# CONTINUOUS SEWER SYSTEMS ASSESSMENT PROGRAM (CSSAP)

FOR

# *Winchester Municipal Utilities*

## *Winchester, Kentucky*

August 2009

(Reviewed 11-30-16)

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## 1.0 EXECUTIVE SUMMARY

Winchester Municipal Utilities (WMU) finalized its Consent Decree with the Environmental Protection Agency (EPA) in April 2007 for violations of the Clean Water Act that included 27 documented recurring Sanitary Sewer Overflow (SSO) locations. The Consent Decree requires the City of Winchester and WMU to develop, submit, finalize, and implement plans for the continued improvement of the wastewater collection and transmission system and of the wastewater treatment plant (WWTP).

The Continuous Sewer System Assessment Program (CSSAP) establishes procedures for setting sewer-basin priorities and schedules for undertaking the assessment components discussed within this document. The CSSAP shall develop these priorities and schedules, taking into consideration: the nature and extent of any customer complaints; flow monitoring, including flow isolation studies; location and cause of SSOs, including those identified pursuant to the SSOP; pump station run times; field crew work orders; any preliminary sewer assessments; and any other relevant information. The CSSAP includes procedures for establishment of an information management system and performance goals for each component.

The CSSAP will be reviewed annually by WMU management to ensure all elements are up-to-date and are being implemented as outlined. A review and update log is provided in Appendix A.

WMU is committed to efficiently maintaining and operating its sanitary sewer system to reduce the negative impact on the environment in Winchester and Clark County, and to conform to requirements set forth in federal and state regulations and in the Consent Decree.

## 2.0 DEFINITION OF TERMS

**Business Hours** – Hours that WMU has customer service representatives available to handle customer inquiries and/or complaints. (Monday – Friday: 7:00 a.m. – 4:00 p.m.)

**Closed-Circuit Television (CCTV)** – The use of video cameras to broadcast images to a specific place and on a limited set of monitors; this is the means by which the internal condition of a pipe or other subsurface structure is visually inspected.

**Collection System** – The network of gravity sewer pipes, manholes, and associated appurtenances that conveys wastewater to a pump station or to the wastewater treatment plant.

**Control Zone** – The immediate area established around an SSO to warn of the potential health hazard associated with the SSO.

**Corrosion** – The deterioration of a material due to chemical reactions with its environment. E.g., oxidation.

**Customer Service Program –** A WMU-developed database program that allows WMU to electronically file customer complaints

**Environmental Protection Agency (EPA)** – United States Environmental Protection Agency, Region 4. Federal regulatory agency with the mission of protecting the environment.

**First Responder(s)** – Qualified WMU personnel who assume initial responsibility for an SSO event. Typically, two (2) employees will be present during initial response.

**Force Main Sewer** – A pressurized sewer line that conveys wastewater to some point in the collection system or to the wastewater treatment plant.

**Full Time Employee** (FTE) – Individual employed by WMU and working a 40-hour work week.

**Geographic Information System (GIS)** – A spatially related, automated mapping database created and maintained by WMU that contains all of WMU's sanitary sewer system and appurtenant structures.

**Gravity Sewer** – A sewer line that utilizes gradient to transport wastewater to a pump station or to the wastewater treatment plant.

**Infiltration** – The introduction of groundwater into the sewer system by such means as defective pipes, pipe joints, connections between pipes, or manhole covers.

**Inflow** – The introduction of surface water runoff to the sewer system from sources such as: roof leaders; drains in basements, driveways, and yards; manhole covers; and cross connections from storm sewers.

**Kentucky Division of Water (KDOW)** – State regulatory agency with the mission of managing, protecting, and enhancing the quality and quantity of the Commonwealth's water resources through voluntary, regulatory, and educational programs.

**Manhole** – Structure within the sanitary sewer system that provides access to the system for visual inspections and for performance of maintenance. Typically located at intersections with other line sections or changes in vertical elevations.

**Non-Business Hours** – Hours that WMU customer service representatives are not available to handle customer inquiries and/or complaints. During this time, customer inquiries and complaints are handled by Emergency Contacts. (Mon -Fri 4:00 p.m. – 7:00 a.m., Saturdays, Sundays, holidays)

**On-Call Staff** – WMU or contact personnel available during non-business hours to respond to emergency situations.

**Point Repair** – Repair made at a specific point in a line section as a means of corrective action.

**Private Sewer** – A sewer not meeting any or a portion of the criteria for ownership and perpetual maintenance as set forth in WMU Policy 408.1.

**Pump Station** – That part of the sanitary sewer system responsible for conveying sewage under pressure from the collection system to another gravity sewer or to the treatment plant.

**Pump Station Technician(s)** – WMU personnel who perform routine maintenance checks on the pump stations appurtenant to the sewer system.

**Sanitary Sewer Overflow (SSO)** – Any discharge to waters of the United States from the Sewer System owned and operated by the City and WMU through point sources not specified in any KPDES permit (otherwise known as "Unpermitted Discharges"), as well as any release of wastewater from the Sewer System to public or private property that does not reach waters of the United States, such as a release to a land surface or structure that does not reach waters of the United States; provided, however, that releases or wastewater backups into buildings that are caused by blockages, flow conditions, or malfunctions in a building lateral, or other piping or conveyance system that is not owned or operationally controlled by the City and WMU, are not SSOs for the purposes of WMU's Consent Decree.

**Sanitary Sewer Overflow Response Plan (SORP)** – Guidance document that delineates WMU's options for responding to sanitary sewer system overflows.

**Service Lateral** – Pipes that receive sewage from homes and businesses and transport that sewage to the publicly-owned sewer system.

**Sewer System –** The wastewater collection, retention, and transmission system owned or operated by the City and WMU designed to collect and convey municipal sewage (domestic, commercial and industrial) to the WWTP. The sewer system does not include any sewer systems that are not owned by the City or WMU.

**Transmission System** – The network of force main sewers, pump stations, and associated appurtenances that conveys wastewater to some point in the collection system or to the wastewater treatment plant.

**Unpermitted Bypass** – Any discharge to the waters of the United States from the Wastewater Treatment Plant (WWTP) which constitutes a prohibited bypass as defined in 40 C.F.R. § 122.41(m).

**Waters of the Commonwealth** –Any and all rivers, streams, creeks, lakes, ponds, impounding reservoirs, springs, wells, marshes, and all other bodies of surface or underground water, natural or artificial, situated wholly within, partly within, or bordering upon the Commonwealth or its jurisdiction as defined by KRS 224.01-010.

**WMU Cleanout** – A vertical pipe with a removable cap extending from a service lateral to the surface of the ground, to provide access to the service lateral for inspection and maintenance. Typically, the WMU cleanout is located at the limit of the easement or right-of-way line.

# 3.0 SYSTEM AND ORGANIZATIONAL STRUCTURE

## *3.1 WMU Wastewater System*

Currently, WMU provides wastewater service to 11,452 residential, commercial, institutional, and industrial customers. The WMU sewer system is comprised of the following:

- 154.36 miles of gravity sewer and force main
- 0.8 miles of private sewer (including private pump stations)
- 3,849 manholes
- 10 pump stations
- 2 wastewater treatment plants

Construction of a new 7.2 MGD average day with 24.0 MGD peak hydraulic wastewater treatment plant was completed and operational January 21, 2008 (Strodes Creek WWTP). The new facility utilizes influent pumping, screening, biological nutrient removal system (BNR), oxidation ditches, clarification, ultraviolet disinfection, and post aeration. Discharge is to Strodes Creek a tributary to the Licking River watershed. Solids generated by the WWTP are dewatered using belt filter presses and stabilized through a lime/alkaline stabilization process to produce Class A biosolids. The biosolids are distributed for local use in Winchester and Clark County. WMU charges users a hauling fee for delivery of the biosolids based on distance.

Construction of a new 2.0 MGD average day with 10.0 MGD peak hydraulic wastewater treatment plant was completed and operational February 12, 2013 (Lower Howards Creek WWTP). The new facility utilizes influent pumping, screening, biological nutrient removal system (BNR), oxidation ditches, clarification, ultraviolet disinfection, and post aeration. Discharge is to the Kentucky River, Pool No. 9. Solids generated by the WWTP are dewatered using belt filter presses and landfilled.

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WMU maintains a GIS database of sanitary sewer line sections within the WMU sewer system. The sanitary sewer line sections are located in five (5) watersheds that are divided into a total of fourteen (14) subwatersheds. WMU owns and maintains sewer system lines in eight (8) of the fourteen (14) subwatersheds. A map of the overall sewer system is provided in Appendix B.

WMU owns and maintains the sewer system and appurtenances that transport the wastewater to the treatment plant. WMU Policies 203.1, 402.2 and 408.1, (Appendix C), establish points of ownership and maintenance for the utility and the customer. In general, WMU owns and maintains the sanitary sewer system to the right-of-way or easement limit. Typically, a cleanout is located at the right-of-way or easement limit to establish the point of responsibility. A private sanitary sewer line is defined in WMU Policy 408.1 and maintained per WMU Policy 203.1. In the event a problem occurs on a private sanitary sewer and repair or maintenance is required to protect the health, safety, and welfare of the general public, work may be initiated by WMU to alleviate, eliminate, or mitigate the problem.

### *3.2 WMU Organizational Structure*

A copy of WMU's organizational structure is shown in Figure 3-1: WMU Organizational Chart. An Emergency Contact List and list of Contract Service Providers is provided in Appendix D. Procedures for notification of personnel in the event of an emergency are outlined in WMU's Sewer Overflow Response Plan, October 2007.

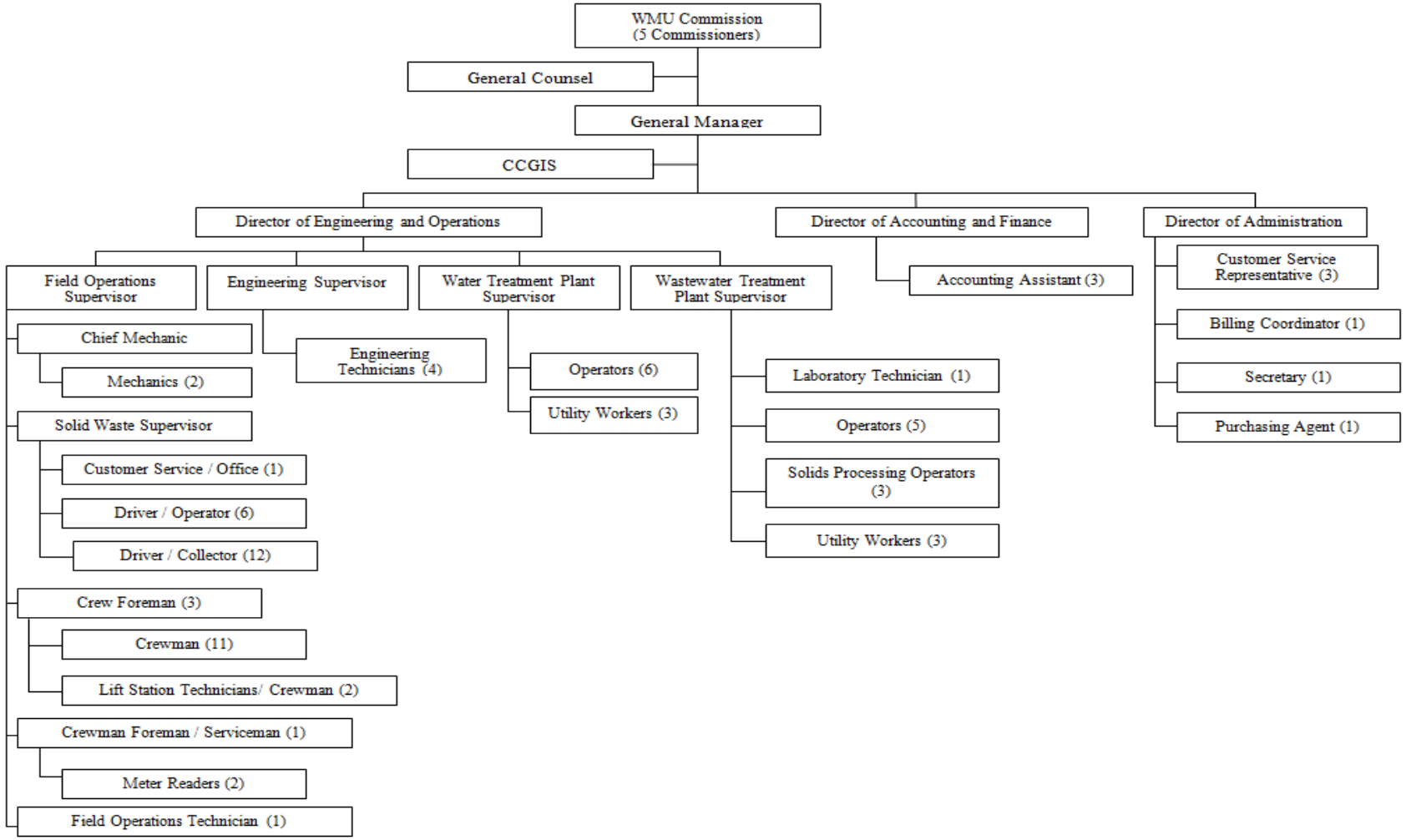
### *3.3 Employee Responsibilities*

- General Manager – Responsible for overall CSSAP compliance. Oversight includes regulatory compliance and ensuring the financial capacity of the utility to comply with CSSAP requirements.

- Director of Operations/Engineering – Serves as the Program Manager. Ensures implementation of the CSSAP with respect to manpower, coordination, and engineering functions.

- Field Operations Supervisor – Responsible for allocating weekly manpower and equipment to comply with the CSSAP.
- Staff Engineer – Responsible for providing engineering support needed to comply with the CSSAP.
- Crew Foreman – Responsible for overseeing the daily tasks performed to comply with the CSSAP.

## FIGURE 3-1: WMU ORGANIZATIONAL CHART



## 4.0 SEWER SYSTEM ASSESSMENT PRIORITY PROGRAM

For normal operations, WMU uses a comprehensive subwatershed approach for scheduling and prioritizing maintenance and assessments, as opposed to scheduling activities on individual line segments spread across different basins. In the event of a problem, such as an overflow, WMU will re-schedule maintenance and inspection activities to the portion of the system where maintenance is required to correct the situation, regardless of location. WMU maintains a Sewer Overflow Response Plan, updated October 2015, which establishes procedures for the notification process and work order generation for sewer system emergencies. A sample work order is shown in Appendix E of this plan.

### *4.1 Scheduling and Prioritization*

#### *4.1.1. Gravity Sewer Lines*

WMU schedules cleaning/inspection of gravity lines by subwatershed according to the following rotating cycle:

1. Strodes Creek, Basin C
2. Strodes Creek, Basin A
3. Strodes Creek, Basin B
4. Strodes Creek, Basin D
5. Lower Howard Creek, Basin A
6. Hoods Creek
7. Four Mile Creek, Basin A
8. Four Mile Creek, Basin B

Prioritization for cleaning and maintenance of the gravity line sections within each subwatershed is based upon WMU's current knowledge of the condition of the system, including, but not limited to:

- Structural Integrity/Pipe Failure Potential – Physical and CCTV inspection data, as well as smoke/dye testing may be used to determine the structural integrity of a pipe segment as well as the presence of leaks that may permit infiltration and inflow (I/I). WMU also considers the age and type of material when evaluating the structural condition of the pipe.
- Potential for Bypass/Surcharge – WMU will review the Historic Blockage Frequency (HBF), available flow monitoring data, as well as historical records of overflows to assess the potential risk of overflows or surcharges that may result in a threat to the public's health or safety.
- Historic Complaint/Work Order Record – WMU will assign higher priorities to pipe segments with a history of overflow and/or odor complaints from customers. When a customer compliant is taken either on the phone or in person, the complaint is entered into the Customer Service Program. This database program generates a Work Order form, upon which the complaint is then recorded. The WMU staff then calls the field crew, notifying them of the Work Order. The field crew takes the WMU Service Department Authorization Form and the Work Order form to the inspection location. The field crew determines the cause of the odor and takes action accordingly, documenting the cause and response on the Work Order. This information is entered into the database program as well. Once per month, a query is run, totaling the number of customer complaints based on type. The results are reported on the Commissioner Departmental Report. This report is distributed to key personnel at WMU and to the WMU Commissioners for review. If deemed necessary by the reviewers, a project or projects addressing a historical complaint or historical complaints may be included in the Infrastructure Rehabilitation Program's project list. Sample screenshots from the database program and forms are shown in Appendix E.

Information on individual line segments is collected and input to the Winchester Municipal Utilities Pipe Evaluation Model Sanitary Sewer Main Inventory Data Sheet (Appendix E), and the WMU Sanitary Sewer Main Replacement Program data sheet (Appendix E). Data is updated for each line segment during cleaning/CCTV activities, or after an incident such as an overflow. Data is maintained electronically in WMU's GIS database, and forms are filed for future reference.

WMU employs a numerical rating system to prioritize pipe segments for rehabilitation or replacement. Pipe attributes, including age, type, material, maintenance history, cost and constructability factors are assigned a point value and multiplied by an "importance factor." Pipe segments are then prioritized for replacement based on their rating. The form used in this prioritization can be found in Appendix E.

### *4.1.2. Force Mains*

Prioritization and scheduling for inspection and maintenance of force mains is primarily based on identifying line segments with the highest potential for corrosion based on WMU's knowledge of the system. WMU maintains a Corrosion Control Program, updated April, 2008, which outlines procedures for the identification and control of corrosion within force mains. WMU's long-term goal is to reduce, through capital projects, the number of force mains in the system.

### *4.1.3. Manholes*

Condition assessments for manholes are scheduled concurrently with inspection, hydraulic cleaning, and camera inspection of associated pipe segments. Procedures for inspection of manholes are described in Section 5.5 of this plan. Manholes are evaluated based on, but not limited to, the following criteria:

- Structural integrity
- Obstructions or debris that may result in restriction of flow or overflows
- Potential for infiltration/inflow through manhole cover, walls, joints, or penetrations

Inspection data is documented on a "Manhole Data – Sewer System Evaluation Survey" form (See Appendix E).

Prioritization for rehabilitation or replacement of manholes is based on the priority rating of its associated pipe segments (see Section 4.1.1 of this plan). Out-of-cycle rehabilitation or replacement of a manhole may be programmed if WMU determines that structural deterioration or I/I in a manhole presents a significant SSO potential.

### *4.1.4. Pump Stations*

WMU currently operates 10 pump stations (See Appendix F for a list of pump stations). Pump stations undergo routine maintenance and inspection no less than 3 times weekly. In addition, a maintenance checklist as shown in Appendix E is completed monthly, documenting pump run times, gauge readings, and general maintenance items, as well as any physical evidence of corrosion. Based on monthly performance measures, WMU will review pump run times to track changes over time and to identify significant changes in pump station performance. Prioritization for further assessment and corrective actions will be given to pump stations exhibiting changes in the following:

- Frequency of pump starts
- Average cycle time
- Daily hours of operation
- Maintenance costs
- Pump station failures

Significant changes to these parameters over time could be indicative of problems such as increased flows due to I/I, decreased capacity due to pump wear, clogs in the pumps or pipes, or air binding in the force main. Further assessment procedures are described in Section 5.6 of this plan. WMU's long-term goal is the reduction of the number of pump stations in the system through capital projects.

### *4.2 Performance Goals*

Based on WMU's current schedule, the overall performance goals for the elements of the CSSAP plan are as follows:

- Sewer Line Condition Assessment (Gravity Lines) – Full system assessment approximately every four years (based on current Routine Hydraulic Cleaning schedule)
- Structural/Corrosion Defect Identification (Force Mains) – as needed
- Routine Manhole Inspection – performed in conjunction with associated gravity line assessment
- Corrosion Defect Identification (Pump Station) – performed during routine maintenance (no less than 3 times weekly)
- Pump Station Performance and Adequacy – every month

## 5.0 ASSESSMENT TOOLS

To support the CSSAP, WMU will employ standard industry techniques to determine the condition and operability of the sanitary sewer system. The following tools provide WMU with various options for assessing and prioritizing different components of the system:

- Closed-Circuit Television (CCTV) Inspection
- Smoke Testing
- Dye Testing
- Corrosion Defect Identification
- Manhole Inspection
- Flow Monitoring
- Pump Station Performance and Adequacy

### *5.1 Closed Circuit (CCTV) Inspection*

CCTV inspection is employed during and after hydraulic cleaning activities, and at other times as directed by WMU management, as in the event of an overflow or blockage. The primary purposes of CCTV are to assess the structural condition of the pipe, verify cleaning, and determine areas that require repair or replacement including manholes. It is also used to assist in pinpointing the location of problems such as blockages or sources of infiltration/inflow. In addition to existing pipes, CCTV inspection is performed on all new pipe segments prior to acceptance into the WMU system.

Results of CCTV inspections are documented on a Hydraulic Cleaning/Camera Report Form and saved to electronic media. Inspections are also recorded on DVD. Report forms are filed and maintained for future reference. WMU has developed procedures for integrating information from CCTV inspection into the GIS database.

WMU currently has two operators trained in National Association of Sewer Service Companies' (NASSCO) Pipeline Assessment and Certification Program (PACP). PACP provides data collection and assessment tools that will allow WMU to benchmark its condition assessments with other systems. WMU will integrate PACP standards into its routine inspection and CCTV program.

WMU maintains a Routine Hydraulic Cleaning Program, updated April 2008, outlining Standard Operating Procedures for routine hydraulic cleaning and CCTV inspection of sewer lines. Standard Operating Procedures for cleaning and CCTV inspection are also included in Appendix G of this plan. Assuming WMU staff has 200 working days in a calendar year, it should take approximately four (4) years to clean and inspect the 154.36 miles of gravity sewer. Once the entire system has been cleaned and inspected, the process starts over, provided review of the program does not determine a need to reprioritize the cleaning schedule.

### *5.2 Smoke/Dye Testing*

WMU Operations personnel will employ smoke testing to identify and locate the presence of inflow/infiltration (I/I) within the sewer system. The procedure consists of blowing air and non-toxic smoke through the lines. The smoke follows the reverse path of the unintended inflow, from its entrance into the pipe to its source on the ground surface. Potential sources of inflow include:

- defects, such as cracks or breaks, in the pipe;
- cross connections with storm sewers;
- unintended drainage, such as roof/cellar drains, yard drains, or sump pumps, to the sanitary sewer;
- broken cleanout caps/covers; and
- damaged manholes.

Dye testing is used to identify rain or groundwater entry into the system by introducing dyed water into area drains and monitoring downstream sewer flows for dyed water.

Smoke and dye testing are directed by WMU Management as needed in areas of the system where excessive inflow or infiltration is suspected.

### *5.3 Flow Monitoring*

Flow monitoring is an important tool in the management of wastewater flows. Data collected from flow monitoring is analyzed for the following uses:

- Determining dry and wet weather flows
- Prioritizing areas for rehabilitation
- Determining the adequacy of the system to support both dry and wet-weather flows
- Quantifying the reduction of I/I in rehabilitated areas
- Providing data for development/calibration of the system hydraulic model and for flow trend analysis

Flow monitoring can be categorized as permanent (long-term) or temporary (short-term). Permanent monitoring is used to monitor the effectiveness of sewer maintenance and rehabilitation programs and to provide long-term I/I data. Temporary flow monitoring uses portable equipment to capture data over a specified period of time, with 60 days being the usual minimum period.

Currently, WMU conducts flow monitoring in concert with the Five Year Capital Plan – a program which contains projects addressing areas that are susceptible to infiltration and inflow. Typically, WMU's temporary (portable) flow-monitoring devices are installed downstream of the Capital Plan project area and utilized for one year before a project begins and for one year after the project has been completed, so as to assess the project's effectiveness in reducing infiltration and inflow. For such an assessment, accurate rain data is necessary. Currently, this data is supplied by rain gauges which are located in the same sewershed as the flow-monitoring equipment. When needed, existing rainfall data is supplemented with Doppler data. It should be noted this work is also performed in concert with flow monitoring work performed as part of the Capacity Assurance Program (CAP).

After the flow monitoring data and rainfall data are collected, the data is analyzed for the purposes of prioritizing areas for the CSSAP and updating the hydraulic models.

### *5.4 Corrosion Defect Identification*

Corrosion in system components can lead to failures resulting in excessive infiltration. In cases of catastrophic failure, such as a pipe collapse, sanitary sewer overflows which threaten public health and safety may occur.

Based upon WMU's knowledge of the existing system, the greatest potential for corrosion exists at the ten (10) pump stations and along the route of the force main sewer from the pumping stations to each station's ultimate discharge location (manhole). Therefore, prioritization for corrosion control assessment will privilege these areas. Other areas of the collection system, including gravity lines and manholes, are addressed in WMU's Corrosion Control Program as well. This program was established in April 2008, to document procedures used to identify and assess areas susceptible to corrosion. WMU will prioritize existing and potential corrosion defects based on their likeliness to cause short-term failure and the results of such a failure.

Blockage in force mains requires special work. In the event of a blockage in a gravity sewer component, hydraulic cleaning may be necessary prior to inspection. Standard Operating Procedures for CCTV inspection and hydraulic cleaning are located in Appendix G, and in the WMU Corrosion Control Plan. In cases of severe corrosion where rehabilitation or replacement may be necessary, WMU will implement the Infrastructure Rehabilitation Program (IRP) to develop and prioritize corrective actions.

During the course of normal operations for sewage pump station maintenance, which occurs three (3) times per week, corrosion problems will be identified. Visual inspection for corrosion will focus on areas with the highest risk, such as: wetwell concrete interiors and exteriors; force main discharge points; steel grates, railings, and bar screens; and other areas potentially exposed to corrosive conditions. Upon identification of a corrosion problem, WMU will take the necessary actions to evaluate the cause and determine a corrective action for the corrosion problem. Typically, chemical addition can be implemented to neutralize the effects of hydrogen sulfide or other corrosives in the sewage.

### *5.5 Manhole Inspection*

Condition assessments for manholes are performed concurrently with inspection of associated pipe segments, per the Routine Hydraulic Cleaning schedule. Out-of-cycle inspections are also performed as directed by WMU management, such as in the event of an overflow or odor complaint.

Routine manhole inspections consist of a visual inspection of the condition of the manhole by component (lid, walls, trough, apron, inlet pipes). Inspection data is documented on a "Manhole Data – Sewer System Evaluation Survey" form.

Hydraulic cleaning and CCTV inspection of manholes is performed in conjunction with the cleaning of associated pipe segments according to the Routine Hydraulic Cleaning schedule, or as directed by WMU Management. Out-of-cycle hydraulic or manual cleaning for individual manholes will be directed if required by a blockage which is causing or could cause an overflow.

### *5.6 Pump Station Performance and Adequacy*

The purpose of WMU's Pump Station Performance and Adequacy Program is to determine if each pump station is capable of providing reliable service at its design operating conditions. To ensure reliable service to WMU customers, it is critical to keep all pumps operable during routine inspections and preventative maintenance, unless additional pumping capacity can be provided, or peak flows through the station are reduced.

WMU maintains a database of its 10 current pump stations, including the following information:

- Name and Location
- Pump Manufacturer and Year
- Type of Station
- Number of Pumps or Compressors
- Type of Pump
- Pump/Motor Information (including pump operating time)
- Force Main Information (Size, Material, Discharge Point)

A key metric for assessment of pump station performance is the pump operating time. Factors affecting pump operating time include:

- Influent flow
- Influent flow rate
- Number and capacity of pumps, singularly and parallel
- Wetwell volume and pump operating set points (i.e., the water level at which a pump activates and the water level at which, once activated, it ceases)
- Type of Pump

During inspections, data will be collected on pump operating times, and any maintenance issues will be identified. For each pump station, WMU will develop and maintain a database to track average pump starts, cycle times, and operating hours.

### *5.7 Defect Analysis*

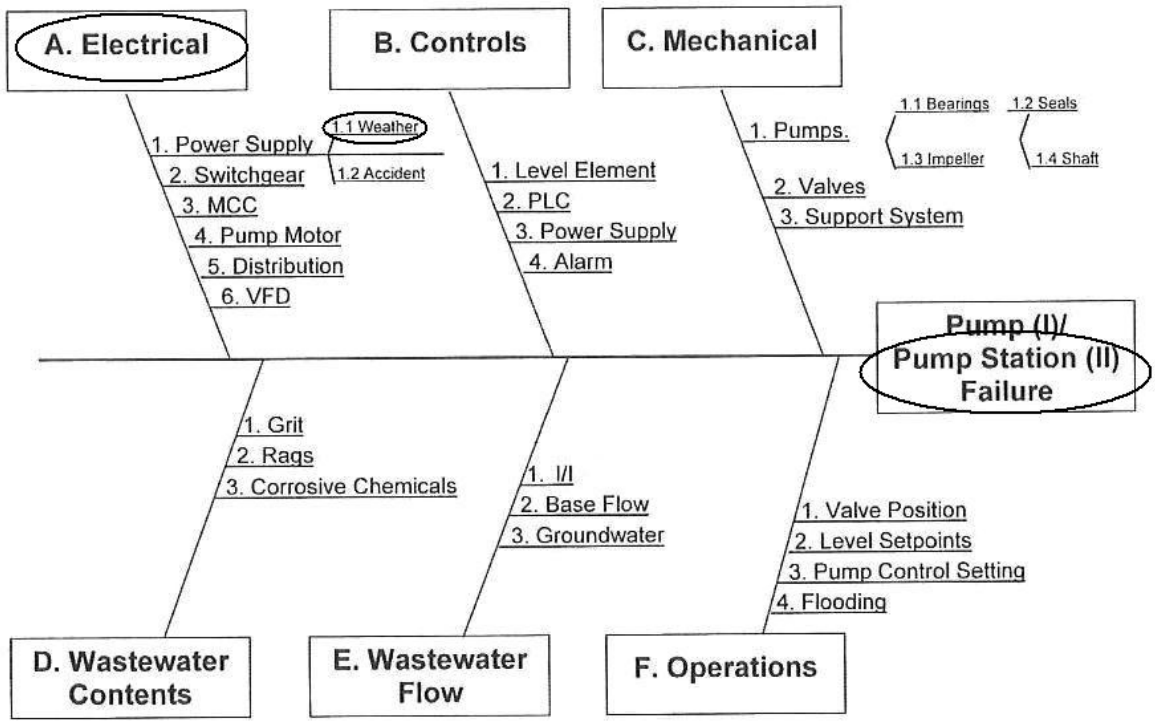
In the event of a system or component failure, WMU will perform a defect analysis to determine the underlying, or root, cause of the failure, and develop a plan for preventing a recurrence. As part of the analysis, WMU will examine records of past failures to identify occurrences of similar failures that may indicate a system-wide performance issue.

Long-term corrective actions will focus on preventing the same chain of events from occurring, as opposed to focusing only on the root cause. Multiple instances of the same failure chain may identify a need for further operations or engineering studies to identify system modifications or improvements required to prevent multiple failures attributed to the same root cause.

### *5.7.1. Root Cause Failure Identification*

As part of a defect analysis, WMU may develop a cause-effect diagram ("fault-tree") to assist in identification of the root cause of a problem, and to establish the chain of events that led to the ultimate failure. In a typical cause-effect diagram, each specific chain of events is assigned a code for tracking purposes. New codes can be added as needed. An example fault tree and failure code system that can be used for pump stations is shown in Figure 5-1: Root Cause Failure Identification Fault Tree.

**FIGURE 5-1: ROOT CAUSE FAILURE IDENTIFICATION FAULT TREE**




In the example shown above, a pump station failure caused by a weather-related power disruption would be assigned the code "II-A-1.1" (II = Pump Station, A = Electrical, 1.1 = Power Supply/Weather). Using the same process, a mechanical failure in an individual pump caused by a faulty seal would be assigned the code "I-C-1.2".

### *5.8 Information Management*

WMU will continue to develop methods for standardizing the management, tracking, and analysis of data collected through assessment activities outlined in the CSSAP. WMU currently employs a number of data management systems to evaluate and document the condition of the sewer system, including:

- Routine Inspection/Maintenance Data Collection (e.g. work orders, maintenance logs)
- Hydraulic Model
- CCTV program software
- Geographic Information System (GIS)

# APPENDIX A – REVIEW/UPDATE LOG

# APPENDIX B – MAPS

## APPENDIX C – RELATED WMU POLICIES

## APPENDIX D – EMERGENCY CONTACT LIST & CONTRACT SERVICE PROVIDERS

# APPENDIX E – FORMS

# APPENDIX F – LIST OF PUMPING STATIONS

# APPENDIX G – CCTV/HYDRAULIC CLEANING STANDARD OPERATING PROCEDURES