Clean Water 2020 Program

INFRASTRUCTURE REHABILITATION REPORT (IR Report)

November 2019

We Are Columbia

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Acronyms

ARV – Air Release Valve

BWWF – Base Wastewater Flow

CAP – Capacity Assurance Program

CCTV – Closed Circuit Television

CD – Consent Decree

CIP – Capital Improvement Project

CSAP – Continuing Sewer Assessment Program

DHEC – South Carolina Department of Health and Environmental Control

EPA – United States Environmental Protection Agency

GIS – Geographic Information System

GWI – Groundwater Infiltration

HMR – Hydraulic Model Report

I/I – Inflow and Infiltration

IR – Infrastructure Rehabilitation

MACP – Manhole Assessment and Certification Program

NASSCO – National Association of Sewer Service Companies

O&M – Operations and Maintenance

PACP – Pipeline Assessment and Certification Program

PCCP – Prestressed Concrete Cylinder Pipe

RDI/I – Rainfall Dependent Inflow/Infiltration

SOP – Standard Operating Procedure

SSO – Sanitary Sewer Overflow

WCTS – Wastewater Collection and Transmission System

WWTP – Wastewater Treatment Plant

Program Summary and Intent

The City of Columbia (City) developed this Infrastructure Rehabilitation Report (IR Report) to summarize the results of the Continuing Sewer Assessment Program (CSAP) of the major components of the Wastewater Collection and Transmission System (WCTS) and to provide a description of the City's proposed rehabilitation projects, including rehabilitation projects currently underway.

This IR Report has been prepared in accordance with the requirements of Paragraph 16 of the Consent Decree (CD) entered by order dated May 21, 2014, in *The United States of America and State of South Carolina by and through the Department of Health and Environmental Control vs. The City of Columbia*, Civil Action No. 3:13-2429-TWL, DOJ Case Number 90-5-1-1-00954.

Table 0-1 is a list of the CD requirements for the IR Report and the sections of this document that address each requirement.

Table 0-1 – Summary of Consent Decree Requirements for the IR Report

CD Section	CD Requirements	IR Report Section
V. 16. Main paragraph	"IR Report for the WCTS. Within six (6) months after Columbia has assessed the major components of the WCTS once pursuant to the CSAP, Columbia shall submit to EPA [United States Environmental Protection Agency] and DHEC [South Carolina Department of Health and Environmental Control] for review, comment, and approval an IR Report setting forth a summary of the results of the CSAP of the major components of the WCTS and a description of Columbia's proposed rehabilitation projects, including rehabilitation projects currently underway."	Sections 2 through 5
	"The summary of the results of the CSAP shall contain a thorough analysis of historical and current flow monitoring, inspection, rainfall and other data, including data collected during the CSAP."	Sections 2 through 4
16.a.	"Results of the CSAP. At a minimum, the CSAP results summary portion of the IR Report Shall include the components set forth in Paragraphs 16.a.i through 16.a.viii. below."	
	"A determination of existing flows for each Subbasin within the WCTS including average and peak daily dry weather flow.	Section 2.2.1.2, Appendix A
	"A determination of the average dry weather Infiltration rate (in gpd/inch diameter-mile)."	Section 2.2.1.2, Appendix A
	"A determination of peak wet weather flow and peaking factors (the ratio of peak flow to average dry weather flow)."	Section 2.2.1.2, Appendix A
	"Identification of the portions of the WCTS experiencing levels of I/I [inflow/infiltration] that cause or contribute to SSOs [sanitary sewer overflows]."	Section 2.2.4, Appendix A
	"A summary of identified sources of I/I to the WCTS organized by Subbasins, or portions of Subbasins, that indicates the specific types of defects found, and the	Sections 2.2.2 and 2.2.3, Appendix C and D

CD Section	CD Requirements	IR Report Section
	quantity of each defect type with a given National Association of Sewer [Service Companies (NASSCO)] defect rating."	
	"The summary shall also estimate the total I/I contributions to such Subbasins or portions of Subbasins."	Section 2.2.4, Appendix A
	"A summary of flow monitoring activities, that include, at a minimum, a map showing the delineation of the Subbasin, the location and type of each flow meter, problems encountered and deviations from the CSAP, and a description of quality control and quality assurance activities, including the use of scattergraphs, to ensure accurate flow measurement."	Section 2.2.1, Appendix A
	"A description of the methods used to estimate I/I, an identification of the locations where the methods were used, and an explanation of the assumptions, rainfall events, and other variables used in estimating I/I."	Section 2.2.1.3, Appendix A
	"A summary of the status of Columbia's development of the hydraulic Model Report required under Paragraph 17.d. of this Consent Decree, including a description of the completed activities and the remaining tasks and activities to be carried out in development of the hydraulic Model Report, and the anticipated dates of completion of such remaining tasks and activities."	Section 6
16.b.	"Rehabilitation of Infrastructure. In accordance with the IR Program, the IR Report shall identify all specific rehabilitation measures and projects, including those currently underway and those additional rehabilitation projects identified through the assessment of the major components of the WCTS pursuant to the CSAP, as needed to address I/I and other conditions causing SSOs."	Sections 2.5, 3.5, 4.5, and 5.1
	"The IR Report will also state the quantity of I/I that Columbia estimates will be removed through each identified rehabilitation project, and describe the methods used to quantify the I/I projected to be removed, including an explanation of the variables used in estimating the I/I projected to be removed."	Section 5.3
	"The IR Report shall include a schedule for completion of all identified rehabilitation projects."	Section 5.2, Table 5-4
	"Based on the results of the initial assessment of major components of the WCTS pursuant to the CSAP, the IR Report shall group the additional rehabilitation projects into three scheduling categories ("Group 1," "Group 2," and "Group 3") according to priority of the projects. The rehabilitation projects in the IR Report shall be prioritized according to their ability to resolve the most serious problems related to capacity overflows and problems related to WCTS segments with the highest defect ratings, as determined by the CSAP's initial assessment of major components of the entire WCTS."	Section 5.1
	"The schedule shall provide for completion of rehabilitation measures identified in the IR Report by the dates listed in Subparagraph b.(i) – (iii) below."	Section 5.2, Table 5-4

Section 1 Introduction

1.1 IR Report Overview

The IR Report is one of several reports required by the CD for continued improvement of the WCTS with a goal of eliminating future SSOs. The IR Report presents a summary of the results of the CSAP assessment of the major components of the WCTS, a description of the proposed rehabilitation measures and projects (including those currently underway), and a prioritized implementation program of system improvements to mitigate SSOs. Rehabilitation measures and projects presented in this IR Report focus on conditions causing SSOs in the WCTS after May 21, 2014, through December 31, 2018, and conditions that may cause future SSOs.

The IR Report is based on implementation of other programs, prepared in accordance with the CD, including the following:

- The CSAP, approved on May 23, 2016, describes the methods and standard procedures used for assessment of the WCTS and establishes the schedules for prioritizing and implementing the continual assessment of the WCTS. Results of the CSAP of the major components of the WCTS are summarized in this IR Report. Results of the CSAP of the minor components of the WCTS will be summarized in the Supplemental IR Report.

- The Infrastructure Rehabilitation Program (IR Program), approved April 27, 2017, describes the policies and procedures for implementing rehabilitation measures to address I/I, structural issues and the other conditions in the WCTS causing SSOs, including the evaluation process by which condition data collected through the CSAP is utilized with factors such as SSO frequencies and SSO volumes to prioritize and implement rehabilitation measures. This IR Report describes the application of the IR Program procedures to assign condition and criticality ratings to major components of the WCTS and identify rehabilitation priorities. The Supplemental IR Report (due after the completion of the minor CSAP) will provide an update to the IR Report to reflect additional information developed through completion of the CSAP of the minor components of the WCTS.

1.2 Summary of Major WCTS Components

The WCTS currently consists of approximately 1,080 miles of mainline Gravity Sewer with diameters ranging from 6 inches to 60 inches, 56 Pump Stations, and approximately 40 miles of Force Main located both inside the city limits and in portions of Richland and Lexington Counties. The major components of the WCTS include all Gravity Sewer and Force Main with diameters 15 inches or larger and their appurtenances, such as manholes and Pump Stations. Major WCTS components are summarized in **Tables 1-1** through **1-3**. Major Gravity Sewer Lines, Major Pump Stations, and major Force Main are shown on **Figure 1-1**.

Table 1-1 – Major Gravity Sewer Lines and Major Manholes

Basin	Approximate Length of Major Gravity Sewer Lines (miles)	Approximate Number of Major Manholes
Broad River	7	100
Crane Creek	29	600
Gills Creek	21	400
Mill Creek	10	200
Rocky Branch	20	400
Saluda River	16	400
Smith Branch	10	300
West Columbia	5	100
Total	**118**	**2,500**

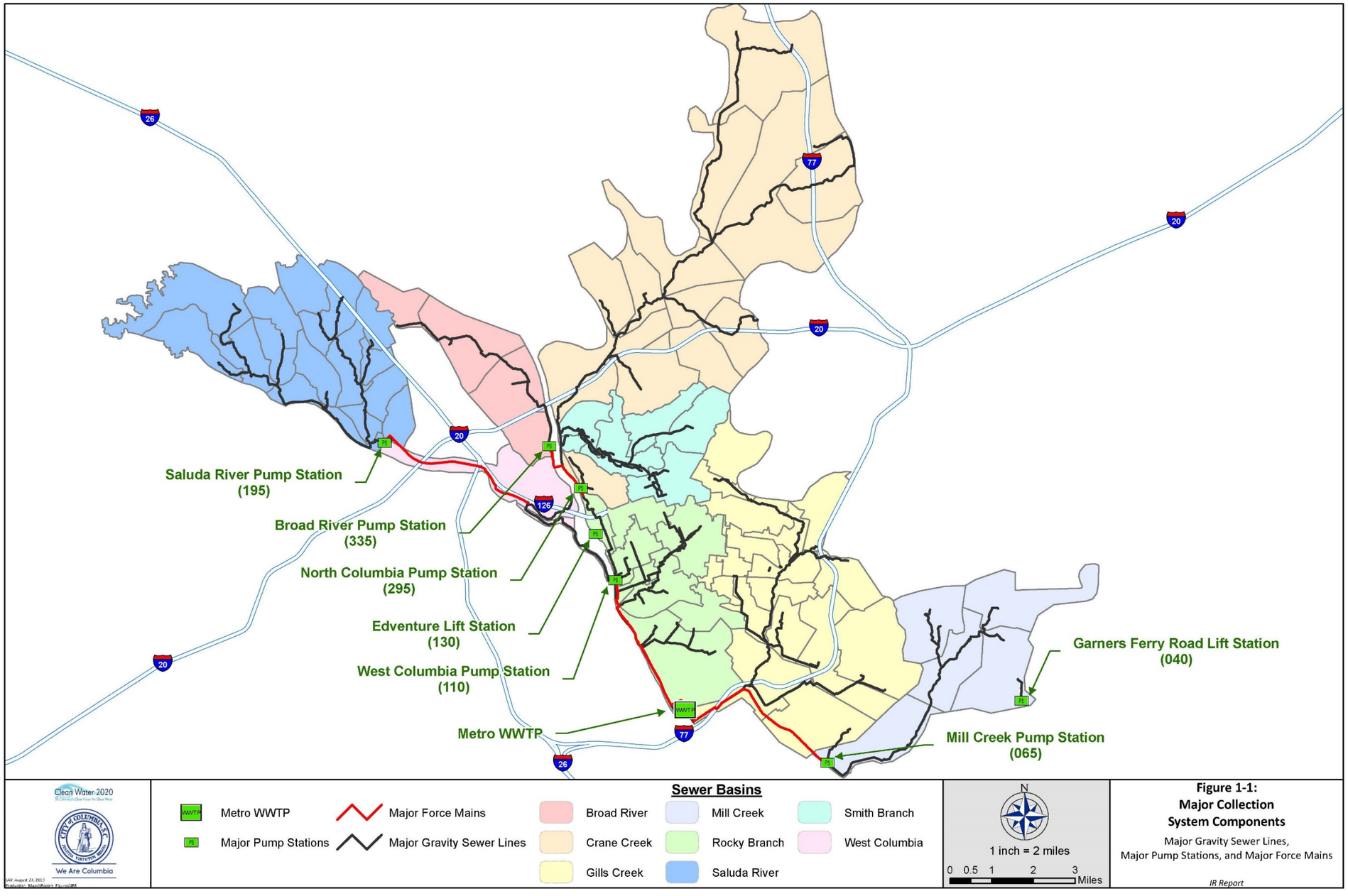
Table 1-2 – Major Pump Stations

Pump Station Number	Pump Station Name
040	Garners Ferry Road Pump Station
065	Mill Creek Pump Station
110	West Columbia Pump Station
130	EdVenture Pump Station
195	Saluda River Pump Station
295	North Columbia Pump Station
335	Broad River Pump Station

Table 1-3 – Major Force Mains

Force Main Name	Approximate Length of Major Force Main (miles)
Mill Creek Pump Station Force Main	4.6
West Columbia Pump Station Force Main	4.2
Saluda River Pump Station Force Main	4.2
North Columbia Pump Station Force Main	0.2
Broad River Pump Station Force Main	1.7
Total	**14.9**

Figure 1-1 – Major Collection System Components



1.3 Approach and Report Organization

The IR Program describes the City's procedures for setting rehabilitation priorities and schedules for WCTS components (Gravity Sewer Lines, manholes, Pump Stations, and Force Mains) that are identified as being in need of rehabilitation based on information collected under the CSAP (as required in Paragraph 15.a. through 15.d. of the CD). The purpose of the prioritization process is to devote the appropriate level of available resources to address conditions causing SSOs. The prioritization considers both the condition (probability of failure) of the WCTS component, as determined from SSO history and CSAP assessment; and the criticality (consequence of failure) of the WCTS component based on relative potential human health, environmental, and other impacts if the asset fails. For a given WCTS asset, the combination of the condition rating and the criticality rating defines the relative rehabilitation priority.

Sections 2, 3, and 4 of this IR Report discuss the results of the CSAP for the major components of the WCTS, application of the IR Program procedures to set priorities, and proposed rehabilitation measures or other actions to address specific conditions that may be causing SSOs by major asset type. Major Gravity Sewer Lines and major manholes are discussed in Section 2. Major Pump Stations are discussed in Section 3. Major Force Mains are discussed in Section 4.

Section 5 presents the prioritization of projects using three scheduling categories ("Group 1", "Group 2", and "Group 3"), as required by the CD.

Section 6 presents a summary of the status of the City's development of the Hydraulic Model Report (HMR) required under Paragraph 17.d. of the CD.

1.4 Early Action Capital Improvement Projects for the WCTS

The CD specifies that the City complete Early Action Capital Improvement Projects (CIP) for the WCTS. These projects were underway prior to the Effective Date of the CD (May 21, 2014). The Early Action CIPs for the WCTS are listed below. These projects were completed pursuant to the schedule presented in Appendix F of the CD.

- Broad River Pump Station Improvements (SS7101)
- North Columbia Pump Station Improvements (SS7102)
- West Columbia Pump Station Improvements (SS711501)
- Installation of 20,000 Linear Feet of 42-inch Force Main from West Columbia Pump Station to the Wastewater Treatment Plant (WWTP) (SS711502)
- Saluda River Pump Station Improvements (SS7116)

Additional Early Action CIPs were completed at the City of Columbia Metro WWTP.

Section 2 Major Gravity Sewer Lines and Major Manholes

This section presents the application of the IR Program procedures for the assessment of rehabilitation needs and prioritization for the Major Gravity Sewer Lines and major manholes based on condition and criticality ratings of the assets. SSO history (**Section 2.1**) and CSAP results (**Section 2.2**) were used to assign pipeline (and manhole) condition ratings. Condition ratings and criticality ratings were combined to complete the prioritization process (**Section 2.3**). Proposed actions were identified from the prioritization process (**Section 2.5**). The schedule for the rehabilitation of the Major Gravity Sewer Lines and major manholes is discussed in Section 5.

As discussed in **Section 2.2.4**, while the theoretical I/I contribution to each Subbasin (a subdivision of a Sewerbasin consisting of hydraulically linked sewers that are tributary to a common point in the sewer system) is determined through flow monitoring using the procedures outlined herein, the total I/I contribution in each Subbasin may be due to I/I sources along both the major and minor components of the WCTS. However, the existing flow monitoring data cannot readily be used to estimate the amount of I/I contributed by the major components of the WCTS. Based on the frequent interconnections of the minor and major components and current metering technology, it is not reasonably feasible to quantify I/I contribution of the Major Gravity Sewer Lines apart from the minor gravity sewer lines. This does not affect the prioritization of rehabilitation projects for these components of the WCTS. Major Gravity Sewer and major manholes in each Subbasin are generally a small percentage of the overall footage of Gravity Sewer and number of manholes in each Subbasin. Based on the footages, it is likely that the majority of I/I typically enters the WCTS through the minor gravity sewer and minor manholes. As such, for Major Gravity Sewer Lines and major manholes, the I/I data, assessments through internal inspections, and historical SSO reports were reviewed. Given that I/I data could not be readily used to differentiate between major and minor WCTS components, more reliance was made on internal inspections and historical SSO reports to establish the pipe condition rating. The Supplemental IR Report on the minor WCTS will incorporate I/I reduction potential into its analyses and recommendations.

2.1 Recent Historical SSOs

As discussed in **Section 2.1.1** of the IR Program, past SSOs related to a given Gravity Sewer Line or manhole are assumed to indicate a higher probability of an SSO occurring at that location in the future if a permanent solution to address the past SSO is not implemented. Therefore, it is important to understand the underlying cause of an SSO. For instance, an SSO may occur at a manhole, but the cause of the SSO may be an electrical problem at a Pump Station located downstream of the overflowing manhole. If the underlying cause of the SSO is attributable to the Gravity Sewer Line or manhole condition, the location and frequency of recent historical SSOs are used, along with CSAP data and professional judgment, to establish the condition rating for Gravity Sewer Lines and manholes.

SSOs that occurred on Major Gravity Sewer Lines and major manholes from May 21, 2014 (the Effective Date of the CD) through December 31, 2018, were used as recent historical SSOs for this evaluation. The cause of each SSO was recorded at the time of the SSO investigation per the Wastewater Spill Response Standard Operating Procedure (SOP). Causes of the recent historical SSOs on Major Gravity Sewer Lines and major manholes are grouped into the following categories:

- Wet Weather – SSOs primarily caused by wet weather events with excessive I/I entering the system and/or by capacity constraints in the WCTS. These SSOs may have been exacerbated by structural or maintenance issues.
- Structural Conditions – SSOs caused by issues related to the structural integrity of the pipe or manhole.
- Operations and Maintenance (O&M) Conditions – SSOs caused by issues related to operations and maintenance such as build-up of grease, roots, and debris or Pump Station failures.
- Other – SSOs that are not related to wet weather, structural, or O&M conditions. This category includes SSOs that are a result of damage caused by third parties or SSOs that occur during temporary bypass operations.

For the purposes of the City's Capacity Assurance Program (CAP), the CD allows the City to exclude those SSOs caused by severe natural conditions such as hurricanes, tornados, widespread flooding, earthquakes, or rainfall events greater than a representative 2-year 24-hour storm event from the definition of Surcharge Condition (Paragraph 12.e.i.F of the CD). Therefore, recent historical SSOs caused by rainfall events greater than a 2-year 24-hour storm event (or other severe natural conditions per the CD) were not considered when assigning condition ratings and identifying rehabilitation priorities.

Recent historical SSOs on Major Gravity Sewer Lines and major manholes are listed in **Table 2-1** and **Table B-1** in **Appendix B** with the reported SSO cause and identified SSO category. Table 2-1 and **Figure 2-1** list recent historical SSOs on Major Gravity Sewer Lines and major manholes that are covered under the CD and addressed in this IR Report. **Table B-1** includes the remaining SSOs caused by severe natural conditions that were not considered in the prioritization and proposed rehabilitation actions discussed in the remainder of Section 2.

Table 2-1 – Recent Historical SSOs on Major Gravity Sewer Lines and Major Manholes[1]

			SSO Characteristics		
Date[2]	SSO ID	Basin	Cause[3]	Category[4]	Estimated Volume (gallons)[5]
09/08/2014	01510	Gills Creek	Wet Weather	Wet Weather	66
09/11/2014	01512	Smith Branch	Grease	O&M	4,500
12/24/2014	01537	Crane Creek	Wet Weather	Wet Weather	166,800
12/24/2014	01538	Crane Creek	Wet Weather	Wet Weather	166,500
01/12/2015	01548	Crane Creek	Wet Weather	Wet Weather	16,153
02/26/2015	01571	Crane Creek	Wet Weather	Wet Weather	233,563
02/26/2015	01573	Crane Creek	Wet Weather	Wet Weather	43,500
05/07/2015	01602	Crane Creek	Roots	O&M	375
06/15/2015	01611	Crane Creek	Roots	O&M	2,000

			SSO Characteristics		
Date[2]	SSO ID	Basin	Cause[3]	Category[4]	Estimated Volume (gallons)[5]
09/19/2015	01631	Smith Branch	Grease	O&M	850
10/29/2015	01656	Gills Creek	Loose hose clamp on bypass pump	Other	4,350
11/02/2015	01659	Crane Creek	Wet Weather	Wet Weather	410,438
11/03/2015	01660	Crane Creek	Wet Weather	Wet Weather	200,023
11/10/2015	01666	Crane Creek	Wet Weather	Wet Weather	176,400
11/19/2015	01669	Crane Creek	Wet Weather	Wet Weather	unknown
11/19/2015	01670	Crane Creek	Wet Weather	Wet Weather	390,700
11/19/2015	01671	Gills Creek	Wet Weather	Wet Weather	17,238
11/19/2015	01672	Gills Creek	Wet Weather	Wet Weather	19,188
11/19/2015	01674	Gills Creek	Wet Weather	Wet Weather	537,720
12/22/2015	01681	Gills Creek	Wet Weather	Wet Weather	unknown
12/22/2015	01682	Gills Creek	Wet Weather	Wet Weather	19,000
12/22/2015	01683	Gills Creek	Wet Weather	Wet Weather	17,175
12/22/2015	01684	Crane Creek	Wet Weather	Wet Weather	327,450
12/22/2015	01685	Crane Creek	Wet Weather	Wet Weather	154,500
12/22/2015	01686	Gills Creek	Wet Weather	Wet Weather	unknown
12/23/2015	01688	Gills Creek	Debris in bypass pump suction hose	O&M	300
12/27/2015	01691	Gills Creek	Wet Weather	Wet Weather	158
12/24/2015	01693	Crane Creek	Wet Weather	Wet Weather	303,188
12/24/2015	01694	Crane Creek	Wet Weather	Wet Weather	290,250
12/30/2015	01697	Crane Creek	Wet Weather	Wet Weather	1,195,888
01/02/2016	01699	Gills Creek	Bypass pump failure	Other	500
07/13/2016	01773	Broad River	Pipeline collapsed	Structural	1
09/02/2016	01797	Gills Creek	Collapse of temporary bypass pipeline	Other	204,750
09/12/2016	01801	Smith Branch	Debris	O&M	7,750
12/20/2016	01844	Rocky Branch	Bypass pump failure	Other	100

			SSO Characteristics		
Date[2]	SSO ID	Basin	Cause[3]	Category[4]	Estimated Volume (gallons)[5]
01/03/2017	01851	Crane Creek	Wet Weather	Wet Weather	66,450
1/3/2017	01852	Crane Creek	Wet Weather	Wet Weather	49,100
03/30/2017	01890	Gills Creek	Wet Weather	Wet Weather	9,000
03/30/2017	01891	Gills Creek	Wet Weather	Wet Weather	15,000
03/30/2017	01892	Rocky Branch	Wet Weather	Wet Weather	unknown
04/24/2017	01915	Gills Creek	Wet Weather	Wet Weather	1,800
04/24/2017	01916	Gills Creek	Wet Weather	Wet Weather	2,938
06/21/2017	01941	Smith Branch	Contractor broke mainline	Other	300
9/19/2018	02183	Gills Creek	Wet Weather	Wet Weather	450
11/12/2018	02217	Gills Creek	Wet Weather	Wet Weather	40,625
11/12/2018	02218	Gills Creek	Wet Weather	Wet Weather	15,000
11/13/2018	02221	Gills Creek	Wet Weather	Wet Weather	600

1) SSOs on Major Gravity Sewer Lines and major manholes caused by severe natural conditions (listed in Appendix B) are not considered in this analysis. SSOs in Table 2-1 are covered under the CD and addressed in this IR Report.

2) Recent historical SSOs occurred from May 21, 2014, (the Effective Date of the CD) through December 31, 2018.

3) SSO cause recorded at the time of the SSO investigation in accordance with the Wastewater Spill Response SOP.

4) SSO category is assigned for this evaluation based on the SSO cause. See Section 2.1 for category definitions.

5) Estimated SSO volume as listed on the SSO reports to DHEC. Volume is estimated per the Wastewater Spill Response SOP. For unobserved overflows where an estimated volume could not be calculated, the volume was reported as unknown.

Figure 2-1 – Recent Historical SSOs on Major Gravity Sewer Lines and Major Manholes

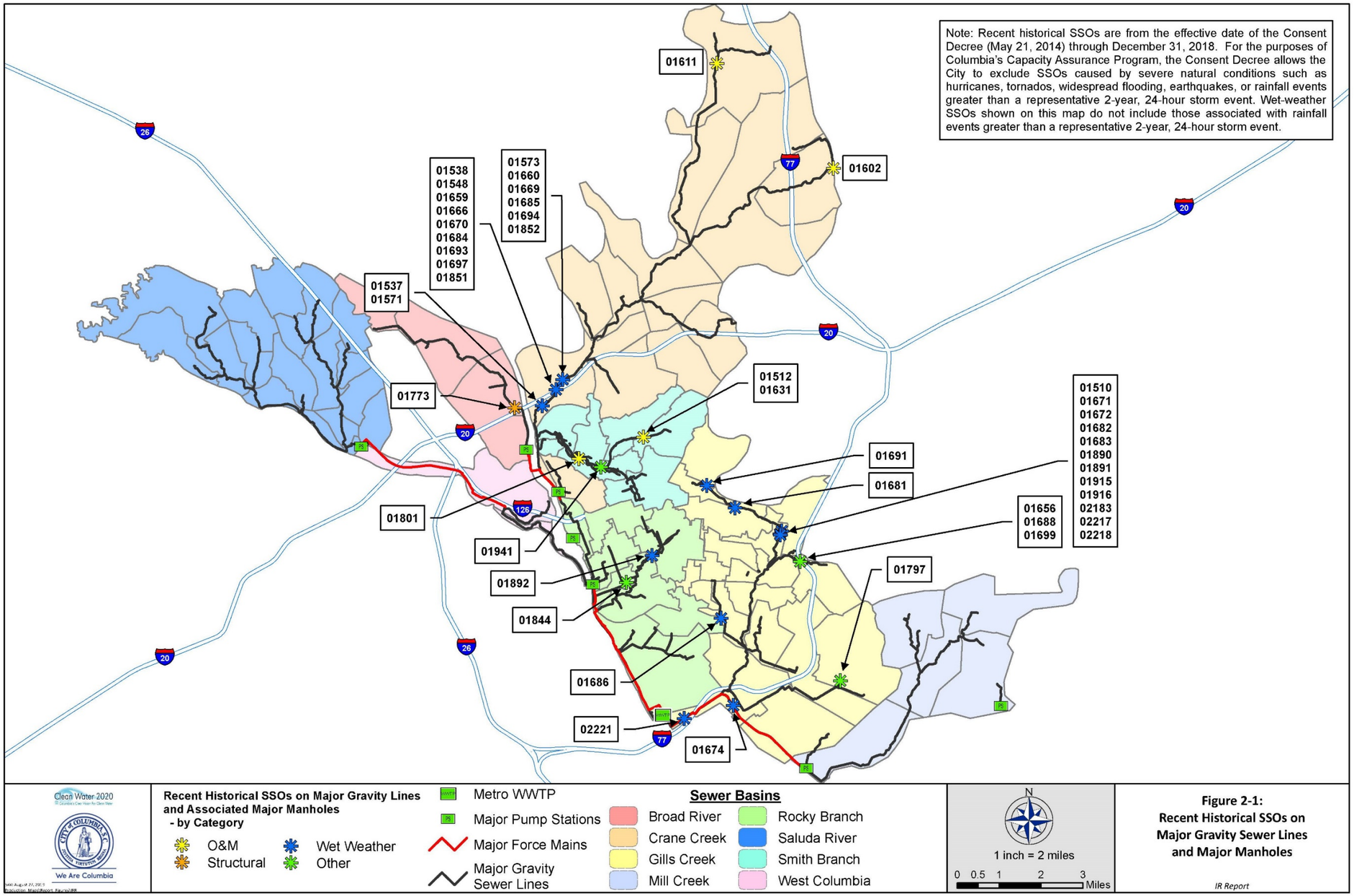


Table 2-2 summarizes the total number and volume of SSOs listed in Table 2-1. The majority of the SSOs on Major Gravity Sewer and major manholes are in the wet weather category.

Table 2-2 – Summary by Category of Recent Historical SSOs on Major Gravity Sewers and Major Manholes*

SSO Category	Number of Recent Historical SSOs	Estimated SSO Volume (gallons)
Wet Weather	34	4,887,000
Structural	1	1
O&M	6	16,000
Other	5	210,000

* For the purposes of the City's CAP, the CD allows the City to exclude those SSOs caused by severe natural conditions such as hurricanes, tornados, widespread flooding, earthquakes, or rainfall events greater than a representative 2-year 24-hour storm event from the definition of Surcharge Condition (Paragraph 12.e.i.F of the CD). This table does not show SSOs listed in Appendix B that were caused by severe natural conditions and are not considered when assigning condition ratings and identifying rehabilitation priorities.

2.2 Results of the CSAP

The CSAP describes various methods and procedures that may be used by the City to assess the condition of the major components of the WCTS. The City selected and completed the following assessments under the CSAP for the Major Gravity Sewer Lines and major manholes which are summarized in the sections referenced below:

- Flow monitoring was conducted in accordance with the procedures defined in CSAP Section 3.5. Results are discussed in **Section 2.2.1** of this report.
- Major Gravity Sewer Lines were assessed by video inspection, in accordance with the procedures defined in CSAP Section 3.6, or multi-sensor inspection, in accordance with the procedures defined in CSAP Section 3.9.1. The maintenance and structural defects found through these assessments are discussed in **Section 2.2.2** of this report.
- Manhole inspections were performed on the manholes on Major Gravity Sewer Lines in accordance with the procedures defined in CSAP Section 3.4. The maintenance and structural defects found through these assessments are discussed in **Section 2.2.3** of this report.

2.2.1 Flow Monitoring

The City continues to collect flow data through temporary and permanent monitors in accordance with procedures set forth in the CSAP. Flow monitoring data is used by the City for: characterization of wastewater flow components, development of design wastewater flows for input in the hydraulic model, calibration of the hydraulic model, verification of the performance of the hydraulic model, prioritization

of minor gravity sewer for CSAP assessment and rehabilitation, and evaluation of the effectiveness of rehabilitation activities on the minor gravity sewer.

It is important to note that the flow monitoring program collects data from one or more Subbasins. While there are both Major and minor Gravity Sewer Lines in each Subbasin, the flow data collected cannot readily be used to reliable differentiate between the I/I uniquely contributed by each of these pipe segment categories. Moreover, installation of additional flow meters to assist in the differentiation between the I/I contributed by Major and minor Gravity Sewer Lines would not be effective due to technology available at the time of monitoring not allowing for this distinct differentiation. In addition, Major Gravity Sewer Lines and major manholes in each basin are generally a small percentage (approximately 7 to 15 percent) of the overall footage of Gravity Sewer and number of manholes in each basin. For the West Columbia basin, the percentage includes contributary sewer pipes from the City of West Columbia. Based on the footages and number of manholes, it is likely that the majority of I/I typically enters the WCTS through the minor gravity sewer lines and manholes. Accordingly, the flow information is used as a guide to help identify overall Subbasins with the highest I/I, as well as for the purposes listed above.

For the Major Gravity Sewer Lines and major manholes presented in this IR Report, the internal pipe inspections and manhole inspections (discussed in Sections 2.2.2 and 2.2.3), as well as the root cause of the SSOs, were the primary factors in assigning condition ratings and developing rehabilitation recommendations.

2.2.1.1 Data Collection and Evaluation

As required under CD Paragraph 16.a.(vi), this section provides a summary of flow monitoring activities, including a map showing the delineation of the Subbasins, the location and type of each flow meter, problems encountered and deviations from the CSAP, and a description of quality control and quality assurance activities.

The City has undertaken several temporary flow monitoring programs in the Major WCTS and maintains permanent flow monitors in the WCTS. The various flow monitoring programs are summarized in **Table 2-3.** Maps showing the delineation of the monitored Subbasins and the location of each meter are provided in **Appendix A**.

Table 2-3 – Summary of Flow Monitoring Programs

	Permanent Flow Monitoring	2012 Temporary Flow Monitoring	2014 Temporary Flow Monitoring	2015 Temporary Flow Monitoring	2016 Temporary Flow Monitoring
Start Date	2013	February 2012	April 2014	April 2015	December 2015
Approximate Duration	Continuing	121 days	78 days	61 days	60 days
Number of Flow Meters	up to 22	65	26	83	70
Type of Flow Meters	Teledyne ISCO 2150-2110	Hach Sigma 910, Hach Flo-Dar®	Hach Sigma 910, ADS FlowShark Triton	Teledyne ISCO 2150-2110	Teledyne ISCO 2150-2110

	Permanent Flow Monitoring	2012 Temporary Flow Monitoring	2014 Temporary Flow Monitoring	2015 Temporary Flow Monitoring	2016 Temporary Flow Monitoring
Number of Rain Gauges	up to 14	10	8	7	7
Number of Rainfall Events Analyzed	Various as needed*	5	7	5	5
General Location of Flow Monitoring	Crane Creek, Saluda River, Gills Creek, Rocky Branch, billing locations	System-wide	Saluda River, Gills Creek, Smith Branch, Rocky Branch Subbasins	System-wide	System-wide
Location Map and Data Tables (Appendix List)	Appendix Figure A-1	Appendix Figure A-2 & Tables A-1 through A-4	Appendix Figure A-3 & Tables A-5 through A-8	Appendix Figure A-4 & Tables A-9 through A-12	Appendix Figure A-5 & Tables A-13 through A-16

*Flow data analysis for permanent metering data was only performed in conjunction with the temporary flow monitoring programs or as needed for billing or other purposes.

During the collection of flow monitoring data, quality control and quality assurance activities are performed consistently using the guidance provided in the CSAP. These activities include periodic meter checking, routine meter maintenance, and data quality reviews, including reviews of scattergraphs, to confirm that reasonable data is being collected.

Routine flow meter maintenance includes periodic verification of the meter calibration, verification of proper data collection and recording, cleaning of velocity and depth sensors, and removal of accumulated sediment or debris in the vicinity of the flow monitor. Rain gauges are checked and maintained periodically to confirm that representative data is being collected.

Data quality reviews are also periodically performed. The velocity and level data are used to make scattergraphs and reviewed with respect to data consistency and reliability and to identify problematic site hydraulic conditions such as turbulent flow, debris blockages or buildup, pipe surcharge conditions, and overflows. In addition, the flow, depth, velocity and rainfall data are plotted over time and reviewed with respect to the following:

- Data gaps – Missing data may occur due to equipment malfunction or debris fouling the equipment sensors.
- Consistency in dry weather flow pattern – Lack of a clear diurnal flow pattern or shifts and spikes in the level or velocity data could indicate turbulent flow conditions or debris buildup in the vicinity of the flow meter.
- Consistency in wet weather response – Inconsistent flow response during wet weather events, including the magnitude of peak flows and shape of hydrographs, may indicate debris or other unusual flow conditions at the meter.

- Flow balance – Where meters are installed downstream of one another, the flow balance is checked by subtracting upstream flows from those downstream.

No significant deviations from the CSAP flow monitoring procedures were encountered with the flow monitoring programs performed to date. Although the 2012 temporary flow monitoring program data was collected and analyzed prior to the development and approval of the CSAP, the flow monitoring quality review and data analysis procedures used for the 2012 temporary flow monitoring program are the same as those outlined in the CSAP. During the 2012 temporary flow monitoring period, Hach Flo-Dar® meters were used at 22 of the 65 flow metering sites. This type of meter does not accurately record flow depth during surcharge conditions once the depth of flow is above the measuring device. Subsequent permanent and temporary flow monitoring programs addressed this limitation through the selection of different metering technology.

No significant problems that would impact the overall validity of results of the flow monitoring were experienced during any of the flow monitoring programs. There were no significant gaps in data and where minor data gaps or suspect data was observed, the data in question was excluded from the flow monitoring data analysis. If necessary, the flow meters or rain gauges were moved to another location to collect reasonable data.

After collection and quality review of flow monitoring data, the data was analyzed using the procedures described in the CSAP to estimate existing flows and I/I within each monitored Subbasin.

2.2.1.2 Subbasin Flow Characteristics

As required under the CD Paragraph, 16.a., the flow data was used to determine the existing flows for each Subbasin within the WCTS including average and peak daily dry weather flow, average dry weather Infiltration rate (in gallons per day per inch-diameter mile), peak wet weather flow, and peaking factors. Existing dry weather flow was estimated by averaging the base flow hydrographs for typical dry weather days (i.e., days when there was no recorded rainfall or observed Rainfall Dependent Inflow/Infiltration (RDI/I)). The average dry weather flow includes both the Base Wastewater Flow (BWWF) and Groundwater Infiltration (GWI) flow components. The existing average daily dry weather flow and peak daily dry weather flow in each flow-monitored Subbasin are listed in the Appendix A Tables corresponding to each temporary flow monitoring program (see appendix list in Table 2-3).

GWI makes up a portion of the dry weather flow and is typically measured by examining the minimum nighttime flows when most base sanitary wastewater flow would be very low. The average dry weather Infiltration rate, in gpd/inch diameter-mile, is determined for each flow-monitored Subbasin as follows:

$$\text{Average dry weather Infiltration rate} = \frac{\text{GWI (gal/day)}}{\sum[\text{pipe length (miles)} * \text{diameter (inches)}]}$$

The average dry weather Infiltration rate calculated for each monitored Subbasin is listed in the Appendix A Tables corresponding to each temporary flow monitoring program (see appendix list in Table 2-3).

The peak wet weather flow for each Subbasin was calculated considering the total wet weather hydrograph for each of the analyzed rainfall events during the temporary flow monitoring programs. The maximum peak hourly flow recorded during any of the analyzed rainfall events is given in the Appendix A Tables corresponding to each temporary flow monitoring program (see appendix list in Table 2-3).

The peaking factor is defined as the ratio of peak hourly wet weather flow to average dry weather flow and was calculated for each of the analyzed rainfall events during the temporary flow monitoring programs. The maximum peaking factor calculated for any of the analyzed rainfall events is given in the Appendix A Tables corresponding to each temporary flow monitoring program (see appendix list in Table 2-3). Data from the temporary flow monitoring programs was analyzed to estimate the total I/I contributions from each flow monitored Subbasin and to compare among Subbasins in terms of their RDI/I contribution. Three factors were considered for estimating RDI/I: R-value, peaking factor, and RDI/I volume per linear foot of sewer.

- The R-value of an area represents the fraction of rainfall entering the collection system as RDI/I. Once the hydrograph decomposition is completed for each monitor, the volume of RDI/I is compared to the volume of rainfall that fell on the area contributing flow to each monitor. The ratio of RDI/I volume to rainfall volume (the inches of rain over the Subbasin sewered area) is defined as the R-value. The higher the R-value, the more RDI/I a sewer system conveys.

- The peaking factor is calculated as the ratio of peak hourly wet weather flow to average dry weather flow for each Subbasin. Even if the volume of Infiltration is low, Inflow could be producing high peak flows that lead to overflows and surcharging. This is reflected by a high peaking factor.

- The amount of RDI/I per foot of sewer is calculated by applying a given design storm rainfall volume to the R-value for each Subbasin. This allows all Subbasins to be compared on an equal basis, even if the measured rainfall varied over the service area during flow monitoring. Dividing this value by the footage of sewer gives the RDI/I volume per foot of sewer. A higher volume of rainfall Infiltration per linear foot of sewer can be a good indicator for future cost-effective rehabilitation.

In general, all three of the methods for estimating I/I were used to calculate I/I contributions to each monitored Subbasin for all of the analyzed rainfall events during the temporary flow monitoring periods. Total I/I contributions to the monitored Subbasins for all three methods are listed in the Appendix A Tables corresponding to each temporary flow monitoring program (see appendix list in Table 2-3).

A summary of the rainfall events used for estimating RDI/I are given in the Appendix A Tables corresponding to each temporary flow monitoring program (see appendix list in Table 2-3). Rainfall events were generally selected based upon the rainfall volume and spatial distribution of rainfall over the WCTS.

In addition to rainfall volume, the Subbasin delineation is an important variable in calculating the R-value. Subbasin delineations were based on sewer, manhole, and parcel Geographic Information System (GIS) shapefiles, and aerial imagery that were available at the time of data analysis. The City is refining the GIS as better information is collected, therefore, the Subbasin delineations are subject to change as the GIS is refined. Large, undeveloped parcels were subtracted from the total area upstream of a flow monitor to obtain the areas containing sewers, also known as the sewered area.

In some cases, flow meters were located downstream of one or more other flow meters. In those instances, the R-values calculated from RDI/I volumes recorded at the downstream flow meter represent the total area upstream of that meter, not the incremental flow from a single Subbasin only. For the 2012

temporary flow monitoring program, the R-values and other estimates of I/I represent the total area upstream of a given flow meter. However, for the 2014 and subsequent temporary flow monitoring programs, separate calculations were performed to estimate R-values for incremental Subbasins in order to prioritize areas in terms of their I/I. In general, an area-weighted R-value for the incremental area was calculated as follows:

$$R_2' = (R_2*A_2 - R_1*A_1) \div A_2'$$

A_1, A_2 = Drainage areas to flow monitors 1 and 2 (acres), respectively

A_2' = Drainage area of incremental area between monitor 1 and upstream monitor 2 (acres)

R_1, R_2 = R-values for flow monitors 1 and 2 based on entire upstream drainage area, respectively

R_2' = R-value for incremental area between flow monitors 1 and 2

Although this method can be useful for calculating the R-value for an incremental Subbasin, there is greater potential for metering error when subtracting. For instance, if the incremental area is small compared to the total area contributing flow to a particular meter, the impacts of metering error have a larger impact on the calculated results, which will sometimes result in a negative R-value being calculated. In those cases, the incremental R-value is assumed to be equal to the total R-value for purposes of estimating RDI/I per linear foot.

2.2.2 Major Gravity Sewer Line Inspections

Condition assessment of Major Gravity Sewer Lines was conducted using one or more of the following methods described in the CSAP: Closed Circuit Television (CCTV) video inspection, zoom camera video inspection, or multi-sensor inspection. Each of these methods is summarized below.

- CCTV inspection uses a color television camera mounted on a remotely controlled, self-propelled robotic device that is placed directly into the sewer through a manhole. The camera device moves through the sewer and allows the operator to examine the condition of the pipeline between manholes via a live video feed to the mobile survey unit, typically a truck or van. The CCTV operator can stop the device and control the camera's pan and tilt to investigate any defects or lateral connections in the sewer. The condition of the pipeline is documented using the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) standardized defect codes and data management practices. Digital video files and photographs of the inspection are also created.

- Zoom camera inspection is performed in conjunction with manhole inspection and uses a pole-mounted stabilized camera system with high-powered zoom lenses and high-intensity lighting to video the pipe condition while "moving" (zooming) upstream and downstream of a given manhole location. The zoom camera may inspect up to approximately 50 feet into each line from the manhole depending on the equipment and assuming debris, high-water levels, bends, or defects do not obstruct the camera's line of sight. The zoom camera allows a quick inspection of pipes to reveal defects, blockages, Infiltration sources, etc. Examples of pipe defects that may potentially be seen with zoom camera inspection include cracks, holes, offset joints, active Infiltration, roots, and debris.

- Multi-sensor inspection utilizes traditional CCTV video inspection in combination with other sensor technologies to provide a comprehensive assessment of the pipeline condition both above and below the water surface that is more detailed than visual inspection alone. Multi-sensor inspection is used in large (36-inch diameter and larger) Gravity Sewers to identify structural defects, ovality, corrosion issues, sediment, and I/I sources. The findings of multi-sensor inspections are documented in report format and a PACP-compliant digital database along with digital photographs and videos.

For a limited number of Major Gravity Sewer Lines, an initial field condition assessment is not warranted in cases where the major component has been installed or rehabilitated within five years from the start of the CSAP inspection period. These assets are in newly installed condition and thus the condition is already reasonably known. Also, inspections were not performed on major components for which the City has already committed to funding a project that will lead to the abandonment of those major components. New or to be abandoned Gravity Sewer accounts for less than 3 percent of the Major Gravity Sewer Lines.

Defects found through Major Gravity Sewer Line inspections that are possible I/I sources are listed in **Table C-1** in **Appendix C**. As required under CD Paragraph 16.a.(v), the table lists defects by Subbasin with specific defect type and NASSCO PACP defect code, quantity of each defect type, and defect rating. The Subbasins referenced in Table C-1 are shown on **Figure C-1** in Appendix C.

2.2.3 Major Manhole Inspections

Manhole inspections were performed for manholes on Major Gravity Sewer Lines. Manhole inspections were used to locate accessible manholes, collect basic information on manhole dimensions, depth, and number and size of pipeline connections, and provide data on defects in the manhole that could cause structural failure or contribute to excessive I/I. As described in the CSAP, the routine manhole inspection program includes visual inspection and/or video camera inspection of all manhole components including frame and cover, wall, steps, bench, invert/channel, service laterals, and pipe inlets and outlets, and documentation of conditions and defects with still photographs and digital video files. Inspections were performed and documented to meet the requirements of NASSCO Manhole Assessment and Certification Program (MACP).

For a limited number of major manholes, an initial field condition assessment is not warranted in cases where the major component has been installed or rehabilitated within five years from start of the CSAP inspection period. These assets are in newly installed condition and thus the condition is already reasonably known. Also, inspections were not performed on major components for which the City has already committed to funding a project that will lead to the abandonment of those major components. New or to be abandoned manholes account for less than 5 percent of the major manholes.

Defects found through major manhole inspections that are possible I/I sources are listed in **Table D-1** in **Appendix D**. As required under CD Paragraph 16.a.(v), the table lists defects by Subbasin with specific defect type and NASSCO MACP defect code, quantity of each defect type, and defect rating. The Subbasins referenced in Table D-1 are shown on Figure C-1 in Appendix C.

2.2.4 Summary of I/I Sources

The defects along the Major Gravity Sewer Lines (summarized in Appendix C) and within major manholes (summarized in Appendix D), may potentially contribute to I/I in the WCTS. The theoretical I/I contribution to each Subbasin (listed in Appendix A) is determined through flow monitoring using the procedures outlined in Section 2.1.1 of the IR Program and engineering judgement. While there are both Major and minor Gravity Sewer Lines in each Subbasin, the flow data collected cannot readily be used to reliable differentiate between the I/I uniquely contributed by each of these pipe segment categories. Moreover, installation of additional flow meters to assist in the differentiation between the I/I contributed by Major and minor Gravity Sewer Lines would not be effective due to technology available at the time of monitoring not allowing for this distinct differentiation. In addition, Major Gravity Sewer Lines and major manholes in each basin are generally a small percentage (approximately 7 to 15 percent) of the overall footage of Gravity Sewer and number of manholes in each basin. For the West Columbia basin, the percentage includes contributary sewer pipes from the City of West Columbia. Based on the footages and number of manholes, it is likely that the majority of I/I typically enters the WCTS through the minor gravity sewer lines and manholes. Accordingly, the flow information is used as a guide to help identify overall Subbasins with the highest I/I, as well as for the purposes listed above.

2.3 Prioritizing Based on Condition and Criticality Ratings

The process established in the IR Program was used to identify and prioritize rehabilitation actions for the Major Gravity Sewer Lines and major manholes. In general, the IR Program considers both the criticality (consequence of failure) of the WCTS component based on relative likely human health, environmental and other impacts, and condition (probability of failure) of the WCTS component as determined from CSAP assessment and SSO history. For a given WCTS asset, the combination of the criticality and condition rating defines the rehabilitation or reassessment priority. Criticality and condition ratings are applied to the Major Gravity Sewer Lines and major manholes as described in the IR Program and summarized as follows.

2.3.1 Criticality Rating

The criticality rating of an asset is used to represent the relative consequence of failure of a component of the WCTS. For the purposes of this analysis, a failure is considered to be an SSO. The criticality rating is a numerical value, with low values assigned to represent a low consequence of failure and high values assigned to represent a high consequence of failure. Criticality ratings were developed for each Major Gravity Sewer Line and major manhole considering factors such as the quantity of flow conveyed by an asset (i.e., potential quantity of an SSO), the potential impact to public health, and the potential impact to the environment. A criticality model was developed in GIS to evaluate the criticality of all Major Gravity Sewer Lines and major manholes in the WCTS.

2.3.2 Condition Rating

The condition rating of an asset is developed to represent the probability that the WCTS asset will fail. The condition rating is a numerical value with low values assigned to represent a good condition and high values assigned to represent a poor condition. The condition rating is primarily assigned using recent historical SSOs, probability of failure based on information collected through the CSAP, and professional judgment (IR Program Section 2.1.1).

For Major Gravity Sewer Lines and major manholes, the I/I data, assessments through internal inspections, and historical SSO reports were reviewed. Given that I/I volume could not be readily attributed to major and minor WCTS components, more reliance was made on internal inspections and historical SSO reports to establish the pipe condition rating.

In general, assets that have recent historical SSOs are assigned the poorest (highest) condition ratings since addressing SSOs is a primary goal of the CD as evidenced by the following statements:

- IR Program (Program Summary and Intent): "The City of Columbia (City) has developed an Infrastructure Rehabilitation Program (IR Program) to describe policies and procedures for implementing rehabilitation measures to address Inflow and Infiltration (I/I), structural issues in the City's wastewater collection and transmission system (WCTS) and other conditions causing sanitary sewer overflows (SSOs), with the goal of eliminating future SSOs."
- EPA IR Program Review Letter dated February 16, 2017 (Comment #3): "…successful implementation of any project by the City is measured by the number of SSOs eliminated and only secondarily by the amount of I/I removed. SSO elimination should be used as the controlling criterion for analyzing project effectiveness. The significance of I/I reduction is derived from its relationship to eliminating and/or reducing SSOs."
- IR Program (Section 5.1): "The primary objective of the IR Program is to reduce the occurrence of SSOs in the WCTS…."

The highest (poorest) condition rating is assigned to Major Gravity Sewer Lines or major manholes whose poor condition is determined to be the root cause of multiple recent historical SSOs. The poor condition of these assets has already resulted in multiple failures, and therefore, the assets are assumed to have a high probability of a future SSO occurring at that location if a permanent solution to address the past failures is not implemented. The failures may be related to the capacity of the asset or the condition as evidenced by information collected through the CSAP.

The next highest condition rating is assigned to Major Gravity Sewer Lines or major manholes whose poor condition is determined to be the root cause of a single recent historical SSO. The poor condition of these assets has already resulted in one failure, and therefore, these assets are assumed to have a high probability of a future SSO occurring at that location if a permanent solution to address the past failure is not implemented.

The remaining condition ratings are assigned based on information collected in the CSAP and professional judgment. Since these assets have not failed, the condition rating based on CSAP results is lower than the condition rating of assets whose condition has caused an SSO.

The overall condition rating of the Major Gravity Sewer Lines or major manholes that do not have recent historical SSOs is generally based on the CSAP investigations and the defects coded using the NASSCO PACP and MACP coding systems. These coding systems are standardized methods of grading sewer and manhole defects by first classifying the defects into one of two categories – structural or O&M, and then assigning a numerical grade to the individual defect based on its severity. An overall condition rating for the pipe or manhole is assigned based on the defects and professional judgment.

However, it is important to note that, as stated in the NASSCO PACP manual, "The PACP Condition Grading System alone is inadequate for determining if a pipe segment should be rehabilitated or replaced. Many other factors in addition to the internal condition of the segment should be considered. The fact that a segment has significant grade 4 or grade 5 defects does not necessarily mean the pipe segment should be immediately rehabilitated, thus PACP does not replace the judgment of professional engineers. Recent experience by PACP users has shown that pipe segments with serious defects such as hinge failures, may remain largely unchanged for many decades if no deterioration factors such as surcharging, roots or groundwater are present" (*Pipeline Assessment Certification Program Reference Manual*, September 2016, Appendix C – PACP® Condition Grading System). Using professional judgment and accounting for deterioration factors, pipes and manholes are assigned an overall condition rating based on the defects coded. In general, pipes and manholes with higher grade defects may be assigned a higher condition rating than pipes and manholes with lower grade defects.

Accordingly, the City used best professional judgment to establish the condition ratings based on the existing asset condition, its characterization identified by current industry protocols, and SSO history.

2.3.3 Prioritization for Rehabilitation

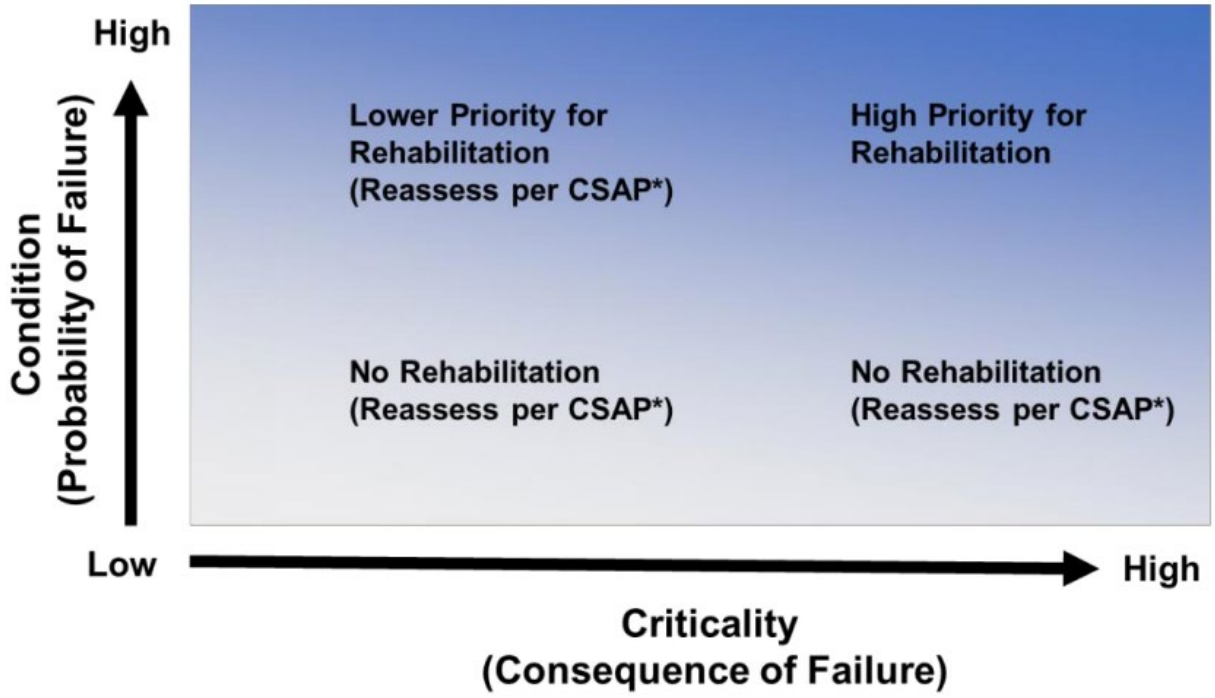
Infrastructure rehabilitation is prioritized based on the combination of condition and criticality ratings as illustrated in **Figure 2-2**. Major Gravity Sewer Lines and major manholes determined to be in poor condition are considered for rehabilitation projects under the IR Program. Under this analysis, rehabilitation projects can refer to rehabilitation of the current asset, replacement of the current asset or O&M procedures when it is discovered that the condition rating is based on O&M issues.

Of the Major Gravity Sewer Lines and major manholes determined to be in poor condition, rehabilitation is prioritized based on the condition (probability of failure) rating and the criticality (consequence of failure) rating. The highest priority for rehabilitation is assigned to Major Gravity Sewer Lines and major manholes with the highest (poorest) condition rating and highest criticality rating. Specific rehabilitation projects for prioritized Major Gravity Sewer Lines and major manholes are presented in Section 2.5. The CD requires that the infrastructure rehabilitation is prioritized into three categories for implementation ("Group 1", "Group 2", and "Group 3"). Grouping of the rehabilitation projects is discussed in **Section 5.1**.

Major Gravity Sewers and major manholes in poor condition (high condition rating), but with a lower criticality rating are tracked in decreasing priority according to decreasing criticality rating. These assets will be considered for potential future infrastructure rehabilitation after the higher priority projects are addressed since a failure of these assets would represent a smaller impact to public health and the environment. Assets not scheduled for rehabilitation will be reassessed, based on the frequencies given in the CSAP, to determine if the condition has deteriorated to the point that the asset would be moved into a higher priority rehabilitation category under the IR Program. Per Section 4.2 of the CSAP, high priority WCTS components, which are those that are both highly critical and suspected to be in poor condition, will receive the most frequent assessment.

Major Gravity Sewer and major manholes in relatively good condition (low condition rating) are prioritized for reassessment rather than rehabilitation. These assets will be reassessed, based on the frequencies given in the CSAP, to determine if the condition has deteriorated to the point that the asset would be moved into a higher priority rehabilitation category under the IR Program. Assets that have a low probability of failure but are highly critical will receive a medium frequency assessment to determine their condition. Remaining WCTS components will be assessed with lower frequency to determine if field investigations are needed.

Figure 2-2 – Prioritization Matrix



*Assets that are not scheduled for rehabilitation should be reassessed, as needed, based on the frequencies given in the CSAP. Per Section 4.2 of the CSAP, high priority WCTS components, which are those that are both highly critical and suspected to be in poor condition, will receive the most frequent assessment. Other WCTS components that are highly critical, but not suspected to be in poor condition, will receive a medium frequency assessment to determine their condition. Remaining WCTS components will be assessed with lower frequency to determine if field investigations are needed.

2.4 Find and Fix Program

In addition to infrastructure rehabilitation projects, the City may also perform small-scale rehabilitation or repairs on a Find and Fix basis as defects are identified. Find and Fix repairs are intended to promptly address assets that are discovered, through the course of continuing WCTS inspections, to be in poor condition with a high probability of failure. Those assets determined to be in poor condition (based on professional judgment and PACP/MACP ratings for gravity pipes and manholes) are scheduled to be repaired without being prioritized and grouped into scheduled rehabilitation projects. The Find and Fix actions also include rehabilitation or repairs that are made to promptly address defects that are found to be the cause of an SSO in order to avoid recurrent SSOs.

2.5 Proposed Corrective Actions

The proposed corrective actions under the IR Report to address conditions causing SSOs on Major Gravity Sewer Lines and major manholes are presented in the following sections. Corrective actions are categorized by those that address multiple recent historical SSOs, those that address a single recent historical SSO, or those to address assets that have not failed but are highest priority for rehabilitation based on condition and criticality. A detailed Prioritization Matrix (based on Figure 2-2) showing how assets are categorized based on their recent SSO history, criticality and condition, with emphasis on the recent historical SSOs is presented in **Figure 2-3**. Overall WCTS project grouping and scheduling is discussed in Section 5.

For the purposes of the IR Program, I/I reduction is a secondary goal, with the primary goal of eliminating future potential SSOs. The projects for Major Gravity Sewer Lines and major manholes presented in the IR Report are identified to best address the primary goal of eliminating future SSOs related to major components of the WCTS. SSOs that are caused by high levels of RDI/I are being addressed primarily through capacity improvements that are increasing conveyance capacity in key areas of the WCTS. Therefore, the primary goal of the IR Program is to address structural issues that may contribute to SSOs more directly.

Figure 2-3 – Detailed Prioritization Matrix

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">Criticality**</td></tr>
<tr><td>3</td><td>4</td><td>5</td></tr>
<tr><td rowspan="7">Condition</td><td>7</td><td colspan="3">Multiple Recent SSOs</td></tr>
<tr><td>6</td><td colspan="3">Single Recent SSO</td></tr>
<tr><td>5</td><td colspan="2">Low Priority Rehabilitation</td><td>High Priority Rehabilitation</td></tr>
<tr><td>4</td><td colspan="3" rowspan="4">No Rehabilitation (Reassess per CSAP*)</td></tr>
<tr><td>3</td></tr>
<tr><td>2</td></tr>
<tr><td>1</td></tr>
</table>

*Assets that are not scheduled for rehabilitation should be reassessed, as needed, based on the frequencies given in the CSAP. Per Section 4.2 of the Continuing Sewer Assessment Program, high priority WCTS components, which are those that are both highly critical and suspected to be in poor condition, will receive the most frequent assessment. Other WCTS components that are highly critical, but not suspected to be in poor condition will receive a medium frequency assessment to determine their condition. Remaining WCTS components will be assessed with lower frequency to determine if field investigations are needed.

**The Criticality Model was created to encompass all Gravity Sewer pipelines in the WCTS. Based on the diameters of the major pipes, no major asset falls into the Criticality rating of 1 or 2; therefore, these are not shown in the detailed matrix. This Detailed Prioritization Matrix was developed to facilitate the prioritization of the rehabilitation of Major Gravity Sewer Lines and major manholes only. For the Supplemental IR Report, the City will use the Figure 2-2 Prioritization Matrix from the CSAP with or without additional details regarding the categorization of those corrective actions.

2.5.1 Multiple Recent Historical SSOs

Proposed projects were identified to address Major Gravity Sewer Lines and major manholes whose poor condition is the root cause of multiple recent historical SSOs (excluding SSOs caused by severe natural

conditions, as discussed in Section 2.1). Within the prioritization matrix, these assets have the highest condition ratings. Although the prioritization matrix also considers the criticality of assets, the primary objective of the IR Program is to reduce the occurrence of SSOs in the WCTS. These assets have already contributed to SSOs; therefore, it was determined that projects be included for these assets regardless of criticality.

The projects listed in **Table 2-4**, with locations shown on **Figure 2-4**, address the root cause of the SSOs as determined through review of SSO investigations, CSAP assessment, hydraulic modeling, or other information. Both projects listed in Table 2-4 are capacity improvements to address conditions causing multiple recent wet weather SSOs on Major Gravity Sewer Lines or major manholes.

Table 2-4 – Capacity Improvement Projects to Address Multiple Recent Historical SSOs on Major Gravity Sewer Lines and Major Manholes

Basin	SSO ID[1]	Project Name	Estimated Total SSO Volume (gallons)
Crane Creek	01537, 01538, 01548, 01571, 01573, 01659, 01660, 01666, 01669, 01670, 01684, 01685, 01693, 01694, 01697, 01851, 01852	SS6954 – 48" Sanitary Sewer Interceptor Along Crane Creek and Broad River	4,191,000
Gills Creek	01510, 01671, 01672, 01681, 01682, 01683, 01890, 01891, 01915, 01916, 02217, 02218	SS7261 – Lake Katherine Sewer Line Capacity Enhancement	157,000

1) SSOs caused by severe natural conditions (listed in Appendix B) are not considered in this IR Report. SSOs in Table 2-1 are covered under the CD and addressed in this report.

2.5.2 Single Recent Historical SSO

Proposed projects were identified to address Major Gravity Sewer Lines and major manholes whose poor condition is the root cause of a single recent historical SSO (not considering SSOs caused by severe natural conditions, as discussed in Section 2.1). Within the prioritization matrix, these assets have the second highest condition ratings. Although the prioritization matrix also considers the criticality of assets, the primary objective of the IR Program is to reduce the occurrence of SSOs in the WCTS. These assets have already contributed to an SSO; therefore, it was determined that projects be included for these assets regardless of criticality.

The projects listed in **Table 2-5**, with locations shown on Figure 2-4, are capacity improvements to address the root cause of a single recent historical wet weather SSO as determined through review of SSO investigations, CSAP assessment, hydraulic modeling, or other information. Find and Fix actions, as listed

in **Table 2-6**, were completed to address the root cause of a single recent historical SSO caused by structural, O&M, or other conditions.

Table 2-5 – Capacity Improvement Projects to Address Single Recent Historical SSOs on Major Gravity Sewer Lines and Major Manholes

Basin	SSO ID[1]	Project Name	Estimated SSO Volume (gal)
Rocky Branch	01892	SS733701 – East Rocky Branch Improvements Phase 1 SS733702 – East Rocky Branch Improvements Phase 2	Unknown[2]
Gills Creek	01674	SS7076 – 30" Gravity Sewer from Burnside #1 Pump Station to Bluff Road and I-77	538,000
Gills Creek	01686	Proposed Lower Gills Creek Sewer Improvements	Unknown[2]
Gills Creek	01691	Proposed Upper Gills Creek Sewer Improvements	200

1) SSOs caused by severe natural conditions (listed in Appendix B) are not considered in this IR Report. SSOs in Table 2-1 are covered under the CD and addressed in this report.

2) For unobserved overflows where an estimated volume could not be calculated, the volume was reported as unknown.

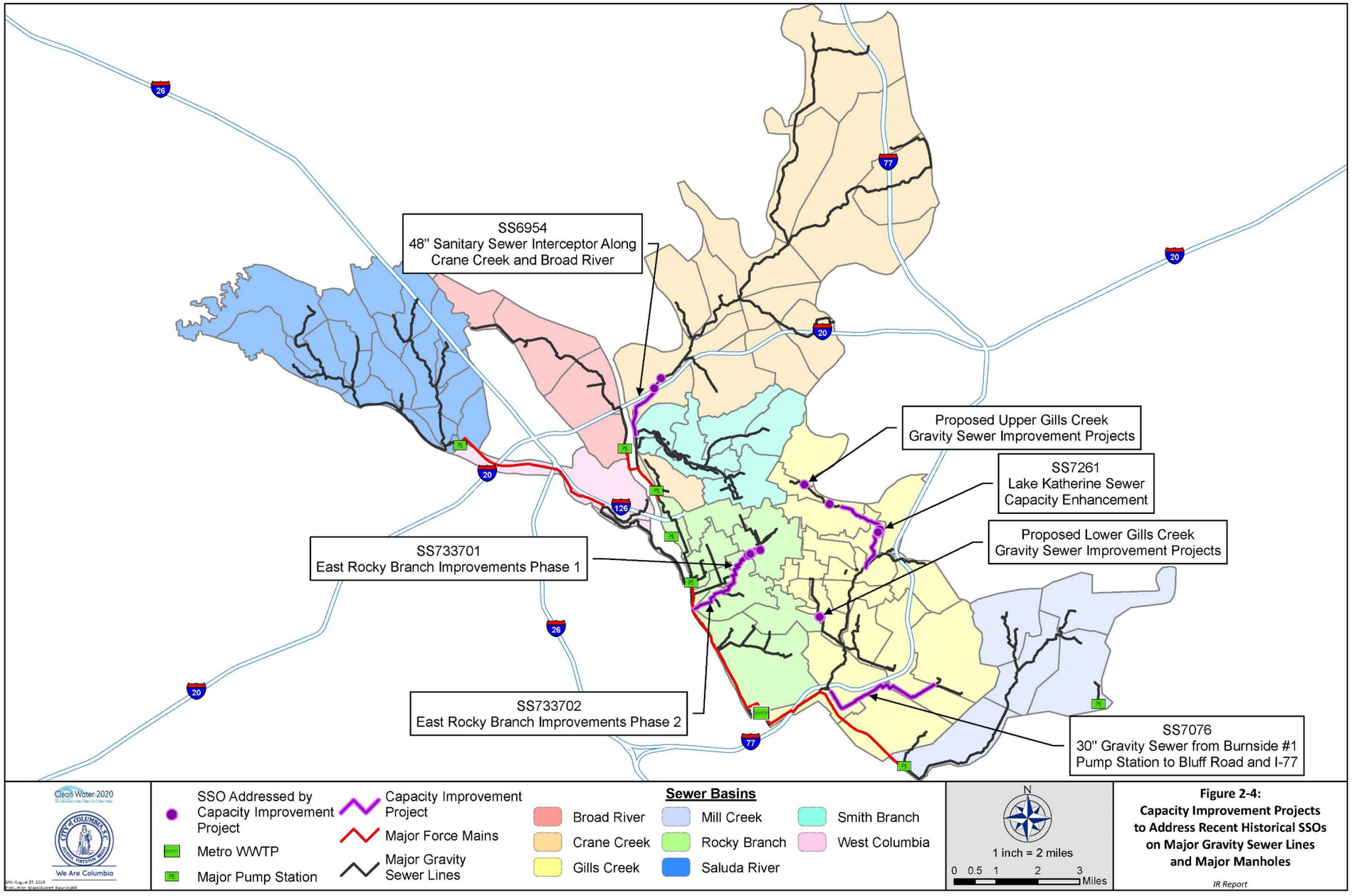
Table 2-6 – Find and Fix Action to Address Single Recent Historical SSOs on Major Gravity Sewer Lines and Major Manholes

Basin	SSO ID[1]	Find and Fix Action	Estimated SSO Volume (gal)
Crane Creek	01602	Washed main line to clear out roots	375
Crane Creek	01611	Washed main line to clear out roots	2,000
Gills Creek	01688	Removed debris and washed screen on suction hose of bypass pump	300
Smith Branch	01801	Removed debris and washed main line	7,750
Smith Branch	01512	Removed grease stoppage and washed main line	4,500
Smith Branch	01631	Removed grease stoppage and washed main line	850
Broad River	01773	Emergency mainline repair completed to fix collapsed pipeline	1
Gills Creek	01656	Bypass pump repaired	4,350
Gills Creek	01699	Bypass pump repaired	500
Gills Creek	01797	Switched to bypass pumps when temporary bypass pipeline collapsed	204,750
Rocky Branch	01844	Bypass pump repaired	100
Smith Branch	01941	Pipe broken by contractor repaired	300

Basin	SSO ID[1]	Find and Fix Action	Estimated SSO Volume (gal)
Gills Creek	02221	Operations called for an additional influent pump to be started at the WWTP to combat the wet weather event	600

1) SSOs caused by severe natural conditions (listed in Appendix B) are not considered in this IR Report. SSOs in Table 2-1 are covered under the CD and addressed in this report.

Figure 2-4 – Capacity Improvement Projects to Address Recent Historical SSOs on Major Gravity Sewer Lines and Major Manholes



2.5.3 High and Low Priority for Rehabilitation

Additional proposed projects were identified to address the most critical Major Gravity Sewer Lines and major manholes in the poorest condition based on defect ratings or other information collected through the CSAP assessments and professional judgment, but that have not resulted in a recent historical SSO. Within the prioritization matrix, these assets have the next highest condition ratings after those assets with recent historical SSO(s). These assets are further prioritized based on criticality with one group considered high (most critical) priority for rehabilitation and the other considered low (less critical) priority for rehabilitation.

The projects listed in **Table 2-7** and **Table 2-8** are proposed rehabilitation projects to address defects found through the CSAP assessments of Major Gravity Sewer Lines and major manholes, respectively. These projects include Gravity Sewer pipes and manholes that are high priority for rehabilitation (high condition and criticality score) as well as low priority Gravity Sewer pipes and manholes that are in poor condition (high condition score), but less critical (lower criticality score), as listed in the tables. **Figure 2-5** and **Figure 2-6** show the locations of the rehabilitation projects for priority Major Gravity Sewer Lines and major manholes, respectively.

In some cases, Major Gravity Sewer Lines and major manholes deemed high and lower priority per the IR Report are currently incorporated into larger planned projects which also include rehabilitation and/or replacement of pipes and manholes which are not scheduled for rehabilitation under the detailed prioritization matrix at Figure 2-2. It is anticipated that these larger planned projects will result in rehabilitation or replacement of the high and low priority pipes and manholes within the project limits. Tables 2-7 and 2-8 show larger planned projects that will include rehabilitation of Major Gravity Sewer Lines and major manholes considered high and low priority. The linear feet (approximately rounded to the nearest hundred feet) of high and low priority pipe and number of high and low priority manholes set forth in Tables 2-7 and 2-8 indicate the portion of the larger planned projects which is subject to the rehabilitation schedule for Group 3 projects (see **Section 5.1.3**). The City reserves the right to rehabilitate the high and low priority assets separately from these larger planned projects if deemed more appropriate by the City. The high and low priority assets will be rehabilitated in accordance with the project scheduling in Section 5. However, complications in implementing the complete project (right-of-way permitting, budgeting, etc.) may dictate that the high and low priority Major Gravity Sewer Lines and major manholes be completed separately from the larger project. Under this analysis, rehabilitation projects can refer to rehabilitation of the current asset, replacement of the current asset or O&M procedures when it is discovered that the condition rating is based on O&M issues.

Table 2-7– Rehabilitation Projects to Address Priority Major Gravity Sewer Lines

Project Name[1]	High Priority Pipe (LF)	Low Priority Pipe (LF)
SS7330 Upper Mill Creek Sewer Improvements	0	800
SS733701 East Rocky Branch Improvements Phase 1	600	1,500
SS733702 East Rocky Branch Improvements Phase 2	0	300

Project Name[1]	High Priority Pipe (LF)	Low Priority Pipe (LF)
SS7428 Lower Saluda River Relief Sewer and Major Pipe Rehabilitation	0	1,100
SS7433 Cunningham Rd/Johnson Ave/Cramer Dr/Summerlea Dr Sewer Relocation	0	600
Major Pipe and Manhole CIPP Rehab Project	6,000	20,000
Major Pipe and Manhole Pipe Bursting Rehab Project	0	1,700
Major Pipe and Manhole Sliplining Rehab Project	0	3,900
Major Pipe and Manhole Spray-Applied Liner Rehab Project	0	2,200
SS7454 Broad River Force Main Replacement and Gravity Sewer Capacity Improvements	0	300
SS7465 Lower Crane Creek Relief Sewer Phase 2	0	400
SS7470 Lower Crane Creek Relief Sewer Phase 1	700	0
SS7474 Upper North Branch Crane Creek Sewer Improvements Phase 1	0	200

1) Sanitary Sewer CIP number provided when available.

Table 2-8 – Rehabilitation Projects to Address Priority Major Manholes

Project Name[1]	High Priority Manholes (# of MHs)	Low Priority Manholes (# of MHs)
SS6786 Annual Gravity Sewer Manhole Lining and Replacement	13	38
SS7331 Upper Kinley Creek Sewer Improvements Phase 1	0	3
SS733701 East Rocky Branch Improvements Phase 1	0	2
SS733702 East Rocky Branch Improvements Phase 2	3	0
SS735003 Crane Creek Lower North Branch Capacity Upgrade Phase 1	1	1
SS7389 Crane Creek and Smith Branch Manhole Repair and Mitigation	3	9
SS7450 Crane Creek Lower North Branch Capacity Upgrade Phase 2	0	1
Major Pipe and Manhole CIPP Rehab Project	13	36
Major Pipe and Manhole Pipe Bursting Rehab Project	0	1
Major Manhole Rehab Project	13	28
SS7454 Broad River Force Main Replacement and Gravity Sewer Capacity Improvements	0	1
SS7465 Lower Crane Creek Relief Sewer Phase 1	0	1

Project Name[1]	High Priority Manholes (# of MHs)	Low Priority Manholes (# of MHs)
SS7470 Lower Crane Creek Relief Sewer Phase 1	0	1
SS7474 Upper North Branch Crane Creek Sewer Improvements Phase 1	0	3

1) Sanitary Sewer CIP number provided when available.

Figure 2-5 – Rehabilitation Project Locations Addressing High and Low Priority Major Gravity Sewer Lines

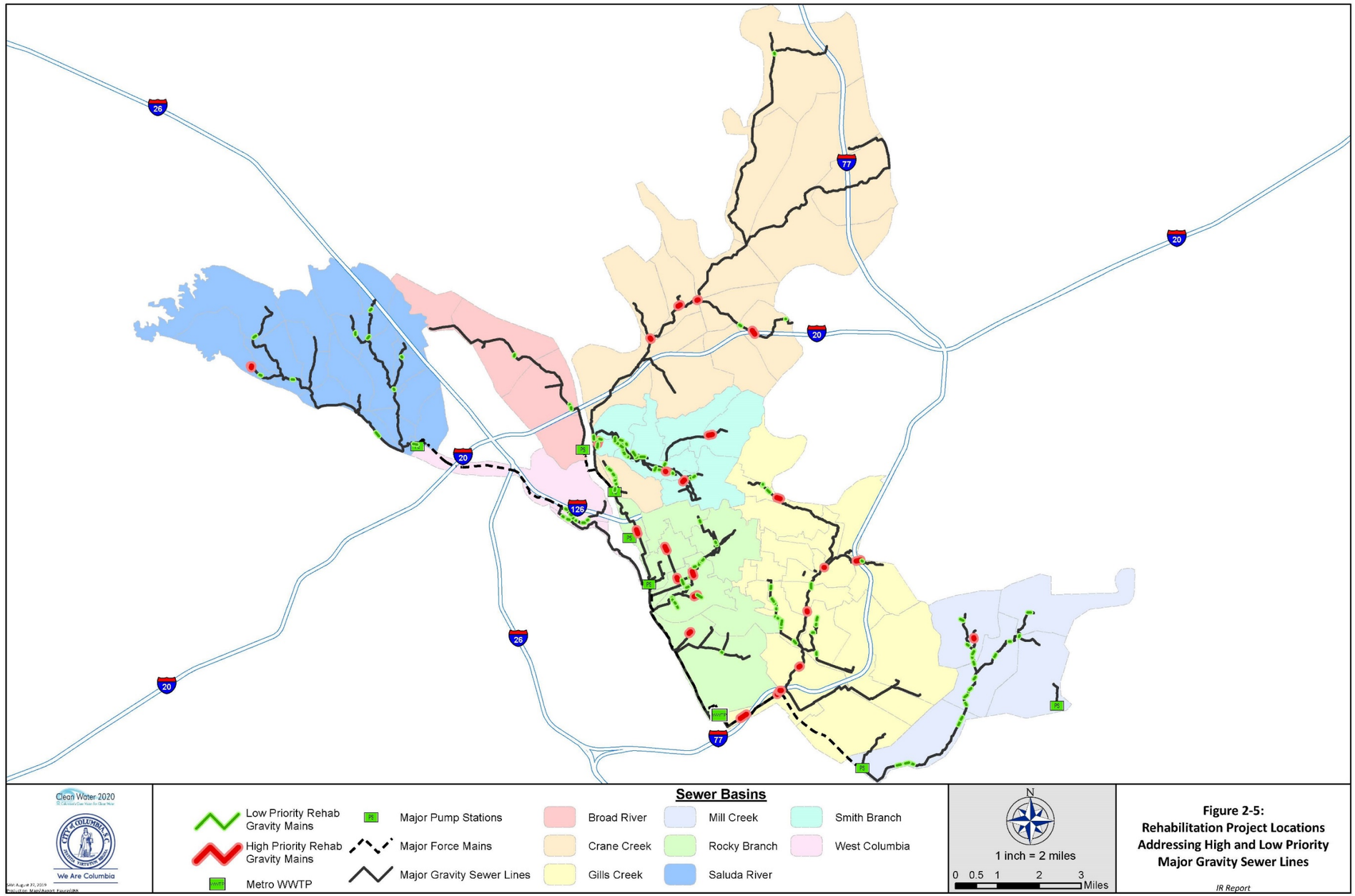
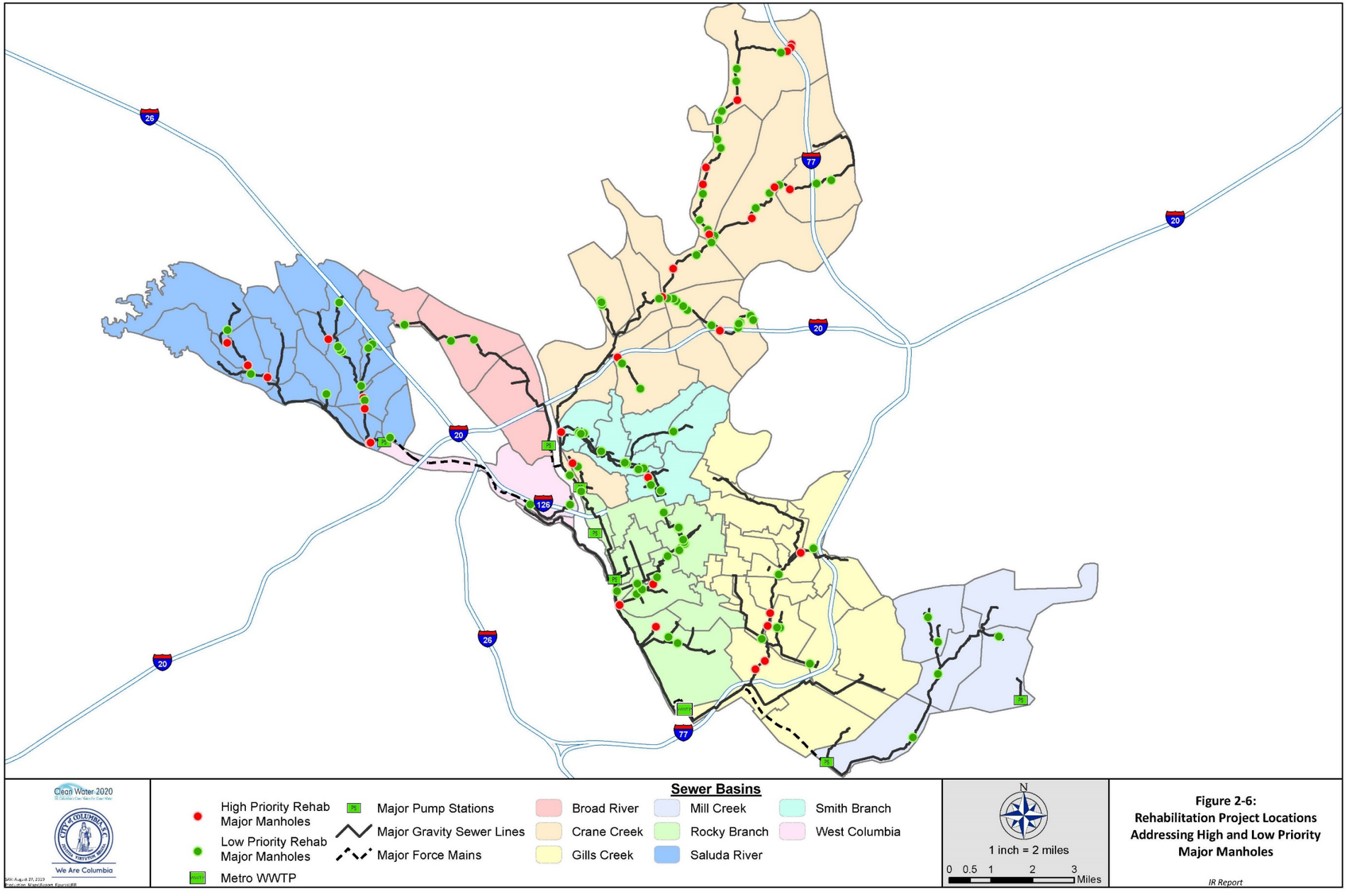


Figure 2-6 – Rehabilitation Project Locations Addressing High and Low Priority Major Manholes



Section 3 Major Pump Stations

This section presents the application of the IR Program procedures for Major Pump Stations. The review of SSO history (**Section 3.1**) and results of the CSAP assessments (**Section 3.2**) were used as a basis to assign condition ratings. Condition ratings and criticality ratings were combined for the prioritization process (**Section 3.3**). From the prioritization process, proposed actions were identified (**Section 3.5**). The schedule for the rehabilitation of the Major Pump Stations is discussed in Section 5.

3.1 Recent Historical SSOs

As discussed in Section 2.2.1 of the IR Program, past SSOs related to a given Major Pump Station are assumed to indicate a higher probability of an SSO occurring at that location in the future if a permanent solution to address the past SSO is not implemented. Therefore, it is important to understand the underlying cause of an SSO. For instance, an SSO may occur at a manhole, but the cause of the SSO may be an electrical problem at a Pump Station located some distance downstream of the overflowing manhole. If the underlying cause of the SSO is attributable to the Pump Station condition, the location and frequency of recent historical SSOs is used, as appropriate, in conjunction with the CSAP data and professional judgment to establish the condition rating for the Pump Station.

SSOs that occurred at or as a result of Major Pump Stations from May 21, 2014 (the Effective Date of the CD) through December 31, 2018, are referred to as recent historical SSOs for this evaluation. The cause of each SSO is recorded at the time of the SSO investigation per the Wastewater Spill Response SOP. Causes of the recent historical SSOs at or as a result of Major Pump Stations are grouped into the following categories:

- Wet Weather – SSOs primarily caused by wet weather events with I/I entering the system and/or capacity constraints in the WCTS. There are no recent historical SSOs on Major Pump Stations caused by wet weather.
- Structural Conditions – SSOs due to issues related to the structural integrity of the Pump Station or components.
- O&M Conditions – SSOs due to issues related to operations and maintenance.
- Other – SSOs that are not related to wet weather, structural, or O&M conditions. This category includes SSOs that are the result of loss of power, electrical issues, or operator error.

Recent historical SSOs on Major Pump Stations are listed in **Table 3-1** and shown on **Figure 3-1**. None of the recent historical SSOs on Major Pump Stations are caused by severe natural conditions (see discussion in Section 2.1). The majority of the SSOs are unrelated to the capacity, structural, or O&M conditions of the Pump Station.

Table 3-1 – Recent Historical SSOs at Major Pump Stations

			SSO Characteristics		
Date[1]	SSO ID	Pump Station	Cause[2]	Category[3]	Estimated Volume (gallons)[4]
10/25/2014	01521	North Columbia	Loss of power, UPS did not work, electrical failure within control panel caused by temperature sensor failure, controls in PLC automatically closed effluent gate	Other	350,000
02/19/2016	01727	Saluda River	Collapsed pipeline at Pump Station	Structural	150
10/09/2016	01818	Mill Creek	Loss of power, no generator fuel	Other	120,000
04/24/2017	01918	Mill Creek	Control panel failure due to temperature probes failure	Other	19,000

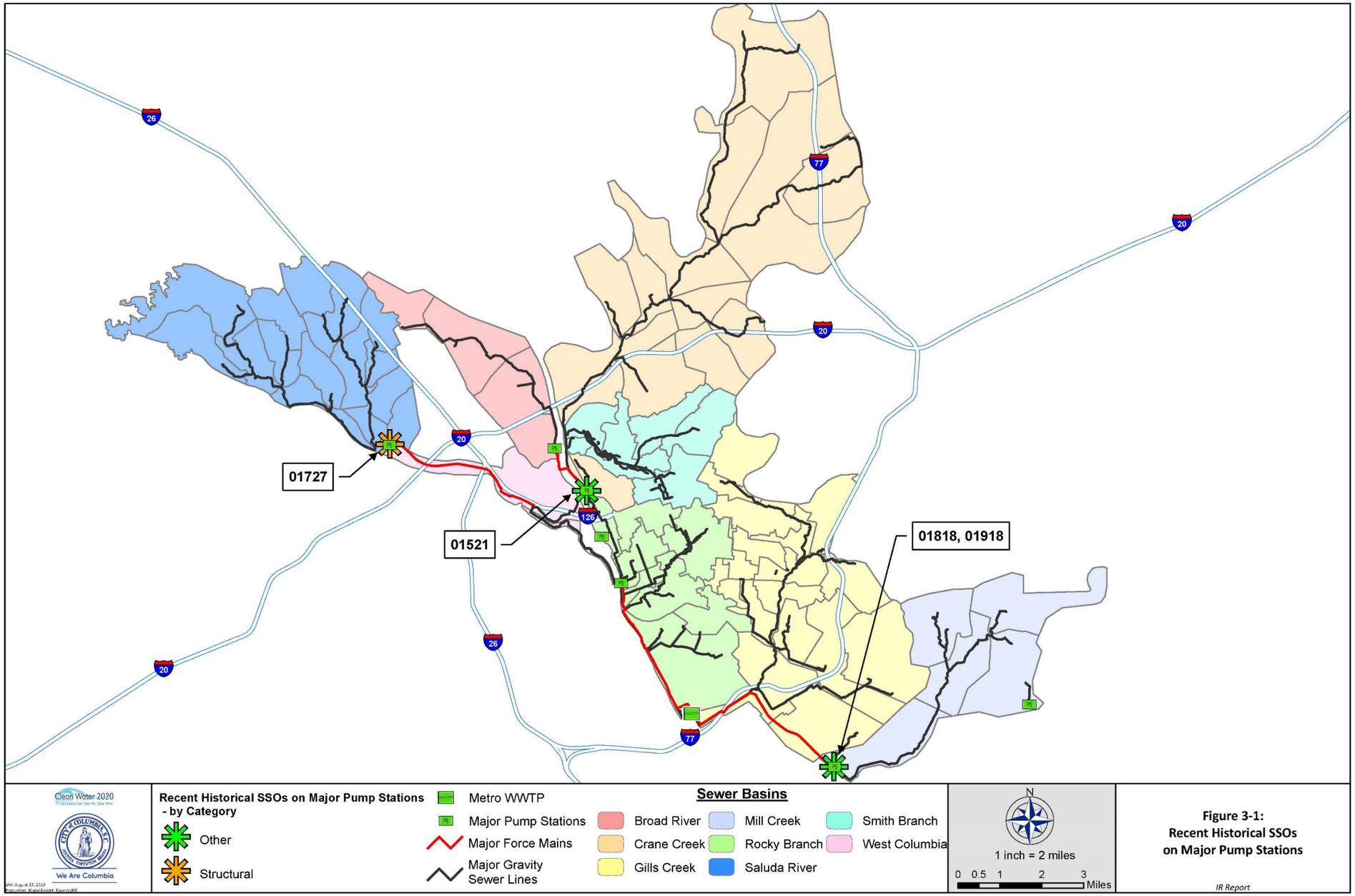
1) Recent historical SSOs occurred from the Effective Date of the CD (May 21, 2014) through December 31, 2018.

2) SSO cause recorded at the time of the SSO investigation per the Wastewater Spill Response SOP.

3) SSO category is assigned for this evaluation based on the SSO cause. See Section 2.1 for category definitions.

4) Estimated SSO volume as listed on the SSO reports to DHEC. Volume is estimated per the Wastewater Spill Response SOP. For unobserved overflows where an estimated volume could not be calculated, the volume was reported as unknown.

Figure 3-1 – Recent Historical SSOs on Major Pump Stations



3.2 Results of the CSAP

The CSAP report describes various methods and procedures that may be used by the City to assess the condition of the major components of the WCTS. The City selected and completed an evaluation of Pump Station condition using the methods and procedures described in CSAP Section 3.10.5 for all the Major Pump Stations. This approach consists of a review of Pump Station operating history and a visual inspection and assessment of the condition of Pump Station components to the extent possible without disrupting operations. The evaluation approach is outlined below.

Field Evaluation – Field evaluation consists of a site visit to each Pump Station, a non-invasive, visual inspection of the assets, and discussions with Pump Station operations and maintenance staff. The following components were evaluated:

- Pumps
- Motor
- System valves
- Control systems
- Generators
- Instrumentation (floats, meters, etc.)
- Control valves
- Structures (buildings, wet wells, tanks, etc.)
- Weight handling equipment
- Comminutors

Each piece of equipment was given an individual field evaluation score, with low values assigned to represent a good condition and high values assigned to represent a poor condition. Assessment and weighting factors were applied to the individual equipment scores to create an overall field evaluation score for the Pump Station under review.

Review of Operating and Mechanical Failure History – Each Pump Station's recent operating and mechanical failure history during the past 5 years was used, when available, as part of this evaluation. The following operating and maintenance data was reviewed, if available:

- Odor or corrosion control issues
- Maintenance related SSOs
- Wet Weather related SSOs
- Pump Station reliability issues
- Pump run times
- Age, based on installation or renovation date

- Response time/time to overflow
- Backup power
- Reserve pump availability

The Pump Station was given an operating and mechanical history score, with low values assigned to represent a good condition and high values assigned to represent a poor condition.

The field evaluation scores and operating and mechanical history scores were averaged to determine the overall condition score for each Pump Station. Early Action CIPs were completed for four of the seven Major Pump Stations prior to the initial CSAP assessment (**Section 1.4**). Based on the results of the CSAP assessment and professional judgment, none of the Major Pump Stations received a poor condition rating. The Pump Stations will be reassessed based on the schedules set forth in the CSAP.

3.3 Prioritizing Based on Condition and Criticality Ratings

The process established in the IR Program was used to identify and prioritize rehabilitation actions for the Major Pump Stations. In general, the IR Program considers both the criticality (consequence of failure) of the WCTS component based on relative likely human health, environmental and other impacts, and condition (probability of failure) of the WCTS component as determined from CSAP assessment and SSO history. For a given WCTS asset, the combination of the criticality and condition rating defines the rehabilitation priority. Criticality and condition ratings are applied to the Major Pump Stations as described in the IR Program and summarized as follows.

3.3.1 Criticality Rating

The criticality rating of an asset is used to represent the relative consequence of failure of a major component of the WCTS. For the purposes of this analysis, a failure is considered to be an SSO. The criticality rating is a numerical value, with low values assigned to represent a low consequence of failure and high values assigned to represent a high consequence of failure. Criticality ratings were developed for each Major Pump Station considering factors such as the quantity of flow conveyed by an asset (i.e., potential quantity of an SSO), the potential impact to public health, and the potential impact to the environment. A criticality model was developed to evaluate criticality of all Pump Stations in the WCTS.

3.3.2 Condition Rating

The condition rating of an asset is developed to represent the probability that the WCTS asset will fail. The condition rating is a numerical value with low values assigned to represent a good condition and high values assigned to represent a poor condition. The condition rating is primarily assigned using recent historical SSOs, probability of failure information collected through the CSAP, and professional judgment (IR Program Section 2.2.1). In general, assets that have recent historical SSOs are assigned the poorest (highest) condition ratings since addressing SSOs is a primary goal of the CD (see discussion in **Section 2.3.2**). The following paragraphs describe the general procedure for assigning relative condition rating based on recent historical SSOs and the information collected through the CSAP.

The highest (poorest) condition rating is assigned to Major Pump Stations whose poor condition is determined to be the root cause of multiple recent historical SSOs. The poor condition of these assets has

already resulted in multiple failures, and therefore, the assets are assumed to have a high probability of a future SSO occurring at that location if a permanent solution to address the past failures is not implemented. The failures may be related to the capacity of the asset or the condition as evidenced by information collected through the CSAP assessments.

The next highest condition rating is assigned to Major Pump Stations whose poor condition is determined to be the root cause of a single recent historical SSO. The poor condition of these assets has already resulted in one failure, and therefore, these assets are assumed to have a high probability of a future SSO occurring at that location if a permanent solution to address the past failure is not implemented.

The remaining condition ratings are assigned based on information collected in the CSAP assessments and professional judgment. Since these assets have not failed, the condition rating based on CSAP results is lower than the condition rating of assets whose condition has caused an SSO.

3.3.3 Prioritization for Rehabilitation

Infrastructure rehabilitation is prioritized based on the combination of condition and criticality ratings as illustrated in Figure 2-2. Major Pump Stations determined to be in poor condition are considered for rehabilitation projects under the IR Program. Under this analysis, rehabilitation projects can refer to rehabilitation of the current asset, replacement of the current asset or O&M procedures when it is discovered that the condition rating is based on O&M issues.

Of the Major Pump Stations in poor condition, rehabilitation is prioritized based on the condition (probability of failure) rating and the criticality (consequence of failure) rating. The highest priority for rehabilitation is assigned to Major Pump Stations with the highest (poorest) condition rating and highest criticality rating. Specific rehabilitation actions for prioritized Major Pump Stations are presented in Section 3.5. The CD requires that the infrastructure rehabilitation is prioritized into three categories for implementation ("Group 1", "Group 2", and "Group 3"). Grouping of the rehabilitation projects is discussed in Section 5.1.

Major Pump Stations in poor condition (high condition rating) but with a lower criticality rating are tracked in decreasing priority according to decreasing criticality rating. These assets will be considered for potential future infrastructure rehabilitation after the higher priority projects are addressed since a failure of these assets would represent a smaller impact to public health and the environment. If they are not scheduled for rehabilitation, these assets will be reassessed, based on the frequencies given in the CSAP, to determine if the condition has deteriorated to the point that the asset would be moved into a higher priority rehabilitation category under the IR Program. Per Section 4.2 of the CSAP, high priority WCTS components, which are those that are both highly critical and suspected to be in poor condition, will receive the most frequent assessment.

Major Pump Stations with a low probability of failure are prioritized for reassessment rather than rehabilitation. These assets will be reassessed, based on the frequencies given in the CSAP, to determine if the condition has deteriorated to the point that the asset would be moved into a higher priority rehabilitation category under the IR Program. Assets that have a low probability of failure but are highly critical will receive a medium frequency assessment to determine their condition. Remaining WCTS components will be assessed with lower frequency to determine if field investigations are needed.

3.4 Find and Fix Program

In addition to infrastructure rehabilitation actions, the City may also perform small-scale rehabilitation or repairs on a Find and Fix basis as defects are identified. Find and Fix repairs are intended to promptly address assets that are discovered, through the course of continuing WCTS inspections, to be in poor condition with a high probability of failure. Those Pump Station components determined to be in poor condition (based on professional judgment and condition assessment) are scheduled to be repaired without being prioritized and grouped into scheduled rehabilitation actions. The Find and Fix actions also include rehabilitation or repairs that are made to promptly address defects that are found to be the cause of an SSO in order to avoid recurrent SSOs.

3.5 Proposed Corrective Actions

None of the Major Pump Stations have multiple recent historical SSOs whose root cause is attributed to the poor condition or capacity of the Pump Station. Find and Fix actions, as listed in **Table 3-2**, were performed to address the root cause of all single recent historical SSOs caused by structural or other conditions at the Major Pump Stations.

Table 3-2 – Find and Fix Action to Address Single Recent Historical SSOs on Major Pump Stations

Pump Station	SSO ID	Find and Fix Action
North Columbia	01521	Removed temperature sensor and gate control function from PLC so it couldn't automatically close effluent gate. Batteries placed on 3-year rotation for replacement. Currently, no other pump stations have this configuration.
Saluda River	01727	Repaired collapsed pipeline at Pump Station.
Mill Creek	01818	Low level indicator added to all fuel tanks on diesel generators. Level indicator tied into SCADA system.
Mill Creek	01918	Pumps rebuilt to change out temperature probes. Pumps placed on annual rebuild cycle.

Early Action CIPs were required and have been completed for four of the seven Major Pump Stations (Section 1.4). Based on the results of the CSAP assessment and professional judgment, none of the Major Pump Stations received a poor condition rating. Therefore, none of the Major Pump Stations are high priority for rehabilitation. Per the IR Program, the Pump Stations will be reassessed based on the schedules set forth in the CSAP.

Section 4 Major Force Mains

This section presents the application of the IR Program procedures for major Force Mains. The major Force Mains are divided into segments for the purposes of the CSAP and prioritization process, and each segment is considered a separate asset by the City. The review of SSO history (**Section 4.1**) and results of the CSAP assessment (**Section 4.2**) are used as a basis to assign condition ratings. Condition ratings and criticality ratings are combined for the prioritization process (**Section 4.3**). From the prioritization process, proposed actions are identified (**Section 4.5**). The schedule for the rehabilitation of the major Force Main segments is discussed in Section 5.

4.1 Recent Historical SSOs

As discussed in Section 2.3.1 of the IR Program, past SSOs related to a given major Force Main segment are assumed to indicate a higher probability of an SSO occurring at that location in the future if a permanent solution to address the past SSO is not implemented. Therefore, if the underlying cause of the SSO is attributable to the Force Main condition, the location and frequency of recent historical SSOs are used, as appropriate, in conjunction with the CSAP data and professional judgment to establish the condition rating for the Force Main segments.

SSOs that occurred on major Force Main segments from May 21, 2014 (the Effective Date of the CD) through December 31, 2018, are referred to as recent historical SSOs for this evaluation. The cause of each SSO is recorded at the time of the SSO investigation per the Wastewater Spill Response SOP. Causes of the recent historical SSOs on major Force Mains are grouped into the following categories:

- Wet Weather – SSOs primarily caused by wet weather events with I/I entering the system and/or capacity constraints in the WCTS. There are no recent historical SSOs on major Force Main segments caused by wet weather.
- Structural Conditions – SSOs due to issues related to the structural integrity of the pipe or other appurtenances such as Air Release Valves (ARVs).
- O&M Conditions – SSOs due to issues related to operations and maintenance. There are no recent historical SSOs on major Force Main segments caused by O&M conditions.
- Other – SSOs that are not related to wet weather, structural, or O&M conditions. This category includes SSOs that are a result of damage caused by third parties, operator error, or SSOs that occur during temporary bypass operations.

Recent historical SSOs on major Force Main segments are listed in **Table 4-1** and shown on **Figure 4-1**. None of the recent historical SSOs on major Force Mains are caused by severe natural conditions (see discussion in Section 2.1).

As listed in Table 4-1, more than half of the SSOs on major Force Main segments are due to structural condition and the remaining are categorized as other causes unrelated to the condition of the Force Main.

Table 4-1 – Recent Historical SSOs on Major Force Mains

			SSO Characteristics		
Date[1]	SSO ID	Force Main Segment with Asset ID	Cause[2]	Category[3]	Estimated SSO Volume (gallons)[4]
05/29/2014	01482	Broad River 335_0804	Flange leaking at gasket	Structural	400
10/09/2014	01518	Saluda River 195-ARV 2 (at the connection of 195_0480 and 195_0481)	Error in ARV operations	Other	27,000
10/27/2015	01654	Mill Creek 065_0132	Force Main damaged	Structural	Unknown[1]
02/17/2016	01718	Saluda River 195_0491	Broken section of pipe	Structural	531,000
05/03/2016	01755	Broad River 335_0807	Broken section of pipe	Structural	442,000
09/19/2016	01802	N/A	Bypass Force Main punctured by contractor	Other	1,000
7/21/2017	01948	N/A	Hole in bypass Force Main	Other	180

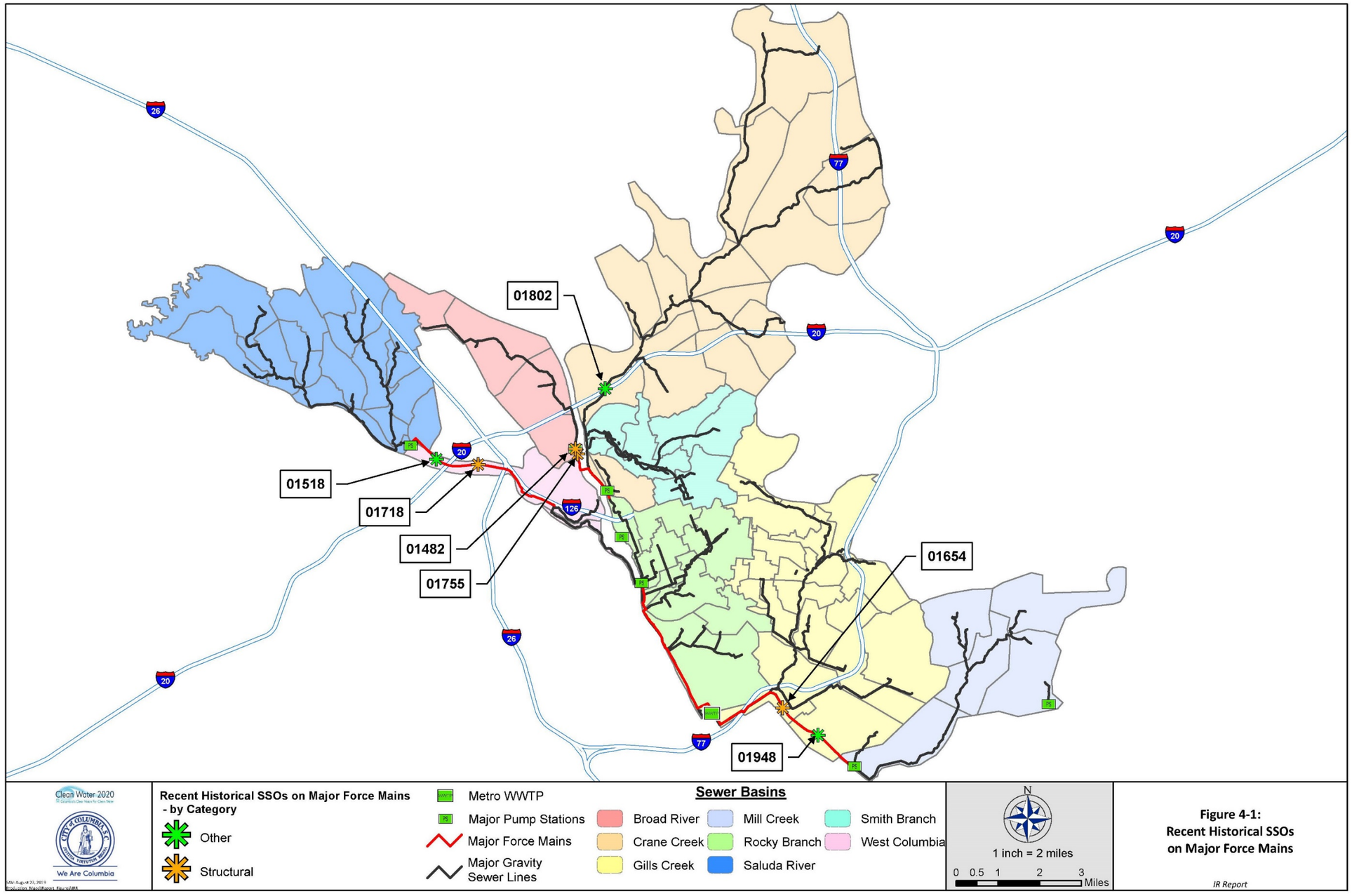
1) Recent historical SSOs occurred from May 21, 2014 (the Effective Date of the CD) through December 31, 2018.

2) SSO cause recorded at the time of the SSO investigation per the Wastewater Spill Response SOP.

3) SSO category is assigned for this evaluation based on the SSO cause. See Section 2.1 for category definitions.

4) Estimated SSO volume as listed on the SSO reports to DHEC. Volume is estimated per the Wastewater Spill Response SOP. For unobserved overflows where an estimated volume could not be calculated, the volume was reported as unknown.

Figure 4-1 – Recent Historical SSOs on Major Force Mains



4.2 Results of the CSAP

The CSAP report describes various methods and procedures that may be used by the City to assess the condition of the major components of the WCTS. The City selected and completed the following assessments under the CSAP for the major Force Mains.

- All major Force Mains were assessed by segment using a Force Main desktop analysis as defined in CSAP Section 3.11. Results are discussed in **Section 4.2.1**.
- Force Main segments that were identified as the highest priority from the desktop analysis were recommended for further assessment by field inspection, rehabilitation, or replacement as discussed in **Section 4.2.2.** Field inspection was performed using transient pressure monitoring as described in CSAP Section 3.11.3, acoustic leak detection as described in CSAP Section 3.11.7, or electromagnetic monitoring for prestressed concrete cylinder pipe (PCCP).

4.2.1 Desktop Analysis

The desktop analysis was used to prioritize each Force Main segment based on the probability and consequence of failure. The highest priority Force Mains from the desktop analysis were identified for condition assessment by field inspection, rehabilitation, or replacement, as follows.

- Based on the initial desktop analysis and engineering judgment, Saluda River Force Main was identified as high priority and recommended for further assessment of the Force Main condition through field inspections.
- Based on the initial desktop analysis and engineering judgment, Mill Creek Force Main was identified as high priority and recommended for further assessment of the Force Main condition through field inspections. However, due to capacity and other concerns with the Force Main, the City initiated a project to replace the Mill Creek Force Main (SS6764) without further assessment.
- Based on the initial desktop analysis and engineering judgment, Broad River Force Main was identified as high priority and recommended for further assessment of the Force Main condition through field inspections. However, due to capacity and other concerns with the Force Main, the City initiated a project to replace the Broad River Force Main (SS7454) without further initial assessment. During the engineering/design phase for the capacity enhancement requirements of the project, further assessment may occur, as needed, for any segments of the Force Main which were not identified for replacement in the capacity enhancement phase of the project.

4.2.2 Field Inspections

As a follow up to the desktop analysis, field inspections were performed on the Saluda River Force Main. Transient pressure monitoring, acoustic leak detection, and electromagnetic monitoring for PCCP were used for the assessment. Each of these methods is described in more detail below.

Transient Pressure Monitoring – Transient pressure monitoring involves installing specialized high sample rate pressure monitoring equipment in the pipeline to continuously monitor the pressure in the pipe. The transient monitor was installed at the Saluda River Pump Station and monitored for a total of

53 days. Results were used to inform the analysis of the Force Main field inspection results and to provide a baseline on pressure conditions in the system.

Acoustic Leak Detection – Acoustic leak detection technology uses specialized acoustic leak detection equipment while the Force Main is in service to identify and pinpoint the location of leaks and air pockets in a Force Main. Where air pockets are identified, more focused inspection, such as coupon extraction or thickness testing, can be performed. The leak detection system is inserted into a live Force Main through any tap larger than 2 inches. In operation, the probe is carried along the pipe by the flow of water. The system locates leaks through identification of the distinctive acoustic signals generated by leaks in the pipe wall, the joints, or steel welds. In addition to locating the leak, the technology can estimate the magnitude of the leak.

For the Saluda River Pump Station, the acoustic leak detection tool was inserted into the Force Main at a point just outside the Saluda River Pump Station and retrieved at the discharge manhole. The location and type of any anomalies found during the field inspection were recorded and analyzed to determine follow up actions and inform the Force Main segment condition ratings.

Electromagnetic monitoring for PCCP – Electromagnetic monitoring for PCCP relies on a magnetic signature for each pipe to identify anomalies that are produced by zones of broken wire wraps in a PCCP Force Main. This technique accurately identifies wire breaks and their location. The electromagnetic tool is inserted into a live Force Main and is carried along the pipe by the flow of water. The data collected during an electromagnetic inspection is reviewed to identify anomalies consistent with broken prestressing wire wraps. The anomalies are then evaluated to estimate the number of broken prestressing wire wraps on each pipe.

For the Saluda River Pump Station, the electromagnetic tool was inserted into the Force Main at a point just outside the Saluda River Pump Station and retrieved at the discharge manhole. The location and type of anomalies found during the field inspection were recorded and analyzed to help establish the rate of deterioration and help predict the life remaining in individual pipe sections.

The results of the different field inspections indicated the Saluda River Force Main is in adequate condition and not in need of rehabilitation. However, the Saluda River Force Main segments will be reassessed, based on the frequencies given in the CSAP, to determine if the condition has deteriorated to the point that the asset would be moved into a higher priority rehabilitation category under the IR Program.

4.3 Prioritizing Based on Condition and Criticality Ratings

The process set forth in the IR Program was used to identify and prioritize actions for the major Force Mains. In general, the IR Program considers both the criticality (consequence of failure) of the WCTS component based on relative likely human health, environmental and other impacts and condition (probability of failure) of the WCTS component as determined from CSAP assessment and SSO history. For a given WCTS asset, the combination of the criticality and condition rating defines the rehabilitation priority. Criticality and condition ratings are applied to the major Force Main segments by asset as described in the IR Program and summarized as follows.

4.3.1 Criticality Rating

The criticality rating of an asset is used to represent the relative consequence of failure of a major component of the WCTS. For the purposes of this analysis, a failure is considered to be an SSO. The criticality rating is a numerical value, with low values assigned to represent a low consequence of failure and high values assigned to represent a high consequence of failure. Criticality ratings were developed for each major Force Main segment considering factors such as the quantity of flow conveyed by an asset (i.e., potential SSO volume), the potential impact to public health, and the potential impact to the environment. A criticality model was developed in GIS to evaluate criticality of all Force Main segments in the WCTS.

4.3.2 Condition Rating

The condition rating of an asset is developed to represent the probability that the WCTS asset will fail. The condition rating is a numerical value with low values assigned to represent a good condition and high values assigned to represent a poor condition. The condition rating is primarily assigned using recent historical SSOs, probability of failure information collected through the CSAP assessments, and professional judgment (IR Program, Section 2.3.1). In general, assets that have recent historical SSOs are assigned the poorest (highest) condition ratings since addressing SSOs is a primary goal of the CD (see discussion in Section 2.3.2). The following paragraphs describe the general procedure for assigning condition rating based on recent historical SSOs and the information collected through the CSAP assessments.

The highest (poorest) condition rating is assigned to major Force Main segments whose poor condition is determined to be the root cause of multiple recent historical SSOs. The poor condition of these assets has already resulted in multiple failures, and therefore, these assets are assumed to have a high probability of a future SSO occurring at that location if a permanent solution to address the past failures is not implemented.

The next highest condition rating is assigned to major Force Main segments whose poor condition is determined to be the root cause of a single recent historical SSO. The poor condition of these assets has already resulted in one failure, and therefore, these assets are assumed to have a high probability of a future SSO occurring at that location if a permanent solution to address the past failure is not implemented.

The remaining condition ratings are assigned based on information collected in the CSAP assessments and professional judgment. Since these assets have not failed, the condition rating based on CSAP results is lower than the condition rating of assets whose condition has caused an SSO.

4.3.3 Prioritization for Rehabilitation

Infrastructure rehabilitation is prioritized based on the combination of condition and criticality ratings as illustrated in Figures 2-2 and 2-3. Major Force Main segments determined to be in poor condition are considered for rehabilitation projects under the IR Program. Under this analysis, rehabilitation projects can refer to rehabilitation of the current asset, replacement of the current asset or O&M procedures when it is discovered that the condition rating is based on O&M issues.

Of the major Force Main segments in poor condition, rehabilitation is prioritized based on the condition (probability of failure) rating and the criticality (consequence of failure) rating. The highest priority for rehabilitation is assigned to major Force Main segments with the highest (poorest) condition rating and highest criticality rating. Specific rehabilitation actions for prioritized major Force Main segments are presented in Section 4.5. The CD requires that the infrastructure rehabilitation is prioritized into three categories for implementation ("Group 1", "Group 2", and "Group 3"). Grouping of the rehabilitation projects is discussed in Section 5.1.

Major Force Main segments in poor condition (high condition rating) but with a lower criticality rating are tracked in decreasing priority according to decreasing criticality rating. These assets will be considered for potential future infrastructure rehabilitation after the higher priority projects are addressed since a failure of these assets would represent a smaller impact to public health and the environment. If they are not scheduled for rehabilitation, these assets will be reassessed, based on the frequencies given in the CSAP, to determine if the condition has deteriorated to the point that the asset would be moved into a higher priority rehabilitation category under the IR Program. Per Section 4.2 of the CSAP, high priority WCTS components, which are those that are both highly critical and suspected to be in poor condition, will receive the most frequent assessment.

Major Force Main segments with a low probability of failure are prioritized for reassessment rather than rehabilitation. These assets will be reassessed, based on the frequencies given in the CSAP, to determine if the condition has deteriorated to the point that the asset would be moved into a higher priority rehabilitation category under the IR Program. Assets that have a low probability of failure but are highly critical will receive a medium frequency assessment to determine their condition. Remaining WCTS components will be assessed with lower frequency to determine if field investigations are needed.

4.4 Find and Fix Program

In addition to infrastructure rehabilitation actions, the City may also perform small-scale rehabilitation or repairs on a Find and Fix basis as defects are identified. Find and Fix repairs are intended to promptly address assets that are discovered, through the course of continuing WCTS inspections, to be in poor condition with a high probability of failure. Those assets determined to be in poor condition (based on professional judgment and condition assessment) are scheduled to be repaired without being prioritized and grouped into scheduled rehabilitation actions. The Find and Fix actions also include rehabilitation or repairs that are made to promptly address defects that are found to be the cause of an SSO in order to avoid recurrent SSOs.

4.5 Proposed Corrective Actions

The proposed corrective actions under the IR Report to address conditions causing SSOs on major Force Main segments are presented in the following sections. None of the major Force Main segments have multiple recent historical SSOs whose root cause is attributed to the poor condition or capacity of the Force Main segment. Corrective actions are categorized by those that address a single recent historical SSO, or those to address assets that have not failed, but are highest priority for rehabilitation based on condition and criticality. Overall WCTS project grouping and scheduling is discussed in Section 5.

4.5.1 Single Recent Historical SSO

Find and Fix actions, as listed in **Table 4-2**, were completed to address the root cause of all single recent historical SSOs caused by structural or other conditions on the major Force Main segments.

Table 4-2 – Find and Fix Action to Address Single Recent Historical SSOs on Major Force Mains

Force Main Segment with Asset ID	SSO ID	Find and Fix Action	Estimated SSO Volume (gallons)
Mill Creek 065_0132	01654	Replaced damaged Force Main	Unknown[1]
Saluda River 195_0491	01718	Replaced broken section of Force Main	531,000
Broad River 335_0807	01755	Repaired section of Force Main	442,000
Broad River 335_0804	01482	Replaced leaking gasket	400
Saluda River 195-ARV 2 (at the connection of 195_0480 and 195_0481)	01518	Corrected error in ARV operations	27,000
N/A	01802	Repaired bypass Force Main punctured by contractor	1,000
N/A	01948	Replaced bypass Force Main	180

1) For unobserved overflows where an estimated volume could not be calculated, the volume was reported as unknown.

4.5.2 High Priority for Rehabilitation

Additional proposed projects were identified to address the most critical major Force Main segments in the poorest condition based on initial desktop prioritization, defect ratings or other information collected through the CSAP assessments and professional judgment, but that have not resulted in a recent historical SSO. Within the prioritization matrix, these assets have the next highest condition ratings after those assets with recent historical SSO(s) and are the most critical. Therefore, these assets are considered high priority for rehabilitation.

The projects listed in **Table 4-3**, with locations shown on **Figure 4-2** were identified to address capacity, condition, and other concerns on major Force Main segments that were identified as high priority from the CSAP desktop analysis.

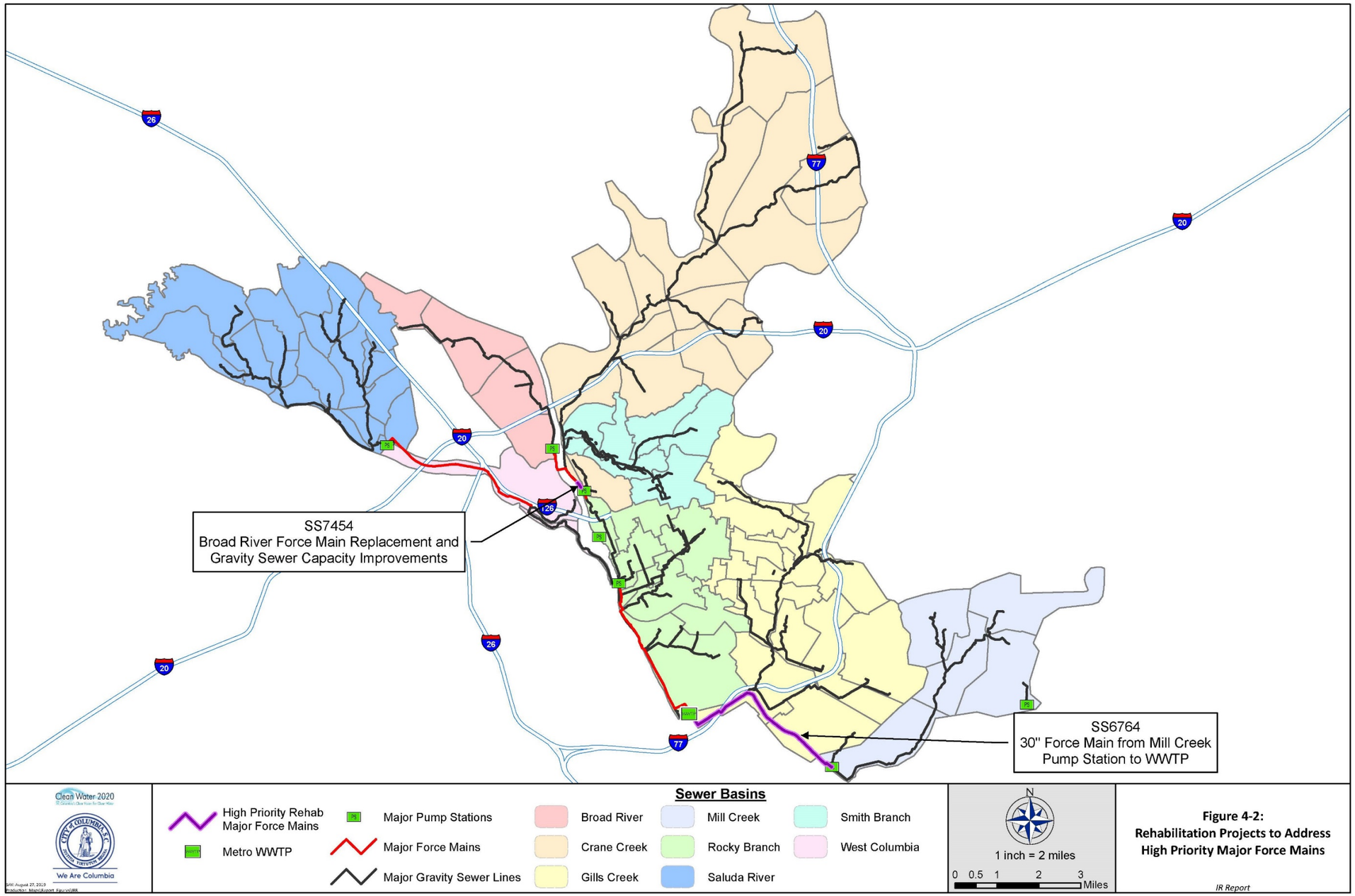
In some cases, major Force Main segments deemed high priority per the IR Report are currently incorporated into larger planned projects which also include rehabilitation and/or replacement of force mains which are not scheduled for rehabilitation under the detailed prioritization matrix at Figure 2-2. It is anticipated that these larger planned projects will result in rehabilitation or replacement of the high priority Force Main segments within the project limits. Table 4-3 shows larger planned projects that will include rehabilitation of major Force Mains considered high priority. The linear feet of high priority pipe set forth in Table 4-3 indicates the portion of the larger planned projects which is subject to the rehabilitation schedule for Group 3 projects (see **Section 5.1.3**). The City reserves the right to rehabilitate the high priority assets separately from these larger planned projects if deemed more appropriate by the City. The high priority assets will be rehabilitated in accordance with the project scheduling in Section 5.

However, complications in implementing the complete project (right-of-way permitting, budgeting, etc.) may dictate that the high priority major Force Main segments be completed separately from the larger project. Under this analysis, rehabilitation projects can refer to rehabilitation of the current asset, replacement of the current asset or O&M procedures when it is discovered that the condition rating is based on O&M issues.

Table 4-3 – Rehabilitation Projects to Address High Priority Major Force Mains

Project Name/Description	Length (LF)
SS6764 30" Force Main from Mill Creek Pump Station to WWTP	24,400
SS7454 Broad River Force Main Replacement and Gravity Sewer Capacity Improvements	700

Figure 4-2 – Rehabilitation Projects to Address High Priority Major Force Mains



Section 5 Rehabilitation of Infrastructure

As required under CD Paragraph 16.b., this section identifies all specific rehabilitation measures and projects, including those currently underway and those additional rehabilitation projects identified through the assessment of the major components of the WCTS pursuant to the CSAP, as needed to address I/I and other conditions causing SSOs. Rehabilitation measures and projects presented in this IR Report focus on conditions causing SSOs in the WCTS after May 21, 2014, through December 31, 2018, and conditions that may cause future SSOs. Under this approach, rehabilitation projects can refer to rehabilitation of the current asset, replacement of the current asset or O&M procedures when it is discovered that the condition rating is based on O&M issues.

5.1 Project Summary and Prioritization

The rehabilitation projects identified in Sections 2, 3, and 4 of this report are grouped into three scheduling categories ("Group 1," "Group 2," and "Group 3") according to priority of the projects, as required under CD Paragraph 16.b. The schedule for each group is presented in Table 5-1. The Find and Fix actions to address recent historical SSOs on Major Gravity Sewer Lines (Table 2-6), Major Pump Stations (Table 3-2), and major Force Main segments (Table 4-2), were completed as the defects were identified and are not included in the prioritized scheduling categories.

Table 5-1 – Schedule for Project Groups

Group	Deadline	Criteria Guidelines
Group 1	Completed by 3 years from IR Report approval	Projects to address major components that have experienced repeated SSOs
Group 2	Completed by 5 years from IR Report approval	Projects to address major components that have experienced a single recent historical SSO
Group 3	Completed by 7 years from IR Report approval	Projects to address major components identified through CSAP assessment, whose condition has not resulted in an SSO, but are a priority for rehabilitation based on condition and criticality

Rehabilitation projects are prioritized according to their ability to resolve the most serious problems related to capacity overflows and problems related to WCTS assets with the highest defect ratings, as determined by the CSAP's initial assessment of major components of the entire WCTS. The criteria for prioritizing projects into Groups 1, 2, or 3 are listed in the following subsections.

It is not anticipated that any of these projects will remove I/I in a way that can be quantified because of their location on the major portion of the WCTS. They will, however, have significant benefits by correcting assets identified to be in poor condition and highly critical.

5.1.1 Group 1 Projects

In accordance with the CD, Group 1 projects shall be completed no later than 3 years following EPA and DHEC approval of the IR Report. As stated in the IR Program, the primary objective of infrastructure rehabilitation is to address SSOs in the WCTS. The City has already completed the Early Action CIPs listed in Section 1.4 pursuant to the schedule presented in Appendix F of the CD. Group 1 includes the highest

priority projects to address major components of the WCTS that have experienced repeated SSOs since the Effective Date of the CD.

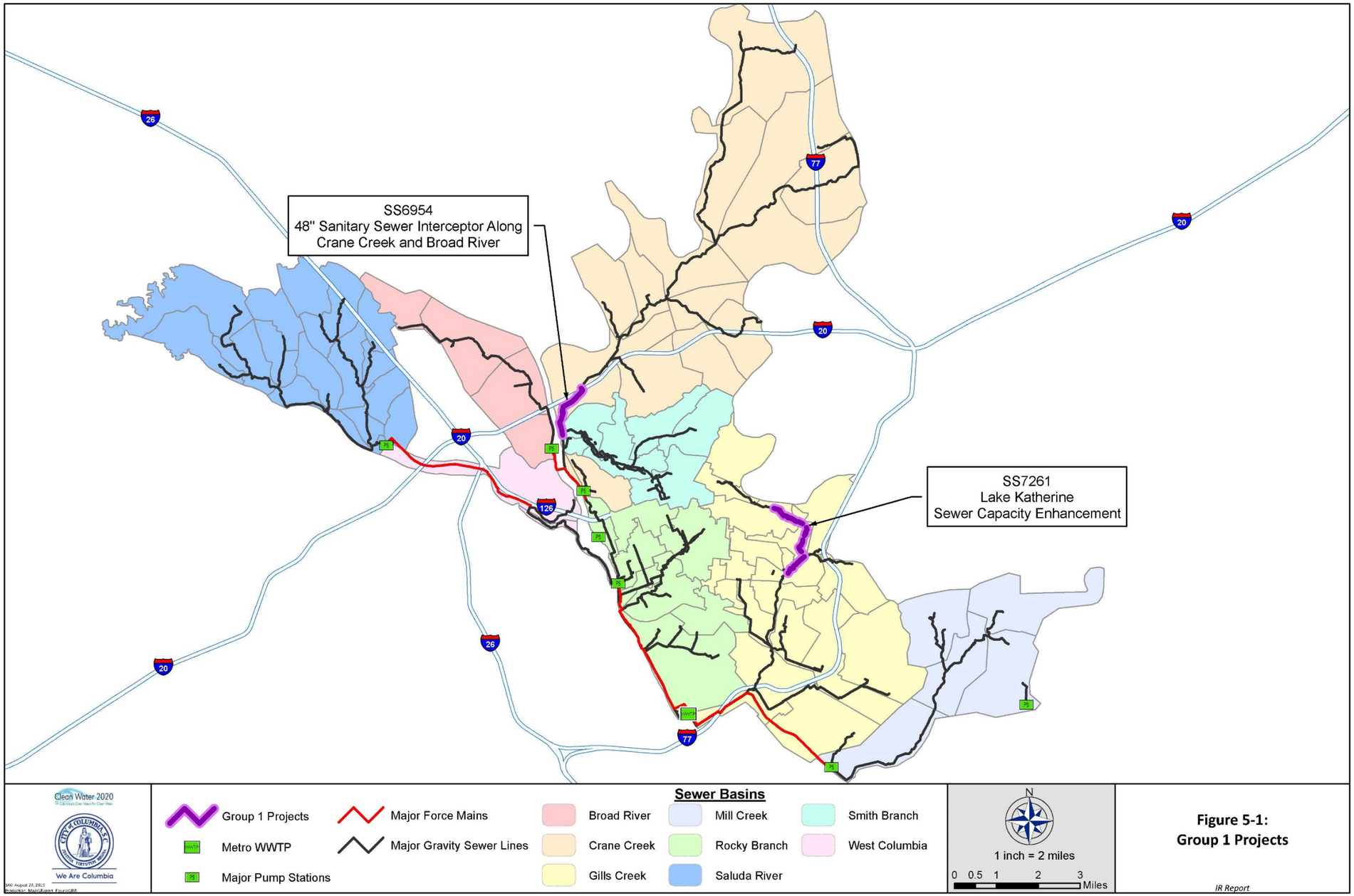
Projects in Group 1 address major components of the WCTS that have experienced multiple recent historical SSOs with a common root cause related to the capacity or poor condition of a Major Gravity Sewer Line, major manhole, Major Pump Station, or major Force Main segment from May 21, 2014 (the Effective Date of the CD) through December 31, 2018.

Table 5-2 includes a summary of the Group 1 projects that the City has undertaken or plans to undertake on major WCTS components, including project description and the number and estimated volume of recent historical SSOs that may be addressed through implementation of these projects. Group 1 projects are shown on **Figure 5-1**.

Table 5-2 – Summary of Group 1 Projects

Project Name	Project Description	Recent Historical SSOs (Number of SSOs)	Volume (gallons)
SS6954 – 48" Sanitary Sewer Interceptor Along Crane Creek and Broad River	Approximately 8,000 LF of pipe capacity upgrades	17	4,191,000
SS7261 – Lake Katherine Sewer Capacity Enhancement	Approximately 13,000 LF of pipe capacity upgrades	12	157,000

Figure 5-1 – Group 1 Projects



5.1.2 Group 2 Projects

In accordance with the CD, Group 2 projects shall be completed no later than 5 years following EPA and DHEC approval of the IR Report. Group 2 projects address the remaining major components of the WCTS that have experienced a single recent historical SSO with root cause related to the capacity or poor condition of a Major Gravity Sewer Line, major manhole, Major Pump Station, or major Force Main segment from May 21, 2014 (the Effective Date of the CD) through December 31, 2018.

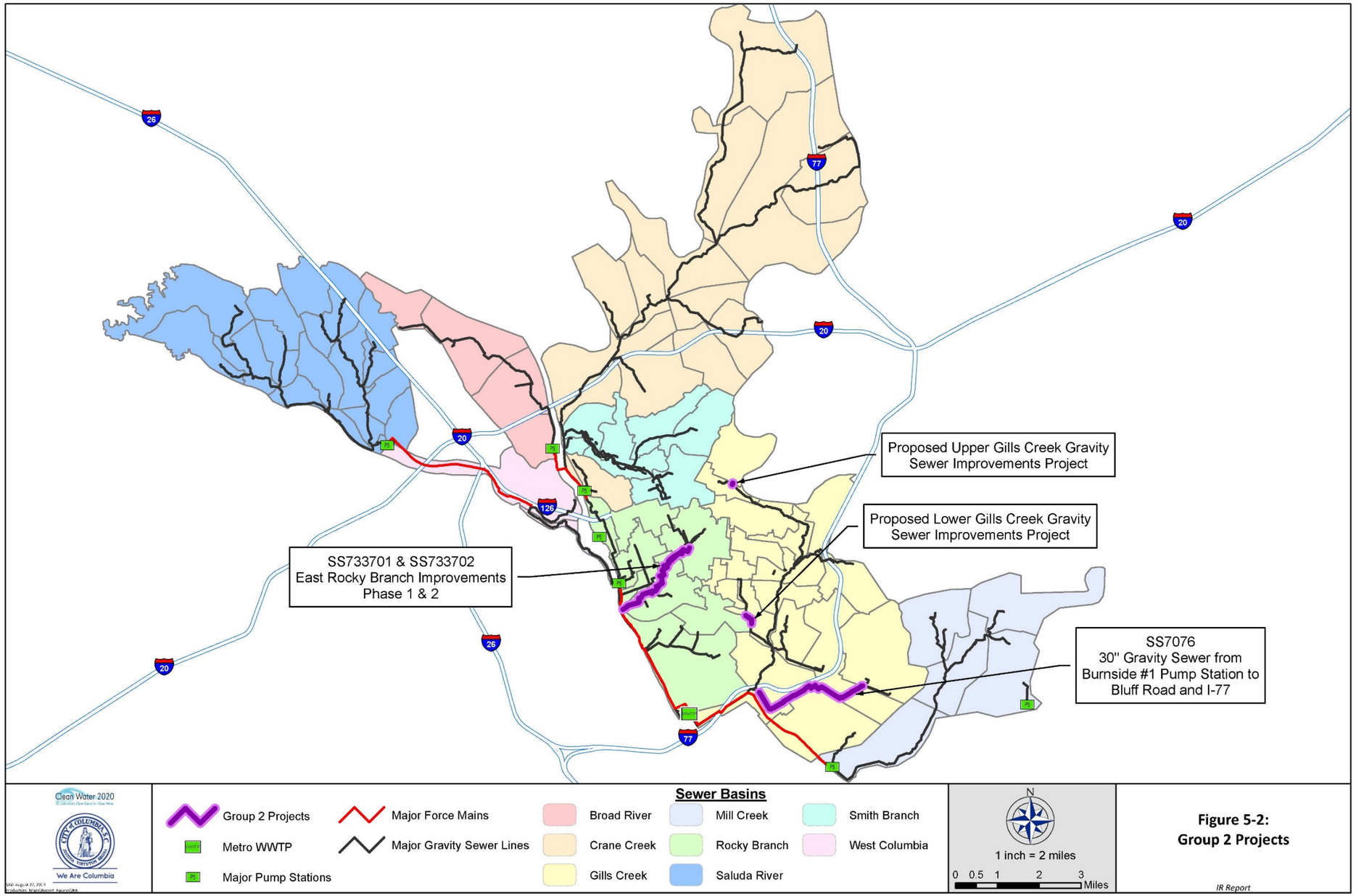
Table 5-3 includes a summary of the Group 2 projects that the City has undertaken or plans to undertake on major WCTS components, including project description and the estimated volume of SSOs that are addressed. Group 2 projects are shown on **Figure 5-2**. Once an asset is selected for rehabilitation, an engineering assessment will determine the method, including the option of constructing a new asset (pipeline, manhole or pump station) or cleaning based on the noted defects.

Table 5-3 – Summary of Group 2 Projects

Project Name	Project Description	Volume of Recent Historical SSO Addressed
SS733701 – East Rocky Branch Improvements Phase 1 SS733702 – East Rocky Branch Improvements Phase 2	Approximately 18,000 LF of pipe upgrades	Unknown[1]
Proposed Lower Gills Creek Gravity Sewer Improvements Project	Approximately 2,000 LF pipe cleaning and/or rehabilitation	Unknown[1]
SS7076 – 30" Gravity Sewer from Burnside #1 Pump Station to Bluff Road and I-77	Approximately 7,000 LF of pipe replacement	538,000
Proposed Upper Gills Creek Gravity Sewer Improvements Project	Approximately 200 LF pipe cleaning and/or rehabilitation	200

1) Estimated SSO volume as listed on the SSO reports to DHEC. Volume is estimated per the Wastewater Spill Response SOP. For unobserved overflows where an estimated volume could not be calculated, the volume was reported as unknown.

Figure 5-2 – Group 2 Projects



5.1.3 Group 3 Projects

In accordance with the CD, Group 3 projects shall be completed no later than 7 years following EPA and DHEC approval of the IR Report. Group 3 projects address major components of the WCTS, identified through CSAP assessment, whose condition has not resulted in an SSO, but are high and low priority for rehabilitation based on condition and criticality as noted in Figure 2-3. These include projects to address Major Gravity Sewer Lines, major manholes, Major Pump Stations, or major Force Main segments that are highest priority for rehabilitation as defined in Sections 2.3, 3.3, and 4.3. **Table 5-4** includes a summary and description of the Group 3 projects that the City has undertaken or plans to undertake on major WCTS components. Group 3 projects are shown on **Figure 5-3**. As discussed more fully in Section 2.5.3, for Group 3 projects including other pipes within the project limits that are not high or low priority, only the prioritized pipe is required to be fixed on the schedule shown in Table 5-5. Once an asset is selected for rehabilitation, an engineering assessment will determine the method including the option of constructing a new asset (pipeline, manhole or pump station) or cleaning based on the noted defects.

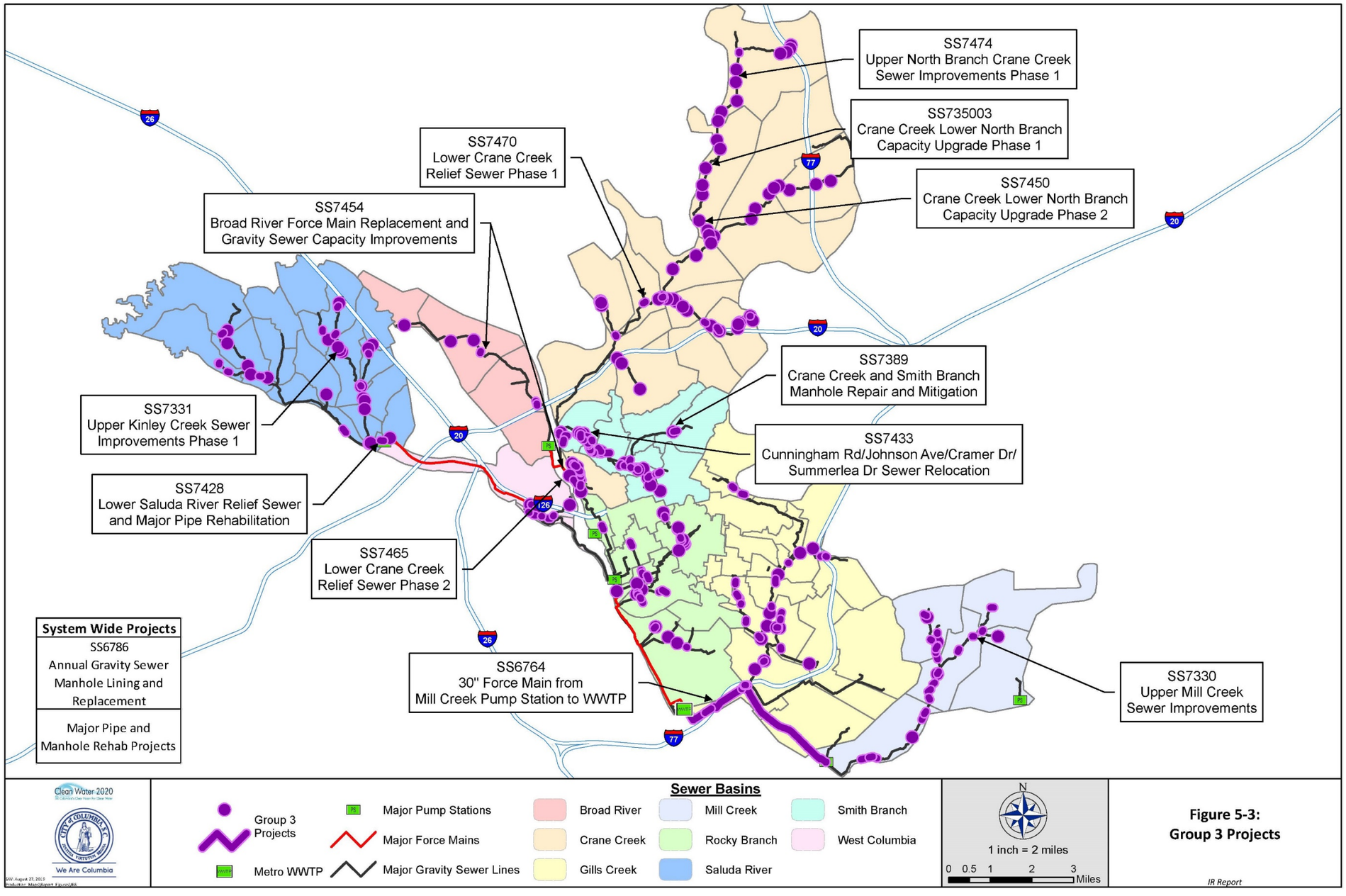
Table 5-4 – Summary of Group 3 Projects

Major Component	Project Name[1]	Project Description	Approximate High Priority Pipe Length or No. of Manholes (LF)	Approximate Low Priority Pipe Length or No. of Manholes (LF)
Gravity Sewer Line	SS7330 – Upper Mill Creek Sewer Improvements	Gravity Sewer replacement	0	800
	SS7428 – Lower Saluda River Relief Sewer and Major Pipe Rehabilitation	Gravity Sewer replacement	0	1,100
	SS7433 – Cunningham Rd/Johnson Ave/Cramer Dr/Summerlea Dr Sewer Relocation	Gravity Sewer replacement/rehabilitation	0	600
	Major Pipe and Manhole CIPP Rehab Project	Gravity Sewer replacement/rehabilitation	6,000	20,000
	Major Pipe and Manhole Pipe Bursting Rehab Project	Gravity Sewer replacement/rehabilitation	0	1,700
	Major Pipe and Manhole Sliplining Rehab Project	Gravity Sewer replacement/rehabilitation	0	3,900
	Major Pipe and Manhole Spray-Applied Liner Rehab Project	Gravity Sewer replacement/rehabilitation	0	2,200
	SS7454 – Broad River Force Main Replacement and Gravity Sewer Capacity Improvements	Gravity Sewer replacement	0	300
	SS7465 – Lower Crane Creek Relief Sewer Phase 2	Gravity Sewer replacement	0	400
	SS7470 – Lower Crane Creek Relief Sewer Phase 1	Gravity Sewer replacement	700	0

Major Component	Project Name[1]	Project Description	Approximate High Priority Pipe Length or No. of Manholes (LF)	Approximate Low Priority Pipe Length or No. of Manholes (LF)
	SS7474 – Upper North Branch Crane Creek Sewer Improvements Phase 1	Gravity Sewer replacement	0	200
Manhole	SS6786 – Annual Gravity Sewer Manhole Lining and Replacement	Manhole rehabilitation	13	38
	SS7331 Upper Kinley Creek Sewer Improvements Phase 1	Manhole replacement/rehabilitation	0	3
	SS735003 Crane Creek Lower North Branch Capacity Upgrade Phase 1	Manhole replacement/rehabilitation	1	1
	SS7389 – Crane Creek and Smith Branch Manhole Repair and Mitigation	Manhole replacement/rehabilitation	3	9
	SS7450 – Crane Creek Lower North Branch Capacity Upgrade Phase 2	Manhole replacement/rehabilitation	0	1
	Major Pipe and Manhole CIPP Rehab Project	Manhole replacement/rehabilitation	3	6
	Major Pipe and Manhole Pipe Bursting Rehab Project	Manhole replacement/rehabilitation	0	1
	Major Manhole Rehab Project	Manhole replacement/rehabilitation	13	28
	SS7454 – Broad River Force Main Replacement and Gravity Sewer Capacity Improvements	Manhole replacement/rehabilitation	0	1
	SS7465 – Lower Crane Creek Relief Sewer Phase 2	Manhole replacement/rehabilitation	0	1
	SS7470 – Lower Crane Creek Relief Sewer Phase 1	Manhole replacement/rehabilitation	0	1
	SS7474 – Upper North Branch Crane Creek Sewer Improvements Phase 1	Manhole replacement/rehabilitation	0	3
Force Main	SS6764 – 30" Force Main from Mill Creek Pump Station to WWTP	Force Main replacement	24,400	-
	SS7454 – Broad River Force Main Replacement and Gravity Sewer Capacity Improvements	Force Main replacement	700	-

1) Sanitary Sewer CIP Number is shown where available.

Figure 5-3 – Group 3 Projects



5.2 Rehabilitation Project Schedule

The City will complete the Group 1, 2, and 3 projects identified in Section 5.1 according to the schedule set forth in Paragraph 16.b. of the CD. The schedule for completion of the rehabilitation projects is summarized in **Table 5-5**. For the Group 3 projects that include other pipes within the currently proposed project limits in addition to the low and high priority rehab pipes, only the prioritized pipe (high and low priority) must be fixed on the schedule shown in Table 5-5.

5.3 I/I Reduction Estimates

As required under CD Paragraph 16.b., the IR Report should address the quantity of I/I that the City estimates will be removed through each identified rehabilitation project.

The projects listed in Group 1, 2, and 3 of the IR Report address conditions causing SSOs on the major components of the WCTS or high priority rehabilitation pipe. These projects include capacity improvements, structural or O&M improvements, and Find and Fix actions; and therefore, do not directly target I/I reduction. It is not anticipated that any of these projects will remove I/I in a way that can be quantified because of their location on the major portion of the wastewater collection and transmission system. They will, however, have significant benefits by correcting defects identified as having caused or having the potential to cause SSOs. Since the IR Report projects do not target I/I reduction, the key assessments of individual rehabilitation projects will rely on whether SSO occurrences have been reduced on rehabilitated WCTS components or in the areas directly affected by the rehabilitation.

Table 5-5 – Initial Rehabilitation Project Schedule

		Year 1 after approval of IRR				Year 2 after approval of IRR				Year 3 after approval of IRR				Year 4 after approval of IRR				Year 5 after approval of IRR				Year 6 after approval of IRR				Year 7 after approval of IRR			
	Year 0	QTR 1	QTR 2	QTR 3	QTR 4	QTR 1	QTR 2	QTR 3	QTR 4	QTR 1	QTR 2	QTR 3	QTR 4	QTR 1	QTR 2	QTR 3	QTR 4	QTR 1	QTR 2	QTR 3	QTR 4	QTR 1	QTR 2	QTR 3	QTR 4	QTR 1	QTR 2	QTR 3	QTR 4
EPA Approval of IR Report																													
Group 1 Projects																													
SS695401 – SS Replacement along Broad River & Crane Creek	*																												
SS7261 – Lake Katherine Sewer Capacity Enhancement																													
Group 2 Projects																													
SS733701 – East Rocky Branch Improvements Phase 1																													
SS733702 – East Rocky Branch Improvements Phase 2																													
Proposed Lower Gills Creek Gravity Sewer Improvements Project																													
SS7076 – Gravity Sewer Line Route from I-77 and Bluff Road to Burnside #1 Pump Station	*																												
Proposed Upper Gills Creek Gravity Sewer Improvements Project																													
Group 3 Projects																													
SS7330 – Upper Mill Creek Sewer Improvements																													
SS7331 - Upper Kinley Creek Sewer Improvements Phase 1																													
SS735003 - Crane Creek Lower North Branch Capacity Upgrade Phase 1																													
SS7428 – Lower Saluda Relief Sewer																													
SS7450 - Crane Creek Lower North Branch Capacity Upgrade Phase 2																													
Major Pipe and Manhole CIPP Rehab Project																													
Major Pipe and Manhole Pipe Bursting Rehab Project																													
Major Pipe and Manhole Sliplining Rehab Project																													
Major Pipe and Manhole Spray-Applied Liner Rehab Project																													
Major Manhole Rehab Project																													
SS7454 – Broad River Force Main Replacement and Gravity Sewer Capacity Improvements																													
SS7465 – Lower Crane Creek Relief Sewer Phase 2																													
SS7470 – Lower Crane Creek Relief Sewer Phase 1																													
SS7474 – Upper North Branch Crane Creek Sewer Improvements Phase 1																													
SS6786 – Annual Sanitary Sewer Manhole Rehabilitation																													
SS7389 – Crane Creek and Smith Branch Manhole Work																													
SS676411 – Mill Creek Force Main Replacement	*																												

** Projects that have already been completed.*

Section 6 Summary of Status of the Hydraulic Model Report

As required under CD Paragraph 16.a.(viii), the IR Report shall summarize the status of the City's development of the HMR, including a description of the completed activities and the remaining tasks and activities to be carried out in development of the HMR, and the anticipated dates of completion of such remaining tasks and activities.

As summarized in **Table 6-1**, all of the CD tasks and activities are being currently being addressed during the development of the HMR, which will be delivered on the date noted below.

Table 6-1 – Progress on Items to be Documented in the HMR

Activity	Status	Anticipated Completion Date
Identify the hydraulic model software. Identify the functional attributes, characteristics, and limitations specific to the Model's software as compared to other products evaluated by the City.	Under Development	August 23, 2020 (15 months after completion of the CSAP for major components of the WCTS)
Explain how the Model accurately predicts the flow rate and hydraulic grade line of wastewater in Force Mains from Major Pump Stations and the Major Gravity Sewer Lines under any historical dry or wet weather condition.	Under Development	August 23, 2020 (15 months after completion of the CSAP for major components of the WCTS)
Explain how the Model accurately predicts the location and severity of SSOs from the WCTS under any historical dry or wet weather condition.	Under Development	August 23, 2020 (15 months after completion of the CSAP for major components of the WCTS)
Explain how the Model is capable of fully dynamic temporal analysis, including an accounting of downstream backwater impacts on upstream flows.	Under Development	August 23, 2020 (15 months after completion of the CSAP for major components of the WCTS)
Explain how the Model is capable of accurately predicting the impacts of changes to Pump Station capacities on upstream and downstream flow rates and hydraulic grade lines, including hydraulic losses which may result from either full or partial Pump Station failures.	Under Development	August 23, 2020 (15 months after completion of the CSAP for major components of the WCTS)

Activity	Status	Anticipated Completion Date
Explain how the Model is capable of generating hydrographs depicting baseline wastewater flow and I/I for the Subbasins for various storm recurrence intervals. The Model shall include methods for accurately estimating the baseline wastewater flows and I/I components in each Subbasin using quality-controlled flow data obtained for the WCTS.	Under Development	August 23, 2020 (15 months after completion of the CSAP for major components of the WCTS)
Identify the date that the Model was deemed to be calibrated and functional.	Under Development	August 23, 2020 (15 months after completion of the CSAP for major components of the WCTS)
Identify all input and output parameters, constants, and assumed values used by the Model.	Under Development	August 23, 2020 (15 months after completion of the CSAP for major components of the WCTS)
Explain the basis for the input parameters used in each Subbasin to characterize baseline wastewater flows and I/I, the quality assurance procedures used in acquiring the input data, and the engineering basis for the selections of constants (e.g., friction factors) and assumed values.	Under Development	August 23, 2020 (15 months after completion of the CSAP for major components of the WCTS)
Develop written procedures, protocols, and schedules to routinely perform calibrations of the Model to account for age-related and other changes to WCTS hydraulics, and to obtain and manage updated data from physical field observations and measurements for this purpose. Identify the individual(s) with their qualifications who are employed to implement the procedures and protocols.	Under Development	August 23, 2020 (15 months after completion of the CSAP for major components of the WCTS)
Develop written procedures, protocols, and schedules to verify the Model's accuracy and performance. Identify the individual(s) with their qualifications who are employed to implement the procedures and protocols.	Under Development	August 23, 2020 (15 months after completion of the CSAP for major components of the WCTS)
Develop written procedures, protocols, and schedules to perform sensitivity analyses to determine how the Model responds to changes in input parameters and variables. Identify the individual(s) with their qualifications who are employed to implement the procedures and protocols.	Under Development	August 23, 2020 (15 months after completion of the CSAP for major components of the WCTS)

Appendix A – Flow Monitoring Results

Table A-1 - Existing Dry Weather Flows and Average Dry Weather Infiltration Rate (2012 Temporary Flow Monitoring Program)[1]

Flow Meter[2]	Existing Dry Weather Flow[3] (mgd)		Estimated Dry Weather Infiltration
	Average	Peak-Hour	(mgd)
CB1	0.41	0.60	0.16
CB2	1.15	1.61	0.32
CB3	1.71	2.45	0.63
CB4	3.08	4.16	0.98
CB5	0.16	0.28	0.02
CB6	0.13	0.17	0.01
CB7	0.40	0.74	0.06
CB8	0.95	1.63	0.36
CB9	0.18	0.30	0.05
CB10	0.48	0.80	0.18
CB11	0.25	0.34	0.03
CB12	1.57	2.26	0.57
CB13	1.43	2.04	0.60
CB14	0.71	0.96	0.27
CB15	0.64	0.84	0.20
CB16	4.52	6.19	1.73
CB17	0.08	0.10	0.01
CB18	1.06	1.65	0.39
CB19	0.25	0.41	0.08
CB20	0.14	0.20	0.06
CB21	0.62	1.04	0.36
CB22	0.24	0.40	0.09
CB23	9.36	11.14	3.62
CB24	0.12	0.32	0.03
CB25	1.10	1.62	0.41
CB26	0.54	0.93	0.20
CB27	0.20	0.27	0.11
CB28	1.91	2.56	0.47
CB29	0.29	0.39	0.09
CB30	0.92	1.23	0.35
CB31	0.19	0.29	0.11
CB32	20.08	26.30	7.22
CB33	2.16	3.37	0.78
CB34	0.29	0.48	0.06
CB35	2.11	3.46	0.77
CB36	1.78	2.92	0.65
CB37	0.19	0.29	0.08

Table A-1 (Continued)

Flow Meter[2]	Existing Dry Weather Flow[3] (mgd)		Estimated Dry Weather Infiltration
	Average	Peak-Hour	(mgd)
CB38	1.36	2.24	0.58
CB39	0.23	0.43	0.06
CB40	0.70	1.10	0.07
CB41	9.66	12.85	3.66
CB42	20.38	25.07	7.44
CB43	5.13	7.28	2.00
CB44	1.96	2.84	0.66
CB45	0.28	0.48	0.04
CB46	0.12	0.27	0.02
CB47	2.54	3.89	0.86
CB48	0.37	0.49	0.16
CB49	0.80	0.96	0.33
CB50	3.34	5.18	1.07
CB51	0.52	0.64	0.17
CB52	1.38	2.13	0.55
CB53	0.65	0.89	0.23
CB54	0.27	0.44	0.15
CB55	0.27	0.39	0.10
CB56	5.52	7.34	1.94
CB57	0.94	1.33	0.46
CB58	2.09	3.36	0.66
CB59	1.15	1.89	0.46
CB60	3.80	5.97	1.33
CB61	0.43	0.78	0.22
CB62	0.63	1.06	0.27
CB63	1.77	2.44	0.56
CB64	15.36	19.35	5.36
CB65	1.14	1.65	0.24

1) Note: The 2012 flow monitoring program data was analyzed prior to the development and approval of the CSAP procedures.

2) 2012 data was evaluated by flow meter location and includes flow from all areas upstream of the meter. Meter locations do not necessarily correspond with system subbasin delineations.

3) For the 2012 analysis, dry-weather infiltration is reported in mgd instead of a dry weather infiltration rate in gpd/inch-diameter-mile. GWI was assumed to vary between 60 percent to 90 percent of the minimum nighttime flow based on the size of the collection system upstream of the meter and GWI volume balance between the meters. The GWI percentage was decreased from 90 percent to 60 percent moving from upstream meters to downstream meters based on professional judgement.

Table A-2 - Peak Wet Weather Flows and Peaking Factors
(2012 Temporary Flow Monitoring Program)[1]

Flow Meter[2]	Maximum Peak Wet Weather Flow[3] (mgd)	Maximum Peaking Factor[3]
CB1	2.87	7.0
CB2	6.05	5.3
CB3	5.77	3.4
CB4	9.07	2.9
CB5	1.85	11.7
CB6	1.52	12.0
CB7	1.38	3.4
CB8	2.03	2.1
CB9	0.43	2.3
CB10	0.74	1.5
CB11	0.93	3.8
CB12	8.19	5.2
CB13	8.37	5.9
CB14	2.13	3.0
CB15	2.66	4.2
CB16	10.32	2.3
CB17	1.30	15.5
CB18	4.74	4.5
CB19	1.33	5.4
CB20	0.58	4.1
CB21	4.02	6.5
CB22	2.56	10.5
CB23	26.77	2.9
CB24	0.39	3.2
CB25	3.09	2.8
CB26	1.81	3.4
CB27	1.55	7.6
CB28	8.61	4.5
CB29	0.90	3.1
CB30	3.58	3.9
CB31	1.02	5.3
CB32	39.96	2
CB33	3.65	1.7
CB34	0.62	2.1
CB35	3.95	1.9
CB36	3.22	1.8
CB37	0.79	4.2
CB38	2.46	1.8

Table A-2 (Continued)

Flow Meter[2]	Maximum Peak Wet Weather Flow[3] (mgd)	Maximum Peaking Factor[3]
CB39	1.01	4.4
CB40	1.7	2.4
CB41	25.21	2.6
CB42	58.55	2.9
CB43	13.22	2.6
CB44	5.6	2.9
CB45	0.56	2
CB46	0.37	3
CB47	4.67	1.8
CB48	1.02	2.8
CB49	4.98	6.2
CB50	6.53	2
CB51	3.32	6.4
CB52	4.5	3.3
CB53	2.32	3.6
CB54	0.87	3.2
CB55	1.41	5.2
CB56	13.66	2.5
CB57	3.36	3.6
CB58	6.85	3.3
CB59	5.69	4.9
CB60	10.6	2.8
CB61	1.21	2.8
CB62	1.56	2.5
CB63	4.43	2.5
CB64	37.26	2.4
CB65	4.97	4.4

1) Note: The 2012 flow monitoring program data was analyzed prior to the development and approval of the CSAP procedures.

2) 2012 data was evaluated by flow meter location and includes flow from all areas upstream of the meter. Meter locations do not necessarily correspond with system subbasin delineations.

3) Represents maximum out of the five rainfall events that were analyzed as part of the 2012 flow monitoring program.

Table A-3 - Rainfall Events used for Estimating I/I
(2012 Temporary Flow Monitoring Program)

Rainfall Event	Average Depth (inch)
2/24/2012	1.4
3/24/2012	1.4
4/22/2012	1.3
5/29/2012	1.1
6/11/2012	1.2

Table A-4 - Estimate of Total I/I Contributions
(2012 Temporary Flow Monitoring Program)[1]

Flow Meter[2]	R Value[3, 4]	Maximum Wet Weather Peaking Factor[3]	RDI/I per foot of Sewer (gal/LF)[3, 5]
CB1	2.7%	7	11
CB2	1.6%	5.3	7
CB3	1.2%	3.4	5
CB4	3.7%	2.9	14
CB5	4.7%	11.7	13
CB6	3.0%	12	14
CB7	2.1%	3.4	7
CB8	4.2%	2.1	12
CB9	1.0%	2.3	1
CB10	0.4%	1.5	1
CB11	3.0%	3.8	14
CB12	2.1%	5.2	11
CB13	2.2%	5.9	6
CB14	1.3%	3	11
CB15	2.5%	4.2	17
CB16	37.2%	2.3	66
CB17	1.6%	15.5	8
CB18	1.5%	4.5	11
CB19	3.3%	5.4	11
CB20	1.7%	4.1	7
CB21	2.9%	6.5	18
CB22	1.1%	10.5	7
CB23	3.4%	2.9	34
CB24	0.6%	3.2	2
CB25	7.1%	2.8	27
CB26	0.6%	3.4	2
CB27	1.4%	7.6	8
CB28	2.9%	4.5	13
CB29	2.3%	3.1	6
CB30	11.7%	3.9	35
CB31	0.6%	5.3	4
CB32	26.2%	2	108
CB33	1.0%	1.7	3
CB34	1.6%	2.1	5
CB35	1.3%	1.9	5
CB36	2.4%	1.8	4
CB37	0.7%	4.2	2
CB38	1.0%	1.8	4

Table A-4 (Continued)

Flow Meter[2]	R Value[3, 4]	Maximum Wet Weather Peaking Factor[3]	RDI/I per foot of Sewer (gal/LF)[3, 5]
CB39	4.0%	4.4	12
CB40	0.5%	2.4	2
CB41	1.9%	2.6	30
CB42	15.8%	2.9	118
CB43	3.1%	2.6	10
CB44	3.8%	2.9	14
CB45	0.4%	2	1
CB46	0.7%	3	1
CB47	1.4%	1.8	5
CB48	5.5%	2.8	17
CB49	18.1%	6.2	54
CB50	5.3%	2	10
CB51	2.4%	6.4	13
CB52	3.9%	3.3	26
CB53	1.6%	3.6	13
CB54	2.3%	3.2	11
CB55	7.0%	5.2	50
CB56	16.1%	2.5	48
CB57	3.5%	3.6	11
CB58	1.5%	3.3	7
CB59	1.5%	4.9	6
CB60	6.3%	2.8	29
CB61	1.3%	2.8	5
CB62	1.4%	2.5	7
CB63	5.3%	2.5	28
CB64	2.2%	2.4	13
CB65	1.6%	4.4	12

1) Note: The 2012 flow monitoring program data was analyzed prior to the development and approval of the CSAP procedures.

2) 2012 data was evaluated by flow meter location and includes flow from all areas upstream of the meter. Meter locations do not necessarily correspond with system subbasin delineations.

3) An 'N/A' is listed in the table if the I/I estimation method was not applied.

4) R value for 2012 flow monitoring data represents the total area upstream of each meter (including any upstream meters).

5) RDI/I per LF is based on maximum RDI/I observed during the monitored rainfall events.

Table A-5 - Existing Dry Weather Flows and Average Dry Weather Infiltration Rate
(2014 Temporary Flow Monitoring Program)

Flow Monitored Subbasin[1]	Existing Weekday Dry Weather Flow (mgd)		Existing Weekend Dry Weather Flow (mgd)		Estimated Average Dry Weather Infiltration Rate[2]
	Average	Peak-Hour	Average	Peak-Hour	(gpd/inch-diameter-mile)
GC02	0.66	0.81	0.66	0.81	1,224
GC06	0.46	0.59	0.47	0.62	892
GC07	0.20	0.32	0.18	0.26	705
GC08	4.41	5.59	4.64	5.59	1,886
GC09	0.42	0.67	0.42	0.58	966
GC10	0.08	0.12	0.08	0.11	722
GC11	0.13	0.20	0.13	0.17	886
GC12	5.40	6.58	4.88	5.95	1,432
GC13	4.44	5.58	4.50	5.53	1,695
RB01A	0.57	0.66	0.55	0.66	1,871
RB01B	0.31	0.40	0.30	0.35	2,068
RB01C	2.30	2.82	2.07	2.46	2,074
RB07A	0.25	0.30	0.25	0.29	2,167
SB02	0.80	1.03	0.67	0.82	1,665
SR01	0.48	0.63	0.49	0.63	1,252
SR02	0.11	0.16	0.11	0.15	255
SR03	0.21	0.29	0.20	0.29	345
SR05	0.18	0.26	0.19	0.27	477
SR06	0.71	0.96	0.72	0.95	629
SR07	0.48	0.72	0.50	0.75	529
SR08	0.27	0.35	0.24	0.31	889
SR10	0.41	0.56	0.43	0.58	1,481
SR12A	0.05	0.08	0.05	0.07	424
SR12B	0.03	0.04	0.03	0.04	464
SR12C	0.04	0.05	0.04	0.05	1,083
SR13	0.36	0.50	0.34	0.48	1,273

1) Data was evaluated by flow meter and represents incremental flow from the flow monitored subbasin (with all upstream monitored flows subtracted). Flow monitored subbasins correspond with system subbasin IDs. Flow monitored subbasins that end in 'A', 'B', or 'C' represent flow from a portion of the respective subbasin.

2) GWI was assumed to be 65 percent of the minimum nighttime flow.

Table A-6 - Peak Wet Weather Flows and Peaking Factors
(2014 Temporary Flow Monitoring Program)

Flow Monitored Subbasin[1]	Maximum Peak Wet Weather Flow[2] (mgd)	Maximum Peaking Factor[2]
GC02	2.37	3.6
GC09	1.32	3.1
SR01	1.10	2.3
SR02	0.54	4.9
SR05	0.58	3.2
GC06	1.32	2.9
GC07	1.78	9.0
GC08	10.93	2.5
GC10	0.27	3.5
GC11	0.49	3.8
GC12[3]	--	--
GC13	10.36	2.3
RB01A	1.11	2.0
RB01B	0.75	2.4
RB01C	6.10	2.7
RB07A	0.74	3.0
SB02	2.77	3.6
SR03	0.87	4.2
SR06	2.22	3.1
SR07	1.87	3.9
SR08	1.26	4.8
SR10	1.11	2.7
SR12A	0.56	11.0
SR12B	0.90	27.6
SR12C	0.73	18.1
SR13	1.59	4.5

1) Data was evaluated by flow meter and represents incremental flow from the flow monitored subbasin (with all upstream monitored flows subtracted). Flow monitored subbasins correspond with system subbasin IDs. Flow monitored subbasins that end in 'A', 'B', or 'C' represent flow from a portion of the respective subbasin.

2) Represents maximum out of the seven rainfall events that were analyzed as part of the 2014 flow monitoring program.

3) Peak flow and peaking factor could not be determined for GC12.

Table A-7 - Rainfall Events used for Estimating I/I
(2014 Temporary Flow Monitoring Program)

Rainfall Event	Average Depth (inch)
4/7/2014	0.47
4/14/2014	0.43
4/18/2014	1.43
5/14/2014	1.32
5/25/2014	0.45
5/30/2014	1.28
6/11/2014	0.91

Table A-8 - Estimate of Total I/I Contributions
(2014 Temporary Flow Monitoring Program)

Flow Monitored Subbasin[1]	Incremental R Value[2]	Maximum Wet Weather Peaking Factor[2]	RDI/I per foot of Sewer (gal/LF)[2, 3]
GC02	3.9%	3.58	26
GC09	4.2%	3.12	34
SR01	2.6%	2.29	19
SR02	1.6%	4.87	11
SR05	2.2%	3.24	12
GC06	1.4%	2.88	7
GC07	3.0%	8.99	21
GC08	5.3%	2.46	79
GC10	2.8%	3.47	18
GC11	4.9%	3.80	28
GC12	3.6%	n/a	22
GC13	4.0%	2.32	33
RB01A	4.3%	1.98	23
RB01B	3.4%	2.43	24
RB01C	2.9%	2.73	32
RB07A	3.4%	2.98	37
SB02	3.8%	3.63	29
SR03	1.7%	4.18	12
SR06	3.2%	3.13	18
SR07	3.2%	3.85	21
SR08	6.8%	4.79	50
SR10	5.2%	2.68	44
SR12A	9.9%	11.02	64
SR12B	13.7%	27.57	94
SR12C	11.1%	18.07	99
SR13	10.0%	4.54	63

1) Data was evaluated by flow meter and represents incremental flow from the flow monitored subbasin (with all upstream monitored flows subtracted). Flow monitored subbasins correspond with system subbasin IDs. Flow monitored subbasins that end in 'A', 'B', or 'C' represent flow from a portion of the respective subbasin.

2) An 'N/A' is listed in the table if the I/I estimation method was not applied.

3) A design storm event with a volume of 3.6-inches (similar to the 2-year design storm) was used to calculate RDI/I.

Table A-9 - Existing Dry Weather Flows and Average Dry Weather Infiltration Rate
(2015 Temporary Flow Monitoring Program)

Flow Monitored Subbasin[1]	Existing Weekday Dry Weather Flow (mgd)		Existing Weekend Dry Weather Flow (mgd)		Estimated Average Dry Weather Infiltration Rate[2, 3]
	Average	Peak-Hour	Average	Peak-Hour	(gpd/inch-diameter-mile)
BR01	0.38	0.48	0.39	0.50	2,642
BR02A	0.19	0.34	0.19	0.33	-
BR02B	0.12	0.16	0.12	0.16	232
BR02C	0.26	0.41	0.24	0.40	-
BR03	0.61	0.90	0.51	0.69	1,364
BR04A	0.17	0.23	0.17	0.22	799
BR04B	0.02	0.03	0.02	0.03	395
BR04C	0.08	0.12	0.08	0.10	1,128
CC02	0.58	1.83	0.67	1.54	-
CC03	0.12	0.14	0.12	0.14	603
CC04	0.09	0.11	0.09	0.12	440
CC06A	0.15	0.19	0.15	0.22	26
CC06B	0.03	0.06	0.02	0.06	-
CC08	0.66	0.77	0.66	0.79	4,478
CC09	0.51	0.78	0.47	0.70	-
CC10	0.23	0.55	0.19	0.41	-
CC11	0.28	0.44	0.32	0.41	145
CC12	0.24	0.32	0.18	0.24	425
CC21	0.67	0.80	0.64	0.82	1,192
GC02	0.54	0.65	0.52	0.65	859
GC04	0.66	0.88	0.58	0.74	970
GC05	0.01	0.07	0.04	0.14	-
GC09	0.33	0.57	0.31	0.46	634
GC12A	0.56	0.79	0.54	0.74	569
GC12B	1.19	1.77	1.20	1.59	726
GC15A	1.04	1.21	1.04	1.28	2,158
GC15B	0.06	0.08	0.05	0.06	770
GC16A	0.39	0.52	0.34	0.46	551
GC16B	0.24	0.30	0.23	0.31	1,223
GC17A	0.07	0.17	0.02	0.12	-
GC18	0.06	0.07	0.07	0.08	638
MC01A	0.01	0.05	0.01	0.05	-
MC01B	0.11	0.16	0.12	0.16	692
MC01C	0.29	0.41	0.29	0.36	562
MC02	0.65	0.81	0.66	0.82	1,330
MC03	0.37	0.47	0.37	0.49	850
MC04A	0.09	0.13	0.08	0.13	403

Table A-9 (Continued)

Flow Monitored Subbasin[1]	Existing Weekday Dry Weather Flow (mgd)		Existing Weekend Dry Weather Flow (mgd)		Estimated Average Dry Weather Infiltration Rate[2, 3]
	Average	Peak-Hour	Average	Peak-Hour	(gpd/inch-diameter-mile)
MC04B	0.04	0.05	0.04	0.05	522
MC05	0.68	1.16	0.60	1.08	-
RB01	1.51	1.84	1.34	1.63	1,639
RB02A	0.40	0.57	0.32	0.40	1,539
RB02B	0.02	0.02	0.01	0.02	292
RB02C	0.53	0.60	0.53	0.60	3,242
RB03A	0.21	0.26	0.17	0.19	2,302
RB03B	0.44	0.54	0.40	0.44	4,346
RB04	0.58	0.72	0.65	0.70	3,544
RB05A	0.27	0.29	0.28	0.30	2,024
RB05B	0.31	0.40	0.34	0.40	315
RB06[4]	-	-	-	-	-
RB07	0.39	0.46	0.37	0.41	2,956
RB08B	0.09	0.13	0.08	0.12	-
RB08D	0.04	0.05	0.04	0.04	2,403
RB08E	0.67	1.30	0.66	1.13	-
SB01A	0.18	0.21	0.18	0.22	1,089
SB01B	0.29	0.37	0.29	0.36	626
SB02	0.58	0.76	0.50	0.62	1,096
SB03A	0.48	0.52	0.48	0.53	3,447
SB03B	0.16	0.19	0.15	0.19	2,229
SB04A	0.09	0.16	0.05	0.13	-
SB04B	0.09	0.11	0.09	0.11	249
SB04C	0.02	0.02	0.02	0.02	322
SB04D	0.45	0.67	0.31	0.42	5,023
SB04E	0.01	0.01	0.01	0.01	576
SB05A	0.53	0.66	0.53	0.63	1,912
SB05B	0.21	0.36	0.19	0.29	2,748
SB06	0.03	0.03	0.04	0.04	821
SR01	0.34	0.46	0.35	0.45	875
SR04A	0.39	0.51	0.39	0.52	558
SR04B	0.48	0.62	0.51	0.68	1,503
SR06	0.09	0.15	0.08	0.12	40
SR07	0.41	0.60	0.41	0.60	421
SR08	0.34	0.43	0.31	0.44	1,353
SR09	0.21	0.33	0.23	0.35	-
SR11	0.44	0.57	0.44	0.58	1,049
SR13	0.22	0.30	0.22	0.29	743
SR14A	0.18	0.63	0.23	0.50	-

Table A-9 (Continued)

Flow Monitored Subbasin[1]	Existing Weekday Dry Weather Flow (mgd)		Existing Weekend Dry Weather Flow (mgd)		Estimated Average Dry Weather Infiltration Rate[2, 3]
	Average	Peak-Hour	Average	Peak-Hour	(gpd/inch-diameter-mile)
SR14B	0.14	0.33	0.13	0.28	-
SR15	0.09	0.15	0.11	0.18	-
WC01	1.28	1.86	0.61	1.16	-
WC02A	1.47	1.93	1.55	2.32	-
WC02B	0.48	0.55	0.46	0.53	4,829
WC02C	0.21	0.26	0.21	0.27	934
WC02D	0.11	0.18	0.08	0.09	1,227

1) Data was evaluated by flow meter and represents incremental flow from the flow monitored subbasin (with all upstream monitored flows subtracted). Flow monitored subbasins correspond with system subbasin IDs. Flow monitored subbasins that end in 'A', 'B', 'C', 'D', or 'E' represent flow from a portion of the respective subbasin.

2) GWI was assumed to be 65 percent of the minimum nighttime flow.

3) Dry weather infiltration rate in gpd/inch-diameter-mile could not be calculated for some basins that had pipe size attributes missing in GIS at the time of data analysis.

4) RB06 did not provide reasonable data for incremental dry weather analysis due to mass balance issues.

Table A-10 - Peak Wet Weather Flows and Peaking Factors
(2015 Temporary Flow Monitoring Program)

Flow Monitored Subbasin[1]	Maximum Peak Wet Weather Flow[2] (mgd)	Maximum Peaking Factor[2]
BR01	1.35	3.5
BR02A	1.58	8.3
BR02B	1.43	11.9
BR02C	2.20	8.8
BR03	2.56	4.4
BR04A	0.82	4.9
BR04B	0.07	3.7
BR04C	0.43	5.6
CC02	3.12	5.1
CC03	3.90	33.1
CC04	1.12	12.3
CC06A	0.95	6.3
CC06B	0.27	10.6
CC08	1.23	1.9
CC09	1.26	2.5
CC10	0.66	3.0
CC11	0.98	3.4
CC12	0.54	2.4
CC21	2.98	4.5
GC02	1.22	2.3
GC04	7.13	11.2
GC05	1.89	94.8
GC09	1.55	4.8
GC12A	3.11	5.7
GC12B	5.00	4.2
GC15A	1.98	1.9
GC15B	0.14	2.4
GC16A	2.38	6.3
GC16B	1.26	5.3
GC17A	2.25	42.3
GC18	0.68	10.9
MC01A[3]	-	-
MC01B	0.19	1.8
MC01C	0.49	1.7
MC02	1.23	1.9
MC03	0.72	2.0
MC04A	0.22	2.5
MC04B	0.07	2.0

Table A-10 (Continued)

Flow Monitored Subbasin[1]	Maximum Peak Wet Weather Flow[2] (mgd)	Maximum Peaking Factor[2]
MC05	1.80	2.7
RB01	6.42	4.4
RB02A	2.01	5.4
RB02B	0.07	4.4
RB02C	2.46	4.7
RB03A	0.41	2.1
RB03B	1.03	2.4
RB04	1.02	1.7
RB05A	2.60	9.5
RB05B	3.41	10.7
RB06[3]	-	-
RB07	1.46	3.8
RB08B	1.98	22.2
RB08D	0.18	4.5
RB08E	8.21	12.3
SB01A	0.82	4.6
SB01B	1.26	4.4
SB02	3.17	5.7
SB03A	1.15	2.4
SB03B	0.48	3.1
SB04A	0.16	2.1
SB04B	0.99	11.1
SB04C	0.07	3.9
SB04D	4.17	10.1
SB04E	0.08	8.1
SB05A	5.52	10.5
SB05B	0.84	4.1
SB06	0.33	10.6
SR01	0.81	2.4
SR04A	1.19	3.0
SR04B	1.09	2.2
SR06	0.19	2.3
SR07	1.05	2.6
SR08	0.93	2.8
SR09	0.82	3.7
SR11	1.34	3.1
SR13	1.60	7.2
SR14A	1.26	6.5
SR14B	0.94	7.0
SR15	1.10	11.8

Table A-10 (Continued)

Flow Monitored Subbasin[1]	Maximum Peak Wet Weather Flow[2] (mgd)	Maximum Peaking Factor[2]
WC01	2.71	2.5
WC02A	4.23	2.8
WC02B	1.12	2.4
WC02C	0.79	3.8
WC02D	0.42	4.2

1) Data was evaluated by flow meter and represents incremental flow from the flow monitored subbasin (with all upstream monitored flows subtracted). Flow monitored subbasins correspond with system subbasin IDs. Flow monitored subbasins that end in 'A', 'B', 'C', 'D', or 'E' represent flow from a portion of the respective subbasin.
2) Represents maximum out of the five rainfall events that were analyzed as part of the 2015 flow monitoring program.
3) Peak flow and peaking factor could not be determined for MC01A and RB06.

Table A-11 - Rainfall Events used for Estimating I/I
(2015 Temporary Flow Monitoring Program)

Rainfall Event	Average Depth (inch)
4/19/2015	1.31
5/11/2015	0.81
5/31/2015	3.42
6/7/2015	1.18
6/10/2015	0.99

Table A-12 - Estimate of Total I/I Contributions
(2015 Temporary Flow Monitoring Program)

Flow Monitored Subbasin[1]	Incremental R Value[2]	Maximum Wet Weather Peaking Factor[2]	RDI/I per foot of Sewer (gal/LF)[2, 3]
BR01	3.7%	3.5	24
BR02A	11.5%	8.3	n/a
BR02B	2.2%	11.9	15
BR02C	4.5%	8.8	42
BR03	1.7%	4.4	22
BR04A	3.5%	4.9	22
BR04B	4.8%	3.7	22
BR04C	13.5%	5.6	80
CC02	23.3%	5.1	93
CC03	3.6%	33.1	28
CC04	9.3%	12.3	47
CC06A	0.5%	6.3	3
CC06B	0.6%	10.6	2
CC08	2.3%	1.9	24
CC09	4.3%	2.5	42
CC10	0.7%	3.0	4
CC11	8.0%	3.4	54
CC12	0.7%	2.4	6
CC21	1.6%	4.5	14
GC02	2.5%	2.3	15
GC04	4.5%	11.2	41
GC05	0.3%	94.8	9
GC09	1.7%	4.8	14
GC12A	1.5%	5.7	9
GC12B	1.2%	4.2	9
GC15A	1.4%	1.9	14
GC15B	0.3%	2.4	7
GC16A	3.1%	6.3	25
GC16B	5.6%	5.3	33
GC17A	12.5%	42.3	73
GC18	2.3%	10.9	19
MC01A	n/a	n/a	n/a
MC01B	0.4%	1.8	3
MC01C	0.8%	1.7	6
MC02	0.9%	1.9	7
MC03	1.4%	2.0	9
MC04A	0.6%	2.5	4

Table A-12 (Continued)

Flow Monitored Subbasin[1]	Incremental R Value[2]	Maximum Wet Weather Peaking Factor[2]	RDI/I per foot of Sewer (gal/LF)[2, 3]
MC04B	0.3%	2.0	2
MC05	3.4%	2.7	30
RB01	2.5%	4.4	16
RB02A	1.3%	5.4	8
RB02B	0.1%	4.4	1
RB02C	0.3%	4.7	2
RB03A	0.3%	2.1	2
RB03B	2.5%	2.4	18
RB04	5.1%	1.7	31
RB05A	1.0%	9.5	8
RB05B	2.0%	10.7	13
RB06	n/a	n/a	n/a
RB07	1.9%	3.8	22
RB08B	0.6%	22.2	5
RB08D	0.2%	4.5	3
RB08E	49.8%	12.3	142
SB01A	2.4%	4.6	15
SB01B	0.9%	4.4	5
SB02	2.8%	5.7	21
SB03A	6.2%	2.4	47
SB03B	1.8%	3.1	14
SB04A	79.6%	2.1	389
SB04B	0.5%	11.1	3
SB04C	0.2%	3.9	2
SB04D	21.7%	10.1	147
SB04E	1.0%	8.1	11
SB05A	6.1%	10.5	41
SB05B	79.9%	4.1	397
SB06	33.0%	10.6	145
SR01	0.5%	2.4	4
SR04A	1.6%	3.0	10
SR04B	0.6%	2.2	6
SR06	0.2%	2.3	1
SR07	2.0%	2.6	14
SR08	2.9%	2.8	20
SR09	0.8%	3.7	5
SR11	3.5%	3.1	25
SR13	1.9%	7.2	12
SR14A	7.0%	6.5	63

Table A-12 (Continued)

Flow Monitored Subbasin[1]	Incremental R Value[2]	Maximum Wet Weather Peaking Factor[2]	RDI/I per foot of Sewer (gal/LF)[2, 3]
SR14B	2.8%	7.0	15
SR15	1.9%	11.8	13
WC01	2.0%	2.5	n/a
WC02A	2.1%	2.8	n/a
WC02B	0.5%	2.4	7
WC02C	0.3%	3.8	3
WC02D	0.8%	4.2	13

1) Data was evaluated by flow meter and represents incremental flow from the flow monitored subbasin (with all upstream monitored flows subtracted). Flow monitored subbasins correspond with system subbasin IDs. Flow monitored subbasins that end in 'A', 'B', 'C', 'D', or 'E' represent flow from a portion of the respective subbasin.

2) An 'N/A' is listed in the table if the I/I estimation method was not applied.

3) A design storm event with a volume of 3.6-inches (similar to the 2-year design storm) was used to calculate RDI/I.

Table A-13 - Existing Dry Weather Flows and Average Dry Weather Infiltration Rate
(2016 Temporary Flow Monitoring Program)

Flow Monitored Subbasin[1]	Existing Weekday Dry Weather Flow (mgd)		Existing Weekend Dry Weather Flow (mgd)		Estimated Average Dry Weather Infiltration Rate[2]
	Average	Peak-Hour	Average	Peak-Hour	(gpd/inch-diameter-mile)
BR01	0.36	0.44	0.37	0.44	2,610
BR02A	0.18	0.26	0.18	0.25	620
BR02B	0.17	0.22	0.17	0.21	960
BR02C	0.82	1.16	0.75	1.00	1,230
BR04A	0.35	0.45	0.38	0.47	1,380
CC01A	0.38	0.46	0.38	0.45	2,460
CC01B	0.59	0.61	0.62	0.69	3,460
CC02[3]	-	-	-	-	-
CC02A[4]	1.16	1.62	1.13	1.55	0
CC03	0.18	0.19	0.19	0.21	990
CC04	0.19	0.21	0.21	0.22	1,360
CC06B	0.34	0.39	0.37	0.45	540
CC08	0.72	0.81	0.71	0.82	2,380
CC09[4]	0.50	0.99	0.34	0.72	0
CC11	0.30	0.43	0.35	0.41	400
CC12	0.27	0.35	0.23	0.28	610
CC21	0.91	1.05	0.90	1.06	1,970
GC02	0.81	0.93	0.80	0.93	2,130
GC04	0.85	1.01	0.82	0.96	1,570
GC05	0.98	1.16	0.94	1.15	1,710
GC12A	0.68	0.94	0.71	0.94	860
GC15A	1.15	1.30	1.19	1.41	2,570
GC15B	0.07	0.09	0.06	0.07	640
GC16A	0.52	0.64	0.50	0.65	950
GC16B	0.38	0.45	0.37	0.46	1,530
GC17A	1.32	1.86	1.26	1.72	820
GC18A	0.16	0.17	0.15	0.17	2,230
MC01A	0.27	0.39	0.28	0.36	890
MC01B	0.17	0.23	0.19	0.25	780
MC02	0.89	1.06	0.93	1.12	1,800
MC03	0.29	0.39	0.31	0.37	990
MC04A	0.42	0.49	0.42	0.49	2,250
MC04C	0.18	0.22	0.18	0.21	2,390
MC05	1.00	1.26	0.94	1.26	1,660
MC05B[3]	-	-	-	-	-
RB01	2.39	2.80	2.27	2.60	2,230
RB03A	0.19	0.20	0.19	0.20	6,010

Table A-13 (Continued)

Flow Monitored Subbasin[1]	Existing Weekday Dry Weather Flow (mgd)		Existing Weekend Dry Weather Flow (mgd)		Estimated Average Dry Weather Infiltration Rate[2]
	Average	Peak-Hour	Average	Peak-Hour	(gpd/inch-diameter-mile)
RB03B	1.00	1.32	0.87	0.99	4,600
RB04	0.47	0.59	0.50	0.53	190
RB05A	0.31	0.35	0.34	0.36	2,580
RB05B	0.38	0.52	0.32	0.43	1,370
RB06[3]	-	-	-	-	-
RB08B	0.65	0.73	0.61	0.71	1,520
RB08E[3]	-	-	-	-	-
SB01B	0.45	0.52	0.47	0.54	1,050
SB02	0.55	0.71	0.48	0.55	1,460
SB02B	0.33	0.38	0.33	0.38	1,890
SB03A	0.64	0.72	0.73	0.85	2,260
SB03B	0.20	0.22	0.18	0.21	3,250
SB04B	0.18	0.22	0.18	0.21	730
SB04C	0.02	0.02	0.02	0.02	1,410
SB04E	0.04	0.05	0.04	0.05	2,820
SB05A	0.95	1.15	0.86	0.97	1,180
SR01	0.37	0.50	0.41	0.54	930
SR04A	0.38	0.46	0.39	0.54	630
SR04B	0.56	0.72	0.62	0.82	1,820
SR06	0.49	0.66	0.52	0.67	2,170
SR07	0.29	0.42	0.31	0.42	330
SR08	0.28	0.30	0.28	0.30	1,480
SR09[4]	0.08	0.19	0.02	0.14	0
SR11	0.60	0.72	0.61	0.74	1,740
SR13	0.37	0.46	0.38	0.46	1,750
SR14A[4]	0.27	0.58	0.31	0.52	0
SR14B[3]	-	-	-	-	-
SR14C	0.09	0.19	0.07	0.19	-
SR15	0.36	0.48	0.41	0.59	250
WC01[4]	1.29	1.68	0.57	1.01	0
WC01B	1.87	2.23	1.81	2.24	1,230
WC02A[3]	-	-	-	-	-
WC02D	0.11	0.17	0.08	0.10	1,570

1) Data was evaluated by flow meter and represents incremental flow from the flow monitored subbasin (with all upstream monitored flows subtracted). Flow monitored subbasins correspond with system subbasin IDs. Flow monitored subbasins that end in 'A', 'B', 'C', 'D', or 'E' represent flow from a portion of the respective subbasin.

2) GWI was assumed to be 65 percent of the minimum nighttime flow.

3) Individual meter subbasin did not provide reasonable data for incremental dry weather analysis due to mass balance issues.

4) No minimum nighttime flow identified for individual meter subbasin.

Table A-14 - Peak Wet Weather Flows and Peaking Factors
(2016 Temporary Flow Monitoring Program)

Flow Monitored Subbasin[1]	Maximum Peak Wet Weather Flow[2] (mgd)	Maximum Peaking Factor[2]
BR01	0.80	2.1
BR02A	0.70	3.8
BR02B	1.50	8.7
BR02C	3.70	4.6
BR04A	1.60	4.4
CC01A	1.70	4.6
CC01B	2.20	3.7
CC02[3]	-	-
CC02A	2.30	2.0
CC03	2.50	13.7
CC04	1.10	5.9
CC06B	4.00	11.7
CC08	2.30	3.2
CC09	1.10	2.4
CC11	1.40	4.4
CC12	0.70	2.9
CC21	3.90	4.2
GC02	4.20	5.2
GC04	4.30	5.1
GC05	1.50	1.5
GC12A	4.10	6.0
GC15A	2.50	2.2
GC15B	0.30	5.6
GC16A	1.90	3.7
GC16B	1.20	3.1
GC17A	2.70	2.1
GC18A	0.70	4.4
MC01A	0.60	2.0
MC01B	0.40	2.1
MC02	2.00	2.2
MC03	1.00	3.4
MC04A	0.70	1.8
MC04C	2.60	14.4
MC05	2.40	2.4
MC05B[3]	-	-
RB01	7.70	3.3
RB03A	0.30	1.5
RB03B	3.50	3.6

Table A-14 (Continued)

Flow Monitored Subbasin[1]	Maximum Peak Wet Weather Flow[2] (mgd)	Maximum Peaking Factor[2]
RB04	0.80	1.7
RB05A	2.10	6.7
RB05B	0.70	1.8
RB06[3]	-	-
RB08B	1.40	2.2
RB08E[3]	-	-
SB01B	3.70	8.2
SB02	3.90	7.4
SB02B	1.80	5.3
SB03A[4]	0.00	0.0
SB03B[4]	0.00	0.0
SB04B	1.60	9.2
SB04C	0.10	6.4
SB04E	0.20	4.7
SB05A	2.60	2.8
SR01	1.40	3.7
SR04A	2.70	7.2
SR04B	2.70	4.7
SR06	1.60	3.2
SR07	1.70	5.7
SR08	5.20	18.4
SR09	3.50	55.0
SR11	4.30	7.1
SR13	1.20	3.3
SR14A	0.80	2.7
SR14B[3]	-	-
SR14C	0.70	9.0
SR15	5.90	15.9
WC01	2.90	2.7
WC01B	9.70	5.2
WC02A[3]	-	-
WC02D	0.30	2.8

1) Data was evaluated by flow meter and represents incremental flow from the flow monitored subbasin (with all upstream monitored flows subtracted). Flow monitored subbasins correspond with system subbasin IDs. Flow monitored subbasins that end in 'A', 'B', 'C', 'D', or 'E' represent flow from a portion of the respective subbasin.

2) Represents maximum out of the five rainfall events that were analyzed as part of the 2016 flow monitoring program.

3) CC02, MC05B, RB06, RB08E, SR14B, and WC02A did not provide reasonable data for incremental dry weather analysis due to mass balance issues.

4) No apparent wet weather response observed at SB03A and SB03B.

Table A-15 - Rainfall Events used for Estimating I/I
(2016 Temporary Flow Monitoring Program)

Rainfall Event	Average Depth (inch)
12/22/2015	3.57
12/30/2015	1.22
1/22/2016	0.78
2/3/2016	1.53
2/15/2016	0.61

Table A-16 - Estimate of Total I/I Contributions
(2016 Temporary Flow Monitoring Program)[1]

Flow Monitored Subbasin[1]	Incremental R Value[2]	Maximum Wet Weather Peaking Factor[2]	RDI/I per foot of Sewer (gal/LF)[2, 3]
BR01	6.5%	2.1	43
BR02A	8.5%	3.8	45
BR02B	10.7%	8.7	88
BR02C	8.0%	4.6	94
BR04A	7.3%	4.4	43
CC01A	19.2%	4.6	119
CC01B	14.6%	3.7	73
CC02	n/a	n/a	n/a
CC02A	32.9%	2.0	201
CC03	11.0%	13.7	87
CC04	19.9%	5.9	104
CC06B	9.7%	11.7	63
CC08	8.4%	3.2	70
CC09	0.0%	2.4	0
CC11	8.6%	4.4	66
CC12	0.8%	2.9	8
CC21	8.2%	4.2	73
GC02	15.4%	5.2	114
GC04	7.2%	5.1	64
GC05	2.7%	1.5	21
GC12A	9.8%	6.0	57
GC15A	3.6%	2.2	37
GC15B	1.6%	5.6	29
GC16A	14.0%	3.7	96
GC16B	8.1%	3.1	65
GC17A	0.5%	2.1	3
GC18A	6.0%	4.4	82
MC01A	2.4%	2.0	15
MC01B	0.9%	2.1	7
MC02	4.5%	2.2	36
MC03	12.4%	3.4	80
MC04A	8.4%	1.8	67
MC04C	32.0%	14.4	227
MC05	16.6%	2.4	207
MC05B	n/a	n/a	n/a
RB01	5.7%	3.3	35
RB03A	1.6%	1.5	19

Table A-16 (Continued)

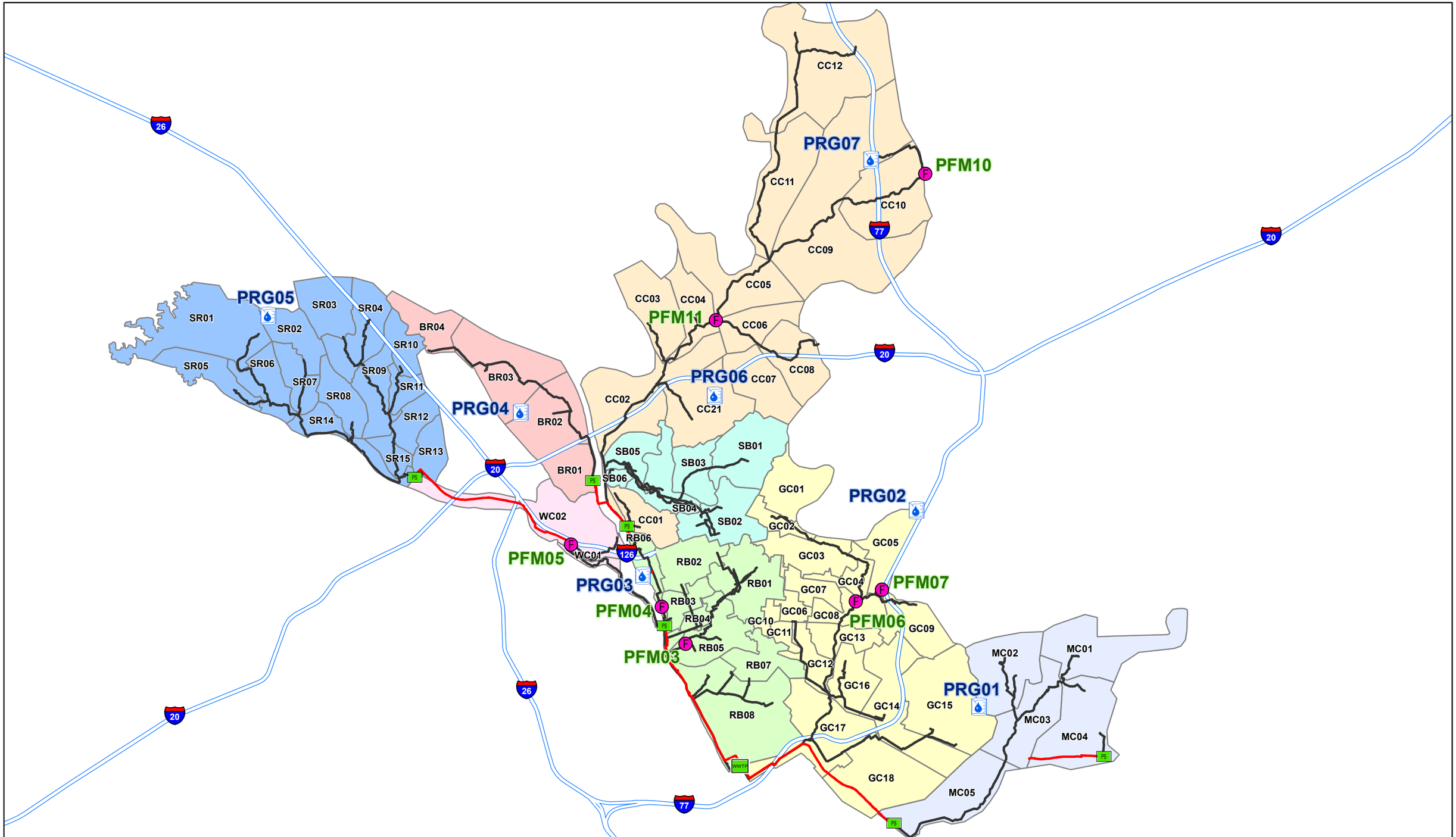
Flow Monitored Subbasin[1]	Incremental R Value[2]	Maximum Wet Weather Peaking Factor[2]	RDI/I per foot of Sewer (gal/LF)[2, 3]
RB03B	17.0%	3.6	110
RB04	0.0%	1.7	0
RB05A	3.0%	6.7	27
RB05B	1.7%	1.8	12
RB06	n/a	n/a	n/a
RB08B	1.9%	2.2	18
RB08E	n/a	n/a	n/a
SB01B	4.4%	8.2	30
SB02	4.4%	7.4	34
SB02B	13.3%	5.3	87
SB03A[4]	0.0%	0	0
SB03B[4]	0.0%	0	0
SB04B	8.0%	9.2	51
SB04C	3.4%	6.4	21
SB04E	9.8%	4.7	68
SB05A	10.4%	2.8	71
SR01	2.0%	3.7	15
SR04A	2.6%	7.2	19
SR04B	6.0%	4.7	52
SR06	8.1%	3.2	50
SR07	3.3%	5.7	22
SR08	7.3%	18.4	52
SR09	1.0%	55.0	7
SR11	10.1%	7.1	68
SR13	5.8%	3.3	36
SR14A	2.4%	2.7	22
SR14B	n/a	n/a	n/a
SR14C	3.0%	9.0	19
SR15	2.3%	15.9	16
WC01	20.2%	2.7	152
WC01B	9.6%	5.2	87
WC02A	n/a	n/a	n/a
WC02D	1.5%	2.8	23

1) Data was evaluated by flow meter and represents incremental flow from the flow monitored subbasin (with all upstream monitored flows subtracted). Flow monitored subbasins correspond with system subbasin IDs. Flow monitored subbasins that end in 'A', 'B', 'C', 'D', or 'E' represent flow from a portion of the respective subbasin.

2) An 'N/A' is listed in the table if the I/I estimation method was not applied.

3) A design storm event with a volume of 3.6-inches (similar to the 2-year design storm) was used to calculate RDI/I.

4) No apparent wet weather response observed at SB03A and SB03B.



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We Are Columbia

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Permanent Rain Gauges
Permanent Flow Meters
Metro WWTP
Major Pump Stations
Major Force Mains
Major Gravity Sewer Lines

Sewer Basins

Broad River
Crane Creek
Gills Creek
Mill Creek
Rocky Branch
Saluda River
Smith Branch
West Columbia

N
1 inch = 2 miles
0 0.5 1 2 3 Miles

Figure A-1
Permanent Flow Monitoring Location Map

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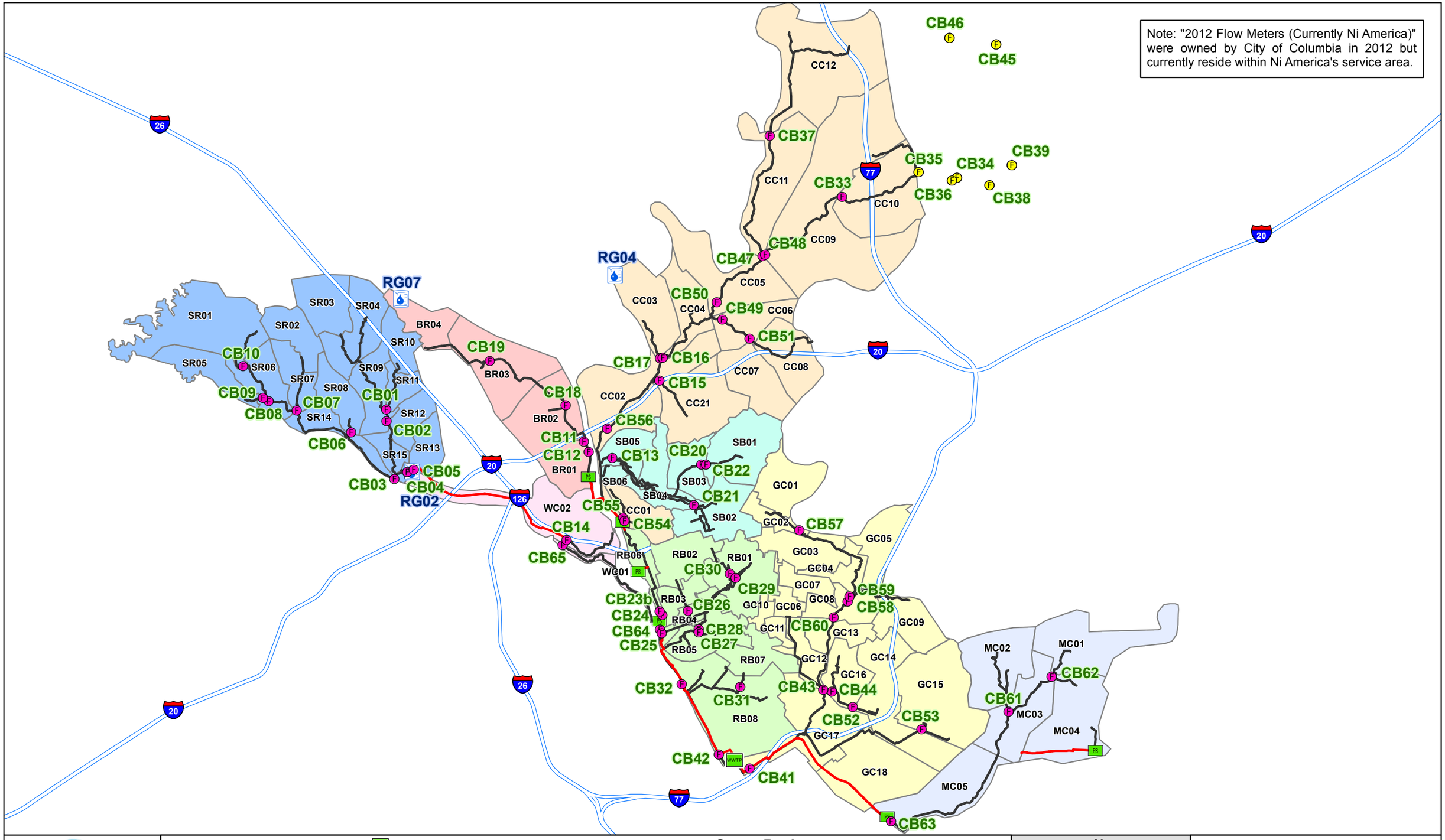
Note: "2012 Flow Meters (Currently Ni America)" were owned by City of Columbia in 2012 but currently reside within Ni America's service area.



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- 2012 Flow Meters (City of Columbia)
- 2012 Flow Meters (Currenty Ni America)
- 2012 Rain Gauges
- Metro WWTP
- Major Pump Stations
- Major Force Mains
- Major Gravity Sewer Lines

Sewer Basins

- Broad River
- Crane Creek
- Gills Creek
- Mill Creek
- Rocky Branch
- Saluda River
- Smith Branch
- West Columbia

N

1 inch = 2 miles

0 0.5 1 2 3 Miles

Figure A-2
2012 Temporary Flow Monitoring Location Map

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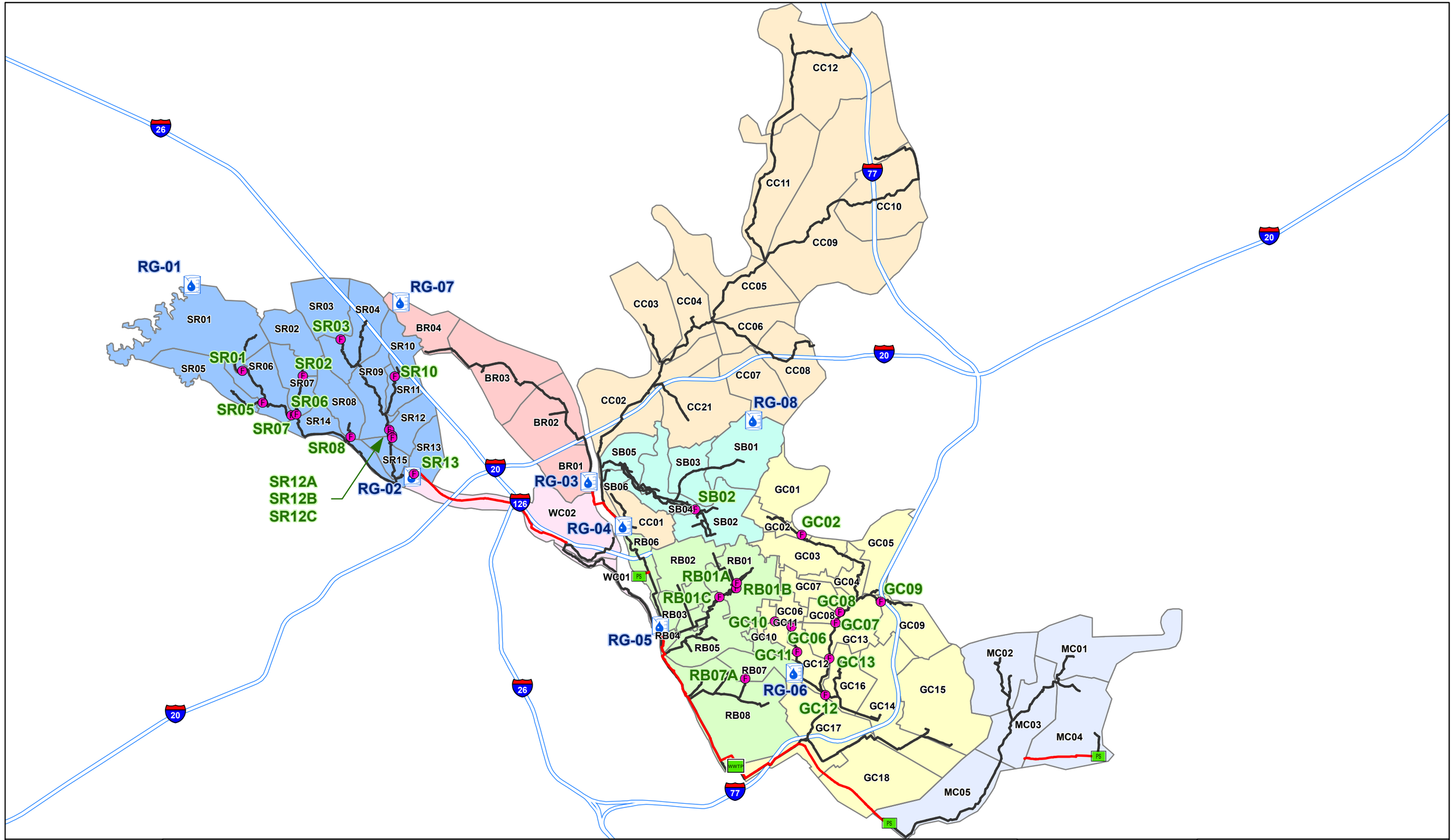

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Temp_FlowMeter_2014
Temp_RainGauge_2014
Metro WWTP
Major Pump Stations
Major Force Mains
Major Gravity Sewer Lines

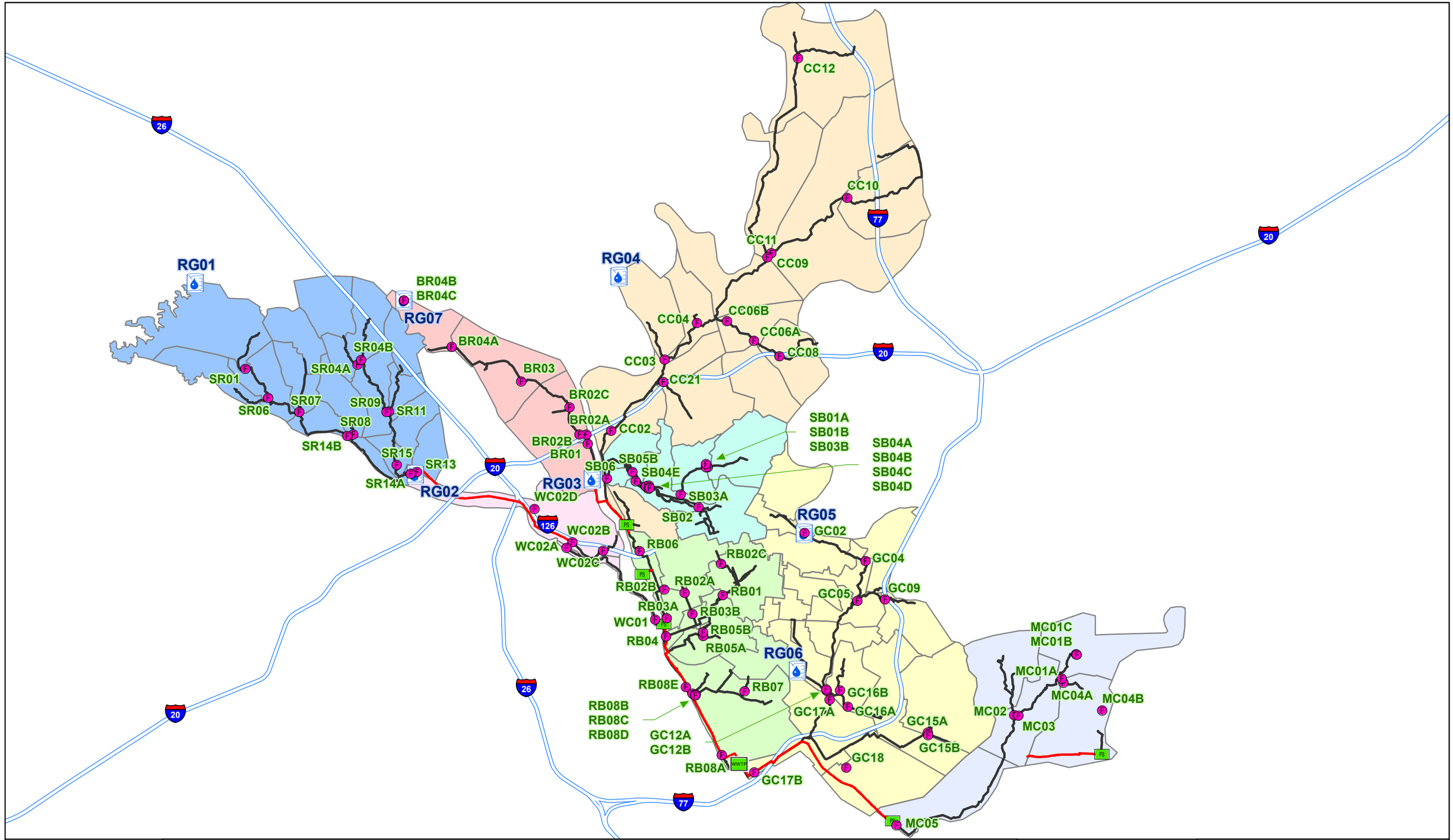
Sewer Basins

Broad River
Crane Creek
Gills Creek
Mill Creek
Rocky Branch
Saluda River
Smith Branch
West Columbia

N
1 inch = 2 miles
0 0.5 1 2 3 Miles

Figure A-3
2014 Temporary Flow Monitoring Location Map

IR Report



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2015 Flow Meters
2015 Flow Meters
Metro WWTP
Major Pump Stations
Major Force Mains
Major Gravity Sewer Lines

Sewer Basins

Broad River
Crane Creek
Gills Creek
Mill Creek
Rocky Branch
Saluda River
Smith Branch
West Columbia

N
1 inch = 2 miles
0 0.5 1 2 3 Miles

Figure A-4
2015 Temporary Flow Monitoring Location Map

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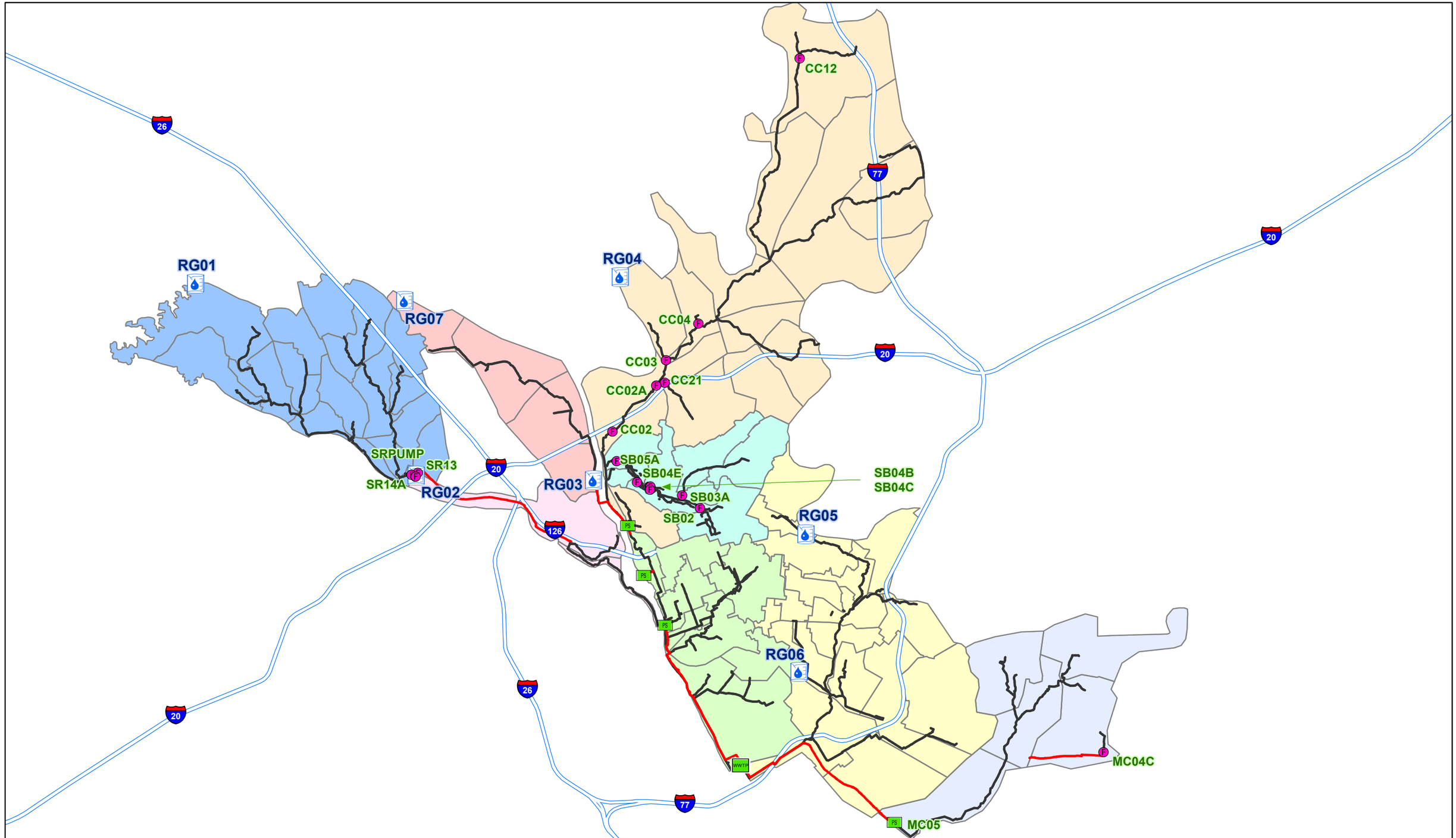

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Sewer Basins

- 2016 Flow Meters
- 2016 Flow Meters
- Metro WWTP
- Major Pump Stations
- Major Force Mains
- Major Gravity Sewer Lines
- Broad River
- Crane Creek
- Gills Creek
- Mill Creek
- Rocky Branch
- Saluda River
- Smith Branch
- West Columbia

N

1 inch = 2 miles

0 0.5 1 2 3 Miles

Figure A-5
2016 Temporary Flow Monitoring Location Map

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Appendix B – Recent Historical SSOs Caused by Severe Natural Conditions on Major Gravity Sewer Lines and Major Manholes

Table B-1 – Recent Historical SSOs Caused by Severe Natural Conditions on Major Gravity Sewer Lines and Major Manholes [1,2]

			SSO Characteristics		
Date[3]	**SSO ID**	**Basin**	**Cause[4]**	**Category[5]**	**Estimated Volume (gallons)[6]**
08/09/2014	01501	Gills Creek	Wet Weather	Wet Weather	13,500
12/24/2014	01541	Gills Creek	Wet Weather	Wet Weather	25,200
12/24/2014	01542	Gills Creek	Wet Weather	Wet Weather	6,300
06/04/2015	01607	Gills Creek	Wet Weather	Wet Weather	unknown
07/18/2015	01620	Gills Creek	Wet Weather	Wet Weather	12,000
08/06/2015	01622	Rocky Branch	Wet Weather	Wet Weather	8,750
08/06/2015	01623	Gills Creek	Wet Weather	Wet Weather	4,800
08/06/2015	01624	Gills Creek	Wet Weather	Wet Weather	4,413
09/21/2015	01632	Rocky Branch	Wet Weather	Wet Weather	2,500
09/21/2015	01633	Gills Creek	Wet Weather	Wet Weather	9,800
09/22/2015	01635	Rocky Branch	Wet Weather	Wet Weather	unknown
09/24/2015	01637	Gills Creek	Wet Weather	Wet Weather	36,000
09/24/2015	01638	Rocky Branch	Wet Weather	Wet Weather	4,900
09/24/2015	01639	Rocky Branch	Wet Weather	Wet Weather	4,688
09/22/2015	01640	Gills Creek	Wet Weather	Wet Weather	4,500
09/24/2015	01641	Gills Creek	Wet Weather	Wet Weather	2,250
09/24/2015	01645	Rocky Branch	Wet Weather	Wet Weather	29,451
09/24/2015	01646	Crane Creek	Wet Weather	Wet Weather	18,000
08/02/2016	01778	Gills Creek	Wet Weather	Wet Weather	unknown
08/01/2016	01779	Rocky Branch	Wet Weather	Wet Weather	34,125

Table B-1 (Continued)

			SSO Characteristics		
Date[3]	SSO ID	Basin	Cause[4]	Category[5]	Estimated Volume (gallons)[6]
08/01/2016	01780	Gills Creek	Wet Weather	Wet Weather	9,750
08/01/2016	01781	Gills Creek	Wet Weather	Wet Weather	6,000
08/01/2016	01783	Gills Creek	Wet Weather	Wet Weather	unknown
08/02/2016	01784	Gills Creek	Wet Weather	Wet Weather	unknown
08/04/2016	01785	Crane Creek	Wet Weather	Wet Weather	6,000
09/02/2016	01792	Crane Creek	Wet Weather	Wet Weather	78,000
09/02/2016	01795	Gills Creek	Wet Weather	Wet Weather	18,000
09/02/2016	01796	Gills Creek	Wet Weather	Wet Weather	10,789
09/02/2016	01798	Crane Creek	Wet Weather	Wet Weather	unknown
10/08/2016	01808	Gills Creek	Wet Weather	Wet Weather	18,975
10/08/2016	01809	Gills Creek	Wet Weather	Wet Weather	42,688
10/08/2016	01811	Crane Creek	Wet Weather	Wet Weather	205,500
10/08/2016	01812	Crane Creek	Wet Weather	Wet Weather	132,750
10/08/2016	01813	Crane Creek	Wet Weather	Wet Weather	unknown
04/05/2017	01898	Gills Creek	Wet Weather	Wet Weather	34,500
04/05/2017	01899	Gills Creek	Wet Weather	Wet Weather	21,250
04/05/2017	01900	Crane Creek	Wet Weather	Wet Weather	84,425
04/05/2017	01901	Crane Creek	Wet Weather	Wet Weather	134,863
04/05/2017	01903	Rocky Branch	Wet Weather	Wet Weather	unknown
07/23/2017	01950	Rocky Branch	Wet Weather	Wet Weather	11,250
07/23/2017	01951	Gills Creek	Wet Weather	Wet Weather	14,844
07/23/2017	01952	Rocky Branch	Wet Weather	Wet Weather	5,313

Table B-1 (Continued)

			SSO Characteristics		
Date[3]	SSO ID	Basin	Cause[4]	Category[5]	Estimated Volume (gallons)[6]
07/23/2017	01953	Gills Creek	Wet Weather	Wet Weather	15,450
07/23/2017	01954	Gills Creek	Wet Weather	Wet Weather	10,000
07/24/2017	01955	Rocky Branch	Wet Weather	Wet Weather	80
07/24/2017	01956	Gills Creek	Wet Weather	Wet Weather	4,950
07/24/2017	01957	Gills Creek	Wet Weather	Wet Weather	1,500
10/11/2018	02190	Gills Creek	Wet Weather	Wet Weather	8,100
10/11/2018	02191	Gills Creek	Wet Weather	Wet Weather	56,400
10/11/2018	02198	Broad River	Wet Weather	Wet Weather	186

1) For the purposes of the City's CAP, the CD allows the City to exclude those SSOs caused by severe natural conditions such as hurricanes, tornados, widespread flooding, earthquakes, or rainfall events greater than a representative 2-year 24-hour storm event from the definition of Surcharge Condition (Paragraph 12.e.i.F of the CD). SSOs listed in this table were caused by severe natural conditions and are not considered when assigning condition ratings and identifying rehabilitation priorities.

2) Beginning on October 3, 2015, the City experienced unprecedented rainfall which resulted in catastrophic flooding. DHEC instructed the City on October 4, 2015, to suspend verbal 24-hour notification of SSOs to DHEC. On October 8, 2015, the City requested guidance from DHEC regarding formal written reporting procedures for SSOs. DHEC responded on October 9, 2015 and instructed the City to suspend normal reporting until the flooding event concluded. Therefore, SSOs that occurred between October 3, 2015, and October 13, 2015, are not included in this table.

3) Recent historical SSOs occurred from May 21, 2014 (the Effective Date of the CD) through December 31, 2018.

4) SSO cause recorded at the time of the SSO investigation per the Wastewater Spill Response SOP.

5) SSO category is assigned for this evaluation based on the SSO cause. See Section 2.1 for category definitions.

6) Estimated SSO volume as listed on the SSO reports to DHEC. Volume is estimated per the Wastewater Spill Response SOP. For unobserved overflows where an estimated volume could not be calculated, the volume was reported as unknown.

Appendix C – Major Gravity Sewer Line Inspection Results

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
Broad River Basin				**53**	**61**	**98**	**21**	**5**	**238**
	BR01			**0**	**0**	**4**	**0**	**0**	**4**
		LFB	Lining Failure Blistered			4			**4**
	BR02			**23**	**29**	**49**	**8**	**4**	**113**
		CC	Crack Circumferential	6					**6**
		CH2	Crack Longitudinal Hinge, 2				6		**6**
		CH3	Crack Longitudinal Hinge, 3					4	**4**
		CL	Crack Longitudinal		17				**17**
		CM	Crack Multiple			4			**4**
		IR	Infiltration Runner				1		**1**
		JOM	Joint Offset Medium	1					**1**
		JSL	Joint Separated Large		1				**1**
		LFB	Lining Failure Blistered			2			**2**
		MWLS	Water Level Sag		8	1			**9**
		RFB	Roots Fine Barrel		3				**3**
		RFJ	Roots Fine Joint	16					**16**
		RMB	Roots Medium Barrel				1		**1**
		RMJ	Roots Medium Joint			31			**31**
		SCP	Surface Corrosion Metal Pipe			11			**11**
	BR03			**19**	**19**	**20**	**11**	**1**	**70**
		BSV	Broken Soil Visible					1	**1**
		CM	Crack Multiple			2			**2**
		FC	Fracture Circumferential		1				**1**
		FL	Fracture Longitudinal			1			**1**
		FM	Fracture Multiple				10		**10**
		ID	Infiltration Dripper			2			**2**
		IR	Infiltration Runner				1		**1**
		ISSR	Intruding Sealing Ring		1				**1**
		ISZ	Intruding Seal Material Other		1				**1**
		JOL	Joint Offset Large		1				**1**
		JSM	Joint Separated Medium	1					**1**
		MWLS	Water Level Sag		15	7			**22**
		RFJ	Roots Fine Joint	18					**18**
		RMJ	Roots Medium Joint			4			**4**
		SCP	Surface Corrosion Metal Pipe			4			**4**
	BR04			**11**	**13**	**25**	**2**	**0**	**51**
		CL	Crack Longitudinal		2				**2**
		FC	Fracture Circumferential		5				**5**
		FL	Fracture Longitudinal			1			**1**
		FM	Fracture Multiple				2		**2**
		LFD	Lining Failure Detached			1			**1**
		MWLS	Water Level Sag		4	1			**5**
		RFJ	Roots Fine Joint	11					**11**
		RMJ	Roots Medium Joint			17			**17**
		RTB	Roots Tap Barrel			1			**1**
		RTJ	Roots Tap Joint		2				**2**
		SCP	Surface Corrosion Metal Pipe			4			**4**
Crane Creek Basin				**339**	**328**	**1,198**	**111**	**13**	**1,989**
	CC01			**83**	**32**	**88**	**50**	**7**	**260**
		B	Broken					3	**3**
		BVV	Broken Void Visible					2	**2**
		CC	Crack Circumferential	3					**3**
		CH2	Crack Longitudinal Hinge, 2				1		**1**
		CL	Crack Longitudinal		16				**16**
		CM	Crack Multiple			8			**8**
		D	Deformed				1		**1**
		FC	Fracture Circumferential		1				**1**

				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
		FL	Fracture Longitudinal			40			**40**
		FM	Fracture Multiple				41		**41**
		FS	Fracture Spiral			2			**2**
		H	Hole			3			**3**
		HSV	Hole Soil Visible					1	**1**
		ID	Infiltration Dripper			2			**2**
		IR	Infiltration Runner				1		**1**
		JOM	Joint Offset Medium	2					**2**
		JSM	Joint Separated Medium	1					**1**
		LFW	Lining Failure Wrinkled			1			**1**
		MWLS	Water Level Sag		4	2			**6**
		OBJ	Obstacle In Joint		1				**1**
		RBC	Roots Ball Connection				1		**1**
		RBJ	Roots Ball Joint				1		**1**
		RBL	Roots Ball Lateral				2		**2**
		RFB	Roots Fine Barrel		5				**5**
		RFC	Roots Fine Connection	1					**1**
		RFJ	Roots Fine Joint	76					**76**
		RMJ	Roots Medium Joint			16			**16**
		RPPD	Repair Patch Defective				2		**2**
		RTJ	Roots Tap Joint		5				**5**
		SCP	Surface Corrosion Metal Pipe			10			**10**
		SMW	Surface Missing Wall					1	**1**
		TBD	Tap Break-In/Hammer Defective			4			**4**
	CC02			**30**	**4**	**277**	**10**	**0**	**321**
		CL	Crack Longitudinal		2				**2**
		ID	Infiltration Dripper			12			**12**
		IR	Infiltration Runner				9		**9**
		JOL	Joint Offset Large		1				**1**
		LFB	Lining Failure Blistered			70			**70**
		LFD	Lining Failure Detached			192			**192**
		LFW	Lining Failure Wrinkled			3			**3**
		MWLS	Water Level Sag		1		1		**2**
		RFJ	Roots Fine Joint	30					**30**
	CC03			**56**	**18**	**65**	**6**	**1**	**146**
		CH2	Crack Longitudinal Hinge, 2				1		**1**
		CM	Crack Multiple			1			**1**
		FC	Fracture Circumferential		1				**1**
		ID	Infiltration Dripper			6			**6**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				3		**3**
		JOL	Joint Offset Large		1				**1**
		MWLS	Water Level Sag		10	1			**11**
		RBJ	Roots Ball Joint				2		**2**
		RFB	Roots Fine Barrel		2				**2**
		RFJ	Roots Fine Joint	56					**56**
		RMJ	Roots Medium Joint			54			**54**
		RTJ	Roots Tap Joint		4				**4**
		SCP	Surface Corrosion Metal Pipe			3			**3**
	CC04			**62**	**12**	**253**	**9**	**1**	**337**
		CL	Crack Longitudinal		10				**10**
		ID	Infiltration Dripper			8			**8**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				9		**9**
		IW	Infiltration Weeper		1				**1**
		LFB	Lining Failure Blistered			42			**42**
		LFD	Lining Failure Detached			202			**202**

				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
		LFDL	Lining Failure Delaminating			1			**1**
		RFB	Roots Fine Barrel		1				**1**
		RFJ	Roots Fine Joint	62					**62**
	CC05			**0**	**33**	**81**	**15**	**0**	**129**
		CL	Crack Longitudinal		29				**29**
		CM	Crack Multiple			2			**2**
		CS	Crack Spiral		2				**2**
		FL	Fracture Longitudinal			1			**1**
		ID	Infiltration Dripper			8			**8**
		IR	Infiltration Runner				15		**15**
		LFB	Lining Failure Blistered			44			**44**
		LFD	Lining Failure Detached			25			**25**
		LFDE	Lining Failure Defective End			1			**1**
		MWLS	Water Level Sag		1				**1**
		OBJ	Obstacle In Joint		1				**1**
	CC06			**1**	**13**	**36**	**1**	**0**	**51**
		ID	Infiltration Dripper			2			**2**
		IR	Infiltration Runner				1		**1**
		LFB	Lining Failure Blistered			14			**14**
		LFD	Lining Failure Detached			18			**18**
		MWLS	Water Level Sag		13	1			**14**
		RFJ	Roots Fine Joint	1					**1**
		SCP	Surface Corrosion Metal Pipe			1			**1**
	CC08			**70**	**30**	**99**	**7**	**3**	**209**
		BSV	Broken Soil Visible					1	**1**
		CH2	Crack Longitudinal Hinge, 2				1		**1**
		CL	Crack Longitudinal		2				**2**
		FC	Fracture Circumferential		1				**1**
		FM	Fracture Multiple				2		**2**
		ID	Infiltration Dripper			11			**11**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				2		**2**
		ISZ	Intruding Seal Material Other		2				**2**
		JOM	Joint Offset Medium	4					**4**
		LFD	Lining Failure Detached			1			**1**
		MWLS	Water Level Sag		14	4			**18**
		OBI	Obstacle Intruding Thru Wall		2				**2**
		RBJ	Roots Ball Joint				2		**2**
		RFB	Roots Fine Barrel		1				**1**
		RFJ	Roots Fine Joint	66					**66**
		RMJ	Roots Medium Joint			80			**80**
		RTJ	Roots Tap Joint		8				**8**
		SCP	Surface Corrosion Metal Pipe			3			**3**
		XB	Collapse Brick Sewer					1	**1**
	CC09			**2**	**35**	**28**	**0**	**0**	**65**
		CL	Crack Longitudinal		3				**3**
		ID	Infiltration Dripper			1			**1**
		LFB	Lining Failure Blistered			3			**3**
		LFD	Lining Failure Detached			21			**21**
		MWLS	Water Level Sag		31				**31**
		RFJ	Roots Fine Joint	2					**2**
		TBD	Tap Break-In/Hammer Defective			3			**3**
		TFD	Tap Factory Made Defective		1				**1**
	CC10			**3**	**31**	**149**	**4**	**0**	**187**
		CC	Crack Circumferential	1					**1**
		CL	Crack Longitudinal		9				**9**
		CM	Crack Multiple			3			**3**

				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
		FC	Fracture Circumferential		2				**2**
		FM	Fracture Multiple				3		**3**
		H	Hole			1			**1**
		ID	Infiltration Dripper			3			**3**
		IR	Infiltration Runner				1		**1**
		LFB	Lining Failure Blistered			114			**114**
		LFD	Lining Failure Detached			17			**17**
		LFW	Lining Failure Wrinkled			8			**8**
		MWLS	Water Level Sag		19	2			**21**
		RFJ	Roots Fine Joint	2					**2**
		RTJ	Roots Tap Joint		1				**1**
		TBD	Tap Break-In/Hammer Defective			1			**1**
	CC11			**22**	**54**	**42**	**3**	**0**	**121**
		CL	Crack Longitudinal		4				**4**
		ID	Infiltration Dripper			3			**3**
		IR	Infiltration Runner				1		**1**
		MWLS	Water Level Sag		49				**49**
		OBJ	Obstacle In Joint		1				**1**
		RBJ	Roots Ball Joint				2		**2**
		RFJ	Roots Fine Joint	22					**22**
		RMJ	Roots Medium Joint			39			**39**
	CC12			**7**	**44**	**39**	**2**	**1**	**93**
		B	Broken					1	**1**
		CC	Crack Circumferential	1					**1**
		CL	Crack Longitudinal		1				**1**
		ID	Infiltration Dripper			3			**3**
		ISZ	Intruding Seal Material Other		1				**1**
		IW	Infiltration Weeper		1				**1**
		MWLS	Water Level Sag		34				**34**
		RFB	Roots Fine Barrel		6				**6**
		RFJ	Roots Fine Joint	6					**6**
		RMB	Roots Medium Barrel				2		**2**
		RMJ	Roots Medium Joint			8			**8**
		RTJ	Roots Tap Joint		1				**1**
		SCP	Surface Corrosion Metal Pipe			28			**28**
	CC21			**3**	**22**	**41**	**4**	**0**	**70**
		CL	Crack Longitudinal		1				**1**
		FM	Fracture Multiple				1		**1**
		IR	Infiltration Runner				2		**2**
		JAL	Joint Angular Large		1				**1**
		JAM	Joint Angular Medium	2					**2**
		JSL	Joint Separated Large		1				**1**
		LFB	Lining Failure Blistered			16			**16**
		LFD	Lining Failure Detached			2			**2**
		MWLS	Water Level Sag		18	20	1		**39**
		RFC	Roots Fine Connection	1					**1**
		RMJ	Roots Medium Joint			1			**1**
		RTJ	Roots Tap Joint		1				**1**
		SCP	Surface Corrosion Metal Pipe			2			**2**
Gills Creek Basin				**161**	**181**	**658**	**180**	**19**	**1,199**
	GC01			**5**	**2**	**0**	**1**	**0**	**8**
		MWLS	Water Level Sag		1				**1**
		RBL	Roots Ball Lateral				1		**1**
		RFJ	Roots Fine Joint	4					**4**
		RFL	Roots Fine Lateral	1					**1**
		TFD	Tap Factory Made Defective		1				**1**
	GC02			**39**	**21**	**55**	**6**	**2**	**123**

				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
		FC	Fracture Circumferential		2				**2**
		H	Hole			1		1	**2**
		HVV	Hole Void Visible					1	**1**
		ID	Infiltration Dripper			18			**18**
		IR	Infiltration Runner				4		**4**
		ISZ	Intruding Seal Material Other		1				**1**
		IW	Infiltration Weeper		3				**3**
		MWLS	Water Level Sag		4	3			**7**
		OBJ	Obstacle In Joint		1				**1**
		RBJ	Roots Ball Joint				2		**2**
		RFB	Roots Fine Barrel		1				**1**
		RFC	Roots Fine Connection	2					**2**
		RFJ	Roots Fine Joint	37					**37**
		RMC	Roots Medium Connection			9			**9**
		RMJ	Roots Medium Joint			15			**15**
		RTJ	Roots Tap Joint		5				**5**
		SCP	Surface Corrosion Metal Pipe			1			**1**
		TBD	Tap Break-In/Hammer Defective			8			**8**
		TFD	Tap Factory Made Defective		1				**1**
		TSD	Tap Saddle Defective		3				**3**
	GC03			**0**	**5**	**20**	**2**	**0**	**27**
		ID	Infiltration Dripper			2			**2**
		IR	Infiltration Runner				2		**2**
		MWLS	Water Level Sag		5	2			**7**
		SCP	Surface Corrosion Metal Pipe			16			**16**
	GC04			**1**	**1**	**2**	**1**	**1**	**6**
		MWLS	Water Level Sag			2	1		**3**
		OBJ	Obstacle In Joint					1	**1**
		RFJ	Roots Fine Joint	1					**1**
		TFD	Tap Factory Made Defective		1				**1**
	GC05			**0**	**1**	**2**	**2**	**0**	**5**
		FC	Fracture Circumferential		1				**1**
		FM	Fracture Multiple				2		**2**
		SCP	Surface Corrosion Metal Pipe			2			**2**
	GC06			**0**	**1**	**2**	**0**	**0**	**3**
		LFW	Lining Failure Wrinkled			2			**2**
		RFB	Roots Fine Barrel		1				**1**
	GC08			**5**	**3**	**25**	**3**	**1**	**37**
		CC	Crack Circumferential	3					**3**
		CL	Crack Longitudinal		2				**2**
		CM	Crack Multiple			1			**1**
		FL	Fracture Longitudinal			1			**1**
		ID	Infiltration Dripper			7			**7**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				3		**3**
		LFB	Lining Failure Blistered			4			**4**
		LFD	Lining Failure Detached			9			**9**
		MWLS	Water Level Sag		1	2			**3**
		RFJ	Roots Fine Joint	2					**2**
		SCP	Surface Corrosion Metal Pipe			1			**1**
	GC09			**7**	**14**	**16**	**2**	**1**	**40**
		B	Broken			1		1	**2**
		CC	Crack Circumferential	1					**1**
		FC	Fracture Circumferential		2				**2**
		FM	Fracture Multiple				2		**2**
		ID	Infiltration Dripper			1			**1**
		JOM	Joint Offset Medium	1					**1**

				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
		MWLS	Water Level Sag		8	9			**17**
		RFJ	Roots Fine Joint	5					**5**
		RMJ	Roots Medium Joint			5			**5**
		RTJ	Roots Tap Joint		4				**4**
	GC12			**88**	**82**	**241**	**141**	**7**	**559**
		B	Broken					2	**2**
		BSV	Broken Soil Visible					3	**3**
		CC	Crack Circumferential	11					**11**
		CH2	Crack Longitudinal Hinge, 2				1		**1**
		CL	Crack Longitudinal		36				**36**
		CM	Crack Multiple			17			**17**
		FC	Fracture Circumferential		17				**17**
		FH2	Fracture Longitudinal Hinge, 2				1		**1**
		FH3	Fracture Longitudinal Hinge, 3					1	**1**
		FL	Fracture Longitudinal			52			**52**
		FM	Fracture Multiple				122		**122**
		FS	Fracture Spiral			8			**8**
		H	Hole			2			**2**
		HVV	Hole Void Visible					1	**1**
		ID	Infiltration Dripper			11			**11**
		IR	Infiltration Runner				7		**7**
		ISGT	Intruding Sealing Grout		2				**2**
		LFB	Lining Failure Blistered			17			**17**
		LFD	Lining Failure Detached			59			**59**
		MWLS	Water Level Sag		6	17			**23**
		RBJ	Roots Ball Joint				1		**1**
		RFB	Roots Fine Barrel		16				**16**
		RFJ	Roots Fine Joint	75					**75**
		RFL	Roots Fine Lateral	2					**2**
		RMB	Roots Medium Barrel				9		**9**
		RMC	Roots Medium Connection			2			**2**
		RMJ	Roots Medium Joint			50			**50**
		RML	Roots Medium Lateral			2			**2**
		RTJ	Roots Tap Joint		2				**2**
		SCP	Surface Corrosion Metal Pipe			2			**2**
		TBD	Tap Break-In/Hammer Defective			2			**2**
		TFD	Tap Factory Made Defective		3				**3**
	GC13			**0**	**1**	**29**	**1**	**1**	**32**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				1		**1**
		IW	Infiltration Weeper		1				**1**
		LFD	Lining Failure Detached			29			**29**
	GC14			**10**	**5**	**19**	**2**	**0**	**36**
		CL	Crack Longitudinal		2				**2**
		FL	Fracture Longitudinal			1			**1**
		ID	Infiltration Dripper			8			**8**
		IR	Infiltration Runner				2		**2**
		JOM	Joint Offset Medium	1					**1**
		MWLS	Water Level Sag		3	4			**7**
		RFC	Roots Fine Connection	2					**2**
		RFJ	Roots Fine Joint	7					**7**
		RMC	Roots Medium Connection			1			**1**
		SCP	Surface Corrosion Metal Pipe			1			**1**
		TBD	Tap Break-In/Hammer Defective			4			**4**
	GC15			**0**	**6**	**2**	**0**	**0**	**8**
		JSL	Joint Separated Large		1				**1**
		MWLS	Water Level Sag		3				**3**

				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
		OBI	Obstacle Intruding Thru Wall		2				**2**
		SCP	Surface Corrosion Metal Pipe			2			**2**
	GC16			**5**	**24**	**77**	**12**	**3**	**121**
		B	Broken					1	**1**
		BSV	Broken Soil Visible					1	**1**
		CL	Crack Longitudinal		3				**3**
		CM	Crack Multiple			3			**3**
		FC	Fracture Circumferential		3				**3**
		FH3	Fracture Longitudinal Hinge, 3					1	**1**
		FM	Fracture Multiple				5		**5**
		ID	Infiltration Dripper			11			**11**
		IR	Infiltration Runner				2		**2**
		LFD	Lining Failure Detached			15			**15**
		MWLS	Water Level Sag		16	30	3		**49**
		RBJ	Roots Ball Joint				1		**1**
		RFB	Roots Fine Barrel		1				**1**
		RFJ	Roots Fine Joint	5					**5**
		RMB	Roots Medium Barrel				1		**1**
		RMJ	Roots Medium Joint			17			**17**
		TBD	Tap Break-In/Hammer Defective			1			**1**
		TFD	Tap Factory Made Defective		1				**1**
	GC17			**1**	**15**	**168**	**7**	**3**	**194**
		B	Broken					1	**1**
		CL	Crack Longitudinal		4				**4**
		CM	Crack Multiple			2			**2**
		ID	Infiltration Dripper			18			**18**
		IG	Infiltration Gusher					2	**2**
		IR	Infiltration Runner				7		**7**
		ISSRB	Intruding Sealing Ring Broken		2				**2**
		IW	Infiltration Weeper		9				**9**
		LFB	Lining Failure Blistered			3			**3**
		LFD	Lining Failure Detached			145			**145**
		RFJ	Roots Fine Joint	1					**1**
Mill Creek Basin				**58**	**51**	**322**	**69**	**22**	**522**
	MC01			**1**	**5**	**7**	**6**	**1**	**20**
		CC	Crack Circumferential	1					**1**
		CH2	Crack Longitudinal Hinge, 2				2		**2**
		CL	Crack Longitudinal		1				**1**
		CM	Crack Multiple			1			**1**
		FM	Fracture Multiple				2		**2**
		ID	Infiltration Dripper			1			**1**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				2		**2**
		MWLS	Water Level Sag		4	2			**6**
		SCP	Surface Corrosion Metal Pipe			2			**2**
		TBD	Tap Break-In/Hammer Defective			1			**1**
	MC02			**8**	**8**	**15**	**10**	**6**	**47**
		CL	Crack Longitudinal		1				**1**
		ID	Infiltration Dripper			2			**2**
		IG	Infiltration Gusher					5	**5**
		IR	Infiltration Runner				9		**9**
		MWLS	Water Level Sag		3	3			**6**
		OBJ	Obstacle In Joint		1				**1**
		RBB	Roots Ball Barrel					1	**1**
		RBL	Roots Ball Lateral				1		**1**
		RFJ	Roots Fine Joint	8					**8**
		RMJ	Roots Medium Joint			2			**2**

				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
		RML	Roots Medium Lateral			1			**1**
		TBD	Tap Break-In/Hammer Defective			7			**7**
		TFD	Tap Factory Made Defective		3				**3**
	MC03			**9**	**29**	**67**	**18**	**9**	**132**
		B	Broken			1			**1**
		CC	Crack Circumferential	2					**2**
		CM	Crack Multiple			1			**1**
		D	Deformed					1	**1**
		FC	Fracture Circumferential		3				**3**
		FL	Fracture Longitudinal			1			**1**
		ID	Infiltration Dripper			35			**35**
		IG	Infiltration Gusher					8	**8**
		IR	Infiltration Runner				17		**17**
		IW	Infiltration Weeper		1				**1**
		MWLS	Water Level Sag		22	18	1		**41**
		OBJ	Obstacle In Joint		2				**2**
		RFJ	Roots Fine Joint	7					**7**
		RMJ	Roots Medium Joint			6			**6**
		SCP	Surface Corrosion Metal Pipe			4			**4**
		TBD	Tap Break-In/Hammer Defective			1			**1**
		TFD	Tap Factory Made Defective		1				**1**
	MC04			**6**	**2**	**2**	**1**	**1**	**12**
		CC	Crack Circumferential	1					**1**
		IG	Infiltration Gusher					1	**1**
		MWLS	Water Level Sag		2				**2**
		RFJ	Roots Fine Joint	4					**4**
		RFL	Roots Fine Lateral	1					**1**
		RMB	Roots Medium Barrel				1		**1**
		SCP	Surface Corrosion Metal Pipe			1			**1**
		TBD	Tap Break-In/Hammer Defective			1			**1**
	MC05			**34**	**7**	**231**	**34**	**5**	**311**
		CC	Crack Circumferential	1					**1**
		CL	Crack Longitudinal		2				**2**
		FL	Fracture Longitudinal			1			**1**
		ID	Infiltration Dripper			75			**75**
		IG	Infiltration Gusher					5	**5**
		IR	Infiltration Runner				33		**33**
		JOM	Joint Offset Medium	1					**1**
		MWLS	Water Level Sag		4	6			**10**
		RBJ	Roots Ball Joint				1		**1**
		RFJ	Roots Fine Joint	32					**32**
		RMJ	Roots Medium Joint			148			**148**
		RTJ	Roots Tap Joint		1				**1**
		SCP	Surface Corrosion Metal Pipe			1			**1**
Rocky Branch Basin				**57**	**149**	**492**	**127**	**30**	**855**
	RB01			**1**	**4**	**63**	**1**	**2**	**71**
		D	Deformed					2	**2**
		H	Hole			4			**4**
		ID	Infiltration Dripper			3			**3**
		IR	Infiltration Runner				1		**1**
		LFPH	Lining Failure Pinhole			38			**38**
		LFUC	Lining Failure Undercut Connection			3			**3**
		LFW	Lining Failure Wrinkled			9			**9**
		MWLS	Water Level Sag		2	4			**6**
		OBI	Obstacle Intruding Thru Wall		2				**2**
		RFC	Roots Fine Connection	1					**1**
		SCP	Surface Corrosion Metal Pipe			1			**1**

				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
		TBD	Tap Break-In/Hammer Defective			1			**1**
	RB02			**8**	**13**	**36**	**4**	**0**	**61**
		CC	Crack Circumferential	1					**1**
		CL	Crack Longitudinal		1				**1**
		CS	Crack Spiral		1				**1**
		FL	Fracture Longitudinal			3			**3**
		FM	Fracture Multiple				4		**4**
		ID	Infiltration Dripper			1			**1**
		JOM	Joint Offset Medium	1					**1**
		LFUC	Lining Failure Undercut Connection			1			**1**
		LFW	Lining Failure Wrinkled			5			**5**
		MWLS	Water Level Sag		4	6			**10**
		RFB	Roots Fine Barrel		6				**6**
		RFC	Roots Fine Connection	2					**2**
		RFJ	Roots Fine Joint	4					**4**
		RMJ	Roots Medium Joint			3			**3**
		TBD	Tap Break-In/Hammer Defective			17			**17**
		TFD	Tap Factory Made Defective		1				**1**
	RB03			**1**	**6**	**4**	**1**	**0**	**12**
		CC	Crack Circumferential	1					**1**
		CL	Crack Longitudinal		1				**1**
		CM	Crack Multiple			1			**1**
		FC	Fracture Circumferential		2				**2**
		FM	Fracture Multiple				1		**1**
		ID	Infiltration Dripper			1			**1**
		MWLS	Water Level Sag		3	1			**4**
		SCP	Surface Corrosion Metal Pipe			1			**1**
	RB04			**12**	**71**	**133**	**72**	**8**	**296**
		B	Broken			1		1	**2**
		BSV	Broken Soil Visible					1	**1**
		CC	Crack Circumferential	4					**4**
		CH2	Crack Longitudinal Hinge, 2				6		**6**
		CH3	Crack Longitudinal Hinge, 3					3	**3**
		CL	Crack Longitudinal		43				**43**
		CM	Crack Multiple			61			**61**
		CS	Crack Spiral		5				**5**
		D	Deformed				2		**2**
		DH	Deformed Horizontal					1	**1**
		FC	Fracture Circumferential		6				**6**
		FH2	Fracture Longitudinal Hinge, 2				1		**1**
		FH3	Fracture Longitudinal Hinge, 3					2	**2**
		FL	Fracture Longitudinal			9			**9**
		FM	Fracture Multiple				60		**60**
		FS	Fracture Spiral			5			**5**
		ID	Infiltration Dripper			6			**6**
		IR	Infiltration Runner				2		**2**
		IW	Infiltration Weeper		2				**2**
		JOL	Joint Offset Large		2				**2**
		LFB	Lining Failure Blistered			1			**1**
		LFPH	Lining Failure Pinhole			4			**4**
		LFUC	Lining Failure Undercut Connection			6			**6**
		LFW	Lining Failure Wrinkled			34			**34**
		MWLS	Water Level Sag		10	3			**13**
		OBI	Obstacle Intruding Thru Wall			1			**1**
		OBP	Obstacle External Pipe or Cable			1	1		**2**
		RFB	Roots Fine Barrel		2				**2**
		RFJ	Roots Fine Joint	8					**8**

				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
		TBD	Tap Break-In/Hammer Defective			1			**1**
		TFD	Tap Factory Made Defective		1				**1**
	RB05			**27**	**37**	**127**	**45**	**17**	**253**
		B	Broken			2		4	**6**
		BSV	Broken Soil Visible					2	**2**
		CC	Crack Circumferential	5					**5**
		CL	Crack Longitudinal		16				**16**
		CM	Crack Multiple			15			**15**
		D	Deformed				5	4	**9**
		FC	Fracture Circumferential		6				**6**
		FL	Fracture Longitudinal			22			**22**
		FM	Fracture Multiple				35		**35**
		FS	Fracture Spiral			3			**3**
		H	Hole			2			**2**
		HSV	Hole Soil Visible					2	**2**
		ID	Infiltration Dripper			14			**14**
		IG	Infiltration Gusher					3	**3**
		IR	Infiltration Runner				3		**3**
		ISGT	Intruding Sealing Grout			1			**1**
		JOL	Joint Offset Large		3				**3**
		JOM	Joint Offset Medium	6					**6**
		JSL	Joint Separated Large		2				**2**
		MWLS	Water Level Sag		5	20			**25**
		OBJ	Obstacle In Joint		4		1		**5**
		RFJ	Roots Fine Joint	16					**16**
		RMB	Roots Medium Barrel				1		**1**
		RMJ	Roots Medium Joint			3			**3**
		RTJ	Roots Tap Joint		1				**1**
		SCP	Surface Corrosion Metal Pipe			43			**43**
		SMW	Surface Missing Wall					2	**2**
		TBD	Tap Break-In/Hammer Defective			2			**2**
	RB06			**0**	**0**	**27**	**1**	**0**	**28**
		IR	Infiltration Runner				1		**1**
		LFD	Lining Failure Detached			1			**1**
		LFPH	Lining Failure Pinhole			3			**3**
		LFW	Lining Failure Wrinkled			22			**22**
		SCP	Surface Corrosion Metal Pipe			1			**1**
	RB07			**0**	**0**	**1**	**0**	**0**	**1**
		TBD	Tap Break-In/Hammer Defective			1			**1**
	RB08			**8**	**18**	**101**	**3**	**3**	**133**
		B	Broken					1	**1**
		BSV	Broken Soil Visible					1	**1**
		CC	Crack Circumferential	1					**1**
		CM	Crack Multiple			1			**1**
		FC	Fracture Circumferential		1				**1**
		ID	Infiltration Dripper			7			**7**
		IR	Infiltration Runner				3		**3**
		ISGT	Intruding Sealing Grout		2				**2**
		ISSR	Intruding Sealing Ring		1				**1**
		ISZ	Intruding Seal Material Other		2				**2**
		JOM	Joint Offset Medium	3					**3**
		LFB	Lining Failure Blistered			73			**73**
		LFD	Lining Failure Detached			7			**7**
		LFW	Lining Failure Wrinkled			1			**1**
		MWLS	Water Level Sag		9	2			**11**
		OBJ	Obstacle In Joint		1				**1**
		RFJ	Roots Fine Joint	3					**3**

				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
		RFL	Roots Fine Lateral	1					**1**
		RMJ	Roots Medium Joint			1			**1**
		SCP	Surface Corrosion Metal Pipe			9			**9**
		TFD	Tap Factory Made Defective		2				**2**
		XP	Collapse Pipe Sewer					1	**1**
Saluda River Basin				**184**	**221**	**356**	**65**	**12**	**838**
	SR01			**5**	**2**	**21**	**1**	**1**	**30**
		ID	Infiltration Dripper			7			**7**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				1		**1**
		LFB	Lining Failure Blistered			1			**1**
		MWLS	Water Level Sag		1	5			**6**
		RFB	Roots Fine Barrel		1				**1**
		RFC	Roots Fine Connection	1					**1**
		RFJ	Roots Fine Joint	4					**4**
		RMJ	Roots Medium Joint			6			**6**
		SCP	Surface Corrosion Metal Pipe			2			**2**
	SR02			**0**	**2**	**1**	**2**	**0**	**5**
		IR	Infiltration Runner				2		**2**
		MWLS	Water Level Sag		2				**2**
		SCP	Surface Corrosion Metal Pipe			1			**1**
	SR03			**0**	**0**	**5**	**0**	**0**	**5**
		SCP	Surface Corrosion Metal Pipe			5			**5**
	SR04			**60**	**86**	**115**	**21**	**6**	**288**
		B	Broken					1	**1**
		CC	Crack Circumferential	6					**6**
		CH2	Crack Longitudinal Hinge, 2				9		**9**
		CH3	Crack Longitudinal Hinge, 3					4	**4**
		CL	Crack Longitudinal		44				**44**
		CM	Crack Multiple			26			**26**
		CS	Crack Spiral		5				**5**
		FC	Fracture Circumferential		2				**2**
		FL	Fracture Longitudinal			8			**8**
		FM	Fracture Multiple				7		**7**
		FS	Fracture Spiral			2			**2**
		HSV	Hole Soil Visible					1	**1**
		ID	Infiltration Dripper			7			**7**
		IR	Infiltration Runner				2		**2**
		ISSRL	Intruding Sealing Ring Loose/Poorly Fitting		1	1			**2**
		IW	Infiltration Weeper		1				**1**
		MWLS	Water Level Sag		28	12			**40**
		OBC	Obstacle Thru Connection			1			**1**
		OBJ	Obstacle In Joint		1				**1**
		RBJ	Roots Ball Joint				3		**3**
		RFB	Roots Fine Barrel		3				**3**
		RFC	Roots Fine Connection	1					**1**
		RFJ	Roots Fine Joint	52					**52**
		RFL	Roots Fine Lateral	1					**1**
		RMC	Roots Medium Connection			6			**6**
		RMJ	Roots Medium Joint			40			**40**
		RTJ	Roots Tap Joint		1				**1**
		SCP	Surface Corrosion Metal Pipe			7			**7**
		TBD	Tap Break-In/Hammer Defective			5			**5**
	SR05			**63**	**27**	**72**	**8**	**3**	**173**
		B	Broken			1		1	**2**
		BSV	Broken Soil Visible					1	**1**
		BVV	Broken Void Visible					1	**1**

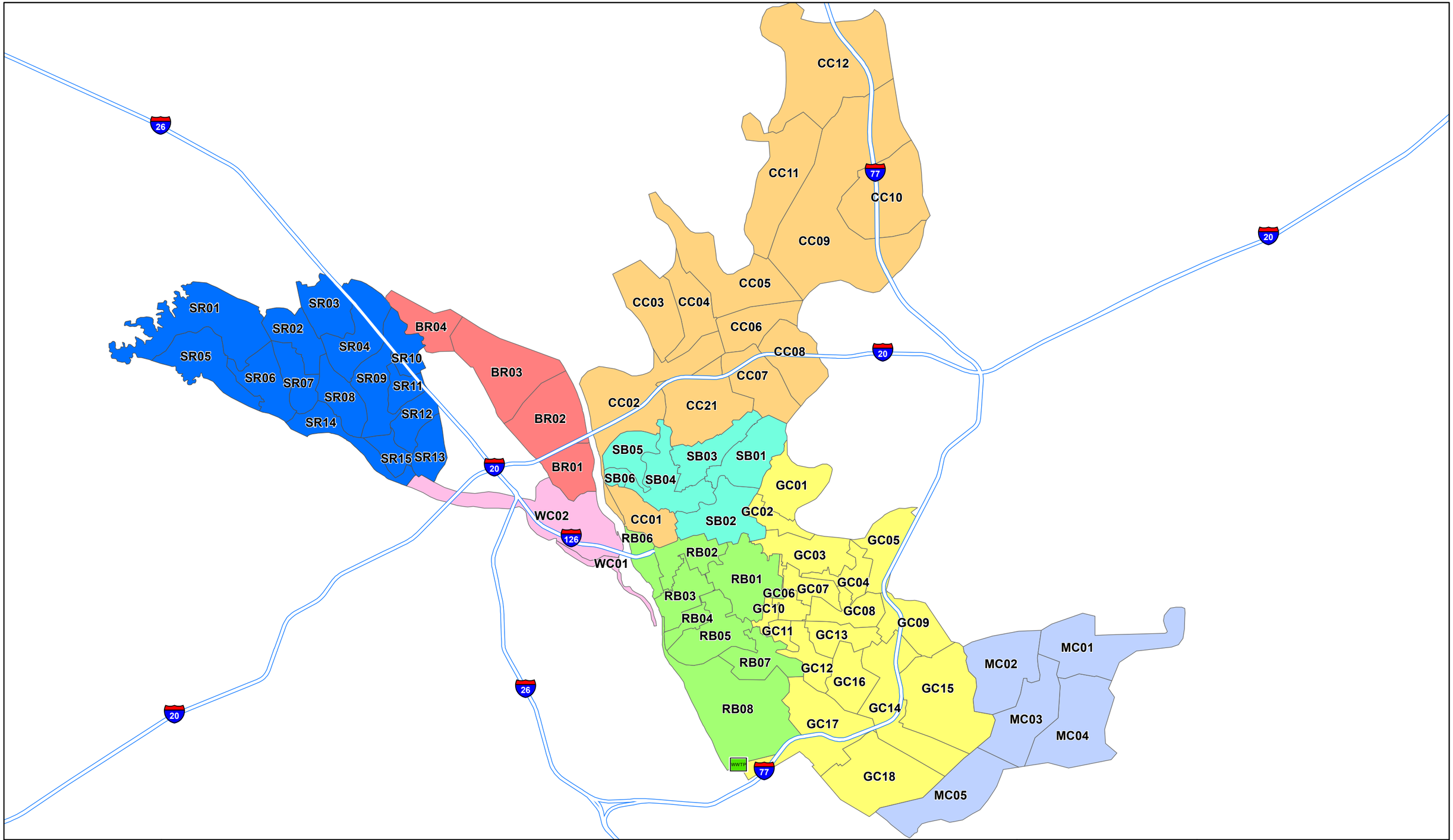
				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
		CL	Crack Longitudinal		1				**1**
		CM	Crack Multiple			2			**2**
		FC	Fracture Circumferential		2				**2**
		FM	Fracture Multiple				1		**1**
		ID	Infiltration Dripper			6			**6**
		IR	Infiltration Runner				2		**2**
		JOL	Joint Offset Large		1				**1**
		JOM	Joint Offset Medium	2					**2**
		MWLS	Water Level Sag		14	8			**22**
		OBI	Obstacle Intruding Thru Wall		1				**1**
		RBJ	Roots Ball Joint				5		**5**
		RFJ	Roots Fine Joint	61					**61**
		RMC	Roots Medium Connection			3			**3**
		RMJ	Roots Medium Joint			42			**42**
		RTB	Roots Tap Barrel			3			**3**
		RTJ	Roots Tap Joint		8				**8**
		SCP	Surface Corrosion Metal Pipe			4			**4**
		TBD	Tap Break-In/Hammer Defective			3			**3**
	SR06			**19**	**13**	**73**	**6**	**1**	**112**
		FC	Fracture Circumferential		2				**2**
		FL	Fracture Longitudinal			1			**1**
		FM	Fracture Multiple				1		**1**
		ID	Infiltration Dripper			6			**6**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				4		**4**
		MWLS	Water Level Sag		4	1			**5**
		RBJ	Roots Ball Joint				1		**1**
		RFB	Roots Fine Barrel		3				**3**
		RFJ	Roots Fine Joint	19					**19**
		RMJ	Roots Medium Joint			17			**17**
		RTJ	Roots Tap Joint		4				**4**
		SCP	Surface Corrosion Metal Pipe			48			**48**
	SR07			**0**	**7**	**5**	**0**	**0**	**12**
		CL	Crack Longitudinal		1				**1**
		ID	Infiltration Dripper			1			**1**
		MWLS	Water Level Sag		6	1			**7**
		SCP	Surface Corrosion Metal Pipe			2			**2**
		TBD	Tap Break-In/Hammer Defective			1			**1**
	SR08			**0**	**0**	**2**	**0**	**0**	**2**
		MWLS	Water Level Sag			2			**2**
	SR09			**1**	**21**	**16**	**4**	**0**	**42**
		IR	Infiltration Runner				4		**4**
		IW	Infiltration Weeper		1				**1**
		MWLS	Water Level Sag		18	6			**24**
		RFJ	Roots Fine Joint	1					**1**
		RMJ	Roots Medium Joint			1			**1**
		SCP	Surface Corrosion Metal Pipe			9			**9**
		TFD	Tap Factory Made Defective		2				**2**
	SR10			**0**	**3**	**1**	**0**	**0**	**4**
		MWLS	Water Level Sag		3	1			**4**
	SR11			**6**	**26**	**6**	**1**	**0**	**39**
		ID	Infiltration Dripper			1			**1**
		IR	Infiltration Runner				1		**1**
		JSM	Joint Separated Medium	2					**2**
		MWLS	Water Level Sag		22	2			**24**
		RFJ	Roots Fine Joint	1					**1**
		RFL	Roots Fine Lateral	3					**3**

				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
		SCP	Surface Corrosion Metal Pipe			3			**3**
		TFD	Tap Factory Made Defective		4				**4**
	SR13			**0**	**5**	**1**	**0**	**0**	**6**
		MWLS	Water Level Sag		5				**5**
		SCP	Surface Corrosion Metal Pipe			1			**1**
	SR14			**28**	**26**	**35**	**20**	**1**	**110**
		CL	Crack Longitudinal		4				**4**
		CM	Crack Multiple			1			**1**
		FL	Fracture Longitudinal			1			**1**
		ID	Infiltration Dripper			11			**11**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				20		**20**
		IW	Infiltration Weeper		1				**1**
		MWLS	Water Level Sag			1			**1**
		RFB	Roots Fine Barrel		21				**21**
		RFJ	Roots Fine Joint	28					**28**
		RMJ	Roots Medium Joint			21			**21**
	SR15			**2**	**3**	**3**	**2**	**0**	**10**
		IR	Infiltration Runner				2		**2**
		MWLS	Water Level Sag		3	1			**4**
		RFJ	Roots Fine Joint	2					**2**
		RMJ	Roots Medium Joint			1			**1**
		SCP	Surface Corrosion Metal Pipe			1			**1**
Smith Branch Basin				**189**	**181**	**262**	**221**	**63**	**916**
	SB01			**18**	**15**	**48**	**27**	**0**	**108**
		CC	Crack Circumferential	1					**1**
		CL	Crack Longitudinal		11				**11**
		CM	Crack Multiple			7			**7**
		FC	Fracture Circumferential		1				**1**
		FL	Fracture Longitudinal			5			**5**
		FM	Fracture Multiple				21		**21**
		FS	Fracture Spiral			1			**1**
		ID	Infiltration Dripper			8			**8**
		IR	Infiltration Runner				5		**5**
		IW	Infiltration Weeper		2				**2**
		MWLS	Water Level Sag			2	1		**3**
		RFJ	Roots Fine Joint	17					**17**
		RMC	Roots Medium Connection			2			**2**
		RMJ	Roots Medium Joint			13			**13**
		SCP	Surface Corrosion Metal Pipe			8			**8**
		TBD	Tap Break-In/Hammer Defective			2			**2**
		TFD	Tap Factory Made Defective		1				**1**
	SB02			**8**	**37**	**31**	**15**	**2**	**93**
		B	Broken					2	**2**
		CL	Crack Longitudinal		10				**10**
		CM	Crack Multiple			2			**2**
		FC	Fracture Circumferential		3				**3**
		FL	Fracture Longitudinal			5			**5**
		FM	Fracture Multiple				9		**9**
		FS	Fracture Spiral			1			**1**
		H	Hole			1			**1**
		ID	Infiltration Dripper			7			**7**
		IR	Infiltration Runner				2		**2**
		ISZ	Intruding Seal Material Other		2				**2**
		JOL	Joint Offset Large		1				**1**
		JOM	Joint Offset Medium	1					**1**
		MWLS	Water Level Sag		16	4	1		**21**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
		RFB	Roots Fine Barrel		3				**3**
		RFJ	Roots Fine Joint	7					**7**
		RMB	Roots Medium Barrel				2		**2**
		RMJ	Roots Medium Joint			4			**4**
		RPPD	Repair Patch Defective				1		**1**
		RTJ	Roots Tap Joint		2				**2**
		SCP	Surface Corrosion Metal Pipe			7			**7**
	SB03			**2**	**2**	**9**	**2**	**0**	**15**
		CL	Crack Longitudinal		1				**1**
		CS	Crack Spiral		1				**1**
		FL	Fracture Longitudinal			5			**5**
		FM	Fracture Multiple				2		**2**
		ID	Infiltration Dripper			3			**3**
		RFJ	Roots Fine Joint	2					**2**
		RMJ	Roots Medium Joint			1			**1**
	SB04			**63**	**68**	**90**	**74**	**22**	**317**
		B	Broken			2		2	**4**
		BSV	Broken Soil Visible					1	**1**
		CC	Crack Circumferential	3					**3**
		CH2	Crack Longitudinal Hinge, 2				1		**1**
		CL	Crack Longitudinal		21				**21**
		CM	Crack Multiple			19			**19**
		CS	Crack Spiral		4				**4**
		FC	Fracture Circumferential		18				**18**
		FH3	Fracture Longitudinal Hinge, 3					1	**1**
		FL	Fracture Longitudinal			14			**14**
		FM	Fracture Multiple				52		**52**
		FS	Fracture Spiral			5			**5**
		H	Hole			1	1	4	**6**
		HSV	Hole Soil Visible					9	**9**
		HVV	Hole Void Visible					1	**1**
		ID	Infiltration Dripper			2			**2**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				2		**2**
		ISSR	Intruding Sealing Ring		5				**5**
		JOL	Joint Offset Large		2				**2**
		JOM	Joint Offset Medium	5					**5**
		JSM	Joint Separated Medium	2					**2**
		MWLS	Water Level Sag		15	3	3		**21**
		OBI	Obstacle Intruding Thru Wall		1				**1**
		RBB	Roots Ball Barrel					1	**1**
		RBJ	Roots Ball Joint				1		**1**
		RFB	Roots Fine Barrel		1				**1**
		RFC	Roots Fine Connection	2					**2**
		RFJ	Roots Fine Joint	51					**51**
		RMB	Roots Medium Barrel				8		**8**
		RMC	Roots Medium Connection			1			**1**
		RMJ	Roots Medium Joint			29			**29**
		RPPD	Repair Patch Defective				6		**6**
		RTB	Roots Tap Barrel			1			**1**
		RTJ	Roots Tap Joint		1				**1**
		SCP	Surface Corrosion Metal Pipe			11			**11**
		SMW	Surface Missing Wall					2	**2**
		TBD	Tap Break-In/Hammer Defective			2			**2**
	SB05			**24**	**17**	**22**	**31**	**17**	**111**
		B	Broken				1		**1**
		CC	Crack Circumferential	1					**1**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
		CM	Crack Multiple			2			**2**
		FC	Fracture Circumferential		4				**4**
		FL	Fracture Longitudinal			8			**8**
		FM	Fracture Multiple				20		**20**
		HSV	Hole Soil Visible					14	**14**
		ID	Infiltration Dripper			5			**5**
		IG	Infiltration Gusher					2	**2**
		IR	Infiltration Runner				4		**4**
		ISSRH	Intruding Sealing Ring Hanging		1				**1**
		IW	Infiltration Weeper		1				**1**
		JOL	Joint Offset Large		1				**1**
		LFPH	Lining Failure Pinhole			1			**1**
		MWLS	Water Level Sag		4				**4**
		RFB	Roots Fine Barrel		5				**5**
		RFC	Roots Fine Connection	1					**1**
		RFJ	Roots Fine Joint	19					**19**
		RFL	Roots Fine Lateral	3					**3**
		RMB	Roots Medium Barrel				6		**6**
		RMJ	Roots Medium Joint			3			**3**
		RML	Roots Medium Lateral			1			**1**
		RTC	Roots Tap Connection		1				**1**
		SCP	Surface Corrosion Metal Pipe			2			**2**
		SMW	Surface Missing Wall					1	**1**
	SB06			**74**	**42**	**62**	**72**	**22**	**272**
		B	Broken			4		3	**7**
		BSV	Broken Soil Visible					5	**5**
		CC	Crack Circumferential	3					**3**
		CH2	Crack Longitudinal Hinge, 2				2		**2**
		CH3	Crack Longitudinal Hinge, 3					1	**1**
		CL	Crack Longitudinal		21				**21**
		CM	Crack Multiple			5			**5**
		D	Deformed				4		**4**
		FC	Fracture Circumferential		7				**7**
		FH2	Fracture Longitudinal Hinge, 2				2		**2**
		FH3	Fracture Longitudinal Hinge, 3					1	**1**
		FL	Fracture Longitudinal			21			**21**
		FM	Fracture Multiple				50		**50**
		FS	Fracture Spiral			2			**2**
		H	Hole					1	**1**
		HSV	Hole Soil Visible					5	**5**
		ID	Infiltration Dripper			2			**2**
		IW	Infiltration Weeper		1				**1**
		JOL	Joint Offset Large		1				**1**
		JOM	Joint Offset Medium	5					**5**
		JSM	Joint Separated Medium	1					**1**
		MWLS	Water Level Sag		5				**5**
		OBI	Obstacle Intruding Thru Wall		1				**1**
		OBJ	Obstacle In Joint		1				**1**
		RFB	Roots Fine Barrel		1				**1**
		RFC	Roots Fine Connection	2					**2**
		RFJ	Roots Fine Joint	63					**63**
		RMJ	Roots Medium Joint			23			**23**
		RPPD	Repair Patch Defective				14		**14**
		RTJ	Roots Tap Joint		4				**4**
		SMW	Surface Missing Wall					6	**6**
		TBD	Tap Break-In/Hammer Defective			5			**5**
West Columbia Basin				**43**	**22**	**216**	**6**	**1**	**288**

				Defect Rating					
Sub-basin ID		PACP Code	Code Description	1	2	3	4	5	Grand Total
	WC01			**0**	**1**	**176**	**1**	**1**	**179**
		ID	Infiltration Dripper			2			**2**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				1		**1**
		IW	Infiltration Weeper		1				**1**
		LFB	Lining Failure Blistered			77			**77**
		LFD	Lining Failure Detached			92			**92**
		MWLS	Water Level Sag			4			**4**
		SCP	Surface Corrosion Metal Pipe			1			**1**
	WC02			**43**	**21**	**40**	**5**	**0**	**109**
		B	Broken			1			**1**
		FC	Fracture Circumferential		3				**3**
		FM	Fracture Multiple				3		**3**
		IW	Infiltration Weeper		1				**1**
		JOM	Joint Offset Medium	1					**1**
		JSM	Joint Separated Medium	1					**1**
		LFDE	Lining Failure Defective End			1			**1**
		LFW	Lining Failure Wrinkled			1			**1**
		MWLS	Water Level Sag		15	6	1		**22**
		OBI	Obstacle Intruding Thru Wall		1				**1**
		OBJ	Obstacle In Joint		1				**1**
		RBJ	Roots Ball Joint				1		**1**
		RFJ	Roots Fine Joint	41					**41**
		RMJ	Roots Medium Joint			24			**24**
		SCP	Surface Corrosion Metal Pipe			7			**7**
Grand Total				**1,084**	**1,194**	**3,602**	**800**	**165**	**6,845**



Clean Water 2020
Columbia's Clear Vision For Clean Water

We Are Columbia

SAV: July 17, 2019
Production...Maps\Report...Figures\IRR

Sewer Basins

- WWTP Metro WWTP
- Broad River
- Crane Creek
- Gills Creek
- Mill Creek
- Rocky Branch
- Saluda River
- Smith Branch
- West Columbia

N

1 inch = 2 miles

0 0.5 1 2 3 Miles

Figure C-1:
Sewer Subbasins

IR Report

Appendix D – Major Manhole Inspection Results

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
Broad River Basin				**17**	**1**	**27**	**4**	**4**	**53**
	BR01			**1**	**0**	**16**	**0**	**0**	**17**
		IS	Infiltration Stain	1					**1**
		LFDC	Lining Failure Discoloration			2			**2**
		LFDL	Lining Failure Delaminating			2			**2**
		LFPH	Lining Failure Pinhole			1			**1**
			Seal condition loose			11			**11**
	BR02			**9**	**0**	**4**	**1**	**0**	**14**
		RFJ	Roots Fine Joint	9					**9**
			Frame condition corroded				1		**1**
			Seal condition loose			4			**4**
	BR03			**7**	**1**	**5**	**3**	**2**	**18**
		IR	Infiltration Runner				2		**2**
		IS	Infiltration Stain	1					**1**
		MMM	Mortar Missing Medium			1			**1**
		RFJ	Roots Fine Joint	5					**5**
			Cover condition broken					1	**1**
			Frame condition broken					1	**1**
			Seal condition loose			1			**1**
			Seal condition offset			2			**2**
			Frame seal inflow				1		**1**
			Chimney inflow and infiltration	1	1	1			**3**
	BR04			**0**	**0**	**2**	**0**	**2**	**4**
			Cover condition broken					1	**1**
			Frame condition broken					1	**1**
			Seal condition loose			2			**2**
Crane Creek Basin				**235**	**134**	**110**	**293**	**65**	**837**
	CC01			**39**	**8**	**9**	**15**	**2**	**73**
		CM	Crack Multiple			2			**2**
		H	Hole				2		**2**
		IS	Infiltration Stain	22					**22**
		IW	Infiltration Weeper		5				**5**
		LFDC	Lining Failure Discoloration			1			**1**
		LFPH	Lining Failure Pinhole			3			**3**
		LFZ	Lining Failure Other			1			**1**
		MMM	Mortar Missing Medium			1			**1**
		MMS	Mortar Missing Small		2				**2**
		RFB	Roots Fine Barrel	1					**1**
		RFJ	Roots Fine Joint	1					**1**
			Cover condition corroded				5		**5**
			Frame condition cracked				1		**1**
			Frame condition broken					2	**2**
			Frame condition corroded				3		**3**
			Seal condition cracked				4		**4**
			Seal condition offset			1			**1**
			Frame seal inflow	1					**1**
			Chimney inflow and infiltration	14	1				**15**
	CC02			**46**	**17**	**26**	**21**	**0**	**110**
		CL	Crack Longitudinal		2				**2**
		IS	Infiltration Stain	28					**28**
		IW	Infiltration Weeper		15				**15**
		LFBU	Lining Failure Bulges			3			**3**
		LFDC	Lining Failure Discoloration			7			**7**
		LFDL	Lining Failure Delaminating			11			**11**
		LFPH	Lining Failure Pinhole			5			**5**
		MB	Missing Brick				2		**2**
		RBL	Roots Ball Lateral				1		**1**
		RFJ	Roots Fine Joint	2					**2**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
			Cover condition corroded				6		**6**
			Frame condition corroded				5		**5**
			Seal condition cracked				6		**6**
			Seal condition missing				1		**1**
			Frame seal inflow	3					**3**
			Chimney inflow and infiltration	13					**13**
	CC03			**2**	**4**	**2**	**6**	**3**	**17**
		IR	Infiltration Runner				1		**1**
		IW	Infiltration Weeper		4				**4**
		RFB	Roots Fine Barrel	2					**2**
		RMB	Roots Medium Barrel				1		**1**
		RTB	Roots Tap Barrel			2			**2**
			Cover condition broken					1	**1**
			Frame condition cracked				1		**1**
			Frame condition broken					2	**2**
			Seal condition cracked				3		**3**
	CC04			**0**	**4**	**4**	**15**	**2**	**25**
		ID	Infiltration Dripper			2			**2**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				1		**1**
		IW	Infiltration Weeper		4				**4**
			Cover condition broken					1	**1**
			Cover condition corroded				12		**12**
			Frame condition corroded				2		**2**
			Seal condition loose			1			**1**
			Seal condition offset			1			**1**
	CC05			**5**	**9**	**1**	**4**	**3**	**22**
		HSV	Hole Soil Visible					2	**2**
		IR	Infiltration Runner				2		**2**
		IS	Infiltration Stain	2					**2**
		IW	Infiltration Weeper		9				**9**
		RFB	Roots Fine Barrel	3					**3**
			Cover condition broken					1	**1**
			Cover condition corroded				1		**1**
			Frame condition corroded				1		**1**
			Seal condition loose			1			**1**
	CC06			**8**	**4**	**8**	**22**	**9**	**51**
		HSV	Hole Soil Visible					7	**7**
		HVV	Hole Void Visible					1	**1**
		ID	Infiltration Dripper			1			**1**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				3		**3**
		IS	Infiltration Stain	3					**3**
		IW	Infiltration Weeper		3				**3**
		LFDL	Lining Failure Delaminating			2			**2**
		MMS	Mortar Missing Small		1				**1**
		RFB	Roots Fine Barrel	3					**3**
		RTB	Roots Tap Barrel			1			**1**
			Cover condition cracked				1		**1**
			Cover condition corroded				14		**14**
			Frame condition cracked				1		**1**
			Frame condition corroded				1		**1**
			Seal condition cracked				2		**2**
			Seal condition offset			4			**4**
			Frame seal inflow	1					**1**
			Chimney inflow and infiltration	1					**1**
	CC08			**32**	**4**	**16**	**30**	**9**	**91**
		FM	Fracture Multiple				1		**1**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
		HSV	Hole Soil Visible					6	**6**
		HVV	Hole Void Visible					1	**1**
		ID	Infiltration Dripper			2			**2**
		IS	Infiltration Stain	6					**6**
		IW	Infiltration Weeper		4				**4**
		RBB	Roots Ball Barrel					1	**1**
		RBC	Roots Ball Connection				1		**1**
		RFB	Roots Fine Barrel	21					**21**
		RFC	Roots Fine Connection	1					**1**
		RMB	Roots Medium Barrel				1		**1**
		RMJ	Roots Medium Joint			1			**1**
		RTB	Roots Tap Barrel			6			**6**
			Cover condition corroded				12		**12**
			Frame condition broken					1	**1**
			Frame condition corroded				9		**9**
			Seal condition cracked				6		**6**
			Seal condition loose			1			**1**
			Seal condition offset			6			**6**
			Frame seal inflow	2					**2**
			Chimney inflow and infiltration	2					**2**
	CC09			**18**	**27**	**12**	**29**	**9**	**95**
		CL	Crack Longitudinal		1				**1**
		HSV	Hole Soil Visible					7	**7**
		ID	Infiltration Dripper			8			**8**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				7		**7**
		IS	Infiltration Stain	9					**9**
		ISSR	Intruding Sealing Ring		1				**1**
		IW	Infiltration Weeper		20				**20**
		RBC	Roots Ball Connection				1		**1**
		RFB	Roots Fine Barrel	4					**4**
		RFC	Roots Fine Connection	1					**1**
		RFJ	Roots Fine Joint	1					**1**
		RMB	Roots Medium Barrel				1		**1**
		RTB	Roots Tap Barrel			2			**2**
		SMW	Surface Missing Wall					1	**1**
			Cover condition corroded				19		**19**
			Ring condition poor install				1		**1**
			Seal condition offset			2			**2**
			Frame seal inflow		5				**5**
			Chimney inflow and infiltration	3					**3**
	CC10			**12**	**36**	**8**	**37**	**4**	**97**
		FC	Fracture Circumferential		1				**1**
		HSV	Hole Soil Visible					2	**2**
		ID	Infiltration Dripper			3			**3**
		IG	Infiltration Gusher					2	**2**
		IR	Infiltration Runner				9		**9**
		IS	Infiltration Stain	6					**6**
		IW	Infiltration Weeper		35				**35**
		RFB	Roots Fine Barrel	2					**2**
			Cover condition corroded				27		**27**
			Ring condition cracked				1		**1**
			Seal condition offset			5			**5**
			Chimney inflow and infiltration	4					**4**
	CC11			**22**	**10**	**8**	**36**	**9**	**85**
		B	Broken		1				**1**
		HSV	Hole Soil Visible					5	**5**
		ID	Infiltration Dripper			1			**1**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
		IR	Infiltration Runner				8		**8**
		IS	Infiltration Stain	2					**2**
		IW	Infiltration Weeper		9				**9**
		RFB	Roots Fine Barrel	14					**14**
		RFC	Roots Fine Connection	1					**1**
		RMB	Roots Medium Barrel				2		**2**
		RMJ	Roots Medium Joint			2			**2**
		RTB	Roots Tap Barrel			4			**4**
			Cover condition broken					1	**1**
			Cover condition corroded				6		**6**
			Frame condition cracked				2		**2**
			Frame condition broken					3	**3**
			Frame condition corroded				10		**10**
			Seal condition cracked				8		**8**
			Seal condition offset			1			**1**
			Frame seal inflow	4					**4**
			Chimney inflow and infiltration	1					**1**
	CC12			**22**	**7**	**14**	**23**	**13**	**79**
		HSV	Hole Soil Visible					4	**4**
		IS	Infiltration Stain	4					**4**
		IW	Infiltration Weeper		7				**7**
		JSM	Joint Separated Medium	1					**1**
		LFPH	Lining Failure Pinhole			1			**1**
		OBI	Obstacle Intruding Thru Wall			1			**1**
		RFB	Roots Fine Barrel	14					**14**
		RFJ	Roots Fine Joint	1					**1**
		RMB	Roots Medium Barrel				2		**2**
		RTB	Roots Tap Barrel			1			**1**
			Cover condition broken					2	**2**
			Cover condition corroded				9		**9**
			Frame condition cracked				3		**3**
			Frame condition broken					6	**6**
			Frame condition missing					1	**1**
			Frame condition corroded				1		**1**
			Seal condition cracked				7		**7**
			Seal condition loose			1			**1**
			Seal condition offset			10			**10**
			Seal condition missing				1		**1**
			Frame seal inflow	1					**1**
			Chimney inflow and infiltration	1					**1**
	CC21			**29**	**4**	**2**	**55**	**2**	**92**
		FL	Fracture Longitudinal			1			**1**
		H	Hole				13		**13**
		IS	Infiltration Stain	11					**11**
		IW	Infiltration Weeper		4				**4**
		RFB	Roots Fine Barrel	1					**1**
		RFJ	Roots Fine Joint	3					**3**
			Cover condition broken					1	**1**
			Cover condition corroded				15		**15**
			Cover condition missing					1	**1**
			Frame condition corroded				17		**17**
			Seal condition cracked				10		**10**
			Seal condition loose			1			**1**
			Frame seal inflow	9					**9**
			Chimney inflow and infiltration	5					**5**
Gills Creek Basin				**289**	**100**	**116**	**96**	**17**	**618**
	GC01			**7**	**2**	**0**	**5**	**0**	**14**
		H	Hole				4		**4**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
		IS	Infiltration Stain	4					**4**
		IW	Infiltration Weeper		1				**1**
		RFB	Roots Fine Barrel	1					**1**
			Ring condition poor install				1		**1**
			Chimney inflow and infiltration	2	1				**3**
	GC02			**10**	**8**	**3**	**10**	**0**	**31**
		CL	Crack Longitudinal		2				**2**
		H	Hole				2		**2**
		ID	Infiltration Dripper			1			**1**
		IS	Infiltration Stain	3					**3**
		IW	Infiltration Weeper		3				**3**
		MMS	Mortar Missing Small		2				**2**
		RFJ	Roots Fine Joint	3					**3**
		RMB	Roots Medium Barrel				2		**2**
		RMJ	Roots Medium Joint			2			**2**
			Frame condition corroded				4		**4**
			Seal condition cracked				2		**2**
			Frame seal inflow	3					**3**
			Chimney inflow and infiltration	1	1				**2**
	GC03			**11**	**2**	**4**	**8**	**0**	**25**
		IR	Infiltration Runner				1		**1**
		IS	Infiltration Stain	5					**5**
		IW	Infiltration Weeper		2				**2**
		RFJ	Roots Fine Joint	1					**1**
		RMJ	Roots Medium Joint			2			**2**
			Frame condition corroded				7		**7**
			Seal condition loose			1			**1**
			Seal condition offset			1			**1**
			Frame seal inflow	1					**1**
			Chimney inflow and infiltration	4					**4**
	GC04			**2**	**3**	**4**	**2**	**0**	**11**
		ID	Infiltration Dripper			2			**2**
		IS	Infiltration Stain	1					**1**
		IW	Infiltration Weeper		3				**3**
		RMJ	Roots Medium Joint			2			**2**
			Frame condition corroded				2		**2**
			Frame seal inflow	1					**1**
	GC05			**3**	**1**	**3**	**5**	**1**	**13**
		ID	Infiltration Dripper			1			**1**
		IS	Infiltration Stain	1					**1**
		IW	Infiltration Weeper		1				**1**
		MB	Missing Brick				2		**2**
		MML	Mortar Missing Large			1			**1**
		RFJ	Roots Fine Joint	1					**1**
			Cover condition corroded				1		**1**
			Frame condition broken					1	**1**
			Frame condition corroded				1		**1**
			Seal condition loose			1			**1**
			Seal condition missing				1		**1**
			Chimney inflow and infiltration	1					**1**
	GC08			**0**	**14**	**2**	**5**	**2**	**23**
		ID	Infiltration Dripper			2			**2**
		IG	Infiltration Gusher					1	**1**
		IR	Infiltration Runner				4		**4**
		IW	Infiltration Weeper		14				**14**
			Ring condition broken					1	**1**
			Ring condition corroded				1		**1**
	GC09			**4**	**3**	**1**	**1**	**0**	**9**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
		IR	Infiltration Runner				1		**1**
		IS	Infiltration Stain	2					**2**
		IW	Infiltration Weeper		2				**2**
		RFJ	Roots Fine Joint	2					**2**
			Seal condition loose			1			**1**
			Frame seal inflow		1				**1**
	GC12			**7**	**2**	**7**	**11**	**5**	**32**
		ID	Infiltration Dripper			5			**5**
		IG	Infiltration Gusher					2	**2**
		IR	Infiltration Runner				5		**5**
		IS	Infiltration Stain	3					**3**
		IW	Infiltration Weeper		1				**1**
		MMM	Mortar Missing Medium			1			**1**
		MMS	Mortar Missing Small		1				**1**
		RFJ	Roots Fine Joint	3					**3**
		RMJ	Roots Medium Joint			1			**1**
			Frame condition broken					1	**1**
			Frame condition missing					2	**2**
			Frame condition corroded				5		**5**
			Seal condition cracked				1		**1**
			Chimney inflow and infiltration	1					**1**
	GC13			**5**	**3**	**2**	**10**	**0**	**20**
		H	Hole				10		**10**
		ID	Infiltration Dripper			2			**2**
		IS	Infiltration Stain	3					**3**
		IW	Infiltration Weeper		3				**3**
		RFJ	Roots Fine Joint	1					**1**
			Chimney inflow and infiltration	1					**1**
	GC14			**68**	**8**	**28**	**7**	**1**	**112**
		CC	Crack Circumferential	1					**1**
		CL	Crack Longitudinal		1				**1**
		H	Hole				2		**2**
		IS	Infiltration Stain	37					**37**
		IW	Infiltration Weeper		6				**6**
		LFDC	Lining Failure Discoloration			21			**21**
		LFDL	Lining Failure Delaminating			4			**4**
		LFPH	Lining Failure Pinhole			3			**3**
		RFJ	Roots Fine Joint	5					**5**
			Ring condition broken					1	**1**
			Ring condition corroded				3		**3**
			Frame condition corroded				2		**2**
			Frame seal inflow	1					**1**
			Chimney inflow and infiltration	24	1				**25**
	GC15			**22**	**1**	**7**	**9**	**1**	**40**
		DB	Displaced Brick					1	**1**
		ID	Infiltration Dripper			2			**2**
		IR	Infiltration Runner				8		**8**
		IS	Infiltration Stain	11					**11**
		IW	Infiltration Weeper		1				**1**
		LFDC	Lining Failure Discoloration			1			**1**
		LFDL	Lining Failure Delaminating			2			**2**
		LFZ	Lining Failure Other			1			**1**
		RBJ	Roots Ball Joint				1		**1**
		RFB	Roots Fine Barrel	2					**2**
		RFJ	Roots Fine Joint	3					**3**
		RML	Roots Medium Lateral			1			**1**
			Frame seal inflow	1					**1**
			Chimney inflow and infiltration	5					**5**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
	GC16			**13**	**2**	**14**	**9**	**3**	**41**
		CL	Crack Longitudinal		1				**1**
		ID	Infiltration Dripper			3			**3**
		IR	Infiltration Runner				3		**3**
		IS	Infiltration Stain	4					**4**
		IW	Infiltration Weeper		1				**1**
		LFD	Lining Failure Detached			2			**2**
		LFDC	Lining Failure Discoloration			2			**2**
		LFDL	Lining Failure Delaminating			3			**3**
		OBI	Obstacle Intruding Thru Wall			1			**1**
		RBB	Roots Ball Barrel					1	**1**
		RBJ	Roots Ball Joint				3		**3**
		RFJ	Roots Fine Joint	8					**8**
		RMJ	Roots Medium Joint			3			**3**
			Frame condition broken					1	**1**
			Frame condition missing					1	**1**
			Frame condition corroded				2		**2**
			Seal condition cracked				1		**1**
			Chimney inflow and infiltration	1					**1**
	GC17			**64**	**29**	**25**	**14**	**4**	**136**
		B	Broken		2				**2**
		CL	Crack Longitudinal		1				**1**
		H	Hole				4		**4**
		HSV	Hole Soil Visible					2	**2**
		ID	Infiltration Dripper			1			**1**
		IR	Infiltration Runner				1		**1**
		IS	Infiltration Stain	36					**36**
		ISSR	Intruding Sealing Ring		1				**1**
		ISSRH	Intruding Sealing Ring Hanging		1				**1**
		IW	Infiltration Weeper		22				**22**
		LFD	Lining Failure Detached			1			**1**
		LFDC	Lining Failure Discoloration			13			**13**
		LFDL	Lining Failure Delaminating			3			**3**
		LFPH	Lining Failure Pinhole			1			**1**
		RFB	Roots Fine Barrel	1					**1**
		RFJ	Roots Fine Joint	2					**2**
		RMJ	Roots Medium Joint			1			**1**
			Frame condition broken					1	**1**
			Frame condition missing					1	**1**
			Frame condition corroded				4		**4**
			Seal condition cracked				5		**5**
			Seal condition loose			3			**3**
			Seal condition offset			2			**2**
			Frame seal inflow		1				**1**
			Chimney inflow and infiltration	25	1				**26**
	GC18			**73**	**22**	**16**	**0**	**0**	**111**
		CM	Crack Multiple			1			**1**
		IS	Infiltration Stain	58					**58**
		IW	Infiltration Weeper		21				**21**
		LFDC	Lining Failure Discoloration			5			**5**
		LFDL	Lining Failure Delaminating			9			**9**
		LFPH	Lining Failure Pinhole			1			**1**
		RFJ	Roots Fine Joint	1					**1**
			Chimney inflow and infiltration	14	1				**15**
Mill Creek Basin				**86**	**40**	**52**	**94**	**14**	**286**
	MC01			**2**	**6**	**10**	**15**	**0**	**33**
		ID	Infiltration Dripper			5			**5**
		IR	Infiltration Runner				2		**2**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
		IW	Infiltration Weeper		3				**3**
		MB	Missing Brick				4		**4**
		RFJ	Roots Fine Joint	2					**2**
		RMJ	Roots Medium Joint			4			**4**
			Cover condition corroded				2		**2**
			Ring condition poor install				1		**1**
			Frame condition corroded				5		**5**
			Seal condition cracked				1		**1**
			Seal condition loose			1			**1**
			Frame seal inflow		2				**2**
			Chimney inflow and infiltration		1				**1**
	MC02			**11**	**1**	**2**	**8**	**8**	**30**
		IR	Infiltration Runner				2		**2**
		IS	Infiltration Stain	7					**7**
		MB	Missing Brick				2		**2**
		RBB	Roots Ball Barrel					4	**4**
		RFB	Roots Fine Barrel	2					**2**
			Frame condition cracked				2		**2**
			Frame condition broken					2	**2**
			Frame condition missing					2	**2**
			Frame condition corroded				2		**2**
			Seal condition loose			2			**2**
			Frame seal inflow		1				**1**
			Chimney inflow and infiltration	2					**2**
	MC03			**22**	**10**	**11**	**46**	**2**	**91**
		B	Broken		1				**1**
		ID	Infiltration Dripper			6			**6**
		IR	Infiltration Runner				5		**5**
		IS	Infiltration Stain	1					**1**
		IW	Infiltration Weeper		6				**6**
		MB	Missing Brick				2		**2**
		MML	Mortar Missing Large			2			**2**
		RBB	Roots Ball Barrel					2	**2**
		RFB	Roots Fine Barrel	17					**17**
		RFL	Roots Fine Lateral	1					**1**
		RMJ	Roots Medium Joint			2			**2**
		RTL	Roots Tap Lateral		2				**2**
			Cover condition corroded				11		**11**
			Frame condition corroded				25		**25**
			Seal condition cracked				3		**3**
			Seal condition loose			1			**1**
			Frame seal inflow	3	1				**4**
	MC04			**16**	**2**	**5**	**17**	**2**	**42**
		H	Hole				4		**4**
		HSV	Hole Soil Visible					1	**1**
		IS	Infiltration Stain	11					**11**
		IW	Infiltration Weeper		2				**2**
		MB	Missing Brick				2		**2**
		MMM	Mortar Missing Medium			1			**1**
		RFJ	Roots Fine Joint	2					**2**
			Cover condition corroded				1		**1**
			Frame condition cracked				1		**1**
			Frame condition broken					1	**1**
			Frame condition corroded				7		**7**
			Seal condition cracked				2		**2**
			Seal condition loose			4			**4**
			Frame seal inflow	1					**1**
			Chimney inflow and infiltration	2					**2**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
	MC05			**35**	**21**	**24**	**8**	**2**	**90**
		HSV	Hole Soil Visible					2	**2**
		ID	Infiltration Dripper			5			**5**
		IR	Infiltration Runner				3		**3**
		IS	Infiltration Stain	7					**7**
		IW	Infiltration Weeper		14				**14**
		LFDC	Lining Failure Discoloration			3			**3**
		LFDE	Lining Failure Defective End			2			**2**
		LFDL	Lining Failure Delaminating			8			**8**
		LFPH	Lining Failure Pinhole			2			**2**
		MMS	Mortar Missing Small		6				**6**
		RFB	Roots Fine Barrel	22					**22**
		RTB	Roots Tap Barrel			4			**4**
			Frame condition corroded				4		**4**
			Seal condition cracked				1		**1**
			Frame seal inflow	2	1				**3**
			Chimney inflow and infiltration	4					**4**
Rocky Branch Basin				**187**	**110**	**254**	**123**	**19**	**693**
	RB01			**23**	**15**	**26**	**15**	**6**	**85**
		B	Broken		2				**2**
		HVV	Hole Void Visible					1	**1**
		ID	Infiltration Dripper			7			**7**
		IG	Infiltration Gusher					2	**2**
		IR	Infiltration Runner				3		**3**
		IS	Infiltration Stain	11					**11**
		IW	Infiltration Weeper		2				**2**
		JOM	Joint Offset Medium	2					**2**
		MMM	Mortar Missing Medium			7			**7**
		MMS	Mortar Missing Small		1				**1**
			Ring condition broken					1	**1**
			Ring condition corroded				1		**1**
			Ring condition poor install				1		**1**
			Frame condition broken					2	**2**
			Frame condition corroded				5		**5**
			Seal condition cracked				5		**5**
			Seal condition loose			7			**7**
			Seal condition offset			5			**5**
			Frame seal inflow	8	7				**15**
			Chimney inflow and infiltration	2	3				**5**
	RB02			**13**	**5**	**10**	**9**	**1**	**38**
		DI	Dropped Invert					1	**1**
		H	Hole				3		**3**
		IS	Infiltration Stain	6					**6**
		MB	Missing Brick				4		**4**
		MMM	Mortar Missing Medium			9			**9**
		MMS	Mortar Missing Small		3				**3**
			Ring condition poor install				1		**1**
			Frame condition corroded				1		**1**
			Seal condition loose			1			**1**
			Frame seal inflow	3	1				**4**
			Chimney inflow and infiltration	4	1				**5**
	RB03			**3**	**1**	**8**	**1**	**0**	**13**
		IS	Infiltration Stain	1					**1**
		LFZ	Lining Failure Other			3			**3**
		MMM	Mortar Missing Medium			5			**5**
			Seal condition cracked				1		**1**
			Frame seal inflow	1	1				**2**
			Chimney inflow and infiltration	1					**1**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
	RB04			**6**	**9**	**53**	**4**	**3**	**75**
		IS	Infiltration Stain	3					**3**
		IW	Infiltration Weeper		1				**1**
		MB	Missing Brick				1		**1**
		MML	Mortar Missing Large			8			**8**
		MMM	Mortar Missing Medium			45			**45**
		MMS	Mortar Missing Small		8				**8**
			Ring condition cracked				1		**1**
			Ring condition broken					2	**2**
			Ring condition leaking				1		**1**
			Frame condition broken					1	**1**
			Frame condition corroded				1		**1**
			Chimney inflow and infiltration	3					**3**
	RB05			**61**	**47**	**84**	**52**	**6**	**250**
		B	Broken		1				**1**
		BSV	Broken Soil Visible			1			**1**
		CL	Crack Longitudinal		1				**1**
		CM	Crack Multiple			1			**1**
		CS	Crack Spiral		1				**1**
		H	Hole				3		**3**
		HSV	Hole Soil Visible					1	**1**
		ID	Infiltration Dripper			3			**3**
		IR	Infiltration Runner				1		**1**
		IS	Infiltration Stain	12					**12**
		ISSR	Intruding Sealing Ring		1				**1**
		IW	Infiltration Weeper		12				**12**
		LFBK	Lining Failure Buckled			3			**3**
		LFD	Lining Failure Detached			1			**1**
		LFDL	Lining Failure Delaminating			8			**8**
		LFZ	Lining Failure Other			1			**1**
		MML	Mortar Missing Large			12			**12**
		MMM	Mortar Missing Medium			42			**42**
		MMS	Mortar Missing Small		18				**18**
		RFB	Roots Fine Barrel	1					**1**
		RFC	Roots Fine Connection	1					**1**
		RFJ	Roots Fine Joint	14					**14**
		RMJ	Roots Medium Joint			1			**1**
		SMW	Surface Missing Wall					1	**1**
			Cover condition corroded				8		**8**
			Ring condition corroded				2		**2**
			Frame condition broken					4	**4**
			Frame condition corroded				26		**26**
			Seal condition cracked				11		**11**
			Seal condition loose			1			**1**
			Seal condition offset			10			**10**
			Frame seal inflow	20	4				**24**
			Chimney inflow and infiltration	13	9		1		**23**
	RB06			**10**	**0**	**15**	**4**	**1**	**30**
		H	Hole				1		**1**
		IS	Infiltration Stain	4					**4**
		LFDC	Lining Failure Discoloration			3			**3**
		LFDL	Lining Failure Delaminating			12			**12**
		RFJ	Roots Fine Joint	1					**1**
			Cover condition cracked				1		**1**
			Cover condition corroded				1		**1**
			Frame condition cracked				1		**1**
			Frame condition broken					1	**1**
			Frame seal inflow	1					**1**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
			Chimney inflow and infiltration	4					**4**
	RB07			**4**	**0**	**1**	**1**	**0**	**6**
		IR	Infiltration Runner				1		**1**
		IS	Infiltration Stain	3					**3**
		MMM	Mortar Missing Medium			1			**1**
			Chimney inflow and infiltration	1					**1**
	RB08			**67**	**33**	**57**	**37**	**2**	**196**
		B	Broken		1				**1**
		CC	Crack Circumferential	1					**1**
		CM	Crack Multiple			1			**1**
		CS	Crack Spiral		1				**1**
		H	Hole				17		**17**
		IR	Infiltration Runner				2		**2**
		IS	Infiltration Stain	42					**42**
		ISSR	Intruding Sealing Ring		2				**2**
		IW	Infiltration Weeper		10				**10**
		LFB	Lining Failure Blistered			1			**1**
		LFD	Lining Failure Detached			2			**2**
		LFDC	Lining Failure Discoloration			5			**5**
		LFDL	Lining Failure Delaminating			11			**11**
		MML	Mortar Missing Large			6			**6**
		MMM	Mortar Missing Medium			21			**21**
		MMS	Mortar Missing Small		18				**18**
		OBP	Obstacle External Pipe or Cable			1			**1**
		RFJ	Roots Fine Joint	6					**6**
			Cover condition corroded				2		**2**
			Frame condition cracked				1		**1**
			Frame condition broken					2	**2**
			Frame condition corroded				12		**12**
			Seal condition cracked				2		**2**
			Seal condition loose			4			**4**
			Seal condition offset			5			**5**
			Seal condition missing				1		**1**
			Frame seal inflow	2	1				**3**
			Chimney inflow and infiltration	16					**16**
Smith Branch Basin				**137**	**31**	**24**	**57**	**17**	**266**
	SB01			**2**	**0**	**2**	**1**	**1**	**6**
		IS	Infiltration Stain	2					**2**
			Frame condition broken					1	**1**
			Seal condition loose			1			**1**
			Frame seal inflow			1	1		**2**
	SB02			**55**	**12**	**3**	**6**	**5**	**81**
		FC	Fracture Circumferential		1				**1**
		FM	Fracture Multiple				2		**2**
		H	Hole				2		**2**
		HSV	Hole Soil Visible					1	**1**
		HVV	Hole Void Visible					1	**1**
		ID	Infiltration Dripper			1			**1**
		IR	Infiltration Runner				2		**2**
		IS	Infiltration Stain	34					**34**
		ISGT	Intruding Sealing Grout		1				**1**
		ISSR	Intruding Sealing Ring		1				**1**
		IW	Infiltration Weeper		7				**7**
		MML	Mortar Missing Large			1			**1**
		MMS	Mortar Missing Small		1				**1**
			Frame condition broken					3	**3**
			Chimney inflow and infiltration	21	1	1			**23**
	SB03			**16**	**6**	**0**	**2**	**0**	**24**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
		CL	Crack Longitudinal		2				**2**
		IR	Infiltration Runner				2		**2**
		IS	Infiltration Stain	11					**11**
		IW	Infiltration Weeper		4				**4**
		RFJ	Roots Fine Joint	2					**2**
			Chimney inflow and infiltration	3					**3**
	SB04			**22**	**6**	**3**	**26**	**6**	**63**
		CC	Crack Circumferential	1					**1**
		CL	Crack Longitudinal		1				**1**
		CM	Crack Multiple			1			**1**
		IS	Infiltration Stain	9					**9**
		IW	Infiltration Weeper		2				**2**
		MB	Missing Brick				1		**1**
		MMS	Mortar Missing Small		3				**3**
		RBB	Roots Ball Barrel					2	**2**
		RBJ	Roots Ball Joint				1		**1**
		RFJ	Roots Fine Joint	2					**2**
		RMJ	Roots Medium Joint			2			**2**
			Cover condition corroded				4		**4**
			Cover condition missing					2	**2**
			Ring condition corroded				1		**1**
			Frame condition cracked				2		**2**
			Frame condition broken					1	**1**
			Frame condition missing					1	**1**
			Frame condition corroded				10		**10**
			Seal condition cracked				7		**7**
			Frame seal inflow	5					**5**
			Chimney inflow and infiltration	5					**5**
	SB05			**38**	**5**	**11**	**13**	**5**	**72**
		BSV	Broken Soil Visible			2			**2**
		CM	Crack Multiple			1			**1**
		H	Hole				1		**1**
		ID	Infiltration Dripper			1			**1**
		IR	Infiltration Runner				1		**1**
		IS	Infiltration Stain	15					**15**
		IW	Infiltration Weeper		2				**2**
		MMM	Mortar Missing Medium			2			**2**
		MMS	Mortar Missing Small		3				**3**
		RFB	Roots Fine Barrel	2					**2**
		RFJ	Roots Fine Joint	8					**8**
		RMJ	Roots Medium Joint			2			**2**
		SMW	Surface Missing Wall					1	**1**
			Cover condition broken					1	**1**
			Cover condition corroded				1		**1**
			Frame condition broken					3	**3**
			Frame condition corroded				8		**8**
			Seal condition cracked				2		**2**
			Seal condition loose			3			**3**
			Frame seal inflow	1					**1**
			Chimney inflow and infiltration	12					**12**
	SB06			**4**	**2**	**5**	**9**	**0**	**20**
		H	Hole				1		**1**
		IR	Infiltration Runner				1		**1**
		IW	Infiltration Weeper		2				**2**
		MB	Missing Brick				3		**3**
		RFJ	Roots Fine Joint	3					**3**
		RMJ	Roots Medium Joint			2			**2**
			Frame condition corroded				3		**3**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
			Seal condition loose			3			**3**
			Seal condition missing				1		**1**
			Chimney inflow and infiltration	1					**1**
Saluda River Basin				**362**	**31**	**81**	**135**	**22**	**631**
	SR01			**20**	**6**	**13**	**7**	**1**	**47**
		CL	Crack Longitudinal		1				**1**
		HSV	Hole Soil Visible					1	**1**
		ID	Infiltration Dripper			9			**9**
		IS	Infiltration Stain	4					**4**
		IW	Infiltration Weeper		3				**3**
		RFB	Roots Fine Barrel	2					**2**
		RFJ	Roots Fine Joint	1					**1**
		RMB	Roots Medium Barrel				3		**3**
		RMJ	Roots Medium Joint			1			**1**
		RTB	Roots Tap Barrel			3			**3**
		RTJ	Roots Tap Joint		2				**2**
			Cover condition corroded				1		**1**
			Frame condition corroded				1		**1**
			Seal condition cracked				2		**2**
			Frame seal inflow	12					**12**
			Chimney inflow and infiltration	1					**1**
	SR02			**6**	**0**	**0**	**17**	**0**	**23**
		RFB	Roots Fine Barrel	1					**1**
		RFJ	Roots Fine Joint	1					**1**
			Cover condition corroded				3		**3**
			Frame condition corroded				7		**7**
			Seal condition cracked				7		**7**
			Frame seal inflow	4					**4**
	SR04			**52**	**2**	**10**	**9**	**2**	**75**
		ID	Infiltration Dripper			2			**2**
		IR	Infiltration Runner				2		**2**
		IS	Infiltration Stain	3					**3**
		LFD	Lining Failure Detached			1			**1**
		MB	Missing Brick				1		**1**
		MMM	Mortar Missing Medium			1			**1**
		RFJ	Roots Fine Joint	4					**4**
		RMB	Roots Medium Barrel				1		**1**
		RMJ	Roots Medium Joint			5			**5**
		RTB	Roots Tap Barrel			1			**1**
		RTJ	Roots Tap Joint		2				**2**
			Frame condition broken					2	**2**
			Frame condition corroded				2		**2**
			Seal condition cracked				1		**1**
			Seal condition missing				2		**2**
			Frame seal inflow	42					**42**
			Chimney inflow and infiltration	3					**3**
	SR05			**24**	**2**	**4**	**10**	**0**	**40**
		IR	Infiltration Runner				1		**1**
		IS	Infiltration Stain	7					**7**
		RFB	Roots Fine Barrel	1					**1**
		RMB	Roots Medium Barrel				1		**1**
		RMJ	Roots Medium Joint			2			**2**
		RTB	Roots Tap Barrel			2			**2**
		RTJ	Roots Tap Joint		1				**1**
			Cover condition corroded				2		**2**
			Frame condition corroded				5		**5**
			Seal condition cracked				1		**1**
			Frame seal inflow	14					**14**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
			Chimney inflow and infiltration	2	1				**3**
	SR06			**54**	**2**	**8**	**9**	**4**	**77**
		H	Hole				2		**2**
		ID	Infiltration Dripper			2			**2**
		IS	Infiltration Stain	5					**5**
		IW	Infiltration Weeper		1				**1**
		MB	Missing Brick				1		**1**
		MMM	Mortar Missing Medium			3			**3**
		RFB	Roots Fine Barrel	1					**1**
		RFJ	Roots Fine Joint	2					**2**
		RMB	Roots Medium Barrel				2		**2**
		RMJ	Roots Medium Joint			3			**3**
			Cover condition broken					1	**1**
			Cover condition missing					1	**1**
			Frame condition broken					2	**2**
			Seal condition cracked				3		**3**
			Seal condition missing				1		**1**
			Frame seal inflow	43	1				**44**
			Chimney inflow and infiltration	3					**3**
	SR07			**32**	**0**	**5**	**41**	**0**	**78**
		IS	Infiltration Stain	2					**2**
		LFDL	Lining Failure Delaminating			1			**1**
		LFPH	Lining Failure Pinhole			1			**1**
		OBI	Obstacle Intruding Thru Wall			1			**1**
		RFJ	Roots Fine Joint	3					**3**
		RMB	Roots Medium Barrel				1		**1**
		RMJ	Roots Medium Joint			1			**1**
			Cover condition corroded				1		**1**
			Ring condition corroded				4		**4**
			Frame condition corroded				19		**19**
			Seal condition cracked				16		**16**
			Seal condition offset			1			**1**
			Frame seal inflow	25					**25**
			Chimney inflow and infiltration	2					**2**
	SR08			**11**	**0**	**0**	**2**	**1**	**14**
			Frame condition broken					1	**1**
			Seal condition missing				2		**2**
			Frame seal inflow	10					**10**
			Chimney inflow and infiltration	1					**1**
	SR09			**40**	**2**	**6**	**9**	**4**	**61**
		B	Broken		1				**1**
		CL	Crack Longitudinal		1				**1**
		CM	Crack Multiple			1			**1**
		IR	Infiltration Runner				3		**3**
		IS	Infiltration Stain	4					**4**
		LFD	Lining Failure Detached			4			**4**
		MML	Mortar Missing Large			1			**1**
		RMB	Roots Medium Barrel				1		**1**
			Frame condition broken					4	**4**
			Frame condition corroded				2		**2**
			Seal condition cracked				2		**2**
			Frame seal inflow	36					**36**
			Chimney inflow and infiltration				1		**1**
	SR10			**3**	**2**	**0**	**0**	**1**	**6**
		IW	Infiltration Weeper		1				**1**
			Frame condition broken					1	**1**
			Frame seal inflow	3					**3**
			Chimney inflow and infiltration		1				**1**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
	SR11			**39**	**1**	**11**	**4**	**1**	**56**
		CM	Crack Multiple			1			**1**
		IS	Infiltration Stain	2					**2**
		ISSR	Intruding Sealing Ring		1				**1**
		LFDL	Lining Failure Delaminating			1			**1**
		LFZ	Lining Failure Other			3			**3**
		MB	Missing Brick				1		**1**
		MML	Mortar Missing Large			1			**1**
		OBI	Obstacle Intruding Thru Wall			1			**1**
		RBJ	Roots Ball Joint				1		**1**
		RFB	Roots Fine Barrel	2					**2**
		RFJ	Roots Fine Joint	5					**5**
		RMB	Roots Medium Barrel				1		**1**
		RMJ	Roots Medium Joint			3			**3**
			Ring condition cracked				1		**1**
			Frame condition broken					1	**1**
			Seal condition loose			1			**1**
			Frame seal inflow	29					**29**
			Chimney inflow and infiltration	1					**1**
	SR13			**2**	**0**	**2**	**5**	**1**	**10**
		IS	Infiltration Stain	1					**1**
		LFD	Lining Failure Detached			1			**1**
			Ring condition corroded				1		**1**
			Frame condition broken					1	**1**
			Frame condition corroded				2		**2**
			Seal condition cracked				2		**2**
			Seal condition offset			1			**1**
			Frame seal inflow	1					**1**
	SR14			**67**	**11**	**13**	**12**	**3**	**106**
		B	Broken		1				**1**
		H	Hole				1		**1**
		ID	Infiltration Dripper			2			**2**
		IR	Infiltration Runner				1		**1**
		IS	Infiltration Stain	28					**28**
		ISSR	Intruding Sealing Ring		3				**3**
		IW	Infiltration Weeper		3				**3**
		LFD	Lining Failure Detached			1			**1**
		LFDL	Lining Failure Delaminating			7			**7**
		MMM	Mortar Missing Medium			2			**2**
		RFJ	Roots Fine Joint	5					**5**
		RMJ	Roots Medium Joint			1			**1**
		RTJ	Roots Tap Joint		1				**1**
			Ring condition broken					1	**1**
			Ring condition corroded				3		**3**
			Frame condition broken					2	**2**
			Frame condition corroded				4		**4**
			Seal condition missing				3		**3**
			Frame seal inflow	26	2				**28**
			Chimney inflow and infiltration	8	1				**9**
	SR15			**12**	**3**	**9**	**10**	**4**	**38**
		B	Broken		2				**2**
		CC	Crack Circumferential	1					**1**
		CL	Crack Longitudinal		1				**1**
		ID	Infiltration Dripper			1			**1**
		IR	Infiltration Runner				1		**1**
		IS	Infiltration Stain	6					**6**
		LFD	Lining Failure Detached			3			**3**
		LFDL	Lining Failure Delaminating			2			**2**

Sub-basin ID		PACP Code	Code Description	Defect Rating					Grand Total
				1	2	3	4	5	
		MMM	Mortar Missing Medium			1			**1**
			Cover condition cracked				1		**1**
			Cover condition broken					2	**2**
			Ring condition broken					2	**2**
			Ring condition corroded				1		**1**
			Ring condition poor install				1		**1**
			Frame condition corroded				3		**3**
			Seal condition cracked				3		**3**
			Seal condition loose			1			**1**
			Seal condition offset			1			**1**
			Frame seal inflow	2					**2**
			Chimney inflow and infiltration	3					**3**
West Columbia Basin				**21**	**5**	**37**	**10**	**2**	**75**
	WC01			**9**	**4**	**27**	**2**	**0**	**42**
		IS	Infiltration Stain	5					**5**
		IW	Infiltration Weeper		3				**3**
		LFBK	Lining Failure Buckled			1			**1**
		LFBU	Lining Failure Bulges			1			**1**
		LFDC	Lining Failure Discoloration			2			**2**
		LFDL	Lining Failure Delaminating			3			**3**
		MMM	Mortar Missing Medium			19			**19**
		MMS	Mortar Missing Small		1				**1**
		OBP	Obstacle External Pipe or Cable			1			**1**
			Cover condition corroded				1		**1**
			Frame condition corroded				1		**1**
			Chimney inflow and infiltration	4					**4**
	WC02			**12**	**1**	**10**	**8**	**2**	**33**
		H	Hole				1		**1**
		HSV	Hole Soil Visible					1	**1**
		HVV	Hole Void Visible					1	**1**
		IS	Infiltration Stain	3					**3**
		MMM	Mortar Missing Medium			7			**7**
		MMS	Mortar Missing Small		1				**1**
		RFB	Roots Fine Barrel	1					**1**
		RFJ	Roots Fine Joint	4					**4**
		RMB	Roots Medium Barrel				1		**1**
		RMJ	Roots Medium Joint			2			**2**
			Cover condition corroded				1		**1**
			Frame condition cracked				1		**1**
			Frame condition corroded				4		**4**
			Seal condition offset			1			**1**
			Frame seal inflow	2					**2**
			Chimney inflow and infiltration	2					**2**
Grand Total				**1,334**	**452**	**701**	**812**	**160**	**3,459**