System-Wide Flow and Rainfall Monitoring Program

Department of Watershed Management (DWM) Capacity, Management, Operations, and Maintenance (CMOM) Program

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Contents

Acronyms

AC	alternating current
AWWTF	Advanced Wastewater Treatment Facility
CMOM	Capacity, Management, Operations, and Maintenance
DC	direct current
DWM	Department of Watershed Management
EPA	Environmental Protection Agency
GIS	geographical information system
I/I	infiltration/inflow
NPDES	National Pollutant Discharge Elimination Systems
NWS	National Weather Service
QA/QC	quality assurance and quality control
RDI/I	Rainfall Derived Infiltration and Inflow
USGS	U.S. Geological Survey
WCTS	Wastewater Collection and Transmission System

1. System-Wide Flow and Rainfall Monitoring Program Overview

1.1 Introduction

DeKalb County (the County) Department of Watershed Management (DWM) currently has a flow and rainfall monitoring program in place. The County has re-evaluated and expanded that program. The details of the enhanced System-Wide Flow and Rainfall Monitoring Program (the Program) resulting from the re-evaluation of the current program are described in this document as outlined below:

- Introduction (provides an overview of the program document);
- Purpose and Goals (provides the aims of the Program);
- Regulatory Drivers (gives an overview of what regulations, policies, and guidance were used in creating the Program);
- Program Resources (details the human and material resources that are available for the County to use in further developing, implementing and maintaining the program);
- Program Re-evaluation (describes the current flow and rainfall monitoring program and highlights any gaps in the current program that will be addressed in the enhanced Program);
- Program Activity (includes (a) an overview of the enhanced monitoring Program, (b) the criteria used to identify the locations of monitoring equipment, (c) a map showing monitoring sites, (d) the computer-based data management system, (e) the quality assurance and quality control (QA/QC) used to ensure accurate and reliable data, and (f) the wastewater flow analysis); and
- Program Procedures (describes the inspection and maintenance procedures developed to ensure consistency and accuracy of the program).

1.2 Purpose and Goals

The purpose of the Program is to:

- Estimate the volume of infiltration/inflow (I/I) entering various sewer segments/ sewersheds in the County's Wastewater Collection and Transmission System (WCTS);
- To provide flow data required for the assessment of the capacity of various sewer segments;
- To measure or predict the effectiveness of I/I related rehabilitation in meeting *Level of Service* performance targets;
- To provide modeling input data for system flow calibration and projections;

- To support the prioritization of sanitary sewers for more advanced inspections and analysis so that cost effective rehabilitation results in I/I reduction and restored capacity; and
- To measure flow coming from and going to inter-governmental users or providers for billing purposes.

The Program's goal is to provide efficient and effective data to assess capacity and I/I issues within the wastewater collection, transmission, and treatment systems.

A System-Wide Flow and Rainfall Monitoring Program is integral to the development and maintenance of the Wastewater System Hydraulic Model relative to making capacity decisions or confirming the capacity status of portions of the conveyance system. The Program serves an important role in building the hydraulic model components and calibrating the results.

1.3 Regulatory Drivers

The County DWM System-Wide Flow and Rainfall Monitoring Program is a program that incorporates criteria that are set forth in the Consent Decree – DeKalb County, Civil Action File No. 1:10-cv-4039-WSD. In addition, various guidance documents and materials were consulted in the formulation of the Program, such as the following:

- U.S. Environmental Protection Agency (EPA) *Guide for Evaluating Capacity, Management, Operations, and Maintenance (CMOM) Programs at Sanitary Sewer Collection Systems*, 2005; and EPA Region 4 *Guide to Collection and Transmission System Management, Operation, and Maintenance Programs,* 2003.
- Georgia Association of Water Professionals and Georgia Water Environment Federation, *Guidance for the Georgia Environmental Protection Division Zero Tolerance Strategy entitled Capacity, Management, Operations, and Maintenance Consent Agreement Guidance*, 2006.
- Metropolitan North Georgia Water Planning District *Wastewater Management Plan*, 2009.
- DWM National Pollutant Discharge Elimination Systems (NPDES) permits for Pole Bridge Advanced Wastewater Treatment Facility (AWWTF) (NPDES - GA0026816) and Snapfinger AWWTF (NPDES - GA0024147).

1.4 Program Resources

The Program is supported by various DWM staff members and resources. Refer to Section 1.6, Enhanced Program Activities, for further details of the work to be performed.

Current DWM Staffing Resources

- Assistant Director of Watershed Management
- Program Management Team (Consulting engineers)
- Engineer Principal
- Contractor and U.S. Geological Services (USGS) support for the installation and maintenance of flow meters and rain gauges
- Two DWM crews consisting of six staff members dedicated to support the program.

Current DWM Material Resources

- 200 Permanent Flow Monitors including 106 existing and 94 newly installed in 2014.
- 15 Inter-jurisdictional Billing Flow Meters
- 34 Rain Gauges including 17 existing and 17 newly installed in 2014
- 20 USGS Rain Gauges including 15 existing and 5 newly installed in 2014

1.5 Re-evaluation of the Current Flow and Rainfall Monitoring Program

The current program consists of a network of flow and rainfall meters within the County as well as data retrieval capabilities, maintenance plans, and QA/QC measures.

Depending on the specific Program's needs, there are two types of flow meters used - permanent and temporary. Permanent meters provide system information over a longer period and produce long-term monitoring data that will provide historical trending. Permanent meters can use alternating current (AC) or direct current (DC) power (a combination of marine batteries and solar panels). Temporary meters or short-term flow monitoring sites provide data as a "snap-shot" in time. Temporary meters use DC power provided by batteries. The current network of flow and rainfall meters includes:

- Two hundred (200) permanent flow meters that are monitored via an automatic wireless system in real time every 15 minutes. Area-velocity flow monitors are primarily used and were installed in 2004, 2006, and 2014. The County currently has sufficient and adequate flow meters in the Intergovernmental, Snapfinger Creek and Pole Bridge Creek drainage basins to meet current hydraulic modeling needs.
- Fifteen (15) inter-jurisdictional permanent flow meters that are used primarily for billing purposes to measure flow at connections with other jurisdictions. Parshall flumes are used in the majority of the billing sites. The meters measure flow to or from these agencies: five (5) measure flow to Atlanta, five (5) meters measure flow from Fulton County, two (2) meter measures flow from Clayton County, two (2) meters measure flow from Rockdale County, and one (1) meter measures flow from Henry County. These inter-jurisdictional meters are used primarily for billing purposes and to support the program needs.

- Twenty four (24) of the existing temporary flow meter sites were converted to permanent flow meter sites in 2014. The County will continue to maintain the option of adding temporary meters as needed by Priority Area Sewer Assessment and Rehabilitation Program, Ongoing Sewer Assessment and rehabilitation Program (OSARP), and Hydraulic Modeling programs.
- Twenty (20) USGS rain gauges are currently located within the County under the County's joint funding agreements with USGS, where the data obtained by USGS is shared with the County. Five (5) out of the 20 rain gauges were installed in 2014.
- Thirty four (34) County rain gauges, including seventeen (17) newly installed in 2014, are used to record rainfall data and wet weather events, to support the needs for hydraulic modeling and Rainfall Derived Infiltration and Inflow (RDI/I) analysis under other CMOM programs.

Data from flow meters and rain gauges are collected via remote wireless technology and can be viewed online.

- Data from permanent flow meters, except those installed in 2014, have been recorded since 2007. The flow data is continuously transferred to the remote server through wireless devices. Flow and rainfall monitoring software is used to organize the data and review the real-time data through web access. The data from the permanent flow meters is reviewed daily for QA/QC to identify any issues at a site. If there is an anomaly, crews are dispatched to inspect the site and equipment.
- The existing rain gauges sites with newly installed wireless equipment will transfer the rainfall data to the remote data server.

The County has contracted for the installation and continued maintenance of flow monitors and rain gauges in the WCTS. The contract includes the following activities, staff, and equipment:

- Installation or Removals: Equipment generally consists of flow meters, digital Doppler velocity sensors, wireless data acquisition modems, battery, solar power option, rain gauges, and software.
- Relocations: Relocation of flow meter and rain gauge sites is conducted as determined by the Program Manager.
- Maintenance: Maintenance of hardware at each location is to be conducted once a month and consists of equipment cleaning / check-ups to provide proper flow meter and rain gauge functioning and accurate data recording.
- Calibration: Flow meter and rain gauge will be calibrated as needed during each visit. Refer to the Maintenance Procedures in Sections 2.6 and 2.7 and the Calibration Sheet in the Appendix.
- QA/QC Process: A QA/QC for real-time data on the web-hosting server is performed for each site. If the QA/QC indicates any data loss or suspicious data, field crews will be sent out to the site. During the visit, a diagnostic test will be performed and necessary actions will be taken such as sensor cleaning and calibration until the equipment malfunction is corrected.

- Reporting: All data will be reported in raw form without any editing or processing. The data will be produced monthly in a tabular format. The report also includes a brief summary of the site including: site description; field interrogation and calibration sheets, and volume data (only noted for billing purposes at inter-jurisdictional sites). See Appendix for examples of reports produced.

1.6 Enhanced Program Activities

1.6.1 Program Overview

The enhanced Program will focus on completing the WCTS flow monitoring networks, improving data management system, improving overall program performance and management, to provide systematic and reliable data. The enhanced program will provide solid support to other programs and activities under CMOM such as the hydraulic modeling flow study to determine the RDI/I volume in various sewer segments and system capacity evaluation to provide guidelines for sewer rehabilitation.

Flow metering and ongoing sewer system investigations, analysis, and cost effective rehabilitation can improve system hydraulic performance. The County uses flow monitors to track wastewater flow trends and to aid in determining the total volume and rate of I/I entering the collection system through system deficiencies upstream of the flow monitor. Flow monitoring is also conducted at major pump stations and wastewater treatment facilities. Data from all meters are used to develop flow characteristics under dry- and wet-weather conditions at the installed locations.

Rainfall data from DWM rain gauges and USGS stations within the County are used with flow data for RDI/I analysis and sewer system hydraulic models. This information is also supplemented by National Weather Service (NWS) stations and NWS radar images if necessary.

The enhanced Program includes a description of the following items:

- Criteria used to identify locations of permanent and temporary flow and rainfall monitoring equipment.
- Geographical Information System (GIS) maps showing permanent and temporary flow monitoring and rainfall monitoring sites.
- County computer-based data management system used to organize, store, analyze, and report flow and rainfall.
- QA/QC to ensure the accuracy and reliability of flow monitoring data.
- Wastewater flow analysis to determine the RDI/I volume and rate and system capacity.

The Following Elements Comprise the Enhanced DWM System-Wide Flow and Rainfall Monitoring Program:

- Criteria for Establishing Location of Equipment
- GIS Maps Showing Monitoring Sites
- Computer-based Data Management System
- QA/QC
- Wastewater Flow Analysis

1.6.2 Criteria for Establishing the Location of Equipment

1.6.2.1 Flow Monitors

The number of flow monitors and their locations are based on several criteria. The first criterion is the facilitation of sewersheds or drainage areas isolation to determine the dry- and wet-weather I/I in a specific isolated area. The sewer map is the basis used for determining the flow paths and points for isolation. The second criterion is even distribution. When the meters are evenly distributed in the sewersheds and drainage areas, the data are more reliable and more useful for modeling and other program needs. GIS maps are used to help determine the distribution of the meters. The third criterion is the relative significance of the flow control points. The County focuses on such points as major lift stations, the wastewater treatment plants, and the inter-jurisdictional connections.

Listed below are the flow isolation and control points for meter locations within the WCTS:

- Most sewershed discharge points, except for sewersheds with small service areas or insignificant flows
- Isolation points upstream of the sewershed for the purposes of I/I determination
- Wastewater Treatment Plants
- Major Lift Stations
- Connection points with other local jurisdictions
- Historical repeated significant Sanitary Sewer Overflow locations

Additional flow monitoring data are also obtained from the run time data and drawdown tests at lift stations.

In meter selection, the County analyzed metering technologies and selected the best suited for the County's specific conditions. The following criteria are used in selecting flow meter types:

- Pipe size
- Flow ranges
- Hydraulic conditions
- Telemetry method
- Operating principle
- Accuracy
- Duration
- Data management
- Cost

1.6.2.2 Rain Gauges

Rain gauges measure rainfall intensity and durations throughout a specific monitoring period. Rainfall data is synchronized with flow monitoring data to determine the RDI/I volume and peaking factor.

The number of rain gauges and their locations are determined based on:

- Geography so they are distributed to cover the entire County area (GIS maps are used to help determine the gauge locations)
- Sewersheds with a high number of RDI/I issues
- Wastewater Treatment Plants

After determining the number and location of the rain gauges, the County selects the type of rain gauge by analyzing the available technology and obtaining the best type suited for the County's specific conditions. The County then follows its standard procedures based on manufacturers' recommended practices to install, calibrate, and maintain the rain gauges.

1.6.3 Location Map for Monitoring Sites

DWM maintains a GIS map that identifies locations of permanent and temporary flow meters, billing meters and rainfall monitoring sites established in the County's WCTS. The Appendix map shows the location of the current locations of the existing and 2014 installed flow monitors, rain gauges, and USGS rain gauges. Temporary, permanent, billing flow monitoring sites, and rain gauges are mapped in GIS and are correlated with each sewershed. The map also identifies USGS stations within the County that could be used for this program.

1.6.4 Computer Based Data Management System

A County server has been designated specifically for flow monitoring data storage under the enhanced Program. The County owns software licenses for flow and rainfall monitoring data storage and process. The flow and rainfall monitoring data team maintains the data internally with the assistance of the County Information Technology Department. Data can also be accessed through the County's server internally. The flow monitoring data is also hosted and backed up by flow monitoring contractors using the same software.

In addition to storing and organizing the data, the flow and rainfall monitoring software will also be used to:

- Communicate with the flow monitoring sites and maintain data continuously uploaded to server
- Allow remote viewing of live data from internet browsers internally and externally and share data with multiple users
- Share data with GIS and modeling software packages, such as InfoWorks™ CS for the sewer system hydraulic modeling
- Generate and print graphs for data QA/QC
- Perform flow analysis to determine the RDI/I volume and rate
- Generate and print monthly reports and flow study reports

Flow and rainfall data stored at Contractor's external remote servers are transferred periodically to the County's server.

1.6.5 Program Operations Quality Assurance and Quality Control

1.6.5.1 Monthly Site Maintenance

Field verification is an important activity in collecting accurate data and assuring minimum loss of data due to malfunctioning equipment or accumulation of debris at the monitoring site. To validate the quality of the data, each flow meter and rain gauge is maintained and calibrated at least once per month or more frequent as needed in the field. Meter calibration is confirmed on site with measurements taken with an independent device. Information will be gathered and notes will be taken during on-site inspection and maintenance activities for each flow monitoring site.

Meter maintenance is very site dependent. Some sites require minimal maintenance visits, while others are continually affected as silt and debris build-up. Information gathered during the on-site inspection and maintenance will be used to determine if additional inspections and maintenance are required. Sites with issues will be visited more frequently than other sites and additional maintenance activities, such as site cleaning, meter calibration will be taken beyond the routine once per month calibration and maintenance.

Based on the flow monitoring site maintenance activities, monthly flow monitoring report will be generated for each site, including:

- Site visit records and observations on hydraulic conditions, including flow depth and velocity, flow turbulence or jumps, backup water, blockage from sediments, fat, grease, and oils, as well as surcharging signs, etc.
- Flow meter diagnostics report for each site visit
- Inventory logging summary
- Actions taken during the visits

1.6.5.2 New Flow Monitoring Site Inspection before Installation

Under the enhanced Program, new flow monitoring sites are identified based on the criteria established. For all anticipated sites (where new monitors and relocated monitors are to be installed), inspections are required prior the installation. A site inspection identifies any issue that might impact the installation and meter performance, such as access, safety, structure, hydraulic, sediment, blockage, and any other conditions. Performing such a site inspection will ensure high data quality because the flow monitor will be able to perform properly.

A Site Inspection Report for all new and relocated flow monitoring sites includes:

- A map of the location
- A photo of the street view to show the site location and surrounding structures
- Plan and cross section views of the manhole and pipes, and proposed monitor position;
- One manhole top view photo to show the flow path inside of manhole
- One section view photo inside the manhole to show the proposed pipe line for sensor installation
- Access
- Safety considerations
- Traffic control

- Structural conditions
- Hydraulic suitability
- Level of flow
- Any other pertinent observations

The flow meter will only be installed at new sites after DWM or DWM's representative reviews and approves the site.

1.6.5.3 Installation of New Flow Monitors

For each newly installed and relocated flow meter sites, an Initial Thirty (30) Day Site Assessment and Testing Report is required. The report should include all items listed in the Site Inspection Report (Section 1.6.5.2), the Monthly Report (Section 1.6.5.1 and 1.6.6.2), and the items listed below:

- Site information, including manhole identification, site address, monitor serial number, etc.
- Manhole and pipe conditions, including structure conditions, materials and sizes of manhole and pipe
- Flow balance check with upstream and downstream sites
- Pole camera recording, in DVD format, for each new/relocated site demonstrating proper installation of the flow monitor and the hydraulic suitability of the site.

1.6.6 Data Quality Assurance and Quality Control

The integrity of the data is an important consideration for billing, hydraulic modeling, calibrating, performing capacity analysis, or I/I investigations. The lack of proper QA/QC procedures, limited on-site data reviews, and proper and detailed field verifications often results in lower-quality data as well as data losses. Therefore, QA/QC checks are performed throughout the program to maintain the monitors in proper operation and generate accurate and reliable data to support other program needs under Consent Decree.

The QA/QC procedures have been and will continuously be implemented for flow meter and rain gauge sites as part of the Flow Monitoring Program.

1.6.6.1 Daily Real-Time Data QA/AC

The web based real-time data is reviewed by staff trained and experienced in the flow and rainfall monitoring program. The velocity, depth, and flow data are reviewed daily to identify issues with meter performance. If data is missing, flat, or suspicious, a field crew will be sent out to check the site. The field crew will perform various actions such as a sensor diagnostic test, site cleaning to remove sediment, field calibrations, or replacing malfunctioning parts to remedy the problem. All actions taken during the site visits will be documented and included in the monthly report.

1.6.6.2 Monthly Data QA/QC

Monthly flow meter and rain gauge data QA/QC will be performed for all flow monitors and rain gauges. Field visit will be performed to physically check the flow meter site and calibrate the depth and velocity sensors. During this visit the flow meter sensor will be scrubbed to remove any buildup of materials and calibrated. Rainfall data is viewed on webpage monthly or

after major storm events to check and compare the volume and intensity. If the rainfall data indicates any issues with the site, field inspection and cleaning, as well as maintenance procedures per manufacturer's recommendations will be performed to ensure the rain gauge is functioning properly.

The monthly flow monitoring data QA/QC report includes:

- Flow meter calibration reports, date and time when meter is calibrated, and calibration results
- A brief summary of each site, including data quality, minimum, average, and maximum flow and depth, network uptime, monitor uptime, change of flow conditions, and any issues with the site
- Hydrographs having site visit information, calibration data, velocity, depth, and flow with the rainfall (see sample in Appendix) (the flow and rainfall monitoring team will review data based on the hydrograph and indicate /flag any issues with the site on the hydrograph, such as missing data, sensor drifting, poor data quality, etc.)
- A scattergraph plotted using depth versus velocity for data quality (see sample in Appendix)

Analysts review the QA/QC report by first observing the dry weather flow pattern based on velocity, depth, and flow. Then the meter response to rainfall events, the magnitude of peak flows, and the shape of hydrographs will be reviewed. If any abnormal behavior is observed in the hydrographs such as a dry weather flow's pattern dramatically changing or the flows not responding to rainfall during storm events, the site will be checked.

A scattergraph is generated as a graphical tool that depicts a relationship between flow depth and velocity under actual conditions. The graph is used to interpret hydraulic conditions and assess sewer capacity. This type of flow monitoring analysis provides information regarding the reaction of the WCTS during storm events and helps identify system deficiencies. The depth and velocity data plot also provides information regarding sewer system behavior under various wet-weather conditions. Analysts establish the hydraulic pattern at a specific meter site based on depth and velocity relationships and look for consistent behavior during various rainfall events. If a portion of the data being reviewed is out of character, the analyst alerts the field crew for a field check. Service requests and work orders will be sent to the construction and maintenance crew for investigation if necessary.

1.6.7 Wastewater Flow Analysis

The purpose of a wastewater flow analysis is to gain a better understanding of base wastewater flow, groundwater infiltration, and RDI/I within the wastewater collection system. The wastewater flow analysis uses the flow and rainfall data gathered and the results of the analysis will

- Provide guidelines for the sewer assessment and rehabilitation program
- Further identify the areas that could benefit from reduction of excessive I/I
- Will help prioritize sanitary sewers systems for rehabilitation, repair and/or replacement

1.6.7.1 Rainfall Data Analysis

Rainfall data from the County's rain gauges and USGS rain gauges will be stored on the designated County server for analysis.

Rainfall data from early 2015 will be used for the analysis to classify the storm events and determine the storm frequency, duration, volume, and peak intensity for all selected rain gauge sites.

From the rainfall data, five (5) top storm events recorded by the majority of the rain gauges within the DeKalb County drainage areas will be selected for the final flow analysis. The storm events chosen will represent a range of intensities and volume in order to accurately assess the RD I/I response for each isolated drainage area.

1.6.7.2 Flow Analysis

The combination of flow and rainfall monitoring data is used to estimate the peak flows associated with selected storm events. Flow and rainfall data are used for InfoWorks™ CS Hydraulic Model calibration and flow analysis to determine RDI/I entering the WCTS. The data is also used to assess capacity availability in the sewer system and prioritize upgrades and rehabilitation needs to provide additional capacity, as needed as well as capacity evaluations for various sewer sections.

The wastewater flow analysis is used to determine the RDI/I for the five (5) selected top storm events and includes comparing the wet weather flow with dry weather flow as well as the following:

- Dry Weather Flow Analysis includes generating dry weather flow pattern where an average 7-day weekday and weekend dry weather flow patterns includes estimated groundwater flow, base wastewater flow, and 24-hour diurnal pattern.
- Performance Trend Analysis is used to determine the sewer system behavior, capacity, and issues (including inflow and infiltration, sediments accumulation, backwater, surcharging, pump station impact, etc.), based on the hydrographs and scattergraphs.
- Wet Weather Flow Data analysis for selected storm event period versus dry weather flow is used to estimate:
  - RDI/I volume and peak flow rate.
  - Peaking Factors.
  - R -Values, as the fraction of rainfall falling within the particular sewershed area that enters a sanitary sewer collection system as RDI/I.
- Determine additional priority area and verify the initial priority area.
- Provide recommendations for sewer capacity improvement and rehabilitation.

If it is necessary, an extended flow-monitoring period might be instituted to obtain the representative storm events for flow analysis.

2. Program Procedures

DWM Procedures for the System-Wide Flow and Rainfall Monitoring Program have been developed to provide consistency and accuracy in the data results. The procedures have been developed to document a process where DWM conducts specific program elements.

System-Wide Flow and Rainfall Monitoring Program procedures are provided in this section and include:

- Flow Monitoring Site Inspection
- Rain Gauge Site Inspection
- Flow Monitor Installation
- Rain Gauge Installation
- Site Test and Acceptance
- Flow Monitor Maintenance
- Rain Gauge Maintenance
- Data Analysis and Reports

DEPARTMENT OF WATERSHED MANAGEMENT

FLOW MONITORING SITE INSPECTION PROCEDURE

2.1 Flow Monitoring Site Inspection

SCHEDULE

Schedule of flow monitoring site inspection is determined by the System-Wide Flow and Rainfall Monitoring Program.

ACTIVITY DESCRIPTION

Inspection of flow monitors site for possible installation of flow monitoring unit.

ACTIVITY GOALS

- To inspect site to ensure that flow monitoring unit can obtain optimum flow monitoring data.
- To document the site inspection (e.g., site-specific conditions) and hydraulic suitability of the site for flow monitoring.

LABOR	MATERIALS
Field crew	Safety equipment - vest, traffic cones and flags, men-working signs, hardhats, steel-toed boots. Leather/cloth and impervious gloves, Tyvek coveralls, half mask disposable respirators, eye protection, ear plugs, flashlights, life vests, safety harness and ropes. Disinfectants Eye wash Fire extinguisher First aid kit
EQUIPMENT	
Camera Manhole Pick Measuring Rod Possible Confined Space Equipment Gas Detector Site Logbook	

SAFETY ANALYSIS

Safety Check List	Potential Hazards
• Collection and Transmission Systems Safety Program Plan • Design Drawings • Protective Clothing and Equipment • Gases and other Hazardous Atmospheres Analysis (Confined Space Entry) • Traffic Safety Requirements	• Infectious Diseases • Slip, Trip, and Fall • Poisonous Snakes, Pests, Insects • Confined Spaces (Confined Space Entry) • Traffic • Vehicle Operation • Mechanical Tools • Flooding and Inundation (Confined Space Entry)

DEPARTMENT OF WATERSHED MANAGEMENT

FLOW MONITORING SITE INSPECTION PROCEDURE

DEPARTMENT OF WATERSHED MANAGEMENT
FLOW MONITORING SITE INSPECTION PROCEDURE

ACTIVITY/SUBTASK

The criteria below are identified for flow monitoring site inspection. The reliability of the data provided by the flow monitor depends on the hydraulic suitability of the installation site.

- Typically, sewer lines contained limited quantities of dirt, silt, sand gravel, rocks, roots, grease, garbage, settled sludge with depth and quantities of debris being unknown. However, the presence of these materials will cause the flow in the sewer line to be naturally turbulent. The goal is to choose a site that has the least amount of turbulence at all times. NOTE: The Program Manager will be notified regarding the sewer line with such issues because it will likely be a problem site. The contractor shall search for an alternative location with more favorable hydraulic conditions and inform the Program Manager for alternative site selection. The goal is to choose a site that has the least amount of turbulence at all times to provide stable velocity and depth readings, especially the sewer line where the flow monitor will be placed.
- A pipe line with steep slope and splash flow should be avoided for monitor installation. Under such condition, the depth sensor will not be able to read stable flow depth. The Contractor shall notify the Program Manager for an alternative site selection if such condition is presented at the site.
- Examination of the manhole where the monitor is to be installed at and will determine the hydraulic suitability of the site. There will be one (1) incoming sewer line into the manhole and one (1) outgoing sewer line from the manhole with no alignment deflection. Secondary small diameter incoming lines with minimal flow may be allowed. Secondary sewer lines larger than 8-inch diameter should be avoided if possible. Determination of the difficulties that may be encountered in gaining access to the manhole and installing the required monitoring equipment. Design drawings are useful to assist understanding the system layout.
- The installation site will have as little turbulence as possible from the incoming sewer line flow. The level of flow in the sewer line has to be such that the sensor is completely submerged and covered by at least one (1) inch of flow at all times.
- After field investigations are complete, a Site Investigation Report describing observed conditions will be submitted to the Program Manager for approval. This information includes site-specific conditions such as access, safety condition, traffic control, structural conditions, hydraulic suitability, level of flow, and any other pertinent observations (within 7 days after site investigation).
- DWM must approve all proposed flow monitoring sites.

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2.2 Rain Gauge Site Inspection

SCHEDULE

Schedule of rain gauge site inspection is determined by the System-Wide Flow and Rainfall Monitoring Program.

ACTIVITY DESCRIPTION

Inspection of rain gauge site for possible installation of rain gauge unit.

ACTIVITY GOALS

- To identify a possible location which allows for rain to fall freely into the bucket and ease access to the rain gauge site.
- To document the site inspection (e.g. site-specific conditions) such as access, safety consideration, traffic control, and structural condition.

LABOR	**MATERIALS**
Field crew	Safety equipment - vest, traffic cones and flags, men-working signs, hardhats, steel-toed boots. Leather/cloth and impervious gloves, Tyvek coveralls, half mask disposable respirators, eye protection, ear plugs, flashlights, life vests, safety harness and ropes. Disinfectants Eye wash Fire extinguisher First aid kit
EQUIPMENT	
Camera Ladder Site Logbook	

SAFETY ANALYSIS

Safety Check List	**Potential Hazards**
• Collection and Transmission Systems Safety Program Plan • Protective Clothing and Equipment • Traffic Safety Requirements	• Infectious Diseases • Slip, Trip, and Fall • Poisonous Snakes, Pests, Insects • Traffic • Vehicle Operation • Mechanical Tools

DEPARTMENT OF WATERSHED MANAGEMENT
RAIN GAUGE SITE INSPECTION PROCEDURE

ACTIVITY/SUBTASK

The criteria below are used for site selection of rain gauge within a sub-basin.

- The site chosen for rain gauge installation will allow the rain to fall freely into the bucket. There will be no obstructions, such as tree canopy or buildings, in the path of the rainfall. The best sites may be on the roof-tops of the County owned buildings, allowing for easy access. Other locations may be chosen per Program Manager's approval.
- After field investigations are complete, a Site Investigation Report describing observed conditions will be submitted to the Program Manager. This information includes the following site-specific conditions such as access, safety condition, traffic control, structural conditions, site suitability, and any other pertinent observations (within 7 days after site investigation).
- All proposed rain gauge site locations will be submitted to the Program Manager for approval.

2.3 Flow Monitor Installation

SCHEDULE

Schedule of flow monitor installation is determined after flow monitor site inspection has been evaluated and approved by the System-Wide Flow and Rainfall Monitoring Program.

ACTIVITY DESCRIPTION

Installation and inspection of flow monitoring unit.

ACTIVITY GOALS

- To ensure the incoming sewer lines is clean.
- To install and inspect flow monitoring unit by calibrating the unit for initial usage.

LABOR	**MATERIALS**
Field crew	Safety equipment - vest, traffic cones and flags, men-working signs, hardhats, steel-toed boots. Leather/cloth and impervious gloves, Tyvek coveralls, half mask disposable respirators, eye protection, ear plugs, flashlights, life vests, safety harness and ropes. Disinfectants Eye wash Fire extinguisher First aid kit PVC Pipes
EQUIPMENT	
Camera Manhole Pick Measuring Rod Possible Confined Space Equipment Gas Detector Flow Monitoring Unit and accessories Portable Velocity Meter Computer	

SAFETY ANALYSIS

Safety Check List	**Potential Hazards**
• Collection and Transmission Systems Safety Program Plan • Protective Clothing and Equipment • Gases and other Hazardous Atmospheres Analysis (Confined Space Entry) • Traffic Safety Requirements	• Infectious Diseases • Slip, Trip, and Fall • Poisonous Snakes, Pests, Insects • Confined Spaces (Confined Space Entry) • Traffic • Vehicle Operation • Mechanical Tools • Flooding and Inundation (Confined Space Entry)

DEPARTMENT OF WATERSHED MANAGEMENT

FLOW MONITOR INSTALLATION PROCEDURE

ACTIVITY/SUBTASK

- If the site requires cleaning then the field crew should locate an alternate site and follow the site inspection procedures detailed above. At all times, the field crew should get approval from the Program Manager prior to installation at an alternate site.
- The ring and sensor will be installed two (2) feet inside the incoming pipe. The ring will be flush with the pipe wall. If the silt inside the pipe cannot be cleaned and has adhered to the pipe, then the ring and sensor may be installed on top of the silt. The level of silt will be measured and entered into the flow monitor setup. An alternate site will be evaluated if possible. For sites with such condition, the field crew should check the silt depth at least once per month to adjust the flow monitor setup for accurate record the depth for flow calculation.
- The sensor will be installed at the 6:00 o'clock position. If the site velocity is determined to be slow enough that debris could get caught on the sensor, then the sensor may be placed in an offset position. The offset has to be measured and entered into the flow monitor setup. Debris depths should be recorded in the Site Visit documentation each time manual depth and velocity measurements are taken. NOTE: The sensor has to be covered by one (I) inch of flow at all times.
- The flow monitor site setup includes naming the site properly in the software (naming convention will be provided by the Program Manager), measuring the pipe size, measuring the level of flow, setting up the correct flow conversion method, choosing the correct pipe geometry, setting the date and time, and setting the data retrieval interval to every fifteen (15) minutes.
- The level of flow shall be determined by measuring from the top of the flow to the top of the pipe and subtracting from the pipe size. At no time shall the measuring device be put into the path of the flow. At no time during the level measurement shall the Contractor obstruct the path of the flow; this may cause a backup into the pipe, which may alter the level measurement. The manual level measurement will be used to calibrate the sensor level measurement.
- Installation includes the flow monitor unit and accessories, rain gauge unit (when requested by the Program Manager, enclosures, power lines (when needed), and solar panel.
- Any poles/posts that are installed into the ground to accommodate flow monitoring, wireless data acquisition, solar panel, fencing, or any other work incidental will be stabilized using concrete blocks and by pouring concrete as necessary.
- All installations are subject to approval by the Program Manager. Site Acceptance Report must be submitted to the Program Manager within 30 days of monitoring.

2.4 Rain Gauge Installation

SCHEDULE

Schedule of rain gauge installation is determined after rain gauge site inspection has been evaluated and approved by System-Wide Flow and Rainfall Monitoring Program.

ACTIVITY DESCRIPTION

Installation and inspection of rain gauge.

ACTIVITY GOALS

- To identify a flat balanced surface away and away from obstruction of the rainfall path such as tree canopy or building.
- To install and inspect rain gauge by calibrating the unit for initial usage.

LABOR	**MATERIALS**
Field crew	Safety equipment - vest, traffic cones and flags, men-working signs, hardhats, steel-toed boots. Leather/cloth and impervious gloves, Tyvek coveralls, half mask disposable respirators, eye protection, ear plugs, flashlights, life vests, safety harness and ropes. Disinfectants Eye wash Fire extinguisher First aid kit
EQUIPMENT	
Camera Ladder Leveler Computer Logbook	

SAFETY ANALYSIS

Safety Check List	**Potential Hazards**
• Collection and Transmission Systems Safety Program Plan • Protective Clothing and Equipment • Traffic Safety Requirements	• Infectious Diseases • Slip, Trip, and Fall • Poisonous Snakes, Pests, Insects • Confined Spaces (Confined Space Entry) • Traffic • Vehicle Operation • Mechanical Tools

DEPARTMENT OF WATERSHED MANAGEMENT
RAIN GAUGE INSTALLATION PROCEDURE

ACTIVITY/SUBTASK

- Field crew installs the rain gauge on a flat surface and make sure that the surface plate is balanced.
- The rain gauge site setup includes naming the site properly in the software (naming convention will be provided by the Program Manager), setting the date and time, setting the reading interval to every fifteen (15) minutes, setting the time span to three-hundred and sixty (360) days, which is the maximum days allowed by the memory of the rain gauge at fifteen (15) minutes interval, and setting the recording mode to "Rollover". The “Rollover” setting will allow the data continuously recorded after 360 days, if the data is not downloaded, and the existing data will be written over from the beginning by the new data on the 361st day. The other recording mode “slat” will stop the data record after 360 days.

  The rainfall data of all rain gauges under the flow monitoring program either will be transferred and stored at a data server constantly by wireless connections, or will be manually downloaded at least biweekly. Therefore, 360 day time span is the maximum days that could be setup to ensure that the data will not be written over.
- Installations are subject to approval by the Program Manager. Site Acceptance Report must be submitted to the Program Manager with 30 days period of monitoring.

2.5 Site Test and Acceptance

SCHEDULE

Schedule for the acceptance of installation of rain gauge or flow monitoring site is determined by the System-Wide Flow and Rainfall Monitoring Program.

ACTIVITY DESCRIPTION

Provide documentation and demonstration that rain gauge or flowing monitoring site are calibrated and providing accurate data.

ACTIVITY GOALS

- To evaluate and approve rain gauge or flowing monitoring site by ensuring that equipment is calibrated and providing accurate data.

LABOR	MATERIALS
Field crew	Safety equipment - vest, traffic cones and flags, men-working signs, hardhats, steel-toed boots. Leather/cloth and impervious gloves, Tyvek coveralls, half mask disposable respirators, eye protection, ear plugs, flashlights, life vests, safety harness and ropes. Disinfectants Eye wash Fire extinguisher First aid kit
EQUIPMENT	
Camera Ladder Leveler Computer Logbook Manhole Pick Measuring Rod Possible Confined Space Equipment Gas Detector Portable Velocity Meter	

SAFETY ANALYSIS

Safety Check List	Potential Hazards
• Collection and Transmission Systems Safety Program Plan • Protective Clothing and Equipment • Gases and other Hazardous Atmospheres Analysis (Confined Space Entry) • Traffic Safety Requirements	• Infectious Diseases • Slip, Trip, and Fall • Poisonous Snakes, Pests, Insects • Confined Spaces (Confined Space Entry) • Traffic • Vehicle Operation • Mechanical Tools • Flooding and Inundation (Confined

	Space Entry)

ACTIVITY/SUBTASK

Field crew provide documentation for each flow monitoring site showing that sensors are calibrated and are reporting the level, velocity, and flow rate correctly.

- Field crew demonstrates that each site maintains telemetry connectivity at a rate of ninety-eight (98) percent or better for a period of thirty (30) days.
- During the thirty (30) day test period, the field crew demonstrates that the sensor can maintain its calibration. The field crew is responsible for the site's maintenance and performance during this period.
- At the end of the thirty (30) day test period, field crew provide to the Program Manager, an end of the thirty (30) day calibration sheet (the format to be provided), diagnostic report from the flow monitor along with a graph of quality and average gain versus time, a graph demonstrating telemetry connectivity, and hydrograph and scattergraph demonstrating that the data quality is good.
- A thirty (30) day flow data analysis report will accompany each site, the format will be provided by the Program Manager.
- Site Test and Acceptance Report shall contain detailed site information, the calibration sheet, diagnostics report, graph of quality and average gain versus time and data analysis, hydrograph and scattergraph, and Pole Camera Recording (DVD Format). The pole-camera recording, in DVD format, demonstrates the proper installation of the flow monitor and the hydraulic suitability of the installation site.

2.6 Flow Monitor Maintenance

SCHEDULE

Schedule of flow monitoring unit maintenance is determined by the System-Wide Flow and Rainfall Monitoring Program.

ACTIVITY DESCRIPTION

Maintenance of Flow monitoring unit including calibrating and documenting reading from units.

ACTIVITY GOALS

- To provide maintenance to the flow monitoring unit to ensure that unit is calibrating, cleaning of the unit and recording accurate data.
- To ensure that the surrounding area is not hindering the proper usage of the flow monitoring unit.

LABOR	**MATERIALS**
Field crew	Safety equipment - vest, traffic cones and flags, men-working signs, hardhats, steel-toed boots. Leather/cloth and impervious gloves, Tyvek coveralls, half mask disposable respirators, eye protection, ear plugs, flashlights, life vests, safety harness and ropes. Disinfectants Eye wash Fire extinguisher First aid kit
EQUIPMENT	
Camera Manhole Pick Measuring Rod Possible Confined Space Equipment Gas Detector Flow Monitoring Unit and accessories Portable Velocity Meter Computer	

SAFETY ANALYSIS

Safety Check List	**Potential Hazards**
• Collection and Transmission Systems Safety Program Plan • Protective Clothing and Equipment • Gases and other Hazardous Atmospheres Analysis (Confined Space Entry) • Traffic Safety Requirements	• Infectious Diseases • Slip, Trip, and Fall • Poisonous Snakes, Pests, Insects • Confined Spaces (Confined Space Entry) • Traffic • Vehicle Operation • Mechanical Tools

DEPARTMENT OF WATERSHED MANAGEMENT
FLOW MONITOR MAINTENANCE PROCEDURE

	• Flooding and Inundation (Confined Space Entry)

ACTIVITY/SUBTASK

Once a flow monitor site has been accepted by the Program Manager, the following procedures are required:

- The field crew will visit a flow monitor site once a month.
- During this visit, the sensor will be scrubbed to remove any buildup of materials. The flow monitor will be connected to a computer and the sensor will be activated to verify its proper operation.
- The field crew will measure the level of flow and compare it to the level reading of the flow monitor. If the two readings are within 0.25 inches of each other, then the level does not need to be calibrated. Otherwise, the field crew will enter the correct level reading in the monitor setup and obtain new level readings.
- A diagnostic report will be downloaded from the flow monitor as well.
- The field crew will check all cable connections and battery levels. The field crew will replace any part that is not functioning properly. The desiccant will be changed and documented if necessary. All sites visited will be left functioning properly, as feasible.
- The field crew will check the flow monitoring sites as they are displayed in real time on a daily basis for data transmission and to determine the performance of the sensor. The field crew is responsible for gaining access to the real time data. If real-time data indicates abnormal readings or lack of real time data display, the crews will be send out to visit the site for corrective action.
- The field crew is responsible to keep all flow monitoring sites, under its maintenance, up and running at all times.

2.7 Rain Gauge Maintenance

SCHEDULE

Schedule of rain gauge unit maintenance is determined by the System-Wide Flow and Rainfall Monitoring Program.

ACTIVITY DESCRIPTION

Maintenance of rain gauge including calibrating and documenting reading from units.

ACTIVITY GOALS

- To provide maintenance to the rain gauge to ensure that unit is calibrating, cleaning and balancing of the unit and recording accurate data.
- To ensure that the surrounding area is not hindering the proper usage of the rain gauge.

LABOR	**MATERIALS**
Field crew	Safety equipment - vest, traffic cones and flags, men-working signs, hardhats, steel-toed boots. Leather/cloth and impervious gloves, Tyvek coveralls, half mask disposable respirators, eye protection, ear plugs, flashlights, life vests, safety harness and ropes. Disinfectants Eye wash Fire extinguisher First aid kit
EQUIPMENT	
Camera Ladder Leveler Computer Logbook	

SAFETY ANALYSIS

Safety Check List	**Potential Hazards**
• Collection and Transmission Systems Safety Program Plan • Protective Clothing and Equipment • Traffic Safety Requirements	• Infectious Diseases • Slip, Trip, and Fall • Poisonous Snakes, Pests, Insects • Traffic • Vehicle Operation • Mechanical Tools

DEPARTMENT OF WATERSHED MANAGEMENT
RAIN GAUGE MAINTENANCE PROCEDURE

ACTIVITY/SUBTASK

Once a rain gauge site has been accepted by the Program Manager, the following procedures are required:

- The field crew will visit a rain gauge site once a month.
- During this visit, the field crew will make sure that the surface plate is balanced, the tipping bucket is cleaned, the battery is good, and retrieve the data from the rain gauge by connecting the logger to a laptop computer and downloading the data.

2.8 Monthly Maintenance Reports

SCHEDULE

Schedule of monthly reports of the rain gauge and/or flow monitoring data is determined by the System-Wide Flow and Rainfall Monitoring Program.

ACTIVITY DESCRIPTION

Creation of the monthly reports of each maintained site for rain gauge or flow monitoring data provides insight of site performance and activities.

ACTIVITY GOALS

- To provide data result from either rain gauge or flow monitoring unit in a report.
- To report meter performance each month and site issues and actions.
- To ensure the site performance and data quality.

LABOR	**MATERIALS**
Field crew	None
EQUIPMENT	
Computer Flow monitoring software	

SAFETY ANALYSIS

Safety Check List	**Potential Hazards**
• None	• None

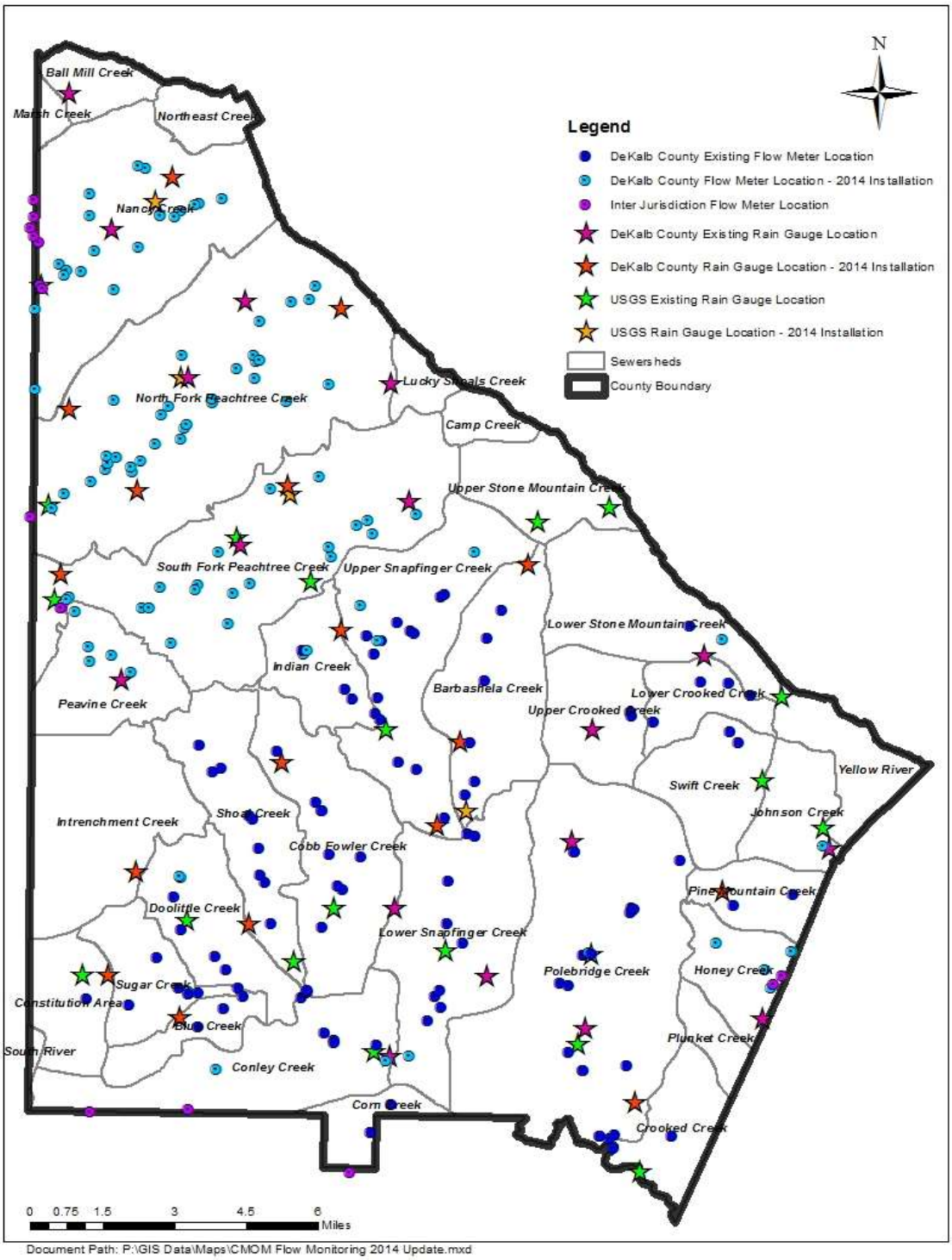
ACTIVITY/SUBTASK

Field crew, as part of the maintenance program, should provide reports on each maintained site that includes: Brief summary of the month for each site, including data quality, minimum, average, maximum of flow and depth, network uptime, monitor uptime, change of flow conditions, and any issues with the site; Site visit records, indicating the crews have visited each site at least once per month to physically check the sensors and equipment in proper position, scrub and clean sensor, and take any other actions as needed; Diagnostic reports for each visit; Calibration sheets, indicating the data and time when depth and velocity were calibrated, and calibration results; Hydrograph include velocity, depth, and flow with the rainfall on top of the graph; review data based on the hydrographs and indicate /flag any issues of the site on the hydrographs, such as missing data, sensor drifting, poor data quality, etc. The calibration and site visits shall be marked on the hydrograph plots; scattergraphs plotted using depth versus velocity.

3. Appendix

- Map of Flow Monitoring and Rainfall Gauge Locations
- Sample of Report Forms and Graphs
  - Sample of Calibration Form for Flow Meters
  - Sample of Flow Monitoring Site Summary Report
  - Sample Raw Data and Charts
  - Sample Hydrograph
  - Sample Scattergraph

3.1 Map of Flow Monitoring and Rain Gauge Locations



Document Path: P:\GIS Data\Maps\CMOM Flow Monitoring 2014 Update.mxd

APPENDIX

3.2 Sample of Report Forms and Graphs

Sample Calibration Form of Flow Meters

Site Name:	CBF8-15-156-S077-24			**Date:**	3/9/12
Project No.:		**Site ID**	CBF8	**Site Address:**	2199 CHEVY CHASE, DECATUR GA 30035.
Manhole No.:	156-S077		**Site Description**		

Serial Number:			
Telog Logger Serial No:	1480	**ESN/Modem Serial No:**	6C1CB365
Recorder Serial No:	122412	**Static I.P. Address:**	166.159.12.72
ISCO Area Velocity Serial No:	210K00258	**Phone Number:**	678-333-6688
ISCO Sensor Serial No:	203B00824	**Tipping Bucket Serial No:**	205K00691

Physical Data:					
Inside Diameter (inch):	24	**Pipe Material:**	CONCRETE	**Manhole Depth (inch):**	109
Manhole Diameter (inch):	48	**Flow Characteristic:**	STEADY	**Evidence of Surcharge:**	NONE
Depth of Surcharge (inch):		**Step Condition:**	FAIR		

Meter Setup:					
Install. Crew:		**Install. Date**	3/29/05	**Install. Time:**	9:30 A.M.
Depth Offset:	0.00	**Site Co efficient:**		**Cycle Time:**	15 MINS.
New Battery:		**Voltage:**	13.6	**Pipe Shape**	ROUND
Check Desiccant:	GOOD	**Change Desiccant:**		**Change Hydrophobic Filter:**	

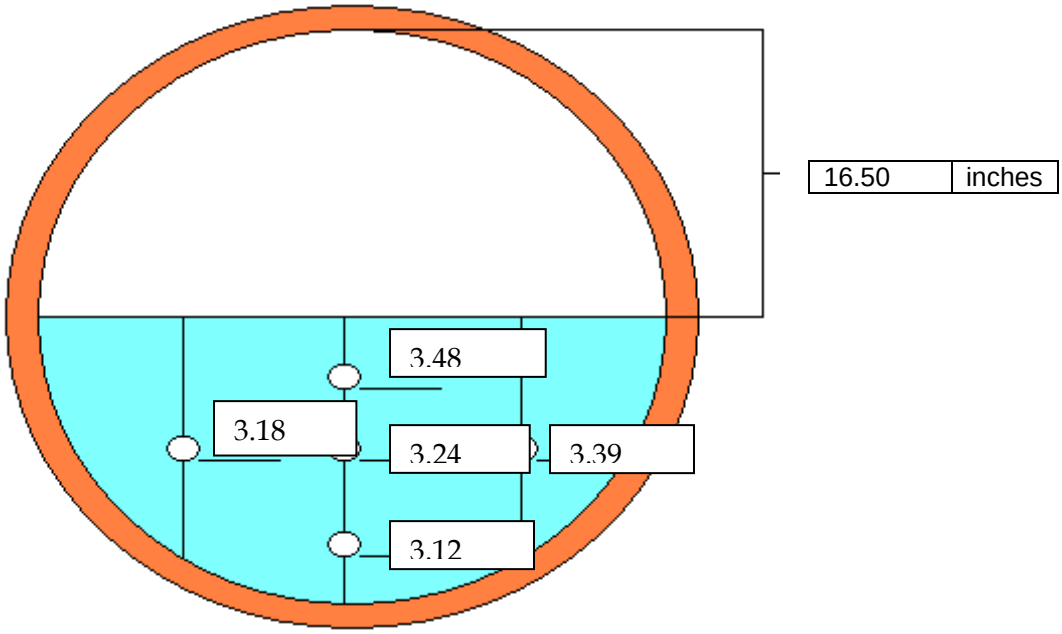
Confine Space:							
Entrance:							
Assistant:							
Attendant:							
Oxygen Level (O2):	20.9%	**Carbon Monoxide Level (CO):**	0%	**Flammable Level (CH4):**	0%	**Hydrogen Sulfide Level (H2S):**	0%

Comments:

DEPARTMENT OF WATERSHED MANAGEMENT
APPENDIX

Before Cleaning Level Measurement:							
Ruler Measurement Time Stamp:				11:45 A.M.			
Ruler Level (inch):	7.50	**Sensor Level (inch):**	7.61	**Velocity (fps):**	3.16	**Flow Rate (gpm):**	1.753

After Cleaning Level Measurement:							
Ruler Measurement Time Stamp:				12:00 P.M.			
Ruler Level (inch):	7.50	**Sensor Level (inch):**	7.42	**Velocity (fps):**	3.07	**Flow Rate (gpm):**	1.649



Calibration:							
Calibration Time Stamp:							
Ruler Level (inch):		**Sensor Level (inch):**		**Velocity (fps):**		**Flow Rate (gpm):**	

DEPARTMENT OF WATERSHED MANAGEMENT

APPENDIX

Document entered by:	

Sample Flow Monitoring Site Summary Report

DEKALB COUNTY
DEPARTMENT OF WATERSHED MANAGEMENT
FLOW MONITORING AT BILLING SITES

SITE SUMMARY REPORT

DK-5

MONTH ENDING: 31-Mar-12

GENERAL INFORMATION

ADDRESS: 1225 Lake Hearn Drive (South Side of Road)

MANHOLE ID: DEVICE: Parshal Flume

SIZE/DIAMETER: 9" EQUIPMENT: ISCO 2110

SENSOR: Ultrasonic TELEPHONE:

SUMMARY DATA

	AVERAGE	MAXIMUM	MINIMUM
FLOW (MGD)	0.25	0.50	0.13
DEPTH (INCHES)	3.14	4.89	2.02

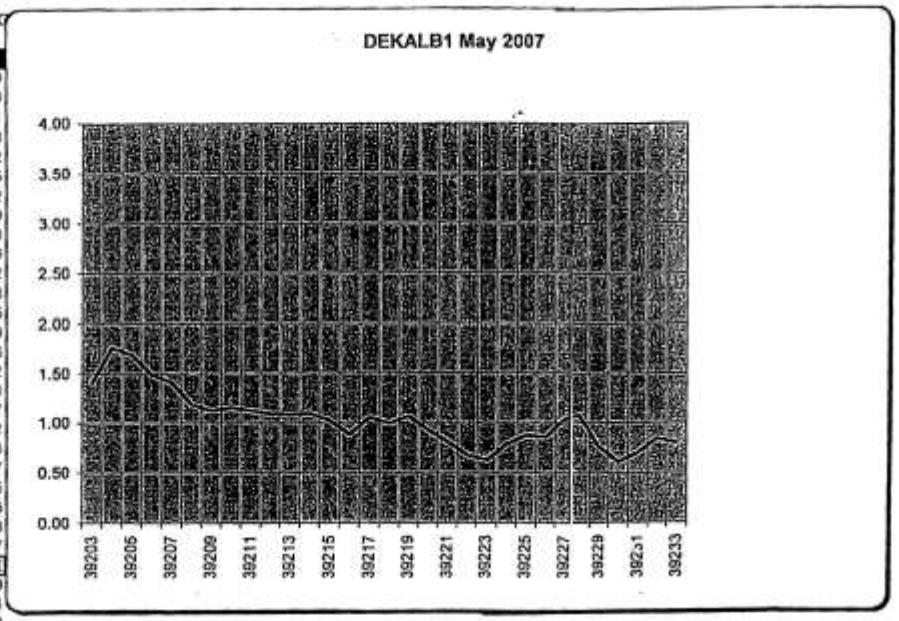
UPTIME %: 100%

TOTAL FLOW IN MILLION GALLONS 8.062

COMMENTS

Sample Raw Data and Charts

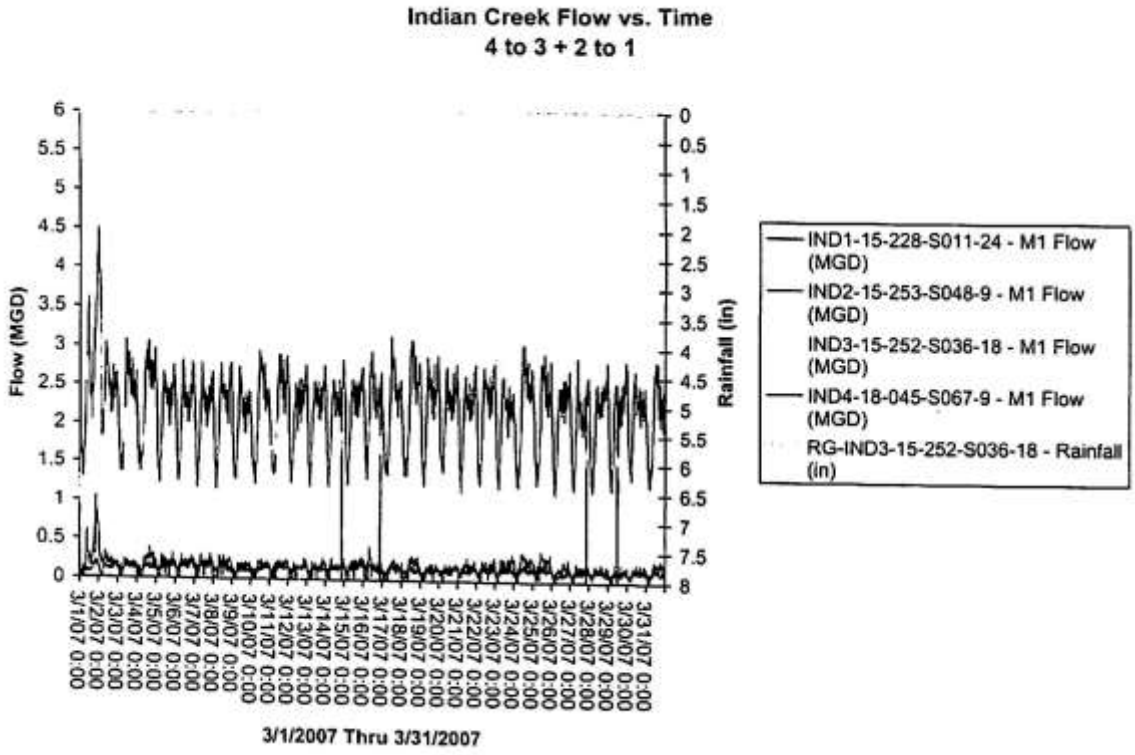
DEKALB1	Depth (IN)	w Rate (MG
05/01/07	7.07	1.41
05/02/07	[illegible]	[illegible]
05/03/07	7.61	1.69
05/04/07	7.33	1.49
05/05/07	7.27	1.41
05/06/07	6.89	1.18
05/07/07	7.13	1.12
05/08/07	7.5	1.15
05/09/07	7.51	1.12
05/10/07	7.45	1.09
05/11/07	6.87	1.08
05/12/07	6.77	1.09
05/13/07	6.42	1.02
05/14/07	6.3	0.88
05/15/07	6.79	1.05
05/16/07	6.66	0.99
05/17/07	6.55	1.06
05/18/07	6.16	0.92
05/19/07	5.91	0.80
05/20/07	5.57	0.67
05/21/07	5.46	0.62
05/22/07	6.01	0.78
05/23/07	6.2	0.87
05/24/07	6.69	0.85
05/25/07	6.69	1.03
05/26/07	6.87	1.08
05/27/07	6.38	0.77
05/28/07	6.01	0.61
05/29/07	6.23	0.70
05/30/07	6.9	0.84
05/31/07	6.65	0.80



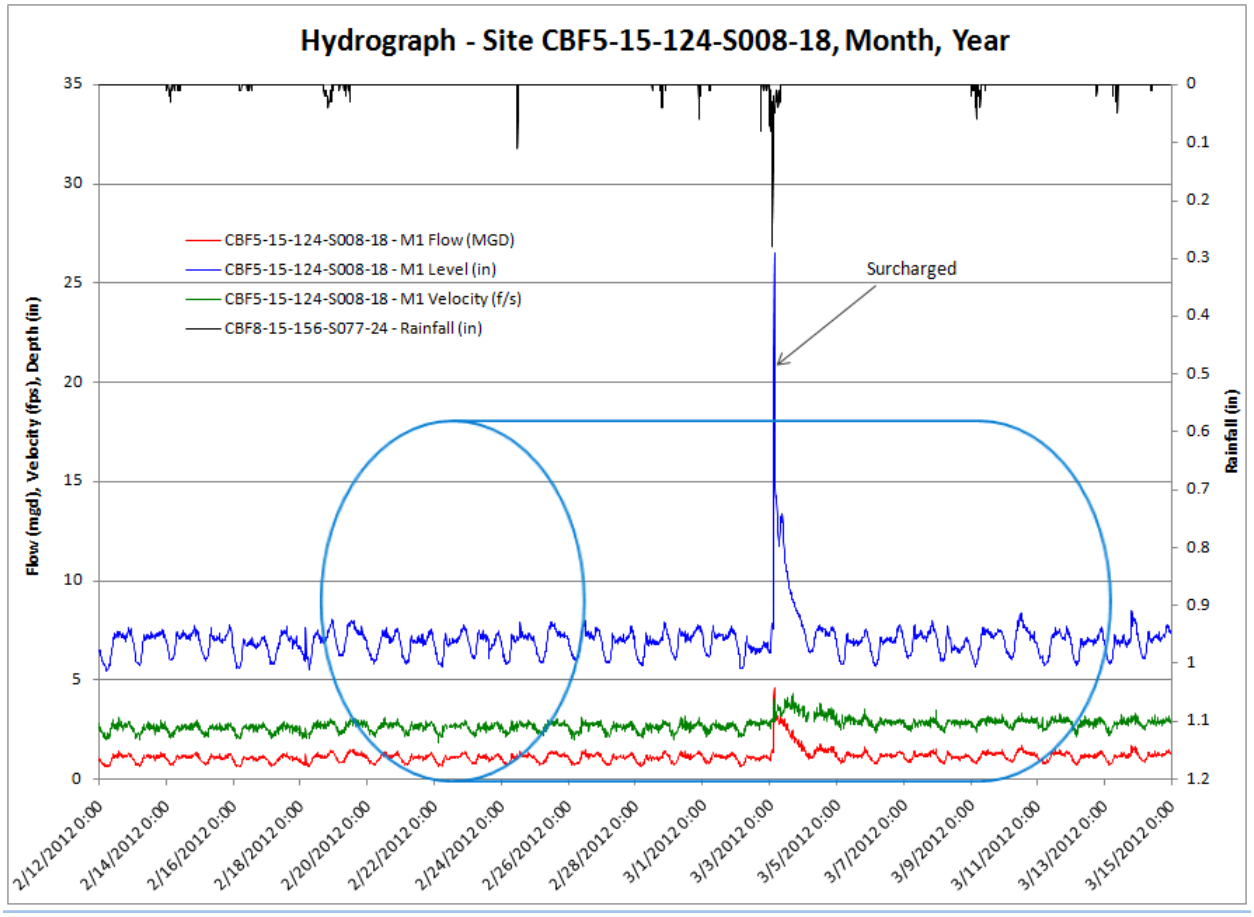
DATA PROVIDED: ***May 1, 2007 to May 31, 2007***

ADDRESS:	1657 Anita Pl NE, Atlanta, GA 30306
PHONE NUMBER:	N/A
PIPE SHAPE:	Round
PIPE DIAMETER:	42" (ISCO 2150 Area Velocity & Sensor)
HYDRAULIC COEFFICIENT:	N/A
SILT:	0.00 (inches)
COMMENTS:	Cleaned & Calibrated on 04/30/2007

AVERAGE DAILY FLOW:	1.03	(MGD)
MINIMUM DEPTH:	6.01	(IN)
MINIMUM FLOW:	0.61	(MGD)
MAXIMUM DEPTH:	7.62	(IN)
MAXIMUM FLOW:	1.76	(MGD)
SURCHARGE PERIOD:	None	
TOTAL FLOW RATE:	**31.93**	**(MGAL)**


Indian Creek Flow vs. Time
4 to 3 + 2 to 1
Flow (MGD)
Rainfall (in)
IND1-15-228-S011-24 - M1 Flow (MGD)
IND2-15-253-S048-9 - M1 Flow (MGD)
IND3-15-252-S036-18 - M1 Flow (MGD)
IND4-18-045-S067-9 - M1 Flow (MGD)
RG-IND3-15-252-S036-18 - Rainfall (in)
3/1/2007 Thru 3/31/2007

Sample Hydrograph



Sample Scattergraph