# GUIDANCE FOR CCTV AND SONAR INSPECTION PIPES PENETRATING LEVEES

**FEBRUARY 2013**

## SECTION 1 - BACKGROUND

Inspection of the interior of gravity pipes that penetrate under or through flood protection systems, discharge pipes from pump stations, and other third-party high-pressure pipelines (e.g., water distribution lines, petroleum product transmission lines) is necessary during pipe condition evaluation. This assists in developing an understanding of the need to replace or rehabilitate a pipe, and selecting appropriate and economical solutions for deteriorated pipes. Pipes are also inspected after replacement or rehabilitation to document the new baseline condition for the pipe.

The current inspection checklist allows for either visual or television camera video-taping (CCTV) with a report of the findings provided to USACE on a 5 year frequency. When CCTV or sonar is employed, pipes shall be inspected using the methods described in this guidance.

Entry/walking-through a pipe should only be done when size (diameter) permits, it is safe to do so, and only when appropriate confined space entry procedures are followed. Examples of unsafe conditions include the potential for fire and explosion, heat stress, asphyxiation, drowning, and engulfment or entrapment. It should also be noted that a heavily corroded or structurally damaged culvert could collapse at any time and is not safe to enter.

Third-party high-pressure pipelines are regulated by other agencies and USACE recognizes those inspection methods as appropriate on a case-by-case basis.

## SECTION 2 – GRAVITY PIPES AND PUMP STATION DISCHARGE PIPES

### INSPECTION PROCEDURES FOR CCTV / SONAR

Pipe inspections are most efficient when planned and executed so that fieldwork is performed during periods of low or no flow in the pipe. Removal of small roots and debris is required prior to inspection. All debris shall be removed from the sewer system and properly disposed of with no debris passing downstream.

Pipes are inspected using either CCTV cameras, sonar devices, or both. The method(s) used are determined by the presence or absence of water in the pipe, the pipe material, and the wall configuration. CCTV inspection is the preferred method because it provides a complete view of the pipe interior. Sonar inspection, which may be used on non-metallic pipes that contain water, portrays offsets and distortions in the interior pipe profile as well as sediment build up in the pipe invert. Sonar inspection will not reveal the presence of fractures without offset, cracks, corrosion or corrosion-induced section loss. The process described below and illustrated in Figure 1 is used to determine proper inspection protocols.

Metallic pipes, including corrugated metal pipes (CMPs) and cast iron pipes, are subject to corrosion and must be CCTV inspected because sonar methods are not able to detect and quantify the nature and extent of corrosion. Therefore, metallic pipes must be temporarily bypassed and dewatered prior to inspection so that 100% of the interior pipe surface is visible to the CCTV camera.

Non-metallic pipes are also dewatered and CCTV inspected when reasonably possible. When non-metallic pipes cannot be dewatered, partially submerged pipes are assessed using CCTV inspection above water and sonar inspection below water. Fully submerged non-metallic pipes are inspected using only sonar inspection. When sonar inspection of a submerged pipe indicates that the pipe cross-sectional profile deviates from the as-built condition, the pipe must be dewatered and CCTV inspected.

The PACP (Pipe Assessment Certification Program) provides procedural guidelines for CCTV pipe inspection. An inspection system specifically designed and constructed for pipe inspection is used. The CCTV camera is capable of panning 360° and tilting 270°. The camera is positioned in the center of circular pipes and 2/3 the height in oval pipes. Lighting for the CCTV camera is suitable to allow a clear picture of the entire periphery of the pipe. The camera is capable of operating in 100% humidity conditions. The minimum acceptable camera resolution is 500 lines. The CCTV monitor and other components of the CCTV system are capable of producing a color picture/CCTV quality to the Owner's satisfaction.

The CCTV camera moves through the sewer at a constant rate, stopping when necessary to permit proper documentation of the sewer's condition for coding. The CCTV camera does not move at a speed greater than 25 feet per minute. Obtain a still picture (color jpeg format) of all significant defects observed during inspection. Record segment, location along sewer, clock position, time and defect code for each picture. Obtain a still photograph coaxial with each lateral.

Sonar inspection equipment is positioned in the pipe in accordance with the equipment manufacturer's recommendations, and makes a complete 360 degree inspection of the pipe circumference at one inch intervals along the length of the pipe.

During the inspection the following information is clearly and continuously displayed on the periphery of the screen, monitor and CCTV recording: starting location ID, ending location ID, and distance from starting manhole or headwall. A global positioning System device is used to document the inlet and outlet locations.

If inspection of an entire sewer segment cannot be completed due to a collapse, excessive deformation, debris, intruding connections, obstructions or large displaced joints, move equipment to the downstream manhole/headwall and attempt inspection in the upstream direction. Advise the Owner's Representative on a daily basis if the complete sewer segment cannot be inspected.

Track all locations where a complete inspection is not obtained and clearly document the length of sewer not inspected, location, segment, distance from adjacent manholes, etc.

**LIMITS OF CCTV AND SONAR INSPECTION**

*Within Levee Embankment Sections.* Pipes penetrating the levee embankment cross section are inspected from headwall to headwall.

*Beneath Levee Embankment Sections.* Pipes underlying levee embankments which do not daylight at the levee toes are inspected a minimum distance of 15 horizontal feet as measured perpendicular from either toe; however, the inspection continues to the riverside headwall if the pipe does not daylight within the 15 horizontal feet.

*T-Wall Sections*. Pipes underlying T-Walls are inspected a minimum distance of 8 horizontal feet as measured perpendicular from either side of the base; however, the inspection continues to the riverside headwall if the pipe does not daylight within the 8 horizontal feet.

*I-Wall Sections*. Pipes underlying I-Walls are inspected a minimum distance of 15 horizontal feet as measured perpendicular from either face of the wall; however, the inspection continues to the riverside headwall if the pipe does not daylight within the 15 horizontal feet.

*Discharge Pipes from Pump Stations*. Discharge pipes from the pump stations are inspected between the pump discharge and the end of the discharge line at the headwall/gate well. If the discharge pipe ends in a gate well, inspection from the gate well to the headwall at the river is required. In this case, pipe access may be possible through an air vent and a push camera with adequate lighting may be used.

**PIPE CONDITION CODING**

Pipe condition coding for pipes subjected to CCTV inspection is done in accordance with the National Association of Sewer Service Companies'

(NASSCO) Pipeline Assessment Certification Program (PACP). The company performing the inspection shall provide qualifications for performing this work including experience and knowledge of NASSCO's PACP procedures. The inspection team leader must demonstrate experience on similar projects and a minimum of 1-year experience in pipe inspection and PACP coding in accordance with NASSCO's pipeline assessment program.

The information called out includes, but is not limited to the following:

- Structural condition and deformation of the pipe walls
- Segment length (from inside walls of adjacent manholes)
- Manhole depth (invert to top of casting to nearest 0.1 ft)
- Blockages or obstructions and associated locations
- Condition of joints and pipe walls
- Standing water/sag conditions
- Infiltration/exfiltration
- Fluctuations in water level
- Size, location and condition of sewer laterals with the clock position

Distance measurements are referenced to the nearest 0.1 foot, using a readily identifiable baseline such as a headwall, manhole, or sluice gate.

The five PACP defect grades are shown in Table 1, and an example PACP report is provided in Attachment 1. Further details of the PACP condition grading system are available at www.nassco.org.

The NASSCO PACP coding procedure does not apply to pipes or portions of pipes where sonar inspection is used. A narrative description of the results of sonar inspection is provided along with profile images of pipe sections that display deterioration, profile offset, sediment accumulation, or any other concern with pipe integrity.

**Table 1. PACP Defect Grades**

| Grade | Description | Estimated Time to Failure |
|---|---|---|
| 1 | EXCELLENT: Minor Defects. | Unlikely in the foreseeable future |
| 2 | GOOD: Defects that have not begun to deteriorate. | 20 years or more |
| 3 | FAIR: Moderate defects that will continue to deteriorate. | 10 to 20 years |
| 4 | POOR: Severe defects that will become grade 5 defects within the foreseeable future. | 5 to 10 years |
| 5 | IMMEDIATE ATTENTION: Defects requiring immediate attention. | Has failed or will likely fail within the next 5 years |

### REPORTS AND SUBMITTALS

Submit two copies of the following items within two weeks following completion of all required CCTV or sonar inspection activities:

- Electronic inspection videos recorded and organized on CD or DVD.
- Electronic still-capture pictures and sonar images of significant defects on CD or DVD.
- Printed inspection logs with As-Built stationing, defect codes, and the PACP Ratings including, the Structural, Operation and Maintenance, Overall Quick Rating shall be provided (see example in Attachment 1). Also provide an overall map locating these with pipe stationing shown. Sonar inspection defects are also mapped in a similar manner.
- List of standard PACP defect codes.
- Grade of the pipe invert in percent (if possible)
- Coordinates of the pipe inlet and outlet determined by handheld GPS, with estimated accuracy reported.
- Copy of location maps (or as-built drawing, if possible) with an arrow added to show the pipe location and direction of CCTV camera travel (can be hand drawn).

Inspection reports shall beprovided in a bound report.

The inspection video is either configured for viewing using the latest version of Windows Media Player, or the appropriate viewing software must be submitted on each CD or DVD. Files are configured to have the ability to use all features of the CCTV player including fast forward capability.

No payment is made for poor or unacceptable quality CCTV's or for portions of pipes that are not inspected for any reason. If, in the opinion of the Owner, the CCTV is of such poor quality that the condition of the sewer cannot be adequately assessed, the Contractor re-inspects the unacceptable segments and resubmit all deliverables for that segment at no additional cost to the Owner.

## SECTION 3 – THIRD-PARTY HIGH-PRESSURE PIPES

The primary types of third-party high-pressure pipes (TPHPPs) are water distribution lines, natural gas pipelines, and hazardous liquid transmission lines. The inspection protocol for TPHPPs used to determine pipe suitability is illustrated in Figure 2.

Water distribution pipes are not regulated by a federal agency and there are no national inspection standards. Several inspection techniques are available to pipe owners to evaluate the condition of the pipes. These methods include video inspection pressure testing, electrical methods, ultrasonics, acoustic emission, magnetic flux leakage, and remote field eddy current.

Owners of high-pressure water distribution pipes may have a pipe inspection program in place. If so, the Local Sponsor shall request confirmation in written format from the company operating the pressurized lines that they are in compliance with the appropriate regulatory agency requirements. The local sponsor should then provide feedback to USACE. USACE may require additional inspection effort for pipes that pass through levees when warranted. If the pipe owner has no inspection program in place, the Local Sponsor shall request the pipe owner to develop a plan for the portion of the pipe that passes through the levee.

Natural gas pipeline safety is regulated under 49 CFR 192, Part 192-*Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards*. The Part 192 requirements include assessment of condition using methods that are set out in a baseline assessment plan. The plan may specify methods such as internal inspection tools capable of detecting corrosion and any other threats; pressure tests; or direct assessment to address threats of external corrosion, internal corrosion, and stress corrosion cracking. Other technology that an operator demonstrates can provide an equivalent understanding of the condition of the line pipe may also be used with approval. The assessment must be repeated at specified intervals

Pipelines that transport hazardous liquids, such as petroleum products, are regulated under 49 CFR 195 Part 195 - *Transportation of Hazardous Liquids by Pipeline*. The Part 195 requirements include the preparation of a baseline assessment plan similar to Part 192 for natural gas pipelines.

Both Parts 192 and 195 apply to pipes in "high consequence areas" which are defined based on the nearby presence of occupied structures. Because these pipes may penetrate a levee in areas without nearby structures, the Local Sponsor shall ensure that the pipes are included in the high consequence area inspection schedule. USACE requires no further inspection unless site specific conditions warrant.

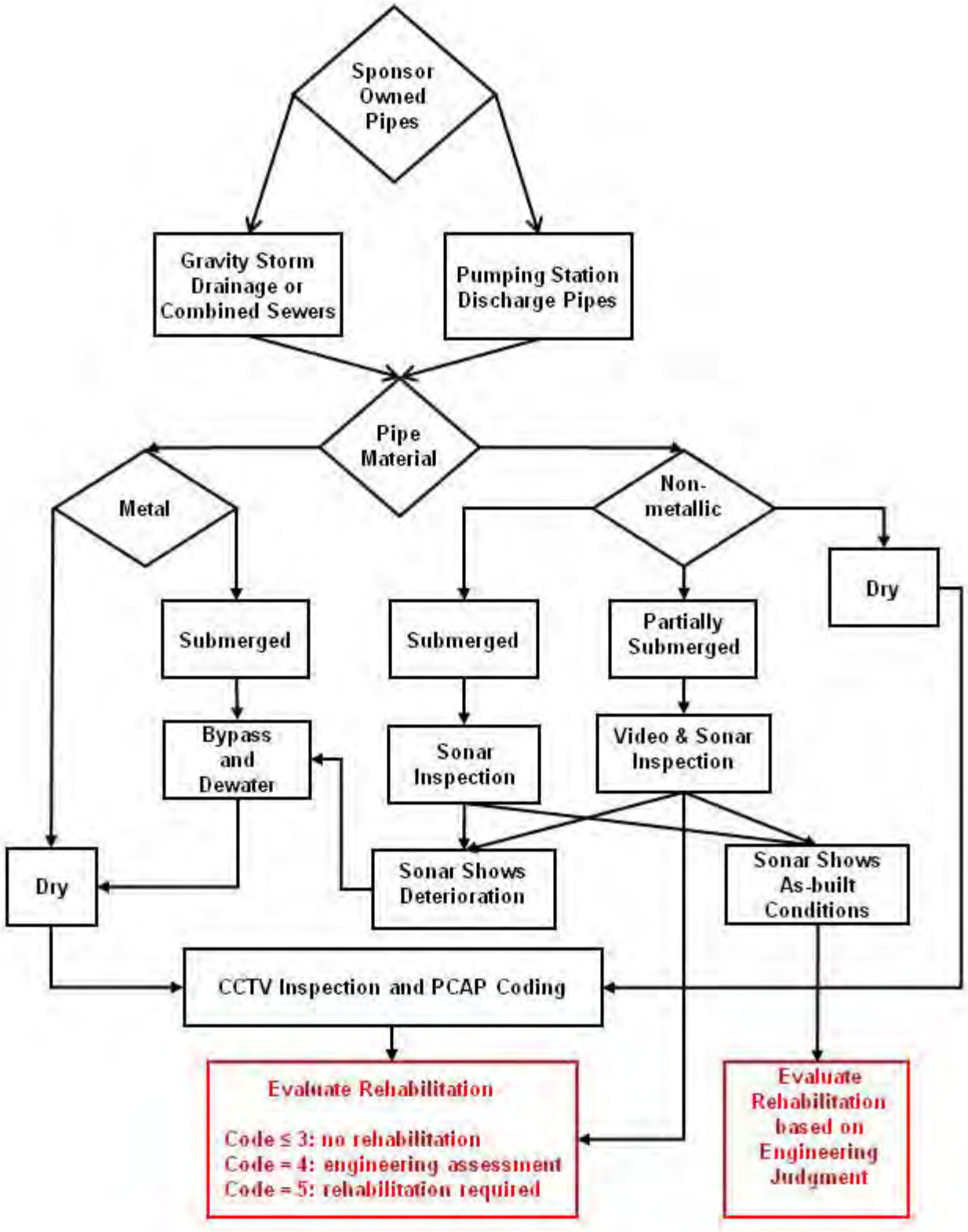



**Figure 1. Pipe Condition Assessment Procedure for Gravity Pipes and Pump Station Discharge Pipes.**

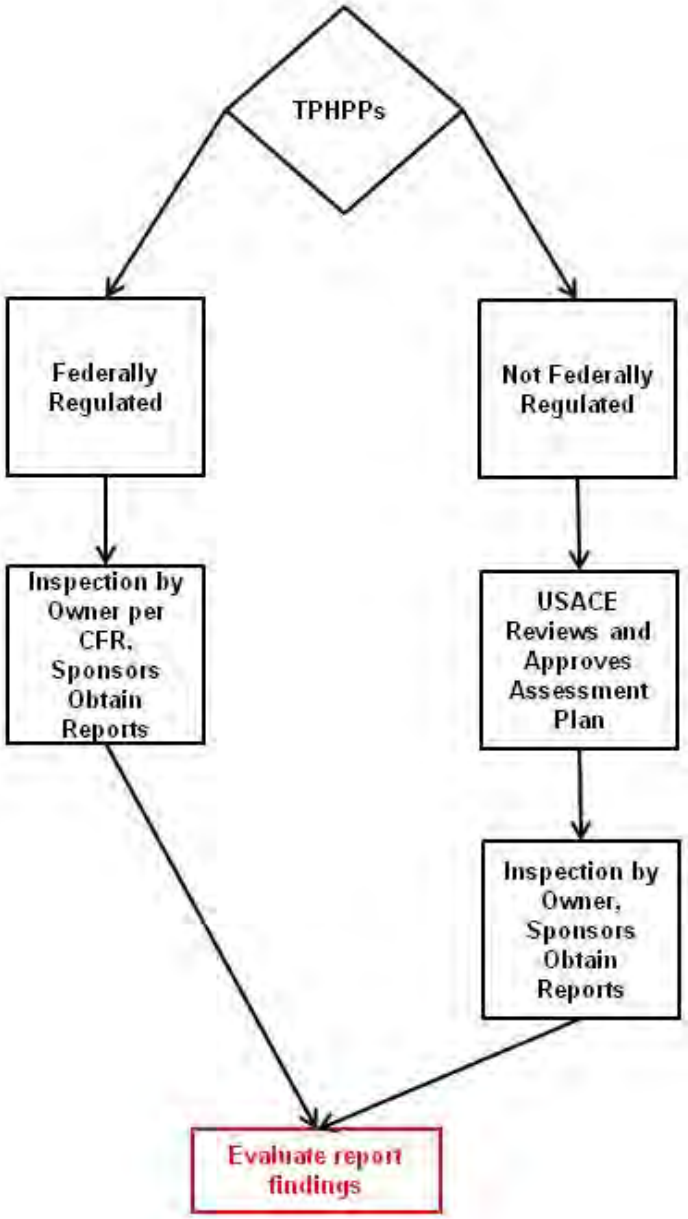



**Figure 2. Pipe Condition Assessment Procedure for Third-Party High-Pressure Pipes (TPHPPs).**

# Flood Wall / Inspection: Gate 150

| Surveyor | Contract | Job No. | Catchment | Certificate Number | |
|---|---|---|---|---|---|
| [redacted] | [redacted] | 4867-2 | Gate 150 | [redacted] | |
| Date | Time | Location | | | |
| 11/5/2009 | 12:36:53 | DIXIE | | | |

| | | | | | |
|---|---|---|---|---|---|
| Upstream MH | OH15269 | Downstream MH | OH15266 | | |
| Use: | Stormwater | Direction of Survey | Upstream | Size / Shape | 36 inch / Circular |
| Material | Vitrified Clay Pipe | Total Length | 115.30 ft | | |
| Lining | | Length Insp. | 115.30 ft | | |
| Comments: | | MPEG Name | OH15269_OH15266.mpg | | |

Add. Loc. Details: Sta. 315+23 GPS Coord. 38.0922, -85.8773


| 1:300 | Position | | Code | Observation | MPEG | Photo | Grade |
|---|---|---|---|---|---|---|---|
| | 0.00 | | AMH | Downstream Manhole, Survey Begins | 00:00:51 | 65_1A | |
| | 0.00 | | MWL | Water Level, 5 %of cross sectional area | 00:00:56 | | |
| | 0.00 | | DSC | Deposits Settled Compacted, 15 %of cross sectional area, from 05 to 07 o'clock, , within 8 inches of joint: YES | 00:01:06 | 65_3A | M 3 |
| | 28.80 | | MWLS | Water Level, Sag in pipe, 15 %of cross sectional area | 00:02:29 | 65_4A | M 2 |
| | 35.80 | | DAE | Deposits Attached Encrustation, 10 %of cross sectional area, from 05 to 07 o'clock, , within 8 inches of joint: YES | 00:02:43 | 65_5A | M 2 |
| | 37.90 | | CM | Crack Multiple, from 09 to 03 o'clock, within 8 inches of joint: YES | 00:02:55 | 65_6A | S 3 |
| | 77.80 | | MMC | Material Change, Reinforced concrete pipe | 00:04:24 | 65_7A | |
| | 83.60 | | MMC | Material Change, Vitrified clay pipe | 00:04:43 | 65_8A | |
| | 83.60 | S1 | CM | Crack Multiple, from 09 to 03 o'clock, within 8 inches of joint: YES, Start | 00:04:50 | 65_9A | S 3 |
| | 104.30 | F1 | CM | Crack Multiple, from 09 to 03 o'clock, within 8 inches of joint: YES, Finish | 00:05:27 | 65_10A | S 3 |
| | 104.30 | | MMC | Material Change, Reinforced concrete pipe | 00:05:34 | 65_11A | |
| | 115.30 | | AMH | Upstream Manhole, Survey Ends / OH15269 | 00:06:07 | 65_12A | |

Summary of Inspection:

| | | | | | | |
|---|---|---|---|---|---|---|
| Str Scores: | Gr1:0000 | Gr2:0000 | Gr3:0015 | Gr4:0000 | Gr5:0000 | Worst Str Grade: 3 |
| O&M Scores: | Gr1:0000 | Gr2:0004 | Gr3:0003 | Gr4:0000 | Gr5:0000 | Worst Maint Grade: 3 |

| QSR | QMR | SPR | MPR | OPR | SPRI | MPRI | OPRI |
|---|---|---|---|---|---|---|---|
| 3500 | 3122 | 15 | 7 | 22 | 3.00 | 2 | 3 |

# Flood Wall Inspection Photos / Inspection: Gate 150

| Upstream MH | Downstream MH | Direction of Survey | | |
|---|---|---|---|---|
| **OH15269** | **OH15266** | **Upstream** | | |

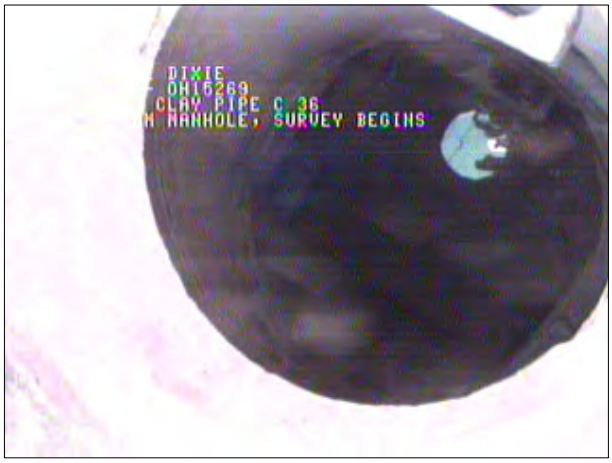



Photo: OH15269_OH15266123825_05112009_A.JPG, VCR No.: FLOOD WALL#2, 01:42:22
0FT, Downstream Manhole, Survey Begins

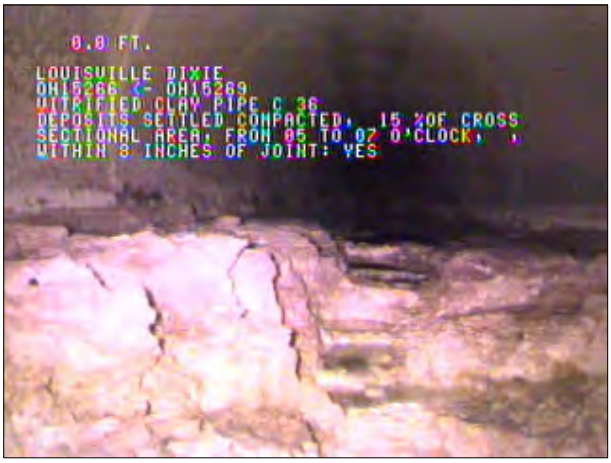



Photo: OH15269_OH15266124326_05112009_A.JPG, VCR No.: FLOOD WALL#2, 01:42:36
0FT, Deposits Settled Compacted, 15 %of cross sectional area, from 05 to 07 o'clock, , within 8 inches of joint: YES


Photo: OH15269_OH15266124455_05112009_A.JPG, VCR No.: FLOOD WALL#2, 01:43:58
28.8FT, Water Level, Sag in pipe, 15 %of cross sectional area

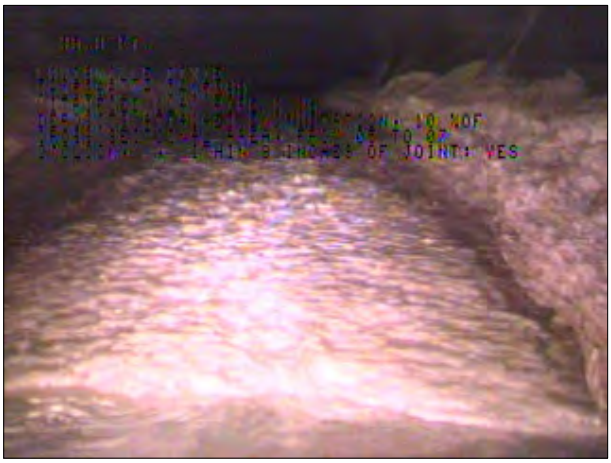


Photo: OH15269_OH15266124520_05112009_A.JPG, VCR No.: FLOOD WALL#2, 01:44:10
35.8FT, Deposits Attached Encrustation, 10 %of cross sectional area, from 05 to 07 o'clock, , within 8 inches of joint: YES

# Flood Wall Inspection Photos / Inspection: 1

| Upstream MH | Downstream MH | Direction of Survey | | |
|---|---|---|---|---|
| **OH15269** | **OH15266** | **Upstream** | | |

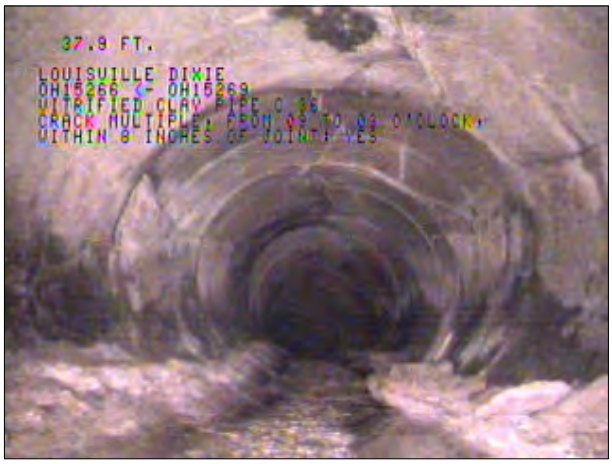



Photo: OH15269_OH15266124541_05112009_A.JPG, VCR No.: FLOOD WALL#2, 01:44:21
37.9FT, Crack Multiple, from 09 to 03 o'clock, within 8 inches of joint: YES

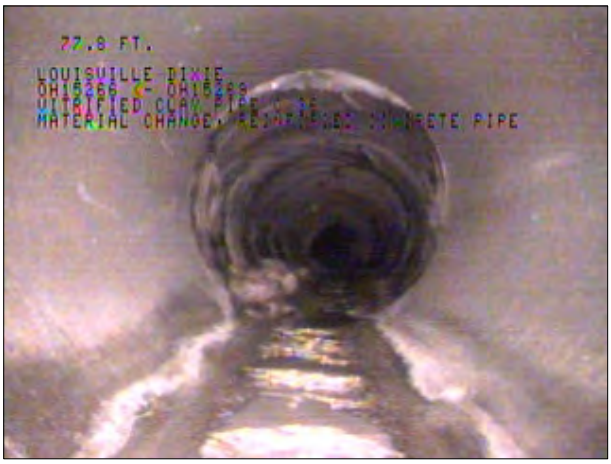



Photo: OH15269_OH15266124720_05112009_A.JPG, VCR No.: FLOOD WALL#2, 01:45:49
77.8FT, Material Change, Reinforced concrete pipe


Photo: OH15269_OH15266124748_05112009_A.JPG, VCR No.: FLOOD WALL#2, 01:46:07
83.6FT, Material Change, Vitrified clay pipe


Photo: OH15269_OH15266124807_05112009_A.JPG, VCR No.: FLOOD WALL#2, 01:46:12
83.6FT, Crack Multiple, from 09 to 03 o'clock, within 8 inches of joint: YES, Start

# Flood Wall Inspection Photos / Inspection: 1

| Upstream MH | Downstream MH | Direction of Survey | | |
|---|---|---|---|---|
| **OH15269** | **OH15266** | **Upstream** | | |


Photo: OH15269_OH15266124848_05112009_A.JPG, VCR No.: FLOOD WALL#2, 01:46:48
104.3FT, Crack Multiple, from 09 to 03 o'clock, within 8 inches of joint: YES, Finish

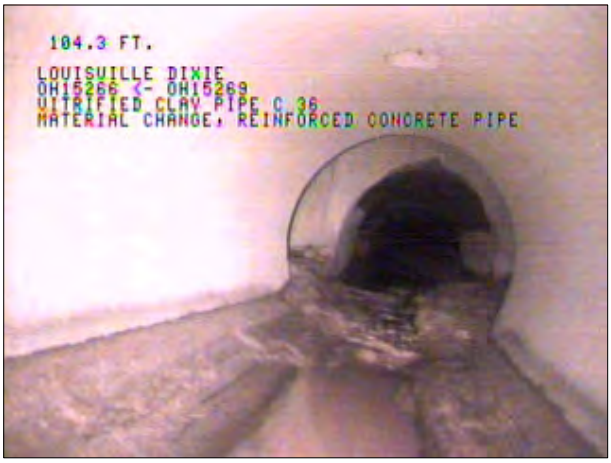
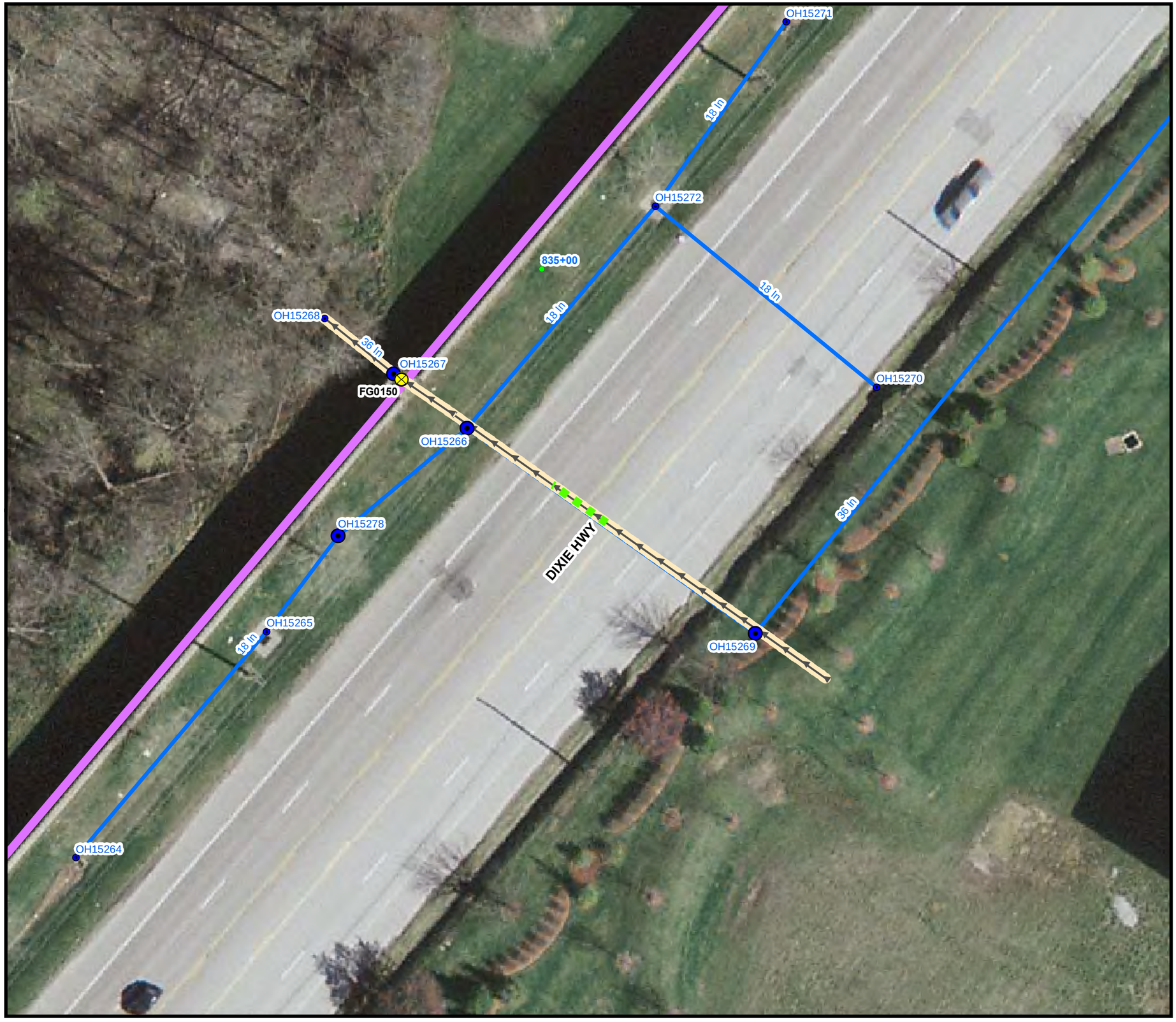



Photo: OH15269_OH15266124907_05112009_A.JPG, VCR No.: FLOOD WALL#2, 01:46:54
104.3FT, Material Change, Reinforced concrete pipe


Photo: OH15269_OH15266124956_05112009_A.JPG, VCR No.: FLOOD WALL#2, 01:47:25
115.3FT, Upstream Manhole, Survey Ends




# Floodwall TV Inspection

## Linear Defects - Gate 150
## STA 835+00 – 840+00

**Legend**

- Flood Gate
- Wastewater Treatment Plant
- Sewer Pump Station
- Other Drainage Point
- Storm Manhole
- Storm Lift Station
- Manhole
- Other Sewer Point
- Inspected Pipe
- Floodwall
- Sewer Line
- Force Main
- Drainage
- Water

**Line Defects**

- Deformed Pipe (D)
- Fracture Longitudinal (FM)
- Fracture Circumferential (FL)
- Crack Longitudinal (CL)
- Crack Circumferential (CC)
- Multiple Crack (CM)
- Infilration Weeper/Dripper (IW,ID)
- Surface Spalling (SSS)
- Surface Damage Aggregate Missing (SAM)
- Surface Reinforcement Visible/Chemical (SRV,SRVC )
- Surface Damage Corossive Metalic Pipes (SCP)
- Obstacle Rocks (OBR)
- Roots Medium at Joints N(RMJ)
- Roots Fine at Joints (RFJ)
- Deposits Attached Encrustation (DAE,DAEJ)
- Deposits  Attached Grease (DAG,DAGS)
- Deposits Attached Ragging/Settled/Other (DAR,DAZ,DSZ)
- Deposits Settled Compacted (DSC)
- Deposits Settled Fine (DSF)
- Lining Failure Detached (LFD)
- Mortar Missing Medium/Large (MML,MMM)
- Surface Aggrigate Visible Chemical (SAV,SAVC)
- Surface Roughness Increased Intruding (SRI,SRIZ)

0 15 30 Feet

N

*1/10/2010*

[redacted]


# Floodwall TV Inspection

## Point Defects - Gate 150
## STA 835+00 – 840+00

**Legend**

- Flood Gate
- Wastewater Treatment Plant
- Sewer Pump Station
- Other Drainage Point
- Storm Manhole
- Storm Lift Station
- Manhole
- Other Sewer Point

**Point Defects**

- Crack Multiple
- Material Change
- Hard/Compacted Material
- Water Level Sag
- Inspected Pipe
- Floodwall
- Sewer Line
- Drainage
- Water

0 15 30 Feet

*1/10/2010*

[redacted]