URBAN UTILITIES GUIDELINE FOR INSPECTION OF SEWERS

REF219

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Document History

Version	Author	Position	Amendments	Date
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Document Approval

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Signature	
Date	9/12/2021

1 INTRODUCTION

The purpose of this guideline is to ensure that all sewer conduit and maintenance hole inspections and condition assessments comply with Urban Utilities requirements and the latest version of the Water Services Association of Australia (WSAA) Conduit Inspection Reporting Code of Australia approved for use by Urban Utilities (WSA 05-2020 Code).

Urban Utilities requires contractors / service providers and Urban Utilities personnel to comply with this guideline in the first instance, and where this guide does not detail requirements, to comply with the current approved version of the WSA 05 Code.

Urban Utilities acknowledges that CCTV and advanced survey techniques are progressing, and as such, reserves the right to modify the standards in this guide to reflect current best practice.

Urban Utilities encourages contractors / service providers to consider innovative methods of delivery. The use of innovative technologies (e.g. AI) must be agreed with Urban Utilities prior to adoption. The contractor must provide all relevant documentation to demonstrate to Urban Utilities that the innovative technology will provide an improved result and will not negatively impact the quality of the inspections or condition assessments undertaken.

Urban Utilities currently uses WinCan software to record CCTV inspections on digital media and to capture defect coding. The requirements and guidelines for the use of WinCan are provided in **Section 2.**

The guidelines outlined in this document in general refer to CCTV inspections with pan and tilt CCTV camera equipment with an inclinometer fitted, as well as laser profiling and sonar surveying. The process for CCTV inspection is outlined in **Section 3**, and the additional requirements for laser profiling and sonar surveying processes is outlined in **Section 4**.

Note that this guideline does not distinguish between the technical requirements for the inspection of existing original sewer infrastructure, or new infrastructure. The guideline is relevant to situations where pre-acceptance and final acceptance inspection requirements apply to new infrastructure, as well as for condition assessment of both existing and new sewer assets where pre- and post- construction impacts are monitored to identify or exclude presence of any damage and/or functional impairment.

A Level 2 formalised asset inspection/condition assessment (as defined by the IPWEA) must be undertaken by the contractor. For a Level 2 assessment of conduits, Urban Utilities requirements are aligned to the current WSA 05 Code. Any additions or deviations from the Code are outlined in **Section 5**. As part of the Level 2 assessment, the contractor must provide Urban Utilities with a recommended structural (STR) intervention and serviceability (SER) intervention for each line inspected. This is to flag lines that require further inspection, rehabilitation or maintenance work.

The Level 2 assessment of maintenance holes involves different approaches for maintenance holes visually inspected when accessed for conduit inspection, and maintenance holes inspected as part of a maintenance hole inspection program. The different approaches for maintenance hole condition assessment are provided in **Section 6**.

Any defects identified during inspection that require urgent attention are to be reported to Urban Utilities in the appropriate timeframe, as outlined in **Section 7**.

Extensive quality assurance (QA) must be undertaken on all sewer conduit and maintenance hole deliverables. The QA processes recommended are outlined in **Section 8**.

This document is a combined version of REF219_6.2 CCTV Inspection Guide for Sewers and Urban Utilities Laser Profiling Technical Specification. The updates to these documents are outlined in Appendix A.

All CCTV operators must be aware that the overall quality of the inspection and the possible benefits to Urban Utilities are dependent on the operator's usage of the camera equipment in the sewer pipe and the accuracy of the defect coding. The speed of the camera, use of the zoom function, 360-degree pan of joints, camera position, adequate lighting and focussing, and recording of details in maintenance holes are primarily influenced by the operator. An inclination report is required to show the grade along the pipe. If this opportunity for detailed recording of defects and other aspects of the survey isn't fully implemented at the time of the inspection, re-inspection at the contractor's expense may be required to properly assess the condition of the asset. Urban Utilities will enforce these quality measures to achieve the highest standard from the investment in CCTV sewer condition monitoring.

A copy of this guideline must be provided to each CCTV operator working in sewer assets managed by Urban Utilities. The information provided in this document is designed to help the operators to consistently achieve the quality outcome as specified by Urban Utilities. The document will be updated on a regular basis to achieve continuous improvements from situations arising from the day-to-day CCTV work practise.

Contractors are invited to provide feedback into the development of the guidelines as there may be situations in the pipe systems which are not yet covered by either the WSA 05 Code or this guide.

2 WINCAN

Urban Utilities currently uses the WinCan software (CDLab Switzerland) to record the CCTV inspections on digital media and to capture defect coding. As long as there is no industry wide agreed transfer format available for CCTV coding data, all contractors must supply the coding information in a WinCan project file, and all digital video files (MP4) must be properly linked into the WinCan project file.

Urban Utilities will only accept CCTV data if it was recorded using WinCan VX or later with Urban Utilities customised coding file and templates. The required database to be utilised in WinCan VX or later version is SQL Lite. CCTV data recorded without using Urban Utilities customised defect coding file and templates or recorded in WinCan V8 or earlier will only be accepted subject to the contractor receiving permission from Urban Utilities to do so before the work is completed. Failure to obtain the permission will lead to the rejection of the CCTV survey work.

Urban Utilities requires contractors to enter all asset IDs and other asset information accurately into the WinCan software by utilising data in GIS or spreadsheets made available by Urban Utilities. Only the official asset name is to be entered in the asset name field (e.g. LS123456). It is important that descriptor letters / words to describe the survey (e.g. R, reverse, post, etc.) are not included as part of the asset name, as incorrect names prevent data being captured in subsequent automated processes. The suffix '-A' will be used when an additional maintenance hole is identified, as outlined in Section 3.5. It is essential that data entry errors are minimised. Accurate asset information and asset condition data, as required by the Urban Utilities WinCan templates, is of paramount importance.

Prior to commencing the CCTV survey work, the contractor must ensure that they can meet the requirements. If unsure, the contractor should approach Urban Utilities to agree a practical and acceptable solution.

The contractor must ensure that the latest version of Urban Utilities customised WSA 05 coding file is loaded onto the vehicle's WinCan computer when working on Urban Utilities assets. On request, Urban Utilities will supply the current Urban Utilities customised WinCan WSA 05 coding files and templates to contractors.

Urban Utilities has established its own templates for WinCan VX and has customised the WSA 05 coding file used by WinCan to apply the WSA 05 Conduit Inspection and Reporting Code of Australia. All contractors working in the Urban Utilities sewer network must use the current WSA 05 coding file as modified by Urban Utilities and the WinCan VX templates provided by Urban Utilities.

The current approved layout template file which must be loaded into WinCan VX when working for Urban Utilities is:

- Layout template: WSA-2020-QUU.xml

The template is located in *C:\Users\Public\Documents\CDLAB\Common\Templates*.

The current approved coding files which must be loaded into WinCan VX when working for Urban Utilities are:

- Section coding file (pipes): WSA_05-2020-QUU_AUS_ENG_SEC.xml
- Node coding file (maintenance holes): WSA_2020_AUS_ENG_NOD.xml

Coding files are located in *C:\Users\Public\Documents\CDLAB\Common\Catalogs*.

For more information on using Urban Utilities customised files for WinCan VX, refer to the Urban Utilities Project Manager.

Urban Utilities has established an internet portal for contractors to access the Urban Utilities GIS data of the Urban Utilities sewerage network to enable the contractor to locate assets and ensure correct asset IDs are used for pipes and maintenance holes. The contractor shall apply to their Urban Utilities representative for a link to the internet portal to access the Urban Utilities GIS data.

3 CCTV PROCESS

3.1 Approvals

Prior to undertaking any inspection, the contractor is required to obtain an Urban Utilities network access permit (NAP) type 2 at minimum. A type 3 NAP and flow control plan (FCP) may also be required.

3.2 Reason for Inspection

The reason for the inspection must be clearly identified in WinCan with the appropriate code from Section 2.6.3 of WSA 05-2020 Code. There are four reasons for inspection used by Urban Utilities that are in addition to the 13 codes listed in Section 2.6.3 of WSA 05-2020 Code. These are to be coded as "Z" for Other, with the reason stated as below.

- **Preliminary inspection** (i.e. pre-acceptance) of new sewers to verify new sewer works are compliant with SEQ Sewerage Code and design and are physically suitable to connect to live sewer systems.
- **Rehabilitation review.** Inspection to determine asset condition and suitability for rehabilitation, or performance of an existing rehabilitation treatment (i.e. liner)
- **Pre-construction condition assessment.** These inspections are undertaken to identify the presence of pre-existing defects and other conditions prior to major civil works near the sewer.
- **Post-construction condition assessment.** These inspections are undertaken to identify any evidence of new defect(s) or emergent adverse impacts to the sewer due to recent civil works near the sewer.

These codes are in addition to the 13 codes listed in Section 2.6.3 of WSA 05-2020 Code, including:

- NC: Final inspection of newly constructed sewers. These inspections are carried out as part of the handover process of assets to Urban Utilities.
- RC: Final inspection of a renovation or repair. These inspections are undertaken to confirm quality of rehabilitation (e.g. relining) and to identify and fix any defects (e.g. wrinkles in lining).
- R: Routine inspection. This is used to indicate a planned condition assessment that is undertaken at agreed intervals (e.g. conduit inspection every 10 years).

- S: Sample inspection. This is a one-off inspection for assets that are not on a planned condition assessment program but have experienced structural issues. This is an Urban Utilities definition as the WSA 05 code does not include any description. The code should only be used if indicated by Urban Utilities in certain work packages.
- O: Operational exam. These inspections are undertaken to determine the functionality of the sewer due to a suspected operational problem. No cleaning should be undertaken prior to the inspection, unless otherwise specified by Urban Utilities.

Refer to the WSAA code for the full coding.

3.3 Cleaning

In general, all sewers must be lightly cleaned (pre-flush) to remove the bio film prior to the CCTV inspection, unless otherwise specified by Urban Utilities or guidance provided in this section.

Before undertaking full cleaning of sewers, refer to Urban Utilities cleaning guidelines:

- Work Instruction: Planned Sewer Pipe Cleaning, TEM172

If Urban Utilities advises the contractor not to clean a sewer prior to the inspection, then the inspection is identified as an operational exam. Operational exams are undertaken for responsive inspections, wet weather overflow inspections, infiltration inspections, or potentially to identify other factors impacting functionality (e.g. bellies).

Where sewers are to be inspected for condition assessment (e.g. routine inspection) and pre- / post- construction impact purposes, the effective quality of the pre-cleaning must remove surface accumulations of grit, grease and rag as is reasonably and practically possible without damaging the assets so that pre-existing and new defects such as fresh cracking can be inspected, measured, and classified by the operator.

Urban Utilities will advise the contractor if the sewer in question was rehabilitated previously or is likely to be in poor condition and need special treatment during cleaning.

3.4 Redlining

Redlining is required to be completed for the following:

- Discovery of new maintenance holes (refer to **Section 3.5**).

- Discrepancies of more than 2.5m between the operator measured length and the GIS length supplied by Urban Utilities (refer to **Section 3.6**).
- Discrepancies of sewer pipe material between material identified by operator and GIS material supplied by Urban Utilities (refer to **Section 3.7**).
- Discrepancies of sewer pipe diameter between diameter identified by operator and GIS diameter supplied by Urban Utilities (refer to **Section 3.8**).

The redlining process is outlined in:

- GIS Redlining Factsheet UV3, included in **Appendix E**

3.5 Discovery of New Maintenance Holes

For each new maintenance hole discovered in the field, the contractor must provide a 'mud map' (hand drawing) of the location with measurements to the nearest permanent structure. The use of aerial maps (e.g. Bing, Google Maps, Nearmaps or alternative) is strongly encouraged as a base on which to draw the existing sewer with the new components added. If no other permanent structures exist close to the new maintenance hole, the measurements should be carried out to the existing upstream and downstream maintenance holes of the existing sewer line segment.

The new maintenance holes are to be inspected in accordance with Section 3.14.

This procedure is also required when maintenance holes are found in a substantially different location than that shown in Urban Utilities GIS.

Redlining (refer to **Section 3.4**) is required to be completed by the contractor for the discovery of new maintenance holes and when maintenance holes are found in a different location.

The new maintenance holes are to be named as MHA, MHB, etc. Refer to **Figure 3-1** for examples of this naming convention.

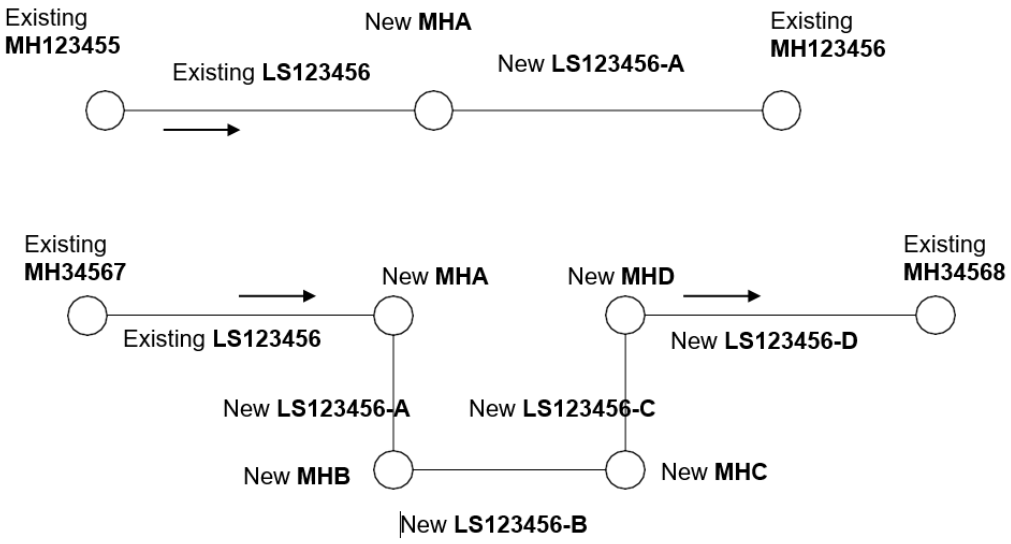


Figure 3-1: Examples of naming convention for identification of new maintenance holes

The upstream sewer line segment from the existing maintenance hole must be named in WinCan with the original line segment ID's and the new downstream line segments (from the new maintenance hole) to use the original line segment ID with an '–A' after it (e.g. LS123456-A).

3.6 Accuracy of Length Measurements

The CCTV camera equipment length measurement must be calibrated using the manufacturer's recommended methods in accordance with the WSA 05 Code. Urban Utilities recommends the inclination of the CCTV tractor is calibrated on a weekly basis.

The actual length of conduits supplied by Urban Utilities may not be accurate. Any discrepancy more than 2.5m between the recorded length with camera equipment and the supplied length by Urban Utilities should be recorded and investigated by the contractor.

The reason for the discrepancy should be determined by checking equipment calibration and camera cable. The necessary follow up action must be undertaken to ensure quality of work. Where necessary and feasible, discrepancies must be investigated by measuring the real distance between the two maintenance holes on the ground (e.g. by running a measurement tape, using a laser measure or alternative). The contractor must consider the practicality of undertaking this measurement, including all traffic management considerations.

If the ground measurement differs by more than 2.5m to the recorded length with camera equipment, the reason (e.g. equipment calibration above tolerance levels, camera cable was not tight, etc.) must be investigated and the necessary follow up action (including reinspection) is to be undertaken to ensure acceptable quality of work is completed. This should include a 'mud map' identifying where the difference occurs if the issue is due to incorrect positioning of the assets in GIS.

If the camera calibration is out of tolerance, the CCTV equipment must be recalibrated as soon as possible before continuing work for Urban Utilities. The contractor must notify Urban Utilities if such an incident has occurred and supply written evidence that the recalibration of the CCTV equipment was undertaken.

The contractor is required to recode and adjust the defect locations (chainages) if the cable was not tight for sections of the survey.

If the length discrepancy is due to incorrect GIS information, the contractor must complete the redlining process (refer to **Section 3.4**).

3.7 Sewer Pipe Materials

Sewer pipe materials recorded in Urban Utilities GIS are not always correct. Urban Utilities intends to use the CCTV inspections to identify the correct pipe materials. The pipe material is of high importance to Urban Utilities as part of the process to confirm the correct sewer identification and to improve the accuracy of the GIS.

Urban Utilities is aware of the difficulties in identifying certain materials in the live sewer environment. Urban Utilities expects that the CCTV operator, based on training and experience should be able to identify the main material groups used by Urban Utilities as listed below:

- Concrete pipes (reinforced and unreinforced)
- Clay pipes (earthenware, salt glazed ware, vitrified clay)
- Asbestos cement pipes
- Ferrous pipes (cast iron, ductile iron, steel, and other metal pipes)
- Plastic pipes (UPVC, PVC, PE, ABS, PP, GRP, and other plastic pipes)
- Relined pipes (spiral wound lining, CIPP and other lining systems)

Note that brick sewers are not used in Brisbane.

The Urban Utilities WinCan template has a drop-down list for the operator to select the appropriate material group if no details are supplied from GIS data or GIS data is incorrect. This drop-down list is aligned to the pipeline material types used in GIS.

As WinCan VX software requires entering of a pipe material at the commencement of the inspection, operators can enter the pipe material supplied by Urban Utilities. If it is revealed that the supplied material is incorrect, the operator must return and change the pipe material in the header information for that sewer line segment. Certain defects are only common in certain materials and the incorrect identification of the pipe material could lead to an incorrect coding of defects or missing defects.

The Urban Utilities WinCan template provides an additional field in the header information to identify the source of the pipe material information.

Appendix C of this guideline provides a summary and examples of the common sewer pipe materials used in sewer conduit assets managed by Urban Utilities. The appendix provides details on the unit lengths, pipe diameters, and installation periods for certain materials. **Appendix C** must be cross referenced to ensure that the pipeline material is likely to be correct. For example, a pipe with a nominated material type of Asbestos Cement (AC) but a nominal diameter of greater than 610mm, is likely to be error and should be investigated further. Any pipe materials identified that do not adhere to the restrictions discussed in **Appendix C** are to be recorded in WinCan using general comments for further investigation by Urban Utilities.

Appendix D provides examples of common sewer pipe relining methods.

If unsure of the pipe material, the operator should provide a comment in the general comments field of the header information.

Where the pipe material identified differs from the details supplied from GIS data, this are to be flagged to Urban Utilities in either the next progress meeting or the next progress report. Urban Utilities will review the footage to ensure the pipe material identified is correct and complete the redlining process (refer to **Section 3.4**).

3.8 Sewer Pipe Diameter

Wherever possible, the pipe diameter should be measured. This can be completed either with the camera / laser equipment or physically with a measuring device. If it is not possible

to measure the diameter because the equipment is incapable of doing so and maintenance holes are too deep for operators to safely measure from the surface, the operators must enter the pipe diameter supplied by Urban Utilities into WinCan.

Person entry into the maintenance hole to establish the pipe diameter is not part of normal CCTV work and should only be undertaken if Urban Utilities gives instruction to do so.

If the CCTV image of the sewer or other things in the maintenance holes or pipes clearly indicate a smaller or larger diameter, the operator should record that information in the general comments field of the header information. The Urban Utilities WinCan template provides an additional field 'Diameter data source' in the header information to identify the source of the pipe diameter information (M = measured, S = supplied, E = estimate). The contractor can record the new diameter and note this change in the 'Diameter data source' field.

Where the pipe diameter identified differs from the details supplied from GIS data, this is to be flagged to Urban Utilities in either the next progress meeting or the next progress report. Urban Utilities will review the footage and operator comments and determine if further investigation is required to confirm the pipe diameter. When the pipe diameter is accurately determined, Urban Utilities will complete the redlining process (refer to **Section 3.4**).

3.9 Sewer Pipe Unit Length

The pipe unit length is important to identify the correct pipe materials for some pipeline rehabilitation technologies. The pipe unit length entered must be measured between the second and third joint of each sewer line segment as shown in the figure below.

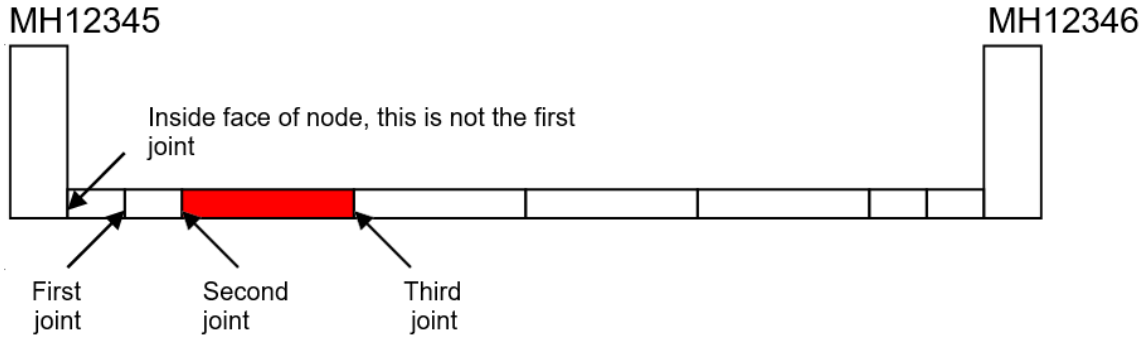


Figure 3-2: Example for measurement of pipe unit length between second and third joint

The sewer construction standards have changed over the past decades. Some only required one short pipe length at the maintenance hole, while newer standards required two lengths. Thus, Urban Utilities requires the distance to be measured between the second and third joint.

If the pipe unit length changes along the sewer line segment, this must be recorded with the appropriate code as specified in Section 2.7.10.3 of WSA 05-2020 Code. The change in unit length could indicate a repair with a new material, a CIPP patch repair, a removed maintenance hole, creek crossings with metal pipes, or other items of interest to Urban Utilities.

The operator must record all changes in pipe unit lengths regardless of whether there is a change in the pipe material, excepting the one or two short pipe lengths at maintenance holes.

3.10 Abandoned Inspections

When an inspection must be abandoned for a variety of reasons including obstructions, blockages, high water level, or equipment failure, the relevant inspection abandoned code from Section 2.7.9.6 of WSA 05-2020 Code is to be used. This code must be the final code entered. Prior to this, all defects must be recorded (including the defect causing the abandonment) and all continuous defects must be closed.

If a survey is abandoned due to equipment failure, the conduit is to be reinspected with new or repaired equipment.

The triggers for a CCTV inspection to be abandoned that is not related to equipment failure include:

- When a blockage of more than 20% of the pipe diameter is encountered (e.g. tree roots) and this could not be cleared by performing a clean.
- When the water level is more than 30% of the pipe diameter and this could not be cleared by performing a clean.
- When an obstruction is present that prevents the camera from being able to continue (e.g. rubble or debris that hampers the functionality of the camera tractor).
- When the pipe is deformed in such a manner that the camera cannot proceed down the conduit (e.g. bulge).

If the survey is abandoned due to an obstruction, blockage, or high-water level, a reverse survey is to be performed from the other maintenance hole to determine extent of obstruction, blockage, or high water level. If the reverse survey is abandoned, the abandoned code must be the final code entered for the reverse survey. If the high-water level continues through the whole length, flow control measures or timing should be implemented, and the conduit reinspected.

3.11 Find and Fix

If the full length of the conduit cannot be inspected through the original and reverse survey due to an obstruction, blockage, or high-water level, once flow control measures or timing have been enacted (e.g. belly), the following actions are to be undertaken:

- Perform a clean or root cut within the timeframes as indicated in the Find and Fix guidelines for the relevant contract and consistent with Urban Utilities cleaning guideline (TEM172).
- If the obstruction or blockage is due to the presence of tree roots, debris, or fats, oil, and grease (FOG):
    - All material is to be removed from the conduit.
    - Photos are to be taken of material that is removed.
    - The reason for the clean and the quantity of debris removed is to be recorded in the unscheduled clean work order comments.
    - Complete the original CCTV inspection of the full length of the conduit from the intended starting maintenance hole.
- For a conduit with a belly, the CCTV camera should follow the jet rodder while it is cleaning to attempt to pass through the belly and complete the original full-length inspection.

Urban Utilities and the Delivery Partner may agree additional Find and Fix activities that can be undertaken. These will be identified within Find and Fix Guidelines issued under each relevant contract. These activities must only be undertaken if they meet the requirements of the Find and Fix Guidelines. These activities may include:

- Maintenance hole location/minor access works

- Maintenance hole cleaning
- Maintenance hole lid components works
- Minor vegetation works

3.12 Push-Rod Inspections

Unless otherwise specified by Urban Utilities, push rod inspections are to be completed in alignment with the conduit inspection requirements specified in this guideline. This includes providing Urban Utilities with CCTV footage and WinCan data for the push-rod inspection.

3.13 Camera Operation

The WSA 05 Code should be referenced for rules concerning camera operation. This section provides additional guidance and discrepancies from the WSA 05 Code where necessary.

3.13.1 Position

Refer to Section 1.7.1 of the WSA 05-2020 Code for requirements on the CCTV camera position. The following points are to be followed in addition to the WSA-05 requirements in relation to camera position.

Wherever possible, the inspection must be performed and recorded from centre start maintenance holes to centre finish maintenance holes. The camera should be positioned in the centre of the conduit.

For all smaller diameter sewers (<600mm) and larger sewer diameters (600mm and above) with lower water levels, the camera head shall be positioned parallel to the pipe.

In larger diameter sewer with higher water levels, the camera head shall be turned up in a slight angle to get a better view of the obvert of the sewer pipe so that the water does not make up more than 30% of the image recorded. In all sewers 900mm diameter and above, the camera head must be turned up in a slight angle for all inspections regardless of the water level.

The contractor should select the most appropriate technology available to centralise the camera, particularly for larger mains.

3.13.2 360-Degree Pan

Refer to Section 1.7.3 of the WSA 05-2020 Code for requirements on 360-degree pans. Additional requirements for 360-degree pans are:

- Each inspection shall start with a 360-degree pan of the maintenance hole wall / pipe interface.
- Every 5th or 6th joint must be recorded with a 360-degree pan, regardless of whether there are any visible defects. The contractor should ensure that the camera lens is not placed under water at any time, as a wet lens can result in blurry images. In high water levels, the pan should only include the pipe surface above water level, to ensure that the camera lens is not placed in the water.
- Every joint with a defect must be recorded with a 360-degree pan. If the contractor can demonstrate a high degree of accuracy in defect coding, at Urban Utilities discretion, the requirement may be relaxed to every 5th or 6th joint if the pipe joint defects are the same.
- The operator must stop and perform a 360-degree pan of the pipe surface once every 10m, or at least once in a sewer conduit shorter than 10m (the joint pans do not count for this requirement).

3.13.3 Turn Camera Head

Refer to Section 1.7.3 of the WSA 05-2020 Code for requirements on 90-degree tilts. Additional to this, the operator must stop the camera once every 5mand turn the camera head towards the pipe wall and obvert regardless of whether there are any visible defects.

The operator must stop the camera and turn the camera head for every change in pipe surface colour and change in wall roughness (more than 1m apart).

Continuous defects must be tracked along the sewer conduit by stopping at least every 2m (or once every pipe unit if the unit length is shorter than 2m) and turning the camera head towards the defect to confirm it continues.

3.13.4 Zoom Function

Refer to Sections 1.14.4 and 1.14.5 of the WSA 05-2020 Code for requirements on the CCTV zoom function. The following points are to be followed in addition to the WSA-05 requirements in relation to zoomed images and videos.

In larger diameter sewers, the zoom function of the camera must be utilised to record details of defects or points of interest in the sewer. If turning of the camera head is insufficient to clearly see details, the zoom function must be used. The zoom function is only to be used when the camera is stationary.

All junctions and connections must be inspected in detail by the camera operator. The zoom function shall be used to record defect details further up connections and junctions.

3.13.5 Defect Photographs

Refer to Sections 1.14.4 of the WSA 05-2020 Code for requirements on the photographs taken during the inspection. The following points are to be followed in addition to the WSA-05 requirements in relation to photographs.

At least one photograph should be taken for each defect. Note that automatic photographs are taken when the observation code is entered and closed. This photograph should show the complete section of the pipe and circumferential location of the defect. This is normally guaranteed if the camera is reversed back by 20-30cm and the camera turned back into the normal position.

There are some defects where Urban Utilities requires an additional defect photograph obtained using a zoomed, tilted, or panned camera. These defects are shown in the following table with the associated WSA 05-2020 Code.

Table 3-1: Defects requiring additional defect photograph

Description	WSA 05 – 2020 Codes
Soil Visible	SV
Void Visible	VV
Large displacements of more than 50mm for longitudinal, 25mm for radial, and 10-degree angular displacement	JDL, JDR, JDA
Defective connections and junctions	CX, JX
Holes	SCH, SACH, SOH
Breaking	B
Gas attack with reinforcement steel visible or projecting	SCRC, SCRV, SCRVP
Extreme Delamination	SACDX
Tree root intrusion causing an obstruction of 20% or more	R

Description	WSA 05 – 2020 Codes
All lining defects	LD

For other situations not listed in **Table 3-1**, the operator should make the decision if a second photograph of a defect would be beneficial to Urban Utilities to clarify a defect or other points of interest in the sewer.

An example of the two photographs required for a longitudinally displaced joint are provided below.

Detailed picture showing the problem

'Normal' defect picture showing the pipe section with a problem

Figure 3-3: Examples of two defect photographs required for longitudinally displaced joint

Note: Header is missing in both photos above.

3.14 Maintenance Holes

For CCTV inspections of conduits, an inspection of the start and end maintenance holes (as well as any new maintenance holes identified in the line) are to be completed. The contractor shall include the manholes in the CCTV inspection videos as outlined in this section.

The CCTV video shall begin with inspection of the start maintenance hole. The camera head is to turn upwards to the maintenance hole opening to record as much as possible of the underside of the maintenance hole top slab, walls, and other ingoing and outgoing pipes. The operator must then record the interface between the maintenance hole wall and the conduit to be inspected.

After the survey of the sewer line segment has been completed, the operator must record the end maintenance hole. The camera head is to turn upwards to record as much as possible of the underside of the maintenance hole top slab, walls, and other ingoing and outgoing pipes. The operator must then record the interface between the maintenance hole wall and the conduit inspected.

If the start maintenance hole cannot be located, the inspection is to begin at the end maintenance hole. If neither the start or end maintenance hole can be located, the inspection is to occur from either the next upstream or downstream maintenance hole. The inspection will therefore be undertaken on both the upstream and/or downstream conduit as well as the planned conduit to be inspected.

Any additional or newly identified maintenance holes in the line are to be inspected similarly to the start and end maintenance holes as outlined above.

Any defects identified through the CCTV inspection of the maintenance hole are to be recorded using the defect codes within Section 3 of WSA 05-2020 Code.

For maintenance holes that are not accessed during the conduit inspection but are inspected through CCTV, any defects identified should be recorded using the general comment code (Section 2.7.9.3 of WSA 05-2020 Code).

Information recorded through CCTV of the accessed maintenance holes is to be included in the visual inspection in alignment with **Section 6.1** of this guideline.

3.15 Data Delivery

The deliverables for individual sewer segments, as a minimum, are:

- Urban Utilities WinCan database (SQL Lite)
- Urban Utilities conduit and maintenance hole inspection reports (PDF)
- Inclination report
- Digital video (MP4)
- Still photographs (JPEG, PNG)
- Relevant 'mud map' (where required)

The WinCan project file is required to be submitted through Urban Utilities' file transfer protocol (FTP) in the original WinCan file structure. Wide screen format should not be used for the digital videos.

All inspection reports and other documentation related to the work carried out must be provided in PDF format and the name must include the following information:

- Relevant asset ID (line segment or maintenance hole ID)
- Content of document (e.g. jet rodding report, drawing of new asset location, etc.)
- Date of inspection (format DD-MM-YYYY)

Some examples of the naming convention are:

- LSXXXXXX_Jet Rodding Report_01-01-2021.pdf
- MHXXXXX_Inspection Report_01-01-2021.pdf

4 LASER PROFILING AND SONAR SURVEYING PROCESS

The WSA 05-2020 Code provides requirements for laser profiling and sonar surveying of conduits (refer to Section 1.10 to Section 1.14 of the WSA 05-2020 Code). These requirements must be adhered to except where otherwise specified in this guideline.

The contractor must select an appropriate technology (Type 1 or Type 2) based on consideration on the reason for performing the laser profile, typically either to measure ovality or to conduit deterioration investigations, and the anticipated water levels.

As a minimum, contractors shall use Type 1, a combination of circumferential laser ring projection system, colour CCTV pipe inspection system (refer to **Section 3**) and a cable distance counter integrated with measurement software capable of delivering the data as required per this guideline.

A Type 2 system uses a direct measurement using a laser signal, usually from a rotating laser, that continuously generates a point cloud of digital data. These point clouds may incur significant additional post-processing cost and the need for a Type 2 inspection must be agreed with the Urban Utilities project manager prior to use.

Appropriate water levels are as outlined in Section 1.10.3 of WSA 05-2020 Code. If water levels are exceeded, temporary flow control measures shall be undertaken. Where it is not possible to achieve appropriate water levels as outlined in Section 1.10.3 of WSA 05-2020 Code, a combined laser and sonar profiling system should be employed as per Section 1.12 of WSA 05-2020 Code.

Where the maximum depth of flow is not exceeded, the contractor must still consider whether a combined laser and sonar profiling system will provide a better outcome and employ the combined system if required.

Laser profiling can be used independently of sonar if the condition of the sewer could cause damage to the sonar sensor and the accuracy of the inspection will not be impacted. If the data accuracy would be compromised by not employing a combined profiling system, the conduit should either be cleaned prior to the inspection to remove the obstructions causing damage, or flow control measures should be implemented to allow increased accuracy of a laser profiling inspection.

The inspection must be performed from upstream maintenance hole to downstream maintenance hole in a continuous run where possible, unless prohibited by obstruction.

4.1 Laser Profiling

The equipment and software used must be tested and approved by a recognised independent testing authority as per Section 1.10.7 of WSA 05-2020 Code. As per Section 1.10.1 of WSA 05-2020 Code, equipment and software must be capable of measuring the deformations and dimensions to the nearest 1% and 0.1% of the conduit diameter for operational conduits and acceptance inspections of flexible pipes respectively.

Refer to Section 1.10.4 of the WSA 05-2020 Code for requirements on the camera position for Type 1 laser profiling. During the inspection, the laser profiler must adhere to the following:

- The laser ring must be clear, central and take up between approximately 2/3 and ¾ of the vertical screen
- Lights shall be turned off
- Distance counter shall be displayed but shall not be within the laser ring
- All other text shall be removed from the screen (if text is displayed, it shall not affect the recording of the laser ring)
- A 360-degree profile of the non-submerged pipe surface is to be recorded
- The travel speed shall not exceed 0.1 m/s, or the distance between two laser frames does not exceed 20mm of conduit length

Refer to Section 1.10.5 of the WSA 05-2020 Code for requirements on the camera position for Type 2 laser profiling systems.

The profiler device intended to be used must meet the following requirements:

1. Laser profiling equipment and laser strength configured as per manufacturer's technical data specifications for the CCTV inspection system to be used.
2. Laser head tested and certified to conform to AS/NAS IEC 60825-1 Safety of Laser Products standard for Class 1 lasers (or equivalent US/EU standards).
3. Only calibration and lens distortion equipment manufactured by the same manufacturer as the laser profiling equipment, or specifically identified as compatible, shall be used.

4. The laser profiling equipment is to be calibrated for each inspection as per the requirements in Section 1.10.7 of the WSA 05-2020 Code.

4.2 Sonar Profiling

The sonar profiling equipment shall be capable of directly measuring distances to objects and surfaces inside pipelines from 1.2m to 5m diameter. If utilised in smaller pipelines, the suitability of the sonar equipment and its accuracy must be certified by the equipment manufacturer before any work in smaller sewers is performed. Urban Utilities must be provided with the relevant documents to prove the suitability of the equipment.

During the inspection, the sonar profiler must adhere to the following:

- A horizontal and vertical calibration hall be carried out confirming with the manufacturer's specifications
- A 360-degree profile of the submerged pipe surface is to be recorded
- The travel speed shall not exceed 0.2 m/s, or the distance between two images does not exceed 200mm of conduit length
- The maximum depth of flow in the conduit shall not exceed those identified in Section 1.13 of the WSA 05-2020 Code

The sonar profiling equipment is to be calibrated for each inspection as per the requirements in Section 1.11.6 of the WSA 05-2020 Code.

4.3 Compatibility with CCTV Camera

The inspecting CCTV camera system must use a lens setting that is compatible with the laser profiling software.

The tractor or float shall not stop in the pipe and the laser profile camera shall not perform pan or tilt during the profile inspection between maintenance holes. The inspection video is to be loaded into the profiling software. The correct camera option must be selected based on CCTV camera used in the profile inspection. The selected camera option is to be automatically stamped into the data file so that the settings cannot be changed. The camera settings are to be displayed in the profiling data file. Horizontal and vertical calibration must be performed on the calibration segment of the inspection video. The profile pipe selection shall be from start maintenance hole to end maintenance hole and selected using the start and end markers in the profile software.

4.4 Combined Laser and Sonar Profiling

Refer to Section 1.12 of the WSA 05-2020 Code for requirements on combining laser and sonar profiling.

The laser and sonar inspection operations shall be performed simultaneously.

For Type 1 systems, a high-resolution laser scan will be produced by taking high resolution individual laser profile and sonar slices and joining them in a 3D slice-based render.

The resulting profiles from laser and sonar shall be combined automatically and seamlessly. The laser scan will be complete and continuous throughout the inspection length. The data must be logged in a digital format (MP4, or as otherwise agreed with Urban Utilities' Asset Data Manager) to enable extraction of all relevant information.

4.4.1 Floating Platform

Where a stable floating platform is used, this must:

- Possess sufficient ruggedness, weight, buoyancy and hydro-dynamic characteristics
- Be capable of deployment through standard maintenance structure access holes
- Be sized for the pipe diameter to be inspected in accordance with manufacturer's recommendations
- Have a calibrated distance counter that is accurate to at least 6cm
- Be equipped with a tether with sufficient safety factor to increase inspection capability and eliminate the risk of becoming lodged or lost in a pipeline
- Be equipped with cables, tethers, power supplies, etc. of sufficient length and capacity to inspect the full length of pipeline from available access points

The float must be capable of operating under the flow conditions of the sewer, with adequate clearance. The float shall be stable under flows up to 3m/s.

A winch must be used to control the floating profiler system through the pipeline. The winch and cable used for the float operation shall be suitable for the job with appropriate safety margins for the weight of the equipment utilised and the flow conditions of the sewer it is operating within.

Ball bearing rollers must be used at any point where the rope will potentially rub against the pipe entry / manhole entry. An industry standard cable distance counter integrated with the profiler system as a grappling hook or backup tether shall be used.

A neutrally buoyant float mounted with sonar should be used when there is less than 300mm clearance from the water level to the obvert of the pipeline for a floating laser profiling inspection.

The laser profile data and sonar profile data must be stored on board the floating equipment. Storage must exceed 3 hours continuous recording. Floating equipment fed by cables from a truck with the data going back to the truck will be considered by Urban Utilities if the contractor can prove the equipment will provide a comparable outcome and sufficient inspection distances are possible.

4.4.2 Crawler

Where a stable tread or wheel mounted carrying platform is used, this must meet the same requirements of the floating platform.

The tread or wheel mounted carrying platform must be capable of operating under the flow conditions of the sewer.

4.5 Data Capture

The operators undertaking the field work must have been trained by the equipment manufacturers for the laser and sonar equipment. All data will be collected by the contractor, with analysis and processing of the CCTV inspection and profile data performed by qualified and certified personnel. Any rework of the data analysis due to the use of unapproved personnel will be at the contractor's expense.

The contractor shall ensure that the data captured on site does not impact on the data analysis options. All necessary measures must be taken to ensure the highest possible data quality is recorded on site. Where necessary, there should be a data cleansing phase in between the data capture and data analysis.

4.6 Data Analysis

For Type 1 systems, the profile software must be tuned to the laser ring to provide maximum number of profile points. A water / debris mask should be positioned to mask the highest water / debris point in the pipe.

The data file should be recorded at 25 to 30 profile cross-sections per second and linked to the profile inspection segment of the video. The recorded video should be used to provide quantitative information of the current pipe diameter, ovality, obstructions and corrosion.

For Type 2 systems, 3D point clouds must be generated georeferenced to x, y, and z coordinates for each scan and label by the corresponding pipeline footage. This must be suitably referenced to establish the 3D point cloud within Urban Utilities coordinate system.

Urban Utilities will supply the nominal diameter and likely pipe material for the sewers to be inspected. The nominal pipe diameter does not represent the internal pipe size for many sewers to be inspected. If sewers are not cleaned prior to the laser profiling inspection, any build-up of material inside the pipe must be considered before determining the original (manufactured) internal diameter using laser profiling. The contractor shall ensure that during the data analysis that the original internal diameter is confirmed at multiple locations along the sewer segment.

The construction method of sewers and the class of pipe used is mostly unknown for the sewers inspected, therefore any assumptions about wall thicknesses in the data analysis and reporting are to be documented in the inspection report.

4.7 Data Delivery

4.7.1 High Resolution Digital CCTV Video

The CCTV footage recorded during the inspection shall be defect coded in WinCan and the relevant deliverables provided to Urban Utilities in accordance with the latest version of the WSA 05 Code and this guideline.

4.7.2 Inspection Report

An inspection report will be prepared by a qualified and experienced engineer and provided to Urban Utilities. If the data recording and subsequent data analysis have been

compromised due to events during the data gathering process, the issues must be outlines in the report with detailed information on the accuracy of the data analysis will be impacted.

The reporting format, level of detail, colour displays, and report content shall be consistent for all sewer segments inspected. If not noted otherwise, the colour scaling within the report to display the severity of defects shall be consistent for each pipe size analysed.

The report content for individual sewer segments must include as a minimum:

- Details and source references of internal diameter, pipe class and wall thickness (including any assumptions made),
- All observed structural defects,
- All asset configurations (e.g. connections, changes in material or diameter),
- All points of interest (anything that impacts the operation and performance of the sewer, including defects, deformations, debris and other obstructions, etc.),
- Wall loss at certain intervals (at least one reading every 10m),
- Location of maximum wall loss,
- Average debris level and total debris volume per pipe segment (MH to MH),
- Maximum debris level and location,
- Flat observations figure for corrosion and debris build-up,
- Flat observations figure and maximum ovality line graph, if deformation is higher than the thresholds given in this section,
- Cross-sectional graphs as per the requirements given in this section,
- Preliminary grading of structural and service condition.

A flat observations figure (see graphs in middle of Figure 4-1) must be produced to show the corrosion and debris build up in the conduit with a colour map of the circular dimensions of the conduit over the inspected length.

Ovality and deflection figures are required if the ovality exceeds the following thresholds:

- Greater than 2% for all rigid pipe materials (e.g. concrete, clay, asbestos cement)
- Greater than 5% for all flexible pipe materials (e.g. PVC, PE)

Ovality is defined in the WSA 05-2020 Code as per Equation 4-1 below. Where water or debris exists, the software shall use a mask over the water and debris to calculate ovality.

$$Ovality\ (\%) = \frac{Maximum\ diameter\ (mm) - Minimum\ diameter\ (mm)}{Diameter\ actual\ undeformed\ (mm)} \times 100$$

Equation 4-1 Ovality formula

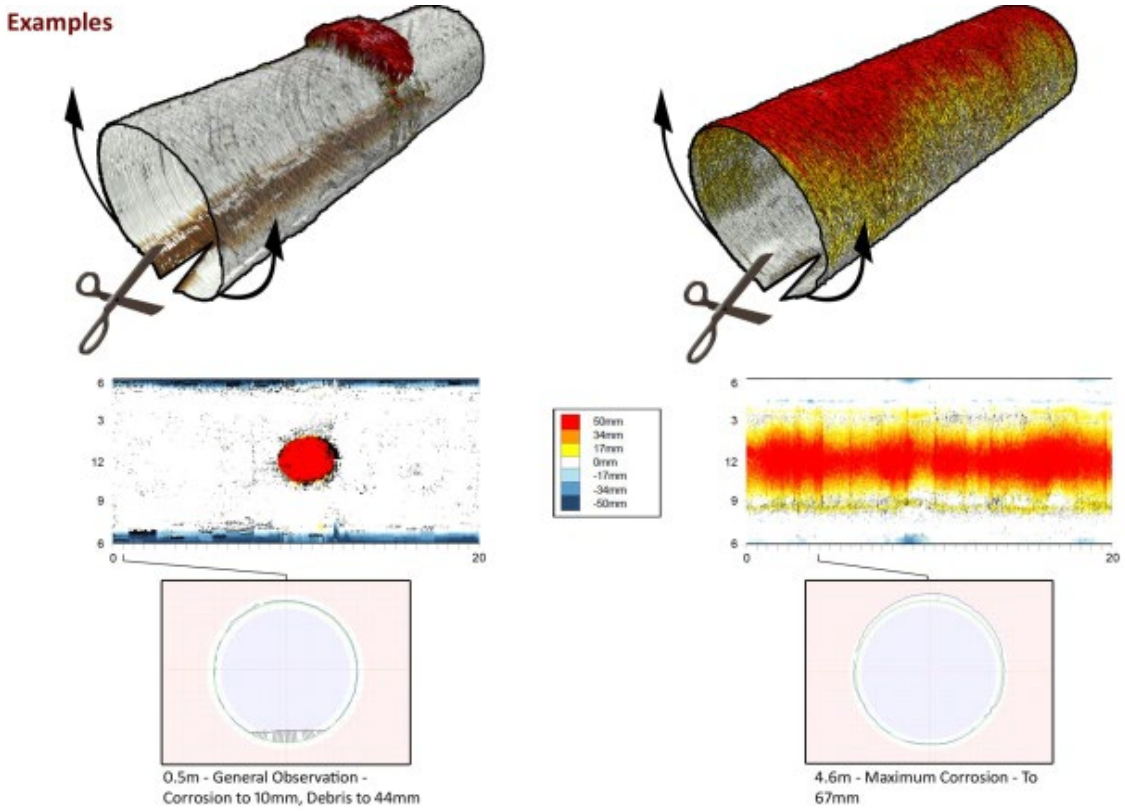


Figure 4-1 Example of corrosion and debris reporting (Source: Redzone Robotics)

A flat observations figure and maximum ovality line graph (see graphs in top right of Figure 4-2) with a colour map of the circular dimensions of the conduit over the inspected length must be produced when the above thresholds are exceeded.

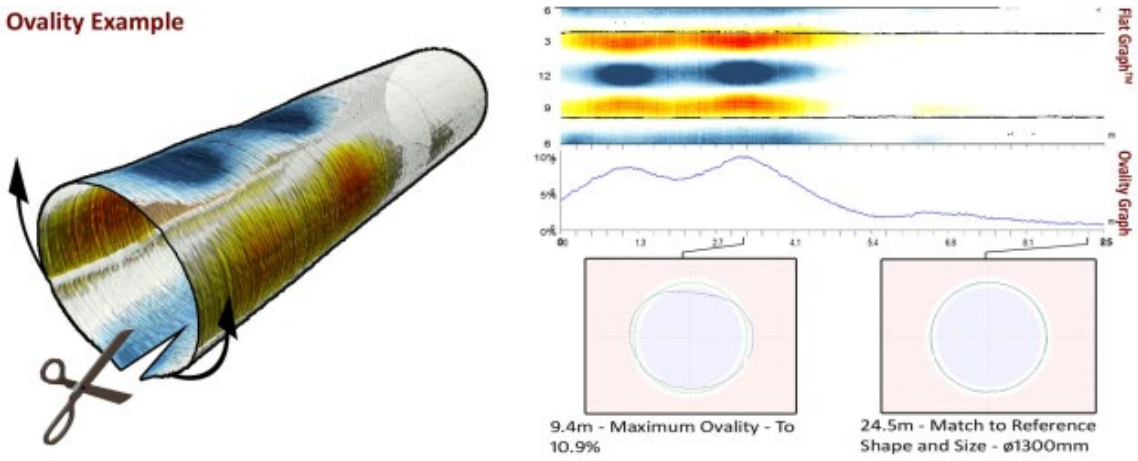


Figure 4-2 Example of ovality report and colour coding (Source: Redzone Robotics)

Cross-sectional graphs (see examples in Figure 4-1, Figure 4-2 and Figure 4-3) are to be provided at least every 10m of sewer length and as per the following locations:

- Where the pipe is a 'match to reference shape and size' (see explanation below),
- Where the wall loss caused by corrosion is greater than 5% of the 'match to reference shape and size' conduit diameter,
- Where the debris is greater than 20% of the 'match to reference shape and size' conduit diameter,
- Where the ovality thresholds are exceeded,
- Where structural defects are observed,
- Where asset configurations are observed,
- Other points of interest that impact the operation and performance.

The cross-sectional graphs are to provide the minimum, maximum and 'match to reference shape and size' diameters of the conduit and maximum deformation (%) for each segment. Urban Utilities reserves the right to request up to 30 additional cross-sections above the minimum of one every 10m of sewer length.

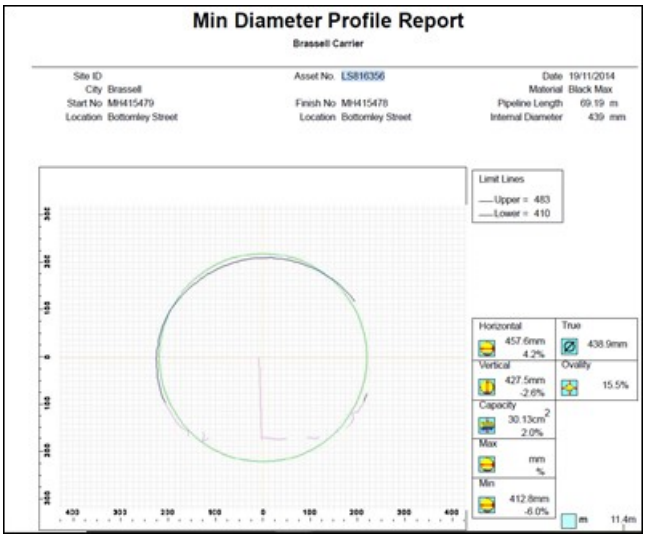


Figure 4-3 Example of cross-sectional graph which displays the minimum and maximum diameters and maximum ovality

Other display formats (e.g. the 3D projections shown in Figure 4-1 and Figure 4-2) can be provided as optional deliverables if it helps Urban Utilities to better understand and assess the situation.

The colour coding of the above flat graphs will be white where the measured pipe ID coincides with the expected values, on a yellow/red colour scale where material loss or ovality is measured by increasing pipe ID, and on a blue colour scale where material gain or ovality is measured by decreasing pipe ID. The red colour for material loss must be set to half the expected wall thickness.

A 'match to reference shape and size' observation shall be shown for each pipe segment highlighting a cross-section where the actual pipe shape and size closest matches the median calculated diameter for each cross-section or the as-built diameter when provided. The 'match to reference shape and size' must be confirmed for each pipe segment and, where multiple pipe segments are included in the investigation, compared across pipe segments. The 'match to reference shape and size' is Urban Utilities interpretation of the 'diameter actual undeformed' terminology which is used in WSA 05-2020 Code.

The inspection reports are to be provided in digital format (PDF).

4.7.3 Full HD Video 4 in 1

Where different technologies are used to create the combined pipe profile, the recorded footage must be combined into one digital video format (MP4) that must include where appropriate the CCTV footage, laser profile scan, sonar profile scan, and coloured flat graph of the pipe wall. The combined video must have sufficient display data to identify as a minimum:

- Sewer line segment asset ID
- Maintenance hole asset ID where inspection started
- Direction of the inspection
- Inspection date and time
- Distance along the sewer
- Pipe material and internal diameter
- Contractor undertaking the work

If the different technologies are not deployed at the same time and a combined video of all different technologies is not possible, the combined video shall at least feature CCTV footage, laser profiler scan, and coloured flat graph of the pipe wall loss.

4.7.4 Raw Data Exports

The contractor must supply the following types of raw data exports to Urban Utilities as part of this work:

1. CSV file format with the recorded data for each laser frame and sonar image
2. CAD file (DWG or DXF format) of internal cross sections of the sewer pipe

The CSV data exports shall consist of the following information as a minimum for each laser frame and/or sonar image:

- Laser frame and/or sonar image number
- GPS latitude and longitude coordinates in decimal degrees
- Horizontal and vertical distance (mm) from start of inspection
- Video timer

- X and Y distance (mm) from the midpoint of the conduit for each data point recorded
- Internal 'match to reference shape and size' diameter (mm)
- Minimum and maximum diameter (mm)
- Maximum ovality (%)
- Debris level (mm)
- Water level (mm)

5 CONDITION ASSESSMENT OF CONDUITS

5.1 Requirements for Training

Contractors performing, assessing, or reviewing the Level 2 assessment of conduits must comply with the training requirements specified in the WSA 05 Code.

Contractors are required to provide evidence of training when requested by Urban Utilities.

5.2 Customised Coding

5.2.1 Coding of Rehabilitated Junctions / Connections

There are an increasing number of rehabilitated junctions / connections and lined house connection service lines in the sewer network managed by Urban Utilities.

To help locate these rehabilitated junctions and relined house service lines in the network, the following CCTV codes were introduced into the customised Urban Utilities coding setup:

- CNSOL = **C**o**n**nection **o**pen, **s**ealed (reinstated with T-seal / top hat), and the house service sewer has been re**l**ined.
- CNSO = **C**o**n**nection **o**pen, **s**ealed (reinstated with T-seal / top hat), and the house service sewer has not been relined.
- CNGO = **C**onnection **o**pen, **g**ood workmanship, and the house service sewer has not been relined.
- CNPO = **C**onnection **o**pen, **p**oor workmanship, and the house service sewer has not been relined.
- CNGOL = **C**o**n**nection **o**pen, **g**ood workmanship, and the house sewer has been re**l**ined.
- CNPOL = **C**o**n**nection **o**pen, **p**oor workmanship, and the house sewer has been re**l**ined
- JNSOL = **J**u**n**ction **o**pen, **s**ealed (reinstated with T-seal / top hat), and the house service sewer has been re**l**ined.
- JNSO = **J**u**n**ction **o**pen, **s**ealed (reinstated with T-seal / top hat), and the house service sewer has not been relined.

- JNGO = **J**unction **o**pen, **g**ood workmanship, and the house service sewer has not been relined.
- JNPO = **J**unction **o**pen, **p**oor workmanship, and the house service sewer has not been relined.
- JNGOL = **J**u**n**ction **o**pen, **g**ood workmanship, and the house sewer has been re**l**ined.
- JNPOL = **J**u**n**ction **o**pen, **p**oor workmanship, and the house sewer has been re**l**ined

5.2.2 Coding of Bellies

Bellies are to be recorded by using either the ponding code (WLP) from Section 2.7.8.3 of the WSA 05-2020 Code, or the point repair bellies code (PRRB) from Section 2.7.7.2 of the WSA 05-2020 Code.

The PRRB code is to be used when the belly is caused by point repair replacement conduit units or pipes being laid incorrectly, resulting in an irregular grade. The ponding code is to be used in all other instances.

If the belly is longer than 1m, it shall be coded as a continuous defect.

Where the ponding caused by the belly results in a water depth of 30% or more of the diameter of the pipe, the belly is to be reported to Urban Utilities at the next project / progress meeting in accordance with **Section 7**.

5.2.3 Coding Under Water

Special or unusual situations identified under water where the flow is turbid or discoloured must be recorded using the general comment code (Section 2.7.9.3 of WSA 05-2020 Code). Special situations may include the following:

- Rough camera travel along the pipe indicating debris in the invert of the pipe.
- Unusual camera movement like driving oversteps (camera drops with front wheels of tractor), which could indicate radial displacement or missing invert.
- Depression investigations to determine if belly is present (using inclination measurement).
- Other situations where a comment will help to assess the situation in the sewer.

Note that an underwater obstruction which leads to an abandoned inspection must be recorded using the obstruction code (Section 2.7.4.4 of WSA 05-2020 Code) and not a comment.

5.3 STR and SER Grade

The structural (STR) and serviceability (SER) grade will be determined by the defect scores as outlined in WSA 05-2020 Code.

5.4 STR Intervention

The STR Intervention field is a recommendation of a maintenance activity required to improve the structural condition of the sewer conduit. The STR Intervention is a mandatory field with a drop-down menu presenting the following options:

- None: Line is in fair to very good structural condition. No major structural defects present. No maintenance activity required.
- CCTV: Line is in poor to fair condition. Urban Utilities to consider an increased CCTV inspection frequency.
- Patch: Single location to be internally patched*.
- Repair: Single location to be repaired*.
- Reline within 1 year: Line in very poor condition (i.e. severe gas attack, holes in pipe, breaking, fracturing).
- Reline within 3 years: Line in poor condition (i.e. heavy gas attack, major or extreme deterioration)
- Reline within 5 years: Line deteriorating (i.e. multiple longitudinal cracks, risk of section of pipe collapsing).

* The selection of patch or repair should be made with consideration of the type and extent of the defect and the depth of the line.

The reason for the chosen STR Intervention should be defined clearly in the comments. In most cases, only one of the above options will be relevant. If more than one option is required, specify the most severe recommendation in the STR Intervention field, and include any other recommendations in the comments. If a patch or repair is recommended, clearly define the defect(s) and location(s) in the comments.

If the STR Grade is 4 or above (based on the maximum of both the peak and average), a STR Intervention other than "None" must be selected. A STR Grade of 5 is likely to indicate that an immediate action is required. Refer to Section 7 for advice on urgent defects.

5.5 SER Intervention

The SER Intervention field is a recommendation of a maintenance activity required to improve the serviceability condition of the sewer conduit. The SER Intervention is a mandatory field with a drop-down menu presenting the following options:

- None: Line is in fair to very good serviceability condition. No major serviceability defects present. No maintenance activity required.
- Root cut: Multiple tree root affected joints.
- Clean fat / grit: Significant debris, heavy fat deposits or large belly in line.

The reason for the chosen SER intervention should be defined clearly in the remarks. In most cases, only one of the above options will be relevant. If more than one option is required, specify the most severe recommendation in the SER intervention field, and include any other recommendations in the comments.

If the SER Grade is 4 or above (based on the maximum of both the peak and average), a SER Intervention other than "None" must be selected. A SER Grade of 5 is likely to indicate that an immediate action is required. Refer to Section 7 for advice on urgent defects.

6 CONDITION ASSESSMENT OF MAINTENANCE HOLES

There are three different type of condition assessment of maintenance holes:

1. Maintenance holes inspected by CCTV within inspections of sewer conduits, recorded using WinCan
2. Maintenance holes inspected by CCTV independently of sewer conduit inspections, recorded in WinCan
3. Maintenance holes visually inspected, recorded in Survey 123

These are discussed in more detail in the following sections.

6.1 Maintenance Holes Inspected with Sewer Conduit Inspection

These maintenance hole inspections are completed as part of a sewer conduit inspection. The operator must perform a visual inspection of the maintenance hole accessed for the CCTV inspection. Information of the visual inspection must be captured in Urban Utilities maintenance hole inspection template in WinCan VX.

The Level 2 inspection should be completed in alignment with Section 3 of WSA 05-2020 Code.

For maintenance holes that are not accessed during the conduit inspection but are inspected through CCTV, the inspection is to be completed in alignment with **Section 3.14**.

6.2 Maintenance Holes Inspected by CCTV

These maintenance hole inspections are completed independent of a sewer conduit inspection. They are likely to be critical maintenance holes that have been selected for review through CCTV.

The Level 2 inspection should be completed according to Section 3 of WSA 05-2020 Code.

Delivery partners should consider the use of new technologies for inspection of maintenance holes and provide proof to Urban Utilities of the benefit of these technologies for Urban Utilities consideration.

6.3 Maintenance Holes Inspected for Maintenance Inspection Program

This inspection form option is to be used only where agreed with the Urban Utilities Project Manager. For the agreed maintenance holes, the contractor is to complete the visual inspection form in Survey 123. This inspection form is consistent with WinCan template.

The Level 2 inspection is to be completed in alignment with Urban Utilities Visual Maintenance Hole Inspection Guideline in Appendix F.

7 URGENT DEFECTS / HAZARDS NOTIFICATIONS

There are situations in the sewer network which require urgent attention by the network operator to avoid blockages causing overflows and environmental damage. Severe structural defects found in the sewer could indicate that a failure of the pipe is imminent and urgent action is needed to prevent the failure. These situations may not be obvious to the contractor without the full knowledge of how the system operates, which is why Urban Utilities has set notification requirements for CCTV contractors.

The notification requirements outlined in the CCTV Contract Services Specifications still apply. In addition to that, Urban Utilities requests notifications from CCTV operators for specific situations. These notifications are required regardless of whether Urban Utilities personnel are present on site during the inspection.

All obstructions, deposits, and tree root intrusion causing a reduction in cross sectional area of more than 40% are defined as significant flow capacity hazards. If these hazards cannot be removed with cleaning or root cutting while on site (following the find and fix procedure outlined in Section 3.11), the location of the problem with a 'mud map' and a description of the problem together with photographic evidence must be reported to Urban Utilities in an appropriate time frame according to the guidance provided in the table below. These hazard rules also apply for all observations on inlet or outlet sewers in the maintenance hole. The observation must be recorded using the general comment code (Section 2.7.9.3 of WSA 05-2020 Code) for the maintenance hole and a notification sent to Urban Utilities.

Severe defects must also be reported to Urban Utilities with a 'mud map' of the location, photographic evidence, and any accompanying issues. The appropriate time frame is outlined in the table below.

The following table presents the notification time frame and a description of the hazard or defect. Where relevant, the applicable code and scores in relation to the WSA 05-2020 Code are provided. Note that the scores are representative of a 1m section (i.e. not continuous defect scores). These codes and scores are only indicative, and the operator should use judgement based on the description to determine the notification time frame of an identified hazard or defect.

Table 7-1: Urgent Notification Defects and Timeframes

Notification Time Frame	Ref. No.	Description	WSA 05-2020 Codes	WSA 05-2020 SER Defect Scores for 1m	WSA 05-2020 STR Defect Scores for 1m
Responsive Action **Immediately to Urban Utilities Faults and Emergencies on 13 23 64**	**1**	Hazards with a reduction in cross sectional area of 60% or more that cannot be cleared through Find and Fix (Section 3.11)	SO, DE, OB, R, DJS, CI, CX, JX, LD, PR	80	N/A
	2	Collapsed sewers	X	80	165
	3	Sewage overflows	N/A	N/A	N/A
Urgent Maintenance Action **Within the next business day to the nominated group of Urban Utilities personnel**	**4**	Hazards with a reduction in cross sectional area of between 40% and 60% that cannot be cleared through Find and Fix (Section 3.11)	SO, DE, OB, R, DJS, CI, CX, JX, LD, PR	50 – 79	N/A
	5	Significant voids, where the void has developed to more than half of the pipe size	VV	N/A	65
	6	Ingress of soil with large scale infiltration	ING and IR/IG	60 – 80	70
	7	Holes larger than 500 cm^2	SCH, SACH, SOH	N/A	80
	8	Severe gas attack in unreinforced concrete pipes, where aggregate is missing	SCAM	N/A	35
	9	Severe gas attack in reinforced concrete pipes, where reinforcement is exposed and corroded or completely removed	SCRC	N/A	65
	10	Severe gas attack in AC pipes, where thick layers of conduit material are evident and/or have been removed from the conduit surface such that the conduit has lost its circular shape	SACDX	N/A	50
	11	Breaking with missing pieces, where the missing pieces make up more than 25% of the diameter and extends more than 100mm in the longitudinal dimension	BM	N/A	50 – 80
	12	Deformations above 20% in flexible pipe materials	D	20 – 45	20 – 125
	13	Major problems with spiral wound lined sewers, where the lining system has started to unwind, and loose liner ends are hanging in the sewer	LDM	N/A	2 – 5
	14	Impending sewage overflows (e.g. backed up sewers)	N/A	N/A	N/A

The following table presents a description of defects for non-urgent hazards. Appropriate STR / SER interventions should be identified, and issues raised during the next project / progress meeting or sooner if contractor has particular cause for concern.

Table 7-2: Non-Urgent Notification Defects and Timeframes

Notification Time Frame	Ref. No.	Description	WSA 05-2020 Codes	WSA 05-2020 SER Defect Scores for 1m	WSA 05-2020 STR Defect Scores for 1m
STR intervention/ SER intervention **At the next project / progress meeting**	**15**	Large scale gushing infiltration	IG	40	N/A
	16	Significant depressions/bellies in sewer conduits (>30% diameter)	WLP, PRRB	WLP – 10 PRRB – 5	N/A
	17	Major structural damage in maintenance holes (e.g. holes, lost concrete aggregate, blocked drop pipes, damaged sewer doors in maintenance holes)	N/A	N/A	N/A
	18	Buried maintenance holes	N/A	N/A	N/A
	19	Significant tree roots in sewer conduits with a reduction in cross sectional area of more than 20%, which cannot be cleared through Find and Fix (Section 3.11)	R	> 30	N/A
	20	Other problems considered to have an impact on the operational performance of the sewer network	N/A	N/A	N/A
	21	Identification of a potentially illegal connection	N/A	N/A	N/A

8 QUALITY ASSURANCE

The quality assurance QA obligations outlined in the contract shall apply. The contractor must provide evidence to Urban Utilities that a quality assurance system is in place and followed for the deliverables submitted to Urban Utilities.

The QA review must be appropriately documented and provided to Urban Utilities when requested.

8.1 QA for Conduit Inspections

The following items must be checked as part of the QA process for conduit inspections:

- Asset ID (recorded accurately without any additional notation)
- Camera speed
- 360-degree pan and zoom requirements
- Recording of correct pipe materials and pipe unit lengths
- Change in pipe materials and pipe unit lengths are captured correctly
- Defect size measurements
- Correct pipe diameters
- Recording of maintenance hole details
- Length discrepancies to supplied information
- Defect coding quality and identification of defects
- New maintenance hole identification procedures are followed
- Abandoned inspection procedures are followed
- Continuous defects are recorded correctly

8.2 QA for Maintenance Hole Inspections

The maintenance hole inspection forms must be checked as part of the QA process to ensure that all relevant data fields have reasonable inputs, and all relevant photographs are provided. If an input or photograph was not provided, the reason should be clearly stated.

A APPENDIX A: MAJOR AMENDMENTS TO DOCUMENT FROM PREVIOUS VERSION

This guideline is a new revision of *REF219_6.2 CCTV Inspection Guide for Sewers*. The major amendments to the document are summarised in **Table A-1** below. The guideline was updated to be aligned to the 2020 WSA-05 2020 Code. The guideline was also refined to remove information already present in the WSA 05 Code and information used for educational rather than instruction purposes. When viewing or analysing inspections completed prior to June 2022, refer to the previous guideline: *REF219_6.2 CCTV Inspection Guide for Sewers.*

Table A-1: Major Amendments to Document from Previous Version

Amendment	Description of Amendment	Relevant Section in Previous REF219 Guideline	Relevant Section in Current Revision of Guideline
Adoption of WSA-05 2020 Code	Refer **Section A.1**	N/A	N/A
Addition of requirements for redlining	Refer **Section A.2**	N/A	**Section 3.4**
Addition of requirements for 'Find and Fix'	Refer **Section A.3**	N/A	**Section 3.11**
Addition of requirements for push-rod inspections	Refer **Section A.4**	N/A	**Section 3.12**
Addition of laser profiling process	Refer **Section A.5**	N/A	**Section 4**
Removal of customised defect coding for displaced joints	Refer **Section A.6**	*Section 2.1.12* and *Section 2.6*	N/A
Removal of customised defect coding for breaking and collapsed pipes	Refer **Section A.7**	*Section 2.1.12*	N/A
Removal of customised defect coding for void visible	Refer **Section A.8**	*Section 2.1.12*	N/A
Removal of customised defect coding for tree roots	Refer **Section A.9**	*Section 2.1.12* and *Section 2.9*	N/A
Removal of additional requirement for coding of infiltration	Refer **Section A.10**	*Section 2.10*	N/A
Removal of special rules for displaced joints in PE sewers jointed with electrofusion couplings	Refer **Section A.11**	*Section 2.7*	N/A
Removal of customised defect coding for gas attack in asbestos cement pipes	Refer **Section A.12**	*Section 2.8* and *Appendix A*	N/A
Addition of requirements for coding of bellies	Refer **Section A.13**	N/A	**Section 5.2.2**
Removal of next maintenance activity, CCTV frequency and secondary maintenance activity	Refer **Section A.14**	*Section 3.2.1*, *Section 3.2.2*, and *Section 3.2.3*	N/A
Addition of STR intervention and SER intervention	Refer **Section A.15**	N/A	**Sections 5.4 and 5.5**
Removal of overall condition assessment	Refer **Section A.16**	*Section 3.2.4*	N/A
Addition of Survey 123 maintenance hole inspection platform	Refer **Section A.17**	N/A	**Section 6**
Update to urgent defects and hazards notification requirements	Refer **Section A.18**	*Section 2.1.14*	**Section 7**

A.1 Adoption of WSA-05 2020 Code

The previous guideline was written in alignment with WSA-05 2008 Code. This new guideline is written for WSA-05 2020 Code.

The major updates to the WSA-05 2020 Code include:

- Update to defect scores.
- Some defect scores amended or reintroduced from earlier versions of the code.
- Defect quantifications have been added and amended.
- Change to mean and peak scores for structural and serviceability grades.
- Some codes moved from structural to serviceability defects or included as both.
- Lateral defects scores for connections and junctions are now required to be recorded separately to the main conduit in a supplementary report.
- Updated to include other methods of inspection rather than just CCTV camera, including 3D optical scanners, push rod cameras, and fixed zoom cameras.
- Added sections on laser profiling and sonar surveying.
- Added recommendation for refresher training to be undertaken every 3 years for operators or when the asset owner and operator/contractor have not previously used this version of the code.
- Update to header codes.
- Added appendix for compendium of defects and features which provides examples for reference.

A.2 Addition of Requirements for Redlining

Redlining requirements are specified in the updated guideline. Refer to **Section 3.4**.

A.3 Addition of Requirements for 'Find and Fix'

'Find and Fix' requirements are specified in the updated guideline. Refer to **Section 3.11**.

A.4 Addition of Requirements for Push-Rod Inspections

In this updated guideline, push-rod inspections are now required to be completed in accordance with WSA 05-2020 Code and the requirements in this guideline. Refer to **Section 3.12**.

A.5 Addition of Laser Profiling Process

The laser profiling and sonar surveying process requirements for inspection of conduits have been added to this guideline. The requirements in the guideline are based on an updated version of the *Laser Profiling CCTV Technical Specification for Sewers*. Refer to **Section 4** of this guideline.

A.6 Removal of Customised Defect Coding for Displaced Joints

In the previous guideline, the defect quantification of longitudinally and radially displaced joints were customised to record the real displacement measured in millimetres while angularly displaced joints were customised to record the real displacement in degrees. This was introduced to replace the small, medium and large quantifications of WSA 05-2008 Code.

The WSA 05-2020 Code has updated quantifications for displaced joints; therefore, this customised defect coding was removed in the updated guideline.

A.7 Removal of Customised Defect Coding for Breaking and Collapsed Pipes

In the previous guideline, the defect quantification for breaking and collapsed pipes was customised to record the length of the break or collapsed pipe in millimetres. Breaks or collapsed pipes measured as longer than 1000mm were to be recorded as continuous defects.

This customisation did not add value for Urban Utilities and is similar to the coding in the WSA 05-2020 Code. The customised defect quantification was removed in the updated guideline.

A.8 Removal of Customised Defect Coding for Void Visible

In the previous guideline, the defect quantification for void visible was customised to record the length and depth of the void in mm.

This customisation did not add value for Urban Utilities and is similar to the coding in the WSA 05-2020 Code. The customised defect quantification was removed in the updated guideline.

A.9 Removal of Customised Defect Coding for Tree Roots

In the previous guideline, customised defect coding was specified for tree roots. According to the previous guideline, at each root intrusion at least one structural defect (e.g. crack or hole) must be recorded in addition to the tree root code. If the type of structural defect could not be identified, a wall crack is to be recorded.

The customised tree root codes in the previous guideline were:

- Tap roots > 10mm in diameter (RBWD, RBWDR)
- Medium roots 5-10mm in diameter (RBWC, RBWCR)
- Fine roots < 5mm in diameter (RBWB, RBWBR)

The customised root scoring was to be used for pipe diameters between 150mm and 525mm, as well as property connections.

The root score was calculated as follows:

Grading score = root size x circumferential entry

The root size score was selected from Table A-2 below.

Table A-2: Root Size Score

Root Size	Description
2	Largest visible tree root ≤ 5mm in diameter (fine roots with defect codes RBWB and RBWBR)
3	Largest visible tree root > 5mm and < 10mm in diameter (medium roots with defect codes RBWC and RBWCR)
4	Largest visible tree root ≥ 10mm in diameter (heavy / tap roots with defect codes RBWD and RBWDR)

The circumferential entry was determined using the percentage of the circumference where the tree roots are entering the pipe as per **Table A-3** below.

Table A-3: Circumferential Entry Score

Circumferential Entry	Description
2	Tree root entry through ≤ 20% of circumference (up to 2 hours based on clock reference)
4	Tree root entry through between 20 and 40% of circumference (between 3 and 5 hours based on clock reference)
6	Tree root entry through between 40 and 60% of circumference (between 6 and 7 hours based on clock reference)
8	Tree root entry through between 60 and 80% of circumference (between 8 and 10 hours based on clock reference)
10	Tree root entry through between 80 and 100% of circumference (more than 10 hours based on clock reference)

For this updated guideline, it was determined that the WSA 05-2020 coding and scoring for root defects was better suited to Urban Utilities requirements. Therefore, the customised root scoring was removed in the updated guideline.

A.10 Removal of Additional Requirement for Coding of Infiltration

The previous guideline included a requirement for operators to record the infiltration sweating (IS) code in addition to any rust marks and encrustation visible, regardless of whether any infiltration was observed.

This requirement was removed in the updated guideline, as it did not provide any value to Urban Utilities.

A.11 Removal of Special Rules for Displaced Joints in PE Sewers Jointed with Electrofusion Couplings

The previous guideline included special defect coding for displaced joints in PE sewers jointed with electrofusion coupling. The purpose of the special rules was to clearly differentiate between the following defects:

- Longitudinal displaced joints (JDL)
- Weld defect poor workmanship (WCPC)
- Weld defect welding wire visible (WCWV)

The special rules were removed in the updated guideline as they did not add value for Urban Utilities and the codes were similar to codes in WSA 05-2020 Code.

A.12 Removal of Customised Defect Coding for Gas Attack in Asbestos Cement Pipes

In the previous guideline, customised defect coding for gas attack in asbestos cement (AC) pipes was included.

The customised defect codes for gas attack in AC pipes were:

- DLC: discolouration of pipe surface
- DLC: slight delamination of AC
- DLM: medium delamination of AC
- DLL: large delamination of AC

- DLE: extreme delamination of AC

These customised defect codes are removed in this updated guideline as the coding of AC gas attack is better captured in the WSA 05-2020 Code than it was in the 2008 Code. Therefore, customised coding is no longer required and the WSA codes are to be adopted.

A.13 Addition of Requirements for Coding of Bellies

Section 5.2.2 of this updated guideline provides instruction on the coding of bellies.

A.14 Removal of Next Maintenance Activity, CCTV Frequency and Secondary Maintenance Activity

In the previous guideline, the next maintenance activity (NMA), CCTV frequency, and secondary maintenance activity (SMA) were required to specified by the contractor based on the Level 2 assessment of the asset.

The NMA was chosen from **Table A-4** below.

Table A-4: Next Maintenance Activity

Next Maintenance Activity	Reason for Assessment and/or Comments
CCTV	Line in reasonable condition – set when next CCTV inspection should occur (refer **Table A-5**)
Reline urgent within 1 year	Line in very poor condition – severe gas attack, holes in pipe, breaking, fracturing
Reline within 3 years	Line in poor condition – heavy gas attack (major or extreme deterioration)
Reline within 5 years	Line deterioration – multiple longitudinal cracks and risk of section of pipe falling in / collapsing

The CCTV frequency in years is a recommendation of when to CCTV again in the future and should reflect on the condition of the asset. The CCTV frequency was chosen from **Table A-5** below.

Table A-5: CCTV Frequency

CCTV Frequency (years)	Reason for Assessment and/or Comments
5	Line currently in poor to average condition – medium deterioration
10	Line currently in average condition – slight deterioration
15	Line in good condition with some defects
20	Line in near new condition – minor defects, closed cracks, etc.
25	Line in as new condition – no defects

The SMA is a recommendation of either a maintenance activity to repair a localised structural issue such as a point repair / patch or a serviceability activity such as a cyclic fat / grit clean or tree root cutting. The options for SMA are outlined in **Table A-6** below.

Table A-6: Secondary Maintenance Activity

Secondary Maintenance Activity	Reason for Assessment and/or Comments
Patch	Single location that can be internally patched – line too deep to dig up
Repair	Single location that can be repaired – line shallow to dig up
Root cut – 182-day cycle	Long line with multiple tree root affected joints – tree root score > 100
Root cut – 364-day cycle	Line with multiple tree root affected joints – tree root score > 40
Clean fat / grit – 182-day cycle	Long line with > 1 bucket of debris removed or heavy fat deposits
Clean fat / grit – 364-day cycle	Line with > 5 cups of debris removed or large belly in line (by 1 pipe diameter or more)

The NMA, SMA and CCTV frequency were removed in the updated guideline and their core functionality was replaced with STR Intervention and SER Intervention, as discussed in the following section.

A.15 Addition of STR Intervention and SER Intervention

The STR Intervention and SER Intervention are added requirements in this updated guideline. Refer to **Section 5.4** and **Section 5.5** of this guideline.

A.16 Removal of Overall Condition Assessment

The previous guideline required the overall condition assessment (OCA) to be specified for each conduit inspection as a rating from 1 to 5 as outlined in **Table A-7** below.

Table A-7: Overall Condition Assessment

Overall Condition Assessment	Reason for Assessment and/or Comments
1	Excellent as new
2	Minor defects – cracks closed, minor gas attack
3	Structural defects with deterioration to failure possible in 10 years – cracks open, significant gas attack
4	Significant structural defects with failure likely in 5 years
5	Failed or about to fail – fractures, breaking, severe gas attack etc.

The OCA was removed in this updated guideline. The OCA scoring was introduced by Urban Utilities as a method of reducing the over scoring typically encountered for continuous defects. A detailed data review of a random selection of over 700 line segments surveyed between 2019 to 2021 demonstrated that the updated WSA 05-2020 Code standard reduces 2008 over estimation of scores for pipe condition at least as much as OCA process. As such, there is no longer a requirement for a manual, subjective process.

A.17 Addition of Survey 123 Maintenance Hole Inspection Platform

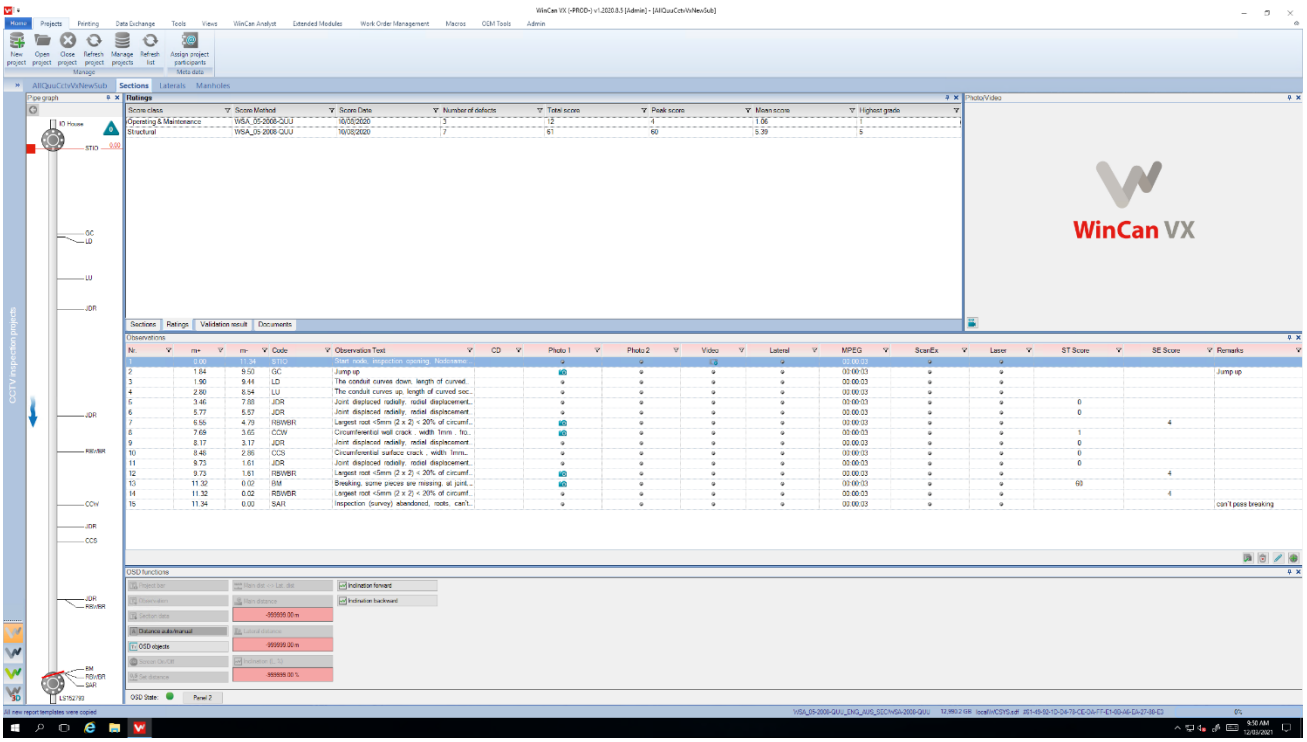
This updated guideline includes instruction on the visual inspection and condition assessment of maintenance holes inspected as part of a maintenance hole inspection program. The program utilises a Survey 123 maintenance hole inspection platform. Refer to **Section 6** of this guideline.

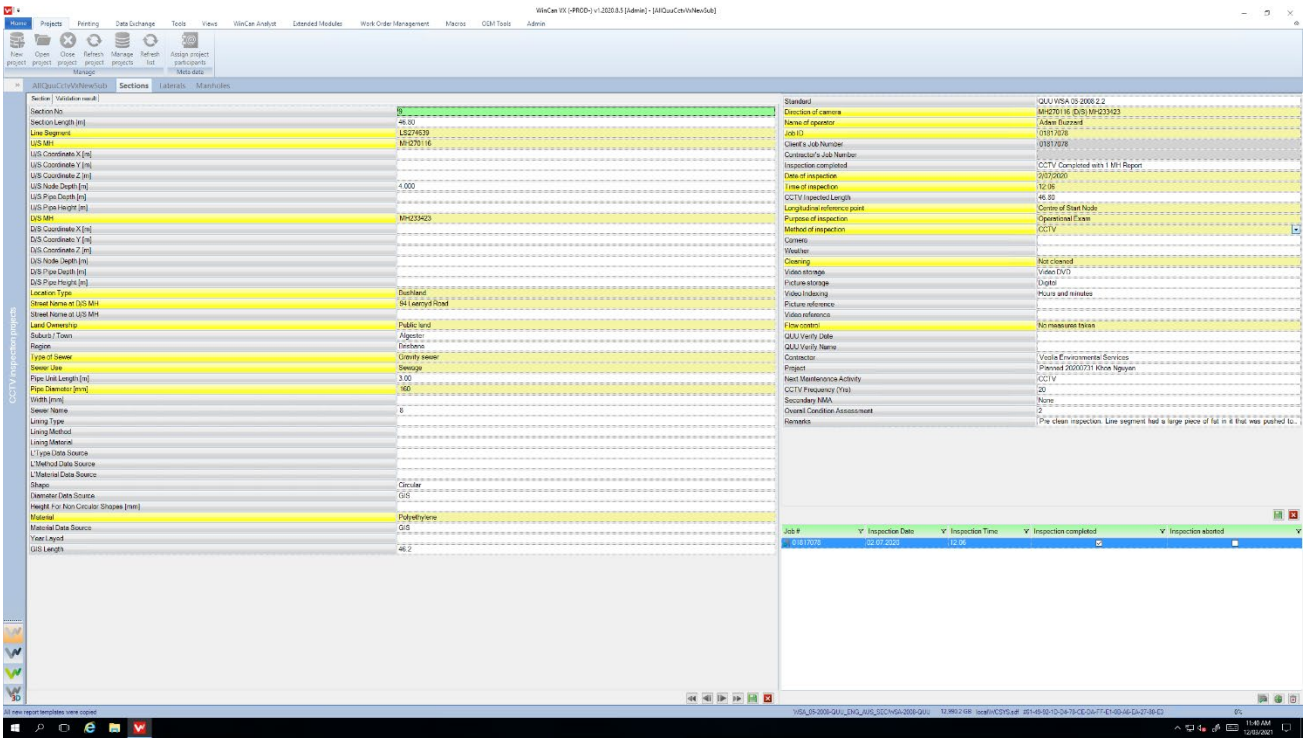
A.18 Update to Urgent Defects and Hazards Notification Requirements

The urgent defects and hazards notification requirements were updated to align with WSA 05-2020 codes and scoring.

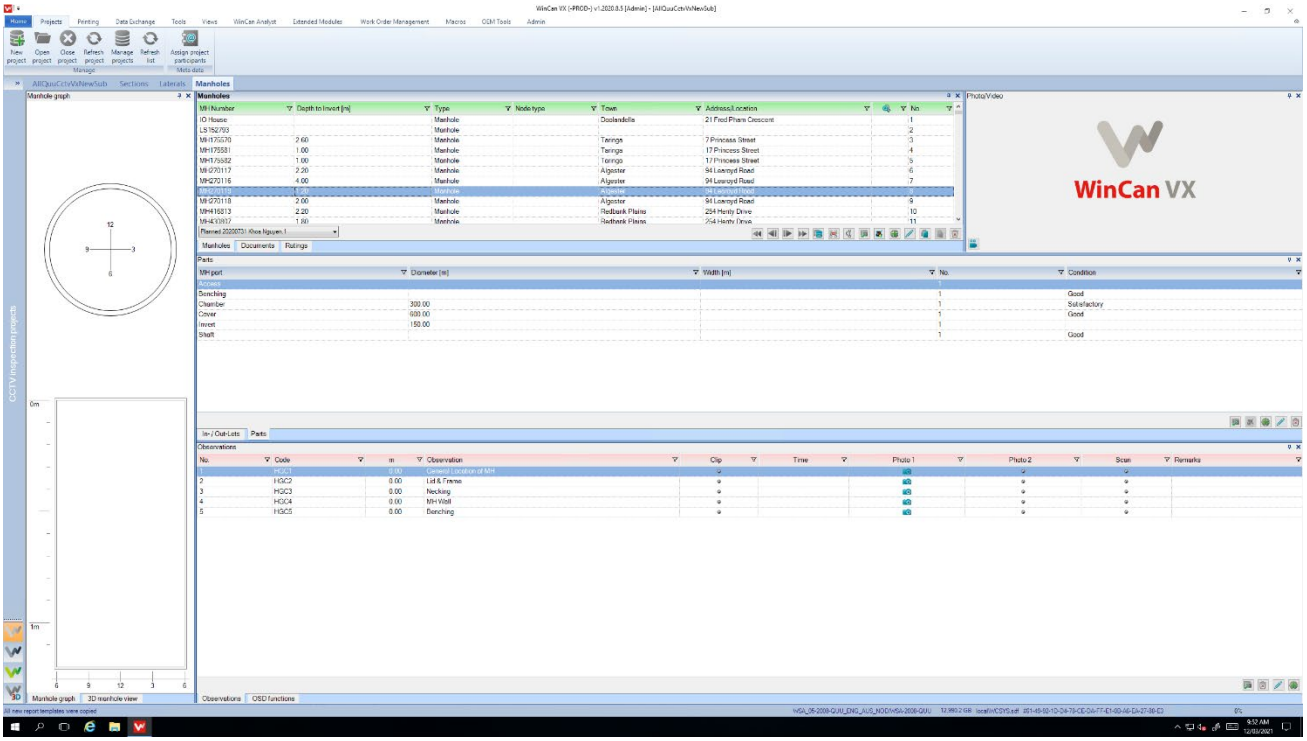
B APPENDIX B: URBAN UTILITIES WINCAN TEMPLATES

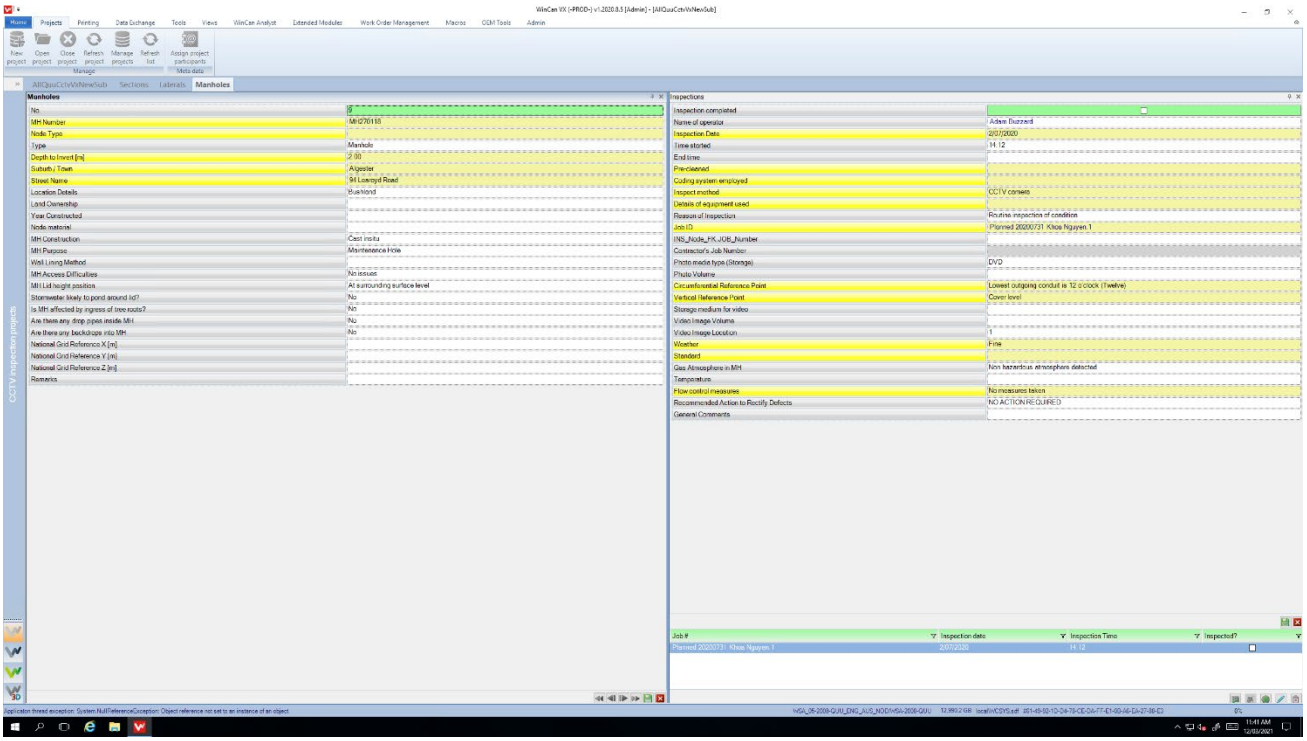
WinCan Pipe Template:





WinCan Maintenance Hole Template:





C APPENDIX C: COMMON SEWER PIPE MATERIALS USED IN ASSETS MANAGED BY URBAN UTILITIES

C.1 Asbestos Cement Pipes

The information provided in the table below is based on Hardie's Fibrolite Asbestos Cement (AC) pipes. The information was taken from Hardie's Pipeline Manual Part 10 (sewer main pipe) published in 1970.

Table C-1: Common Manufactured Pipe Sizes for AC Pipes

Pipe size (inch)	Nominal pipe size (mm)	Manufactured standard pipe unit length	Manufactured special pipe unit length
4	102 (100)	3.96m, 1.99m	91cm, 61cm
6	152 (150)	3.96m, 1.99m	91cm, 61cm
8	203 (200)	3.96m	1.99m, 91cm, 61cm
9	228 (225)	3.96m	1.99m, 91cm, 61cm
10	254 (250)	3.96m	1.99m, 91cm, 61cm
12	305 (300)	3.96m	1.99m, 91cm, 61cm
15	381 (375)	3.96m	1.99m, 91cm, 61cm
18	457 (450)	3.96m	1.99m, 91cm, 61cm
21	533 (525)	3.96m	1.99m, 91cm, 61cm
24	610 (600)	3.96m	1.99m, 91cm, 61cm

Any pipe size above 600mm or pipe unit length discovered in a live sewer different from the values listed above is unlikely to be an AC sewer. These situations shall be clearly recorded in WinCan using general comments if the operator is confident that the pipe appears to be an AC main. If unsure and unable to identify the material correctly, the operator shall record the sewer as 'unknown' material.

C.2 Clay pipes

There are a number of different clay-based pipes, which were installed in the past 100 years in Brisbane and the surrounding area. In the Urban Utilities GIS system, these pipes carry different names based on their installation / manufacturing periods. The names are Earthenware pipes (EW), Salt Glazed Ware pipes (SGW) and Vitrified Clay pipes (VC).

Clay pipes are normally easy to identify given the colour and glaze most clay pipes have. No Clay pipes were manufactured in unit length of more than 2.5m. Any pipe material discovered in a live sewer with a unit length of more than 2.5m is not a clay pipe. There is the possibility of a number of different pipe unit lengths between 75cm and 2.5m. It's difficult to research this information over the last 100 plus years, but nearly all possible 25cm increments

between 75cm and 2.5m could have been manufactured. Possible pipe sizes include 75cm, 100cm, 125cm, 150cm, 175cm, 200cm and 250cm. These measurements may vary a bit if the pipe units are based on imperial units.

The manufactured sizes of clay pipes have changed over the years and are now available up to 1400mm. The following table gives an indication of certain installation periods and diameter restrictions that should apply:

Table C-2: Installation Periods of Clay Pipes and Associated Diameter Restrictions

Construction Period	Nominal pipe size (mm)	Comment
Before 1950	<=525mm	Installed pipe sizes
1950 - 1970	<=600mm	Installed pipe sizes
1970 – 2000	<=750mm	Installed pipe sizes
After 2000	100mm - 1400mm	Manufactured product range

Any clay pipe outside the listed range are to be recorded in WinCan using general comments for further investigation by Urban Utilities.

C.3 Concrete Pipes

Concrete pipes were widely used in the area over the last 100 years. Predominantly unreinforced concrete was used for sewer pipes until around 1970. After that period, reinforced concrete pipes were introduced for larger diameter pipes (>=600mm).

A big proportion of large diameter concrete pipes were installed in tunnels. These concrete sewers were cast inside the tunnel using timber formwork and normally don't have clearly visible joints. The tunnel sewers are generally unreinforced concrete.

Urban Utilities GIS lists a material named 'Box Culvert', but these assets are rectangular shaped concrete overflow pipes, so 'Box Culvert' is not a separate pipe material.

The common pipe unit length for concrete pipes varies depending on the construction period but in general does not exceed 2.5m. The exceptions are the concrete tunnel sewers mentioned above.

C.4 Plastic Pipes

There are a number of plastic pipe materials used in the sewer networks managed by Urban Utilities. The different pipe materials are:

- Polyethylene (PE) pipes (butt welded or electrofusion couplings)

- Poly Vinyl Chloride (PVC) pipes
- Acrylonitrile Butadiene Styrene (ABS) pipes
- Polycrete pipes
- Glass reinforced pipes

Urban Utilities GIS has a number of different names for certain plastic pipe materials. Some are just product brand names. To help understand the information that is provided from Urban Utilities GIS, here some of the product brand names listed:

- Hardies black brute = PE
- Hardies blue brute = PVC
- Hobas = Glass reinforced pipe

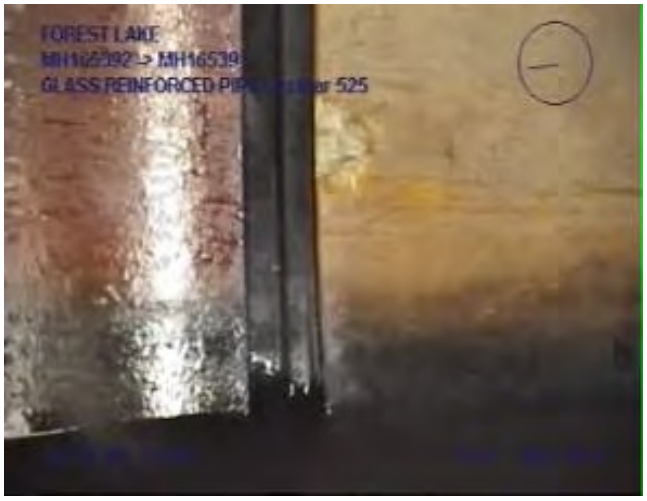
Most plastic pipes are produced in a wide range of unit lengths. The pipes are easily cut on site to adjust for local situations, so it is difficult to rule out certain lengths for plastic pipes. The main point to separate the different types of plastic pipe materials is the jointing technology. Butt welds are only common for PE pipes.

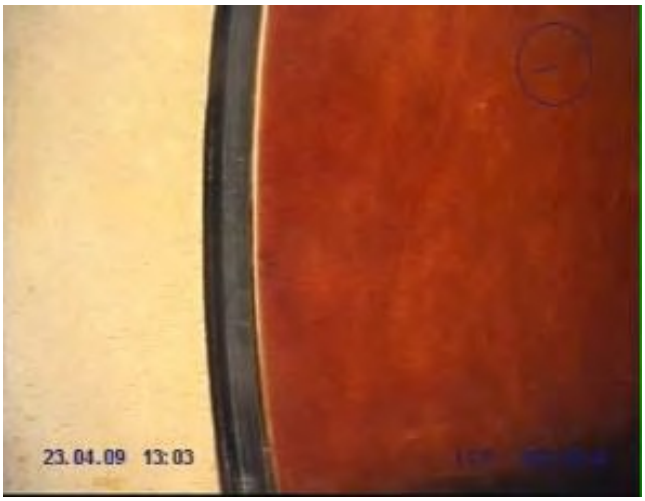
If unsure, the operator can identify the pipes as 'unidentified plastic' material.

The following sub-sections provide example photographs for plastic pipes.

3.4.1 Glass reinforced pipes (GRP)

Most GRP pipes have a gel coat; therefore, the surface can look similar to VC pipes. However, the joints clearly differentiate the two materials.





3.4.2 Polyethylene (PE)

The internal walls of PE pipes can have different colours, not just black as shown in the photographs below. An electrofusion coupling joint is shown in the bottom right photograph below.

C.5 Metal Pipes

There are a number of different types of ferrous based pipes installed in the sewer networks managed by Urban Utilities. The different ferrous based pipe materials are:

- Unlined cast iron pipes
- Cement mortar lined cast iron pipes
- Unlined ductile iron pipes
- Cement mortar lined ductile iron pipes
- Unlined mild steel pipes
- Cement mortar lined mild steel pipes

Metal pipes in a gravity sewer network are only used for special locations where other materials are not suitable.

Common pipe unit length for most metal pipes should be 6m, 9m or 12m, but local situations might have required shorter pipe length. Unlined metal pipes should be easily identified by the operators. Cement lined pipes should be identified based on the different wall surfaces.

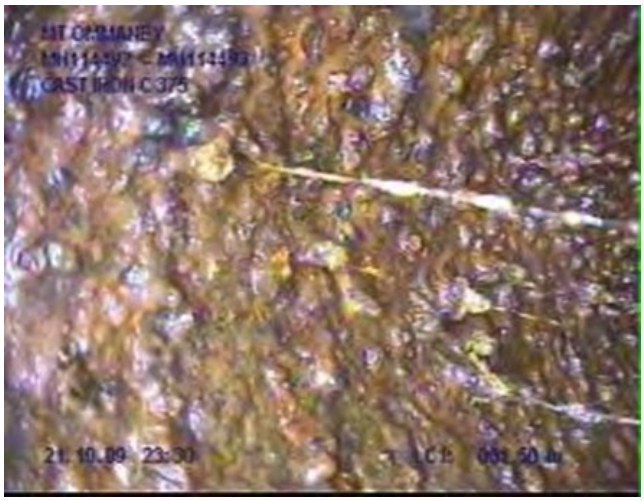
The following sub-sections provide example photographs for some metal pipes.

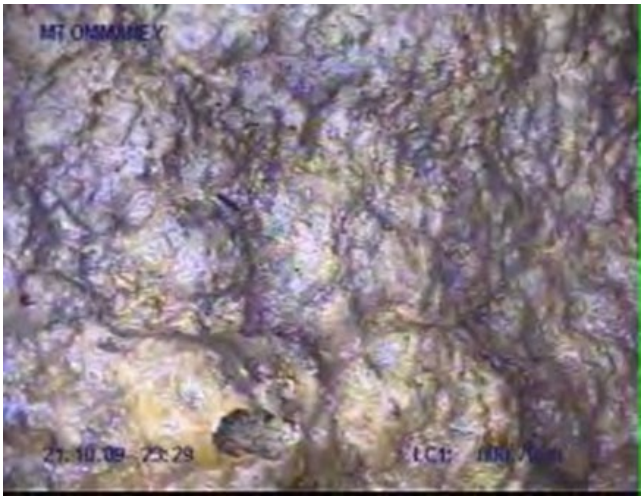
3.5.1 Mild Steel Cement Lined (MSCL)

3.5.2 Ductile Iron Cement Lined (DICL)

3.5.3 Cast Iron (CI)

Most unlined metal pipes are likely to be cast iron pipes.





D APPENDIX D: COMMON SEWER RELINING METHODS USED IN ASSETS MANAGED BY URBAN UTILITIES

This section provides example photographs of common relining methods used in assets managed by Urban Utilities. The sewer relining methods include:

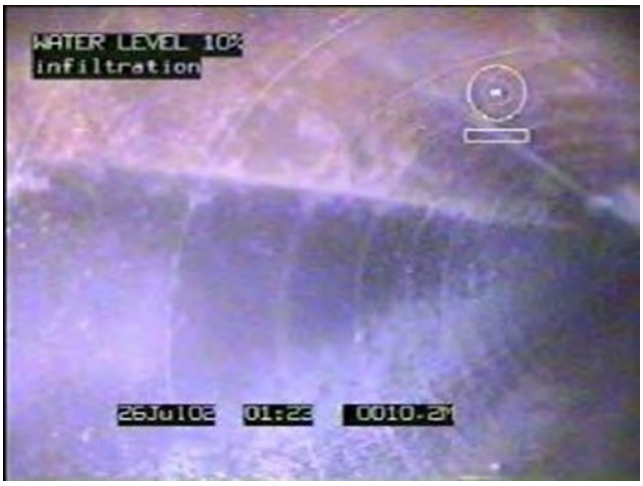
- Cured in place pipe liner (CIPP)
- EX liner from Kembla PVC
- Spiral wounded liner (Ribloc) PVC
- Spiral wounded liner (PanelLok Danby) PVC
- Insituform liner (CIPP polyester resin felt)
- NU-pipe (PVC)
- Slip lining (PE pipe segments)
- Troliner (HD-PE)
- Slip lined with Hobas GRP pipes
- Slip lined with short PE pipe segments

D.1 Cured in Place Pipe Liner

D.2 EX Liner from Kembla PVC

D.3 Spiral Wounded Liner (Ribloc) PVC

D.4 Spiral Wounded Liner (PanlLok Danby) PVC



D.5 Insituform Liner (CIPP Polyester Resin Felt)

D.6 NU-Pipe (PVC)

This relining method is similar to the EX method.

D.7 Slip Lining (PE Pipe Segments)

D.8 Troliner (HD-PE)

D.9 Slip Lined with Hobas GRP Pipes

D.10 Slip Lined with Short PE Pipe Segments

E APPENDIX E: GIS REDLINING FACTSHEET UV3

F APPENDIX F: VISUAL MAINTENANCE HOLE INSPECTION GUIDELINE