CORROSION CONTROL PROGRAM

FOR

CAPACITY, MANAGEMENT, OPERATION, AND MAINTENANCE (CMOM) PROGRAM

PREPARED BY:

W. L. Burle Engineers, P.A.
111 South Walnut Street
Greenville, MS 38701

PREPARED FOR:

City of Greenville
Public Works Department
340 Main Street
Greenville, MS 38701

PROGRAM DATE:
December 22, 2017

TABLE OF CONTENTS

	Certification	ii
1.0	INTRODUCTION/PURPOSE	1
2.0	DEFINITIONS	1
	2.1 General	1
3.0	BACKGROUND	3
	3.1 Microbiological Considerations	4
	3.2 Concrete Deterioration	5
	3.3 Metallic Corrosions	7
4.0	SYSTEM AND ORGANIZATION STRUCTURE	7
	4.1 City Operation and Functional Structure	8
	4.2 CITY Resources	9
	4.3 Greatest Potential for Corrosion in Sanitary Sewer Collection System	9
5.0	PROGRAM	9
	5.1 Inspection of Sanitary Sewer Infrastructure	10
	5.2 Site Specific Corrosion Control Measures	10
	5.3 Monitoring Program and Performance Measures	14
	5.4 Information Management System	16
6.0	PERSONNEL TRAINING	17
7.0	PROGRAM UPDATES	17

TABLES

TABLE 1:	Contact Information for CCP Response Personnel	8

APPENDICES

Appendix A:	Corrosion Control Program Revision/Update Log	A-1
Appendix B:	City of Greenville, MS Forms A, B, and C	B-1
Appendix C:	Greenville, MS Pump Stations	C-1
Appendix D:	Standard Operating Procedures for Sewer Cleaning	D-1

CERTIFICATION

Corrosion Control Program
Partial Consent Decree
City of Greenville, MS

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering such information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Errick D. Simmons, Mayor

12/28/17
Date

1.0 INTRODUCTION/PURPOSE

On April 4, 2016, a Partial Consent Decree (PCD), issued by the United States of America on behalf of the United States Environmental Protection Agency (EPA) to the City of Greenville, Mississippi (CITY), was executed. The PCD cited the CITY for violations to both their National Pollutant Discharge Elimination System (NPDES) Permit and the Clean Water Act (CWA). The PCD, among other things, required the CITY to develop and implement a Capacity, Management, Operation and Maintenance (CMOM) Program with one of the major sub-programs being a Corrosion Control Program (CCP).

The purpose of the CCP is to establish provisions for inspecting the sanitary sewer system infrastructure for corrosion caused by hydrogen sulfide or other corrosives, the development and implementation of site specific corrosion control measures, application of corrosion control measures where needed, a monitoring program to evaluate corrosion control programs and performance measures, and a corrosion control program information management system.

Implementation of the CCP will enhance the CITY's ability to maintain regulatory compliance and reduce the potential for SSOs from the CITY's Wastewater Collection and Transmission System (WCTS) and/or Wastewater Treatment Plant (WWTP). The CCP will enable the CITY's staff to reduce system blockages and maintain the original hydraulic capacity of the WCTS. Additionally, the program will allow the CITY to identify areas that require additional maintenance, rehabilitation and/or replacement.

2.0 DEFINITIONS

2.1 General

The following words and/or phrases are defined as follows:

A. **CITY** means the City of Greenville, Mississippi, a municipal corporation, including all of its departments, agencies, instrumentalities such as the Public Works Department, and any successor thereto.

B. **Corrosion** shall mean the act of deteriorating (relating to infrastructure within this document).

C. **Corrosion Control Program (CCP)** means a guidance plan that presents strategy for the timely and effective means of responding to corrosion related complications to the Sanitary Sewer System Infrastructure.

D. **Environmental Protection Agency (EPA)** means United States Environmental Protection Agency, Region 4. Federal regulatory agency with respect to the Clean Water Act and Consent Decree.

E. **Force Main Sewer** means any pipe that receives and conveys, under pressure, wastewater from the discharge side of a pump. A force main is intended to convey wastewater under pressure.

F. **Gravity Sewer** means a pipe that receives, contains and conveys wastewater not normally under pressure, but is intended to flow unassisted under the influence of gravity.

G. **Geographic Information System (GIS)** means a spatially related, mapping database maintained by the CITY.

H. **Manhole** means a structure within the sanitary sewer collection system that can be accessed to visually inspect and maintain the collection system. Typically located at intersections with other line sections or changes in vertical elevation and/or horizontal alignment.

I. **National Association of Corrosion Engineers (NACE)** means a professional organization for the corrosion control industry that publishes standard practice, test method, and material requirements standards for use by industry and other corrosion societies.

J. **Private Sewer** means that portion of a sanitary sewer conveyance pipe that extends from the wastewater main to the single-family, multi-family, apartment, or other dwelling unit or commercial or industrial structure which wastewater service is or has been provided.

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

L. **Pump Station** means facilities comprised of pumps which lift wastewater to a higher hydraulic elevation, including all related electrical, mechanical and structural systems necessary to the operation of that pump station.

M. **Sanitary Sewer Overflow (SSO)** means any discharge to waters of the United States from the sewer system owned and operated by the CITY through point sources not specified in the NPDES permit, as well as any release of wastewater from the sanitary 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 are not SSOs for the purposes of the PCD.

N. **Sanitary Sewer Overflow Response Plan (SORP)** means a guidance plan that presents a strategy for the timely and effectively means of responding to an SSO.

O. **Supervisory Control and Data Acquisition (SCADA)** means a system for remote monitoring and control that operates with coded signals over communication channels.

P. **Service Lateral** means pipes that convey sewage from homes and businesses and transport that sewage to the publicly owned collection system.

Q. **Sewer Cleanout** means a vertical pipe with a removable cap extending from a service lateral to the surface of the ground. It is used for access to the service lateral to the publicly owned gravity sewer for inspection and maintenance.

R. **Sewershed** means a geographic and/or hydraulic region, or basin in which all wastewater flows are conveyed to a single point, or outlet, before being conveyed elsewhere.

S. **Treatment** means any method, technique, or process which changes the physical, chemical, or biological character or composition of wastewater and thereby reduces its potential for polluting waters of the United States.

T. **Wastes** means sewage, industrial wastes, and all other liquid, gaseous, solid, radioactive, or other substances which may tend to pollute any waters of the United States.

U. **Waters of the United States** means any and all rivers, streams, creeks, lakes, ponds, impounding reservoirs, springs, wells, marshes, and all other bodies of surface or ground water, natural or artificial, situated wholly or partly within or bordering upon the United States or its jurisdiction.

V. **Wastewater** means the combination of liquid and water-carried pollutants from residences, commercial buildings, industrial plants, and institutions together with any groundwater, surface runoff or leachate that may be present.

W. **Wastewater Collection Transmission System (WCTS)** means the entire municipal wastewater collection, retention and transmission system, including all pipes, force mains, gravity sewer lines, pump stations, pumps, manholes and appurtenances thereto, which are owned or operated by the CITY.

X. **Wastewater Treatment Plant (WWTP)** means devices or systems used in the storage, treatment, recycling, and reclamation of municipal wastewater. For the purpose of this document, this definition shall include all facilities owned, managed, operated, and maintained by the CITY, including but not limited to the treatment facility located on Highland Plantation Road, Greenville, Mississippi, and all components of such sewage treatment plant(s).

3.0 BACKGROUND

"Wastewater" in a municipal setting consists of relatively weak solutions of non-aggressive contaminant chemicals in "used" water. The water is collected and conveyed to the wastewater treatment plant in pipes made of common materials, including cement mortar lined cast (ductile) iron, precast concrete, vitrified clay and plastic, which include variety of thermoplastic or thermoset materials.

The concentrations of contaminants (i.e. fats, oils, greases, soaps, organic matter, dirt, human waste, food waste, etc.) in raw wastewater from domestic and commercial sources is normally at total concentrations below 1000 ppm. Wastewater is aerated in most parts of the wastewater system, at least where the biological reactions do no consume all the dissolved oxygen. In areas where wastewater is not aerated, it produces much more corrosive conditions for many materials.

The most common chemical contaminants in domestic wastewater are a wide variety of organic compounds and ions of chlorides, nitrogens, sulfates, and phosphates. The pH of wastewater typically is between 6 and 7, running slightly on the alkaline side of neutral where there is higher use of soaps and household cleansing materials, most of which are mildly alkaline to increase their detergent effectiveness. Industrial wastewater can also have a wide range of contaminants, some of which may significantly affect the corrosiveness of wastewater. However, most industrial wastewater today must meet limits for contamination levels, especially for pH and heavy metal ions. If not properly managed, metals removal and pH control can affect the corrosivity and toxicity of the wastewater in municipal collection and treatment systems.

3.1 Microbiological Considerations

Sewage and other wastewaters contain significant levels of biological and organic materials, including many bacteria that remain active in waste streams. From a corrosion point of view, the most important types of bacteria are those that metabolize sulfur compounds because this microbiological activity can produce acidic chemicals that are corrosive to concrete, steel and iron. Some bacteria also oxidize ferrous ions to ferric ions, which makes the local environment more corrosive to carbon steel. These bacteria can exist in wide ranges of pH (both acidic and basic) and temperatures and live to oxidize various organic compounds found in wastewater. The most common way these microorganisms effect wastewater streams is by growing colonies in the organic slimes and deposits that form, usually in headspaces above the flowing wastewater. The environment created by these organisms can become acidic enough to dissolve concrete and to corrode steel and ductile iron, and form mounds that can clog steel or iron pipes.

Perhaps the most common and major microbiological contribution to corrosion comes from the bio-generation of sulfides to form hydrogen sulfide (H_2S) in municipal wastewater systems. Septic sewage contains an ample supply of sulfate ions (SO_4^{-2}). In anaerobic conditions, sulfate reducing bacteria (SRB) metabolize the sulfate ions reducing them to sulfide ions (S^{2-}), which in turn react with hydrogen ions in the wastewater to form hydrosulfide, also known as bisulfide ion (HS^-). Bisulfide ions acidify the wastewater, increasing the concentration of hydrogen ions speeding up the formation of HS ions and of H_2S gas. Gaseous H_2S acidifies surface moisture in headspaces of enclosed or covered structures, causing acidic corrosion of concrete or metal surfaces. H_2S and oxygen combine to form polythionic acids – a weak form of sulfuric acid.

In aerobic conditions, Sulfate Oxidizing Bacteria (SOB) colonize on wet surfaces with pH above 9.5 and are especially active in a nutrient rich, scum layer generally found above the waterline. SOB uses dissolved oxygen to metabolize H_2S and other sulfides to sulfuric acid (H_2SO_4). Different SOB thrive under different conditions. If one type can no longer survive because conditions become too acidic, another will take over. This process continues to very acidic pH levels of around 1.0, provided the bacteria have enough nutrients, H_2S and dissolved oxygen to keep conditions aerobic.

3.2 Concrete Deterioration

Uncoated concrete pipe and structures in wastewater systems deteriorate, sometimes quickly, from exposure to a variety of chemical and physical conditions. Design and selection of appropriate protection or remedial measures for concrete in wastewater treatment requires an understanding of the chemical and physical conditions that cause concrete to deteriorate.

The four primary mechanisms of chemical deterioration of concrete are:

1. Acid attack (by biogenic acids)
2. Carbonation
3. Chloride – related deterioration
4. Sulfate attack

Acid Attack

Acids react with concrete in a standard, acid- base neutralization reaction. The most common acid environment in wastewater is the sulfuric acid formed by bacterial action and from reaction of hydrogen sulfide, water, and air. The rate of neutralization depends on the initial acid concentration and on the type of acid.

When exposed to acids or acidic solutions the cement reacts with the acid to produce soluble salts. These are mostly calcium salts because the hydrated cement is about 25% calcium hydroxide. An acid attack dissolves the cement phase of the concrete away, exposing the less soluble coarse aggregate materials. An acid attack of the aggregate material in the concrete depends on its chemical nature and the type of acid. An acid attack is therefore characterized by severe aggregate exposure and aggressive section thickness loss of concrete. Exposed steel reinforcement is also vulnerable to acid corrosion.

Prolonged exposure to mild acidic attack will be indicated by rust bleeding (from corroding reinforcing steel) and cracking and spalling of the concrete. With an aggressive acid attack, there is no concrete to crack and spall and only piles of loose aggregate eventually remain. Rates of attack by acids depend on the type, volume and strength (pH) of the acid, as well as on the associated physical parameters such as frequency or duration of exposure, temperature, flow rates, etc.

Carbonation

Carbonation is a special type of acid attack of concrete. It involves reaction of atmospheric or dissolved carbon dioxide with the hydrated constituents in

Portland cement paste, especially calcium hydroxide. Carbon dioxide combines with humidity in the air to form a weak, carbonic acid. The carbonic acid that permeates the concrete, reacts with the cement paste, neutralizing the alkalinity (lowering the pH) by converting hydroxides to carbonates. The products of the carbonation reaction are relatively insoluble and do no normally weaken the concrete.

Carbonation occurs to some extent on all concrete surfaces exposed to the weather. Rates of carbonation depend primarily on the permeability of the concrete, the relative humidity and the temperature. More permeable concrete is carbonated more rapidly and the carbonation zone also extends deeper into the concrete. Carbonation rates are accelerated if there is a large temperature gradient through the concrete presumably because the strong condensation gradient formed pulls moisture from the warmer side to the colder side of the concrete.

The main effect of carbonation is a localized reduction in the alkalinity (pH) of the concrete. By reducing the alkalinity required to keep carbon steel from corroding, carbonation that extends around the reinforcing steel make it more susceptible to corrosion.

Chloride – Related Deterioration

When wet concrete is placed around bare, carbon reinforcing bars, a corrosion reaction between the steel and alkaline cement paste produces a tightly adherent, protective, oxide film on the steel surface. This "passive" film is stable at pHs higher than 11 and prevents corrosion of the steel as long as the film is not damaged or removed. Passive self-protection of the steel can be lost when the pH decreases, making the steel susceptible to corrosion by the same agents that lowered the pH. The steel will then be corroded by moisture, oxygen and especially chloride ions that reach the steel, either slowly through permeation or rapidly via cracks.

The concrete matrix is not chemically affected by chlorides and chloride ions are not harmful to carbon steel if there is no wetness present – i.e., dry rebar is not subject to chloride related attack or any other corrosion. The main harmful role of the chlorides is in accelerating penetration of the iron oxide passive layer. Higher concentration of chloride ions increase this attack.

Rebar corrosion usually starts at localized places on the steel, creating local, anodic corrosion sites. Formation of steel corrosion products creates expansion forces within the concrete that easily exceed the tensile strength of the concrete. The concrete fails by cracking and spalling, which increases access by the corrosive environment to the steel, causing more corrosion.

Sulfate Attack

Concrete exposed to sulfate ions can be attacked via reaction of sulfate ions with certain hydrated constituents of Portland cement paste. Sulfate ions and sulfate attack are present in wastewater treatment plants and sewers due to the high concentration of sulfur compounds present in the environments. Compounds formed when sulfate ions react with specific constituents in hydrated Portland cement paste are more voluminous than the initial reactants. This increase in volume produces expansion forces, which promote cracking and disintegration of the concrete matrix. Higher concentrations of sulfates usually lead to more aggressive deterioration of susceptible concrete.

The initial indication of sulfate attack is micro-cracking in the cement paste. These cracks then grow and enlarge as the attack progresses. The concrete subsequently disintegrates in a friable powdery manner at the exposed surfaces, which also experience significant aggregate exposure as the cement phase is lost.

3.3 Metallic Corrosions

The most common metallic construction materials in wastewater environments are made of the metal Iron (Fe) ex., carbon steel, ductile iron and stainless steel. Zinc (Zn) may be present as the coating on galvanized steel. Carbon steel and ductile iron both corrode slowly in aerated wastewaters and more rapidly in locally acidified conditions caused by microbiological reactions (5 to 10 times more rapidly). Corrosion rates in the normal aerated wastewater depend on the amount of aeration and to a lesser degree on the temperature. Furthermore, pipes and other structure made from carbon steel and ductile iron can be externally corroded by the surrounding soil.

4.0 SYSTEM AND ORGANIZATIONAL STRUCTURE

Currently, the CITY provides wastewater services to approximately 13,400 customers. The CITY's wastewater collection and treatment system is comprised of the following:

- 1 WWTP
- ~200 miles of gravity sewers
- ~3400 manholes
- 104 active pumping stations (115 total including privately owned/operated)

The WCTS is an integral part of CITY's unseen infrastructure, taking sanitary wastes from residences, commercial establishments and industry and conveying it to the CITY's WWTP for appropriate treatment and discharge. The WCTS is divided into three (3) sewer sheds, all of which feed into the WWTP. The CITY owns and maintains pump stations including force mains and gravity lines in all of the sewer sheds. The CITY's WWTP is permitted to discharge 20 million gallons per day (MGD) but is designed to handle flows as great as 30 MGD. For detailed information and maps for each of the mini-systems, refer to Figure 1 and Appendix A of SORP.

4.1 CITY Operation and Functional Structure

The CITY's Sewer Maintenance Division of the Public Works Department maintains a staff of 13 individuals to manage, operate, maintain and improve the WCTS. The CITY has out-sourced the operation and maintenance (O&M) of the WTCS and the WWTP to Clearwater Solutions, LLC (CS) of Opelika, AL, a utility O&M company. Given the current arrangement, having a chain of command that defines clean lines of authority and responsibilities for system personnel speeds up response time and helps eliminate confusion. System personnel need to know how to report the emergency, who manages the emergency, who makes decisions, and/or what their responsibilities are.

Table 1 provides contact information for the personnel responsible for CCP response. Job titles are used to identify individuals that are assigned to certain responsibility.

Position/Company	**Employee**	**Office (O) / Mobile (M) Phone Numbers**
Public Works Director/CS	Donde Baldwin	662-378-1650 (O) 662-404-2444 (M)
Deputy Director/CITY	Ronnie Washington	662-378-1693 (O) 662-822-7004 (M)
Deputy Director/CITY	Jermaine Thornton	662-378-1693 (O) 662-822-5133 (M)
Division Chief – Pumps & Wells/CS	Jeff Appleton	662-378-1608 (O) 662-822-1620 (M)
Supervisor Pumps & Wells/CS	Kendrick Davis	662-378-1608 (O) 662-820-3083 (M)
Crew Chief Sewer Collection/CS	Brian Cook	662-378-1699 (O) 662-822-1205 (M)
Equip operator Sewer Collection/CS	Cordana Carter	662-378-1699 (O) 662-820-9526 (M)
WWTP Manager/CS	Adrick McMiller	662-378-1697 (O) 662-390-7918 (M)
Water Plant Manager (Operator of Record)/CS	Milton Kearney	662-378-1699 (O) 662-616-9190 (M)
Water Operator/CS	Russell Reynolds	662-378-1699 (O) 662-695-0612 (M)
PCD Liaison/CS	Brad Jones	662-378-1650 (O) 662-822-0094 (M)

Table 1: Contact information for CCP Response Personnel

In the case that responsibilities are not assigned to a specific individual, the highest ranking responder present will be responsible for ensuring the proper implementation of this CCP response.

4.2 CITY Resources

The following resources will be utilized in implementing the CCP:

- Combination rodder/vacuum truck
- Jet rodder truck
- Backhoes
- Dump Trucks
- Utility Crew trucks (equipped with crane)
- Standard pick-up trucks
- Sewer mapping (GIS based)
- Trained employees
- External resources, as needed

4.3 Greatest Potential for Corrosion in Sanitary Sewer Collection System

Based on the CITY's knowledge of the existing system and various EPA studies on the matter, the greatest potential for corrosion exits at the following components of WCTS/WWTP system:

- Gravity Sewers
- Manholes
- Pump Stations and Force Mains
- Treatment Facilities

Prioritization for corrosion control will be focused on these components of the system. Other areas of the system will be addressed on as-needed basis. With the identification of a corrosion problem, the CITY will take the appropriate action to investigate and determine a corrective action for the problem.

5.0 CORROSION CONTROL PROGRAM (CCP)

As a requirement of the partial consent decree, the CITY developed a Sanitary Sewer Evaluation/Rehabilitation (SSER) Work Plan that provides for the continual assessment, analysis, and rehabilitation of the WCTS infrastructure including corrosion related inspections. The following CCP has been developed to build upon the SSER work plan, and to provide the CITY with a guide to reduce corrosion-related system blockages and maintain the original hydraulic capacity of the WCTS. Upon completion of the SSER projects as described in Section VI of the SSER Work Plan or within 12 months of EPA's approval of the CCP, whichever occurs first, the CITY will fully implement the CCP.

5.1 Inspection of Sanitary Sewer Infrastructure

A. All inspections of the WCTS will be performed as described in the SSER Work Plan Section IV.

B. The CITY will conduct Ultrasonic Nondestructive Testing (NDT), when applicable, for material thickness, integrity, or other physical properties when the CITY suspects the presence of corrosion.

C. Any epoxy or polyethylene coatings on concrete structures will be inspected at a rate of 10% of the structures and documented per year.

D. Upon suspicion of internal corrosion or corrosion related leaks in pressurized pipes, the CITY may employ methods, such as the SmartBall™ Technology, to evaluate the condition of the pressurized pipe.

E. The CITY will perform soil corrosivity testing on an as-needed basis when soils in the area of a pipeline or any other sanitary sewer system are suspect.

F. The CITY will select ten (10) monitoring stations within the WCTS based on area served; length, diameter, flow and hydraulic gradient of the sewers; manholes, lift stations, and location of force main discharges; other site-specific factors where corrosives such as sulfide generation are likely to exist, and perform annual inspections or as otherwise recommended by a NACE certified engineer and/or technician.

G. The CITY will annually evaluate ten (10) manholes selected as monitoring stations for corrosion by conducting the appropriate testing such as field observations, hydrogen sulfide measurement, probing manhole walls etc.

H. The CITY will annually inspect all components used in the headworks area of the WWTP due to the high potential of hydrogen sulfide corrosion.

I. The CITY will annually walk all forcemains to check for leaks and/or other signs of damage.

J. Electrical components of WTCS and WWTP are particularly sensitive to hydrogen sulfide because copper, iron, and silver are all directly attacked by hydrogen sulfide and are to be inspected on a semi-annual basis.

K. Special structures such as those utilized for flow measurement and valves used for flow isolation and air release are also susceptible to hydrogen sulfide corrosion and therefore will be inspected annually or as otherwise recommended by a NACE certified technician and/or engineer. If the annual inspection indicates that more frequent inspections are needed, the CITY shall develop an inspection schedule tailored for the special structure in question.

L. All corrosion related inspections that the CITY's Sewer Maintenance Division is not equipped to handle are to be performed by a NACE certified engineer or technician.

5.2 Site Specific Corrosion Control Measures

A. Gravity Sewers and Manholes

1. Corrosion due to hydrogen sulfide in gravity sewers and odor related problems due to the subsequent release of H_2S gas are to be addressed on a case by case basis using the following control measures:

   a. Oxidation of hydrogen sulfide in gravity sewers using air or oxygen injection or addition of oxidizing chemicals such as hydrogen peroxide (H_2O_2), chlorine (CL_2) or potassium permanganate ($KMnO_2$).
   b. Sewer ventilation to dilute sewer air, and to reduce humidity level along sewer walls and structure walls.
   c. Elevation of pH through stock treatment with a caustic to inactivate the sulfate-reducing bacteria in the slime layer.
   d. Implementation of other methods as directed by a NACE certified engineer and/or technician.

2. CCTV and visual methods will be used by the CITY to inspect the internal conditions of gravity sewers and sub-surface structures when the presence of corrosion is suspected.
3. Gravity sewers design recommendations for corrosion control are:

   a. No public gravity sewer conveying wastewater shall be less than 8 inches in diameter.
   b. A minimum cover of three (3) feet shall be provided for all gravity sewers.
   c. All sewers should be designed and constructed to give mean velocities, when flowing full, of no less than 2 feet per second (FPS).

B. Pump Stations and Force Mains

1. Constant-speed pump stations are to be operated with start-stop cycles that are short enough to avoid backup of wastewater into influent lines and to avoid excessive wet-well detention times.
2. Any air entrainment into the force mains as a result of improper design and/or operation of pump stations should be corrected.
3. Pipe coupons will be removed for evaluation from forcemains which are believed to be experiencing corrosion.
4. Any accumulation of sulfides in wet wells due to reasons such as excessive turbulence, long detention times, lack of wet well cleaning etc., are to be corrected as pump stations and force mains are highly susceptible to hydrogen sulfide corrosion.
5. All existing wet well interior concrete and metallic surfaces which are experiencing corrosion will be coated with appropriate coatings to provide resistance to hydrogen sulfide corrosion. New pump

stations are required to be lined or coated with appropriate materials not susceptible to corrosion.

6. All electrical enclosures vulnerable to corrosion at pump stations should be protected. One or more of the following methods should be used to prevent corrosion of electrical enclosures from corrosive gasses:

    a. Using gasketed enclosures to prevent entry of corrosive gases; and/or
    b. Maintaining positive air pressure within the enclosures.

7. Pump station design recommendations for corrosion control are:

    a. Corrosion control should always be considered for corrosion-prone systems, such as pump station wet wells, force mains & manholes due to the possibility of anaerobic conditions to form over time.
    b. Three other instances where anaerobic conditions should be anticipated are:

        1) Areas where high concentrations of organics are entering a flow such as near food processing and handling facilities;
        2) Areas where sewage residence time are extended, such as a pump station handling a flow situation where wet well residence times are relatively long; and
        3) Areas where the sewage flow has already had a long residence in the system such as at a major pumping station which takes in flow from a large area.

    c. Turbulence and solids deposition should be minimized to discourage the release of corrosive gasses.
    d. Wet wells, where feasible, should be retrofitted with intake fans for ventilation.

8. Force main design recommendations for corrosion control are:

    a. Gas accumulation due to gradient changes cannot be allowed since it can form an air pocket which has the potential of restricting flow and/or corroding the pipe surface.
    b. Force mains from lift stations should be designed for velocities between 2 fps to 10 fps based on the most economical pipe diameters.
    c. Mains should have a slope that is minimal such that gas pockets are not formed.

d. Force mains should be designed so that they are always full with appropriate pressures to prevent the accumulation of and release of sewer gasses.
e. Venting of any high point is absolutely necessary for concrete force mains and the air relief valves must be properly maintained.
f. All areas where force mains empty into other force mains, wet wells, gravity manholes, etc. should also be carefully reviewed to provide a high level of corrosion protection.

C. Treatment Facilities

1. Catwalks, railings, platforms, clamps, beams, and other structural elements should be constructed or coated with corrosion resistant material to insure the safety of plant operators and inspectors.
2. Due to highly corrosive conditions, components or structures at the waterline are to be properly coated and recoated when previous coatings are penetrated by the various corrosive agents.
3. For enclosed wet wells, grit chambers, holding tanks, and buildings housing wastewater sludge processing equipment, corrosion should be addressed on a case by case basis and any corrosion control measures are to be performed as needed.
4. Corrosion of materials subjected to special conditions which foster corrosion, such as physical-chemical treatment processes, anaerobic digester heating systems, plant boilers and steam piping etc., are to be addressed on a case by case basis and any corrosion control measures are to be performed as needed.
5. Corrosion of metals due to hydrogen sulfide gas (or other corrosives) are to be addressed on a case to case basis using the following control measures:

   a. Cathodic Protection is a technique used to protect metal structures and buried metallic pipelines susceptible to corrosion. Cathodic protection has successfully been used for corrosion control of iron and steel components such as clarifiers, aeration tanks, and sludge digesters at wastewater treatment plants. Sacrificial anode and impressed current are two common types of cathodic protection systems.

      1) Impressed Current Cathodic Protection (ICCP) use anodes connected to a direct current (DC) power source or an alternating current (AC) powered DC rectifier to provide an electrical path from the anode array to the cathode (pipeline) allowing the anode to corrode, reducing the corrosive reaction in the pipeline.

2) Sacrificial Anode Systems use galvanic anodes designed to have a more negative electrochemical potential than the metal of the structure that they are protecting. The galvanic anode corrodes by consuming the anode material until it must be replaced, and thus halts the corrosive reaction of the structure it's protecting.

b. Chemical addition can be employed to control sulfide-induced corrosion and other corrosive conditions in WWTPs. Hydrogen peroxide, metal salts, nitrates, and chlorine are some of the chemicals effective for sulfide control. For low pH waters, addition of alkalis, such as caustic soda, can elevate the pH to a neutral range, greatly reducing the rate of acid-induced corrosion of concrete and metal surfaces.

5.3 Monitoring Program and Performance Measures

A. Gravity Sewers and Manholes

1. Basic goals and treatment levels should be established on a case-by-case basis after identifying the extent of the problem. Treatment objectives are to be developed with respect to the control measures and the following performance measures:

   a. Maintain DO greater than 0.5 mg/l to eliminate sulfate reduction, or increase ORP to + 100 mv.
   b. Reduce dissolved sulfide to 0.1 to 0.3 mg/l.
   c. Reduce hydrogen sulfide gas to less than 3 to 5 ppm.
   d. Increase crown pH to 4.0 or greater.

2. Hydrogen sulfide is often discovered in pipes when slow velocities and slow moving solids concentrate on the bottom. When corrosion is suspected, gravity lines should be monitored and adjusted to their maximum design velocities.
3. CCTV and visual methods will be used by the CITY to inspect the internal conditions of gravity sewers and sub-surface structures when corrosion is suspected.

B. Pump Stations and Force Mains

1. Proper operation and maintenance of pump stations minimizes the conditions promoting microbiological activity and therefore, are to be routinely performed.

2. Detention times in the wet well should be minimized to reduce the settlement of organic matter to the bottom and the wet well, which will ultimately reduce dissolved sulfide and hydrogen sulfide gas.
3. Wet well cleaning activities will be dependent on the inspection work performed by the City under the Pump Station Operation and Preventative Maintenance Program. The frequency for such activities will depend on the observations (e.g. excessive floating solids, frequent pump cleaning, solids build-up, etc.) made by the City during the wet well inspections.
4. Surcharged pipes and force mains can generate significant quantities of hydrogen sulfide under anaerobic conditions and therefore, should be routinely monitored for corrosion.
5. Force mains and inverted siphons should be routinely monitored for air pockets. Air pockets can lead to corrosion of force mains and inverted siphons due to significant quantities of dissolved sulfides generated under anaerobic conditions.
6. Upon re-entry of wastewater from force mains and inverted siphons to gravity sewers or treatment plant headworks, an immediate release of hydrogen sulfide gas occurs due to high level of turbulence. Force mains and inverted siphon termini are, therefore, highly susceptible to hydrogen sulfide corrosion and should be monitored on an annual basis or as recommended by a NACE certified technician and/or engineer.
7. Special structures, such as those utilized for flow measurement, and valves used for flow isolation and ais release are areas of concern with regard to hydrogen sulfide corrosion and should be monitored on an annual basis or as recommended by a NACE certified technician and/or engineer.
8. Force mains should be walked on an annual basis to check for leaks.

C. Treatment Facilities

1. Plant components or structures at the waterline are subject to the most severe exposure due to the structures being subjected to wet and dry conditions and fluctuations in ambient temperatures. All wastewater treatment plant structures at the waterline are to be monitored on an annual basis or as recommended by a NACE certified technician and/or engineer.
2. Influent sources typically convey wastewater which is septic and already has a significant dissolved sulfide concentration. Sulfide concentrations should be monitored on an annual basis at influent terminus locations and corrosion control measures should be addressed as needed.
3. Headwork systems most susceptible to corrosion attacks include influent channels, flow measurement facilities, comminutors, bar

racks, grit chambers and areas where vertical drops occur. These components are known to promote turbulent conditions and should be monitored on an annual basis due to the high potential for the release of hydrogen sulfide.

4. Sludge storage tanks, sludge thickeners, sludge dewatering systems, and solids processing operations are particularly susceptible to corrosion and should be monitored on a quarterly basis.
5. Structural elements such as gratings, railings, platforms, structural inserts, clamps, columns and beams located in enclosed spaces, where the potential for hydrogen sulfide exists, should be monitored on an annual basis.

D. Performance Measures

The performance of the CCP will be measured by compiling the number of corrosion-related SSOs on an annual basis and comparing the findings to previous yearly totals.

5.4 Information Management System

The purpose of the Information Management System (IMS) is to manage information regarding WCTS from all sources. The CITY currently has a system in place where information is organized in a system of in-field documents, Microsoft Excel spreadsheets and GIS Mapping Program. When the CITY receives a call or knowledge of a sewer related problem, a CITY crew is dispatched with a work order, as described in SORP, to take appropriate corrective measures. The information is then updated on the spreadsheet and/or marked on the GIS mapping program, if warranted. A reliable IMS not only enhances operational performance, but provides city officials with guidance and instruction to adequately evaluate operations, maintenance, customer service, and sewer system rehabilitation activities.

Work identified and performed as part of the CCP will be recorded on the work order form. The CITY will follow standard operating procedures when inspecting for corrosion through the appropriate means, and corrective measures will be taken with respect to the site-specific corrosion control measures. Report forms will be filed and maintained for future references.

In case of a service call, a work order will be generated and a crew foreman or a supervisor of field operations will be promptly notified to be dispatched to the problematic location for assessment of the situation. If a corrosion problem is verified, it will be recorded on the work order and updated on to the IMS system for future references. The CITY will, overtime, identify problematic areas and enhance its ability to identify potential future SSOs and perform the required corrective measures.

6.0 PERSONNEL TRAINING

The CITY will provide CCP training for the crews and support staff. The CCP training will go hand-in-hand with the training for SORP to ensure the efficient and effective reduction in the number of SSOs. Continued education will be repeated on an annual basis, whenever new employees are hired, and whenever new changes are made to the SORP or the CCP.

7.0 PROGRAM UPDATES

The CCP is intended to be a working document and will be updated by the CITY as necessary to reflect any changes in staffing or notification requirements. Key personnel should make suggestions for adding or revising procedures where insight and experience dictate.

[END OF REPORT]

APPENDICES

APPENDIX A

CORROSION CONTROL PROGRAM
REVISION/UPDATE LOG

CORROSION CONTROL PROGRAM
REVISION/UPDATE LOG

Revision	Date

APPENDIX B

CITY OF GREENVILLE, MS
FORMS A, B, AND C

Form A
City of Greenville, MS
CCP Inspection Form

Public Works Department
P.O. Box 897
340 Main Street
Greenville, MS 38701
Phone: 662-378-1548

Inspector Name: ________________________
Date: ________________________________
Location/Area: ________________________
Last Inspection Date: ____________________

SANITARY SEWER INFRASTRUCTURE TYPE

☐ WTTP ☐ Pump Station No. ______________ ☐ Force Main

☐ Manhole No. ______________ ☐ Gravity Sewer

INSPECTION DATA

Address: ____
Entry time/date: __________________________ Exit time: __________________________

Name(s) of On-site Representatives / Title(s)/ phone and Fax Numbers(s):
____
____

Other Site Data: _____________________
____
____
____

AREAS EVALUATED DURING INSPECTION

(S = Satisfactory, M = Marginal, U = Unsatisfactory, N = Not Evaluated, N/A = Not Applicable)

	Structural Components		Electrical Components		Hydraulic Structures		Manhole
	Pumps		Influent Channels		Bar Screens		Aeration basin
	Wet Wells		Effluent Channels		Grit Chamber		Clarifiers
	Reinforced Steel		Pipes		Influent Conduits		Settling tank
	Valves		Flow Meters		Effluent Conduits		Chlorine contact basin
	Other(s)						

SUMMARY OF FINDINGS/COMMENTS

(Attach additional sheets if necessary)

____
____
____
____
____
____

Name(s) and signature(s) of inspector(s)	Agency Office/Telephone/Fax	Date
Signature of Management	Management office phone/fax	Date

Form B
City of Greenville, MS
Wastewater System Work Order

Public Works Department
P.O. Box 897
340 Main Street
Greenville, MS 38701
Phone: 662-378-1548

To be completed by person receiving call:

Received by:	Date:	Time:
Caller's Name:	Phone No.	Address:
Location of the complaint (address/nearby cross-street):		
Description of the complaint:		
Time crew dispatched:		

To be completed by field crew leader:

Crew Leader Name:	Time of arrival:
Crew Member Name:	Time of arrival:
Crew Member Name:	Time of arrival:
Crew Member Name:	Time of arrival:
Upstream MH number:	Downstream MH number:
Diameter of line:	Length of line:
Was there a blockage in the public main?	
Was the blockage in the street or easement:	
Location of obstruction:	
Observations at site:	
Remedial measures taken:	
Time cleared:	Did an overflow occur?
Property damage?	
Time overflow started:	Time overflow stopped:
Duration of overflow:	Overflow rate:
Sources of overflow (manhole, cleanout, etc.):	
Cause:	
Steps taken to clean up:	
Did spill reach surface water?	
______________________________ ***Person completing report***	______________________________ ***Date***

Attach photos and return completed report to Public Work Director.

Form C
City of Greenville, MS
Hydraulic Cleaning/Camera Report Form

Public Works Department
P.O. Box 897
340 Main Street
Greenville, MS 38701
Phone: 662-378-1548

Date:	
Customer name (if applicable)	
Location	

Pavement:	**Easement:**
Project number	

MH NUMBER START	MH NUMBER STOP	MH TYPE	PIPE SIZE	PIPE TYPE	LINE SECTION FOOTAGE
TOTAL DAILY FOOTAGE					

COMMENTS:			
EQUIPMENT USED	**HRS**	**WATER**	**WORK PERFORMED BY**

APPENDIX C

GREENVILLE, MS PUMP STATIONS

GREENVILLE, MS PUMP STATIONS

PUMP	NEAREST INTERSECTION/APPROXIMATE LOCATION
1	Sisson Drive
1A	Sisson Drive and Northview Drive
2	North Broadway and Sampson Road
3	Sampson Road and Townsend Street
4	North Theobald and Lacey Street
5	North Theobald and Hancock Street
6	Union Street and Redbud
7	Percy Lane and Shelby Street
8	HWY 1 at Alabama Drive
9	HWY 1 and Union Street
10	Moore Street and Carrie Stern Lane
11	Wortham Drive and Kirk Circle
12	Lyon Street and Penn Lane
13	Hernando Street and Elm Street
14	Broadway and Clay Street
15	HWY 82 and Byrd Street
16	Delesseps Street and Phelps Street
17	South Theobald Street and Archer Street
18	North Theobald Street Extended and Pickett Street (Cleaver Brooks)
19	Thornton Street and Pickett Street
20	Legion Drive and Wasson Street
21	Shannon Street and Old Leland Road
22	Old Leland Road and Tennessee Street
23	North Raceway Road and Alexander Street
24	East Alexander Street and Henry drive
25	Anita Joyce Lane
26	Reed Road and Raceway Road (O'Bannon School)
27	Beauchamp and Naples Street
28	Smith Street and Colorado Street
29	Causey Drive and Colorado Street
30	Reed Road and Garden Drive
31	South Colorado Street and Reed Road (Cottonwood Apartments)
32	Barbara Street and Marilyn Avenue
33	Walker Lane and Toni Street
34	Reed Road and Mary Street

35	Sudan Drive and Bowman Boulevard
36	Bowman Boulevard and Canal Street
37	Canal Avenue and Iris Street
38	St. Anthony Street and Canal Street
39	Causey Drive, Gamwyn Park Drive and Wilzin Street
40	Daniels Street & Reed Road
41	Wildwood Road and Gregory Street
42	McClain Drive and Idlewild Drive
43	North Plantation Drive and McClain Drive
44	Foxchase Drive and Countrywood Drive
45	South Ingram and Champian Drive
46	Essex Place and Oxford Place
47	Black Bayou Road at Emmanuel Baptist Church
48	Rayner Road and Bobolink Place
49	Anne Stokes Road and Briarwood Cove
51	Beauchamp Road and Thornton Street
52	Lowe/Fairgrounds Road near South Colorado Street
53	Tennessee Gas Road and Main Extended
54	East Moore Street and Forth Street
55	Union Street and Carter Street
56	South Beauchamp Avenue at Saint Elizabeth Street
57	South Beauchamp Ave at Nottingham Apartments
58	East End of Naples Avenue
59	South Broadway Loop and Delesseps (Baseball Field)
60	Metcalf Road at South Entrance to Greenville Airport
61	Gamari Road at Pre-School Facility
63	Lisa Drive and Pear Lane
66	May Street and Abraham Court
67	VFW Road and Greenville Christian School Road (Vessels of Mercy)
68	Highway 1 at WalMart
70	Sharon Street at River Club Estates Community Swimming Pool
71	Wildwood Drive and Lance Cove
72	Theobald & Hwy 1 North
76	2616 Highway 82 at Fred's Dollar Store - East Park Addition
79	South Colorado Street at Greenville Clinic
81	North Theobald Extended and Main Canal (The Sports World)

82	Warfield Point Park - Bathroom
83	Warfield Point Park - Dump Pit and Campground
84	Peripheral System Influent Station at the WWTP
86	Cauley Cove and Beauchamp Street
89	Cypress Ridge Drive and Cypress Lane
90	Greenville Welcome Center
91A	101st Street and Echo Street
91B	102nd Street and Bravo Street
91C	104th Street and Bravo Street inside fence
91D	101st Street and Foxtrot Street
91E	102nd Street and Echo Street
91F	5th Street and Debbie Street
92	Ferguson Drive (Rosebud Estates)
93	Hwy 1 North and Barnes Landing Road at Shady Acres Trailer Park
94	SE Corner of George Lewis Estates (North Cornell Street)
95	End of Princeston Drive
96	2190 Robinson Lane
97	Greenpoint Industrial Park (MP&L RD Base of Levee Across from Warfield Point Park Ramp)
98	Oak Drive and Lillie Drive
99	Hwy 82 and industrial Fill Road
100	Cloverdale Subdivision
101	Industrial Fill Road at Coast Guard
102	Tampa Drive at Greentree Trail
103	NE Corner of Guerdon Road and Sharon Lane
104	Highland Plantation Rd- Greenpoint Industrial (In 90˚ Curve that turns back southwesterly)
105	Warfield Point Park - Main Entrance
106	Producers Rice
110	Karen Drive Across from Armory (Near Mars Food)
111	South Bayou Road (approximately 0.15 West of Redman Road)
112	North Bayou Road (132 Bayou Road)
113	Public Works. North of Reed Road and East of HWY 82
114	Public Works. North of Reed Road and East of HWY 82 on westbank of Drainage Canal
115	Greenpoint Industrial Park (Fruit of the Loom Rd & Stokes King Rd)

APPENDIX D

STANDARD OPERATING PROCEDURES
FOR SEWER CLEANING

STANDARD OPERATING PROCEDURES FOR SEWER CLEANING

Purpose

The purpose of this Standard Operating Procedure is to ensure that sewer cleaning is performed in a manner that will produce a high quality work product. Quality is important because it ensures that the sanitary sewers will not experience problems prior to their next scheduled cleaning.

Goal

The goal of cleaning a gravity sewer is to restore the flow area to 95% of the original flow area of the pipe.

Required Equipment and Tools

1. Personal Protective Equipment (PPE) (hardhat, steel toe boots, gloves, eye/face protection, hearing protection)
2. Proper safety cones/barricades/flagging/signs or other traffic control devices
3. Sanitary sewer system map book
4. Combo (jet rodder/vacuum) truck
5. Sewer cleaning nozzles
6. Debris traps
7. Manhole hook or pick-axe
8. Measuring wheel
9. Disinfectant

Required Forms

1. Work order
2. Hydraulic cleaning report form

Procedures for Sewer Cleaning Crew

Prior to leaving the yard

1. Plan the work so that it starts in the upstream portion of the area and moves downstream.
2. Whenever possible, plan to clean sewers from the downstream manhole.
3. Inspect the sewer cleaning equipment for wear. Replace nozzles that are excessively worn.

At the Jobsite

1. Wear proper PPE.
2. Fill the water tank at or near the first jobsite.
3. Determine and confirm location of upstream and downstream manholes (use street addresses, if possible).
4. Look for any overhead utilities that many come into contact with the vacuum boom during the cleaning operation.

5. Set up proper traffic control and work zone by placing traffic signs, flags, cones, and other traffic control devices.
6. Move the cleaning unit into the traffic control/work zone so that the hose reel is positioned over the manhole.
7. Open the manhole and determine if it is safe to proceed with the cleaning operation.
8. Install the sewer cleaning nozzle or the hose.

Cleaning Operation

1. Initiate proper procedure to place hydro/vac truck in "work mode."
2. Lower the hose, with a guide or roller to protect the hose, into the manhole and direct it into the sewer to be cleaned.
3. Start the high pressure pump and set the engine speed to provide adequate pressure for the sewer cleaning operation.
4. Open the water valve and allow the hose to proceed up the sewer. The hose speed should not exceed the manufacturers recommended speed.
5. If applicable, allow the hose to proceed 25% of the length of the sewer (or 50 feet minimum) and pull the hose back.
6. Observe the nature and the quantity of debris pulled back to the manhole.
7. If there is little or no debris, allow the hose to proceed to the upstream manhole.
8. If there is moderate to heavy debris, clean the remaining portion of the sewer in steps not to exceed 25% of the length of the sewer (or 50 feet minimum).
9. Open the upstream manhole and verify that the nozzle is at or past the manhole.
10. The sewer has been adequately cleaned when:
    a. Successive passes with a cleaning nozzle do not produce any additional debris, and;
    b. The sewer is able to pass for its entire length
11. Determine the nature and quantity of the debris removed during the cleaning operation.
12. Remove the debris form the manhole using the vacuum unit.
13. Rewind the hose on the reel.
14. Clean the mating surface and close the manhole. Ensure that the manhole is properly seated.
15. Enter the results in the Hydraulic Cleaning Report Form.
16. Move the cleaning unit, break down and stow the traffic controls.
17. Proceed to the next cleaning jobsite.

At the end of the day

1. Inspect the equipment and tools for problems.
2. Report any problems with equipment, tools, or sewers that were cleaned during the day to the supervisor.
3. Submit daily work reports, if any to the supervisor at the end of the shift.

STANDARD OPERATING PROCEDURE FOR CCTV OF SEWERS

Purpose

The purpose of this standard operating procedure is to ensure the proper and adequate inspection of Sanitary Sewer lines.

Goal

The goal of CCTV inspection is to provide live camera footage of a Sanitary Sewer line.

Required equipment

1. Television inspection equipment shall have an accurate footage counter that will display on the monitor and record the camera distance from the centerline of the starting manhole.
2. The camera shall be of the remotely operated pan / tilt type. The rotating camera and light head configuration shall have the capability of panning 360 degrees with pan and tilt capability of providing a full view of the pipe to ensure complete inspection of the mainline pipe and service laterals.
3. The camera, television monitor, and other components shall be color. To insure peak picture quality throughout all conditions encountered, the color camera shall be equipped with the necessary circuitry to allow for the remote adjustment of the optical focus iris from the power control unit at the viewing station. A variable intensity of the camera lights shall also be located at the viewing station.
4. Lighting and camera quality shall be suitable to allow a clear, in-focus picture for the entire periphery of pipelines extending at least ten (10) feet in front of the camera. In High Density Polyethylene (HDPE) or ductile iron poly-lined pipe, lighting should be sufficient enough to provide a clear view at least two (2) feet in front of the camera. The replay of the recorded video information shall be free of electrical interference and shall provide a clear stable image.
5. Camera quality shall be suitable to provide a full 360 degree view of the pipe during inspection.
6. The travel speed of the camera shall be variable but uniform and shall not exceed 30 feet per minute. Any means of propelling the camera through the sewer line which would produce non-uniform or jerky movement of the camera, will not be acceptable.
7. The television system shall be capable of performing line segment inspection in increments of at least 400 feet with one setup.
8. Service laterals shall be inspected utilizing a CCTV inspection push rod camera system, capable of inspecting up to one hundred (100) feet of pipe.

Required Forms

1. CCTV inspection report form

Procedure for CCTV

1. Prior to performing CCTV inspection activities, clean the sewer line(s) and service laterals designated to be televised thoroughly.
2. Just prior to performing the video inspection procedure, introduce water into the nearest upstream manhole until observed at the nearest downstream manhole. This will insure that any pipe segments with sags are easily identified during CCTV inspection.
3. Evacuate all debris from the pipeline and keep the pipeline clear of any debris during the CCTV inspection process
4. Main Line Inspection
   a. Perform the inspection on all mainline sections from manhole to manhole
   b. Should access to a particular sewer segment be difficult, and where adjacent segments require television inspection, the CCTV operator is allowed to complete the inspection of multiple sewer line segments with one setup. When multiple sewer line segments are inspected utilizing one setup, the CCTV operator shall zero the footage counter at each subsequent sewer manhole to establish a uniform starting point for each line segment televised.
   c. Carefully inspect the interior of the pipe to determine the location and extent of all deficiencies.
   d. At all service connections, the camera shall be stopped and the pan and tilt features shall be used to obtain a clear picture. At each service lateral, the camera shall be panned to view up each lateral or point of connection. Make note of any deficiencies through the use of Data Collection Software.
   e. Prior to the beginning of each CCTV inspection, manhole identification numbers as indicated on the record drawings, shall become a part of the video record.
   f. Stop the camera to view and analyze conditions that appear unusual or uncommon. The CCTV inspection technician shall, at all times, be able to move the camera through the lines in either direction without the loss of quality in the video presentation.
5. Service Lateral Inspection
   a. Perform the inspection of all service laterals from property line cleanout to the mainline connection.
   b. Prior to beginning each CCTV inspection, service addresses, as indicated on the record drawings, shall be added to the video record.