	14.65
H	2.88	1.25	26.75	1	1	24.25	105.47	949.54	18.30	524.71	11.17	24.25	105.47	18.30
					78								702.86	64.57
Estimated Annual Time During Runoff Events (hours)											426			
Estimated Annual Time Between Runoff Events											8,334			
Estimated Annual Inflow at ADWF Between Runoff Events (mg)											972.3097222			
Estimated Total Annual Inflow to Diversion Structure (mg)											1675.17			
Estimated Annual Volume Retained in System (mg)											1610.60			
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS											91%			
ESTIMATED OVERALL CAPTURE											96%			

Combined Sewer System
 Diversion Structure Discharge Characteristics
 MOAV

Basin: **St. Joseph CSO**
 Diversion Structure No.:
 Discharges to Outfall No.:
 Design Condition/Alt.: **ALT 4 - Phase 2**
 Average Dry Weather Flow (mgd): **2.1 (ADWF)**

Or to: _____ At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	2.83	66.41	0.00
A	0.29	0.20	6.00	36	18	5.67	3.16	4.55	0.00	0.00	0.00	7.79	68.87	0.00
B	0.51	0.26	8.75	18	6	9.92	4.49	11.70	0.00	0.00	0.00	11.33	36.34	0.00
C	0.86	0.58	12.25	12	6	12.75	7.62	43.00	0.00	0.00	0.00	15.50	63.81	0.00
D	1.41	0.75	16.75	6	2	18.25	13.65	115.07	0.00	0.00	0.00	19.33	32.44	0.03
E	1.82	0.87	19.75	4	1	20.42	18.79	168.25	0.03	3.84	2.08	21.21	20.04	2.05
F	2.00	0.95	21.00	3	1	22.00	21.29	213.38	4.06	245.47	3.50	23.21	23.83	4.64
G	2.37	1.06	23.75	2	1	24.42	26.36	252.16	5.22	457.01	3.00	27.00	29.95	8.82
H	2.88	1.25	26.75	1	1	29.58	33.54	321.62	12.43	443.16	3.42	29.58	33.54	12.43
					78								375.22	27.97
											Estimated Annual Time During Runoff Events (hours)	560		
											Estimated Annual Time Between Runoff Events	8,200		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	717,507,2917		
											Estimated Total Annual Inflow to Diversion Structure (mg)	1092.72		
											Estimated Annual Volume Retained in System (mg)	1064.75		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS	93%		
											ESTIMATED OVERALL CAPTURE	97%		

Basin: **St. Joseph CSO**
 Diversion Structure No.: **BNB-24**
 Discharges to Outfall No.: **BNB-28** Or to: At:
 Design Condition/Alt.: **ALT 4 - Phase 2**

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	2.25	41.32	0.00
A	0.29	0.20	6.00	36	18	4.50	1.97	2.33	0.00	0.00	0.00	5.71	39.63	0.00
B	0.51	0.26	8.75	18	6	6.92	2.44	9.58	0.00	0.00	0.00	8.38	20.42	0.00
C	0.86	0.58	12.25	12	6	9.83	4.37	27.73	0.00	0.00	0.00	12.13	48.32	0.00
D	1.41	0.75	16.75	6	2	14.42	11.73	86.25	0.00	0.00	0.00	15.88	31.13	0.00
E	1.82	0.87	19.75	4	1	17.33	19.40	146.56	0.00	0.00	0.00	17.96	21.53	0.00
F	2.00	0.95	21.00	3	1	18.58	23.67	202.67	0.00	0.00	0.00	19.88	28.17	8.30
G	2.37	1.06	23.75	2	1	21.17	32.66	445.91	16.60	517.03	13.08	23.50	39.28	21.60
H	2.88	1.25	26.75	1	1	25.83	45.89	594.22	26.61	462.36	15.25	25.83	45.89	26.61
					78							25.83	315.68	56.50
											Estimated Annual Time During Runoff Events (hours)	439		
											Estimated Annual Time Between Runoff Events (hours)	8,321		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	436,84375		
											Estimated Total Annual Inflow to Diversion Structure (mg)	752.52		
											Estimated Annual Volume Retained in System (mg)	696.02		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS	82%		
											ESTIMATED OVERALL CAPTURE	92%		

**Diversion Structure Discharge
Characteristics
Alternative 4 Phase III**

St. Joseph, MO

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Basin Summary

Basin:
 Diversion Structure No.:
 Design Condition/Alt.:
 Average Dry Weather Flow (ADWF), mgd:

St. Joseph CSO
 All
 ALT 4 - Phase 3
 17.417

Rainfall Characteristics						Summary Data during Precipitation Events			
Design Storm ID	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Design Storm Summary		Estimated Annual Totals	
						Total Volume to Diversion Structures (mg)	Total Overflow Volume (mg)	Total Volume to Diversion Structures (mg)	Total Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.000	0.00	559.57	0.00
A	0.29	0.20	6.00	36	18	26.646	0.00	514.02	0.00
B	0.51	0.26	8.75	18	6	30.468	0.00	232.50	0.00
C	0.86	0.58	12.25	12	6	47.031	0.00	487.79	0.00
D	1.41	0.75	16.75	6	2	115.564	0.00	297.37	0.00
E	1.82	0.87	19.75	4	1	181.805	0.00	199.32	7.85
F	2.00	0.95	21.00	3	1	216.836	15.71	254.92	43.73
G	2.37	1.06	23.75	2	1	292.998	71.75	351.17	118.40
H	2.88	1.25	26.75	1	1	409.335	165.06	409.33	165.06
Totals					78			3305.99	335.04
Long-Term Mean Annual Rainfall (inches)					36.5				
Long-Term Median Annual Rainfall (inches)					35.0				
Total Rainfall Depth Represented Above (inches)					37.04				
Estimated Total Annual Inflow to Diversion Structures (mg)						9127.35			
Estimated Annual Volume Retained in System (mg)						8792.31			
ESTIMATED BASIN-WIDE ANNUAL CAPTURE DURING PRECIPITATION EVENTS						90%			
ESTIMATED BASIN-WIDE OVERALL CAPTURE						96%			

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Roys_Branch

Basin: **St. Joseph CSO**
 Diversion Structure No.: **BSS-30**
 Discharges to Outfall No.: **BSS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 3**

Or to: _____ At: _____

Average Dry Weather Flow (mgd):

0.0 (ADWF)

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.00	0.00
A	0.29	0.20	6.00	36	18	0.00	0.00	0.00	0.00	0.00	0.00	15.25	0.07	0.00
B	0.51	0.26	8.75	18	6	30.50	0.01	0.04	0.00	0.00	0.00	30.08	2.06	0.00
C	0.86	0.58	12.25	12	6	29.67	0.68	1.22	0.00	0.00	0.00	28.79	37.54	0.00
D	1.41	0.75	16.75	6	2	27.92	11.84	34.52	0.00	0.00	0.00	27.29	28.51	0.00
E	1.82	0.87	19.75	4	1	26.67	16.67	70.38	0.00	0.00	0.00	26.54	18.15	0.00
F	2.00	0.95	21.00	3	1	26.42	19.63	93.79	0.00	0.00	0.00	26.17	22.98	0.00
G	2.37	1.06	23.75	2	1	25.92	26.33	143.46	0.00	0.00	0.00	25.79	31.22	0.00
H	2.88	1.25	26.75	1	1	25.67	36.11	243.33	0.00	0.00	0.00	25.67	36.11	0.00
					78								176.63	0.00
Estimated Annual Time During Runoff Events (hours)											787			
Estimated Annual Time Between Runoff Events											7,974			
Estimated Annual Inflow at ADWF Between Runoff Events (mg)											0			
Estimated Total Annual Inflow to Diversion Structure (mg)											176.63			
Estimated Annual Volume Retained in System (mg)											176.63			
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS											100%			
ESTIMATED OVERALL CAPTURE											100%			

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Blacksake

Basin: **St. Joseph CSO**
 Diversion Structure No.: **BSS-30**
 Discharges to Outfall No.: **BSS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 3**

Or to: At:

Average Dry Weather Flow (mgd): 4.6 (ADWF)														
Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	1.67	141.80	0.00
A	0.29	0.20	6.00	36	18	3.33	6.75	4.87	0.00	0.00	0.00	4.42	122.94	0.00
B	0.51	0.26	8.75	18	6	5.50	6.91	7.21	0.00	0.00	0.00	7.33	44.48	0.00
C	0.86	0.58	12.25	12	6	9.17	7.92	12.85	0.00	0.00	0.00	11.54	65.92	0.00
D	1.41	0.75	16.75	6	2	13.92	14.05	66.63	0.00	0.00	0.00	15.46	35.66	0.00
E	1.82	0.87	19.75	4	1	17.00	21.61	127.69	0.00	0.00	0.00	17.63	23.65	0.05
F	2.00	0.95	21.00	3	1	18.25	25.69	195.51	0.11	8.53	1.17	19.38	30.30	0.55
G	2.37	1.06	23.75	2	1	20.50	34.91	297.80	1.00	28.73	2.00	22.42	42.12	1.56
H	2.88	1.25	26.75	1	1	24.33	49.32	513.46	2.12	67.65	2.00	24.33	49.32	2.12
					78								556.19	4.29
											Estimated Annual Time During Runoff Events (hours)	377		
											Estimated Annual Time Between Runoff Events	8,383		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	1606,661806		
											Estimated Total Annual Inflow to Diversion Structure (mg)	2162.85		
											Estimated Annual Volume Retained in System (mg)	2158.57		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS	99%		
											ESTIMATED OVERALL CAPTURE	100%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Francis

Basin: **St. Joseph CSO**
 Diversion Structure No.: **16-37**
 Discharges to Outfall No.: **16-River1**
 Design Condition/Alt.: **ALT 4 - Phase 3**

Or to: _____ At: _____

Average Dry Weather Flow (mgd):

0.0 (ADWF)

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.02	0.00
A	0.29	0.20	6.00	36	18	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.02	0.00
B	0.51	0.26	8.75	18	6	4.00	0.00	0.00	0.00	0.00	0.00	5.38	0.03	0.00
C	0.86	0.58	12.25	12	6	6.75	0.01	0.07	0.00	0.00	0.00	8.13	0.11	0.00
D	1.41	0.75	16.75	6	2	9.50	0.03	0.33	0.00	0.00	0.00	10.50	0.08	0.00
E	1.82	0.87	19.75	4	1	11.50	0.05	0.59	0.00	0.00	0.00	12.04	0.05	0.00
F	2.00	0.95	21.00	3	1	12.58	0.06	0.82	0.00	0.00	0.00	13.63	0.07	0.00
G	2.37	1.06	23.75	2	1	14.67	0.08	1.02	0.00	0.00	0.00	16.71	0.09	0.00
H	2.88	1.25	26.75	1	1	18.75	0.11	1.47	0.00	0.00	0.00	18.75	0.11	0.00
					78								0.58	0.00
Estimated Annual Time During Runoff Events (hours)											199			
Estimated Annual Time Between Runoff Events											8,561			
Estimated Annual Inflow at ADWF Between Runoff Events (mg)											0			
Estimated Total Annual Inflow to Diversion Structure (mg)												0.58		
Estimated Annual Volume Retained in System (mg)												0.58		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												100%		
ESTIMATED OVERALL CAPTURE												100%		

Basin: **St. Joseph CSO**
 Diversion Structure No.: **SBS-33**
 Discharges to Outfall No.: **SBS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 3**
 Average Dry Weather Flow (mgd): **1.2 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.42	1.78	2.19	0.00	0.00	0.00	1.71	37.31	0.00
B	0.51	0.26	8.75	18	6	5.42	2.33	12.10	0.00	0.00	0.00	4.42	36.94	0.00
C	0.86	0.58	12.25	12	6	7.67	4.19	31.12	0.00	0.00	0.00	6.54	19.55	0.00
D	1.41	0.75	16.75	6	6	11.75	8.84	88.32	0.00	0.00	0.00	9.71	39.10	0.00
E	1.82	0.87	19.75	4	2	14.75	13.12	143.65	0.00	0.00	0.00	13.25	21.96	0.00
F	2.00	0.95	21.00	3	1	16.08	15.23	195.18	0.00	0.00	0.00	15.42	14.18	0.00
G	2.37	1.06	23.75	2	1	18.58	19.71	235.17	0.00	0.00	0.00	17.33	17.47	0.00
H	2.88	1.25	26.75	1	1	21.58	26.18	324.07	0.00	0.00	0.00	20.08	22.94	0.00
					78							21.58	26.18	0.00
												235.63	0.00	
Estimated Annual Time During Runoff Events (hours)												350		
Estimated Annual Time Between Runoff Events												8,410		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												420.5166667		
Estimated Total Annual Inflow to Diversion Structure (mg)												656.15		
Estimated Annual Volume Retained in System (mg)												656.15		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												100%		
ESTIMATED OVERALL CAPTURE												100%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Messanie

Basin: **St. Joseph CSO**
 Diversion Structure No.: **9-75**
 Discharges to Outfall No.: **9-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 3**
 Average Dry Weather Flow (mgd): **0.1 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.75	0.23	1.19	0.00	0.00	0.00	1.88	4.79	0.00
B	0.51	0.26	8.75	18	6	6.08	0.34	2.73	0.00	0.00	0.00	4.92	5.12	0.00
C	0.86	0.58	12.25	12	6	9.50	0.60	5.76	0.00	0.00	0.00	7.79	2.81	0.00
D	1.41	0.75	16.75	6	2	14.17	1.16	11.99	0.00	0.00	0.00	11.83	5.27	0.00
E	1.82	0.87	19.75	4	1	17.33	1.65	17.57	0.00	0.00	0.00	15.75	2.81	0.00
F	2.00	0.95	21.00	3	1	18.67	1.90	22.29	0.79	23.97	2.92	18.00	1.78	0.39
G	2.37	1.06	23.75	2	1	21.42	2.41	27.00	4.46	94.17	5.17	20.04	2.15	2.63
H	2.88	1.25	26.75	1	1	26.00	3.15	36.15	2.54	97.09	3.58	23.71	2.78	3.50
					78							26.00	3.15	2.54
												30.65	9.06	
Estimated Annual Time During Runoff Events (hours)												404		
Estimated Annual Time Between Runoff Events												8,356		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												41,77875		
Estimated Total Annual Inflow to Diversion Structure (mg)												72.43		
Estimated Annual Volume Retained in System (mg)												63.37		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												70%		
ESTIMATED OVERALL CAPTURE												87%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Patee

Basin: **St. Joseph CSO**
 Diversion Structure No.: **9-76**
 Discharges to Outfall No.: **9-R2**
 Design Condition/Alt.: **ALT 4 - Phase 3**
 Average Dry Weather Flow (mgd): **0.1 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.08	0.13	0.36	0.00	0.00	0.00	1.54	2.65	0.00
B	0.51	0.26	8.75	18	6	5.08	0.21	1.75	0.00	0.00	0.00	4.08	2.99	0.00
C	0.86	0.58	12.25	12	6	7.58	0.44	4.20	0.00	0.00	0.00	6.33	1.94	0.00
D	1.41	0.75	16.75	6	2	11.75	1.00	10.56	0.00	0.00	0.00	9.67	4.31	0.00
E	1.82	0.87	19.75	4	1	14.92	1.50	16.70	0.00	0.00	0.00	13.33	2.49	0.00
F	2.00	0.95	21.00	3	1	16.17	1.76	21.72	8.98	91.89	6.25	15.54	1.63	4.49
G	2.37	1.06	23.75	2	1	18.75	2.24	26.62	16.11	110.14	8.25	17.46	2.00	12.54
H	2.88	1.25	26.75	1	1	23.17	3.03	37.28	11.97	110.51	7.92	20.96	2.63	14.04
					78							23.17	3.03	11.97
												23.67	43.04	
Estimated Annual Time During Runoff Events (hours)												338		
Estimated Annual Time Between Runoff Events												8,422		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												28.07319444		
Estimated Total Annual Inflow to Diversion Structure (mg)												51.75		
Estimated Annual Volume Retained in System (mg)												8.70		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS													-82%	
ESTIMATED OVERALL CAPTURE													17%	

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Olive

Basin: **St. Joseph CSO**
 Diversion Structure No.: **9-76**
 Discharges to Outfall No.: **9-R2**
 Design Condition/Alt.: **ALT 4 - Phase 3**
 Average Dry Weather Flow (mgd): **0.0 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.58	0.05	0.42	0.00	0.00	0.00	1.79	1.09	0.00
B	0.51	0.26	8.75	18	6	6.00	0.10	1.05	0.00	0.00	0.00	4.79	1.39	0.00
C	0.86	0.58	12.25	12	6	9.25	0.22	2.49	0.00	0.00	0.00	7.63	0.97	0.00
D	1.41	0.75	16.75	6	6	13.75	0.45	5.65	0.00	0.00	0.00	11.50	2.01	0.00
E	1.82	0.87	19.75	4	2	16.67	0.63	7.66	0.00	0.00	0.00	15.21	1.08	0.00
F	2.00	0.95	21.00	3	1	18.08	0.72	9.33	0.00	0.00	0.00	17.38	0.68	0.00
G	2.37	1.06	23.75	2	1	21.00	0.90	10.78	0.00	0.00	0.00	19.54	0.81	0.00
H	2.88	1.25	26.75	1	1	24.25	1.15	13.76	0.00	0.00	0.00	22.63	1.03	0.00
					1							24.25	1.15	0.00
					78								10.20	0.00
											Estimated Annual Time During Runoff Events (hours)	390		
											Estimated Annual Time Between Runoff Events	8,370		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	8.020810764		
											Estimated Total Annual Inflow to Diversion Structure (mg)	18.22		
											Estimated Annual Volume Retained in System (mg)	18.22		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS		100%	
											ESTIMATED OVERALL CAPTURE		100%	

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Mitchell

Basin: **St. Joseph CSO**
 Diversion Structure No.: **N7**
 Discharges to Outfall No.: **BDCS-RIVER** Or to:
 Design Condition/Alt.: **ALT 4 - Phase 3** At:
 Average Dry Weather Flow (mgd): **4.7 (ADWF)**

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	0.00	7.03	4.68	0.00	0.00	0.00	0.00	147.67	0.00
B	0.51	0.26	8.75	18	6	0.00	7.09	4.95	0.00	0.00	0.00	0.00	127.06	0.00
C	0.86	0.58	12.25	12	6	7.33	8.94	18.17	0.00	0.00	0.00	3.67	48.07	0.00
D	1.41	0.75	16.75	6	6	10.67	20.92	136.29	0.00	0.00	0.00	9.00	89.58	0.00
E	1.82	0.87	19.75	4	2	12.42	35.36	264.25	0.00	0.00	0.00	11.54	56.28	0.00
F	2.00	0.95	21.00	3	1	13.33	43.13	382.67	0.00	0.00	0.00	12.88	39.24	0.00
G	2.37	1.06	23.75	2	1	15.00	60.58	589.85	0.00	0.00	0.00	14.17	51.86	0.00
H	2.88	1.25	26.75	1	1	18.25	87.64	969.77	89.18	1162.49	15.33	16.63	74.11	44.59
					78							18.25	87.64	89.18
												721.51	133.77	
Estimated Annual Time During Runoff Events (hours)												161		
Estimated Annual Time Between Runoff Events												8,599		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												1683.970833		
Estimated Total Annual Inflow to Diversion Structure (mg)												2405.48		
Estimated Annual Volume Retained in System (mg)												2271.71		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												81%		
ESTIMATED OVERALL CAPTURE												94%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Duncan

Basin: **St. Joseph CSO**
 Diversion Structure No.: **83-18**
 Discharges to Outfall No.: **83-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 3**
 Average Dry Weather Flow (mgd): **0.0 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	4.08	0.07	1.14	0.00	0.00	0.00	2.04	1.37	0.00
B	0.51	0.26	8.75	18	6	6.50	0.16	2.41	0.00	0.00	0.00	5.29	2.06	0.00
C	0.86	0.58	12.25	12	6	9.75	0.36	5.16	0.00	0.00	0.00	8.13	1.58	0.00
D	1.41	0.75	16.75	6	6	14.67	0.73	9.75	0.00	0.00	0.00	12.21	3.28	0.00
E	1.82	0.87	19.75	4	2	17.50	1.02	12.64	0.00	0.00	0.00	16.08	1.75	0.00
F	2.00	0.95	21.00	3	1	18.83	1.16	15.11	0.79	16.25	4.25	18.17	1.09	0.40
G	2.37	1.06	23.75	2	1	22.00	1.45	17.33	1.97	20.31	5.92	20.42	1.31	1.38
H	2.88	1.25	26.75	1	1	24.92	1.84	21.72	1.31	20.60	4.33	23.46	1.64	1.64
					78							24.92	1.84	1.31
												15.94	4.73	
Estimated Annual Time During Runoff Events (hours)												422		
Estimated Annual Time Between Runoff Events												8,338		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												1,389,645,833		
Estimated Total Annual Inflow to Diversion Structure (mg)												17.33		
Estimated Annual Volume Retained in System (mg)												12.60		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												70%		
ESTIMATED OVERALL CAPTURE												73%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Maple

Basin: St. Joseph CSO
 Diversion Structure No.: 84-8
 Discharges to Outfall No.: 84-RIVER
 Design Condition/Alt.: ALT 4 - Phase 3
 Average Dry Weather Flow (mgd): 0.3 (ADWF)

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	3.67	0.50	0.96	0.00	0.00	0.00	1.83	10.49	0.00
B	0.51	0.26	8.75	18	6	5.83	0.68	3.55	0.00	0.00	0.00	4.75	10.60	0.00
C	0.86	0.58	12.25	12	6	8.92	1.31	9.22	0.00	0.00	0.00	7.38	5.98	0.00
D	1.41	0.75	16.75	6	6	13.42	2.97	29.65	0.00	0.00	0.00	11.17	12.85	0.00
E	1.82	0.87	19.75	4	2	16.33	4.51	47.58	0.00	0.00	0.00	14.88	7.48	0.00
F	2.00	0.95	21.00	3	1	17.50	5.28	64.25	0.04	2.79	5.25	16.92	4.90	0.02
G	2.37	1.06	23.75	2	1	20.00	6.92	79.34	1.75	55.55	5.83	18.75	6.10	0.90
H	2.88	1.25	26.75	1	1	25.25	9.32	111.87	1.25	72.60	5.17	22.63	8.12	1.50
					78							25.25	9.32	1.25
												75.82	3.67	
Estimated Annual Time During Runoff Events (hours)												387		
Estimated Annual Time Between Runoff Events												8,373		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												90.70704861		
Estimated Total Annual Inflow to Diversion Structure (mg)												166.52		
Estimated Annual Volume Retained in System (mg)												162.85		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												95%		
ESTIMATED OVERALL CAPTURE												98%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Hickory

Basin: **St. Joseph CSO**
 Diversion Structure No.: **33-1**
 Discharges to Outfall No.: **33-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 3**
 Average Dry Weather Flow (mgd): **0.3 (ADWF)**

Or to: _____

At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00			
A	0.29	0.20	6.00	36	18	0.00	0.41	0.31	0.00	0.00	0.00	0.00	8.54	0.00
B	0.51	0.26	8.75	18	6	4.58	0.44	0.67	0.00	0.00	0.00	2.29	7.58	0.00
C	0.86	0.58	12.25	12	6	7.17	0.68	2.61	0.00	0.00	0.00	5.88	3.35	0.00
D	1.41	0.75	16.75	6	6	10.00	1.53	12.63	0.00	0.00	0.00	8.58	6.65	0.00
E	1.82	0.87	19.75	4	2	12.25	2.41	23.20	0.00	0.00	0.00	11.13	3.94	0.00
F	2.00	0.95	21.00	3	1	13.42	2.86	33.16	1.08	33.90	5.92	12.83	2.63	0.54
G	2.37	1.06	23.75	2	1	15.67	3.83	42.72	6.29	113.84	8.58	14.54	3.34	3.69
H	2.88	1.25	26.75	1	1	19.58	5.29	63.91	4.38	135.88	7.25	17.63	4.56	5.34
					78							19.58	5.29	4.38
												45.88	13.95	
Estimated Annual Time During Runoff Events (hours)												215		
Estimated Annual Time Between Runoff Events												8,545		
Estimated Annual Inflow at ADWF Between Runoff Events (mg)												96.133125		
Estimated Total Annual Inflow to Diversion Structure (mg)												142.01		
Estimated Annual Volume Retained in System (mg)												128.07		
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS												70%		
ESTIMATED OVERALL CAPTURE												90%		

Combined Sewer System
 Diversion Structure Discharge Characteristics
 Whitehead

Basin: **St. Joseph CSO**
 Diversion Structure No.: **WMS-19**
 Discharges to Outfall No.: **WMS-RIVER**
 Design Condition/Alt.: **ALT 4 - Phase 3**
 Average Dry Weather Flow (mgd): **2.8 (ADWF)**

Or to: _____ At: _____

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	2.29	90.37	0.00
A	0.29	0.20	6.00	36	18	4.58	4.30	3.88	0.00	0.00	0.00	5.71	84.11	0.00
B	0.51	0.26	8.75	18	6	6.83	5.04	10.98	0.00	0.00	0.00	8.04	43.34	0.00
C	0.86	0.58	12.25	12	6	9.25	9.41	37.98	0.00	0.00	0.00	11.25	106.83	0.00
D	1.41	0.75	16.75	6	2	13.25	26.21	168.39	0.00	0.00	0.00	14.67	70.36	0.00
E	1.82	0.87	19.75	4	1	16.08	44.16	301.75	0.00	0.00	0.00	16.71	48.84	1.88
F	2.00	0.95	21.00	3	1	17.33	53.52	369.08	3.76	110.07	10.00	18.67	63.83	10.57
G	2.37	1.06	23.75	2	1	20.00	74.15	579.13	17.39	343.48	12.50	22.13	89.83	16.62
H	2.88	1.25	26.75	1	1	24.25	105.51	946.35	15.86	555.14	11.08	24.25	105.51	15.86
					78								703.05	44.94
Estimated Annual Time During Runoff Events (hours)											426			
Estimated Annual Time Between Runoff Events											8,334			
Estimated Annual Inflow at ADWF Between Runoff Events (mg)											972,319,444			
Estimated Total Annual Inflow to Diversion Structure (mg)											1675.37			
Estimated Annual Volume Retained in System (mg)											1630.43			
ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS											94%			
ESTIMATED OVERALL CAPTURE											97%			

Combined Sewer System
 Diversion Structure Discharge Characteristics
 MOAV

Basin: **St. Joseph CSO**

Diversion Structure No.:

Discharges to Outfall No.:

Design Condition/Alt.:

ALT 4 - Phase 3
2.1 (ADWF)

Or to:

At:

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	5.13	69.11	0.00
A	0.29	0.20	6.00	36	18	10.25	3.29	4.49	0.00	0.00	0.00	12.83	71.03	0.00
B	0.51	0.26	8.75	18	6	15.42	4.60	11.52	0.00	0.00	0.00	16.00	37.01	0.00
C	0.86	0.58	12.25	12	6	16.58	7.73	42.96	0.00	0.00	0.00	18.33	64.32	0.00
D	1.41	0.75	16.75	6	2	20.08	13.70	115.07	0.00	0.00	0.00	20.42	32.54	0.00
E	1.82	0.87	19.75	4	1	20.75	18.83	168.26	0.00	0.00	0.00	24.42	20.10	0.08
F	2.00	0.95	21.00	3	1	28.08	21.37	213.38	0.16	19.55	2.17	26.46	23.82	2.91
G	2.37	1.06	23.75	2	1	24.83	26.27	252.17	5.67	239.92	3.75	27.92	29.94	7.62
H	2.88	1.25	26.75	1	1	31.00	33.61	321.57	9.57	431.23	3.42	31.00	33.61	9.57
					78								381.47	20.19
											Estimated Annual Time During Runoff Events (hours)	803		
											Estimated Annual Time Between Runoff Events	7.957		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	696.2484375		
											Estimated Total Annual Inflow to Diversion Structure (mg)	1077.72		
											Estimated Annual Volume Retained in System (mg)	1057.53		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS			95%
											ESTIMATED OVERALL CAPTURE			98%

Basin: **St. Joseph CSO**
 Diversion Structure No.: **BNB-24**
 Discharges to Outfall No.: **BNB-28** Or to: At:
 Design Condition/Alt.: **ALT 4 - Phase 3**

Design Storm ID	Rainfall Characteristics					Total Design Storm Flow to Diversion Structure			Overflow Characteristics			Design Year Summary for All Events in Range		
	Storm Depth (inches)	Peak Hour Intensity (in/hr)	Storm Duration (hours)	Times Equalled or Exceeded in Design Year	No. of Events in Range During Design Year	Runoff Event Time Base (hours)	Total Volume to Diversion Structure (mg)	Peak Rate of Flow to Diversion Str. (mgd)	Overflow Volume (mg)	Peak Overflow Rate (mgd)	Duration of Overflow (hours)	Mean Runoff Event Duration (hours)	Total Volume to Diversion Structure (mg)	Overflow Volume (mg)
None	0.00	0.00	0.00	78	42	0.00	0.000	0.00	0.00	0.000	0.00	18.00	44.36	0.00
A	0.29	0.20	6.00	36	18	36.00	2.11	2.43	0.00	0.00	0.00	36.00	42.10	0.00
B	0.51	0.26	8.75	18	6	36.00	2.57	10.54	0.00	0.00	0.00	36.00	21.32	0.00
C	0.86	0.58	12.25	12	6	36.00	4.54	27.83	0.00	0.00	0.00	36.00	50.03	0.00
D	1.41	0.75	16.75	6	2	36.00	12.14	88.62	0.00	0.00	0.00	36.00	32.42	0.00
E	1.82	0.87	19.75	4	1	36.00	20.28	151.19	0.00	0.00	0.00	36.00	22.41	0.00
F	2.00	0.95	21.00	3	1	36.00	24.53	210.00	0.00	0.00	0.00	36.00	28.88	8.55
G	2.37	1.06	23.75	2	1	36.00	33.23	513.25	17.11	366.87	13.17	36.00	40.16	21.99
H	2.88	1.25	26.75	1	1	36.00	47.09	656.13	26.87	407.89	15.25	36.00	47.09	26.87
					78							36.00	47.09	26.87
											328.77	57.41		
											Estimated Annual Time During Runoff Events (hours)	2,052		
											Estimated Annual Time Between Runoff Events (hours)	6,708		
											Estimated Annual Inflow at ADWF Between Runoff Events (mg)	352.17		
											Estimated Total Annual Inflow to Diversion Structure (mg)	680.94		
											Estimated Annual Volume Retained in System (mg)	623.52		
											ESTIMATED ANNUAL CAPTURE DURING PRECIPITATION EVENTS	83%		
											ESTIMATED OVERALL CAPTURE	92%		



**APPENDIX G
WATER QUALITY
MODELING DATA**

Appendix G
QUAL2K Rate Assumptions

Parameter	Value	Units	Symbol
<i>Stoichiometry:</i>			
Carbon	40	gC	gC
Nitrogen	7.2	gN	gN
Phosphorus	1	gP	gP
Dry weight	100	gD	gD
Chlorophyll	1	gA	gA
<i>Inorganic suspended solids:</i>			
Settling velocity	0.3	m/d	v_i
<i>Oxygen:</i>			
Reaeration model	Churchill		
Temp correction	1.024		θ_a
Reaeration wind effect	Banks-Herrera		
O2 for carbon oxidation	2.3	gO ₂ /gC	r_{oc}
O2 for NH4 nitrification	4.57	gO ₂ /gN	r_{on}
Oxygen inhib model CBOD oxidation	Exponential		
Oxygen inhib parameter CBOD oxidation	0.60	L/mgO ₂	K_{soef}
Oxygen inhib model nitrification	Exponential		
Oxygen inhib parameter nitrification	0.60	L/mgO ₂	K_{sona}
Oxygen enhance model denitrification	Exponential		
Oxygen enhance parameter denitrification	0.60	L/mgO ₂	K_{sodn}
Oxygen inhib model phyto resp	Exponential		
Oxygen inhib parameter phyto resp	0.60	L/mgO ₂	K_{sop}
Oxygen enhance model bot alg resp	Exponential		
Oxygen enhance parameter bot alg resp	0.60	L/mgO ₂	K_{sob}
<i>Slow CBOD:</i>			
Hydrolysis rate	0	/d	k_{hc}
Temp correction	1.07		θ_{hc}
Oxidation rate	0	/d	k_{dcs}
Temp correction	1.047		θ_{dcs}
<i>Fast CBOD:</i>			
Oxidation rate	0.4	/d	k_{dc}
Temp correction	1.047		θ_{dc}
<i>Organic N:</i>			
Hydrolysis	0.2	/d	k_{hn}
Temp correction	1.07		θ_{hn}
Settling velocity	0.1	m/d	v_{on}
<i>Ammonium:</i>			
Nitrification	0.2	/d	k_{na}
Temp correction	1.07		θ_{na}
<i>Nitrate:</i>			
Denitrification	0	/d	k_{dn}
Temp correction	1.07		θ_{dn}
Sed denitrification transfer coeff	0	m/d	v_{di}
Temp correction	1.07		θ_{di}

Appendix G
QUAL2K Rate Assumptions

Parameter	Value	Units	Symbol
<i>Organic P:</i>			
Hydrolysis	0.2	/d	k_{hp}
Temp correction	1.07		θ_{hp}
Settling velocity	0.1	m/d	v_{op}
<i>Inorganic P:</i>			
Settling velocity	2	m/d	v_{ip}
Inorganic P sorption coefficient	0	L/mgD	K_{dpi}
Sed P oxygen attenuation half sat constant	0.05	mgO ₂ /L	k_{spi}
<i>Phytoplankton:</i>			
Max Growth rate	0	/d	k_{gp}
Temp correction	1.07		θ_{gp}
Respiration rate	0.2	/d	k_{rp}
Temp correction	1.07		θ_{rp}
Death rate	0.2	/d	k_{dp}
Temp correction	1.07		θ_{dp}
Nitrogen half sat constant	25	ugN/L	k_{spp}
Phosphorus half sat constant	5	ugP/L	k_{snp}
Inorganic carbon half sat constant	1.30E-05	moles/L	k_{scp}
Light model	Half saturation		
Light constant	100	langleys/d	K_{Lp}
Ammonia preference	25	ugN/L	k_{hmxp}
Settling velocity	0.5	m/d	v_a
<i>Bottom Algae:</i>			
Growth model	Zero-order		
Max Growth rate	0	mgA/m ² /d or /d	C_{gb}
Temp correction	1.07		θ_{gb}
First-order model carrying capacity	1000	mgA/m ²	$a_{b,max}$
Respiration rate	0.1	/d	k_{rb}
Temp correction	1.07		θ_{rb}
Excretion rate	0.05	/d	k_{eb}
Temp correction	1.07		θ_{db}
Death rate	0.1	/d	k_{db}
Temp correction	1.07		θ_{db}
External nitrogen half sat constant	300	ugN/L	k_{sPb}
External phosphorus half sat constant	100	ugP/L	k_{sNb}
Inorganic carbon half sat constant	1.30E-05	moles/L	k_{sCb}
Light model	Half saturation		
Light constant	100	langleys/d	K_{Lb}
Ammonia preference	25	ugN/L	k_{hmxb}
Subsistence quota for nitrogen	0.72	mgN/mgA	q_{0N}
Subsistence quota for phosphorus	0.1	mgP/mgA	q_{0P}
Maximum uptake rate for nitrogen	72	mgN/mgA/d	ρ_{mN}
Maximum uptake rate for phosphorus	5	mgP/mgA/d	ρ_{mP}

Appendix G
QUAL2K Rate Assumptions

Parameter	Value	Units	Symbol
Internal nitrogen half sat constant	0.9	mgN/mgA	K_{qN}
Internal phosphorus half sat constant	0.13	mgP/mgA	K_{qP}
<i>Detritus (POM):</i>			
Dissolution rate	0.5	/d	k_{dt}
Temp correction	1.07		θ_{dt}
Fraction of dissolution to fast CBOD	1.00		F_f
Settling velocity	0.1	m/d	v_{dt}
<i>Pathogens:</i>			
Decay rate	2	/d	k_{dx}
Temp correction	1.07		θ_{dx}
Settling velocity	0	m/d	v_x
Light efficiency factor	0.00		α_{path}
<i>pH:</i>			
Partial pressure of carbon dioxide	347	ppm	p_{CO2}



**APPENDIX H
AFFORDABILITY
ANALYSIS**

December 21, 2007

Mr. J. Bruce Woody
 Director of Public Works and Transportation
 City of St. Joseph
 1100 Frederick Avenue
 St. Joseph, MO 64501-2346

Dear Mr. Woody:

We submit herewith our Affordability Analysis for the City of St. Joseph's Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP). The purpose of this report is to provide an objective view of the City's and its residents' financial ability to construct and operate the improvements to the sewer system required to control combined sewer overflows, as mandated by the United States Environmental Protection Agency (EPA) and the Missouri Department of Natural Resources (MDNR). Our guidance for this analysis is the EPA document Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development (1997). This Affordability Analysis report presents the 10 analysis worksheets outlined in the EPA guidance document to determine the relative financial “burden” on the City and its residents as a result of the proposed CSO control projects.

Summary of Findings

Based on the Financial Capability Matrix¹ shown below, the combination of the Residential Indicator and the Financial Capability Indicator score places St. Joseph in the High Burden range.

Table A			
Financial Capability Matrix			
Financial Capability Indicator Score	Residential Indicator		
	Low (Below 1%)	Mid-Range (1% - 2%)	High (Above 2%) St. Joseph = 2.07
Weak (Below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (1.5 – 2.5) St. Joseph = 2.33	Low Burden	Medium Burden	High Burden
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

Based on the EPA guidance document, the resulting burden from the Financial Capability Matrix is used to establish general time periods for the implementation schedule for CSO related

¹ Financial Capability Matrix is referenced from Table 3 of “Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development”, page 41.

projects. The high burden range that the City falls under places the recommended implementation schedule at 15 years, with a schedule of up to 20 years or more based on negotiation with EPA and MDNR. As we will present with the LTCP, the alternatives for the City will greatly exceed a reasonable burden using these implementation guidelines, and we will request an extended implementation schedule that corresponds with a reasonable Residential Indicator that otherwise would be far in excess of 2%.

Methodology

The affordability analysis is based on the standardized approach outlined in the EPA document Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development (1997). The approach provides an EPA defined and approved approach to determine the impact on the community implementing CSO controls. The analysis consists of 10 worksheets. The first two calculate the Residential Indicator, which is a measure of the cost per household of sewer utility projects relative to the median household income (MHI) of the community. The next six worksheets calculate the inputs for the Financial Capability Indicator, which is a measure of the financial strength of the government and the community as a whole. The measures look at debt indicators, socioeconomic indicators, and financial management indicators. The ninth worksheet combines the scores of the Financial Capability worksheets and develops an average score. The tenth worksheet combines the Residential Indicator score and the Financial Capability Indicator score into a matrix to determine the overall burden impact on the community.

Analysis

The following presents the detailed analysis and assumptions used to determine the Residential Indicator (RI) and Financial Capability Indicator.

Residential Indicator

The Residential Indicator measures the financial impact of the current and proposed wastewater treatment (WWT) and CSO controls on residential users. The first step (Worksheet 1) is to determine the cost per household (CPH) of the current and proposed WWT and CSO projects. The second step (Worksheet 2) divides the CPH by the median household income (MHI) of the community to determine the Residential Indicator, expressed as a percentage. The Residential Indicator (RI) is scored as Low, Mid-Range, or High Impact based on the following levels:

Financial Impact	Residential Indicator (CPH as % of MHI)
Low	Less than 1.0% of MHI
Mid-Range	1.0% - 2.0% of MHI
High	Greater than 2.0% of MHI

Worksheet 1 – Cost Per Household

Worksheet 1 develops the cost per household for the residential customers of St. Joseph's wastewater utility. Lines 100 and 101 show the current operating and debt service costs for WWT, based on the most recent rate study, performed by Black & Veatch and submitted in August 2007. Lines 103 and 104 show the projected costs for future projects for both WWT and

CSO improvements. Additional Operation and Maintenance (O&M) expenses related to the future projects are estimated at 0.5% of total project costs. Annual debt service on projected capital projects is based on the equal annual bond payment for \$180 million in projected WWT and CSO project, using a 20 year term and a 4.75% interest rate. The development of the \$180 million in projects is shown in Table B.

Worksheet 1		
Wastewater Cost Per Household		
Line No.	Description	Value
	Current WWT Costs	
100	Annual O&M Expense (2007) ¹	\$7,925,100
101	Annual Debt Service Payment (2007) ¹	<u>\$2,420,400</u>
102	Subtotal (Line 100 + Line 101)	\$10,345,500
	Projected WWT and CSO Costs	
103	Estimated Additional O&M Expense ²	\$901,300
104	Annual Debt Service on Projected Capital Projects ³	<u>\$14,158,900</u>
105	Subtotal (Line 103 + Line 104)	\$15,060,200
106	Total Current and Projected WWT and CSO Costs (Line 102 + Line 105)	\$25,405,700
107	Residential Share of Total WWT and CSO Costs (68%) ¹	\$17,284,200
108	Total Number of Residential Customers ¹	24,021
109	Annual Cost Per Household (Line 107 / Line 108)	\$720
Notes:		
(1) From Report on Revenue Requirements and Cost of Service Rates, August 2007		
(2) Estimated at 0.5% of total estimated project costs		
(3) Debt Service based on \$180 million in projected WWT and CSO projects over 20 years. \$14.2 million represents the equal annual bond payment at 4.75% over 20 years.		

The estimate of future capital projects was developed with a three step process: 1) express the City's current (non-CSO) sewer 5-year capital improvement program (CIP) in 2007 dollars, 2) estimate the next 15 years of projects based on the average of the first 5 years, and 3) determine the maximum amount of CSO projects possible without the CPH exceeding 2% of the MHI. This last step of determining the CPH as a percentage of MHI is shown in Worksheet 2. Table B shows the development of these project costs.

As shown in Table B, the 20-year estimate of capital projects for the current WWT system (non-CSO projects) is approximately \$105 million (Line 4). This estimate is based on the current 5-year Capital Improvement Program (CIP) shown in the Sewer Rate Study submitted in August 2007. The City has also prepared a CIP that forecasts capital projects through 2028 and beyond. This document is attached to this letter report as Appendix A, and can be used to validate the assumptions used to develop the \$105 million estimate of non-CSO projects.

Table B								
Development of WWT and CSO Project Estimate								
Line No.	Description	2007 \$	2008 \$	2009 \$	2010 \$	2011 \$	2012 \$	2013-27 \$
1	Current CIP		6,777,900	8,209,000	6,145,000	2,369,000	4,490,000	
2	Discount to 2007\$ ¹		6,619,000	7,828,700	5,723,000	2,154,600	3,987,900	
3	Estimated Annual Projects (2013 – 2027) ²							5,262,600
4	Total Non-CSO Projects (2008 – 2027) ³	105,252,200						
5	CSO Projects	75,000,000						
6	Total For Bond Estimate	180,252,200						
7	Bond Payment ⁴	14,158,900						

Notes:

- (1) Discounted using 5-year average CPI – 2.4%
- (2) Average of Line 2
- (3) Sum of Line 2 plus Line 3 times 15
- (4) Equal annual bond payment on total from Line 6, 20 year term, 4.75% interest rate

Worksheet 2 – Residential Indicator

The second step to determine the Residential Indicator is to determine the adjusted median household income (MHI). The MHI for St. Joseph from the most recent census in 2005 was \$33,127. This value needs to be escalated to 2007 dollars using the consumer price index (CPI). The average CPI for the most recent 5 years is 2.4%. The adjusted MHI in 2007 dollars is \$34,736.

As shown in Table 3, the RI is calculated by dividing the CPH from Worksheet 1 (\$720) by the adjusted MHI (\$34,736). The RI for St. Joseph is 2.07, which places the City in the “high impact” range.

Worksheet 2 Residential Indicator		
Line No.	Description	Value
201	Median Household Income Census Year MHI (2005\$)	\$33,127
202	MHI Adjustment Factor (5-year average CPI) ¹	1.0486
203	Adjusted MHI (Line 201 x Line 202)	\$34,736
204	Annual WWT and CSO CPH (Table 2, Line 109)	\$720
205	Residential Indicator (Line 204 / Line 203 x 100)	2.07

Notes:

- (1) Consumer Price Index, Midwest Urban, not seasonally adjusted. Adjustment factor calculation = $(1+2.4\%)^2$

Financial Capability Indicator

The second phase of the affordability analysis assesses the financial capability of the community. There are three general categories of financial capability: debt indicators, socioeconomic indicators, and financial management indicators.

- Debt Indicators – Assess the current debt burden of the community and their ability to issue additional debt to finance the CSO controls. The indicators used to measure this are:
 - Bond Ratings (Worksheet 3)
 - Overall Net Debt as a Percent of Full Market Property Value (Worksheet 4)
- Socioeconomic Indicators – Assess the general well-being of residential users in the community. The indicators selected for this purpose are:
 - Unemployment Rate (Worksheet 5)
 - Median Household Income (Worksheet 6)
- Financial Management Indicators – Evaluate the community’s overall ability to manage financial operations. The indicators selected for this purpose are:
 - Property Tax Revenue Collection Rate (Worksheet 7)
 - Property Tax Revenues as a Percentage of Full Market Property Value (Worksheet 8)

The source data used in determining these six indicators come from a variety of resources, including: debt rating agencies, Bureau of Labor Statistics, and the Comprehensive Annual Financial Report (CAFR) of the City of St. Joseph.

Worksheet 3 – Bond Rating

The debt indicator in Worksheet 3 is a composite bond rating for the community that recognizes both the general obligation (GO) bond rating of the City and the rating on revenue bonds issued by the Wastewater Utility. The City has no GO bonds outstanding; however Standard & Poor’s issued a Rationale on July 31, 2007 reaffirming St. Joseph’s issuer credit rating (ICR) of “A”. This is the long term rating for the City.

As an enterprise fund, the Wastewater Utility issues revenue bonds to fund its major capital improvement projects. The rating on the most recent revenue bonds (2004) was “A-”.

Worksheet 3 Bond Rating		
Line No.	Description	Value
301	Most Recent General Obligation Bond Rating ¹	A
302	Most Recent Revenue Bond Rating ²	A-
303	Summary Bond Rating	A
Notes: (1) St. Joseph has no GO bonds, but Standard and Poor’s has issued an ICR long term rating for the City. (2) 2004 Revenue Bonds rating		

The bond rating is scored as weak, mid-range, or strong according to the following scale for S&P bond ratings:

- Weak – BB, B, CCC, CC, C, D
- Mid-Range – BBB
- Strong – AAA, AA, A

Based on the City’s Summary Bond Rating of A (Worksheet 3, Line 303), this indicator is scored as “strong”.

Worksheet 4 – Overall Net Debt as a Percent of Full Market Property Value

Overall net debt is debt repaid by property taxes in the permittee’s service area. It excludes the debt of revenue bonds issued and repaid with user fees. This indicator provides a measure of the debt burden on residents and the ability of the local government to issue additional debt. It includes the debt issued directly by the local government and the debt of overlapping entities, such as school districts. The indicator compares the level of debt owed by the service area population with the full market value of real property used to support the debt.

As shown in Worksheet 4, St. Joseph has direct net debt of \$68.9 million. This includes all government related debt and debt for business type activities not related to revenue bonds supported by user fees. The City has no GO bonds outstanding. Line 402 shows the City’s proportionate share of School District debt (95.75% of \$32.6 million). The overall net debt of the City is \$100.1 million (Line 403).

Worksheet 4				
Overall Net Debt as a Percent of Full Market Property Value				
Line No.	Description			Value
401	Direct Net Debt	GO Bonds		\$0
		Government Activities ¹		\$68,350,506
		Business Type Activities ¹		<u>\$544,495</u>
		Total Outstanding Principal		\$68,905,001
402	Debt of Overlapping Entities (Proportionate share of multijurisdictional debt) School District ²	Debt Outstanding	% Applicable	Share of Overlapping Debt
		\$32,570,000	95.75%	\$31,185,775
403	Overall Net Debt (Line 401 + 402)			\$100,090,776
404	Market Value of Property ³			\$2,681,510,000
405	Overall Net Debt as a % of Full Market Value of Property (Line 403 / 404 x 100)			3.7%
Sources:				
(1) CAFR, p. FN-25				
(2) CAFR, p. T-14				
(3) CAFR, p. T-9				

Full market value of property in St. Joseph is approximately \$2.7 billion. As shown on Line 405, the overall net debt divided by the market value of the property is 3.7%. This indicator is scored on the following scale:

- Weak – Above 5%
- Mid-Range – 2% - 5%
- Strong – Below 2%

Based on the above scale, the score for Worksheet 4 is “mid-range”.

Worksheet 5 – Unemployment Rate

Unemployment rate data for St. Joseph was collected from the Bureau of Labor Statistics. The most recent annual rate available was 4.6% in 2006. To score this indicator, a comparison is made to the national unemployment rate. The U.S. unemployment rate for 2006 was also 4.6%. This indicator is scored according to the following scale:

- Weak – More than 1% above the national average
- Mid-Range – ± 1% of the national average
- Strong – More than 1% below the national average

Because the unemployment rate for St Joseph is equal to the national average, this indicator is scored as “mid-range”.

Worksheet 5 Unemployment Rate		
Line No.	Description	Value
501	Unemployment Rate – Permittee ¹	4.6%
502	Unemployment Rate - County (use if permittee rate is not available)	n/a
503	Average National Unemployment Rate ²	4.6%
Notes: (1) Bureau of Labor Statistics, St. Joseph, MO, 2006 Annual (2) Bureau of Labor Statistics, United States, 2006 Annual		

Worksheet 6 – Median Household Income

The median household income used in this measure of financial capability is the same as the MHI calculated in Worksheet 2. In this instance, it is compared to the national average MHI, providing an overall indicator of community earning capacity. This comparison is shown in Table 6.

Worksheet 6 Median Household Income		
Line No.	Description	Value
601	Median Household Income (2007\$ Adjusted) ¹	\$34,736
602	Census Year National MHI (2005)	\$46,242
603	MHI Adjustment Factor ²	1.0486
604	Adjusted National MHI (2007\$ Adjusted)	\$48,488
Notes: (1) Worksheet 2, Line 203 (2) Worksheet 2, Line 202		

Scoring for the MHI indicator is based on the following scale:

- Weak – More than 25% below Adjusted National MHI
- Mid-Range – ± 25% of the Adjusted National MHI
- Strong – More than 25% above the Adjusted National MHI.

The MHI of St. Joseph is 28.4% below the national average and is scored as “weak”.

Worksheet 7 – Property Tax Revenues as a Percent of Full Market Property Value

This indicator can be viewed as the “property tax burden” since it indicates the funding capacity available to support debt based on the wealth of the community. The full market value of real property was determined in Worksheet 4, Line 404. Fiscal year 2006 property tax revenues collected amount to \$10.2 million. As shown in Table 7, the property tax revenues as a percent of full market property value are 0.38%, and based on the scale below places St. Joseph in the “strong” category.

Scoring for Worksheet 7 is as follows:

- Weak – Above 4%
- Mid-Range – 2% - 4%
- Strong – Below 2%

Worksheet 7		
Property Tax Revenues as a Percent of Full Market Property Value		
Line No.	Description	Value
701	Full Market Value of Real Property ¹	\$2,681,510,000
702	Property Tax Revenues ²	\$10,170,697
703	Property Tax Revenues as a Percent of Full Market Property Value (Line 702 / Line 701)	0.38%
Notes: (1) Worksheet 4, Line 404 (2) CAFR, p. T-12		

Worksheet 8 – Property Tax Revenues Collection Rate

The property tax revenue collection rate is an indicator of the efficiency of the tax collection system and the acceptability of tax levels to residents. Table 8 displays the property tax revenues previously used in Worksheet 7 (Line 702) and compares them to the amount of property taxes actually levied. As shown on Line 803, the actual property tax revenue collection rate in the 2006 CAFR was 85%, which places the City in the “weak” category according to the following scale:

- Weak – Below 94%
- Mid-Range – 94% - 98%
- Strong – Above 98%

While the current year (2006) property tax collection rate is 85%, the collection rate from 1997 to 2005 ranged from a low of 98.82% to a high of 99.94%, indicating a very strong record of collecting property taxes. We consider the 85% collection rate for 2006 an anomaly that will most likely be collected in later years and we estimate the average collection rate for St. Joseph to be 99% placing the City in the “strong” category.

Worksheet 8		
Property Tax Revenue Collection Rate		
Line No.	Description	Value
801	Property Tax Revenue Collected ¹	\$10,170,697
802	Property Taxes Levied ²	\$11,939,359
803a	Property Tax Revenue Collection Rate (actual) (Line 801 / Line 802)	85.2%
803b	Property Tax Revenue Collection Rate (estimated)	99.0%
Notes: (1) Worksheet 7, Line 702 (2) CAFR, p. T-12		

Worksheet 9 – Summary of Permittee Financial Capability Indicators

Worksheet 9 summarizes the 6 indicators used to develop the Financial Capability Indicator. In previous sections, each of the indicators was categorized as weak, mid-range, or strong. To develop the overall Financial Capability Indicator, we score it with a 1, 2, or 3 using the following scale:

- Weak: 1
- Mid-Range: 2
- Strong: 3

Once each indicator from Worksheets 3 through 8 is scored, an average score is taken and assigned an overall rating of weak, mid-range, or strong. As shown in Worksheet 9, Line 907, the overall score for St. Joseph is 2.33, which places them in the “mid-range” for the Financial Capability Indicator.

Worksheet 9				
Summary of Financial Capability Indicators				
Line No.	Description	Value	Benchmark	Score
901	Bond Rating (Line 303)	A	Strong	3
902	Overall Net Debt as a Percent of Full Market Property Value (Line 405)	3.7%	Mid-Range	2
903	Unemployment Rate (Local rate minus National rate) (Line 501 – Line 503)	0%	Mid-Range	2
904	Median Household Income (vs. National MHI) (Line 601 / Line 604)	-28.4%	Weak	1
905	Property Tax Revenues as a Percent of Full Market Property Value (Line 703)	0.38%	Strong	3
906	Property Tax Revenue Collection Rate (Line 803b)	99%	Strong	3
907	Permittee Indicator Score (Average of Scores)			2.33

Worksheet 10 – Financial Capability Matrix Score

The results of the Residential Indicator and Financial Capability Indicators analyses are combined in the Financial Capability Matrix to evaluate the level of financial burden the CSO controls may impose on the permittee. As shown in Worksheet 10, the City’s Residential Indicator is 2.07, which places it in the High Impact range. The City’s Financial Capability Indicator is 2.33, which places it in the Mid-Range. The combined impact of these two indicators in the matrix places the CSO control costs for St. Joseph in the High Burden range of financial impact to the community.

Worksheet 10			
Financial Capability Matrix			
Financial Capability Indicator Score	Residential Indicator		
	Low (Below 1%)	Mid-Range (1% - 2%)	High (Above 2%) St. Joseph = 2.07
Weak (Below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (1.5 – 2.5) St. Joseph = 2.33	Low Burden	Medium Burden	High Burden
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

Impact of Affordability Analysis and Summary

According to EPA guidelines, St. Joseph’s high burden rating indicates an implementation schedule of 15 years with the ability to negotiate to 20 years or more. St. Joseph is in a unique situation where the square mileage of the CSO drainage area is much larger than other cities of comparable population. For example, St. Joseph’s CSO drainage area is 30 square miles, not including an additional 10 square miles of undeveloped upstream area whose stormwater drains directly into the combined system via drainage channels. By comparison, Kansas City, Missouri’s CSO drainage area is 56 square miles, roughly twice as large. However, Kansas City’s population of 440,000 is six times as large as St. Joseph’s at 73,000. Another large city, Louisville, Kentucky has roughly the same CSO drainage area (27 sq. mi.), but has 10 times the population (701,000). The impact of this is St. Joseph has a big city CSO problem with a small city population to pay for it. To compound the affordability issue, St. Joseph’s MHI is 28 percent below the national average, further depressing the ability to reasonably afford the needed CSO improvements. For these reasons, we believe the City of St. Joseph will require an implementation schedule significantly in excess of 20 years to prevent undue burden on its residents.

Conclusion

Based on the Financial Capability Matrix shown in Worksheet 10, the combination of the Residential Indicator and the Financial Capability Indicator scores place St. Joseph in the High Burden range.

Based on the EPA guidance document, the resulting burden from the Financial Capability Matrix is used to establish general time periods for the implementation schedule for CSO control related projects. The high burden range that the City falls under places the recommended implementation schedule at 15 years, with a schedule of up to 20 years or more based on negotiation with EPA and MDNR. As we will present with the LTCP, the alternatives for the City will greatly exceed a reasonable burden using these implementation guidelines, and we will request an extended implementation schedule that corresponds with a reasonable Residential Indicator that otherwise would be far in excess of 2%.

We appreciate the opportunity to provide this report to the City of St. Joseph and we are available for discussion and questions at your convenience.

Very truly yours,

BLACK & VEATCH CORPORATION



Peggy L. Howe
Vice President
Enterprise Management Solutions

CEB/BWB

Appendix A

City of St. Joseph, MO

Wastewater Utility
20-Year Capital Improvement Plan

WPC Capital Expenditures 20 Year Projection 2009 - 2028

WPC Capital Expenditures 20 Year Projection 2009 - 2028								
	Activity	2009-2013	2014-2018	2019-2023	2024-2028	Total	20 Years +	
1	Administration Building							
	1 Lab - Inductive Coupled Plasma / Mass Spectrophotometer (I.C.P. / M.S.) (X - 3)	\$87,000		\$120,000	\$120,000			
	2 Building Addition (Lab & Office)		\$400,000					
	3 Radio Communications Equipment		\$200,000					
	4 HVAC			\$50,000				
	5 Roof		\$65,000		\$65,000			
	6 Plant Paving & Drainage	\$100,000						
	<i>Subtotal</i>	<i>\$187,000</i>	<i>\$665,000</i>	<i>\$170,000</i>	<i>\$185,000</i>	<i>\$1,207,000</i>		
2	Maintenance Garage							
	1 Building Addition (Sewer Maintenance)	\$750,000						
	2 Furnace		\$10,000	\$10,000				
	3 Roof		\$75,000		\$75,000			
	<i>Subtotal</i>	<i>\$750,000</i>	<i>\$85,000</i>	<i>\$10,000</i>	<i>\$75,000</i>	<i>\$920,000</i>		
3	Digester Complex							
	1 Heat Exchangers (X - 6)		\$400,000		\$400,000			
	2 Convert #1 Anaerobic Digester to Thermophilic		\$2,000,000					
	3 Convert #3 Anaerobic Digester to Thermophilic						\$2,000,000	
	4 Rehab #2 Anaerobic Digester			\$1,200,000				
	5 Rehab #4 Anaerobic Digester				\$1,200,000			
	6 Replace Gas Burnoff		\$50,000					
	7 SCADA System (Solids handling only)		\$100,000					
	8 Sludge Piping Replacement			\$100,000				
	9 HVAC		\$100,000					
	10 Belt Filter Presses (2 meter, X - 2)	\$500,000		\$500,000				
	11 Roof				\$55,000			
	12 Motor Control Center (Belt Press Room)		\$40,000					
	<i>Subtotal</i>	<i>\$500,000</i>	<i>\$2,690,000</i>	<i>\$1,800,000</i>	<i>\$1,655,000</i>	<i>\$6,645,000</i>		
4	Grit:							
	Chambers #1 & #2							
	1 Complete Rehab		\$3,000,000					
	2 36" Plant Influent Magnetic Flowmeter			\$36,000				
	3 42" Plant Influent Magnetic Flowmeter		\$42,000					
	4 Roofs (X - 2)		\$300,000					
	5 Rehab Muffin Monsters (Shredding Devices) (3 x 7 rebuild Cycles) (21 X \$30,000)		\$630,000					
	Missouri Avenue							
	1 Design & Installation	\$900,000						
	<i>Subtotal</i>	<i>\$900,000</i>	<i>\$3,972,000</i>	<i>\$36,000</i>		<i>\$4,908,000</i>		

	Activity	2009-2013	2014-2018	2019-2023	2024-2028	Total	20 Years +
5	Raw Sludge #1 & #2						
	1 Replace Raw Sludge Magnetic Flowmeter (X - 2)			\$8,000	\$8,000		
	2 Rehab Primary Clarifier #2	\$300,000					
	3 Roofs (X - 2)	\$11,000					
	4 Piping Replacement		\$50,000	\$50,000			
	5 Replace Progressive Cavity Pumps (6) (\$10,000 ea.)		\$30,000	\$30,000			
	<i>Subtotal</i>	\$311,000	\$80,000	\$88,000	\$8,000	\$487,000	
6	Plant Sewage Pump Station						
	1 Replace Centrifugal Raw Wastewater Pumps (X - 3)		\$90,000				
	2 Replace Variable Speed Motor Drives (X - 3)		\$250,000				
	3 Rehab Pump Controls			\$20,000			
	4 Replace Bar Screens (X - 2)	\$74,000	\$74,000				
	5 Roof		\$6,500				
	6 Elevator		\$100,000				
	<i>Subtotal</i>	\$74,000	\$520,500	\$20,000		\$614,500	
7	Dissolved Air Floatation (D.A.F.)						
	1 Rehab Floatation Equipment (X - 3)		\$100,000	\$100,000	\$100,000		
	2 Roofs		\$47,500				
	3 Floatation Building Rehab		\$100,000				
	4 Motor Control Center			\$50,000			
	<i>Subtotal</i>		\$247,500	\$150,000	\$100,000	\$497,500	
8	Chemical Precipitation						
	1 Roof		\$4,500				
	2 Clarifier Rehab		\$400,000				
	<i>Subtotal</i>	\$0	\$404,500	\$0		\$404,500	
9	Aerobic Digesters						
	1 Rehab Aeration Arms (X - 84) (X - \$4,500)		\$378,000				
	2 Replace Butterfly Valves (X - 84) (X - \$125)		\$10,500				
	3 Replace Diffusers (X - 2016) (X - \$125) (X - 2)		\$241,920		\$241,920		
	4 Rehab Cross Beams		\$40,000				
	<i>Subtotal</i>	\$0	\$670,420		\$241,920	\$912,340	
10	Blower Building						
	1 Add Centrifugal Blowers	\$500,000					
	2 American Air Filters Socks (X - 188) (X - \$43)		\$43,428				
	3 Replace Variable Speed Motor Drives (X - 6) (X - 2)	\$384,000			\$384,000		
	4 Roof		\$47,500				
	5 Conversion for ammonia removal	\$6,000,000					
	<i>Subtotal</i>	\$6,884,000	\$90,928		\$384,000	\$7,358,928	

	Activity	2009-2013	2014-2018	2019-2023	2024-2028	Total	20 Years +
11	Intermediate Pumping Station						
	1 Replace Variable Speed Motor Drives (X - 3) (X - 2)	\$300,000			\$300,000		
	2 Replace Horizontal Roughing Filter External Support Beams		\$100,000				
	3 Replace 24" SSJISD Magnetic Flow Meter		\$50,000				
	4 Roof		\$17,000				
	5 Elevator		\$100,000				
	<i>Subtotal</i>	\$300,000	\$267,000		\$300,000	\$867,000	
12	Return Sludge #1						
	1 Replace 60" Screw Pump (X - 2)	\$200,000					
	2 Roof				\$3,000		
	3 Replace Gates & Controllers (X - 9)			\$90,000			
	4 Motor Control Center				\$50,000		
	<i>Subtotal</i>	\$200,000		\$90,000	\$53,000	\$343,000	
13	Return Sludge #2						
	1 Replace 60" Screw Pump (X - 3)	\$200,000					
	2 Roof				\$3,000		
	3 Replace Gates & Controllers (X - 18)			\$180,000			
	4 Motor Control Center				\$50,000		
	<i>Subtotal</i>	\$200,000		\$180,000	\$53,000	\$433,000	
14	Secondary Clarifiers						
	1 Rehab Clarifiers (X - 3)	\$1,200,000					
	<i>Subtotal</i>	\$1,200,000				\$1,200,000	
15	Whitehead Pump Station (1)						
	1 Ball Check Valves (X - 5)	\$650,000					
	2 Replace Variable Speed Motor Drives (X - 5) (X - 2)		\$320,000		\$320,000		
	3 Roof			\$6,500			
	4 Paving	\$55,000					
	5 Replace Pumps (X - 5)	\$225,000	\$225,000	\$112,500			
	6 Elevator			\$100,000			
	7 Motor Control Center		\$20,000				
	<i>Subtotal</i>	\$930,000	\$565,000	\$219,000	\$320,000	\$2,034,000	
16	Browns Branch Pumping Station						
	1 Add Raw Wastewater Pump & Channel Grinder (CSO Control)	\$100,000		\$105,000			
	2 MCC Replacement	\$50,000					
	3 Replace Pumps (X - 2)			\$35,000	\$35,000		
	4 Barscreens (X - 2)		\$250,000				
	5 Roof			\$5,000			
	6 Paving		\$10,000				
	<i>Subtotal</i>	\$150,000	\$260,000	\$145,000	\$35,000	\$590,000	

	Activity	2009-2013	2014-2018	2019-2023	2024-2028	Total	20 Years +
17	Faraon Street Pump Station						
	1 Acquire Land for Hydrogen Peroxide Injection Station	\$50,000					
	2 Roof				\$15,000		
	<i>Subtotal</i>	\$50,000	\$0		\$15,000	\$65,000	
18	Collection System (costs listed not in 1st t yrs)						
	1 Collection System Maint. In Sewer Maint.						
	a. Root Foaming \$50K	\$200,000	\$250,000	\$250,000	\$250,000		
	b. CIPP \$400K	\$750,000	\$1,200,000	\$1,200,000	\$1,200,000		
	c. Sewer Cleaning (contractor) \$50K	\$100,000	\$250,000	\$250,000	\$250,000		
	d. Emergency Repairs (large - contractor) \$500K	\$1,325,000	\$2,500,000	\$2,500,000	\$2,500,000		
	e. Manhole lining \$10K	\$50,000	\$50,000	\$50,000	\$50,000		
	f. Gunite \$150K	\$0	\$750,000	\$750,000	\$750,000		
	g. Mainline Sewer Rehabilitation (1 project per decade- 2 cycles) \$5 million/project		\$5,000,000	\$2,500,000	\$2,500,000		
	h. Cave-ins \$270,600	\$75,000	\$135,300	\$135,300	\$135,300		
	2 I/I reduction	\$0	\$4,000,000	\$2,000,000	\$2,000,000		
	3 CMOM Program-						
	a. Manhole Inspection program - annual \$40K	\$200,000	\$200,000	\$200,000	\$200,000		
	b. Update Aerial Photography - annual \$25K	\$125,000	\$125,000	\$125,000	\$125,000		
	c. CMOM Program Technician - annual \$50K	\$250,000	\$250,000	\$250,000	\$250,000		
	d. GPS Equipment - 6 year life (3 cycles) \$30K/cycle	\$22,500	\$22,500	\$22,500	\$22,500		
	e. TV Van - 6 year life (3 cycles) \$140/cycle	\$105,000	\$105,000	\$105,000	\$105,000		
	f. Other Rolling Stock - Sewer Maint.- 6 year life (3 cycles) \$400K/cycle	\$300,000	\$300,000	\$300,000	\$300,000		
	g. Portable TV Unit - 6 year life (3 cycles) \$63K/cycle	\$47,250	\$47,250	\$47,250	\$47,250		
	h. Jet Machine - 6 year life (3 cycles) \$200K/cycle	\$150,000	\$150,000	\$150,000	\$150,000		
	i. Easement Jet Machine - 6 year life (3 cycles) \$40K/cycle	\$200,000	\$200,000	\$200,000	\$200,000		
	j. One-time costs:						
	*TV Van Retrofit \$96K	\$96,000					
	*Build Collection System Map & Mgt. System \$600K	\$600,000					
	<i>Subtotal</i>	\$4,595,750	\$15,535,050	\$11,035,050	\$11,035,050	\$42,200,900	
19	System Expansion						
	1 Expansion of mains	\$8,894,000	\$1,000,000	\$1,000,000	\$1,000,000		
	<i>Subtotal</i>	\$8,894,000	\$1,000,000	\$1,000,000	\$1,000,000	\$11,894,000	
20	Rosecrans Lagoons						
	1 Disinfection or evaporation cell addition	\$1,000,750					
	<i>Subtotal</i>	\$1,000,750				\$1,000,750	
21	Package Lift Stations						
	1 Install Generators (X - 3)		\$60,000				
	<i>Subtotal</i>		\$60,000			\$60,000	

	Activity	2009-2013	2014-2018	2019-2023	2024-2028	Total	20 Years +
22	Plant Disinfection						
	1 Design	\$500,000					
	2 Construct	\$4,500,000					
	Subtotal	\$5,000,000				\$5,000,000	
23	Aeration Basins						
	1 Rehab Aeration Arms (X - 48) (X \$4,500)		\$216,000				
	2 Replace Butterfly Valves (X - 48) (X - \$225)		\$10,800				
	3 Replace Diffusers (X - 48 X 37) (X \$125) (X 2)		\$222,000		\$222,000		
	4 Replacement Diffuser Sheaths (X - 48 - X - 37 - (X - \$64)		\$113,664	\$113,664			
	Subtotal	\$0	\$562,464	\$113,664	\$222,000	\$898,128	
24	South St. Joseph Industrial Pump Station						
	1 Wet Well Rehab Design	\$150,000					
	2 Wet Well Rehab	\$850,000					
	3 Replace Variable Speed Motor Drives (X -3) (X - 2)		\$350,000	\$350,000			
	4 Roof			\$30,000			
	5 Replace Wastewater Pumps (X - 3)		\$100,000				
	Subtotal	\$1,000,000	\$450,000	\$380,000	\$0	\$1,830,000	
25	Rolling Stock						
	1 170 hp Farm Tractor for Land Application			\$140,000			
	2 Diesel Dump Trucks (20 cu. Yd.) (X - 3)			\$300,000			
	3 Over the road Diesel Tractor Trucks (X - 2)			\$200,000			
	4 Manure Spreader			\$50,000			
	Subtotal			\$690,000		\$690,000	
26	East Side Collection System*						
	1A Easton Road Pump Station**						
	a new expanded station	\$2,000,000					
	b extended mainline and forcemain and	\$3,500,000					
	1B Faraon Street Pump Station Upgrade***						
	a 4th pump and second parrallel forcemain						\$5,000,000
	b Flow equalization basin						\$3,000,000
	c Wet well rehabilitation		\$6,000,000				
	d Interceptor expansion						\$7,000,000
	Subtotal	\$5,500,000	\$6,000,000	\$0		\$11,500,000	
27	Fats Oils & Grease Program						
	1 Installation of Uploading Station for Septic Haulers	\$130,000					
	Subtotal	\$130,000				\$130,000	



**APPENDIX I
ABATEMENT ORDER
ON CONSENT**

SPECIAL **ORDINANCE No.** 7174

AN ORDINANCE TO ENTER INTO AN ABATEMENT ORDER ON CONSENT WITH THE MISSOURI DEPARTMENT OF NATURAL RESOURCES CONCERNING THE CITY'S LONG TERM CONTROL PLAN FOR OPERATING THE CITY'S COMBINED SEWER SYSTEM.

WHEREAS, The Environmental Protection Agency (EPA), in compliance with the Clean Water Act, and the Missouri Department of Natural Resources, (MDNR), in compliance with the Code of State Regulations, require all communities with combined sewer systems to complete a Long Term Control Plan (LTCP); and

WHEREAS, The City of St. Joseph first submitted its LTCP on December 19, 2002; and

WHEREAS, The MDNR returned the City's first LTCP requiring it to be revised to meet additional water quality concerns and to be updated to comply with subsequent revisions to the state water quality standards.

NOW, THEREFORE, BE IT ORDAINED BY THE COUNCIL OF THE CITY OF ST. JOSEPH, MISSOURI, AS FOLLOWS:

SECTION 1: That the Abatement Order on Consent, by and between the City of St. Joseph, Missouri and the Missouri Department of Natural Resources be, and hereby is, approved and that a true and accurate copy of said Abatement Order on Consent is attached hereto and incorporated herein by reference as though fully set out herein.

SECTION 2: That the City Manager be, and hereby is, authorized to execute said Abatement Order on Consent with the Missouri Department of Natural Resources by and on behalf of the City of St. Joseph, Missouri, and to sign all necessary documents, amendments and addenda thereto which may subsequently be required to effectuate the purpose and intent of this Abatement Order on Consent.

SECTION 3: That this Ordinance shall be in full force and effect from and after date of passage.

RECEIVED
OCT 04 2007
WATER PROTECTION PROGRAM

CITY CLERK'S
ORIGINAL DOCUMENT
PLEASE RETURN

Authenticated Copy
of Reso., G.O., S.O. 7174
PAULA HEYDE, City Clerk
By Ken Shearin
Deputy
date 9-26-07

Approved as to form:

[Signature]

ASST City Attorney

Passed September 24, 2007

Attest: /s/Paula Heyde, CMC
(Seal)

City Clerk

/s/Ken Shearin

Mayor

Date: September 11, 2007
Type of Ordinance: Special

EXPLANATION TO COUNCIL BILL

ORIGINATING DEPARTMENT: Public Works & Transportation

PURPOSE: For the City of St. Joseph to enter into an Abatement Order on Consent with the Missouri Department of Natural Resources (MDNR) regarding submittal of its Long Term Control Plan (LTCP).

REMARKS: The Clean Water Act of 1972 required all communities across the United States with combined sewer systems to prepare LTCP's for review and approval by the EPA and State environmental regulatory agencies regarding how those communities will operate and maintain their combined sewer systems to produce an effluent in compliance with the Act. There are 772 cities in the U. S. that have combined sewer systems. Some are relatively small and best managed through separation of their systems, thus eliminating their combined sewers. However, many of the larger communities, including St. Joseph, have very invasive systems which require detailed operation and maintenance strategies in order to comply with the provisions of the Clean Water Act.

The City of St. Joseph's LTCP was originally submitted to the MDNR on December 19th, 2002. The original LTCP demonstrated that the City's discharges to the Missouri River through its 15 combined sewer overflows were compliant with the existing water quality standards. However, upon review, the MDNR rejected the initial submittal stating that although the LTCP met the requirements of the Clean Water Act, it did not meet all aspects of the higher standards promulgated by the State of Missouri. Additionally, since that time the MDNR has significantly revised the State's water quality standards, adding yet additional requirements to be met, including such items as disinfection.

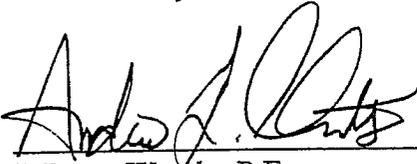
Nationwide, the EPA has been pressuring state regulatory agencies on the issue of completing LTCP's. As a part of that effort, state regulatory agencies have either been entering into voluntary legal agreements with municipalities or have initiated involuntary lawsuits. Earlier this year the Metropolitan Sewer District in St. Louis received an involuntary lawsuit filed by the EPA and MDNR on this very topic. The City of St. Joseph has been making submittals to the MDNR and has been keeping in communication with the State regarding our progress in completing a revised LTCP. However, to be in compliance with the EPA's initiatives to set a specified date for completing the LTCP, the City of St. Joseph received a proposed Abatement Order on Consent from the MDNR. The abatement order is a voluntary agreement between the state regulatory agencies and the City for the purpose of specifying the final completion date of our LTCP. Attached is the Abatement Order on Consent as negotiated with the state by staff.

This Abatement Order on Consent requires the City of St. Joseph to complete its LTCP and submit it to the State by February 15th, 2008. The City Council on June 18th, 2007 entered into an agreement with Black & Veatch Corporation for the completion of the City's LTCP. Staff will be making presentations to the City Council regarding options for how to manage the City's combined sewer system to meet the expectations of the EPA for compliance with the Clean Water Act. These recommendations will involve significant capital improvements to the City's combined sewer system over the next several decades. The capital improvements as listed in the LTCP will be a series of projects including a proposed implementation schedule and funding plan. Typical improvements will include maximizing flow to the wastewater treatment plant; maximizing inline storage within the collection system; construction of wet weather treatment and disinfection facilities at several existing combined sewer overflow locations; and continuing public education regarding our combined sewer system.

The City of St. Joseph is one of five combined sewer system communities in the State of Missouri. However, the only three significant ones in the entire state are St. Louis, Kansas City, and St. Joseph. St. Joseph is fortunate in that we only have 15 combined sewer overflow locations and they are all located immediately adjacent to the river. While that provides us with several technical advantages over the other two combined sewer overflow communities, we still have a significant investment to face in order to meet the expectations of the Clean Water Act. However, once completed, the local community and state at large will benefit from the environmental improvements resulting from these investments.

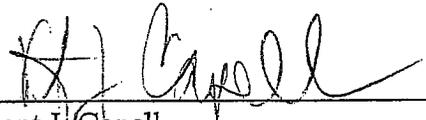
Staff recommends adoption of this ordinance.

Submitted By:



J. Bruce Woody, P.E.
Director of Public Works & Transportation

Reviewed By:



Vincent J. Capell
City Manager

for

3. The City's Facility has one (1) outfall, outfall 001, which discharges treated wastewater to the Missouri River, waters of the state, pursuant to the terms and conditions contained in Missouri State Operating Permit No. MO-0023043 (Permit).
4. The City also owns, operates and maintains a wastewater collection system located throughout the City that collects and carries wastewater from the sources to the Facility for treatment. Some of the collection system carries combined stormwater and wastewater, and within this combined sewer system are fifteen (15) Combined Sewer Overflows (CSO) diversions.
5. On July 1, 1996, the Department renewed the City's Permit that included a Schedule of Compliance in Part "C" Special Condition 8, which required the City to submit to the Department a Long Term Control Plan (LTCP) for its CSO on or before June 30, 1999.
6. In January 1997, the City submitted the *Combined Sewer Overflow Characterization Report for St. Joseph, Missouri* to the Department as required by its Permit. In a letter dated October 2, 2001, the Department informed the city the characterization report fulfilled the corresponding requirement contained in Special Condition 8 of the Permit.
7. The City could not submit a LTCP to the Department on or before June 30, 1999, until the Department approved the *Characterization Report for St. Joseph, Missouri*.
8. The City entered into a Settlement Agreement with the Department and the AGO that became effective on February 7, 2002.

9. As part of the February 7, 2002, Settlement Agreement the City agreed to submit a LTCP to the Department for review and approval on or before December 31, 2002.
10. On December 19, 2002, the City submitted a LTCP to the Department for review and approval.
11. Correspondence from the Department to the City dated May 6, 2003, informed the City that the LTCP submitted in December 2002, "lists some activities that are acceptable, but does not appear to be comprehensive to all impacts associated with combined sewers, and therefore was not approvable".
12. On May 19, 2006, the City submitted a work plan to the Department and the United States Environmental Protection Agency (EPA) that included a schedule to submit an updated LTCP to the Department by November 30, 2006.
13. In correspondence to the Department dated November 28, 2006, the City submitted a progress report and requested an extension to submit the updated LTCP by January 31, 2007, to await further regulatory comments.
14. In correspondence dated December 14, 2006, from the EPA to the City, the EPA granted the request for an extension to submit the updated LTCP by January 31, 2007. In this correspondence the EPA also provided the City the anticipated list of comments, which needed to be addressed in the updated LTCP.
15. On February 8, 2007, the City met with staff from the Department and the EPA to discuss activities related to the City's LTCP. During this meeting the City requested additional time to submit an updated LTCP in order to obtain overflow sampling data during the spring. At this meeting all parties agreed

that additional sampling locations would improve the thoroughness of the report and the City volunteered to add five (5) additional monitoring points.

16. On April 2, 2007, the City submitted a progress report to the Department and the EPA detailing the City's progress in developing its LTCP since February 7, 2007. In the report, the City reported that it had conducted one trial monitoring event that identified mechanical issues with the flow meters and that the City was working with its consultants to resolve the mechanical issues. Lack of rain events of sufficient size to cause an overflow also hampered collection of data. The City also reported that it was ordering five (5) additional flow meters that were scheduled to be installed in May 2007. In this report the City requested time to obtain volume, rainfall and analytical sampling data during five CSO events.

17. On May 10, 2007, the City submitted a progress report to the Department and the EPA detailing activities the City completed in developing its LTCP since April 2, 2007. The City reported that it conducted one (1) monitoring event during this time and that it was in the process of installing five (5) additional flow meters. In this report the City also proposed a schedule to develop and submit its LTCP. In the schedule the City proposed to submit the final LTCP to the Department and EPA on or before February 15, 2008.

III. CITATIONS AND CONCLUSIONS OF LAW

The Department finds that the following violations of the Missouri Clean Water Law, Chapter 644, RSMo, have occurred and are occurring as follows:

18. On December 27, 2002, the City submitted to the Department a CSO Long Term Control Plan as required in Part "C" Special Condition 8 of its permit, however the Department informed the City on May 6, 2003, that the report did not meet the requirements of the LTCP and was therefore is in violation of Section 644.076.1, RSMo, and 10 CSR 20-6.010 (7)(A).

IV. TERMS

19. The Department and the City desire to amicably resolve all claims that might be brought against the City for the violations alleged above without the City admitting the validity or accuracy of such claims.

20. The provisions of this Abatement Order on Consent shall apply to and be binding upon the parties executing this Agreement, their successors, assigns, agents, subsidiaries, affiliates, and lessees, including the officers, agents, servants, corporations, and any persons acting under, through, or for the parties.

21. The City shall:

- a. On or before February 15, 2008, submit to the Department the City's final LTCP developed pursuant to the U.S. EPA's CSO Control Policy, 59 Fed. Reg. 18688 (April 19, 1994), and which also addresses the comments submitted to the City by the Department, on May 6, 2003, and by the EPA, on September 26, 2005, and by both the Department and the EPA on December 14, 2006. The final LTCP shall also include a schedule, with clearly stated dates, to both implement and complete all of the improvements listed in the LTCP. The City shall also submit annual

progress reports to the Department, which lists all completed and yet to be completed LTCP items.

- b. Within sixty (60) days of the Department's approval of the LTCP, commence implementation of the LTCP in accordance with the approved schedule. If the schedule contained within the LTCP is not approvable, i.e. as expeditious as possible nor consistent with Section II.C.8 of the CSO Control Policy, the Department will submit to the City a revised schedule that it deems more appropriate consistent with the February 1997 Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development. If requested by the Department, the City will perform the financial capability assessment described in Sections I through IV of this guidance and submit the results to the Department.
- c. In the period of time from the effective date of this Abatement Order on Consent until the City completes all of the improvements listed in the LTCP, as approved by the Department, the City shall operate its Facility and all CSO outfalls at all times to meet the requirements of its Permit and to prevent dry weather sanitary sewer overflows from the City's collection system. In addition, the City shall also meet the Nine Minimum Controls as set forth in Missouri State Operating Permit MO-0023043.

22. Should the City fail to meet the terms of this Order, including the deadlines set out in paragraph 21, the City agrees to pay stipulated penalties in the following amount:

<u>Days of Violation</u>	<u>Amount of Penalty</u>
1 to 30 days	\$1,000.00 per day
31 to 90 days	\$2,500.00 per day
91 days and above	\$5,000.00 per day

Any such stipulated penalty shall be paid within thirty (30) days of demand by the Attorney General to the Attorney General's Office in the form of a check made payable to the "*State of Missouri (Buchanan County School Fund)*". The check shall be mailed to:

Jo Ann Horvath, Collections Specialist
Missouri Attorney General's Office
PO Box 899
Jefferson City, MO 65102

This stipulated penalty is not a civil penalty, nor an administrative penalty.

Rather it is a sanction for not complying with the terms of this Order.

23. Nothing in this Abatement Order on Consent forgives the City from future noncompliance with the laws of the state of Missouri, nor requires the Department or state of Missouri to forgo pursuing by any legal means any noncompliance with the laws of the state of Missouri.
24. The terms stated herein constitute the entire and exclusive agreement of the parties. There are no other obligations of the parties, be they express or implied, oral, or written, except those, which are expressly set forth herein. The terms of this Abatement Order on Consent supersede all previous memoranda or understanding, notes, conversations, and agreements, express or implied.
25. The Department will send a fully executed copy of the Abatement Order on Consent to all parties.

26. The effective date of the Abatement Order on Consent shall be the date the Department signs the Agreement.

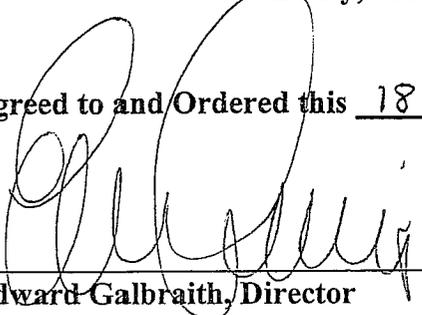
27. The City agrees to comply with the Missouri Clean Water Law, Chapter 644, RSMo, and its implementing regulations at all times in the future.

V. CORRESPONDENCE AND DOCUMENTATION

28. Correspondence or documentation with regard to conditions outlined in this Abatement Order on Consent shall be directed to:

Ms. Elena M. Seon
Compliance and Enforcement Section
Water Protection Program
Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102-0176

Agreed to and Ordered this 18 day of October, 2007



Edward Galbraith, Director
Water Protection Program
Missouri Department of Natural Resources



Vincent J. Capell, City Manager
City of St. Joseph

c. Ms. Diane Huffman
Water, Wetlands, and Pesticides Division
U.S. Environmental Protection Agency, Region VII
901 North Fifth Street
Kansas City, KS 66101

Mr. Joseph P. Bindbeutel, Chief Council
Agriculture and Environment Division
Office of the Attorney General
P.O. Box 899
Jefferson City, MO 65102-0899

Mr. Karl Fett
Regional Director
Kansas City Regional Office
Department of Natural Resources
500 NE Colbern Road
Lee's Summit, MO 64086-4710

Mr. William A. Easley, Jr., Commissioner
Missouri Clean Water Commission
P.O. Box 126
Cassville, MO 65625

Mrs. Kristin M. Perry, Vice-Chair
Missouri Clean Water Commission
P.O. Box 418
Bowling Green, MO 63334

Mr. Ron Hardecke, Commissioner
Missouri Clean Water Commission
3944 Blocks Branch Rd.
Owensville, MO 65066

Mr. Frank Shorney, Commissioner
Missouri Clean Water Commission
4609 Northeast Dick Howser Circle
Lee's Summit, MO 64064

Mr. Jan C. Tupper, Commissioner
Missouri Clean Water Commission
2827 South Michigan
Joplin, MO 64804

Mr. Ben A. "Todd" Parnell, Commissioner
Missouri Clean Water Commission
3545 Cinnamon Place
Springfield, MO 65809