

CONDUIT INSPECTION REPORTING CODE OF AUSTRALIA

Version 4.1

WSA 05-2020

FRONTMATTER

GENERAL

ACKNOWLEDGEMENTS

The WSAA Board would like to express its appreciation to WSAA and industry members of the working group for their contributions to the revision of this Code. In particular the following individuals and associated organisations deserve special mention for their productive work and commitment to the development of this edition of the Code:

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The working group acknowledges the support and encouragement provided by Sarah Mahar, WSAA Project Manager.

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PUBLICATION DETAILS

Published by Water Services Association of Australia Limited, Suite 8.02, Level 8, 401 Docklands Drive, Docklands, Vic 3008 Australia

ISBN 1 920760 83 0

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FOREWORD

The fourth edition of the **Conduit Inspection Reporting Code of Australia** has been prepared to take account of the experiences of asset owners that have adopted the Code as part of their condition assessment practices for <u>conduit</u> and maintenance structures. Advice has also been provided by a small number of practitioners, who deliver training courses for operators as well as contract and asset managers.

The fourth edition of the Code has been further revised to improve the functionality of the Code as an aid to effective asset management of sewerage and stormwater drainage systems.

Conceptually the Australian codes used to describe **conduit** condition bear some relationship to the codes used in EN 13508-2:2003 *Conditions of drain and sewer systems outside buildings Part 2: Visual inspection coding system.* However, the Australian codes have endeavoured to make as much use as possible of the codes previously established in the Australian Conduit Condition Evaluation Manual (ACCEM) - 1991. Consequently, the Australian codes generally define the same features and defects as their European equivalents, but the codes themselves are quite different.

Additional information is sometimes appropriate to enable monitoring of the deterioration of **conduit** and maintenance structures in the Australian environment and, as a result, the characterisation and quantification information in some Australian codes is more comprehensive.

The first edition of the Conduit Inspection Reporting Code of Australia was published in 2002 as the Sewer Inspection Reporting Code of Australia. Since the first edition was published there had been major technological advances in **conduit** inspection technology and equipment as well as decision-making software.

Defect scoring and condition grading guidance have been upgraded in this edition to provide a more realistic guide to the service and structural condition of **conduit** for a range of conduit types and defects. However, the reports generated using this Code and condition grades are only a guide for asset owners in determining priorities for repair, rehabilitation and/or continued monitoring of assets.

Acceptance Inspection Specification for newly constructed gravity sewers and stormwater **conduit** has been reintroduced as Appendix J in this edition.

Some codes have been reintroduced from the WSA 05-2008 edition with minor modifications. Some codes in the WSA 05-2013 edition have been removed while others have been modified to reduce ambiguity and simplify the process of inspecting and reporting.

It is expected that further enhancements of this Code may be needed from time to time to take account of on-going technological developments in inspection equipment and the introduction of and experience with new products for **conduit** systems.

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Adam Lovell

Executive Director, Water Services Association of Australia

PREFACE

CODE PURPOSE

This Code establishes a uniform standard coding system for recording and comparing defects and features observed as a result of inspection of conduits and maintenance structures predominantly associated with but not limited to

gravity sewers and stormwater drains. By defining codes to be used to describe the various observations, the Code establishes a system to ensure that every operator uses the same terms to objectively record defects and features and take measurements or make estimates where required. Asset managers reviewing a report will be able to assume the same meaning to each reported code, description and measurement.

The Code provides a framework for consistent communication between computer systems used to generate reports, analyse results and inform asset management and geographical information systems (GIS) databases.

This Code may be applied to all conduits, culverts, open drains, channels and canals and associated structures such as access **chamber**, maintenance holes, inlet and outlet structures, pits and traps where access is feasible. Any such application is at the user's own risk.

The Code prescribes minimum requirements for reporting and leaves it to the marketplace to develop technology to take advantage of data collecting, analysis, reporting and management procedures.

Although it is not appropriate for this Code to prescribe a software package, the experience of those undertaking inspections and producing reports has highlighted the need to have software that is efficient to use and will provide consistent and standardised results with the capacity for data to be easily communicated with asset management systems. To facilitate this, a specification for software is provided in APPENDIX A — SPECIFICATION FOR SOFTWARE.

SCOPE OF CODE

This Code details the condition assessment of new and existing conduit systems, principally, but not limited to, sewers, drains and culverts and their related maintenance structures, by internal inspection, status codification and consideration of external factors and other information.

It is applicable to conduit systems that operate under gravity. For example, in the case of sewerage systems, it applies to sewers and sanitary drains from the point of collection to the point of discharge to a treatment works or receiving water.

The Code specifies a coding system for the description of the internal features of conduits and maintenance structures identified through visual inspection. The asset owner may also allow it to be used for rising mains, pressure and vacuum conduit systems. The Code may also be used as a guide for inspection and reporting on electrical or telecommunications ducts and other conduits. However, in these circumstances the defect/feature codes may not be relevant and the scoring and grading will not be applicable.

The Code also references laser and sonar profiling, which may be specified to provide additional information on the condition of the conduit.

This Code does not specify contractual requirements for carrying out inspections. *Different parts of the Code should be used with consideration given to the intent of the proposed inspection*. Not all elements outlined in this Code need be applied unless otherwise specified by the asset owner.

MANDATORY AND INFORMATIVE

The Code provides a mixture of mandatory and informative statements.

The information and guidance (informative text) contained in the Code has been deliberately interspersed throughout the mandatory requirements to provide some context and enable better understanding of the mandatory requirements. Informative text has been *italicised* to enable clearer differentiation.

However, it is emphasised that the exact approach taken to all aspects of a particular condition assessment project is the decision of the asset owner and its asset managers. This Code provides technical information to aid in that process.

APPENDICES

Appendices to this Code can be accessed through the links provided throughout the text and as given below:

A SPECIFICATION FOR SOFTWARE

- B MATERIALS AND ACRONYMS
- C SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF THE APPARENT CONDITION OF OPERATIONAL SEWERS
- D SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF OPERATIONAL STORMWATER DRAINS
- E SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF MAINTENANCE STRUCTURES
- F CRACKING, BREAKING, DEFORMATION, CORROSION AND COLLAPSE OF RIGID, FLEXIBLE AND MASONRY CONDUITS
- G SUMMARY OF MAIN CODES FOR DESCRIBING CONDUIT CONDITION
- H SUMMARY OF MAIN CODES FOR DESCRIBING MAINTENANCE STRUCTURES
- I COMPENDIUM OF DEFECTS AND FEATURES
- J GUIDE FOR INTERNAL INSPECTION OF NEWLY CONSTRUCTED SEWERS OR STORMWATER CONDUITS AND CRITERIA FOR ACCEPTANCE
- K MANUAL CODING SHEETS

INDUSTRY TRAINING

To enable successful adoption of this Code it is essential that persons responsible for identifying and recording information from inspections, for preparing reports and operating equipment are suitably trained and hold appropriate qualifications required by the National Water Training Package 2015 or Water Industry Training Package NWP07 and other qualifications specified by the asset owner.

WSAA invites Registered Training Organisations, or qualified trainers in association with Registered Training Organisations, which can demonstrate appropriate expertise and experience, to enter into licence agreements to enable use of the Code and its contents for training purposes and cost-effective provision of the Code to course participants.

WSAA will make available the names and contact details of training organisations/ individuals that have entered into licensing agreements.

PROPOSED AMENDMENTS

WSAA Codes and their supporting documentation are living documents that reflect progress in science, technology and systems. To maintain their currency, all Codes are periodically reviewed, and new editions are published. Between editions, amendments may be issued.

It is important that Users assure themselves that they are using a current Code, which should include any amendments that may have been published since the Code was published.

Detailed information about Codes and their supporting documentation including amendments can be found by visiting the **WSAA Codeshop**.

WSAA welcomes suggestions for improvements and encourages Users to notify us immediately of any apparent inaccuracies or ambiguities. Users may use the feedback link on the side menu of this Code to submit comments or suggested improvements. Alternatively, you can also contact us via email at codes@wsaa.asn.au or write to the National Codes Manager, Suite 8.02, Level 8, 401 Docklands Drive, Docklands, 3008.

To increase the likelihood of suggested amendments being adopted, it is recommended that Users seek preliminary review by and support of a WSAA Member or other relevant organisation, for example, CSIRO, Civil Contractors Federation or PIPA for inclusion with the submission.

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PART 0: GLOSSARY, ABBREVIATIONS AND REFERENCES

Conduit Inspection Reporting Code of Australia Version 4.1

WSA 05-2020

GLOSSARY, ABBREVIATIONS AND REFERENCES

I GLOSSARY OF TERMS

For this Code, the following definitions shall apply. For additional definitions of stormwater assets not specifically mentioned in this Code, refer to the Local Government and Municipal Knowledge Base at http://lgam.wikidot.com/drainage.

In this Code, unless the context requires otherwise:

- (a) The singular means the plural (or vice versa); and
- (b) The masculine shall mean the feminine (or vice versa).

Definition
Component of a maintenance hole between the cover and frame and the shaft used to adjust the surface level of the maintenance hole cover
Damage has extended sufficiently for several pieces of large aggregate to have been removed and loss of conduit or maintenance structure fabric is leading to hole formation
Coarse aggregate is projecting from the concrete surface after the surrounding cement-sand matrix has been removed
Some coarse aggregate in the concrete is visible or exposed
Something that has potential or actual value to an organisation. For this Code, assets are conduits, culverts, maintenance structures, chambers, change points, inlets, outlets, pits, gullies, etc.
The Agency, Authority, Board, Company, Controlling Authority, Corporation, Council, Department, Individual, Regulator, Utility or other legal entity who is the owner of the asset and/or who has responsibility for the asset
Near horizontal surface adjacent to the channel in a maintenance hole
A bubble on the surface of an asset particularly an asset's gel coat or liner. A blister is smaller than a <u>bulge</u> and more likely to occur in a group.
The breaking of an asset into a few or many separate pieces where there is significant movement of some or all of the pieces resulting in measurable local or general distortion from the original conduit cross section. Pieces of asset may be missing or sections of the asset may have been displaced through shear action such that soil or a void is visible.
A broken asset where all the broken piece(s) are still present but one or more of them is significantly displaced from original position
The asset is broken as a result of an exceptional event, e.g. external trauma from trenchless installation of other utilities
A broken asset where one or more of the broken pieces is no longer present in the wall of the asset. It is probable that soil or a void is visible through the missing structure.
A liner which could be incorporated in the manufacture or construction of the asset or is installed to rehabilitate an asset has formed a significant convex bulge intruding into the conduit or structure. A bulge is larger than a blister and may occur in isolation.
Part of a maintenance structure providing working space above the channel and benching

Term	Definition	
chamber unit	Component part of a maintenance structure manufactured as a single entity and intended to be joined with other chamber units	
Coder/Assessor	The person identifying and coding features and defects observed during a conduit inspection. This process may occur during the inspection and be carried out by the Operator or it may be conducted by the Coder/Assessor from images recorded during the conduit inspection.	
collapse	A complete loss of structural integrity or continuity measured as a deformation or displacement resulting in a >25% reduction of a conduit's diameter or in the case of a maintenance structure >25% of the chamber unit or largest cross section element in the structure	
combined system	Sewer system designed to carry both sewage and surface water in the same conduit(s)	
conduit	A pipe or other closed passage for the conveyance of liquids	
conduit unit	Component part of a conduit manufactured as a single entity and intended to be joined with other conduit units	
conduit unit length	The length of a typically manufactured conduit unit used in the construction of a conduit	
connection	A feature where one conduit joins another previously constructed conduit or maintenance structure by making a hole in the original conduit or maintenance structure and setting the connecting conduit in place using materials and/or products to effect a leak-tight joint. In relation to maintenance structures, connection may refer to those constructed integrally with the maintenance structure.	
corrosion products	Corrosion products are the chemical compounds resulting from the breakdown of the fabric of the conduit or structure. These compounds occur on the surfaces of the asset and as the corrosion progresses the surface layer of corrosion products becomes thicker.	
cracking	An apparent discontinuity in the fabric of a conduit or structure where the pieces on either side of the crack may remain interlocked with negligible separation along the discontinuity or may be separated by a measurable gap or displacement, but with the individual pieces still in place and the cross section effectively retaining its original shape.	
	Crack separation may vary at different times depending on internal forces within the wall of the conduit and externally applied loads.	
	Open cracks were previously described as fractures.	
culvert	One or more adjacent pipes or enclosed channels for conveying surface water or a stream below formation level	
cured in place pipe	A lining technique that employs a resin impregnated felt tube of polyester, fibreglass or similar that is inserted in an existing conduit, then inflated and cured to form a "pipe within a pipe"	
deformation	The shape of the conduit or maintenance structure has changed significantly from its original shape. Deformation may be associated with the breaking of rigid conduits or maintenance structures (including masonry) or distortion of flexible conduits and structural liners due to external loads. The deformation description should not be applied to non-structural linings. The measure of deformation used in this Code is the maximum percentage reduction in the internal diameter regardless of the orientation of the deformation.	

Term	Definition	
delamination	Conduit and maintenance structures produced using fibres with a bonding agent of cement or resin may disintegrate in service for various reasons. In the case of asbestos cement pipes, the fibres of asbestos tend to hold a weak cement matrix together which can separate from the underlying layers in sheets or laminations. There may be several laminations removed before complete structural failure of the conduit occurs.	
deposits	Describes a range of substances or materials that enter a conduit and settle in the invert or adhere to the wall of the conduit above the water normal line	
encrustation	Encrustation is associated with mineral rich water seeping through joints and cracks and producing a crust of minerals on the surface of the conduit or maintenance structure. Typically, the encrustation will be apparent above the water line and may be a rusty iron colour or other characteristic colour of predominant mineral(s) in the surrounding soil.	
engaging agency	Any corporate body or individual who engages a contractor to undertake an inspection of a conduit or a maintenance structure, e.g. asset owner, construction manager, other party	
exfiltration	Unintended escape of flow from an asset into the surrounding ground through a defect or defective joint	
feature	An all-encompassing term to include defects, descriptions, types, artefacts, condition and the like observed during an inspection	
finished surface level	Ground level at the completion of construction and landscaping	
gate slot	An arrangement whereby a slot is formed into the channel at the maintenance structure to allow a gate or stop logs to be installed temporarily to permit blockage of flow so as to maximise system storage capacity or divert flows should the need arise e.g. due to downstream maintenance	
grade	Ratio between the vertical and the horizontal projections of a conduit length; commonly expressed as a percentage. Also known as gradient and slope.	
gravity system	A system where flow is caused by the force of gravity and where the conduit is designed normally to operate partially full	
groundwater	Water present in the sub#surface strata	
high definition video	Any digital video with a resolution greater than that of PAL TV (720 x 576 pixels). No standard aspect ratio or pixel count is specified, however standard formats include 1280x720 (HD/720p), 1920x108 (Full HD/1080i/1080p) and 3840x2160 (4K).	
hole	The description 'hole' in this code is applied to extensive surface damage that has resulted in the complete loss of fabric such that soi or a void is visible through the opening. The hole may extend over a significant portion of the conduit or structure.	
infiltration	Unintended ingress of groundwater into a buried asset through defects	
inflow	Unintended ingress of surface water and unauthorised discharges (e.g. roof water) into a surface feature of a buried asset	
ingress of soil	Soil or embedment material is observed to be entering the conduit or structure at a defect joint, connection or other entry point.	

Term	Definition	
	The characteristics of the soil entering may be helpful for asset managers in determining the level of risk.	
inspection	The internal visual examination of a conduit or maintenance structure using remotely controlled camera units or by person entry often supplemented with sonar, laser scanning and/or other technologies.	
inspection abandoned (survey abandoned)	The inspection has been terminated before the destination node or location was reached	
inspection length	The length of conduit or maintenance structure continuously inspected, measured from the nominated reference point	
inspection opening, IO	A manufactured (moulded or fabricated) fitting, generally buried and with a capped or plugged opening located at the 12 o'clock position provided on sanitary drains and some reticulation sewers (sometimes a feature of a junction fitting), for visual inspection and testing and/or clearing of obstructions	
inspection shaft, IS	A structure, usually on a sewer, constructed using a manufactured (moulded or fabricated) fitting (e.g. square junction) in the line with a vertical riser (conduit), usually DN 150, extending to the surface, where it can be accessed via a removable cover for visual examination. This feature includes a variety of previously installed structures such as lamp holes which are generally located midway between maintenance holes and/or at minor changes to direction.	
intruding connection	A connecting conduit is not flush with the wall and is projecting into the conduit or structure being inspected	
invert	Lowest point of the internal surface of the barrel of a conduit or channel at any cross section	
joint	The feature at the ends of a conduit unit or maintenance structure component segments that enables the pieces to be joined with a sealing media. The interface between successive concrete pours may also be referred to as joints.	
joint displacement	Adjacent conduit segments or pipes are displaced exceptionally from their intended position relative to each other. The displacements may be angular, longitudinal or radial.	
junction	A junction is a manufactured (moulded or fabricated) fitting provider to enable flow from a minor conduit (usually a property connection) to enter the main conduit	
lamphole	A feature similar to an inspection shaft but designated a lamphole become agencies	
landing	Intermediate rest platform used to limit the height of a run of rungs or steps in a maintenance structure	
lifting hole	A hole formed in the manufacture of a conduit unit or precast maintenance structure unit (or bashed through the wall of the unit after manufacture) to facilitate lifting using a sling and bar	
lining defective	The lining of a conduit or maintenance structure is defective in some way. This applies to defects in linings that have been incorporated in the manufacture or construction of the asset as well as lining installed as part of rehabilitation	
maintenance chamber, MC	Structure with a moulded and channelled base with up to three inlets #DN 225 (inlets at the base only), a shaft of nominal shaft size DN 450 – DN 600 and a removable cover constructed on a conduit that allows limited change of grade and/or direction and provides access	

Term	Definition
	to the conduit for inspection and most maintenance equipment, but which does not permit entry of a person
maintenance hole, MH	Structure with a channelled base with multiple inlets at base and above (drop inlets), a shaft of nominal shaft size DN 1050 – DN 1500 with a removable cover #600 mm clear opening constructed on a conduit that allows limited change of grade and/or direction and provides person and equipment access to a (typically buried) conduit; abbreviation MH retains the abbreviation for the traditional term "Manhole". See Figure I for illustration of typical MH features.
maintenance shaft, MS	Structure with a moulded and channelled or spherical base with up to three inlets #DN 225 (inlets at the base only), a shaft of nominal shaft size DN 225 – DN 300 and a removable cover constructed on a conduit that allows limited change of grade and/or direction and provides access to the conduit for inspection and some maintenance equipment but does not permit entry of a person. MSs are not permitted on sewers >DN 225 where only MHs are used. An MS at the end of a reticulation sewer is known as a terminal maintenance shaft, TMS.
maintenance structure	Any structure with a removable cover constructed on a conduit that provides access for personnel, equipment and inspection (person-entry) or only for equipment and inspection (non-person-entry). The term maintenance structure includes maintenance hole, maintenance chamber, maintenance shaft, terminal maintenance shaft, inspection shafts,inspection opening and any other structure providing access. Also known as access structure and manhole.
masonry	The building of structures from individual masonry units such as stones, bricks, concrete blocks and the like, laid in and bound together by mortar. The term includes stonework, brickwork and block work.
node	A point of reference used to identify sections of the asset. For ease of identification a maintenance hole, maintenance shaft or other significant intermediate or terminal point may be used as a node. Other nodes include inspection shafts , major connection without a maintenance structure (typically on ovoid sewers), outfalls and inlet fittings.
obstruction	An object or objects in the conduit or maintenance structure that are creating an obstruction to water flow or access
offset maintenance hole (structure)	In some circumstances the location of the maintenance hole requires the access opening to be offset from the main structure and a tunnel connects the entrance chamber to the main chamber over the conduit. An example of such a situation is a tramway directly over the maintenance hole which would prohibit direct access and thereby requiring the offset configuration described.
operator	The person controlling the inspection and making recordings required by this Code. This person may also make the observations, or this could be done by the Coder/Assessor.
outfall	Final length of conduit from which sewage or stormwater is discharged from a treatment works or stormwater discharged to receiving water
ovality	Ovality is a term sometimes used to describe deformation in circular conduits. It is defined as ovality (%) = ((diameter max – diameter min) / diameter actual undeformed) x 100. All diameters are internal.
peak dry weather flow	The most likely peak sanitary flow in the sewer during a normal day. It exhibits a regular pattern of usage with morning and evening

Term	Definition		
	peaks related to water usage for toilets, showers, baths, washing and other household activities.		
pressure main	A conduit through which sewage or stormwater is pumped generally rising from the pumping station to the point of discharge into the receiving sewer or drain. Also known as rising main or force main.		
property connection fitting	Most upstream fitting of a property connection sewer; the upstream end of the fitting is the connection point		
property connection sewer	A short sewer, owned and operated by the Water Agency, which connects the main sewer and the customer sanitary drain; it includes a junction on the main sewer, a property connection fitting, in some cases a vertical riser, and sufficient straight pipes to ensure the property connection fitting is within the lot to be serviced. Also known as side lines or branch sewer.		
receiving water	A body of water receiving the discharge from the end of an outfall conduit		
rehabilitation	The improvement or restoration of an asset by any means, trenchless or otherwise, which incorporates the fabric of that asset and is aimed at enhancing its performance and extending its life		
renovation	The restoration of an asset		
repair	Rectification of local damage or defect		
roots-beard	An arc of interwoven mass roots that remains along the line of root penetration, generally at a joint or defect, after root cutting within the conduit		
segmental lining	A lining system used in larger diameter conduits consisting of discrete conduit segments that when joined together circumferentially form the new internal surface of the conduit. These components are joined to the previously assembled components. The longitudinal joints between the segments are usually staggered in relation to the adjoining lining. The gap behind the assembled segments is grouted. Segments may be formed of concrete, GRP or PVC. Some PVC products are clear.		
sewage	Polluted water conveyed by a sewer to a treatment works or other point of disposal		
sewer	Conduit or other construction, usually underground, designed to carry sewage usually from more than one source		
sewerage	Network of sewers and ancillary works that conveys sewage to a treatment works or other place of disposal		
shaft	Upper part of a maintenance structure between the <u>adjusting</u> <u>construction</u> and the <i>chamber</i> and usually of a smaller diameter		
shear displacement	Radical shift of adjacent sections of an asset either at a joint or a plane of shear failure intersecting the asset. Often observed at maintenance holes and chambers where the short sections of pipes have been omitted.		
sliplining	The lining of a conduit with another conduit which is pushed or pulled through the host conduit. The outside diameter of the sliplining conduit is smaller than the inside diameter of the host conduit. The gap between the two conduits will usually be grouted. Sliplining may be achieved by assembling a continuous pipe on the surface and pulling it through the host conduit or by pushing discrete conduit lining units through the host conduit where they are joined inside the host pipe.		

Term	Definition	
soffit	The inside top of a conduit. Also known as obvert.	
spalling	Significant removal of the conduit material in discrete fragments from the surface triggered by physical and/or chemical processes. The material removed is considerably larger than individual grains of material removed by erosion/abrasion. The loss of conduit fabric from spalling does not extend through the full thickness of the conduit wall.	
staging bars	Two or more parallel bars attached to the walls of the shaft in structures with an external drop structure to allow for a temporary landing board to be placed across them to assist the operator in rodding or jetting the drop structure and/or incoming conduit	
subsoil drain	A buried conduit for the collection and conveyance of groundwater	
surface water	Water from rainfall or other source is discharged to the stormwater drainage or sewerage system directly from the ground or from exterior building surfaces via a range of appurtenances or defects	
survey	Another and traditional term used to describe inspections	
taper, straight back taper, squat cone	Part of maintenance hole or maintenance shaft that provides a transition from a smaller to a larger diameter	
terminal maintenance shaft, TMS	A structure at the end of a reticulation sewer to allow insertion into the sewer of equipment for inspection and maintenance	
T-seal or top hat liner	Repair systems used to seal laterals at connections or junctions	
tuberculation	Nodules of corrosion products (rust) formed on the inside of cast iron or other ferrous pipes that progressively reduce the internal cross section as corrosion continues	
video clip	A video capture of inspection of a specific feature or defect that is less than 30 seconds in duration. Particularly useful for defects or features that are associated with movement.	
Water Agency	An authority, board, business, corporation, council, local government body with the responsibility for planning or defining planning requirements, for defining and authorising design requirements, for defining and authorising construction requirements and for operating and maintaining or defining operation and maintenance requirements for a water supply and/or sewer system or systems	

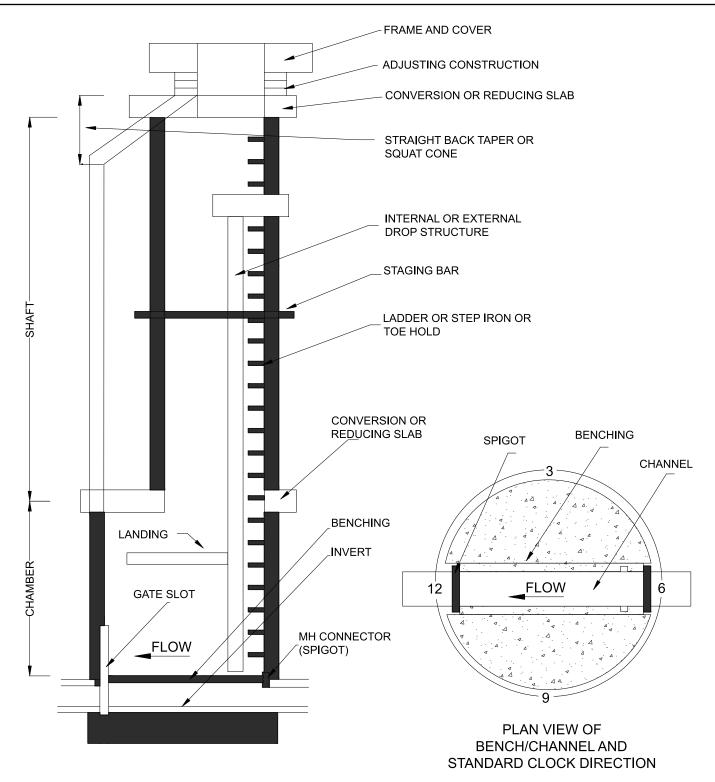


FIGURE I ILLUSTRATION OF TYPICAL MH FEATURES

Notes

The configuration of maintenance holes varies considerably. This figure provides a general illustration of typical features only.

II ABBREVIATIONS

ABBREVIATION	INTERPRETATON	
ACCEM	Australian Conduit Condition Evaluation Manual	
ВМР	bitmap picture	
ССТУ	closed circuit television	
DN	prefix for nominal diameter in mm of pipe or maintenance structure - (for most pipes this is the internal diameter to nearest 5 mm but for plain wall polyethylene it is the outside diameter)	
DVD	digital versatile disc	
FIS	facility information system	
FSL	finished surface level	
GIS	geographical information system	
GPS	Global Positioning System	
h	hour	
HD	high definition	
Hz	Hertz	
Ю	inspection opening	
IPF	interchangeable preservation format	
IPWEA	Institute of Public Works Engineering Australia	
IS	inspection shaft	
JPEG	joint photographic experts group	
kHz	kiloHertz	
m	metre	
MC	maintenance chamber	
MH	maintenance hole	
MS	maintenance shaft	
mm	millimetre	
MJPEG	motion joint photographic experts group	
MPEG	motion picture experts group	
m/s	metres per second	
PAL	phase alternate line	
ppm	parts per million	
ROV	remotely operated vehicle	
RTO	Registered Training Organisation	

ABBREVIATION	INTERPRETATION	
TMS	terminal maintenance shaft	
TV	television	
USB	universal serial bus	
WSAA	Water Services Association of Australia	
0	degree	
%	percentage	

Refer to <u>Table B.1</u> in <u>APPENDIX B — MATERIALS AND ACRONYMS</u> for pipe material acronyms.

III REFERENCED DOCUMENTS

The following documents are referred to in this Code:

STANDARD		TITLE	CLAUSE / TABLE
AS—downloadable from https://www.saiglobal.com/search-publications/			
3996	Metal access covers, road grates and frames		3.6.4
EN—downloadable from https://www.saiglobal.com/search-publications/			
13508	Conditions of drain and sewer systems outside buildings		Foreword, Preface, 2.6.1 2.6.3, 2.7.1, 3.1, 3.7.4, 3.8.4.4, 3.8.7.3
13508-2	Part 2: Visual inspection coding system		Foreword
IEC downloadable from https://www.saiglobal.com/search-publications/			
60079-0	Ed 6.0 Explosive atmospheres – Part 0: Equipment – General requirements		1.3
ISO—downloadable from https://www.saiglobal.com/search-publications/			
8601	Data elements and interchange formats—Information interchange— Representation of dates and times		2.5.4.9, 2.6.3, 3.5.3.8, 3.6.3
WSAA—may be ordered from http://www.wsaa.asn.au			
02	Gravity Sewerage Code of Austral	ia	Foreword, 2.5.4.2



PART 1: REQUIREMENTS FOR THE CONDUCT OF INSPECTIONS

Conduit Inspection Reporting Code of Australia Version 4.1

WSA 05-2020

PART 1

1 REQUIREMENTS FOR THE CONDUCT OF INSPECTIONS

1.1 GENERAL

This Code does not attempt to set out contract documents that define the contractual relationship between <u>asset owner</u> and <u>operator</u> or the process requirements for inspections. However, it does set out requirements in this Section suitable for inclusion or reference in the technical specification of a contract.

The <u>asset owner</u> should provide a technical specification to be read with the requirements set out in this Code. The technical specification should set out the scope, specific technical requirements and acceptance criteria specific to the asset owner.

This Code does not preclude the use of any imaging processes that deliver results proven to be satisfactory and that are acceptable to the <u>asset owner</u>. However, any inspection, video or image data needs to be in the format specified to ensure that it will integrate with the asset owner's systems as required.

Agreement should be reached on the video record format before commencing inspection (Refer to 1.14.3 Video record). Where not specified, all video records shall be produced in mpeg1 / mp4 format and be supplied in digital format complete with associated inspection data.

1.2 REFERENCE DOCUMENTS TO BE AVAILABLE

The <u>operator/Coder/Assessor</u> shall have available for reference, during the inspection and/or coding, the following documents:

- (a) A copy of this Code;
- (b) A copy of any specifications/instructions issued in relation to the inspection by the asset owner;
- (c) Asset information in printed and/or digital format; and
- (d) A copy of the Statement of Attainment of the <u>operator/Coder/Assessor</u> shall be kept on site (e.g. in vehicle or on person) and be available as requested by the **asset owner**, project manager, etc.

1.3 TRAINING AND ACCREDITATION OF PERSONNEL

1.3.1 OPERATORS

Persons responsible for identifying and recording defects, service conditions and construction features, for preparing reports and operating equipment shall hold a suitable qualification issued by a Registered Training Organisation (RTO).

A suitable qualification shall be:

- (a) A Certificate III in Water Industry Operations including Unit NWPNET037—Inspect sewer or stormwater assets from the National Water Training Package 2019 or <a href="https://www.nwpnetcommons.org/nwpnetcommo
- (b) A Statement of Attainment in Unit NWPNET037—Inspect sewer or stormwater assets from the National Water Training Package 2019 or NWPNET016—Inspect sewer or stormwater line from the National Water Training Package 2015 (or Unit NWP031B—Inspect conduit and report on condition and features from NWP07) plus any additional training/qualifications required by the asset owner and State or National Regulations; or
- (c) An alternative recognised qualification that has incorporated the encoding and other requirements of this Code.

All work carried out within <u>conduit</u>, maintenance structures or other confined spaces shall be performed under the <u>Model Code of Practice – Confined Spaces</u> and Occupational Health and Safety Act and Regulations applicable to the State or Territory concerned, as well as any additional precautions that may be specified by the asset owner.

The asset owner or system operator may also institute a system of accreditation that requires CCTV operators to have additional training/certification to undertake work on their assets. This may include (but is not limited to) workplace induction, confined space entry, traffic control implementation and other applicable credentials as well as the qualifications identified in (a), (b) and (c) above.

Further measures may require that operators/contractors can provide evidence that they meet the specific requirements in terms of qualifications, equipment, insurance etc.

Operators undertaking a workplace-based component of training shall be supervised by appropriately qualified and accredited personnel.

1.3.2 ASSET MANAGERS, ASSESSORS/CODERS AND CONTRACT MANAGERS

Assessors, asset managers, supervisors, reviewers and contract managers responsible for using the data from **conduit** inspections, supervising inspectors/operators, reviewing/editing reports or managing CCTV inspection contracts conducted in line with this Code and/or other requirements as specified by the asset owner, shall be competent in:

- (a) interpreting information contained in the inspection reports;
- (b) identifying and coding of defects and other features;
- (c) applying a scoring/grading system;
- (d) recognising the structural deterioration features, and the likely parameters involved in the process, of pipes and other **conduit** for a variety of materials;
- (e) recognising service defects and the likely parameters contributing to the defects in sewers and stormwater systems;
- (f) recognising poor quality inspection videos and camera operation;
- (g) providing adequate information for CCTV operators to undertake safe and successful inspections; and
- (h) managing data from inspections.

The applicable qualification, from the National Water Training Package 2015/2019 or the Water Training Package NWP07, for asset managers, assessors/coders, supervisors, reviewers and contract managers is:

- (i) A Statement of Attainment in Unit <u>NWPNET017</u>—Supervise and report on conduit inspections from National Water Training Package 2019/2015 (or Unit <u>NWP440A</u>—Supervise conduit inspection and reporting from NWP07); and
- (ii) Verification that the qualification has incorporated the encoding and other requirements of this Code.

1.3.3 REFRESHER TRAINING

Refresher training and assessment is recommended at least every three years for operators to ensure coding accuracy and camera operation is maintained in accordance with this Code.

In addition, refresher training is required when an asset owner and the operator/contractor have not previously used this version of the Code for reporting on the condition of assets.

Similarly, refresher training for supervisors, managers and <u>Assessor</u> using this Code for the first time is applicable.

1.4 PLANNING THE INSPECTION

Before commissioning an inspection, the asset owner should consider the desirability of providing the operator with all information available regarding the asset. In general, the provision of more comprehensive information to the operator will enable a better interpretation of the observations. Moreover, extra details can then be permanently included within the operator's report enabling better comprehension and judgement by all those who might subsequently review the information. Those extra details should include:

(a) A scalable plan/map of the asset showing, the asset, maintenance structures and their node numbers, property boundaries, street names, the location of junctions or other features of the asset such as flow direction;

- (b) The locality;
- (c) The size, material and class of conduits;
- (d) Date of construction:
- (e) Depths of maintenance holes and/or surface and invert levels;
- (f) Coordinates of maintenance holes or other nodes;
- (g) System (catchment) name or descriptor, and
- (h) A technical specification that sets out the scope, specific technical requirements and acceptance criteria specific to the asset owner.

Ideally this information should be provided on a suitable form of digital media allowing the operator full access to asset information and permitting a plan to be imported for inclusion in reports.

In addition, the asset owner should ensure that the operator is aware of the operational requirements for the asset such as:

- (i) Critical flow patterns that could affect the value or safety of an inspection;
- (ii) Pumped discharges affecting the area to be inspected;
- (iii) Asset isolation/flow control procedures;
- (iv) Emergency procedures;
- (v) All relevant Occupational Health and Safety information; and
- (vi) All relevant environmental information in relation to wetlands, vegetation, fauna etc.

Where it has been determined by hazard survey and risk analysis that there is a likelihood of explosive atmospheres in the conduit to be inspected, measures should be taken to eliminate the risk. Methods like the use of EX rated equipment or removal of the risk by site-specific means such as forced air ventilation of the conduit should be considered before items that are not explosion rated are placed into the conduits or structures that may contain such hazards. Persons assessing the fitness-for-purpose of hazardous areas explosion-protected equipment should at least hold a Statement of Attainment in Unit UEENEEM068A—Assess the fitness-for-purpose of hazardous areas explosion-protected equipment – gas atmospheres. It is both the supervisor's and operator's responsibility to assess and control such hazards before commencement of and during work.

For further information on electrical equipment in hazardous areas refer to http://en.wikipedia.org/wiki/Electrical equipment in hazardous areas and IEC 60079-0 Ed. 6.0 Explosive atmospheres – Part 0: Equipment – General requirements.

1.5 PREPARATION OF CONDUITS AND MAINTENANCE STRUCTURES

The asset owner may require the operator to clean the **conduit** and/or maintenance structures prior to inspection or may make other arrangements as necessary to ensure that all features of interest may be properly observed. The extent of cleaning required will depend on the purpose of the inspection.

While most inspections are carried out as part of a condition assessment program to provide information on the structural condition and/or serviceability of the **conduit** and/or maintenance structures, this does not mean that pre-cleaning should be done as a matter of course.

Thoroughly cleaned surfaces normally yield the most detailed inspection results for structural assessment. On the other hand, investigations of operating performance such as sediment or fat build-up and the sources of undesirable discharges may be more effective if carried out on an uncleaned **conduit** and/or maintenance structures.

Inspection for tree roots will often provide the maximum relevant information if the **conduit** and/or maintenance structures are jetted clean but the roots are not pre-cut. Alternatively, if the inspection follows immediately after root cutting, an experienced operator can properly interpret the residual root pieces.

The asset owner may specify additional preparations to be undertaken by the operator depending on the type of inspection work being undertaken.

1.6 CAMERA AND SCANNER

1.6.1 GENERAL (CONDUIT)

Inspection of sewer and stormwater **conduit** is usually undertaken with a CCTV camera mounted on a remotely controlled transport platform (referred to as tractor or crawler) with a light source suitable for the camera characteristics, the conduit size and material. Most cameras now have a pan and tilt function to enable inspection of all parts of the conduit. Power supply, control of the transport platform, camera operation and image transmission is facilitated by a cable connected to computer hardware. Software allows control of camera movement and logging of observations.

To inspect <u>conduit</u> that are too steep for a tractor camera to traverse, skid-mounted cameras, which are pulled through the sewer by winch, may be used. CCTV cameras may also be attached to a 'raft' and floated through a conduit where water levels prohibit successful use of a tractor transport system. Some of these systems are purpose built with 'on board' battery storage for lighting systems and with supplementary devices allowing for sonar scanning of the conduit below the water line and laser scanning above.

3D optical scanners have a similar transport system to the CCTV camera above but the capture of images does not require direct control by an operator. The scanner travels at a constant speed and captures a complete record of the interior of the **conduit**. With associated software an inspector can conduct a virtual inspection of the conduit using mouse control to move through the conduit and examine features and defects. An unfolded view is usually available to assist with interpretation.

Push rod cameras may be used to inspect smaller pipes, mostly used in sanitary and stormwater drainage and plumbing systems in domestic and commercial properties. These camera systems can be pushed through tight bends such as gullies. The configuration of some push rod systems is limited to straight view camera heads although newer systems generally have pan and tilt capability.

Fixed zoom cameras, positioned in a maintenance structure, may be used to inspect <u>conduit</u> to identify obvious structural or operational issues. These cameras are not suitable for comprehensive condition assessment and care should be taken to work within the limitations of the technology.

In large <u>conduit</u> person entry is possible. A hand-held video or still camera can be used to capture images of features and defects but lighting, distance measurement recording of observations are problematic. **Person entry to conduits** is a high-risk option and is not recommended except in unusual circumstances and then with full risk controls being implemented.

Unless otherwise specified by the asset owner, a CCTV camera or a 3D optical pipeline scanner shall be used to inspect the **conduit**.

1.6.2 GENERAL (MAINTENANCE STRUCTURE)

Inspection of maintenance structures may be conducted by various techniques that will provide varying levels of detail and measurement. The asset owner should determine which technique is applicable to their requirements and provide an appropriate specification. Techniques include:

- (a) Inspection from the surface and photography using conventional hand-held digital cameras and measurement with simple tape or laser measuring devices. This method of inspection will be adequate for many shallow maintenance holes and could be easily undertaken in association with the inspection of the associated <u>conduit</u>. If the inspection does not include the connecting conduits, this method will provide limited information in relation to the connecting conduits.
- (b) Person entry to maintenance structure with a hand-held camera and measuring devices to record distances to features/defects and dimensions of significant aspects of the structure. Person entry may be necessary in some situations but is generally not an option because of the confined space risks along with the significant costs to comply with the risk controls. In addition, the nature of access to most structures makes comprehensive examination of the structure difficult. Person entry will be required in offset access maintenance structures possibly with the option of using other technologies in the main chamber. Connecting conduit can usually be inspected, measured and recorded in person entry.
- (c) Inspection with a zoom camera system. These systems are intended to inspect conduit up to 200 m from a pit but can be used in conjunction with a tripod and control system to lower and rotate the camera to fully inspect

the maintenance structure. Recording of depth to observations is done manually and measurements of the features can only be estimated. A video record of the inspection along with still photographs can be captured with available software and observations may be recorded on-site. Inspection depths will be limited by the hardware. A downward view is not possible with this system.

- (d) Inspection with modified pan and tilt CCTV camera head from a conduit inspection system, set for horizontal viewing with downward view achieved by tilt mechanism. This also requires a tripod and control system to lower the camera to fully inspect the maintenance structure. Depth recording will be automatic as it uses the measuring wheel attached to the cable reel. A video record of the inspection along with still photographs can be captured with available software. Measurement/estimation of dimensions may be assisted with laser markers depending on the camera head used. Inspection depths will be limited by the hardware.
- (e) Inspections with standard pan and tilt CCTV conduit inspection camera system suspended and lowered with a winch cable. Depth recording will be automatic as it uses the measuring wheel attached to the cable reel. A video record of the inspection, along with still photographs, can be captured with available software. Measurement/ estimation of dimensions may be assisted with laser markers depending on the camera head used. Inspection depths are limited only by camera and winch cable which will generally exceed 100 m. Complete inspection is achieved with a downward viewing position and pan and tilt capability to view the walls and other features of the maintenance structure. Cameras suspended in this manner are prone to swinging movement and some rotation.
- (f) 3D optical scanning captures a complete record of the interior of the maintenance structure. A virtual inspection can be undertaken using a computer and mouse control to move through the structure and examine features using pan and tilt function. An unfolded view is usually available to assist with interpretation. Depth to features/defects is automatically recorded and some measurement capability is possible. The camera is suspended and is suitable for structures over 100 m in depth. Vehicle access to the maintenance structure is usually required with this system.
- (g) Inspection with a combined optical scanner and laser profiler provides visual and accurate spatial information on the maintenance structure. Specialist software allows investigation and reporting of the asset's condition off-site. One available system is portable and has a maximum inspection depth of 8 m.
- (h) Laser scanning, independent of visual inspection, can complement the information gained in visual inspection and allow for accurate reporting of quantifications, such as loss of fabric, deformation and connecting conduit size, that would otherwise not be possible. Various technologies are available with different capabilities and asset owners should ensure that the technology is applicable for the maintenance structure being inspected.

1.6.3 CAPABILITY

Cameras and scanners shall be capable of inspecting **conduit** or maintenance structures as nominated by the asset owner (Refer to **1.4 PLANNING THE INSPECTION**).

Where not specified, CCTV systems shall operate on the PAL standard with minimum resolution of 720 x 576 pixels for all points of the inspection. *High definition CCTV systems may also be used.*

3D optical scanners shall provide 100% maintenance structure wall or **conduit** internal surface coverage. Images from the scanner shall be processed to allow virtual inspection of the structure with a full pan and tilt function. The individual scanner images shall have a resolution of at least 1040 x 1040 pixels.

All camera/scanner systems shall enable full viewing of connecting **conduit** in maintenance structures.

Similarly, cameras and scanners shall be capable of viewing the full lateral at junctions and connections while traversing downstream. That is, pan and tilt cameras shall be capable of 360⁰ rotation and tilt up to 135⁰ from the axis. *Pan and tilt camera systems should have zoom capability.*

Steerable cameras or scanners should be used for inspections of largeconduit, culverts and conduits constructed with horizontal curves.

Camera, scanner, control hardware and/or software shall enable the operator to provide:

- (a) A continuous video or digital record of the entire inspection to its conclusion or until the inspection is terminated;
- (b) Still images of defects and features of interest as detailed elsewhere in this Code; and
- (c) A record of all defects and features required to be reported by this Code.

Separate video clips of features of particular interest may also be included.

The format of such deliverables is set out in 1.14 INSPECTION REPORT.

1.6.4 IMAGE QUALITY

Cameras and scanners shall have suitable illumination and shall be capable of providing an accurate and clear record of internal condition of **conduit** or maintenance structures as appropriate.

Measures should be employed to ensure the quality of images, such as:

- (a) Keep the camera's external lens clean;
- (b) Prevent scratching of the external lens by protection during handling and transport and cleaning with suitable materials;
- (c) Keep lights clean and replace any failed units;
- (d) Use the correct lighting for the **conduit** or maintenance structure;
- (e) Keep connections clean;
- (f) Replace seals on connections when signs of damage or wear are apparent;
- (g) Re-terminate the cable when the images show signs of broken or damaged conductors; and
- (h) Recalibrate scanner to ensure picture quality, as required.

The camera or scanner shall be tested at least annually by the manufacturer's accredited agent, and, after any necessary repairs or modifications to verify that the camera's operational parameters are in accordance with the manufacturer's specifications. The agent shall certify that the camera meets the manufacturer's specifications in respect of:

- (i) auto iris operation;
- (ii) automatic and manual focus;
- (iii) zoom function;
- (iv) resolution in wide and zoomed position;
- (v) pan and tilt function;
- (vi) linearity or distortion;
- (vii) video or digital signal; and
- (viii) calibration of front and rear lenses in 3D scanner camera.

The testing of parameters shall be undertaken with respect to the range of *conduit* or maintenance structure sizes and materials for which the camera/scanner is designed.

Poor quality images may result in the inspection report, incorporating photographs and video record, being rejected by the engaging agency.

1.7 CAMERA AND SCANNER OPERATION

1.7.1 POSITION (CONDUIT)

The camera or scanner shall be positioned to reduce the risk of picture distortion. In circular or regular shaped conduits and maintenance structures the camera or scanner lens shall be maintained centrally $\pm 10\%$ of the diameter or vertical and horizontal dimensions and, in oviform conduits, at the mid-point of the horizontal dimension $\pm 10\%$ and at a height two-thirds $\pm 10\%$ of the vertical dimension of the **conduit**.

The camera operator shall be able to demonstrate that the combination of wheel diameter, spacers and/or camera lifting mechanism will achieve the above criteria.

Where conditions require the camera or scanner to be floated, the camera position shall be maintained centrally between the side walls of the **conduit** within a tolerance of ±20%.

Whilst travelling, the camera or scanner shall view directly along the conduit axis.

At junctions and connections, the operator shall position the camera to obtain a clear view of the lateral. *Focusing and light adjustment may be necessary to identify defects in the lateral.* The operator shall then allow a minimum of 5 s lateral viewing time before resuming the inspection.

1.7.2 POSITION (MAINTENANCE STRUCTURE)

The camera or optical scanner shall be positioned to reduce the risk of picture distortion. *In circular or regular shaped maintenance structures, the camera or scanner lens should be maintained centrally*±20% of the diameter.

Whilst moving, it is preferable that the camera or scanner view vertically downwards.

For manually controlled cameras, the operator shall position the camera to obtain a clear view of any connecting conduits. Focusing and light adjustment may be necessary to identify defects in the connecting conduit. The operator shall then allow a minimum of 5 s lateral viewing time before resuming the inspection.

1.7.3 **SPEED**

Unless otherwise agreed in writing by the asset owner, the camera speed in conduit shall not exceed:

- (a) 0.1 m/s for conduit of less than 200 mm internal diameter and maintenance structures;
- (b) 0.15 m/s for conduit of internal diameter greater than 200 mm but not greater than 300 mm; and
- (c) 0.2 m/s for conduit of internal diameters exceeding 300 mm,

provided that the limits specified by the manufacturer are not exceeded. The speed limits for scanners and other technology shall be specified by the manufacturer.

For maintenance structures, the camera speed shall not exceed 0.2 m/s unless it can be demonstrated that a higher speed of inspection will not compromise the capture of clear images.

Notwithstanding the requirements above, the camera or scanner shall travel through the **conduit** or maintenance structure at a speed no greater than that which will permit the observer to anticipate arrival at all defects and features, as might vary according to the nature and state of cleanliness of the asset.

The camera shall not move and pan simultaneously. The camera shall be stopped at all defects and features where quantification is required and a 90⁰ tilt and a full 360⁰ rotation shall be executed to inspect the defect(s) and/or feature(s) thoroughly, to ensure all defects are examined and coded. The camera shall be returned to forward/downward facing direction (as appropriate) before proceeding with the inspection.

1.8 DISTANCE MEASUREMENT

The location of features/defects shall be measured from the nominated zero position and be recorded in metres to the nearest tenth of a metre.

The zero position for conduits is termed the Longitudinal Reference Point and shall be nominated by the asset owner or Specification and encoded in header detail, ABC (Refer to <u>2.5.4.5 Longitudinal location</u>). The zero position for maintenance structures is termed the Vertical Reference Point and shall be nominated by the asset owner or Specification and encoded in header detail, CBC (Refer to <u>3.5.4.6 Vertical location</u>).

Care shall be taken during set up and operation to ensure the accuracy of measurements, which may be used to supplement Work As Constructed information, determine repair locations or lining requirements and other asset management procedures.

The following practices are recommended:

- (a) Clean measuring wheel and cable regularly;
- (b) Confirm accuracy of measurement by comparing recorded distances with tape or known distances regularly and before critical inspections;

- (c) Maintain a taut cable from the measuring wheel to the camera or scanner; and
- (d) Determine the 'pre-set' distance at which the measuring wheel is activated at the start of the inspection for the system being used and apply this when starting inspections. (May not be necessary in maintenance structure inspections.)

Two techniques may be used by the operator to record the location of features/defects, viz:

- (i) 'Field of view', which is suitable for straight view cameras without pan and tilt where the distance recorded, is that location in the conduit closest in view in front of the camera. The distance to that location will vary with the diameter of the conduit and, in large diameters, will be a metre or more in front of the camera. Pre-set distances will vary with conduit size and camera angle of view characteristics, and should be taken into account if 'field of view' is used.
- (ii) 'Camera head' which is suitable for pan and tilt cameras or scanners where the distance recorded aligns with the camera head or, in the case of scanners a "virtual camera". This technique requires the operator to rotate the camera head to 90° to the camera axis at the defect/feature.

The technique for determining distance of defects and features for reporting shall be used consistently throughout the inspection.

In maintenance structures only the camera head distance shall be used to record the vertical location of features.

The length displayed shall be accurate to $\pm 0.25\%$ or ± 0.25 m, whichever is the greater, unless the asset owner specifies a different level of required accuracy.

The distance counter shall be sensitive to all camera travel, whether forward/backward or up/down.

1.9 DATA DISPLAY DURING VIDEO PLAYBACK OR DIGITAL IMAGE ANALYSIS

1.9.1 CONDUITS

1.9.1.1 TITLE FRAME DISPLAY

At the start of each **conduit** inspection, the following information shall be displayed for a period of not less than 20 seconds:

- (a) Node reference numbers, with start and finish nodes clearly identified;
- (b) Nominal <u>conduit</u> size and material. Where the conduit is lined, through rehabilitation or during manufacture, the original material or conduit structural material and a description of the lining shall be displayed e.g. 150 VC CIPP lined, 225 VC PVC spiral lined etc;
- (c) Road/street name and location/suburb/town;
- (d) The Longitudinal Reference Point used in the inspection;
- (e) Direction of inspection;
- (f) Date and time of start of inspection;
- (g) Use of conduit; and
- (h) Name of company undertaking the inspection and operator's name.

Notes

Some inspection technologies may not be able to display all of the above parameters. Where limited because of the inspection technology, this requirement may be modified by the engaging agency.

1.9.1.2 CONTINUOUS DISPLAY

The following data shall be continuously superimposed on the video or digital images of the inspection:

- (a) Node reference numbers with start and intended finish nodes clearly identified;
- (b) Nominal <u>conduit</u> size and material. Where the conduit is lined, through rehabilitation or during manufacture, the original material or conduit structural material and a description of the lining shall be displayed e.g. 150 VC CIPP lined, 225 VC PVC spiral lined etc;
- (c) The camera's or scanner's longitudinal position along the **conduit**, displayed in metres to one decimal place and automatically updated;
- (d) Direction of inspection; and
- (e) Date of inspection.

Notes

Some inspection technologies may not be able to display all of the above parameters. Where limited because of the inspection technology, this requirement may be modified by the engaging agency.

The size and position of the displayed data shall be such as not to interfere with the main subject of the image and the text shall be provided with a background contrast.

1.9.2 MAINTENANCE STRUCTURES

1.9.2.1 TITLE FRAME DISPLAY

At the start of each maintenance structure inspection, the following information shall be displayed for a period of not less than 20 seconds:

- (a) Node reference number;
- (b) Nominal size of the main <u>chamber</u> (usually the diameter at the base) and material. Where the maintenance structure is lined, through rehabilitation or during manufacture, the original material or the structural material of the maintenance structure and a description of the lining shall be displayed e.g. 1800 Concrete Epoxy Coated;
- (c) Vertical reference point;
- (d) Circumferential reference point;
- (e) Direction of inspection;
- (f) Time of start of inspection; and
- (g) Name of company undertaking the inspection and operator's name.

1.9.2.2 CONTINUOUS DISPLAY

The following data shall be continuously superimposed on the video or digital images of the inspection:

- (a) The camera's or scanner's position (for example, depth from access cover top surface) within the maintenance structure, displayed in metres to one decimal place and automatically updated;
- (b) Nominal size of the main <u>chamber</u> (usually the diameter at the base) and material. Where the maintenance structure is lined, through rehabilitation or during manufacture, the original material or the structural material of the maintenance structure and a description of the lining shall be displayed e.g. 1800 mm dia Concrete Epoxy Coated;
- (c) Node reference number;
- (d) Node type; and
- (e) Date of inspection.

Notes

Some inspection technologies may not be able to display all of the above parameters. Where limited because of the inspection technology, this requirement may be modified by the engaging agency.

The size and position of the displayed data shall be such as not to interfere with the main subject of the image and the text shall be provided with a background contrast.

1.10 LASER PROFILING OF CONDUITS

1.10.1 GENERAL

Currently there are two systems used for laser profiling of conduit:

- (a) Type 1 where a laser source is attached in front of a CCTV camera producing a ring of laser light on the conduit wall. The software is calibrated for the conduit size and the camera travels through the conduit with camera lights off and camera focused on the light ring. During travel the image is analysed with appropriate software, to determine a measure for deformation, loss of conduit fabric or other features of the conduit.
- (b) Type 2 uses a direct measurement using a laser signal, usually from a rotating laser, that continuously generates a point cloud of digital data as the laser travels through the **conduit**. A direct measure of the pipe size, shape, loss of fabric or other features are obtained. Software specific to the laser hardware provides a range of techniques and images to interpret the data.

To achieve a satisfactory outcome for the asset owner, the requirements given in Clauses 1.10.2 to 1.10.6 shall apply.

For operational **conduit** the laser hardware along with the interpretive software shall be sufficient to measure:

- (i) the deformation of the conduit to the nearest 1%; and
- (ii) the **conduit** dimensions in cross-section to the nearest 1% of the conduit diameter.

For acceptance inspections of flexible pipes the technology shall be sufficient to measure:

- (a) the deformation of the conduit to the nearest 0.1%; and
- (b) the conduit dimensions in cross-section to the nearest 0.1% of the conduit diameter.

These values are based on the accuracy requirements for flexible pipes list in <u>Table J.1</u> in <u>APPENDIX J — GUIDE FOR INTERNAL INSPECTION OF NEWLY CONSTRUCTED SEWERS OR STORMWATER CONDUITS AND CRITERIA FOR ACCEPTANCE</u>

1.10.2 CLEANING

To ensure accurate results, all <u>conduit</u> should be cleaned to remove all fat, deposits, encrustations and corrosion products before the laser profiling survey is carried out. Prior to cleaning any severely deteriorated conduits, the contractor, in consultation with the asset owner, should ensure that the cleaning activity will not further damage the conduit. If the conduit cannot be cleaned to a satisfactory level, the contractor shall seek authorisation from the asset owner before resuming the laser profiling survey.

1.10.3 WATER LEVELS

There are two principal reasons for performing a laser profile of a <u>conduit</u> and each approach requires different constraints on the water level in the conduit.

The water level, expressed as a percentage of the vertical diameter of the **conduit**, in the conduit during laser profiling for measuring ovality shall be below 5%. Flow control measures shall be applied, if the water level is 5% or more.

Laser profiling for **conduit** deterioration investigations, e.g. concrete corrosion, requires that the water level be below the point where the laser profiler is able to measure the original diameter of the pipe. The original diameter of the pipe can be measured if the water level is below the point at which the originally sized undamaged pipe wall can be observed for at least 10% of the nominal diameter. If this cannot be achieved, flow control measures should be applied.

Where loss of fabric, such as 'aggregate missing', has occurred in concrete conduit and has extended around the circumference of the conduit without an original surface visible, the 'reference calibration' of the laser profiler shall be

based on the best estimate of the original surface. For effective laser profiling of conduits exhibiting these conditions, the water level should be less than 5%.

1.10.4 CAMERA POSITION FOR TYPE 1 LASER PROFILING

At all times during the profiling survey the camera shall be located at the centre of the conduit.

For Type 1 laser profiling, the camera shall be focused on the projected laser ring. Any camera pan and tilt function shall not be used during profiling.

If the <u>conduit</u> was constructed prior to 1950 (possibility of cast in place concrete pipes with non-standard shapes and diameter) or the conduit has been relined, the contractor shall establish the correct diameter at an appropriate maintenance structure.

Care shall be taken to ensure that the observation point for the laser profiler relates distances to the longitudinal reference point.

Because of the configuration of maintenance structure channels and the laser hardware, it may not be possible for the laser profiling process to provide data on the full length between nodes. This missing data and its location should be noted in reports.

1.10.5 LASER SCANNER POSITION FOR TYPE 2 LASER PROFILING

For Type 2 laser profiling, the laser scanner shall be positioned centrally in the **conduit** in accordance with manufacturer's tolerances. Although a centred scanner position is desirable, the Type 2 laser profiling is less sensitive to positioning than Type 1 laser profiling and an off-centre position may be acceptable.

Care shall be taken to ensure that the observation point for the laser profiler relates distances to the longitudinal reference point.

1.10.6 SPEED LIMIT

The travel speed along the <u>conduit</u> for Type 1 laser profiling shall not exceed 0.1 m/s during profiling work, unless the contractor can demonstrate that, with a nominated speed exceeding 0.1 m/s, the distance between two laser frame measurements does not exceed 20 mm of conduit length.

For Type 2 laser profiling, the typical scanner will not be limited in function by speed of travel. Other practical factors such as tractor transport, cable feed, **conduit** condition and so on are likely to put an upper limit on travel speed.

1.10.7 LASER CALIBRATION

For Type 1 laser profiling a horizontal and vertical calibration of the laser ring shall be carried out for each **conduit** surveyed in accordance with the laser profiler manufacturer's specifications.

The accuracy of the diameter measurement depends on:

- (a) The vertical video image resolution;
- (b) The zoom factor of the lens; and
- (c) The inner pipe diameter.

The accuracy of measurement shall be demonstrated by means of an approved test device and a video or digital record of the calibration made and kept on record so that it may be supplied to the engaging agency on request.

Accuracy of measurements achieved during profiling may vary due to irregularities in the **conduit**, video image resolution, size of the conduit, camera type, laser scanning technology and other factors.

Type 2 laser profiling will provide accurate measurements to less than 1 mm for conduit diameters up to 10 m without calibration.

The contractor shall demonstrate to the engaging agency's satisfaction that the accuracy of profiling of the <u>conduit</u> in the project is suitable for the purpose of condition assessment or acceptance determination. Refer to <u>APPENDIX J — GUIDE FOR INTERNAL INSPECTION OF NEWLY CONSTRUCTED SEWERS OR STORMWATER CONDUITS AND CRITERIA FOR ACCEPTANCE</u> for acceptance requirements.

1.11 SONAR SURVEYING OF CONDUITS

1.11.1 GENERAL

CCTV or 3D optical pipeline scanner inspection cannot provide visual information on internal conduit conditions below the waterline.

Sonar technology can provide data on silt level, deposit accumulation, pipe deformation, displaced joints and other features below the waterline. There are two techniques that can be employed:

- (a) Imaging where visual images provide the viewer with enough data to draw conclusions about the environment being scanned. The operator will be able to recognise sizes, shapes and surface reflecting characteristics of the chosen target.
- (b) Profiling where quantitative data is obtained that enables pen plots of bottom profiles, <u>conduit</u> features, defects and obstructions to be produced.

In fully charged **conduit**, such as siphons, sonar profiling can provide the visual profile, profile comparison and dimensional data of significant items, defects and features. Some conduits that are not normally charged may be flooded for the purpose of a sonar survey but this technique would only be employed in special or unusual circumstances.

Sonar profiling of a fully or partially charged <u>conduit</u> provides a two- or three-dimensional profile of the interior conduit wall with defects and other features identifiable and measurable. Accurate measurements can be made between any two points within the sonar image enabling defects and features to be quantified. In partially charged conduits, the sonar profiling can be combined with CCTV or 3D optical pipeline scanner inspection to provide a simultaneous composite image of the conduit both above and below the waterline.

For fully charged/flooded <u>conduit</u> and for normal gravity conduits flowing less than full, sonar can be employed in conduits from 150 mm to greater than 5 m in diameter.

Sonar profilers can be skid, float, tractor or ROV mounted and rated for operation up to 1,000 m operational depth. Internal pitch and roll sensors display the orientation of the sonar in the pipe.

Sonar range capability will depend on the technology of the sonar and the presence of contaminants in water. As a guide, the sonar capability could be expected to measure distances to the **conduit** wall or hard surface accurately from 50 mm clear of the sonar transmitter and up to 6 m.

1.11.2 CLEANING

Depending on the purpose of the inspection, <u>conduit</u> may need to be cleaned to remove deposits, encrustations and corrosion products before the sonar profiling survey is conducted. However, it is more likely that sonar will be used to identify the presence of deposits, obstructions and defects under the water surface without cleaning.

Should cleaning of any severely deteriorated **conduit** be required prior to sonar profiling, the contractor, in consultation with the asset owner, should ensure that the cleaning activity will not further damage the conduit. If the conduit cannot be cleaned to a satisfactory level, the contractor shall seek authorisation from the asset owner before resuming the sonar survey.

1.11.3 WATER LEVELS

Sonar profiling may be carried out in a fully charged <u>conduit</u> or a partially full conduit. Before a survey is undertaken fully submerged, measures shall be undertaken to remove all air from the conduit as far as practicable. Before undertaking a survey of a partially full conduit, the water level should be controlled to suit the sonar profiling equipment requirements.

1.11.4 SONAR POSITION

At all times during the profiling survey the sonar shall be located below the waterline in accordance with the equipment supplier's recommendations.

Care shall be taken to ensure that the observation distance for the sonar images/data relates to the longitudinal reference point.

1.11.5 SPEED LIMIT

The travel speed along the *conduit* shall not exceed the equipment manufacturer's recommendation.

The travel speed along the *conduit* shall not exceed 0.2 m/s (1 image/s) during profiling, unless the contractor can demonstrate that, with a nominated speed exceeding 0.2 m/s, the conduit length per image does not exceed 200 mm.

The speed limit requirement is related to the needs of the asset owner to have adequate quality data to enable detailed condition assessment.

1.11.6 SONAR CALIBRATION

A horizontal and vertical calibration of the sonar profiler shall be carried out for each <u>conduit</u> surveyed conforming with the sonar profiler manufacturer's specifications. A video or digital record of the calibration shall be made and kept on record so that it may be supplied to the asset owner on request.

1.12 COMBINED LASER PROFILING AND SONAR PROFILING

Where it is not possible to reduce water levels to acceptable levels for laser profiling alone, a floating combined laser and sonar profiling system may be appropriate. Where such a system is employed the principles outlined in 1.10 LASER PROFILING OF CONDUITS and 1.11 SONAR SURVEYING OF CONDUITS shall be employed to achieve a satisfactory outcome.

The accuracy of the measurements obtained using this combined technology shall be demonstrated to the satisfaction of the asset owner such that the condition of the **conduit** can be adequately assessed.

1.13 MAXIMUM DEPTH OF FLOW

This requirement applies only to the inspection of existing **conduit** that convey flow of a liquid. It does not apply to newly constructed conduits before they are commissioned for service.

The inspection shall be carried out in low flow conditions to maximise the perimeter of **conduit** structure viewed. This requirement will generally require the inspection to be carried out in dry weather and at times of the day or night when flow in the conduit is low. Flow management measures such as pumping station control, plugging and/or bypassing may be required to achieve acceptable water levels in the conduit or maintenance structure channel.

Unless otherwise agreed to in writing by the asset owner, the maximum depth of flow in **conduit** shall not exceed that shown in **Table 1.1** at commencement of the conduit inspection.

Table 1.1 MAXIMUM DEPTH OF FLOW AT COMMENCEMENT OF INSPECTION

Conduit size or vertical dimension in mm	Maximum depth of flow % of conduit vertical dimension
<150	15
150 - 225	20
300 - 600	25
>600	30

When a temporary rise in depth of flow exceeds these values due to increased flow during inspection, the operator shall:

- (a) wait for the flow to reduce below the maximum depth before continuing; or
- (b) withdraw the camera or scanner from the **conduit** or maintenance structure and inspect the next asset on the program that meets maximum depth of flow requirements.

When inspecting <u>conduit</u>, the camera or scanner and their transport mechanisms shall be removed immediately if back-up of flow to a depth above the <u>benching</u> occurs in the upstream maintenance structure and the inspection reprogrammed for another time with flow management.

Where the depth of flow during inspection exceeds the values in <u>Table 1.1</u> due to blockage, ponding or any other localised feature the inspection may be continued.

This requirement shall be waived where flows cannot be controlled to achieve the maximum depths of flow in <u>Table 1.1</u>. Sonar profiling may be used to examine <u>conduit</u> conditions below the water line where flow levels are high.

1.14 INSPECTION REPORT

1.14.1 GENERAL

The inspection report shall consist of:

- (a) specific elements nominated in the technical specification;
- (b) a written or computerised report detailing the features and defects observed in the inspection which shall comply with 1.14.2 Compilation of the inspection report;
- (c) a video or digital record of the entire inspection complying with 1.14.3 Video record;
- (d) photographs of features of interest complying with 1.14.4 Photographs taken during inspection;
- (e) a preliminary grading of the structural and service condition of the asset (refer 1.15 PRELIMINARY GRADING OF INTERNAL CONDITION);
- (f) a supplementary report on defects identified in laterals in a format similar to that provided in Appendix L3; and
- (g) in addition, the report should also include brief video clips of features of interest complying with <u>1.14.5 Video</u> clips of specific features/defects.

The file format for inspection reports, video or digital records, photographs and video clips shall be agreed with the asset owner. Where not agreed, the following file format shall be adopted:

[AssetID]_[InspectionDate]InspectionTime]_[InspectionDirection]_[xxxxxxNumber].file type where:

xxxxxx = report, video, photograph etc.; and file type = pdf, mpeg (.mpg/ .mp4), ipf (IBAK Panaramo Scan), jpeg (.jpg) etc

1.14.2 COMPILATION OF THE INSPECTION REPORT

The inspector (operator or <u>Coder/Assessor</u>) shall provide a written report in hard copy and/or electronic format on the location and characteristics of defects and features of interest together with mandatory header fields that define the details of the asset and the inspection in accordance with the requirements of this Code. In addition, the report header shall incorporate those non-mandatory and user defined fields where specified by the asset owner or engaging agency.

This Code has been written on the assumption that to manage and collate the data collected all observations will be encoded directly into a computerised logging system. It is possible to encode onto a manual coding sheet in accordance with <u>APPENDIX K — MANUAL CODING SHEETS</u> and although there are occasions when manual coding may be useful, it is not recommended.

The report shall include all the mandatory details together with such other informative details as may be specified by the asset owner (Refer to <u>2.4.2 Mandatory information</u> and <u>2.4.3 Optional information</u> for conduits and <u>3.4.2 Mandatory information</u> and <u>3.4.3 Optional information</u> for maintenance structures).

The report shall be written, printed or take the form of computer data. These reports shall be consistent with coding and terminology outlined in this document.

Defects reported using the defective junction (JX) and defective connection (CX) codes may not affect the structural or service condition of the main conduit but can affect the service to the customer/s connected to that property connection sewer or branch drain. Scores associated with such defects are not applicable to the main conduit being inspected. To capture the data of defects in these connecting conduits a supplementary report shall be provided in a format similar to that shown in **APPENDIX K — MANUAL CODING SHEETS** (sheet K3).

The format for computer generated reports shall be in accordance with <u>APPENDIX A — SPECIFICATION FOR SOFTWARE</u>.

1.14.3 VIDEO RECORD

The video record shall include the entire inspection.

Unless already specified in the contract document for asset condition inspection, the contractor shall seek agreement from the asset owner on the form of the video record, which may include:

- (a) A DVD or USB solid state 'flash' drive or external hard drive containing digital video files encoded to MPEG1, MPEG2 or MP4 format: or
- (b) A PAL DVD video disc, separated into chapters for each inspection video record; or
- (c) A DVD or USB solid state 'flash' drive or external hard drive containing streaming still images in formats such as JPEG/MJPEG or IPF (IBAK Panoramo Film); or
- (d) Other media and/or in such other format as the asset owner may specify, including electronic transfer and cloud storage.

For compatibility with legacy systems, video shall be stored in mpeg format (i.e. MPEG1, MPEG2 or MP4), or a format that is readily transcoded to MPEG1, MPEG2 or MP4. If a format other than mpeg is used, the engaging agency should be consulted before job commencement.

Some corporate systems have storage and network capacity issues surrounding the use of High Definition video (such as 1080i/1080p or 4k). Should HD camera's be used, the resultant file formats and sizes should be discussed with the engaging agency.

1.14.4 PHOTOGRAPHS TAKEN DURING INSPECTION

Photographs shall be taken with the camera stationary and with the feature in focus. Photographs are required to record the:

- (a) general condition of the conduit or maintenance structure;
- (b) condition of the conduit or maintenance structure where it changes significantly during the inspection; and
- (c) general condition of each significant portion of the conduit or maintenance structure.

A photograph should be taken whenever an inspection is abandoned and every time one of the following defects or features is encountered:

- (i) collapse, deformed or broken conduits or maintenance structures.
- (ii) Multiple cracks.
- (iii) Continuous defects or features as specified by the asset owner;
- (iv) Significant erosion, corrosion or surface damage;
- (v) Defective junction or connection;
- (vi) Running or gushing infiltration;
- (vii) Defective steps, ladders, platforms, safety bars, chains, silt traps etc;
- (viii) Intrusion of an external object including connections;

- (ix) Obstructions such as debris, root mass >20% of cross sectional area etc;
- (x) Typical features of covers and frames;
- (xi) The maintenance structure cover showing details of lifting points; or
- (xii) The relative levels of the maintenance structure cover and the finished surface level of the surrounding area showing, where possible, an identifying landmark.

At least one image at an observation should be a 'straight ahead view' showing the defect or feature in the context of the conduit. Images from zoomed, tilted or panned camera are supplementary and should not be used alone. Still images captured with the lens in a zoomed position should be overwritten with 'ZOOMED' placed in a location that does not obscure the feature(s) of interest.

Where coding/reporting is not carried out during inspection, any zoomed images used in the report shall be noted in remarks.

Lighting, iris and focus should be adjusted to ensure a quality image. If the feature is not identifiable it may be useful to capture several images from different positions.

Digital photographs should be provided in a commonly used image format (such as JPEG, BMP or PNG), with JPEG being the current industry standard.

The asset owner should specify the resolution and file format of digital images prior to commencement of inspection. Where not specified, digital photographs shall be at least PAL resolution (i.e. 720 x 576 pixels).

The asset owner may specify the requirements for additional and/or specific photographs in their technical specification.

1.14.5 VIDEO CLIPS OF SPECIFIC FEATURES/DEFECTS

Video clips provide valuable information about an observation that sometimes cannot be obtained from still images. Video clips should be used where there is movement such as with <u>infiltration</u>, ingress of soil, unusual flow from a <u>junction</u>/ connection or the defect/feature cannot be adequately illustrated by a still image.

The clip shall be arranged to provide a minimum period of 2 s "familiarisation time" in which the field of view moves from 'straight ahead' showing the defect or feature in the context of the general conduit environment and then pans, scans, zooms onto or moves past the feature of interest.

Camera travel, panning and zooming should be slow and steady during video clips.

Video clips shall be of adequate duration to show the feature or defect with a maximum duration of 30 s. Clips shall be accessible in a similar way to photographs and may be extracted and transmitted in e-mail attachments. *File types may be mpg or mp4*.

Capturing video clips may not be possible with some technologies and with post inspection reporting using a video or image record.

1.15 PRELIMINARY GRADING OF INTERNAL CONDITION

The inspection report shall include a preliminary grading of the structural and service condition of the asset, calculated under APPENDIX C — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF THE APPARENT CONDITION OF OPERATIONAL SEWERS, APPENDIX D — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF OPERATIONAL STORMWATER DRAINS or APPENDIX E — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF MAINTENANCE STRUCTURES or calculated according to such other method as the asset owner or engaging agency may specify.



PART 2: INSPECTION OF CONDUITS - THE DESCRIPTION AND ENCODING OF OBSERVERVATIONS

Conduit Inspection Reporting Code of Australia Version 4.1

WSA 05-2020

PART 2

2 INSPECTION OF CONDUITS — THE DESCRIPTION AND ENCODING OF OBSERVATONS

2.1 PURPOSE

This section specifies a system to identify and record features and defects observed during the inspection of a **conduit** by visual and/or complementary technologies.

2.2 METHODS OF INSPECTION

This Code presupposes that the inspection of **conduit** will be carried out by inspection from within the conduit by a tractor mounted, push-rod or floatable CCTV camera or a 3D optical pipeline scanner with or without a laser profiler and/or a sonar scanner. However, the standard classification, description and encoding of conduit condition is equally applicable, with appropriate procedural modification, for inspections carried out by other camera types such as fixed position zoom cameras, and for larger conduits direct visual inspections during 'walk-throughs' by operators.

This Code has been written on the assumption that, to manage and collate the data collected, all observations will be encoded directly into a computerised logging system. It would be possible to encode into a written coding sheet in accordance with <u>APPENDIX K — MANUAL CODING SHEETS</u>, but this is likely to be cumbersome in practice, and is not recommended.

2.3 CONDUITS — CODING SYSTEM

The coding system for <u>conduit</u> comprises a series of codes that can be used to describe the defects and features observed as well as other data collected during the inspection. For operator convenience, Clauses describing the operation of the process and specifying requirements have been separated from the actual codes as follows:

- (a) Header information—this is information relating to the <u>conduit</u> as a whole, the bulk of which would normally be collected from the records of the asset owner. This information is described in <u>2.4 CONDUITS</u> <u>HEADER INFORMATION</u> and the codes are described in <u>2.6 CONDUIT HEADER CODES</u>.
- (b) Information about individual observations of defects and features encountered within the <u>conduit</u>. This information is described in <u>2.5 ENCODING OF OBSERVATIONS</u> and the codes are described in <u>2.7 CODES</u> FOR REPORTING THE INSPECTION OF CONDUITS.

The main codes for describing <u>conduit</u> condition are summarised in <u>APPENDIX G — SUMMARY OF MAIN CODES</u> FOR DESCRIBING CONDUIT CONDITION.

2.4 CONDUITS — HEADER INFORMATION

2.4.1 RECORDING OF INFORMATION

Header information shall be entered at the start of each <u>inspection length</u>. The appropriate header codes are listed in brackets below and explained in **2.6 CONDUIT HEADER CODES**.

Any changes to header information identified during an inspection shall be recorded as they arise within the main observation report, using the codes set out in **2.7.10 Codes for changing header information**.

2.4.2 MANDATORY INFORMATION

The following information shall be recorded in all circumstances:

- (a) Name of asset owner or engaging agency (AAM);
- (b) Asset owner or engaging agency's job reference (ABJ);
- (c) Name of the company performing the inspection, name of the operator and **Coder** / **Assessor** (ABS, ABH, ABL);
- (d) Operator's job reference (ABI);
- (e) Date of inspection (ABF);
- (f) Coding system employed and software version compliance reference (ABA);
- (g) Method of inspection (ABE);

- (h) Time of commencement of inspection (ABG);
- (i) Whether the **conduit** was pre-cleaned (ACM);
- (j) Precipitation at the time of inspection (ADA);
- (k) Description of any measures taken to control flow during the inspection (ADC);
- asset owner conduit length identification, either by conduit reference or by defining the nodes (often maintenance structures) at both ends. The nodes may be defined by node reference or by coordinates (AAA, AAB, AAC, AAD, AAE, AAF, AAG, AAH, AAI);
- (m) Inspected length. This field may be filled by software when the final observation distance is recorded at FH or SA (ABR);
- (n) Textual description of the location, e.g. street address and suburb, district (AAJ, AAN, AAO);
- (o) Direction in which the camera or scanner is viewing (AAK);
- (p) Longitudinal reference point (ABC);
- (q) Purpose of the inspection (ABP);
- (r) Material forming the fabric of the **conduit** (ACD);
- (s) Material and technique of lining (ACE, ACF);
- (t) Structural characteristics of the **conduit**. This field may be filled by the software through reference to Appendix B (ACP);
- (u) Depth of <u>conduit</u> at start node (ACH);
- (v) Operation of conduit (ACJ);
- (w) Use of conduit (ACK);
- (x) The depth from the surface to evidence of surcharge in start node (ABN);
- (y) Any other information required by the asset owner record in remarks (ADE);
- (z) Shape of **conduit** (ACA).;
- (aa) Size of the **conduit** diameter/height and/or width (ACB, ACC);
- (ab) **conduit** location risk factors observed by operator (ABD);
- (ac) Asset owner or engaging agency's user defined codes as specified (AEA, AEB, AEC, AED, AEE); and
- (ad) <u>conduit</u> structural and service statistics. *These fields may be filled automatically by software at the completion of the inspection* (AFA, AFB, AFC, AFD, AFE, AFF, AFG, AFH).

2.4.3 OPTIONAL INFORMATION

Where practicable and/or where required in the inspection contract, the operator may be able to include the following information within the inspection report:

- (a) Classification of the type of location (AAL);
- (b) Name of conduit system (AAP);
- (c) Conduit jointing method (ACO);
- (d) conduit unit length (ACG);
- (e) Date of construction or commissioning (ACN);
- (f) Land ownership (AAQ);
- (g) Depth at end node (ACI);
- (h) GIS or design length of conduit (ABQ);
- (i) Ambient temperature (ADB);
- (j) Details of inspection equipment used report in remarks (ADE);
- (k) Details of trees known to be causing root problems report in remarks (ADE);
- (I) Errors in asset data such as location of maintenance structures, connections, vents, material types, diameters etc report in remarks (ADE);
- (m) Condition of maintenance structures reported by exception where not part of the inspection contract report in remarks (ADE);
- (n) Presence of depressions or subsidence e.g. sink holes along the line of the **conduit** report in remarks (ADE);
- (o) Original coding system (ABB);
- (p) Tidal influence (ADD); and
- (q) Asset owner's criticality classification of the conduit (ACL).

2.4.4 INFORMATION TO BE PROVIDED BY THE ASSET OWNER

The asset owner shall provide information relevant to the inspection that will enable the operator to prepare equipment and resources for the inspection and to ensure details of the asset are correctly recorded in reports.

The following information should be provided:

- (a) Node and asset numbers for the asset being inspected;
- (b) Name of suburb, district and conduit system as defined by the asset owner;
- (c) Plans/GIS showing the conduit in relation to streets, properties and other system assets;
- (d) Purpose of inspection, e.g. condition assessment;
- (e) Description of the cross section and dimensions of the conduit, e.g. circular, ovoid;
- (f) Material forming the fabric of the **conduit**, e.g. VC, concrete or where the conduit is lined, through rehabilitation or during manufacture, the original material or conduit structural material;
- (g) Material and technique of lining (see APPENDIX B MATERIALS AND ACRONYMS);
- (h) Repair locations;
- (i) GIS or design length of the conduit;
- (j) Depth of conduit at nodes;
- (k) Operation of conduit, e.g. gravity or pressure;
- (I) Use of conduit as defined by the asset owner, e.g. reticulation sewer, stormwater drain, outfall;
- (m) Year the conduit was placed in operation; and
- (n) The asset owner's criticality classification of the conduit.

Operators should be made aware that information provided by the asset owner may not always be correct such that, in the process of undertaking the inspection, operators should confirm such parameters as **conduit** dimensions, material, lining, various conduit configurations and other relevant features. Editing of the report header may be required where a discrepancy exists between asset records and observations / measurements of the conduit parameters. Such a discrepancy shall be noted in the comments field of the report header.

Where parameters of the **conduit** such as material, lining or diameter etc. are not known before the inspection, the operator shall determine those parameters during inspection and include them in the inspection report.

Observation from the surface may be helpful in identifying **conduit** materials and sizes different to those records supplied by the asset owner.

The report header shall include a comments field to incorporate comments or information about the inspection that is not part of the **conduit** inspection, such as defects in the maintenance structures, any assumptions made in relation to zoom camera distance estimates, discrepancies in asset data etc.

2.5 ENCODING OF OBSERVATIONS

2.5.1 GENERAL

Each observation of a feature within a **conduit** shall be described by one or more main observation codes, each of which shall be accompanied, as appropriate, by up to 13 data fields of supporting information.

It should be noted that "feature" is used as an all-encompassing term to include defects, descriptions, types, artefacts, condition and the like, "camera" includes scanners and "video" includes digital images.

2.5.2 OBSERVATION CODES

Each observation of a feature shall be recorded using a main code (refer to **2.5.3 Main observation codes**) that broadly describes the feature together with the following information, where applicable:

- (a) Characterisation—up to two codes that describes a feature in more detail;
- (b) Quantification—up to two values that quantify a feature:
- (c) Circumferential location—one or two clock face references that locate the position of a feature around the circumference as viewed during camera travel;
- (d) joint —whether a feature is associated with a joint;
- (e) Longitudinal location—the distance from the stated reference point;
- (f) Continuous observation code—denotes a feature (observation) that continues for a length greater than 1 m or is a repeated feature that occurs in at least three out of four adjoining **conduit**;

- (g) Photograph reference;
- (h) Video reference—to locate a particular feature within the continuous video record of the inspection;
- (i) Video clip reference—to locate a particular feature within the collection of video clips; and
- (j) Remarks—text that describes aspects of the observation that cannot be described any other way.

Table 2.1 EXAMPLE OF OBSERVATION FORMAT

Code	Ch1	Ch2	Q1	Q2	Circumi loca	ferential tion	ngitudi 6 location	Phot	o ref	Video ref	Video clip ref	Remarks
С	L		3		12		10.5			00.10.30		

<u>Table 2.1</u> outlines the coding for the observation of a longitudinal crack of width 3 mm at the 12 o'clock position first observed at 10.5 m.

2.5.3 MAIN OBSERVATION CODES

The main observation codes, which are used to describe features, are set out in 2.7 CODES FOR REPORTING THE INSPECTION OF CONDUITS together with a description of the feature and the use of the code.

Features shall only be recorded using these codes. Where necessary two or more codes shall be used to describe a complex observation that cannot be addressed by a single code.

For simplification of use, these codes have been formed into related groups. This grouping is intended purely to simplify the problem of locating relevant codes by association and should not be used to interpret or otherwise restrict the meaning of the terms. Operators/Coder (Assessor) should use whichever of the codes of 2.7 CODES FOR REPORTING THE INSPECTION OF CONDUITS that best describes the situation.

Groups include:

- (a) Codes relating to structural performance of conduit (includes some aspects in common with masonry);
- (b) Codes specific to masonry conduit;
- (c) Codes relating to blocking and leakage of the conduit;
- (d) Codes relating to the performance of joints and jointing material (seals);
- (e) Codes relating to connections and junctions;
- (f) Codes relating to linings and repairs;
- (g) Codes describing miscellaneous observations concerning the construction and performance of the conduit;
- (h) Miscellaneous codes relating to the administration of the inspection; and
- (i) Codes for changing header information.

2.5.4 SUB-CODES

2.5.4.1 CHARACTERISATION SUB-CODES

Characterisation sub-codes further describe the feature. Up to two types of characterisation may be required for each observation type, depending on the nature of the feature. Meaningful names have been assigned to the characterisation data field in many cases to assist comprehension.

Characterisation codes shall be recorded in the order in which they are provided.

Where a feature cannot be directly observed but there is evidence to suggest a feature exists, then it shall be coded with the appropriate main code and characterisations. Where such a feature is likely, a remark shall be included to indicate that the feature is suspected and may warrant further investigation.

Any other relevant information that cannot be communicated using the prescribed codes shall be the subject of a General Comment code (refer to **2.7.9.3 General comment—GC**).

2.5.4.2 QUANTIFICATION SUB-CODES

Quantification should be estimated values or measurements.

Up to two values shall be recorded as specified in the various codes described in **2.7 CODES FOR REPORTING THE INSPECTION OF CONDUITS** to record the magnitude of the feature. Some features require the actual measurement or estimate of a dimension, area, % etc. In other cases, the operator may be required to make a judgement of severity. Some codes allow a choice between the two modes of reporting. Meaningful names have been assigned to the quantification data field in many cases to assist comprehension.

Percentages of deformation of the *conduit* that indicate loss of structural integrity shall be expressed in whole numbers to the nearest 5%. Deformation less than 5% shall be recorded as <5%. An exception shall be made for deformation in new assets, where it shall be recorded to the nearest 0.1%.

Percentages >25% shall be coded as a **collapse**. At PDFW the depth of flow is generally taken to be not more than 60% of **conduit** diameter (refer to Clause 5.5.3 on minimum air space for ventilation in WSA 02:2014 Version 3.1).

Percentages of loss of cross-sectional area of the *conduit* due to obstructions, roots, tuberculation, <u>bulge</u>, <u>blister</u> etc. and which affects hydraulic flow and/or serviceability shall be expressed as a whole numbers to the nearest 5%. Loss of cross-sectional area less than 5% shall be recorded as <5%.

Other physical measurements, e.g. separation of masonry courses, depth of missing mortar, loss of wall thickness etc. shall be expressed as a whole number to the nearest 5 mm or 10 mm as appropriate to the defect or feature.



The above requirements shall not apply to crack widths.

2.5.4.3 CIRCUMFERENTIAL LOCATION

Where specified in <u>2.7 CODES FOR REPORTING THE INSPECTION OF CONDUITS</u> for each code, the position of a feature within the cross section shall be recorded using the hours of an imaginary clock face reference under <u>Table 2.2</u>. The imaginary reference clock shall be positioned at the centre of the <u>conduit</u>, 12 o'clock being vertically upwards (see <u>Figure 2.1</u> for examples).

Notes

In oviform conduits the imaginary reference clock shall be positioned vertically above the **invert** at a height two thirds of the vertical dimension of the **conduit**.

Table 2.2 VALUES OF CLOCK FACE REFERENCES

Angle degrees	Clock face reference	Angle degrees	Clock face reference
0 ± 15	12	180 ± 15	06
30 ± 15	01	210 ± 15	07
60 ± 15	02	240 ± 15	08
90 ± 15	03	270 ± 15	09
120 ± 15	04	300 ± 15	10
150 ± 15	05	330 ± 15	11

A small feature requires a single imaginary clock reference to approximately define the position of its centre. A larger feature requires a pair of references to approximately define its extent. The clock reference data field allows for a pair of clock references. For coding purposes any single clock reference shall occupy the first clock reference position.

Where <u>2.7 CODES FOR REPORTING THE INSPECTION OF CONDUITS</u> requires that the start and finish clock face references be given these shall be recorded in the clockwise direction. The circumferential location of a feature occupying the entire periphery shall be recorded as "from 12 o'clock to 12 o'clock". Where the feature or defect requires only a single clock face reference this shall relate to the centre/mid-point of the feature.

Clock references shall be given to the nearest hour, as shown in examples given in Figure 2.1.

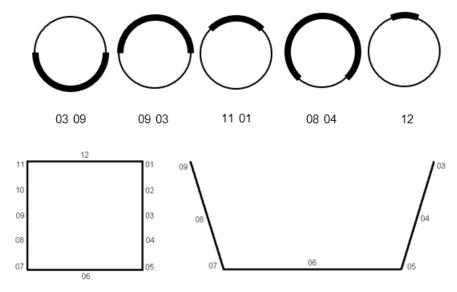


Figure 2.1 EXAMPLES OF CLOCK FACE REFERENCES

2.5.4.4 OBSERVATION ASSOCIATED WITH A JOINT

Where a feature occurs at a joint between two adjacent *conduit* units or concerns a feature that is structurally or otherwise associated with a joint, this association shall be recorded in the joint code by inserting the character "J" into the data field.

2.5.4.5 LONGITUDINAL LOCATION

The location of each feature shall be specified by stating the distance in metres from the reference point at the start of the inspection. The reference point shall be one of the following (See also <u>Figure 2.2</u>):

- (a) 'W' inside face of the wall of the starting node e.g. MC, MH, MS, IS or outfall at the point where the *conduit* passes through the wall;
- (b) 'P' soffit of the end of the *conduit* length inside the starting node. This will be the same point at described in (a) above except where the conduit projects into the MH. This is the preferred reference point;
- (c) 'C' centre of the starting maintenance structure, generally a MC, MH or MS;
- (d) 'IP' intersection of the incoming and outgoing conduit, measured along the channel; or
- (e) Adjacent surface level (when inspecting a vertical conduit).

Measurements shall be recorded in metres to at least one decimal place.

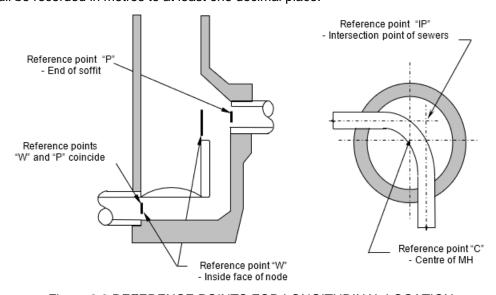


Figure 2.2 REFERENCE POINTS FOR LONGITUDINAL LOCATION

2.5.4.6 APPLICATION OF A SPECIFIED LENGTH

A 'specified length' of 1 m shall be adopted. Asset owners may wish to change this length but this Code's scoring and condition grading has been developed on the basis of a 1 m specified length.

The specified length is applied by dividing the **conduit** inspection length into 1 m intervals starting at zero (Longitudinal Reference Point).

Defects observed within an interval shall be reported at the distance at which it is first observed. The scores for the defects observed shall be assigned to the interval in which they occur. For continuous defects, the score shall be allocated proportionally to the metre division in which it first occurs and for each metre division until the continuous defect finishes. Where it finishes within the metre division, the score shall be allocated proportionally.

2.5.4.7 REPORTING EXTREME AND MINOR DEFECTS

Recording of each defect where multiple structural defects occur within a metre division may not be required unless the 'lesser' defects are substantially different to the more 'extreme' defects.

For example, cracking will usually be associated with <u>breaking</u> of a <u>conduit</u> but only breaking should be recorded and not the individual cracks associated with breaking; where deformation is measured #25% within a metre division, only <u>collapse</u> should be recorded; where coarse <u>aggregate visible</u> and also projecting from the surface within a metre division, only <u>aggregate projecting</u> should be recorded.

2.5.4.8 CONTINUOUS FEATURES

Where features continue over a length of 1 m or 3 out of 4 adjoining <u>conduit</u> lengths, as appropriate to the feature ¹, the start and finish of the feature shall be recorded separately, using a code S (start) and F (finish) and a label which identifies all references to the same feature. The first continuous feature in a conduit length shall be labelled 1 and subsequent continuous features shall be assigned progressively increasing numbers (1, 2, 3,....9, A, B,....Z).

A continuous feature that "wanders" i.e. changes its circumferential location along the *conduit*, or develops in quantity or characteristic, shall be noted by using a code "C" and its label, to record each progressive change.

A typical label should be encoded in the form "S1" "F1" i.e. the start or finish marker followed by the label with no separator.

Connections, junctions and similar features shall not be recorded using the continuous notation.

Refer also to 2.5.2 Observation codes.

2.5.4.9 PHOTOGRAPH REFERENCE

A reference to identify any still photographs or still computer images shall be recorded against a feature whenever a photograph is taken. If the photograph is of an uncoded feature the code GP (refer to 2.7.9.4 General photograph—GP) shall be used with an appropriate remark.

2.5.4.10 VIDEO LOCATION REFERENCE

Where the inspection is recorded electronically, a reference to allow the defect or feature to be located on the video record shall be recorded. The method of locating used shall be stated in the header information code ABL (refer to <u>2.6.3</u> <u>Header codes for reporting inspection details</u>). Where a time based method is used, the time shall be recorded in line with ISO 8601 in an hh:mm:ss format.

2.5.4.11 VIDEO CLIPS

Where an observation of a feature or defect is illustrated by a video clip, a reference to define the video clip shall be recorded.

^{1.} Some features only relate to particular elements of the conduit e.g. joints, sockets, welds etc. If a feature is repeatedly observed at each element of 3 out of 4 adjoining conduit lengths it can be considered a continuous feature. Junctions and connections are not normally regarded as continuous features.

2.5.4.12 SPECIFIC REMARKS

Where a feature cannot be fully described by a code, further information shall be recorded in the remarks field for that observation. Such a remark should be as short as possible. Where additional explanation or description of the feature is necessary, the code GC (refer to 2.7.9.3 General comment—GC) shall also be used.

Code GC alone shall not be used to describe a feature that can be described by a code.

2.5.5 LOGGING PROCEDURES

2.5.5.1 DEFINING LOCATION AND DIRECTION OF INSPECTION

The requirements of 2.4.4 Information to be provided by the asset owner (a) and (b) shall be met either by:

- (a) recording a *conduit* reference (code AAA) and the start node reference (code AAB) or the start node coordinate (code AAC); or
- (b) recording the two node references (codes AAD and AAF) or coordinates (codes AAE and AAG) and the start node reference or coordinate (code AAB or AAC).

For inspections of a lateral <u>conduit</u> e.g. a property connection sewer, the requirements of <u>2.4.2 Mandatory</u> <u>information</u> (a) and (c) shall be met either by recording the details of the main conduit using either methods (a) or (b) above, together with the longitudinal location, along the main conduit, of the start point of the lateral conduit and the circumferential location of that connection (codes AAH and AAI).

The requirements of 2.4.2 Mandatory information (c) shall be met by recording the location (code AAJ).

2.5.5.2 START OF INSPECTION

Before the logging of features can proceed, the following observations shall be encoded at longitudinal location 0.0 m to denote the start of every inspection:

- (a) Start node code (refer to 2.7.9.1 Start node—ST), and its details to record and confirm the details of the start node:
- (b) Water level code (refer to 2.7.8.3 Water level—WL);
- (c) Other code or observation as noted in the asset owner's technical specification; and
- (d) For masonry conduits the number of masonry layers comprising the masonry *conduit* (usually observable at the start of the inspection) shall be recorded in a general comment.

2.5.5.3 FINISH OF INSPECTION

Finish node code (refer to 2.7.9.2 Finish node—FH) and its details to record and confirm the details of the finish node shall be encoded at the completion of each inspection.

2.5.5.4 INSPECTION ABANDONED

Inspection (Survey) abandoned code (refer to <u>2.7.9.6 Inspection (Survey) abandoned—SA</u>) and the reason shall be encoded at the abandonment of an inspection. Ensure the feature or defect preventing the inspection continuing is coded before entering this code.

Code GC (refer to <u>2.7.9.3 General comment—GC</u>) shall be used to indicate the actions, if any, to be taken to complete the inspection.

2.5.5.5 INSPECTION RECOMMENCED

When an inspection is re-commenced a new header shall be completed and the remaining *conduit* shall be treated as a completely new inspection.

When completing header code ABP, reason "C" shall be used to show that this is the resumption of a previously discontinued inspection.

Whether the second attempt consists of a reinspection of the entire length or approaching an obstruction from the other direction it shall be reported as an independent inspection, complete in its own right.

Where an inspection has been abandoned due to debris or blockage and the **conduit** has been subsequently cleaned along its entire length, it is recommended that the reinspection be undertaken from the beginning to ensure that all features are recorded.

2.6 CONDUIT HEADER CODES

2.6.1 GENERAL

These codes are used to describe information about the **conduit unit length** and aspects of the inspection.

The main header reporting codes for <u>conduit</u> are largely identical to those specified in EN 13508. However, there are some differences. The Australian feature/defect codes are mnemonic and do not all align precisely with those in the EN 13508 Code. If required, these codes must be translated to report in EN 13508 format.

2.6.2 HEADER CODES TO DESCRIBE THE LOCATION OF THE INSPECTION

Code	Name	Data to be recorded	
AAA	Conduit reference	The conduit reference as specified by the asset owner	
AAB	Start node reference	The node reference of the start node	
AAC	Start node coordinates	The grid reference (easting and northing coordinates) of the start node	
AAD and A	AE not used		
AAF	Finish node reference	The node reference of the finish node	
AAG	Finish node coordinates	The grid reference (easting and northing coordinates) of the finish node	
AAH	Longitudinal location of start of lateral	The longitudinal location, along the main conduit, of the connection between the start of the lateral conduit and the main conduit in m (Refer to 2.5.5.1 Defining location and direction of inspection)	
AAI	Circumferential location of start of lateral	The circumferential location, around the main conduit, of the connection between the start of the lateral conduit and the main conduit (Refer to 2.5.5.1 Defining location and direction of inspection)	
AAJ	Location	A description of the location of the conduit e.g. street name. Include a street directory reference where this is a normal method of defining location	
AAK	Direction of inspection	Record the direction in which the camera is travelling to record images as follows:	
		D The camera is travelling downstream—the same direction as the normal direction of flow	
		Q The direction of flow is not known (Query)	
		U The camera is travelling upstream—directly opposite the normal direction of flow	
AAL	Location type	Record the most predominant and/or critical type of location of the conduit as follows:	
		B <u>B</u> ushland/parkland	
		BO Under a permanent building (<u>B</u> uilt <u>o</u> ver)	
		C Under a waterway (Creek) or body of water	
		D On property with buildings (<u>D</u> eveloped)	
		E <u>E</u> asement	
		F In a footway beside road	
		G <u>G</u> ardens	
		M In other pedestrian area (Mall)	
		MR Motorway or operational railway	

Code	Name	Data to be recorded		
		NS In verge beside a road (Nature Strip)		
		P In a field (<u>P</u> addock)		
		R In a road carriageway		
		RE Road to easement		
		W <u>W</u> ater foreshore		
		Z Other—further details shall be stated in remarks		
AAM	Asset owner or engaging agency	The name of the asset owner or engaging agency for inspection of the conduit		
AAN	Town or suburb	The name of the town or suburb as specified by the asset owner		
AAO	District	The name of the district as specified by the asset owner		
AAP	Name of conduit system	The name of the conduit system, or a conduit system reference as specified by the asset owner		
AAQ	Land ownership	Record the ownership of the land denoted as:		
		C Public land (Common or Crown land)		
		Q Not known (Query)		
		T Private land (Torrens Title)		
AAR	Mapping grid datum system	Record the grid datum system used for coordinates		
AAS	Mapping grid zone	Record the appropriate grid zone for coordinates		

2.6.3 HEADER CODES FOR REPORTING INSPECTION DETAILS

Code	Name	Data to be recorded		
ABA	Standard	The version of the standard and software used to record the data (Refer to APPENDIX A — SPECIFICATION FOR SOFTWARE)		
ABB	Original coding standard	The name of the original coding standard where the coding has been translated from an earlier version or from another system		
ABC	Longitudinal reference point	Record the point of reference for the longitudinal location as follows (Refer to 2.5.4.5 Longitudinal location)		
		C The <u>c</u> entre of the starting MH, MS or IS		
		IP The intersection point of the incoming and outgoing conduits		
		P The soffit of the end of the conduit (pipeline) length inside the starting node		
		SA Adjacent <u>surface area</u> (for use when inspecting a vertical conduit)		
		W The inside face of the <u>wall</u> of the starting node, (MH, MS, IS or headwall etc.) At the point where the conduit passes through the wall		
		Z Other—further details shall be stated in a general header comment (Code ADE) immediately following		

Code	Name	Data to be recorded	
ABD	Conduit location risk factor observed by operator	M Under <u>m</u> otorway	
		B Under a <u>b</u> uilding	
		R Under a <u>r</u> ailway	
		T Under a <u>t</u> ramway	
		S Under a <u>s</u> chool playground	
		H Under high value properties	
		O Other location of potential critical impact – describe in remarks	
ABE	Method of inspection	Record the method used to access the conduit for inspection as follows:	
		FZ Inspection by means of a fixed position zoom pipeline camera	
		LP Inspection by means of a remotely controlled laser profiler passed through the conduit	
		M Direct inspection of a conduit by a person walking through the conduit (<u>M</u> anned)	
		PR Push rod	
		PS Inspection by means of a remotely controlled 3D optical <u>pipeline scanner passed</u> through the conduit	
		SS Inspection by means of a remotely controlled sonar scanner passed through the conduit	
		TV Inspection by means of a remotely controlled <u>television</u> camera passed through the conduit	
		Z Other	
ABF	Date of inspection	Record the calendar date of the inspection using the DD-MM-YYYY format, e.g. 01-04-2006 means 1 St April 2006. Leading zeros shall be included where necessary.	
ABG	Time of inspection	The local time as specified in ISO 8601 using the hh:mm format, e.g. 14:41 means 2.41 pm local time. Leading zeros shall be included where necessary.	
ABH	Operator	Record the name of the operator, company, work group or individual engaged to conduct the inspection. Record the name of the individual person conducting the inspection where appropriate.	
ABI	Inspection company's job reference	The inspection company's or operator's job reference	
ABJ	Asset owner's job reference	The asset owner's or engaging agency's job reference	
ABK	Not used	Formerly used to describe storage medium for inspection video	
ABL	Coder/Assessor	Record the name of the person coding observations and producing report	
ABM	Video image location system	For moving images, record the method of recording the position on the tape or DVD as follows:	
		HM The elapsed time in hours and minutes since the start of the tape	
		L Longitudinal location from the reference point at the start of inspection	
		MC A machine dependent numeric counter	

Code	Name	Data t	o be recorded		
		Z	Other—further details shall be stated in a general header comment (code ADE) immediately following		
ABN	Evidence of surcharge in start node		Measure from the surface and record the apparent highest level of surcharge in the start node evidenced by accumulation of debris on step irons or walls		
ABO	Not used	Forme	rly used to describe the video volume reference		
ABP	Purpose of inspection	Recor	d the purpose of the inspection as follows:		
		В	Inspection before and after building works over or near the conduit		
		С	Completion of an earlier abandoned inspection		
		IE	Suspected infiltration problem (Infiltration exam)		
		IP	Investment planning		
		L	Locating a conduit, connection or a maintenance structure		
		NC	Final control of new construction		
		OE	Suspected operational problem (Operational exam)		
		R	Routine inspection of condition		
		RC	Final control of renovation or repair (Renovation/repair control)		
		S	Sample inspection		
		SE	Suspected structural problem (Structural exam)		
		Т	Transfer of ownership		
		W	End of warranty period		
		Z	Other—the reason shall be recorded as a header remark (code ADE) immediately following		
ABQ	Anticipated length of inspection	The anticipated length of the inspection as advised by the asset owner (to enable comparison with the actual length if the inspection is abandoned). NOTE: The distance provided by the asset owner is most likely to be the distance between the intersection of lines or approximately centre to centre of maintenance holes or pits. It is important to verify the convention used by the asset owner before applying the distance information provided.			
ABR	Actual inspection length (Formerly used to describe the storage medium for video clips)	The actual length of conduit inspected may be significantly different to the anticipated length due to the inspection being abandoned or errors in the recorded information. This field may be automatically populated at the end of the inspection.			
ABS	Name of company responsible for inspection	Record the company or trading name of the entity responsible for undertaking the inspection			
ABT	Not used	Forme	rly used to describe the video clip volume reference		

2.6.4 HEADER CODES FOR RECORDING CONDUIT DETAILS

Code	Name	Data to be recorded
ACA	Shape	Record the shape of the cross section of the conduit as follows:
		A Arch shaped—circular soffit and flat invert with parallel sides

Code	Name	Data to be recorded	
		C <u>C</u> ircular	
		E Oviform (egg shaped)	
		O <u>O</u> val—circular invert and soffit (of equal diameter) with parallel sides	
		R <u>R</u> ectangular	
		U <u>U</u> shape—circular invert and flat top with parallel sides	
		X_ Local section code to be specified by the asset owner and prefixed by an X, e.g. XA, XB etc	
		Z Other—a description shall be included as a general header comment (code ADE) immediately following	
ACB	Height	The height or diameter of the section in mm	
ACC	Width	The width of the section in mm—not required where both dimensions are the same, e.g. circular	
ACD	Material	The material of the fabric of the conduit, under the coding of <u>Table B.1</u> of <u>APPENDIX B — MATERIALS AND ACRONYMS</u> . Where a conduit is a combination of two or more materials record all materials. Where the conduit has been lined the material to be recorded is the material of the original conduit	
ACE	Lining type	Where a conduit has been lined, record the method of lining as follows:	
		CFL <u>C</u> lose <u>f</u> it <u>l</u> ining	
		CIP <u>C</u> ured <u>i</u> n <u>p</u> lace lining	
		LCP Lining with a continuous conduit (pipeline), e.g. a pipe string welded on the surface and pulled through the host conduit. Also called slip lining	
		LDP Lining with discrete pipe units transported into and joined in the host conduit	
		MFL Lining inserted during manufacture (Manufacturer's lining)	
		SEG <u>Seg</u> mental <u>l</u> inings	
		SPL <u>Sprayed lining</u>	
		SWL <u>Spirally wound lining</u>	
		Z Other	
ACF	Lining material	Where a conduit has been lined, record the lining material using the coding of <u>Table</u> B.2 of <u>APPENDIX B — MATERIALS AND ACRONYMS</u>	
ACG	conduit unit length	Record the length in m of the individual conduit units that comprise the conduit. Where the conduit is continuous, e.g. masonry, this code is not used. NOTE: It is suggested that the operator should measure the typical pipe length in the first 5 m to 10 m of the inspection and record this as a general comment. This information can be inserted in the header at completion of the inspection	
ACH	Depth at start node	Record the depth of the invert of the conduit below cover level at the start node in m	
ACI	Depth at finish node	Record the depth of the invert of the conduit below cover level at the finish node in m	
ACJ	Operation of conduit	Record the operational mode of the conduit as follows:	
		G <u>G</u> ravity	

Code	Name	Data to be recorded	
		O Other, e.g. duct	
		P <u>P</u> ressure	
ACK	Use of conduit	Record the use of the conduit system as follows:	
		COM Combined system (Sewage and surface water combined)	
		CUL <u>Cul</u> verted watercourse, e.g. a short buried section for a road crossing or similar	
		D A drain designed to carry only surface water	
		S The installation is designed to carry only sewage	
		TW Trade effluent sewer (<u>Trade waste</u>)	
		Z Other—further information shall be included as a general header remark (code ADE) immediately following	
ACL	Criticality	A client defined alpha-numeric code describing how critical the conduit is to the system	
ACM	Cleaning	Record whether the conduit was cleaned prior to the inspection as follows:	
		C The conduit was <u>c</u> leaned prior to the inspection	
		NC The conduit was not cleaned prior to the inspection	
ACN	Year came into operation	The approximate year the conduit came into operation. Report in YYYY format either as a single year or as a range in YYYY#YYYY format, e.g. 1970–1979	
ACO	Jointing method	Record the apparent conduit jointing method if possible as follows:	
		A Conduit sections <u>a</u> butted with no jointing elements or material	
		BF <u>B</u> utt <u>f</u> usion welded, e.g. steel and PE	
		BFD <u>Butt fusion welded with ground weld reinforcement (steel) or debeading (PE)</u>	
		CMJ <u>Cement mortar jointed e.g. earthenware/vitrified clay concrete</u>	
		EF <u>E</u> lectro <u>f</u> usion coupling weld (PE only)	
		F <u>F</u> lange jointed – steel, cast or ductile iron	
		L <u>Lap fillet weld (steel only)</u>	
		MC <u>M</u> echanical <u>c</u> oupling	
		RRJ Rubber ring (elastomeric seal) jointed (socket and spigot or joint coupling/collar)	
		SCJ <u>S</u> olvent <u>c</u> ement jointed, e.g. PVC, ABS	
		Z Other	
	<u> </u>		

2.6.5 HEADER CODES FOR RECORDING MISCELLANEOUS INFORMATION

Code	Name	Data to be recorded	Data to be recorded		
ADA	Precipitation	Record the precipitation as follows:	Record the precipitation as follows:		
		N	No precipitation		

Code	Name	Data to be recorded	
		R	Precipitation (<u>rain</u>)
		S	Melting snow or ice
ADB	Temperature	Record the ambient temperature in Celsius	3
ADC	Flow control measures	Record the measures taken to deal with the	e flow at the time of the inspection as follows:
		В	Flows have been <u>blocked</u> or diverted upstream
		N	No measures taken
		Р	Flows partially blocked or diverted upstream
		Z	Other—record further details in remarks
ADD	Tidal influence (where applicable)	Record tidal influence as follows:	
		A The conduit is at or above high tide	level
		B The conduit is <u>b</u> elow high tide level	
ADE	General comment	Record any information that cannot be included in any other way including errors in asset information, defects in the maintenance structures etc.	

2.6.6 USER DEFINABLE HEADER CODES

Experience has shown that many agencies need to record specific information about their assets or job record systems that do not comply with the mandatory or optional fields above. To facilitate this requirement without compromising standardised fields and software the following user definable fields are provided.

Code	Name	Data to be recorded
AEA	User defined	User defined
AEB	User defined	User defined
AEC	User defined	User defined
AED	User defined	User defined
AEE	User defined	User defined

2.6.7 HEADER CODES FOR STRUCTURAL AND SERVICE CONDITION STATISTICS

These fields allow the statistics for structural and service conditions to be incorporated in the report header.

Code	Name	Data to be recorded
AFA	Structural grade	Condition grade from 1-5 as determined using APPENDIX C — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF THE APPARENT CONDITION OF OPERATIONAL SEWERS OF APPENDIX D — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF OPERATIONAL STORMWATER DRAINS
AFB	Number of structural defects	Number of structural defects reported
AFC	Structural peak score	The maximum aggregated structural defect scores within a single metre length of the conduit

Code	Name	Data to be recorded	
AFD	Structural mean score	The total of all structural defect scores divided by the length in metres	
AFE	Service grade	Condition grade from 1-5 as determined using Appendices C or D	
AFF	Number of service defects	Number of service defects	
AFG	Service peak score	The maximum aggregated service defect scores within a single metre length of the conduit	
AFH	Service mean score	The total of all service defect scores divided by the length in metres	

2.6.8 CHANGE OF CODES FOR HEADER INFORMATION

When information given in header codes changes during an inspection the appropriate change header code shall be inserted within the inspection report. *User definable header codes do not have change codes. Header change codes are set out in* **2.7.10 Codes for changing header information**.

2.7 CODES FOR REPORTING THE INSPECTION OF CONDUITS

2.7.1 GENERAL

Observations of features or defects shall be coded according to the descriptions and explanations in the following sections.

The format of observations shall be in accordance with <u>Table 2.1</u>. That is, the main code, characterisation 1, characterisation 2, quantification 1, quantification 2, circumferential location, joint influence, distance continuous notation, photo reference, video reference, video clip reference and remarks as appropriate.

To assist correct coding and interpretation of features/defects in <u>conduit</u> and maintenance structures, a compendium of photographs showing some defects and features with suggested coding and a commentary is provided in <u>APPENDIX I</u> — <u>COMPENDIUM OF DEFECTS AND FEATURES</u>.

2.7.2 CODES RELATING TO THE STRUCTURAL INTEGRITY OF CONDUITS

2.7.2.1 CRACKING—C

Code	Description		
С	Cracking of a conduit ¹ . An apparent discontinuity in the fabric of a conduit where the pieces on either side of the crack may remain interlocked with negligible separation along the discontinuity or may be separated by a measurable gap or displacement, but with the individual pieces still in place and the cross section effectively retaining its original shape. This code does not apply to masonry conduits, and masonry codes should be applied instead ² .		
	Additional Information		
	Characterisation 1—Orientation Record the orientation of the cracking as follows:		
	С	Circumferential—generally a single crack oriented approximately perpendicular to the centreline of the conduit	
	L	<u>L</u> ongitudinal—generally a single crack ³ oriented approximately parallel to the centreline of the conduit	
	М	Multiple/Complex—a crack or cracks whose inter- relationship is not easily defined by the previous descriptions	

Code	Description	
		ingle crack oriented other than ferential that typically starts and returns
	Quantification 1—Width ^{5,6} Measure and record the maximum width of cracking in mm to the nearest 1 mm	
	Circumferential location: —record the position of a longitudinal crack as a single clock reference —record the extent of other cracks as a pair of clock references	

Notes

- (1) The asset owner may determine that reporting cracking with a gap of less than 1 mm may not be warranted. However, any variation to reporting requirements shall be clearly specified by the asset owner and conveyed to the operator or **Coder/Assessor**.
- (2) Use code MBC (refer to 2.7.3.3 Masonry (brick) cracking—MBC) when cracking occurs through masonry units, and code MUS (refer to 2.7.3.4 Masonry unit separation—MUS) when separation occurs within the mortar joints.
- (3) Single cracks may branch and re-enter the main crack path forming one or two segments or branch for short distances before stopping.
- (4) This defect occurs in pipe **conduit** only. It is typically a failure propagating from a collar or socket end of the pipe.
- (5) Where technology permits, measure and record maximum crack width to nearest 0.1 mm. Where such technology is not available for that level of accuracy, estimate and record the crack width to the nearest mm in accordance with Note 6. For the acceptance of newly installed assets, refer to the requirements in ACCEPTANCE.
- (6) Procedures used in the inspection shall be able to demonstrate accurate crack width estimates to at least 1 mm accuracy.

2.7.2.2 BREAKING—B

Code	Des	Description		
В	Breaking of a conduit ¹ . The conduit is breaking into a few or many separate pieces where there is significant movement of some or all of the pieces resulting in measurable local or general distortion from the original conduit cross section. Pieces conduit wall may be missing or lengths of the conduit may have been displaced through shear action such that soil or a vois visible. Additional Information			
	Characterisation 1—Extent			
	D	All pieces are present but some of them are significantly <u>d</u> isplaced from position ^{2,6}		
Missing—one or more pieces of conduit are missing ^{3,4}		\underline{M} issing—one or more pieces of conduit are missing 3,4		
	E	Conduit broken as a result of an <u>e</u> xceptional event, e.g. external trauma such as damage from trenchless installation of other utilities		
	Quantification 1—Extent of breaking Measure or estimate the extent of the breaking in the longitudinal dimension in the following ranges: • #100 mm			
		• >100 – #500 mm		
		$^{\bullet}$ >500 - #1000 mm ⁵		

Code Description

Circumferential location—record the extent of breaking as a pair of clock references

Notes

- (1) Do not code 'breaking' if a repair has been made. This applies mainly to 'breaking-missing' that has been repaired and should be reported using the code PRH (refer to 2.7.7.2 Point repair—PR).
- (2) Includes shear displacement. Shear displacement >25% shall be reported using code X (refer to 2.7.2.4 Collapsed conduit—X).
- (3) Where the spigot end of the **conduit** has been damaged with loss of the fabric within the joint socket report as '**breaking-missing**' only if the jointing seal or material is visible and/or the joint integrity is seen to be compromised. Otherwise report with a general comment on loss of part of the spigot end of the conduit.
- (4) It is probable that soil or void is visible through the missing wall.
- (5) **breaking** may extend beyond 1 m. Use this quantification and apply the continuous code notation.
- (6) Where <u>breaking</u> of the <u>conduit</u> significantly affects the capacity of the conduit, also report the loss of cross section as code OBM (refer to <u>2.7.4.4 Obstruction—OB</u>).

2.7.2.3 DEFORMATION—D

Code	Description	
D^1	The cross sectional shape of the conduit has deformed from its original shape 2,3,6	
	Additional Information	
	Characterisation 1—Orientation of deformation Record the orientation of the direction of maximum deformation as follows:	
	H <u>H</u> orizontal deformation—the horizontal dimension has been reduced	
	M Mixed orientation deformation	
	V <u>V</u> ertical deformation—the vertical dimension has been reduced	
	Quantification 1—Magnitude Measure or estimate and record the maximum percentage change in dimension for deformation in 5% increments ⁴ as follows: 5, 10, 15, 20, 25	
	Quantification 2—Extent Measure or estimate the extent of the deformation in the longitudinal dimension in the following ranges: • #500 mm of deformed length (usually a local deformation from a point load)	
	 >500 mm to #1000 mm⁵ 	

Circumferential location—record the apparent direction of loading causing deformation as a single clock reference

Notes

- (1) The asset owner may specify whether this code is only to be used for flexible conduit.
- (2) Where the deformation appears to be localised in part of the conduit only, record details in remarks.
- (3) The deformation code shall also be used to record shear displacement.
- (4) Deformation >25% shall be recorded as a collapse (refer to 2.7.2.4 Collapsed conduit—X).
- (5) breaking may extend beyond 1 m. Use this quantification and apply the continuous code notation.
- (6) For deformation of structural lining use code LDD (refer to 2.7.7.1 Lining defective—LD).

2.7.2.4 COLLAPSED CONDUIT—X

Code Description X The conduit has collapsed 1 – a complete loss of structural integrity or continuity measured as a deformation or displacement resulting in a >25% reduction of an asset's diameter or other relevant dimension. For masonry conduits use code XM (refer to 2.7.3.8 Masonry conduit collapse—XM), and for structural linings use code LDX (refer to 2.7.7.1 Lining defective—LD)



(1) Where the **collapse** appears to be localised in part of the **conduit** only, record details in remarks.

2.7.2.5 SURFACE DAMAGE CONCRETE—SC

Code Description		ription	
SC	The surface of a concrete conduit has been damaged Additional Information		
	AV ¹	Some coarse <u>aggregate</u> is <u>v</u> isible or exposed	
	AP ¹	Coarse <u>aggregate</u> is <u>projecting</u> from the surface after the surrounding cement-sand matrix has been removed	
	AM ¹	Aggregate is missing – the damage has extended sufficiently for several pieces of large aggregate to have been removed and loss of conduit fabric is leading to hole formation	
	СР	Corrosion products from the degradation of concrete are visible as a build-up on or a discolouration of the surface of the conduit. These corrosion products are generally friable and are easily removed in cleaning to reveal AV, AP, AM and/or RC.	
	H ²	A <u>h</u> ole in the conduit – surface damage that has resulted in the complete loss of fabric such that soil or a void is visible through the opening. The hole may extend over a significant portion of the conduit.	
	JR	Joint ends of the conduit have become significantly rounded through corrosion/erosion and/or eroded away	
	RC	The concrete cover to the steel reinforcement has been removed due to corrosion/spalling/erosion/other reason and the \underline{r} einforcement is exposed and \underline{c} orroded ³	
	RV	Steel reinforcement is visible with little or no corrosion evident ⁴	
	RVP	Steel reinforcement is visible with little or no corrosion evident and is projecting into the conduit	
	S	Spalling of the surface has occurred characterised by a significant loss of conduit material in discrete fragments. The material removed is considerably larger than individual grains of material removed by erosion or abrasion. The loss o conduit fabric from spalling does not extend through the full thickness of the conduit wall.	
	RS	Reinforcement staining is evident on the surface of the conduit due to the corrosion of the underlying steel reinforcement 5	
	Z	Other—record details in remarks	
	Where	tification 1—Loss of wall thickness ⁶ e specified, measure maximum loss of wall thickness using laser profiling in 5 mm increments as follows: 15, 20, 25, 30, 35, 40, 45, 50 and so on	

Code Description

Circumferential location—record the location or extent of the defect as one or two clock references

Notes

- (1) Use code AP in preference to code AV when one or more features are intermixed over the area of the concrete surface. Use code AM only where there is a hole forming and noticeable loss of cross section which has affected the shape/diameter of the pipe.
- (2) The hole may allow exfiltration (refer to <u>2.7.4.2 Exfiltration—EX</u>), infiltration (refer to <u>2.7.4.3 Infiltration—I</u>), the ingress of soil (refer to <u>2.7.4.5 Ingress of soil—ING</u>) and/or roots (refer to <u>2.7.4.6 Roots—R</u>) which shall be reported separately.
- (3) Also use this code if the steel reinforcement has completely corroded away.
- (4) This may occur in the manufacture of concrete pipe if the reinforcement is displaced relative to the internal surface and/or where some other post-installation intervention has exposed reinforcement. This code is applicable to both sewer and stormwater **conduit**.
- (5) Staining may have several causes, however, for this code it is specifically related to the corrosion of the underlying steel reinforcement. Occurrence of this defect is most likely where reinforcement is close to the surface. RS may often precede RC. Where both RS and RC are evident only code RC. This code is applicable to both sewer and stormwater conduit.
- (6) Laser profiling is usually undertaken in a separate activity to visual reporting of **conduit** condition. The determination of loss of wall thickness at a specific observation distance shall be correctly aligned and recorded manually to incorporate this quantification.

2.7.2.6 SURFACE DAMAGE ASBESTOS CEMENT—SAC

Code	Description		
SAC	The surface of an AC or FC conduit has been damaged Additional Information		
	Characterisation 1—Type of damage Record the type of damage according to the following codes—the damage may be caused by erosion, corrosion, abrasion, mechanical equipment, a combination of two or more or any other agent		
	CP ¹	Corrosion products from the degradation of the conduit material are visible as a build-up on or a discolouration of the conduit surface)	
	DI	Initial delamination—thin layers of conduit material are evident and/or have been removed from the surface	
	DM	Moderate delamination—thick layers of conduit material are evident and/or have been removed from the conduit surface without evidence of the conduit losing its (circular) shape	
	DX	Extreme delamination—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	
	S	Spalling of the surface has occurred characterised by a significant loss of conduit material in discrete fragments. The material removed is considerably larger than individual grains of material removed by erosion or abrasion. The loss of conduit fabric from spalling does not extend through the full thickness of the conduit wall.	
	Н	A <u>h</u> ole in the conduit – surface damage that has resulted in the complete loss of fabric such that soil or a void is visible through the opening. The hole may extend over a significant portion of the conduit ² .	
	Z	Other—record details in remarks	
	Wher	ntification 1—Loss of wall thickness ³ re specified, measure maximum loss of wall thickness using laser profiling in 5 mm increments as follows ⁴ : , 15, 20, 25, 30, 35, 40, 45, 50 and so on	

Code Description

Circumferential location—record the location or extent of the defect as one or two clock references

Notes

- (1) Do not use code DEE (refer to 2.7.4.1 Deposits on the wall and/or in the invert—DE) to code corrosion on the inside of AC conduit.
- (2) The hole may allow exfiltration (refer to <u>2.7.4.2 Exfiltration—EX</u>), infiltration (refer to <u>2.7.4.3 Infiltration—I</u>), the ingress of soil (refer to <u>2.7.4.5 Ingress of soil—ING</u>) and/or roots (refer to <u>2.7.4.6 Roots—R</u>) which shall be reported separately.
- (3) Laser profiling is undertaken in a separate activity to visual reporting of **conduit** condition. The determination of loss of wall thickness at a specific observation distance shall be correctly aligned and recorded manually to incorporate this quantification.
- (4) Where significant delamination and loss of fabric has occurred, the asset owner should undertake a risk assessment in relation to the presence of asbestos fibres in treatment plant sludge.

2.7.2.7 SURFACE DAMAGE OTHER—SO

Code	Description		
so	The surface of the conduit (VC, plastics, metal etc. but not concrete, AC, masonry or FRC) has been damaged Additional Information Characterisation 1—Type of damage Record the type of damage according to the following codes—the damage may be caused by erosion, corrosion, abrasion, mechanical equipment, or a combination of two or more or any other agent. The damage may also be a manifestation of manufacturing defects exacerbated by normal operation of the conduit.		
	MD	The surface of plastics conduits is mechanically damaged exhibiting scoring or gouging etc. ²	
	S	Spalling of the surface has occurred characterised by a significant loss of conduit material in discrete fragments. The material removed is considerably larger than individual grains of material removed by erosion or abrasion. The loss of conduit fabric from spalling does not extend through the full thickness of the conduit wall.	
	T ³	Tuberculation corrosion products 4 are visible on the inside of cast iron and other ferrous conduits	
	Z	Other—record details in remarks	
	Quantification 1—Obstruction caused by tuberculation, blistering etc. Estimate and record the percentage reduction in cross sectional area from one of the following estimates: <5, 10, 20, 30, 40, 50, 60, 70, 80 or 90%		
	Quantification 2—Loss of wall thickness ³ Where specified, measure maximum loss of wall thickness, 10, 15, 20, 25, 30, 35, 40, 45, 50 and so on	ness using laser profiling in 5 mm increments as follows:	
	Circumferential location—record the location or extent	of the defect as one or two clock references	



- (1) The hole may allow exfiltration (refer to <u>2.7.4.2 Exfiltration—EX</u>), infiltration (refer to <u>2.7.4.3 Infiltration—I</u>), the ingress of soil (refer to <u>2.7.4.5 Ingress of soil—ING</u>) and/or roots (refer to <u>2.7.4.6 Roots—R</u>) which shall be reported separately.
- (2) Not to be used for damage to lined conduit.
- (3) Do not use code DEE (refer to <u>2.7.4.1 Deposits on the wall and/or in the invert—DE</u>) to code corrosion (tuberculation) on the inside of cast iron and other ferrous pipes.
- (4) These corrosion products may appear as rust coloured nodules although, if the **conduit** has been cleaned, some may appear black where the nodule has been partly broken away. Where tuberculation is evident the internal surface of the conduit under the tubercule will be graphitised or pitted or both.

2.7.2.8 SOIL VISIBLE THROUGH DEFECT—SV

Code	Description	
SV	The soil outside the conduit is visible through a defect (such as a hole, break or extreme joint displacement) ¹	
	Additional Information	
	Circumferential location—record the location or extent of the defect as one or two clock references	



(1) Where a void is visible outside the **conduit** use code VV (refer to **2.7.2.9 Void visible through defect—VV**) in preference to this code, even if soil is still visible.

2.7.2.9 VOID VISIBLE THROUGH DEFECT—VV

Code	Description	
VV	A void outside the conduit is visible through a defect (such as a hole, break or extreme joint displacement) ¹	
	Additional Information	
	Quantification 1—Void dimensions Where it is possible measure or estimate and record the dimensions of the void in mm to the nearest 50 mm or leave blank	
	Circumferential location—record the location or extent of the void as two clock references	



(1) Where soil is visible at the edges of the void outside the **conduit** still use this code in preference to code SV (refer to **2.7.2.8 Soil visible through defect—SV**).

2.7.2.10 POROUS CONDUITS—PP

Code	Description	
PP	The conduit material is seen to be porous 1	
	Additional Information	
	Circumferential location—record the extent of the porous area as one or two clock references	



(1) Pipes most likely to exhibit porosity are concrete, asbestos cement and fibre reinforced cement. The cause may be a manufacturing defect or in areas where pipes are subject to acidic groundwater the pipe may soften and become porous.

2.7.3 CODES SPECIFIC TO MASONRY CONDUITS

2.7.3.1 MISSING MORTAR—MM

Code	Description	
MM	All or part of the mortar from the masonry is missing 1,2	
	Additional Information	
	Quantification 1—Extent of mortar loss Estimate or measure and record the typical depth of mortar loss over the affected area in 10 mm increments as follows:	
10, 20, 30, 40, 50 and so on to total mortar loss, which should be recorded as 100^3		
	Circumferential location—where only one or a few masonry units are affected, record the position of the affected area as a single clock reference. For more extensive areas, record the circumferential extent of the affected area as a pair of clock references	



- (1) Missing mortar normally occurs over a continuous length of masonry **conduit**. Where it occurs locally, record in remarks.
- (2) Missing mortar does not refer to rendered mortar, which should be reported under code LD (refer to 2.7.7.1 Lining defective—LD).
- (3) If exfiltration (refer to 2.7.4.2 Exfiltration—EX), infiltration (refer to 2.7.4.3 Infiltration—I) or ingress of soil (refer to 2.7.4.5 Ingress of soil—ING) is apparent through the mortar course, this indicates total mortar loss.

2.7.3.2 DISPLACED MASONRY UNITS—DMU

Code	Description	
DMU	Individual masonry units have moved from their original position. All masonry units are still present	
	Additional Information	
	Characterisation 1— Nature of displacement	
	I One or more masonry units have moved inwards	
	O One or more masonry units have moved outwards	
	Quantification 1—Maximum displacement Estimate and record the maximum displacement of the most affected masonry unit(s) in mm to the nearest 10 mm	
	Circumferential location—where only one or a few masonry units are affected, record the position of the centre of the affected area as a single clock reference. For more extensive areas record the circumferential extent of the affected area as a pair of clock references	

2.7.3.3 MASONRY (BRICK) CRACKING—MBC

Code	Description	
MBC	Cracking going through the individual masonry unit (as opposed to the mortar joint 1). An apparent discontinuity in the fabric of a conduit where the pieces on either side of the crack may remain interlocked with negligible separation along the discontinuity or may be separated by a measurable gap or displacement, but with the individual pieces still in place and the cross section effectively retaining its original shape.	
	Additional Information	
	Characterisation 1—Orientation The second code letter to be C or L according to orientation of the feature as follows:	
	C <u>Circumferential or inclined</u> —generally a single crack oriented approximately perpendicular or at an angle to the centreline of the conduit	
	L <u>L</u> ongitudinal—generally a single crack oriented approximately parallel to the centreline of the conduit	
	Quantification 1—Width ² Measure and record the maximum width of cracking to the nearest 1 mm	
	Circumferential location: —record the position of a longitudinal crack as a single clock reference —record the extent of other cracks as a pair of clock references	



- (1) Use code MUS (refer to <u>2.7.3.4 Masonry unit separation—MUS</u>) when separation occurs within the mortar joints.
- (2) Procedures used in the inspection shall be able to demonstrate accurate crack width estimates to at least 1 mm accuracy.

2.7.3.4 MASONRY UNIT SEPARATION—MUS

Code	Description		
MUS	The regularity of the original bond pattern has been disturbed with masonry courses separating along mortar joints and possibly becoming misaligned ¹		
Additional Information			
	Quantification 1—Separation of masonry courses Estimate or measure and record the typical separation width of masonry courses over the length of the defect in 5 mm increments as follows: 5, 10, 15, 20 and so on		
	Circumferential location—where only one or a few masonry units are affected, record the position of the centre of the affected area as a single clock reference. For more extensive areas, record the circumferential extent of the affected area as a pair of clock references.		

✓ Notes -

(1) This defect may be accompanied by considerable cracking of adjacent masonry work, frequently extending for some distance beyond the separation and misalignment or there may be no indication of cracking at the extremities of the misalignment.

2.7.3.5 MISSING MASONRY UNITS-MMU

Code	Description	
MMU	One or more masonry units are missing	
	Additional Information	
	Characterisation 1—Extent of further layers	
	NV	No further layer(s) of masonry is visible—if soil or a void is visible through the gap also report using code SV or VV
	Р	The masonry structure has been <u>penetrated</u> or damaged by an external agent and part of or whole masonry unit(s) is/are missing. Most commonly this occurs when cables, pipes etc. have been installed through masonry conduits ¹ .
	V	Another layer of masonry is visible through the hole left by the missing masonry
	Circumferential location—where only one or a few masonry units are affected, record the position of the centre of the affected area as a single clock reference. For more extensive areas, record the circumferential extent of the affected area a pair of clock references.	



(1) Any obstruction evident in the conduit also needs to be reported using code OBP.

2.7.3.6 MASONRY DROPPED INVERT—MDI

Code	Description	
MDI	A section of the invert has dropped in relation to the walls leaving a gap of more than 10 mm along a longitudinal mortar joint	
	Additional Information	
	Quantification 1—Depth of drop Estimate and record the depth of drop in mm to nearest 10 mm	
	Circumferential location—Record the clock reference of each of the separated courses that define the dropped area	

2.7.3.7 MASONRY CONDUIT SPALLING—MS

Code	Description	
MS	Spalling of the surface has occurred characterised by a significant loss of conduit material in discrete fragments ¹ . The material removed is considerably larger than individual grains of material removed by erosion or abrasion. The loss of conduit fabric from spalling does not extend through the full thickness of the conduit wall.	
	Additional Information	
	Quantification 1—Loss of fabric Where specified, measure maximum loss of fabric (depth) in 5 mm increments as follows: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 and so on	



(1) Compression spalling may extend over a significant area.

2.7.3.8 MASONRY CONDUIT COLLAPSE—XM

Code	Description
XM	The masonry conduit has collapsed in that the internal surface has dropped/deformed/deflected >25% in the plane of the drop/deformation/deflection across the conduit ¹

Notes

(1) For vertical deformation of a masonry **conduit** it is likely that masonry could drop from the roof before 25% deformation occurs. As such complete loss of all masonry layers from 9 to 3 o'clock can be coded as **collapse**. For a lesser extent of missing masonry use code MMU (refer to **2.7.3.5 Missing masonry units—MMU**).

2.7.4 CODES RELATING TO THE BLOCKAGE AND LEAKAGE OF CONDUITS

2.7.4.1 DEPOSITS ON THE WALL AND/OR IN THE INVERT—DE

Code	Description		
DE	Material is attached to the wall of the conduit or is deposited in the invert		
	Additional Information Characterisation 1—Type of deposit		
	F	Fouling—an organism or growth attached to the walls	
	G	<u>G</u> rease	
	E ¹	Encrustation—deposits attached to the walls. Encrustation deposits will usually result from the evaporation of groundwater permeating through defects in the conduit leaving mineral salts which build up layers and reduce the cross section ² .	
	S The material deposited is fine sediments— <u>s</u> and or s	silt	
	R The material deposited is coarse sediments—gravel or rubble		
	C The material deposited is hard or compacted e.g. co	oncrete	
	Z Other—record details in remarks		
	Quantification 1—Obstruction Estimate and record the percentage reduction in cross sectional area from one of the following ranges: <5, 10, 20, 30, 40, 50, 60, 70, 80 or 90%		
	Circumferential location—record the location or extent of the obstruction in the cross section as one or two clock references		

Notes

- (1) Use code SO (refer to **2.7.2.7 Surface damage other—SO**) to code corrosion (tuberculation) on the inside of cast iron and other ferrous pipes.
- (2) Where encrustation is observed it is not necessary to also record the infiltration seeping/sweating usually associated with the formation of encrustation.

2.7.4.2 EXFILTRATION—EX

Code	Description	
EX	There is a visible flow of water out of the conduit	
	Additional Information	
	Characterisation 1—Location of exfiltration	
	J Visible flow exiting through joint	
	D Visible flow exiting through a defect e.g. broken missing, surface damage hole	
	Circumferential location—record the location or extent of the exfiltration as one or two clock references	

2.7.4.3 INFILTRATION—I

Code	Desc	Description		
I	_	Ingress of water through the wall of the conduit, through joints, or through other defects, which are separately reported, is occurring at the time of inspection ¹		
	Additional Information			
	Characterisation 1—Rate of infiltration Record the apparent rate of infiltration as follows:			
	S	Seepage—slow ingress of water, no visible drips		
	D	<u>D</u> ripping—individual drips, flow not continuous		
	R	Running—a continuous flow		
	G	Gushing—a copious flow entering under pressure		
	Circu	Circumferential location—record the location or extent of the infiltration as one or two clock references		



(1) Past infiltration may have occurred when a much higher water table existed, but at the time of observation the water table is lower than the <u>conduit</u>. Where there are signs of past infiltration, report using the GC code (refer to <u>2.7.9.3 General comment—GC</u>).

2.7.4.4 OBSTRUCTION—OB

Code	Description		
ОВ	An object or object(s) in the conduit is obstructing the cross sectional area		
	Additional Information		
	Characterisation 1—Nature of obstruction Characterise the nature of the obstruction as follows:		
	В	Dislodged <u>brick</u> or masonry unit(s) lying in the invert	
	С	An object is entering through a connection or junction	
	ı	An object is intruding through the wall	

Code	Desc	cription
	J	An object is wedged in the joint
	М	One or more fragments of conduit <u>material</u> are lying in the invert or are protruding as a consequence of conduit breaking
	P ¹	External cables or pipes have been built through the conduit
	S	A structure has been built into the conduit
	Z	Other—record details in remarks
	Estin	ntification 1—Obstruction nate and record the percentage reduction in conduit cross sectional area from one of the following estimates: 0, 20, 30, 40, 50, 60, 70, 80 or 90%
	Reco	ntification 2—Hazard warning ord code "H" for hazard as quantification 2 to draw attention to a potentially major problem requiring urgent investigation tention. Advise the asset owner/operator of the perceived problem as soon as possible
		imferential location—record the location or extent of the defect in the cross section as one or two clock references, as opriate



(1) Code B (refer to **2.7.2.2 Breaking—B**) or code MMU (refer to **2.7.3.5 Missing masonry units—MMU**) shall be used in association with this code, as appropriate.

2.7.4.5 INGRESS OF SOIL—ING

Code	Description	
ING ¹	Soil or embedment material is observed to be entering the conduit at a defect, joint, unpatched hole, connection or other entry point	
	Add	itional Information
		racterisation 1—Type of soil ord the type of soil as follows:
	S	Sand or other fine, non-cohesive (free-running) soil or embedment material
	F	Clay, silt, cohesive (ordinary) soil (Fine material)
	G	<u>G</u> ravel or rubble
	Z	Other—record details in remarks
	Circu	umferential location—record the location of the ingress in the cross section as one or two clock references

Notes

(1) Do not use this code to record the presence of soil inside the <u>conduit</u>. Use code DE (refer to <u>2.7.4.1 Deposits on the wall and/or in the invert—DE</u>) instead.

2.7.4.6 ROOTS—R

Code	Desc	ription
R		s of trees or other plants are growing into the conduit through defects, joints, connections or other entry points including us pipes 1
	Addi	tional Information
		acterisation 1—Type of roots ² acterise the type of root growth as follows:
	Т	Tap roots—a small number of major roots (10 mm or greater) without a significant mass of fine roots
	F	Fine roots—a relatively small number of flexible minor roots
	М	A mass of mostly fine roots, which has developed into an interwoven clump
	RT	Recently cut tap roots—a small number of cut major roots (10 mm or greater) is evident close to the conduit wall
	RF	Recently cut fine roots—a relatively small number of cut minor roots remain close to the conduit wall
	RB	Recently cut interwoven mass of mostly fine roots leaving a beard of roots close to the conduit wall
	Estin	ntification 1—Obstruction nate and record the percentage reduction in conduit cross sectional area from one of the following estimates: 0, 20, 30, 40, 50, 60, 70, 80 or 90%
		imferential location—record if the root entry can be associated with a specific position around the conduit or through or a specific joint or connection. Record the position or extent as one or two clock references.



- (1) Entry of roots will normally be associated with a defect allowing such entry. Where this can be identified ensure that the defect is coded separately.
- (2) In some inspections it may be possible to provide details of trees or other plants causing obstructions in which case record the findings in remarks. Details may include common name, species, location, distance from **conduit** etc.

2.7.5 CODES RELATING TO THE PERFORMANCE OF JOINTS

2.7.5.1 DISPLACED JOINT—JD

Code	Description	
JD	Adjacent conduit segments or pipes are displaced excepuse for constructed curves 1	otionally from their intended position relative to each other. Do not
	Additional Information	
	Characterisation 1—Nature of displacement Record the nature of the displacement as follows:	
	A ^{2,3,4}	Angular displacement—adjacent conduit segments or pipes are not in line. The conduit changes direction at the joint
	L ^{4,5,6}	Longitudinal displacement—the conduit segments or pipes are displaced along the line of the conduit

Code	Description	
	R ^{4,5,7}	Radial displacement—the conduit segments or pipes are displaced in a direction at right angles to the line of the conduit

Quantification 1—Magnitude of displacement

- —for angular displacement:
 - (a) If the angular displacement can be accurately measured—record the angle of displacement between the axes of the two conduit segments or pipes in degrees to the nearest degree.
 - (b) If the angular displacement cannot be measured leave the field blank
- —for longitudinal displacement estimate or measure and record longitudinal displacement², i.e. the distance between the end of the spigot and the inside of the socket of the adjacent conduit segment or pipe, in 10 mm increments as follows: 10, 20, 30, 40 and so on
- —for radial displacement estimate or measure and record radial displacement² in 5 mm increments⁷ as follows: <5, 10, 15, 20 and so on

Quantification 2-Magnitude of gap

—for angular displacement, record the maximum gap width at the joint in mm

Circumferential orientation:

- —for radial displacement record the clock reference of the direction of apparent displacement of the next conduit segment or pipe, i.e. the direction in which the camera will move as it enters the next conduit segment or pipe
- —for angular displacement record the clock reference of the point at which pipe ends are touching or are closest

Notes

- (1) Use code LXX (<u>2.7.8.4 Line of conduit deviates—L</u>) where a change in direction has been deliberately introduced into a <u>conduit</u> by the use of a fabricated or moulded bend fitting (e.g. "lobster-back" bend), by bending a flexible conduit, or by building a smooth curve in masonry.
- (2) Where a **conduit** has been formed into an extended deliberate curve by the use of angular displacement at successive joints, use code JDA with the continuous feature coding to record the start and finish of the curve, giving the feature a suitable label.
- (3) The presence of a single "displaced joint, angular" may indicate poor control of laying during construction, with a need for the **conduit** to suddenly change direction to arrive at the required location of the next maintenance structure.
- (4) Where the sealing ring or gasket is visibly displaced at the joint record this occurrence using code DJS (refer to 2.7.5.2 Defective joint seal —DJS).
- (5) Longitudinal displacements less than 10 mm, radial displacements less than 5 mm and values within known jointing tolerances shall not be recorded. In the case of larger **conduit**, longitudinal joint displacements may exceed 10 mm in which case the asset owner should nominate a set value below which coding is not required. Unless the asset owner nominates a set value below which coding is not required, record all radial displacements 5 mm and larger. Similarly, angular displacements will depend on the permitted angular deflection of the joint which typically could vary from 0 to 6 degrees.
- (6) VC and concrete pipes joined with rolling rubber rings usually exhibit a small but noticeable longitudinal displacement after the pipe is pushed home and 'rebounds' as the rubber relaxes. In smaller diameter pipes, the 'rebound' will be typically less than 10 mm.
- (7) Where radial displacement at a joint is such that a void or soil is visible the defect shall be recorded using code BD (refer to 2.7.2.2 Breaking—B) or code X (refer to 2.7.2.4 Collapsed conduit—X), depending on the magnitude of the displacement.

2.7.5.2 DEFECTIVE JOINT SEAL —DJS

Code	Description
DJS	All or part of the material used to seal the joint between two adjacent components is intruding into the conduit and/or is visibly displaced from its correct position

Code	Description	
	Additional Information	
	Characterisation 1—Type of sealing material Record the type of material used for sealing as follows:	
	R Sealing ring	
	Z Other—record details in remarks	
	Characterisation 2—Nature of defect in seal For a defective seal only, record the nature of the failure using the following codes:	
	N Seal is visibly displaced and/or damaged but not intruding into the conduit	
	HH Seal is hanging or intruding but not broken—lowest point above the centre. (Hanging high)	
	HL Seal is hanging or intruding but not broken—lowest point below the centre. (Hanging low)	
	B Seal is hanging or intruding and is cut, torn or <u>b</u> roken	
	Quantification 1—Other sealant Where the sealing material is intruding into the conduit record the reduction in cross sectional area in the following ranges: <5, 10, 20, 30, 40, 50, 60, 70, 80 or 90%	
	Circumferential location—record the position or extent of the intrusion in the cross section as one or two clock references	

2.7.5.3 DEFECTIVE JOINT WELD—DJW

Code	Description	
DJW	A de	efect in a joint weld is evident
	Add	litional Information
		racterisation 1—Nature of defect ord the nature of the defect as follows:
	С	The weld is <u>c</u> racked
	E	The <u>electrofusion</u> fitting (PE welding only) has incompletely fused with the pipe for part or the full length of the fitting. Welding wires may or may not be visible and a longitudinal joint displacement could be apparent.
	Р	A cured pool of excess solvent cement (PVC and ABS only) is evident in the conduit or fitting adjacent to the joint or as a discrete flap of cured solvent cement
	Z	Other—look for unevenness, malformation, porosity, shrinkage, contamination, lack of fusion etc. Record details in remarks.
	Rec For	racterisation 2—Weld bead (applicable to butt fusion welded polyethylene pipes) ord an "X" if the weld bead intrudes by more than the following: conduits #200 mm internal diameter—5 mm conduits >200 mm internal diameter—10 mm
-	Circumferential location—record the location and the extent of the defect as one or two clock references	

2.7.6 CODES RELATING TO CONNECTIONS AND JUNCTIONS

These codes mostly relate to the structure and performance of a lateral **conduit** (e.g. a property connection sewer and/ or sanitary drain) and its connection to the main conduit. Some of these codes relate to features that also impact on the main conduit.

2.7.6.1 CONNECTION—CN

Code	Description		
CN	Another conduit has been connected to the conduit being inspected, after it has been constructed and commissioned, by making a hole in the original conduit and setting the connecting conduit in place 2,3,4,5,7		
	Additional Information		
	Characterisation 1—Availability Record whether the connection is available (open) or has been closed off as follows:		
	C Connection appears to be <u>closed</u> , <u>capped</u> or plugged adjacent to the main conduit		
	O Connection appears to be available (open). Assume connection to be open unless there is evidence of closure		
	Characterisation 2—Lining of the connection or connecting conduit Record the form of the connection as follows:		
	L The connecting conduit has been <u>l</u> ined ⁶		
	T A <u>T</u> -seal or top hat liner has been used to seal the gap between main conduit and connecting lateral (branch) conduit		
	Quantification 1—Diameter/height Record the diameter/vertical dimension of the connecting conduit to the nearest 5 mm		
	Quantification 2—Width As necessary, measure or estimate and record the horizontal dimension of the connecting conduit, if different from the vertical size, to the nearest 5 mm		
	Circumferential location—record the location of the connection in the cross section as a clock reference		
	Remarks—for non-circular sections record the shape of the connecting conduit in remarks		

✓ Notes —

- (1) Also known as a lateral or branch conduit.
- (2) It is assumed that the majority of connections recorded using this code will be circular in section.
- (3) The asset owner may determine whether the location of a connection should be regarded as a node.
- (4) Use code JN (refer to <u>2.7.6.4 Junction—JN</u>) where the connection is achieved by means of a moulded or prefabricated (factory made) fitting.
- (5) Where **conduit** have been lined and a T-seal or top hat liner has been installed at the connection/junction, it is not possible to determine if the original lateral connection to the main conduit was a connection or a junction. For simplicity in recording, code all these as connections rather than junctions, unless specified otherwise by the asset owner.
- (6) Where the connecting **conduit** has been lined and also a top hat or T seal installed, code T only and add a remark noting the lining of the connecting conduit.
- (7) Where the connection has been effected using a proprietary fitting such as a 'Flowcon Conconnect' or 'saddle', describe the fitting in remarks.

2.7.6.2 INTRUDING CONNECTION—CI

Code	Description
CI	A connecting conduit is projecting into the conduit being inspected and is obstructing the cross sectional area. Where this code is used, the code CN (refer to 2.7.6.1 Connection—CN) must also be used.
	Additional Information
	Quantification 1—Magnitude of intrusion (obstruction)

Code	Description
	Estimate and record the percentage reduction in conduit cross sectional area from one of the following ranges: <5, 10, 20, 30, 40, 50, 60, 70, 80 or 90%
	Circumferential location—record the location of the connection in the cross section as a clock reference

2.7.6.3 DEFECTIVE CONNECTION—CX

Code	Desc	ription	
cx ¹	The connection is defective. Where this code is used the code for a connection CN must also be used ²		
	Addi	tional Information	
	Characterisation 1—Nature of defect ³ Record the nature of the defect as follows:		
	В	The connecting conduit is partially or completely blocked. Describe the obstruction in remarks	
	D	The connecting conduit is damaged. Describe the type of damage in remarks	
	G	There is an unsealed gap between the end of the connecting conduit and the outside of the main conduit. The gap may extend around the complete or part of the circumference of the connecting conduit 4	
	JD	One or more of the joints in the connecting conduit are <u>defective</u> . Describe the defect in remarks ⁴ . For example, no evidence of solvent cement jointing, displaced or damaged seal, welding defects etc	
	LD	The lining in the connecting conduit has been damaged or has become fully or partially detached from the connecting conduit. Describe in remarks	
	Р	The <u>p</u> osition of the connection is incorrect ⁶	
	SE	Soil is entering or is present as a deposit in the connecting conduit	
	sr ⁷	Roots are growing into and/or down the connecting conduit (some roots)	
	TD	A <u>T</u> -seal or top hat liner, which has been used to seal the gap between main conduit and connecting lateral (branch) conduit, has been <u>d</u> amaged or wrinkled or has become fully or partially unsealed	
	Z	Other—record details in remarks	
	Estim	tification 1—Magnitude of obstruction in the connecting conduit nate and record the percentage reduction in cross sectional area from one of the following estimates: 0, 20, 30, 40, 50, 60, 70, 80 or 90%	
	Estim	tification 2—Magnitude of obstruction in the main conduit ⁸ late and record the percentage reduction in cross sectional area from one of the following estimates:	

Notes

5, 10, 20, 30, 40, 50, 60, 70, 80 or 90%

- (1) There may be more than one defect observed in the lateral. Report each defect separately using the appropriate code.
- (2) The process of providing a connection may have caused minor damage to the main **conduit** or the sealing around the conduit may look untidy with broken pieces of conduit used as permanent formwork for concrete sealing and support of the connecting conduit. Most of these features associated with the installation do not warrant reporting unless there is a significant defect in the installation.
- (3) These characterisations describe service or structural defects that affect the operational performance of the lateral or connecting **conduit** or may impact the structural integrity or operational capacity of the main conduit.
- (4) Where infiltration, roots etc are associated with this defect record those defects separately.

- (5) Examples include no evidence of solvent cement jointing, displaced or damaged seal, welding defects.
- (6) Examples include—the connecting **conduit** is directing incoming flow upstream; the connecting conduit does not line up with the hole in the main conduit; there is backfall in the connecting conduit.
- (7) Where roots are growing down the connecting **conduit** and are affecting flow in the main conduit (e.g. reticulation sewer) use code R (refer to **2.7.4.6 Roots—R**) as well.
- (8) The quantification is applicable only where the T seal or top hat has been dislodged and is obstructing the main conduit.

2.7.6.4 JUNCTION—JN

Code	Description	
JN	A junction is a manufactured (moulded or fabricated) fitting provided to enable flow from a minor conduit (usually a property connection) to enter the main conduit ^{1,2,3,4,5}	
	Additional Information	
	Characterisation 1—Availability ⁶ Record whether the junction is available (open) or has been closed off as follows:	
	C ⁷ Junction appears to be <u>closed</u> , capped or plugged adjacent to the main conduit	
	O Junction is open. Assume the junction to be open/available unless there is evidence to the contrary	
	Characterisation 2—Lining of the junction or connecting conduit Record lining observations as follows:	
	L The connecting conduit has been <u>l</u> ined ⁷	
	T A <u>T</u> -seal or top hat liner has been used to seal one or more of the joints between the junction and the main or connecting conduit	
	Quantification 1—Diameter/height Measure or estimate and record the diameter/vertical dimension of the junction branch to the nearest 5 mm	
	Quantification 2—Width As necessary, measure or estimate and record the width of the junction branch, if different from the height to the nearest 5 mm	
	Circumferential location—record the location of the connection in the cross section as a clock reference	

- (1) It is assumed that the majority of junctions recorded using this code will be circular in section.
- (2) The asset owner may determine that where a connecting **conduit** is equal to the size of the conduit or where it is greater than a specified size, the location of a junction should be regarded as a node.
- (3) Use code CN (refer to <u>2.7.6.1 Connection—CN</u>) where another conduit has been connected to the conduit being inspected, after it has been constructed and commissioned, by making a hole in the original conduit and setting the connecting conduit in place.
- (4) IS and IO features are usually indicated by the presence of a square junction with the connecting **conduit** at 12 o'clock. These features should be reported as a junction with IS or IO in remarks as appropriate. An IO will be capped or plugged at the fitting.
- (5) If a junction has been inserted post commissioning, report using code PR (refer to 2.7.7.2 Point repair—PR). If joints or other aspects of the inserted junction are defective, in relation to the main conduit, then report as defective repair.
- (6) This may indicate a junction has been provided during construction for future connection, or it may indicate that the junction has been abandoned and capped.

(7) Where the connecting **conduit** has been lined and also a top hat or T seal installed, code T only and add a remark noting the lining of the connecting conduit.

2.7.6.5 DEFECTIVE JUNCTION—JX

Code	Desc	Description	
JX ¹	The j	The junction is defective. Where this code is used, the code JN (refer to 2.7.6.4 Junction—JN) must also be used.	
	Addi	Additional Information	
	Chara Reco	acterisation 1—Nature of defect ^{1,2} rd the nature of the defect as follows:	
	В	The connecting conduit is partially or completely blocked. Describe the obstruction in remarks.	
	D	The connecting conduit beyond the junction fitting is cracked or <u>d</u> amaged. Describe the damage in remarks.	
	JC	The branch of the junction fitting immediately adjacent to the main conduit is cracked or damaged. Describe the damage in remarks.	
	JD	One or more of the joints in the connecting conduit are <u>defective</u> . Describe the defect in remarks ³ . For example, no evidence of solvent cement jointing, displaced or damaged seal, welding defects etc.	
	LD	The <u>lining</u> in the connecting conduit has been <u>damaged</u> or has become fully or partially detached from the connecting conduit. Describe in remarks.	
	Р	The position of the junction is incorrect ⁴	
	SE	Soil is entering or is present as a deposit in the connecting conduit	
	SR ⁵	Roots are growing into and/or down the connecting conduit (some roots)	
	TD	A <u>T</u> -seal or top hat liner has been damaged or has become fully or partially unsealed	
	Z	Other—record details in remarks	
	Estim	ntification 1—Magnitude of obstruction in the connecting conduit nate and record the percentage reduction in cross sectional area from one of the following estimates: 0, 20, 30, 40, 50, 60, 70, 80 or 90%	
	Estim	ntification 2—Magnitude of obstruction in the main conduit 6 nate and record the percentage reduction in cross sectional area from one of the following estimates: , 20, 30, 40, 50, 60, 70, 80 or 90%	

- (1) There may be more than one defect observed in the lateral. Report each defect separately using the appropriate code.
- (2) These characterisations describe service or structural defects that affect the operational performance of the lateral or connecting **conduit** or may impact the structural integrity or operational capacity of the main conduit.
- (3) Examples include no evidence of solvent cement jointing, displaced or damaged seal, welding defects.
- (4) Examples include—the connecting **conduit** is directing incoming flow upstream; there is backfall in the connecting conduit.
- (5) Where roots are growing down the connecting **conduit** and are affecting flow in the main conduit, use code R (refer to **2.7.4.6 Roots—R**).
- (6) This quantification is applicable only where the T seal or top hat has been dislodged and is obstructing the main **conduit**.

2.7.7 CODES RELATING TO LININGS AND REPAIRS

2.7.7.1 LINING DEFECTIVE—LD

Code	Desc	Description	
LD	The li	The lining ¹ of the conduit is defective	
	Addit	ional Information	
		acterisation 1—Nature of defect rd the nature of the defect as follows:	
	В	The lining is <u>b</u> listered	
	BU	The non-structural liner has <u>bulged</u> (no longer attached but liner is still intact)	
	D ^{2,3}	The structural lining is <u>deformed</u> (other defects may be associated with the deformation)	
	Н	Holes or perforations are evident in the lining	
	E	The end or edge of the lining is defective or irregular e.g. not finished, cut correctly and/or not sealed	
	М	Sections of the lining have become detached and are missing	
	RC	The <u>re-establishment of a customer connection exhibits ragged edges</u> , unsealed around opening and/or perforations of the lining around the opening	
	RM	Rendered cement mortar lining has been removed through deterioration or is missing from lined cast iron, ductile iron, steel or rendered masonry conduit	
	RMCF	Corrosion products from the degradation of rendered cement mortar lining in cast iron, ductile iron, steel pipes and rendered masonry conduits are visible as a build-up on or discolouration of the surface	
	SJ	<u>J</u> oints in a spiral liner have become <u>s</u> eparated or unlocked	
	W	The lining is wrinkled (cured in place only)	
	WD	A weld in the lining is defective	
	x ⁴	The lining has <u>c</u> ollapsed (structural lining only)	
	Z	Other—record details in remarks	
Quantification 1—Loss of cross section in the main conduit Where the defective lining reduces the capacity of the conduit, estimate and record the percentage		tification 1—Loss of cross section in the main conduit e the defective lining reduces the capacity of the conduit, estimate and record the percentage reduction in cross	
		nal area from one of the following estimates (deformation of structural lining is not included) ⁶ : 0, 20, 30, 40, 50, 60, 70, 80 or 90%	
	Circui	mferential location—record the position or extent of the defect as one or two clock references	

- (1) Lining may be incorporated into **conduit units** during manufacture to protect the structural fabric or be installed to rehabilitate and extend the life of an in service **conduit**. Linings may be structural or non-structural.
- (2) In **conduit** rehabilitated with CIPP and close fit linings it is likely that irregularity of the lining will be observed coinciding with radial displacements at joints or other defects in the host pipe. These are not defects in the lining as such, but their presence should be recorded with a general comment.
- (3) Deformation of structural lining shall also be recorded using code D (refer to 2.7.2.3 Deformation—D).
- (4) Deformation >25% shall be recorded as LDX.

2.7.7.2 POINT REPAIR—PR

Code	Description		
PR	A short section of conduit has been repaired Additional Information		
	H Hole repaired externally using a range of materials and techniques, excluding routine patching of lifting holes for stormwater conduits		
	I <u>I</u> njected cementitious material		
	IS Installation of an internal stainless steel sleeve. Where known, record the sleeve type or model in remarks.		
	L <u>L</u> ocalised CIPP lining—less than the complete inspection (asset) length. Where known, record the lining type and/or material ¹ in remarks.		
	R Conduit unit(s) or pipe(s) replaced		
	RE Defects have been <u>re</u> ndered, sealed or applied with cement mortar, epoxy or similar products		
	S Injected sealing material other than cementitious, e.g. chemical grout		
	Z Other—record details in remarks		
	Characterisation 2—Defective repair ² Where the repair has failed or is defective in some way record as follows:		
	B <u>B</u> ellies in the line—replacement conduit units or pipes have been laid without sufficient control such that the line now has irregular line and grade. Only applies to a repair using a replacement conduit unit or pipe.		
	D Rendering layer is <u>d</u> elaminating or has dislodged completely		
	G There are major or irregular gaps or both in the conduit wall at the transition between existing and inserted conduit units or pipes. Only applies to a repair using a replacement conduit unit or pipe code ² .		
	P A CIPP lining patch is displaced or has become defective ^{2,4} . Record details in remarks.		
	S The internal stainless steel sleeve is damaged or defective ^{2,3} . Record details in remarks.		
	Z Other ⁵ —record details in remarks		
	Quantification 1—Length of repaired section Measure or estimate the extent of repair to the nearest 100 mm. If the repair extends over 1 m use the continuous notation		
	Quantification 2—Loss of cross section ⁶ Estimate and record the percentage reduction in cross sectional area associated with the defective repair from one of the following estimates for those defects causing obstruction of the main conduit: <5, 10, 20, 30, 40, 50, 60, 70, 80 or 90%		
	Circumferential location—where the repair affects only a portion of the circumference record the location or extent of the repair as one or two clock references		

- (1) Refer to <u>Table B.2</u> of <u>APPENDIX B MATERIALS AND ACRONYMS</u> for lining material.
- (2) Defects associated with the defective repair such as roots, ingress of soil, or void visible etc. are to be reported with the appropriate code.

- (3) Defects include misaligned with the underlying defect, ineffective sealing allowing infiltration, ingress of soil or root ingress, failed locking mechanism, locking mechanism located in the invert, damage from cleaning equipment, and deformation.
- (4) Defects include ragged ends of the lining patch, delamination of the reinforcing layers, loss of adhesion with the host pipe, and damage from cleaning equipment.
- (5) Other defects could include failure to seal such that infiltration or ingress of soil is occurring, structural failure of the repair, some feature of the repair is catching debris, or the repair has significantly reduced **conduit** cross section etc.
- (6) Reporting obstructions associated with the repair, using the OB code, is not required.

2.7.8 CODES RELATING TO MISCELLANEOUS OBSERVATIONS CONCERNING THE CONSTRUCTION AND PERFORMANCE OF THE CONDUIT

2.7.8.1 ATMOSPHERE IN THE CONDUIT—GAS

Code	Description	
GAS	A potentially hazardous atmosphere was identified at the start ¹ of or during the inspection	
	Additional Information	
	Characterisation 1—Hazard Record the type of hazard detected as follows:	
	HS <u>H</u> ydrogen sulphide	
	CO <u>C</u> arbon monoxide	
	ME <u>M</u> ethane	
	O <u>O</u> xygen	
	OF Other flammable gas—record type of gas where known in remarks	
	Z Other—record details in remarks	
	Quantification 1—Concentration, percentage Record the concentration of gas as a % where this is known	
	Quantification 2—Concentration, parts per million Record the concentration of gas in ppm where this is known	



(1) Gas testing to identify gases present in the maintenance structure/<u>conduit</u> is best conducted immediately after opening the cover. Gas testing during the inspection will only be available with specialised technologies.

2.7.8.2 FLOW IN INCOMING CONNECTING CONDUIT—IF

Code	Description
IF ¹	Connections that show continuous or unusual flow in the connecting conduits. Where this is used the code for a connection or a <u>junction</u> must also be used.
	Additional Information
	Characterisation 1—Nature of flow

Code	Description	
	Record the nature of the flow in the incoming conduit as follows:	
	C <u>C</u> lear flow	
	SW Sea water where it is known or suspected to be the source of flow	
	T <u>Turbid or discoloured flow</u>	
	Characterisation 2 ² —Cross-connection between sewer and stormwater systems	
	SE <u>Sewage appears to be entering the stormwater asset being inspected</u>	
	ST Stormwater or sea water appears to be entering the sewer asset being inspected	
	Quantification 1—Depth Record the water level in the connecting conduit, expressed as a percentage of the vertical dimension of the connecting conduit to the nearest 10% from one of the following estimates: <5, 10, 20, 30, 40, 50, 60, 70, 80 or 90%	
	Circumferential location—record the location of the connection in the cross section as a clock reference	



- (1) The 'IF' code generally only applies to gravity sewers and stormwater drains.
- (2) Leave blank if no wrong connection is observed.

2.7.8.3 WATER LEVEL—WL

Code	Description	
WL	The presence and nature of water and changes in depth of water above invert	
	Additional Information	
	Characterisation 1—Presence of water above the invert Record the presence of the water as follows:	
	F Water flow at constant depth ¹	
	N <u>N</u> o water	
	P Ponding 1,2 of water with or without flow. Record where ponding starts and finishes. Use the continuous code if ponding extends beyond 1 m .	
	Characterisation 2—Clarity of water ³ Record the clarity of the water as follows:	
	C <u>C</u> lear water	
	T <u>Turbid or discoloured water</u>	
	Quantification 1—Level of water and any changes in depth Estimate and record the water depth at the start of every inspection as a percentage of the diameter or vertical dimension to nearest 5% and whenever it changes by more than 10% of diameter or vertical dimension or, in the case of newly constructed conduits, 5% of diameter or vertical dimension	
	Quantification 2—Depth of ponding Estimate and record the maximum water depth as a percentage of the diameter or vertical dimension to the nearest 5%	



- (1) The continuous code should only be used for ponding.
- (2) Ponding of water may be due to the **conduit** being laid at an irregular grade. Where associated with a defective repair use code PR (refer to **2.7.7.2 Point repair—PR**).
- (3) Leave blank if there is no water flow.

2.7.8.4 LINE OF CONDUIT DEVIATES—L

Code	Description	
L	The route of the conduit deviates ¹ . It is not used where the deviation is achieved only by the angular displacement of joints between <u>conduit units</u> .	
	Additional Information	
	Characterisation 1—Horizontal deviation Record the deviation in the horizontal plane as follows:	
	L The conduit curves to the left	
	R The conduit curves to the <u>rig</u> ht	
	Characterisation 2—Vertical deviation Record the deviation in the vertical plane as follows:	
	D The conduit curves down	
	U The conduit curves <u>up</u>	

Notes

(1) Deviation may be by curving of the **conduit** or by the use of a bend fitting(s) or by constructing a curve in the case of masonry and polyethylene conduits. Fabricated bend fittings – 'lobster back' bends may be observed in concrete, steel, polyethylene or other materials are to be reported using this code.

2.7.8.5 VERMIN-V

Code	Description	
V	Living creatures (rodents, reptiles, mammals, birds, insects 1) actually observed	
	Additional Information	
	Characterisation 1—Type of living creature Record the type of living creature observed as follows:	
	R	<u>R</u> odent
	Z	Other—record details in remarks. Do not code cockroaches.
	Characterisation 2—Location Record the location of the observation as follows:	
	S In the conduit	
	C In a connection	
	J In an open joint	

Code	Description	
	Z Other—record details in remarks	
	Quantification 1—Numbers Record the number of living creatures observed	

Notes

(1) For insects, only record an infestation.

2.7.8.6 LIFTING HOLE—LH

Code	Description	
LH	The presence of a lifting hole and characteristics is recorded (for concrete stormwater pipes only) 1,2,3,4,6	
	Additional Information	
	Cha	racterisation 1—Lifting hole formation
	М	The hole was formed in the <u>m</u> anufacturing process
	В	A hole appears to have been <u>b</u> ashed in to facilitate lifting with a sling and bar
	Characterisation 2—Lifting hole sealing	
	U	The lifting hole is <u>unsealed</u> —there is no visible plug or seal in the hole. Soil or a void will be visible 3.
	S	The lifting hole has been sealed with a proprietary plastic plug, concrete or other material. Note unusual materials in remarks.
	Circumferential location—record the location as a single clock reference ⁵	

- (1) Lifting holes are typically used in reinforced concrete stormwater pipes to facilitate lifting with a sling eye pushed through the hole and secured with a bar inside the pipe. The lifting hole is in the centre of the pipe length and when lifting at this point the pipe is close to balanced. Lifting holes are often associated with other defects.
- (2) If a lifting hole is properly sealed and located at 12 o'clock it is not required to log an observation. The asset owner however may specify that this code is to be used to report on the condition of each lifting hole.
- (3) Where defects such as cracking, ingress of soil, infiltration, soil or void visible, reinforcement visible etc. are observed at the lifting hole they shall be recorded using the appropriate code.
- (4) Minor spalling or reinforcement visible around the lifting hole is typical and may be ignored unless otherwise directed or specified by the asset owner.
- (5) A clock reference location other than 12 o'clock may indicate the pipe's structural integrity could be compromised.
- (6) The asset owner may specify the use of this code or the conditions under which it is to be used.

2.7.9 MISCELLANEOUS CODES RELATING TO THE ADMINISTRATION OF THE INSPECTION

2.7.9.1 START NODE—ST

Code	Description		
ST	Records information about the node at the start of the inspection ¹ – 0.0 m		
	Additional Information		
	Characterisation 1—Nature of node Record the type of node as follows:		
	В	Bend in line	
	С	Major connection without a maintenance structure	
	СМ	Change in material of conduit	
	DE	<u>D</u> ead <u>e</u> nd	
	GJP	Grated junction pit	
	GSP	Grated side entry pit	
	Ю	Inspection opening	
	IS	Inspection shaft	
	J	Junction or connection with another conduit	
	LH	<u>Lamphole</u>	
	МС	Maintenance chamber	
	МН	Maintenance hole	
	MS	Maintenance shaft	
	0	Outfall or culvert headwall	
	RE	Rodding eye	
	SP	Side entry pit	
	TMS	Terminal maintenance shaft	
	VD	Vertical drop	
	Z	Other—record details in remarks	
	Quan	tification 1—Node reference ² or easting coordinate	
	Quan	tification 2—Grid reference ² or northing coordinate	

Notes

(1) The operator should make every effort to obtain the node numbers from the asset owner. Without asset owner supplied information on the node reference the operator shall assign a unique description to the node such as GPS coordinates where this can be given to an accuracy of ±0.5 m or a description relating to landmarks such as property lot numbers or property boundaries.

(2) It will not normally be necessary to report both the node reference Q1 and the grid reference Q2.

2.7.9.2 FINISH NODE—FH

	ription			
Records information about the node at the finish of the inspection 1,3 Additional Information Characterisation 1—Nature of node Record the type of node as follows:				
			В	Bend in line
			С	Major connection without a maintenance structure
СМ	Change in material of conduit			
DE	<u>D</u> ead <u>e</u> nd			
DJ	Camera or scanner has reached the <u>drop</u> junction (external drop) at a maintenance structure and cannot complete the inspection all the way to the maintenance structure			
GJP	Grated junction pit			
GSP	Grated side entry pit			
Ю	Inspection opening			
IS	<u>Inspection shaft</u>			
J	<u>J</u> unction or connection with another conduit			
LH	<u>Lamph</u> ole			
МС	<u>M</u> aintenance <u>c</u> hamber			
МН	<u>M</u> aintenance <u>h</u> ole			
MS	<u>M</u> aintenance <u>s</u> haft			
0	Qutfall or culvert headwall			
RE	Rodding eye			
SP	Side entry pit			
TMS	Terminal maintenance shaft			
VD	<u>V</u> ertical <u>d</u> rop			
Z	Other—record details in remarks			
Quant	tification 1—Node reference ² or easting coordinate			
Quant	tification 2—Grid reference ² or northing coordinate			
	Additi Chara Recor B C CM DE DJ GJP GSP IO IS J LH MC MH MS O RE SP TMS VD Z Quant			

Notes

(1) The operator should make every effort to obtain the node numbers from the asset owner. Without asset owner supplied information on the node reference the operator shall assign a unique description to the node such as

GPS coordinates where this can be given to an accuracy of ± 0.5 m or a description relating to landmarks such as property lot numbers or property boundaries.

- (2) It will not normally be necessary to report both the node reference Q1 and the grid reference Q2.
- (3) End continuous codes before finishing inspection.

2.7.9.3 GENERAL COMMENT—GC

Code	Description	
GC	A remark which cannot be included in any other way	
	Additional Information	
	Quantification 1—Urgency Indicate a situation that is a matter of urgency such as imminent structural or service failure, a public safety issue or some other circumstance that needs to be drawn to the attention of the asset owner by recording "U" as Quantification 1	
	Remark—explain the reason for the urgency and contact the appropriate personnel within the asset owner's organisati report with details	

2.7.9.4 GENERAL PHOTOGRAPH—GP

Code	Desc	Description	
GP	A still photograph has been taken to record the general condition of the conduit 2		
	Addi	Additional Information	
		acterisation 1—Horizontal orientation of camera re is any possibility of confusion the horizontal orientation of the camera shall be defined as below ²	
	В	The camera is pointing directly opposite the direction of travel (<u>b</u> ackward)	
	F	The camera is pointing in the direction of travel (forward)	
	L	The camera is pointing to the <u>l</u> eft of the previous direction of travel	
	R	The camera is pointing to the <u>right</u> of the previous direction of travel	
	Characterisation 2—Vertical orientation of camera ³ If there is any possibility of confusion the horizontal orientation of the camera shall be defined as below		
	D	The camera is pointing down	
	Н	The camera is pointing approximately <u>h</u> orizontally	
	U	The camera is pointing <u>u</u> p	

- (1) Where the **conduit** is a stormwater drain with lifting holes, the general condition photograph shall include a typical patched hole.
- (2) Still images captured with the lens in a zoomed position should be overwritten with 'ZOOMED' placed in a location that does not obscure the feature(s) of interest. Where coding/reporting is not carried out during inspection, or if the camera system does not have this feature, any 'ZOOMED' image shall be noted in remarks. This is not applicable to fixed zoomed cameras, as everything is zoomed.
- (3) This characterisation information need not be duplicated if it is adequately recorded by a position "mimic" display.

2.7.9.5 LOSS OF VISION—LOV

Code	Desc	Description	
LOV	The view within the conduit is obscured		
	Addi	tional Information	
		acterisation 1—Reason rd the reason for the loss of vision as follows:	
	D	Debris or obstruction ¹	
	F	Unable to focus 1	
	L	<u>L</u> ine deviates ¹	
	LI	Light source insufficient	
	S	Condensation (Steam) or fog	
	UW	Camera is <u>u</u> nder <u>w</u> ater	
	Z	Other—record details in remarks	



(1) Applicable to fixed zoom cameras.

2.7.9.6 INSPECTION (SURVEY) ABANDONED—SA

Code	Description	
SA	The inspection has been terminated before the destination node was reached. Where this is due to an obstruction it shall be coded separately using the appropriate main code ¹ .	
	Addi	tional Information
		acterisation 1—Reason rd the reason for the termination as follows:
	D	<u>D</u> ebris ²
	EC	End of cable
	EF	Equipment failure
	F	Unable to focus ²
	HW	High flow (water) level
	L	Line deviates ²
	LI	Light source insufficient
	ОВ	<u>Ob</u> struction
	R	Roots
	Z	Other—record details in remarks

Notes

- (1) A major defect code should generally precede this code, except in the case of equipment failure. Record the reason code before using this code.
- (2) Applicable to fixed zoom cameras.

2.7.10 CODES FOR CHANGING HEADER INFORMATION

2.7.10.1 CHANGE OF LINING—LC

Code	Description		
LC	Allows reporting a change in the method and/or material used for conduit lining—ACE and ACF ¹		
	Additional Information		
	Characterisation 1—New method 1,2,3 _ Where a conduit has been lined, record the method of lining now used from the following codes:		
	CFL Close fit lining		
	CIP <u>Cured in place lining</u>		
	LCP Lining with continuous pipes, e.g. a pipe string welded up on the surface prior to insertion		
	LDP <u>Lining with discrete pipes or conduit units and joined in situ</u>		
	MFL <u>L</u> ining inserted during <u>manufacture</u> (Manufacturer's lining)		
	SEG Segmental lining		
	SPL <u>Sprayed lining</u>		
	SWL <u>S</u> pirally <u>w</u> ound <u>l</u> ining		
	Z Other—record details in remarks ⁴		
	Characterisation 2—New material Record the material now used for conduit lining using <u>Table B.2</u> of <u>APPENDIX B — MATERIALS AND ACRONYMS</u> . The		

Notes

(1) Where a top hat or T-lining has been inserted at a connection or junction, a change of lining shall not be recorded.

structural characteristics of the lining shall be applied to the scoring of defects in accordance with Appendix B.

- (2) Patch liners (point repairs) shall not be recorded as a change of lining.
- (3) Where system data (GIS) does not show the presence of a rehabilitation liner, a 'change of lining' shall be recorded at the start of the inspection.
- (4) Where the lining method cannot be identified from the nominated techniques, describe the characteristics in remarks. If the lining is no longer present due to non-installation in manufacturing or rehabilitation, note the lack of lining in remarks.

2.7.10.2 CHANGE OF CONDUIT MATERIAL—MC

Code	Description
MC	Allows updating of code ACD when the conduit material changes between nodes 1,2,3

Code	Description Additional Information		
	F Flexible		
	M Masonry		
	R Rigid		
	Remark—report that there is more than one material in the inspection in field ADE in the header		



- (1) Where the **conduit** material apparent at the start of the conduit is different to the system records (GIS) and recorded in the header data, the material shall be determined from its characteristics and recorded as a change of material.
- (2) Where the **conduit** is also lined code LC (refer to **2.7.10.1 Change of lining—LC**) shall also be recorded.
- (3) Where the **conduit** has been lined with a structural liner the characteristics of that liner shall be applied in lieu of the original host conduit material.

2.7.10.3 CHANGE IN CONDUIT UNIT LENGTH—PC

Code	Description
PC	Allows reporting a change in typical conduit (pipe) unit length ¹ between nodes—code ACG
	Additional Information



(1) The typical conduit unit length is generally not known before the inspection.

2.7.10.4 CHANGE OF CROSS SECTION—CC

Code	Description	
CC	Allows reporting that the cross section of the conduit has changed between nodes—original cross section code ACA	
	Additional Information	
	Characterisation 1—Shape Record the new cross sectional shape as follows:	
	A Arch shaped—circular soffit, flat invert, parallel sides	
	C <u>C</u> ircular	

Code	Description	
	Е	Oviform (egg shaped)
	0	<u>O</u> val
	R	<u>R</u> ectangular
	U	U Shape—circular invert, parallel sides
	Z	Other—record details in remarks
	Quantification 1—Diameter/height ¹ Estimate and record the diameter or height of the new cross section to the nearest 10 mm	
	Quantification 2—Width ¹ Estimate and record the width of the new cross section to the nearest 10 mm—not required when both dimensions are the same	

Notes

(1) For many inspections conducted without laser profiling, the actual dimensions of the changed cross section will be difficult to estimate. Operators should gauge the best they can the dimensions of the new cross section. Reference to records is also advised.



PART 3: INSPECTION OF MAINTENANCE STRUCTURES - THE DESCRIPTION AND ENCODING OF OBSERVATIONS

Conduit Inspection Reporting Code of Australia Version 4.1

WSA 05-2020

PART 3

3 INSPECTION OF MAINTENANCE STRUCTURES — THE DESCRIPTION AND ENCODING OF OBSERVATIONS

3.1 PURPOSE

This section specifies a system to identify and record features and defects observed during the inspection of a maintenance structure by visual and/or complementary technologies.

3.2 METHODS OF INSPECTION

The procedures of this section are applicable to inspections of maintenance structures conducted by the entry of personnel and/or by the movement of a CCTV camera or a 3D optical pipeline scanner through the structure. However, the standard classification, description and encoding of maintenance structure condition is equally applicable, with appropriate procedural modification, for inspections carried out by other camera types or visual inspection methods. See **1.6.2 General (maintenance structure)** for further explanations of inspection techniques.

This Code has been written on the assumption that, to manage and collate the data collected, all observations will be encoded directly into a computerised logging system. It would be possible to encode into a written coding sheet, but this is likely to be cumbersome in practice, and is not recommended.

3.3 MAINTENANCE STRUCTURES — CODING SYSTEM

The coding system for maintenance structures comprises a series of codes that can be used to describe the defects and features observed as well as other data collected during the inspection. For operator convenience, clauses describing the operation of the process and formally specifying requirements have been separated from the actual codes as follows:

- (a) Header information relating to the maintenance structure as a whole, the bulk of which would normally be collected from the records of the asset owner. This information is described in 3.4 MAINTENANCE STRUCTURES—HEADER INFORMATION and the codes are described in 3.6 MAINTENANCE STRUCTURE HEADER CODES.
- (b) Observation codes detailing information about individual observations of defects and features encountered within a maintenance structure. The information is described in <u>3.5 ENCODING OF OBSERVATIONS</u> and the codes are described in <u>3.7 CODES FOR REPORTING THE INSPECTION OF MAINTENANCE STRUCTURES</u>.

The main codes for describing maintenance structures are summarised in <u>APPENDIX H — SUMMARY OF MAIN</u> <u>CODES FOR DESCRIBING MAINTENANCE STRUCTURES</u>.

3.4 MAINTENANCE STRUCTURES—HEADER INFORMATION

3.4.1 RECORDING OF INFORMATION

Header information shall be entered at the start of each inspection. *The appropriate header codes are listed in brackets below and explained in* **3.6 MAINTENANCE STRUCTURE HEADER CODES**. Any changes to the header information identified during the inspection shall be recorded using the change codes set out in **3.7.12 Codes for changing header information during an inspection**.

3.4.2 MANDATORY INFORMATION

The following information shall be recorded in all circumstances:

- (a) Name of asset owner or engaging agency (CAM);
- (b) Asset owner or engaging agency's job reference (CBJ);
- (c) Name of the company performing the inspection and name of the operator (CBN, CBH);

- (d) Name of the Coder/Assessor completing report (CBL);
- (e) Inspection company's job reference (CBI);
- (f) Date of inspection (CBE);
- (g) Coding standard employed and software version compliance reference (CBA);
- (h) Where applicable, the previous coding standard used for reporting (CBB);
- (i) Method of inspection (CBE);
- (j) Details of equipment used (CDG);
- (k) Time of commencement of inspection (CBG);
- (I) Whether the maintenance structure was pre-cleaned (CCL);
- (m) Signs of surcharge (CDF);
- (n) Precipitation at the time of inspection (CDA);
- (o) Description of any measures taken to control flow during the inspection (CDC);
- (p) Cover details (CCO, CCP, CCQ, CCX, CCY);
- (q) Details of steps and ladders (CCR, CCS);
- (r) Identification of the maintenance structure by node reference or coordinates (CAA, CAB, CAC, CAD);
- (s) Type of structure (CAR);
- (t) The vertical reference point (CBC);
- (u) The circumferential reference point (CBD);
- (v) Textual description of the location e.g. street address, directory reference (CAJ, CAN, CAO);
- (w) Atmosphere (CDD);
- (x) Type of effluent use of system (CCJ);
- (y) Any other information required by the asset owner (CEA, CEB, CEC, CED, CEE); and
- (z) Condition statistics. These fields may be filled automatically by software at the completion of the inspection (CFA, CFB, CFC, CFD, CFE, CFF, CFG, CFH, CFI, CFJ, CFK, CFL).

3.4.3 OPTIONAL INFORMATION

Where practicable and/or where required in the inspection contract, the operator may be able to include the following information within the inspection report:

- (a) Access details (CCA, CCB, CCC);
- (b) Ambient temperature (CDB);
- (c) Classification of the type of location (CAL);
- (d) Details of any hazards associated with the location and/or condition of the structure (CDG);
- (e) Unusual devices or features within the maintenance structure (CDG);
- (f) Details of trees known to be causing root problems (CDG); and
- (g) Errors in asset data such as location of connections, vents, material types, diameters etc (CDG).

3.4.4 INFORMATION TO BE PROVIDED BY THE ASSET OWNER

Where available, the asset owner shall provide information relevant to the inspection that will enable the operator to prepare equipment and resources for the inspection and to ensure details of the asset are correctly recorded in reports.

The following information should be provided:

- (a) Node and asset numbers for the asset being inspected;
- (b) Name of suburb, district or conduit system as defined by the asset owner;
- (c) Plans showing maintenance structure in relation to streets, properties and other system assets;
- (d) Purpose of inspection, e.g. condition assessment;
- (e) Type of maintenance structure, e.g. MH, grated side entry pit etc;

- (f) Details of access cover and frame, e.g. DN 600 ductile iron circular watertight and gastight cover;
- (g) Details of step irons or ladder, e.g. stainless steel monorail ladder;
- (h) Material forming the fabric of the structure, e.g. concrete;
- (i) Material and lining (See <u>APPENDIX B MATERIALS AND ACRONYMS</u>);
- (j) Repair locations;
- (k) Recorded depth of maintenance structure in m;
- (I) Year the maintenance structure was placed in operation; and
- (m) The asset owner's criticality classification of the maintenance structure.

Operators should be made aware that information provided by the asset owner may not always be correct such that, in the process of undertaking the inspection, operators should confirm such parameters as structure depth, material, lining, configurations and other relevant features. Editing of the report header may be required where a discrepancy exists between asset records and observations/measurements of the maintenance structure parameters.

Where parameters of the maintenance structure such as type, material, depth etc. are not known before the inspection, the operator shall determine those parameters during inspection and report.

To assist in the interpretation of features, operators should have access to detailed maintenance structure drawings for the structures being inspected where this is possible.

3.5 ENCODING OF OBSERVATIONS

3.5.1 GENERAL

Each observation of a feature within a maintenance structure shall be described by one or more main observation codes, each of which shall be accompanied, as appropriate, by data fields of supporting information. Although the process of data encoding could be carried out and reported manually, it is presumed that operators will encode directly into computer equipment using a software program that is acceptable to the asset owner.

It should be noted that "feature" is used as an all-encompassing term to include defects, descriptions, types, artefacts, condition and the like, "camera" includes scanner and "video" includes digital.

3.5.2 RECORDING OF INFORMATION

Each feature shall be recorded using an observation type code, which is a main code that broadly describes the feature, together with the following additional information where required:

- (a) Characterisation(s)—up to two codes that describes the feature in more detail;
- (b) Quantification(s)—up to two values that measures the feature;
- (c) Circumferential location—up to two clock face references that locate the position of the feature around the circumference;
- (d) Joint—identifies when the feature is associated with a joint between two adjacent prefabricated units or a construction joint for cast in-situ structures;
- (e) The descriptive location—a code describing the part of maintenance structure affected, e.g. <u>chamber</u> or <u>benching</u>;
- (f) The vertical location—the distance from the stated reference point;
- (g) A continuous observation code to denote features that continue over a significant length;
- (h) Photograph reference;
- (i) Video reference—to locate a particular feature within the continuous video record of the inspection;
- (j) Video clip reference—to locate a particular feature within the collection of video clips; and
- (k) Remarks—text that describes aspects of the feature that cannot be described any other way.

The asset owner may specify which features are to be recorded and the amount of detail to be recorded for each feature.

3.5.3 MAIN OBSERVATION CODES

The main observation codes, which are used to describe features, are set out in 3.7 CODES FOR REPORTING THE INSPECTION OF MAINTENANCE STRUCTURES together with a description of each feature and the use of the code. Features shall only be recorded using these codes. Where necessary two or more codes shall be used to describe a complex situation not covered by a single code.

For ease of use these codes have been formed into 10 groups:

- (a) Codes relating to structural integrity;
- (b) Codes specific to masonry structures;
- (c) Codes relating to joints and jointing;
- (d) Codes relating to leakage through the structure;
- (e) Codes relating to connecting conduits and flows;
- (f) Codes relating to lining and repairs;
- (g) Codes relating to operational performance;
- (h) Codes relating to access and safety;
- (i) Miscellaneous observations; and
- (j) Miscellaneous codes relating to the administration of the inspection.

This grouping is intended to make it easier to find the reference to a particular code. The grouping should not be used to interpret or otherwise restrict the meaning of the terms. The code whose definition seems most appropriate to the feature should be used regardless of this grouping.

3.5.4 SUB-CODES

3.5.4.1 CHARACTERISATION SUB-CODES

Characterisation sub-codes further describe the feature. Up to two types of characterisation may be required for each observation type, depending on the nature of the feature. *Meaningful names have been assigned to the characterisation data field in many cases to assist comprehension.*

Characterisation codes shall be recorded in the order in which they are provided.

Where a feature cannot be directly observed but there is evidence to suggest a feature exists, then it shall be coded with the appropriate main code and characterisations. Where such a feature is likely, a remark shall be included to indicate that the feature is suspected and may warrant further investigation.

Any other relevant information that cannot be communicated using the prescribed codes shall be the subject of a General Comment code (refer to 3.7.10.3 General photograph—HGP).

3.5.4.2 QUANTIFICATION SUB-CODES

Up to two values shall be recorded as specified in the various codes described in 3.7 CODES FOR REPORTING THE INSPECTION OF MAINTENANCE STRUCTURES to record the magnitude of the feature. Some features require the actual measurement or estimate of a dimension, %, number etc. In other cases, the operator is required to make a personal judgement of severity. Some codes allow a choice between the two modes of reporting. Meaningful names have been assigned to the quantification data field in many cases to assist comprehension.

Percentages of deformation of a structure that indicate loss of structural integrity shall be expressed in whole numbers to the nearest 5%. Deformation less than 5% shall be recorded as <5%.

Where deformation is not measurable because it is so small as to be indiscernible, the feature should not be coded as its usefulness relies on it being quantified. Percentages >25% shall be coded as a **collapse**.

Percentages of loss of cross-sectional area of the channels, <u>chamber</u>, shafts etc. due to roots and other obstructions and which affects hydraulic flow, surcharge capacity and/or serviceability shall be expressed as a whole numbers to the nearest 5%. Loss of cross-sectional area less than 5% shall be recorded as <5%.

Other physical measurements, e.g. separation of masonry courses, depth of missing mortar, loss of wall thickness etc. shall be expressed in whole number to the nearest 5 or 10 as appropriate to the feature.



The above requirements shall not apply to crack widths

3.5.4.3 CIRCUMFERENTIAL LOCATION

Where specified in 3.7 CODES FOR REPORTING THE INSPECTION OF MAINTENANCE STRUCTURES for each code, the position of the feature around the circumference of the maintenance structure (or perimeter for non-circular maintenance structures) shall be recorded using the hours of an imaginary clock face reference under Table 3.1. The imaginary reference clock shall be set relative to the outgoing sewer (see Figure 3.1) as defined in code CBD (refer to 3.6.3 Header codes for reporting inspection details). It is recommended that the imaginary clock be set with 12 o'clock to the outgoing sewer (CBD = T).

Where there is more than one outgoing conduit at the same level, the reference point shall be the largest of those conduits.

Where a feature is repeated around the circumference of the maintenance structure at the same vertical location, each occurrence of the feature shall be encoded separately.

A small feature requires a single imaginary clock reference to approximately define the position of its centre. A larger feature requires a pair of references to approximately define its extent. The clock reference data field allows for a pair of clock references. For coding purposes any single clock reference shall occupy the first clock reference position.

Where 3.7 CODES FOR REPORTING THE INSPECTION OF MAINTENANCE STRUCTURES requires that the start and finish clock face references be given these shall be recorded in the clockwise direction. The circumferential location of a feature occupying the entire periphery shall be recorded as "from 12 o'clock to 12 o'clock". Where a code only requires only a single clock face reference this shall relate to the centre/mid-point of the feature.

Clock references shall be given to the nearest hour, as shown in examples given in Figure 3.1.

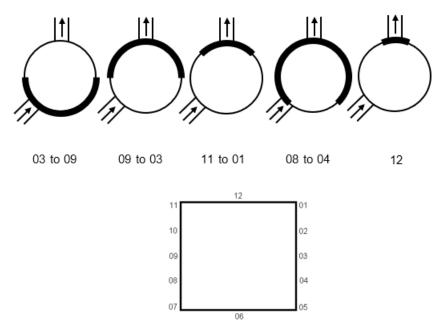


Figure 3.1 CLOCK FACE REFERENCES IN SHAFTS OF MAINTENANCE STRUCTURES

3.5.4.4 OBSERVATION ASSOCIATED WITH A JOINT

Where a feature occurs at a joint between two adjacent prefabricated units or concerns a feature that is structurally or otherwise associated with a joint, this association shall be recorded in the joint code by inserting the character "J" into the data field.

3.5.4.5 DESCRIPTIVE LOCATION

The location of the observation within the maintenance structure shall be recorded as follows (see also Figure 3.2):

- (a) Cover and frame;
- (b) adjusting construction;
- (c) Shaft;
- (d) Straight back taper or squat cone;
- (e) Reducing slab;
- (f) chamber;
- (g) Landing or staging bars;
- (h) benching;
- (i) Channel or chase; or
- (j) invert.



Figure 3.2 ILLUSTRATION OF TYPICAL MANHOLE FEATURES

3.5.4.6 VERTICAL LOCATION

The vertical reference point for all observations shall be recorded as code CBC (refer to <u>3.6.3 Header codes for reporting inspection details</u>). The vertical location of each feature shall be recorded in metres, to one decimal place, relative to such reference point.

3.5.4.7 FEATURES AT THE SAME LOCATION

Where more than one feature occurs at a single location, or where a feature cannot be described with only one code, a separate code shall be logged for each observation.

Where features are observed at the same vertical location ± 0.1 m, the worse or most extreme feature shall be recorded and the lesser features ignored and not recorded.

For example, where cracking and <u>breaking</u> are observed at the same vertical location only breaking should be recorded and where separated and missing masonry units are observed at a vertical location only missing masonry units should be recorded.

3.5.4.8 PHOTOGRAPH REFERENCE

A reference number to identify any still photographs or still computer images shall be recorded against an observation wherever a photograph is taken. If the photograph depicts an uncoded feature the code HGP (refer to <a href="https://doi.org/10.3.3.10.3.3.10.3.3.10.3.3.10.3.3.10.3.3.10.3.3.10.3.3.10.3.3.10.3.3.10

3.5.4.9 VIDEO LOCATION REFERENCE

Where the inspection is recorded electronically, a reference that allows the observation to be located on the video file shall be recorded. The method of locating used shall be stated in the header information code CBK (refer to 3.6.3 Header codes for reporting inspection details). Where a time based method is used, the time shall be recorded in line with ISO 8601 in an hh:mm:ss format.

3.5.4.10 VIDEO CLIP REFERENCE

Where an observation of a feature or defect is illustrated by a video clip, a reference to locate the video clip shall be recorded.

3.5.4.11 SPECIFIC REMARKS

Where a feature cannot be fully described by a code, further information shall be recorded in the remarks field for that observation. Such a remark should be as short as possible. Where additional explanation or description of the feature is necessary, the code HGC (refer to 3.7.10.2 General comment—HGC) shall also be used.

Code HGC alone shall not be used to describe a feature that can be described by a code.

3.5.5 LOGGING PROCEDURES

3.5.5.1 **GENERAL**

A separate report shall be produced for each maintenance structure.

3.5.5.2 START OF INSPECTION

Before the logging of features can proceed, the following observations shall be encoded at longitudinal location 0.0 m to denote the start of every inspection:

- (a) Start feature code (refer to <u>3.7.11.1 Start feature—HST</u>), and its details to record and confirm the details of the start node;
- (b) Water level code (refer to 3.7.9.10 Water level—HWL), if appropriate; and
- (c) Other code or observation as noted in the asset owner's technical specification.

3.5.5.3 INSPECTION ABANDONED

Inspection (Survey) Abandoned code (refer to <u>3.7.11.3 Inspection (Survey) abandoned—HSA</u>) and the reason shall be encoded at the abandonment of an inspection. Ensure the feature or defect preventing the inspection continuing is coded before entering this code.

Code HGC (refer to <u>3.7.10.2 General comment—HGC</u>) shall be used to indicate the actions, if any, to be taken to complete the inspection.

Table 3.1 EXAMPLE OF OBSERVATION FORMAT

Code	Ch1	Ch2	Q1	Q2	Circumferen	tial location	Joint	Descriptive location	Vertica locatio
HCN	PM	IC	C301	150				н	2.2
НСР	С	1	100		6			н	2.2

Notes

No values shown for photo reference, video clip reference and remarks.

An example of the record for a 100 mm diameter intruding lateral connection – a rising main/pressure main discharge to the maintenance structure at bench level and intruding 150 mm into the **chamber** at a distance of 2.2 m from the vertical reference point is shown in **Table 3.1**.



Two codes are necessary to describe the feature.

3.6 MAINTENANCE STRUCTURE HEADER CODES

3.6.1 GENERAL

These codes are used to describe information about the maintenance structure and aspects of the inspection.

3.6.2 HEADER CODES TO DESCRIBE THE LOCATION OF THE INSPECTION

Code	Name	Data to be recorded
CAA	Node reference	The node reference of the maintenance structure as specified by the client
CAB	Node coordinate	The grid reference (easting and northing coordinates) of the node
CAC	Mapping and datum system	When coordinates are used, record the grid datum system used
CAD	Mapping grid zone	When coordinates are used, record the appropriate grid zone
CAE to CA	I – not used	
CAJ	Location	A description of the location of the maintenance structure e.g. street name. Include a street director reference where this is a normal method of defining location.
CAL	Location type	The type of location of the maintenance structure as follows:
		B <u>B</u> ushland / parkland
		BO Inside a permanent building (<u>B</u> uilt <u>o</u> ver)
		C In a waterway (Creek) or body of water
		D On property with buildings (<u>D</u> eveloped)
		E <u>E</u> asement
		F In a <u>f</u> ootway beside road
		G <u>G</u> ardens
		M In other pedestrian area (<u>M</u> all)
		MR <u>M</u> otorway or operational <u>r</u> ailway
		NS In verge beside a road (Nature strip)
		P In a field (Paddock)
		R In a <u>r</u> oad carriageway
		RE Road to easement
		W <u>W</u> ater foreshore
		Z Other – further details shall be stated in remarks
CAM	Asset owner or engaging agency	The name of the asset owner or engaging agency for inspection of the maintenance structure
CAN	Town or suburb	The name of the town or suburb as specified by the asset owner
CAO	District	The name of the district as specified by the asset owner
CAP Name of conduit system The name of the conduit system or a conduit system reference owner		The name of the conduit system or a conduit system reference as specified by the asset owner

Code	Name	Data to be recorded	
CAQ	Land ownership	Class	of land ownership as follows:
		С	Public land (Common or Crown land)
		Q	Not known (Query)
		Т	Private land (Torrens Title)
CAR	Node type	The ty	ype of node as follows:
		ERS	Maintenance structure as part of emergency relief structure
		GC	Gas check (water seal) manhole
		GJP	Grated junction pit
		GSP	Grated side entry pit
		Ю	Inspection opening
		IS	Inspection shaft
		LH	<u>L</u> amp <u>h</u> ole
		MC	Maintenance chamber
		МН	<u>M</u> aintenance <u>h</u> ole
		MS	<u>M</u> aintenance <u>s</u> haft
		0	<u>O</u> utfall
		SC	Sealed chamber
		TMS	Terminal maintenance shaft
		VD	Vertical drop
		OF	Offset access to main structure
		Z	Other special structure—a description shall be recorded using the general header comment (code CDE) as the next code

3.6.3 HEADER CODES FOR REPORTING INSPECTION DETAILS

Code	Name	Data to be recorded
CBA	Standard	The version of the standard and software used to record the data (refer to APPENDIX A — SPECIFICATION FOR SOFTWARE)
СВВ	Original coding system	The name of the original coding system where the coding has been translated from an earlier version or from another system
CBC	Vertical reference point	The reference point for vertical location as follows:
		AHD <u>A</u> ustralian <u>H</u> eight <u>D</u> atum
		C <u>C</u> over level
		LD <u>L</u> ocal <u>d</u> atum
		O Invert of the lowest outgoing conduit

Code	Name		Data to be recorded			
		Z	Other—further details shall be recorded using the general header comment (code CDE) as the next code			
CBD	Circumferential reference point		eference point for circumferential location as follows:			
			Lowest and largest outgoing conduit is 6 o'clock (Six)			
		Т	Lowest and largest outgoing conduit is 12 o'clock (Twelve)			
		Z	Other—further details shall be recorded using the general header comment (code CDE) as the next code			
CBE	Method of inspection	The m	ethod of inspection as follows:			
		FZ	Inspection by means of a fixed zoom camera			
		М	Direct inspection of maintenance structure by an operator (Manual)			
		PS	Inspection by means of a remotely controlled 3D optical "manhole" scanner			
		S	Inspection from the surface only			
		TV	Inspection by means of a remotely controlled television camera			
		L	Any form of inspection supplemented with <u>laser scanning</u> . Report details in header comments field			
		Z	Other—further details shall be recorded using the general header comment code (CDG) as the next code			
CBF	Date of inspection	01-04	d the calendar date of the inspection using the DD-MM-YYYY format, e.g2006 means 1 St April 2006. ng zeros shall be included where necessary.			
CBG	Time of inspection	The local time as specified in ISO 8601 using the hh:mm format, e.g. 14:41 means 2.41 pm local time. Leading zeros shall be included where necessary.				
СВН	Name of operator		d the name of the operator, company, work group or individual engaged to conduct spection. Record the name of the individual person conducting the inspection where priate.			
СВІ	Inspection company's job reference	The in	spection company's job reference			
CBJ	Asset owner or engaging agency's job reference	The a	sset owner or engaging agency's job reference			
CBK	Not used. Was formerly used to	describe	storage medium for inspection video.			
CBL	Coder/Assessor	Recor	d the name of the person coding observations and producing report			
СВМ	Video image location system	For m	oving images, record the method of recording the position on the tape or video clip ows:			
		НМ	The elapsed time in hours and minutes since the start of the medium			
		L	Vertical location from the reference point at the start of inspection			
		MC	A <u>m</u> achine dependent numeric <u>c</u> ounter			
		Z	Other—further details shall be stated in remarks			

Code	le Name		Data to be recorded		
CBN	Name of company responsible for inspection		Record the company or trading name of the entity responsible for undertaking the inspection		
СВО	Not used. Was formerly used to	describ	e inspection video volume reference.		
CBP Purpose of inspection Record to		Reco	ord the purpose of the inspection as follows:		
		С	Resumption of an earlier incomplete inspection (Completion)		
		ΙE	Suspected infiltration problem (Infiltration examination)		
		IP	Investment planning		
		NC	Final control of new construction		
		OE	Suspected operational problem including hydraulic performance, blockages, odour issues (Operational examination)		
		R	Routine inspection of condition		
		RC	Final control of renovation or repair (Repair control)		
		S	Sample inspection		
		SE	Suspected structural problem (Structural examination)		
		Т	Transfer of ownership		
		W	End of warranty period		
		Z	Other—the reason shall be recorded as a header comment immediately following (code CDG)		

3.6.4 HEADER CODES FOR RECORDING MAINTENANCE STRUCTURE DETAILS

Code	Name	Data to be recorded		
CCA	Shape of access	Record the shape of the opening (i.e. the most restrictive opening into the maintenance structure) as below. Where the shape of the structure is different to the opening record the change using HSC.		
		C <u>C</u> ircular		
		H <u>H</u> exagonal		
		O <u>O</u> val		
		OC <u>Oc</u> tagonal		
		R <u>R</u> ectangular		
		T <u>T</u> riangular		
		Z Other—further details shall be recorded as a header comment (code CDG) immediately following		
ССВ	Width/diameter of access	The width/diameter (maximum clear opening) of the access in mm		
		The breadth (minimum clear opening) of the access in mm—do not record if opening is circular. Where the breadth of the structure is different to the most restrictive opening record the change using HSC.		

Code	Name	Data to be recorded				
CCD	Material	Record the material used for the fabric of the maintenance structure using the coding in APPENDIX B — MATERIALS AND ACRONYMS . Where a structure is a combination of two or more materials, e.g. concrete and coursed masonry, record all materials, e.g. CP/MAC. Where the structure has been lined record the material of the original maintenance structure.				
CCE	Lining type	Where the maintenance structure has been lined during manufacture, construction or in rehabilitation record the method of lining as follows:				
		MFL	Manufactured plastic lining installed in a factory or incorporated in construction			
		С	A <u>c</u> oated lining of epoxy or similar material applied by spray, brush or roller			
		SEG	Segments of liner assembled and joined within the structure and then grouted			
		Р	Whole components inserted, joined within the structure and then grouted			
		CIP	<u>C</u> ured <u>in place membrane</u>			
		S	Sprayed or trowelled cementitious coating			
		BC	Complete lining of the structure including $\underline{\textbf{b}}\text{enching}$ and $\underline{\textbf{c}}\text{hannels}$			
		Z	Other lining - describe			
CCF	Shape of chamber		rds details of the cross section of the chamber (the structure immediately above the hes) of the maintenance structure as follows:			
	,	CC	<u>C</u> ircular and <u>c</u> ylindrical			
		СО	<u>C</u> ircular and <u>co</u> nical			
		R	<u>R</u> ectangular			
		X_	Local section—code to be specified by the asset owner and prefixed by an X			
		Z	Other—further details are to be recorded in remarks			
CCG	chamber unit length	chamber unit lengths will gene	dividual prefabricated maintenance structure ring units. The rally not be known before the inspection and may vary over a typical chamber unit length. (This code shall not be used crete chambers.)			
ССН	Diameter or width of chamber	Diameter or width (largest dime	ension) of the chamber in mm			
CCI	Breadth of chamber	Breadth (smallest dimension) o circular	of the chamber in mm- do not record if the chamber is			
CCJ	Use of system	The type of the system shall be	e recorded as follows:			
		C The maintenance struct system	ture serves a combined sewerage and stormwater drainage			
		O Other—describe the co	nduit system			
		Q Not known				
		S The system is designed	I to carry only <u>s</u> ewage			

Code	Name	Data to be recorded			
		SW The system is designed to carry only stormwater			
CCK	Criticality	An alpha-numeric code, defined and provided by the asset owner, describing how critical the structure is to the system			
CCL	Cleaning	Record whether the structure was cleaned prior to inspection as follows:			
		C The structure was <u>c</u> leaned prior to the inspection			
		NC The structure was <u>n</u> ot <u>c</u> leaned prior to the inspection			
ССМ	Year came into operation	The approximate year the maintenance structure came into operation. Report in the YYYY format either as a single year or as a range YYYY–YYYY, e.g. 1970-1979.			
CCN	Shape of cover	Record the shape of the cover as follows:			
		C <u>C</u> ircular			
		H <u>H</u> exagonal			
		O <u>O</u> val			
		OC <u>Oc</u> tagonal			
		R <u>R</u> ectangular			
		T <u>T</u> riangular			
		Z Other—further details shall be recorded using the general header comment (code CDG) as the next code			
CCO	Material of cover	Record the material of the cover using the codes in <u>APPENDIX B — MATERIALS AND ACRONYMS</u>			
ССР	Width of cover	The width/diameter of the cover in mm. (For multi component covers, describe details in header remarks field CDG.)			
CCQ	Breadth of cover	The breadth of the cover in mm. (For multi component covers, describe in header rema field CDG.) Do not record breadth if cover is circular.			
CCR	Form of access within structure	Record the type of steps as follows:			
		D <u>D</u> ouble width step irons—wide enough for two feet			
		L <u>L</u> adder			
		N <u>N</u> o provision			
		S Single width step irons—wide enough for one foot			
		SR <u>S</u> tep irons or ladder <u>r</u> emoved			
		T <u>T</u> oe holes			
		Z Other—further details are to be recorded using the general header comment code (CDF) as the next code			
CCS	Material of steps or ladder	Record the material from which the steps or ladder are made using the codes in APPENDIX B — MATERIALS AND ACRONYMS			
ССТ	Material of lining	Where the maintenance structure has been lined, record the lining material using the coding in APPENDIX B — MATERIALS AND ACRONYMS			
CCU	Anticipated depth	Depth from surface to invert from records			

Code	Name	Data to be recorded			
CCV	Inspected/scanned depth	The depth at which the inspection finishes			
CCW—not	CCW—not used				
CCX	Type of cover	Describe the type of access cover using the most suitable code below based on load classifications (duty Classes) as described in AS 3996. If the cover has a locking feature or hold down bolts give details in the header general comment code CDG.			
		EHC <u>E</u> xtra <u>h</u> eavy duty (Class E, F or G, trafficable), <u>c</u> oncrete, rectangular			
		EHRC <u>E</u> xtra <u>h</u> eavy duty (Class E, F or G, trafficable), <u>c</u> oncrete, <u>r</u> ound			
		EHRI Extra heavy duty (Class E, F or G, trafficable), round, metal with concrete infill			
		EHRS <u>E</u> xtra <u>h</u> eavy duty (Class E, F or G, trafficable), <u>r</u> ound, metal, <u>s</u> olid top (e.g. diamond pattern cast iron)			
		EHSI <u>E</u> xtra <u>h</u> eavy duty (Class E, F or G, trafficable), <u>s</u> quare, metal with concrete <u>i</u> nfill			
		EHSS <u>E</u> xtra <u>h</u> eavy duty (Class E, F or G, trafficable), <u>s</u> quare, metal, <u>s</u> olid top			
		EHT Extra heavy duty (Class E, F or G, trafficable), triangular segments, metal, solid top			
		HC Heavy duty (Class C or D, trafficable), concrete, round			
		HRI <u>H</u> eavy duty (Class C or D, trafficable), <u>r</u> ound, metal with concrete <u>i</u> nfill			
		HRS Heavy duty (Class C or D, trafficable), round, metal, solid top			
		HSI <u>H</u> eavy duty (Class C or D, trafficable), <u>s</u> quare, metal with concrete <u>i</u> nfill			
		HSS <u>H</u> eavy duty (Class C or D, trafficable), <u>s</u> quare, metal, <u>s</u> olid top			
		HT <u>Heavy</u> duty (Class C or D, trafficable), <u>t</u> riangular segments, metal, solid top			
		LC <u>Light duty (Class A or B, non-trafficable), concrete, round</u>			
		LRI Light duty (Class A or B, non-trafficable), round, metal with concrete infill			
		LRS <u>Light duty</u> (Class A or B, non-trafficable), <u>r</u> ound, metal or plastics, <u>s</u> olid top			
		LSI <u>Light duty (Class A or B, non-trafficable), square,</u> metal or plastics with concrete <u>i</u> nfill			
		LSS <u>Light duty (Class A or B, non-trafficable), square,</u> metal or plastics, <u>s</u> olid top			
		Z Other type of cover—a description shall be recorded using the general header comment (code CDG) as the next code			

Code	Name	Data	to be recorded
CCY	Removal or lifting features on cover or grate	Desc	ribe the type of provision incorporated into the cover for lifting or removal
		С	Centre lift key hole
		Н	Hole(s) formed in concrete
		W	Wire staples cast in concrete
		K	Key hole(s) other than centre (includes Gatic)
		S	Swift lift lug(s) cast in concrete
		N	No obvious lifting feature or lifting feature unusable
		НА	A <u>ha</u> ndle is provided for lifting – it may be retractable or not. Give details in a general header comment (CDG)
		Z	Other type of feature for lifting incorporated into the cover or grate—give details in a general header comment code (CDG)

3.6.5 HEADER CODES FOR RECORDING MISCELLANEOUS INFORMATION

Code	Name	Data to be recorded
CDA	Precipitation	Record the precipitation entering the system (inflow/infiltration) as follows:
		N No precipitation or melting snow or ice observed entering the system
		R Precipitation (<u>rain</u>) observed entering the system
		S Melting snow or ice observed entering the system
CDB	Temperature	Record the ambient temperature in Celsius
CDC	Flow control measures	Record the measures taken to deal with the flow at the time of the inspection as follows:
		FB Flows have been blocked upstream (Fully blocked)
		N <u>N</u> o measures taken
		PB Flows partially blocked upstream
		Z Other—further details shall be recorded as a remark
CDD	Atmosphere	Record the nature of the atmosphere within the structure at the start of the inspection as follows:
		CO <u>C</u> arbon monoxide
		H <u>H</u> ydrogen sulphide
		M <u>M</u> ethane
		N <u>N</u> on-hazardous atmosphere
		O <u>O</u> xygen
		OF Other flammable gas—record type of gas where known in remarks
		Z Other—the name shall be recorded as a header comment, code CDG

Code	Name	Data to be recorded
CDE	Tidal influence (where applicable)	Record tidal influence as follows:
		A All of the structure is <u>at</u> or <u>above</u> high tide level
		B All or part of the structure is <u>b</u> elow high tide level
CDF	Evidence of surcharge	Measure from the surface and record the apparent highest level of surcharge in m, using evidence from accumulation of debris on step irons or walls
CDG	General comment	A remark that cannot be included in any other way

3.6.6 USER DEFINED HEADER CODES

Experience has shown that many agencies need to record specific information about their assets or job record systems that do not comply with the mandatory or optional fields above. To facilitate this requirement, without compromising standardised fields and software, the following user definable fields are provided.

Code	Name	Data to be recorded
CEA	User defined	User defined
СЕВ	User defined	User defined
CEC	User defined	User defined
CED	User defined	User defined
CEE	User defined	User defined

3.6.7 HEADER CODES FOR STRUCTURAL, SERVICE AND OPERATIONAL SAFETY CONDITION STATISTICS

These fields allow the statistics for structural, service and operational safety conditions to be incorporated in the report header as shown in the following descriptions.

Provision is made for these fields in anticipation that completion of Appendix E will enable the fields to be automatically filled in the maintenance structure inspection reports.

Code	Name	Data to be recorded
CFA	Structural grade	Condition grade from 1-5 as determined using <u>APPENDIX E</u> — <u>SCORING OF DEFECTS</u> <u>AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF MAINTENANCE STRUCTURES</u>
CFB	Number of structural defects	Number of structural defects reported
CFC	Structural peak score	The maximum aggregated structural defect scores within a single metre depth of the structure
CFD	Structural mean score	The total of all structural defect scores divided by the depth of the structure in metres
CFE	Service grade	Condition grade from 1-5 as determined using Appendix E
CFF	Number of service defects	Number of service defects reported
CFG	Service peak score	The maximum aggregated service defect scores within a single metre depth of the structure
CFH	Service mean score	The total of all service defect scores divided by the depth of the structure in metres

Code	Name	Data to be recorded
CFI	Operational safety grade	Condition grade from 1-5 as determined using Appendix E
CFJ	Number of operational safety defects	Number of safety defects reported
CFK	Operational safety peak score	The maximum aggregated operational safety defect scores within a single metre depth of the structure
CFL	Operational safety mean score	The total of all operational safety defect scores divided by the depth of the structure in metres

3.7 CODES FOR REPORTING THE INSPECTION OF MAINTENANCE STRUCTURES

3.7.1 GENERAL

Observations of features or defects shall be coded according to the descriptions and explanations in the following sections. The format of observations shall be in accordance with <u>Table 3.1</u>. That is, the main code, characterisation 1, characterisation 2, quantification 1, quantification 2, circumferential location, joint influence, distance, continuous notation, photo reference, video reference, video clip reference and remarks as appropriate.

For all observations the vertical location (e.g. distance from vertical reference point) and the descriptive location (3.5.4.5 Descriptive location) shall be recorded.

Defects or features have been grouped in the following categories to enable extraction of data for condition assessment and follow a similar theme to conduits:

- Codes relating to structural integrity;
- · Codes specific to masonry structures;
- · Codes relating to joints and jointing;
- Codes relating to leakage through the structure;
- · Codes relating to connecting conduits and flows;
- · Codes relating to lining and repairs;
- Codes relating to operational performance;
- · Codes relating to access and safety;
- · Miscellaneous observations; and
- Miscellaneous codes relating to the administration of the inspection.

To assist correct coding and interpretation of features/defects in conduits and maintenance structures a compendium of photographs showing some defects and features with suggested coding and a commentary are provided in <u>APPENDIX I</u> — <u>COMPENDIUM OF DEFECTS AND FEATURES</u>.

3.7.2 CODES RELATING TO STRUCTURAL INTEGRITY

3.7.2.1 CRACKING—HC

Code	Description
HC	Cracking of the maintenance structure. An apparent discontinuity in the fabric of structure where the pieces on either side of the crack may remain interlocked with negligible separation along the discontinuity or may be separated by a measurable gap or displacement but with the individual pieces still in place and the cross section effectively retaining its original shape. This code does not apply to masonry structures, and masonry codes should be applied instead 1.
	Additional Information
	Characterisation 1—Orientation

Code	Desc	cription
	Reco	ord the orientation of the cracking as follows:
	V	<u>V</u> ertical
	Н	Horizontal
	М	Multiple/Complex—a group of cracks which cannot be described as vertical or horizontal
	ı	<u>Inclined</u>
	S	Helical (spiral)
		ntification 1—Width sure and record the maximum width of cracking in mm to the nearest 1 mm
	Circu	umferential location—record the position or extent of the observation as one or two clock references

✓ Notes -

(1) Use code HMC (refer to <u>3.7.3.2 Masonry (brick) cracking—HMC</u>)when cracking occurs through masonry units, and use code HMS (refer to <u>3.7.3.4 Masonry unit separation—HMS</u>) when cracking occurs within the mortar joints.

3.7.2.2 BREAKING—HB

Code	Description
НВ	Breaking of the maintenance structure ¹ – the breaking of an asset into a few or many separate pieces where there is significant movement of some or all of the pieces resulting in measurable local or general distortion from the original maintenance structure cross section. Pieces of asset may be missing or sections of the asset may have been displaced through shear action such that soil or a void is visible.
	Additional Information
	Characterisation 1—Extent Record the extent of the defect coded as follows:
	D All pieces are present but some of them are significantly <u>d</u> isplaced from position ²
	M Missing—one or more pieces of maintenance structure wall are missing ³
	E Structure broken as a result of an <u>e</u> xceptional event, e.g. external trauma such as damage from trenchless installation of other utilities
	Quantification 1—Length (vertical) Record the length of the defect in mm to the nearest 100 mm
	Circumferential Location—record the position or extent of the observation as one or two clock references

Notes

- (1) Do not code 'breaking' if a repair has been made. This applies mainly to 'breaking-missing' that has been repaired and should be reported using code HPR (refer to 3.7.8.2 Point repair—HPR) with suitable characterisation.
- (2) Shear displacement at a joint such that soil or a void is visible shall be reported as <u>breaking</u> displaced. The magnitude of shear displacement shall be recorded using code HD (refer to <u>3.7.2.3 Deformation—HD</u>). Shear displacement >25% shall be reported using code HX (refer to <u>3.7.2.4 Collapsed structure—HX</u>).
- (3) It is probable that soil or a void is visible through the missing wall.

3.7.2.3 DEFORMATION—HD

Code	Description
HD	The cross sectional shape of the maintenance structure has been deformed from its original shape due to external forces. In the case of concrete and masonry structures, this may be associated with other defects such as breaking.
	Additional Information
	Quantification 1—Magnitude
	Estimate and record the percentage reduction in diameter 2 for deformation in 5% increments 3,4 as follows: 5, 10, 15, 20 and 25%
	Circumferential location—record the position of the point of maximum deformation as a single clock reference

Notes -

- (1) Includes shear displacement of adjacent precast elements.
- (2) For other than circular cross sections, record the percentage change of the principal dimension and record the details in remarks.
- (3) Where the deformation appears to be localised in part of the maintenance structure only, record details in remarks.
- (4) Deformation >25% shall be recorded as a collapse (refer to 3.7.2.4 Collapsed structure—HX).

3.7.2.4 COLLAPSED STRUCTURE—HX

Code	Description
HX	A complete loss of structural integrity or continuity of the structure has occurred. Deformation or displacement >25% of the chamber unit or largest cross section element in the structure and possibly other damage is observed ¹ . For masonry structures use code HXM (refer to <u>3.7.3.5 Masonry maintenance structure collapsed—HXM</u>).
	Additional Information
_	Circumferential location—record the position or extent of the observation as one or two clock references

Notes

(1) A **collapse** may be limited to a single location of a maintenance structure and may not affect hydraulic capacity and/or overall structural integrity.

3.7.2.5 SURFACE DAMAGE CONCRETE—HSC

Code	Description
HSC	The surface of the maintenance structure has been damaged. Use code HLD (refer to 3.7.8.1 Defective lining or coating—HLD) for rehabilitated concrete structures 1 or those lined at the time of construction.
	Additional Information
	Characterisation 1—Type of damage Record the type of damage according to the following codes—the damage may be caused by erosion, corrosion, abrasion, mechanical equipment, a combination of two or more or any other agent
	, ,

Code	Desc	Description		
	AP ²	Some pieces of coarse aggregate are projecting from the surface and the damage may have extended sufficiently for individual pieces of aggregate to have been removed		
	AM	Aggregate is missing—the damage has extended sufficiently for individual pieces of aggregate to have been removed and loss of fabric is leading to hole formation		
	СР	Corrosion products from the degradation of concrete are visible as a build-up on or a discolouration of the surface of the structure. These corrosion products are generally friable and are easily removed in cleaning to reveal AV or AP or AM and/or RC.		
	H ³	<u>H</u> ole in wall—surface damage has extended right through the wall of the structure in places. Also look for soil visible, void visible, ingress of soil, infiltration or exfiltration.		
	RC	The concrete cover to the \underline{r} einforcement has been removed due to corrosion/spalling/erosion/other reason and the steel reinforcement is exposed and \underline{c} orroded ^{4,5}		
	RV	Steel reinforcement is visible with little or no corrosion evident ⁶		
	RVP	Steel reinforcement is visible and is projecting into the structure		
	S	Spalling of the surface has occurred characterised by a significant loss of material in discrete fragments. The material removed is considerable larger than individual grains of material removed by erosion or abrasion. The loss of fabric from spalling does not extend through the full thickness of the structure.		
	RS	Staining is evident on the surface of the structure due to the corrosion of the underlying steel reinforcement 7		
	Z	Other—record details in remarks		
	Wher	tification 1—Loss of wall thickness ⁸ e specified, measure maximum loss of wall thickness using laser profiling in 5 mm increments as follows: 15, 20, 25, 30, 35, 40, 45, 50 and so on		
	Circu	mferential location—record the location or extent of the defect as one or two clock references		

Notes -

- (1) Where unsure consult with asset owner.
- (2) Use code AP in preference to code AV when one or more features are intermixed over an area of the concrete surface.
- (3) The hole may allow the ingress of soil (refer to 3.7.4.1 Ingress of soil—HING), infiltration (refer to 3.7.4.2 Infiltration—HI), exfiltration (refer to 3.7.4.3 Exfiltration—HEX) and/or roots (refer to 3.7.9.3 Roots—HR) which shall be reported separately.
- (4) The steel reinforcement may or may not be corroded.
- (5) Also use this code if the steel reinforcement has completely corroded away and record details in remarks.
- (6) This may occur in the manufacture of concrete pipe if the reinforcement is displaced relative to the internal surface and/or where some other post-installation intervention has exposed reinforcement.
- (7) Staining may have several causes, however, for this code it is specifically related to the corrosion of the underlying steel reinforcement. Occurrence of this defect is most likely where reinforcement is close to the surface. RS may often precede RC. Where both RS and RC are evident only code RC.
- (8) Laser profiling is undertaken in a separate activity to visual reporting of structure condition. The determination of loss of wall thickness at a specific observation distance shall be correctly aligned and recorded manually to incorporate this quantification.

3.7.2.6 SURFACE DAMAGE OTHER—HSO

Code	Desc	cription	
HSO	The surface of a maintenance structure (masonry, plastics etc. but not concrete) has been damaged. Use code HLD (refer to 3.7.8.1 Defective lining or coating—HLD) for lined structures Additional Information		
	Н	Hole in wall—surface damage has extended right through the wall of the conduit in places	
	MD	The surface of plastics structure is mechanically damaged exhibiting scoring or gouging or erosion etc	
	S	Spalling of the surface has occurred characterised by a significant loss of conduit material in discrete fragments. The material removed is considerably larger than individual grains of material removed by erosion or abrasion. The loss of fabric from spalling does not extend through the full thickness of the structure. This code can be applied to masonry structures.	
	СВ	The <u>c</u> orrosion <u>b</u> arrier layer of a glass-reinforced plastics maintenance structure has been damaged or is defective, including blistering, discoloured, star cracked etc. Record details in remarks.	
	Z	Other—record details in remarks	
	Whe	ntification 1—Loss of wall thickness re specified, measure maximum loss of wall thickness using laser profiling in 5 mm increments as follows: , 15, 20, 25, 30, 35, 40, 45, 50 and so on	
	Circu	unferential location—record the location or extent of the defect as one or two clock references	



(1) Where unsure consult with asset owner.

3.7.2.7 SOIL VISIBLE THROUGH DEFECT—HSV

Code	Description
HSV	The soil outside the wall of the maintenance structure is visible through a defect (such as a hole, break or extreme joint displacement) 1
	Additional Information
	Circumferential location—record the extent of the visible soil as one or two clock references



(1) Where a void is visible outside the maintenance structure use code HVV (refer to 3.7.2.8 Void visible through defect—HVV) in preference to this, even if soil is still visible.

3.7.2.8 VOID VISIBLE THROUGH DEFECT—HVV

Code	Description
HVV	A void outside the wall of the maintenance structure is visible through a defect (such as a hole, break or extreme joint displacement) 1
	Additional Information
	Quantification 1—Void dimensions Where it is possible, measure or estimate and record the extent of the void beyond the outside of the structure in mm to the nearest 50 mm or leave blank
	Circumferential location—record the extent of the void as two clock references

■ Notes

(1) Where soil is visible at the edges of the void outside the maintenance structure still use this code in preference to code HSV (refer to 3.7.2.7 Soil visible through defect—HSV).

3.7.2.9 POROUS WALL—HPW

Code	Description
HPW	The material forming the wall exhibits porosity, e.g. due to a construction or manufacturing defect
	Additional Information

3.7.3 CODES SPECIFIC TO MASONRY STRUCTURES

3.7.3.1 MISSING MORTAR—HMM

Code	Description
НММ	All or part of the mortar from masonry is missing ¹
	Additional Information
	Quantification 1—Extent of mortar loss Estimate or measure and record the typical depth of mortar loss over the affected area in 10 mm increments as follows:
	10, 20, 30, 40, 50 and so on to total mortar loss, which should be recorded as 100^2
	Circumferential location—where only one or a few masonry units are affected, record the position of the affected area as a single clock reference. For more extensive areas, record the circumferential extent of the affected area as a pair of clock references.

Notes

- (1) Missing mortar does not refer to rendered mortar, which should be reported using code HJD (refer to <u>3.7.7.1</u> <u>Displaced joint—HJD</u>).
- (2) Use code HEX (refer to 3.7.4.3 Exfiltration—HEX) or code HI (refer to 3.7.4.2 Infiltration—HI) if it is apparent through the mortar course, which indicates total mortar loss or cracking of the mortar.

3.7.3.2 MASONRY (BRICK) CRACKING—HMC

Code	Description	
MBC	Cracking going through the individual masonry unit (as opposed to the mortar joint 1). An apparent discontinuity in the fabric of a conduit where the pieces on either side of the crack may remain interlocked with negligible separation along the discontinuity or may be separated by a measurable gap or displacement, but with the individual pieces still in place and the cross section effectively retaining its original shape.	
	Additional Information	
	Characterisation 1—Orientation The second code letter to be C or L according to orientation of the feature as follows:	
	C <u>Circumferential or inclined</u> —generally a single crack oriented approximately perpendicular or at an angle to the centreline of the conduit	
	L <u>L</u> ongitudinal—generally a single crack oriented approximately parallel to the centreline of the conduit	
	Quantification 1—Width ² Measure and record the maximum width of cracking to the nearest 1 mm	
	Circumferential location: —record the position of a longitudinal crack as a single clock reference —record the extent of other cracks as a pair of clock references	



- (1) Use code HMS (refer to <u>3.7.3.4 Masonry unit separation—HMS</u>) when separation occurs within the mortar joints.
- (2) Procedures used in the inspection shall be able to demonstrate accurate crack width estimates to at least 1 mm accuracy.

3.7.3.3 MISSING MASONRY UNITS—HMMU

Code	Description	
нмми	One or more masonry units are missing	
	Addi	tional Information
	Characterisation 1—Extent of further layers	
	NV	\underline{N} o further layer(s) of masonry is \underline{v} isible—if soil or a void is visible through the gap also report using code HSV or HVV
	Р	The masonry structure has been penetrated or damaged by an external agent and part of or whole masonry unit(s) is/are missing. Most commonly this occurs when cables, pipes etc. have been installed through the structure. If cables, pipes etc also create an obstruction in the structure the obstruction shall be reported using the HOBP code.
	V	Another layer of masonry is visible through the hole left by the missing masonry
	Circumferential location—where only one or a few masonry units are affected, record the position of the centre of the affected area as a single clock reference. For more extensive areas, record the circumferential extent of the affected area as a pair of clock references.	

3.7.3.4 MASONRY UNIT SEPARATION—HMS

Code	Description	
HMS	The regularity of the original bond pattern has been disturbed with masonry courses separating along mortar joints and possibly becoming misaligned 1,2	
	Additional Information	
	Characterisation 1—Orientation of separation Record orientation of the separation	
	C <u>C</u> ircumferential (generally horizontal)	
	L <u>L</u> ongitudinal (generally vertical)	
	Quantification 1—Separation of masonry courses Where specified, measure or estimate and record the typical separation of masonry courses in 5 mm increments as follows: 5, 10, 15, 20, 25 and so on	
	Circumferential location—where only one or a few masonry units are affected, record the position of the centre of the affected area as a single clock reference. For more extensive areas, record the circumferential extent of the affected area as a pair of clock references.	

✓ Notes –

- (1) This defect may be accompanied by considerable cracking of adjacent masonry course work, frequently extending for some distance beyond the separation and misalignment or there may be no indication of cracking at the extremities of the misalignment.
- (2) Also use code HC (refer to 3.7.2.1 Cracking—HC) where cracking of individual masonry units occurs.

3.7.3.5 MASONRY MAINTENANCE STRUCTURE COLLAPSED—HXM

Code	Description
НХМ	A maintenance structure constructed from masonry has collapsed. The fabric of the maintenance structure has wholly or partly fallen into the structure so that the channel, benching and pipework at the base of the structure is not visible or accessible.
	Additional Information
	Circumferential location— record the position or extent of the observation as one or two clock references

3.7.4 CODES RELATED TO LEAKAGE THROUGH THE STRUCTURE

3.7.4.1 INGRESS OF SOIL—HING

Code	Description	
HING ¹	Soil or embedment material is observed to be entering the maintenance structure at a defect, joint, hole, connection or other entry point	
	Additional Information	
	Characterisation 1—Type of soil Record the type of soil as follows:	
	S <u>Sand or other fine, non-cohesive (free-running) soil or embedment material</u>	

Code	Des	Description	
	F	Clay, silt, cohesive (ordinary) soil (Fine material)	
	G	<u>G</u> ranular embedment material	
	Z	Other—record details in remarks	
	Circumferential location—record the position or extent of the observation as one or two clock references		

✓ Notes -

(1) Do not use this code to record the presence of soil inside the maintenance structure. Report using code HDE (refer to 3.7.9.7 Deposits—HDE).

3.7.4.2 INFILTRATION—HI

Code	Description	
HI	The ingress of water through the wall of the maintenance structure or through joints or defects in the wall, benching or channel, which are separately reported, is occurring at the time of inspection 1	
	Additional Information	
	Characterisation 1—Quantity	
	S <u>S</u> eepage—slow ingress of water, no visible drips	
	D <u>D</u> ripping—individual drips, flow not continuous	
	R Running—a continuous flow	
	G <u>G</u> ushing—a copious flow entering under pressure	
	Circumferential location—record the position or extent of the observation as one or two clock references	

Notes

(1) Past infiltration may have occurred when a much higher water table existed but at the time of observation the water table is lower than the structure. Where there are signs of past infiltration, report using code HGC (refer to 3.7.10.2 General comment—HGC).

3.7.4.3 EXFILTRATION—HEX

Code	Description
HEX	Visible flow out of the maintenance structure 1
	Additional Information
	Circumferential location— record the position of exfiltration as one or two clock references, as appropriate

Notes

(1) Exfiltration generally occurs through defects in the channel, base or **benching** or through the adjacent maintenance structure connector.

3.7.5 CODES RELATING TO CONNECTING CONDUITS AND FLOWS

3.7.5.1 CONNECTION TYPE—HCN

Code	Description		
HCN	A conduit or ventilation pipe has been connected to the maintenance structure. This code primarily records the method of connection. Code HCP (refer to 3.7.5.2 Connecting conduit—HCP) shall also be used to record details of the conduit.		
	Additional Information		
	Characterisation 1—Method of connection Record the method of making the connection as follows:		
	B Connection in the <u>b</u> enching (channel)		
	BD <u>Backdrop or external drop</u>		
	DC <u>Drop chamber</u>		
	DP Internal drop pipe. Record pipe material in remarks.		
	FD <u>F</u> ree <u>d</u> rop		
	PM Pressure main discharge		
	RC Ramp connection		
	VP <u>V</u> entilation <u>pipe</u> and ventilation line		
	Z Other—record details in remarks		
	Characterisation 2—Intruding connection A connecting conduit is intruding into the maintenance structure		
	IC A connecting conduit identified in Characterisation 1 is intruding into the structure. Leave blank if the connecting conduit does not intrude.		
	Quantification 1—Connecting conduit reference Record the conduit reference identification of the connecting conduit		
	Quantification 2—Length of intruding connection into the structure Record the length of the intrusion in mm to the nearest 50 mm		

3.7.5.2 CONNECTING CONDUIT—HCP

Code	Description	
НСР	Details of a conduit connecting to the maintenance structure	
	Addi	itional Information
		racterisation 1—Shape ord the shape of the connecting conduit using the following codes:
	А	Arch shaped—circular soffit, flat invert, parallel sides
	С	<u>C</u> ircular
	Е	Oviform (egg shaped)
	0	Oval—circular invert and soffit of equal diameter, parallel sides

Code	Desc	Description	
	R	<u>R</u> ectangular	
	U	<u>U</u> -shape—circular invert, flat top, parallel sides	
	Z	Other—record details in remarks	
		acterisation 2—Availability ord whether the connection is incoming, outgoing or sealed, as follows:	
	I	The connection discharges into the maintenance structure (inlet)	
	0	The connection accepts flows from the maintenance structure (outlet)	
	S	The connection is sealed/closed	
		ntification 1—Diameter/height sure or height of the connecting conduit in mm to the nearest 10 mm	
	Whe	ntification 2—Width re necessary, measure or estimate and record the width of the connecting conduit in mm to the nearest 10 mm. Where dimensions are the same this field may be left blank	
		imferential location—record the position of the centre of the connection around the maintenance structure as a single reference	

3.7.5.3 DEFECTIVE CONNECTING CONDUIT—HDC

Code	Desc	ription	
HDC	The connecting conduit to a maintenance structure is defective. Where this code is used the connection codes HCN (refer to 3.7.5.1 Connection type—HCN) or HCP (refer to 3.7.5.2 Connecting conduit—HCP) are required.		
	Additional Information		
		acterisation 1—Nature of defect ord the nature of the defect as follows:	
	В	The connecting conduit is partially or completely blocked. Describe the obstruction causing the blockage in remarks.	
	D	The connecting conduit is damaged. Describe the type of damage in remarks.	
	DS	Deposits of sand, silt, gravel, grout etc. are observed in the invert of the connecting conduit	
	DW	\underline{D} eposits on the \underline{w} all such as grease, encrustation, fouling are observed on the wall of the connecting conduit above the invert	
	GA	There is an unsealed gap or joint between the end of the connecting conduit and the maintenance structure as a result of poor construction or subsequent defect (gap <u>a</u> round)	
	JD	One or more of the joints observed in the connecting conduit are <u>defective</u> . Describe the defect in remarks. For example, no evidence of solvent cement jointing, radial or longitudinal displacement, seal ring visible, damaged seal, welding defects etc.	
	LD	The lining in the connecting conduit has been damaged or has become fully or partially detached from the original connecting conduit	
	Р	The position of the connecting conduit in relation to the maintenance structure is incorrect 1	
	SE	Soil is entering the connecting conduit	
	SR	Roots are growing into the connecting conduit (some roots)	
	-		

Code	Description	
	IN <u>Infiltration</u> is observed entering the connecting conduit	
	Z Other—record details in remarks	
	Quantification 1—Magnitude of obstruction in the connecting conduit Estimate and record the percentage reduction in cross sectional area from one of the following estimates: 5,10, 20, 30, 40, 50, 60, 70, 80 or 90%	
	Quantification 2—Where possible, estimate and record the distance to the location of the defect in the connecting conduit in m	
	Circumferential location—record the position of the centre of the connection around the maintenance structure as a single clock reference	

✓ Notes

- (1) A connecting inlet conduit with significant backfall.
- (2) Where more than one significant defect is observed in the connecting conduit, record each occurrence with a separate observation.

3.7.5.4 DEFECTIVE DROP PIPE—HDP

Code	Des	Description	
HDP	An ir	An internal drop pipe is defective	
	Add	itional Information	
		racterisation 1—Nature of defect ord the nature of the defect using the following code:	
	В	The drop pipe is <u>b</u> locked	
	С	The drop pipe is <u>c</u> racked	
	D	The drop pipe is <u>d</u> eformed	
	М	The drop pipe is <u>missing</u> or has been dislodged, separated and/or disconnected so that flow is not being directed to the channel in the base of the structure	
	R	Cast iron or steel pipework is severely <u>r</u> usted or corroded	
	Т	The outlet of the drop pipe is not correctly positioned so that flow is misdirected or is causing unnecessary turbulence and/or splashing	
	Х	The drop pipe has collapsed	
	Z	Other—record details in remarks	
	Circ	umferential location—record the position or extent of the observation as one or two clock references	

3.7.5.5 FLOW IN CONNECTING CONDUIT—HIF

Code	Description
HIF	inflow from a connecting conduit indicates a cross connection between two systems, generally sewerage and stormwater. This is to describe an unusual or illegal connection. Where this code is used the connection codes HCN (refer to 3.7.5.1 Connection type—HCN) or HCP (refer to 3.7.5.2 Connecting conduit—HCP) are required.

Code	Description			
	Additional Information			
	Characterisation 1—Nature of flow Record details of the nature of the flow in the connecting conduit using the following codes:			
	C The flow in the connecting conduit is clear effluent			
	SW Sea water where it is known or suspected to be the source of flow			
	T The flow in the connecting conduit is turbid or discoloured			
	Characterisation 2—Propriety of connections Record the following details as appropriate:			
	SE <u>Sewage appears to be entering the stormwater asset being inspected</u>			
	ST Stormwater or sea water appears to be entering the sewerage asset being inspected			
	Quantification 1—Inflow level Estimate and record the depth of inflow in the connecting conduit as a percentage of the vertical dimension of the conduit to the nearest 10%			

3.7.5.6 SEALED CONDUIT THROUGH MAINTENANCE STRUCTURE—HSP

Code	Description	
HSP	A sealed conduit passes through the maintenance structure	
	Additional Information	
	Characterisation 1—Access to conduit Record details of the access to the conduit using the following codes:	
	CM Proper access provisions exist but <u>c</u> overs are <u>m</u> issing	
	CS Access is possible but covers are sealed	
	NA There is <u>no access to the conduit</u>	
	Circumferential location—record the position or extent of the observation as one or two clock references	

3.7.6 CODES RELATING TO ACCESS AND SAFETY

3.7.6.1 DEFECTIVE COVER AND/OR FRAME—HCF

Code	Description
HCF	A defect is visible in the cover or frame or both. Where there is more than one defect in the cover and frame the code shall be repeated. The cover or frame cannot be inspected or they are at an inappropriate level with respect to the immediate surrounding area.
	Additional Information
	Characterisation 1—Nature of defect Record the nature of the defect using the following code:
	CB <u>C</u> over cracked or <u>b</u> roken
	CD <u>C</u> over <u>d</u> eformed

Code	Description	
	СН	Cover above (higher) surface level
	CL	Cover below surface level
	СМ	Cover missing
	CR	Cover rocking
	FB	Frame cracked or broken
	FD	Frame displaced
	FL	Frame loose
	FM	Frame missing
	G	Gap or hole between frame and chamber, shaft, conversion slab etc.
	HD	Holding down bolts missing or defective
	Z	Other—record details in remarks
		acterisation 2—Other relevant observation or other observation or other observations of relevance to the operation or siting of the cover or frame or both using the following code:
	В	Buried, not able to inspect cover and frame—include any observations regarding probable cause as a specific remark, e.g. road works, landscaping, new building
	S	Subsidence around or adjacent to cover and frame
	Z	Other—record details as a specific remark
	When	ntification 1—Difference in level rethe cover is above or below the surface level record the difference in levels in mm to the nearest 10 mm. The nce the cover is above the surface is to be recorded with '+' prefix and below the surface with a '-' prefix

3.7.6.2 DEFECTIVE STEP, LADDER, HANDRAIL OR STAGING BAR—HSL

Code	Description		
HSL	A defect is visible in a step iron, ladder, handrail, toe hole or staging bar ¹		
	Additional Information		
	Characterisation 1—Nature of defect Record the nature of the defect as follows:		
	ED	Plastics encapsulation of step or staging bar is damaged or broken	
	НС	Ladder or steps <u>h</u> andrail is <u>c</u> orroded or missing	
	LC	Ladder cracked. Record details of cracked item in remarks	
	LCC	Ladder support corroded (<u>L</u> adder <u>c</u> lip <u>c</u> orroded)	
	LCL	Ladder support loose (<u>L</u> adder <u>c</u> lip <u>l</u> oose)	
	LCM	Ladder support missing (<u>Ladder clip missing</u>)	
	LRM	Ladder rung missing	
	RC	Ladder runner corroded	

Code	Desc	Description	
	SB	Step or staging bar <u>b</u> ent	
	SC	Step or staging bar corroded	
	SL	Step or staging bar loose	
	SM	Step or staging bar missing	
•	TH	Defective toe hole	
	Z	Other—record details in remarks	
		ntification 1—Quantity ord the number of step irons, rungs, toe holes or staging bars that are defective	
	Circu	Imferential location—record the position or extent of the observation as one or two clock references	



(1) Record in remarks the presence of rags, paper, debris attached to rungs or staging bars.

3.7.6.3 LANDING DETAILS AND CONDITION—HLAN

Code	Description				
HLAN	A permanent landing is present in the structure. Also apply this code for offset maintenance structures with appropriate remarks ¹ .				
	Additional Information				
	Characterisation 1—Construction of landing Record the construction materials of the landing:				
	RC	Reinforced concrete			
	GG	Galvanised steel support structure with grid decking			
	GC	<u>G</u> alvanised steel support structure with <u>c</u> heckerplate decking			
	GP	Galvanised steel support structure with GRPgrid decking			
	SG	Stainless steel support structure and stainless steel grid decking			
	SC	Stainless steel support structure and stainless steel checkerplate decking			
	SP	Stainless steel support structure with GRP grid decking			
	Z	Other—record details in remarks			
	Characterisation 2—Defective landing Record defects observed in the landing and/or supports				
	AP ³ Coarse <u>aggregate</u> is <u>projecting</u> from the landing surface removed	s after the surrounding cement-sand matrix has been			
	AM ³ Aggregate is missing from the landing surfaces and hole	es are forming			

Code	Description
	CP ³ Corrosion products are evident on the landing surfaces
	RC ^{3,4} Concrete cover to the reinforcement has been removed on some or all surfaces and the <u>reinforcement</u> is exposed and <u>c</u> orroded
	$RV^{3,4}$ Reinforcement is visible on some surfaces with little or no corrosion
	MC Steel support structure and/or deck appears to have minor corrosion or deterioration
	SC Support structure and/or deck is severely corroded or deteriorated possibly with holes in structural members and/or deck
	Z ⁵ Other—record details in remarks
	Circumferential location—record the extent of the landing around the maintenance structure with two clock references

Notes

- (1) Describe the details of offset ("walk in") maintenance structures in remarks and/or using code HGC (refer to 3.7.10.2 General comment—HGC).
- (2) Report defective handrails associated with landings using code HSL (refer to 3.7.6.2 Defective step, ladder, handrail or staging bar—HSL).
- (3) These codes only apply to concrete landings.
- (4) These defects are more likely to be observed on the underside of the landing.
- (5) Other defects include weld failure, deformed structure, loose components etc.

3.7.6.4 DEVICES UNDER COVER OR GRATE—HGT

Code	Desc	Description	
HGT	Reco	Records the presence of devices under the cover or grate	
	Addi	tional Information	
		Characterisation 1—Type of device Record the type of device under the cover or grate as follows:	
	AB	Access barrier (Coversafe)	
	MW	Maintenance warning marker	
	SD	Sensing device	
	ST	Sediment or litter trap	
	Z	Other—record details in remarks	
		acterisation 2—Condition of device rd the condition of the device as follows:	
	D	Device is present but defective—record full details in remarks	
	М	All or part of the device is missing with evidence that one was previously present—record details in remarks	
	U Device is <u>u</u> nlocked or disconnected—record details in remarks		

3.7.6.5 SAFETY BARS AND CHAINS—HSC

Code	Desc	Description	
HSC	Reco	Records the type and condition of safety chains or bars on the outgoing or incoming connections	
	Addi	tional Information	
		Characterisation 1—Type of device and condition Record the following information:	
	CG	Safety chain present with no defects (good)	
	СМ	Safety chain missing with evidence that one previously existed	
	CD	Safety chain defective	
	СС	Safety chain in position but covered with rags and paper (covered) - can't determine condition	
	BG	Safety <u>b</u> ar present with no defects (good)	
	ВМ	Safety <u>bar missing</u> with evidence that one previously existed	
	BD	Safety <u>b</u> ar <u>d</u> efective	
	ВС	Safety <u>bar</u> in position but covered with rags and paper (<u>c</u> overed) - can't determine condition	
	Circumferential location—record the location of chains or bars as one or two clock references		

3.7.7 CODES RELATING TO JOINTS AND JOINTING

3.7.7.1 DISPLACED JOINT—HJD

Code	Description
HJD	Adjacent structural units, precast or cast in-situ are displaced from their intended position relative to each other
	Additional Information
	Characterisation 1—Orientation of displacement Record the orientation of the displacement using the following codes:
	A Angular—the axes of successive units are not parallel
	H <u>H</u> orizontal—successive units are displaced horizontally
	V <u>V</u> ertical—the units are displaced vertically
	Quantification 1—Magnitude of displacement —for vertical and horizontal displacements record the length of the displacement to the nearest 10 mm —for angular displacements record the maximum length of the displacement between the units to the nearest 10 mm
	Circumferential location of horizontal and angular displacements: —for horizontal displacements record the clock reference of the direction in which the upper unit has moved relative to the lower, i.e. the position of the maximum apparent step —for angular displacements record the clock reference of the position at which the upper unit is least distant from the lower unit on the side on which both units can be seen when looking vertically down

3.7.7.2 DEFECTIVE JOINT SEAL—HDJS

Code	Description	
HDJS	All or part of the material used to seal a joint between two adjacent chamber units is intruding into the maintenance struct	
	Additional Information	
	Characterisation 1—Type of sealing material Record the type of sealing material observed using the following code:	
	R Elastomeric sealing ring	
	M <u>M</u> astic sealant material	
	Z Other—record details in remarks	
	Characterisation 2—Jointing ring appearance Where the seal is a jointing ring, record the features of the intrusion as follows:	
	N Ring is visibly displaced and/or damaged but not intruding into the chamber	
	H Ring is hanging or intruding, unbroken, into the chamber	
	B Ring is hanging or intruding and <u>b</u> roken, torn, cut or split	
	Quantification 1—Projection of seal Where the seal is not a ring, record the maximum projection into the structure to the nearest 10 mm	
	Circumferential location—record the position or extent of the defect as one or two clock references	

3.7.8 CODES RELATING TO LININGS AND REPAIRS

3.7.8.1 DEFECTIVE LINING OR COATING—HLD

Code	Desc	Description	
HLD	The I	The lining ^{1,2,3} or protective coating of the maintenance structure is defective	
	Addi	tional Information	
	Characterisation 1—Nature of defect Record the nature of the defect as follows:		
	В	The lining or coating is <u>b</u> listered	
	BU	The non-structural liner ⁴ has <u>bulged</u> (no longer attached but liner is still intact)	
	D	The structural lining is <u>deformed</u> ⁵ (other defects may be associated with the deformation)	
	Н	Holes or perforations are evident in the lining	
	Е	The end or edge of the lining is defective or irregular e.g. not finished or cut correctly	
	М	Sections of the lining have become detached and are missing	
	Р	The lining or coating is peeling off	
	RM	Rendered mortar missing from rendered maintenance structure	
	W	The lining is wrinkled	

Code	Description		
	WD A weld in the protective lining is defective		
	X ⁶ The structural lining has collapsed		
	Z Other—record details in remarks		
	Quantification 1—Projection ² of bulging, wrinkling, blistering etc Where specified, measure or estimate and record the extent of projection in 10 mm increments as follows: 10, 20, 30, 40, 50 mm and so on		
	Circumferential location—record the position or extent of the defect as one or two clock references		

Notes

- (1) Linings may be structural or non-structural.
- (2) Lining may be incorporated into maintenance structure units during manufacture to protect the structural fabric or be installed to rehabilitate and extend the life of an in-service maintenance structure.
- (3) In rehabilitated maintenance structures it is likely that irregularity of the lining will be observed coinciding with displacements at joints or other irregularities in the original structure. These are not defects in the lining as such, but their presence should be recorded with code HGC (refer to 3.7.10.2 General comment—HGC).
- (4) Non-structural lining may **bulge** inwards if it becomes detached from the structure.
- (5) Deformation of structural lining shall also be recorded using code HD (refer to 3.7.2.3 Deformation—HD).
- (6) Deformation of structural liners >25% of the section of the structure shall be recorded as lining collapse.

3.7.8.2 POINT REPAIR—HPR

Code	Desc	Description	
HPR	The maintenance structure has been repaired		
	Addi	tional Information	
		Characterisation 1—Type of repair Record the type of repair as follows:	
	W A whole circumferential component has been replaced. Look for different material, different texture and jointing material.		
	ı	Injected cementitious material 1	
	L	Localised lining or patch. Record details in remarks	
	LR	Lining has been point repaired (structural or non-structural). Where possible, report repair methods used in remarks.	
	R	Part of the structure has been replaced or patched using the original or similar materials of construction, e.g. cement mortar rendering, bricks replaced	
	S	Injected sealing material other than cementitious, e.g. chemical grout	
	Z	Other—record details in remarks	
	Characterisation 2—The repair is defective ² Where the repair has failed or is defective in some way record as follows:		
	CD	The replaced/inserted <u>co</u> mponent has been <u>di</u> slodged or joins between new and/or old components are defective	

Code	Description	
	G	Injected sealing material is now defective, e.g. infiltration or ingress of soil is apparent at the grouting location. Record the nature of the defect(s) in remarks.
	P	Localised lining or patch is now defective, e.g. the localised lining is peeling, dislodged, bulged, disintegrating. Record the nature of the defect(s) in remarks.
	RD	The lining that has been point repaired is now defective. Record the nature of the defect(s) in remarks.
	W	Part of the wall that has been replaced is now defective. Record the nature of the defect(s) in remarks.
	Z	Other—record details in remarks
	Circumferential location—record the position or extent of the re	pair as one or two clock references

Notes

- (1) Look for signs of a drilled hole with remains of a grout plug apparent.
- (2) For defects in linings or coatings of whole maintenance structures use code HLD (refer to 3.7.8.1 Defective lining or coating—HLD).

3.7.9 CODES RELATING TO OPERATIONAL PERFORMANCE INCLUDING BENCHING, CHANNEL AND MAIN FLOW

3.7.9.1 BENCHING—HBE

Code	Description	
HBE	The condition of the benching	
	Additional Information	
	Characterisation 1—Condition Record the condition of the benching as follows:	
	D	Benching is <u>defective</u> , e.g. cement mortar rendering breaking up and infill bricks may be visible, no fall on benching etc. Record details in remarks.
	ND	Benching is not defective
	NB	There is <u>n</u> o <u>b</u> enching
	Circumferential location—record the location or extent of the	defective benching as one or two clock references

3.7.9.2 CHANNEL—HCH

Code	Description
НСН	Records the condition and dimensions of the channel
	Additional Information
	Characterisation 1—Condition

Code	Description		
	Record the condition of the channel using the following coding:		
	D Channel is defective, e.g. cement mortar rendering breaking up and infill bricks may be visible or no fall in channel or channel holding water etc. Record details in remarks.		
	ND Channel is <u>n</u> ot <u>d</u> efective		
	NC There is no channel		
	Quantification 1—Width Record the width of the channel at the bench level in mm to the nearest 10 mm		
	Quantification 2—Height Record the height of the channel in mm to the nearest 10 mm		
	Circumferential location—record the location or extent of the defective channel as one or two clock references		

3.7.9.3 ROOTS—HR

Code	Description		
HR	Roots of trees or other plants are growing into the maintenance structure		
	Additional Information		
	Characterisation 1—Type of roots ¹ Characterise the type of root growth within the maintenance structure as follows:		
	Tap roots—a small number of major roots (10 mm or greater) without a significant mass of fine roots		
	F <u>Fine roots—a relatively small number of flexible minor roots</u>		
	M A mass of mostly fine roots, which has developed into an interwoven clump		
	RT Recently cut tap roots—a small number of cut major roots (10 mm or greater) is evident		
	RF Recently cut fine roots—a relatively small number of cut minor roots remain		
	RB Recently cut interwoven mass of mostly fine roots leaving a beard of roots		
	Quantification 1—Obstruction in channels at base. (If roots in the channel cannot be observed due to obstructions or other impediments to vision leave the field blank.) Estimate and record the percentage reduction in cross sectional area of the channel(s) at the base of the maintenance structure from one of the following estimates: <5, 10, 20, 30, 40, 50, 60, 70, 80 or 90%		
	Quantification 2—Obstruction within chamber or shaft section restricting access for maintenance. (Where no roots are observed in this part of the structure leave the field blank.) Estimate and record the percentage reduction in cross sectional area of the chamber or shaft section of the maintenance structure from one of the following estimates: <5, 10, 20, 30, 40, 50, 60, 70, 80 or 90%		
	Circumferential location—record if the root entry can be associated with a specific position around the structure or through or around a specific joint or connection. Record the position or extent as one or two clock references.		

Notes

(1) In some inspections it may be possible to provide details of trees or other plants causing obstructions in which case record the findings in remarks. Details may include common name, species, location, distance from structure etc.

3.7.9.4 HYDRAULIC PERFORMANCE—HHP

Code	Description	
HHP	Records information about poor hydraulic performance, e.g. excessive turbulence, a rise in water level above the outlet or splashing onto the benching	
	Additional Information	
	Characterisation 1—Nature of flow Record details of the nature of the flow through the maintenance hole with the following codes accompanied by photographs where possible:	
	D The outlet conduit becomes submerged during peak flows (<u>D</u> rowned)	
	S Splashing and turbulence occurs at some stage during normal daily flows	
	OB An <u>ob</u> struction which may be part of the construction or an object 1 restricts the outlet. Where possible describe the cause of the obstruction in remarks.	
	Circumferential location—record the location of the outlet where the problem is apparent as one clock reference	



(1) Where it is an object in the invert also use code HOB (refer to 3.7.9.8 Obstructions—HOB).

3.7.9.5 FLOW CONTROL—HFC

Code	Desc	ription
HFC	A flov	w control device is present
	Additional Information	
	Characterisation 1—Type of control 1,2 Record the type of hydraulic structure using the following codes:	
	FL	Float operated valve
	FV	<u>F</u> lap <u>v</u> alve
	G	Gauge and canister, e.g. sewer gauging station
	MF	Measuring flume, e.g. venturi
	OP	Orifice plate
	Р	Penstock, gate stop, valve etc
	S	<u>S</u> yphon
	SS	Special structure, e.g. flap gate or other controls in a purpose-built structure
	TR	Trash rack, screens etc
	V	Vortex flow control
	W	<u>W</u> eir
	Z	Other—record details in remarks
	Characterisation 2—Flow control	

Code	Description	
	Record the aspect of flow controlled by the device as follows:	
	CF <u>C</u> ontinuation <u>f</u> low	
	OF <u>O</u> ver <u>flow</u>	
	Circumferential location—record the normal direction of the flow across the control structure to the outlet when in operation as one clock reference	

✓ Notes

- (1) Where the device controls an overflow record details in remarks.
- (2) Where an overflow from a sewer discharges in a stormwater pit, conduit or water course provide direct advice to the asset owner.

3.7.9.6 DEFECTIVE FLOW CONTROL DEVICE—HFX

Code	Desc	Description	
HFX	Records the condition of a flow control device(s) on a connection(s)		
	Add	itional Information	
		racterisation 1—Condition of flow control device ord the condition of the gate stop as follows:	
	D	Flow control device defective—record details in remarks	
	М	Flow control device missing (or parts thereof) with evidence that one previously existed. Describe details in remarks.	
	Z	Other—record details in remarks	
	Circu	umferential location—record the centreline position of the defective flow control device as a single clock reference	

3.7.9.7 DEPOSITS—HDE

Code	Description	
HDE	Material is attached to the surfaces of the maintenance structure or deposited on surfaces of landings, benches etc Additional Information Characterisation 1—Type of deposit on walls and vertical surfaces above the channel/benching	
	Е	Encrustation—there is an encrustation of unknown material attached to the wall, typically the deposit left by the evaporation of groundwater
	F	Fouling—an organism or growth attached to the walls
	G	<u>G</u> rease
	W	Other—record details in remarks
	Char	racterisation 2—Type of deposit in channel inverts and/or benching and/or on landings (horizontal surfaces)
	С	Material deposited is hard or compacted, e.g. concrete
	R	Material deposited is coarse sediments, e.g. gravel or rubble

Code	Desc	Description	
	S	Material deposited is fine sediments, e.g. sand or silt	
	Z	Other—record details in remarks	
	-,	ntification 1—Obstruction ord the thickness of the deposits in mm to the nearest 10 mm	
	Circu	Imferential location— record the position or extent of the deposits as one or two clock references	

3.7.9.8 OBSTRUCTIONS—HOB

Code	Desc	ription	
НОВ	Obstructions or objects are present in the maintenance structure. This code shall not be used where codes HR (refer to 3.7.9.3 Roots—HR) or HDE (refer to 3.7.9.7 Deposits—HDE) are applicable.		
	Additional Information Characterisation 1—Type of obstruction		
	В	One or more objects are lying on the <u>b</u> enches—record details in remarks	
	С	An object is entering through a connection	
	F	Eormwork or other construction materials have been left in the structure	
	I	An object is intruding through the wall	
	J	An object is wedged in a joint	
	М	A fragment of conduit material is lying in the channel 1	
	MU	Masonry unit/s is/are lying in the channel	
	0	An object is built into the structure	
	Р	An external conduit (pipe) or cable is built though the structure	
	Z	Other—record details in remarks	
	Estim struct	ntification 1—Obstruction in channels. (If obstructions in the channel cannot be observed leave the field blank.) nate and record the percentage reduction in cross-sectional area of the channel(s) at the base of the maintenance ture from one of the following estimates: 0, 20, 30, 40, 50, 60, 70, 80 or 90%	
	Quantification 2—Obstruction within chamber or shaft section restricting access for maintenance. (Where no obstruction is observed in this part of the structure leave the field blank.) Estimate and record the percentage reduction in cross-sectional area of the chamber or shaft section of the maintenance structure from one of the following estimates: <5, 10, 20, 30, 40, 50, 60, 70, 80 or 90%		
	Circu	mferential location—record the location or extent of the defect in the cross section as one or two clock references	



(1) Where deposits are observed use code HDE (refer to 3.7.9.7 Deposits—HDE).

3.7.9.9 SILT TRAP IN INVERT—HTS

Code	Desc	Description	
HTS	A silt	A silt or grit trap or pit is present in the invert of the maintenance structure	
	Additional Information		
		acterisation 1—Presence and condition of trap ord the condition of the silt trap as follows:	
	TP	Silt trap is present with no defects	
	TC	Silt trap is covered with debris such as rags and paper	
	TD	Silt trap is damaged—record details of the defects in remarks	
	TF	Silt trap is full of silt and grit and needs to be cleaned out	
	TM	All or part of the trap is missing with evidence that one was previously present—record details in remarks	

3.7.9.10 WATER LEVEL—HWL

Code	Description	
HWL	The nature and changes in depth of water above invert of channel in or base of the maintenance structure. Historic surcharge levels are identified in header code CDF (refer to 3.6.5 Header codes for recording miscellaneous information).	
	Additional Information	
	Characterisation 1—Presence of water above the invert of channel or base Record the presence of the water as follows:	
	A Above benching	

3.7.10 MISCELLANEOUS OBSERVATIONS

3.7.10.1 ATMOSPHERE WITHIN THE MAINTENANCE STRUCTURE—HGA

Code	Description	
HGA	A potentially hazardous atmosphere is identified during the inspection	
	Additional Information	
		acterisation 1—Nature of hazard rd the nature of the hazard using the following codes:
	СО	<u>C</u> arbon monoxide
	HS	Hydrogen sulphide
	ME	<u>Me</u> thane
	0	<u>O</u> xygen
	OF	Other flammable gas—record type of gas where known in remarks

Code	Description		
	Z Other—record details in remarks		
	Quantification 1—Percentage Record the percentage of gas where this is known		
	Quantification 2—Parts per million Record the concentration of the gas in ppm where this is known		

3.7.10.2 GENERAL COMMENT—HGC

Code	Description	
HGC	A comment or remark which cannot be included in any other way	
	Additional Information	
	Quantification 1—Urgency Indicate a situation that is a matter of urgency such as imminent structural or service failure, a public safety issue or some other circumstance that needs to be drawn to the attention of the asset owner by recording "U" as Quantification 1	
	Remark—explain the reason for the urgency and contact the appropriate personnel within the asset owner's organisation to report with details	

3.7.10.3 GENERAL PHOTOGRAPH—HGP

Code	Description	
HGP	A still photograph has been taken to record the general condition of the maintenance structure and is not related to any particular feature	
	Additional Information	
	Characterisation 1—Vertical orientation of camera If the camera is not viewing horizontally record the vertical orientation as follows:	
	D The camera is looking <u>d</u> ownwards	
	U The camera is looking <u>u</u> pwards	
	Z Other, at an angle to the horizontal—record details in remarks	
	Circumferential orientation—record the clock reference of the direction in which the camera is pointing	

3.7.10.4 VERMIN—HV

Code	Description	
HV	Living creatures (reptiles, mammals, birds, rodents, insects ¹) actually observed	
	Additional Information	
	Characterisation 1—Type of living creature Record the type of living creature actually observed as follows:	
	R Rodent	
	Z Other—record details in remarks. Do not code cockroaches.	
	Characterisation 2—Location	

Code	Description	
	Record the location of the observation as follows:	
	A In the maintenance (<u>a</u> ccess) structure	
	C In a connection	
	J In an open joint	
	Z Other—record details in remarks	
	Quantification 1—Numbers Record the number of living creatures observed	
	Circumferential location—record the position or extent of the observation as one or two clock references	



(1) For insects, only record an infestation (>5).

3.7.11 MISCELLANEOUS CODES RELATING TO THE ADMINISTRATION OF THE INSPECTION

3.7.11.1 START FEATURE—HST

Code	Description		
HST	Records information about the node at the start of the inspection (refer to Figure 3.1 for manholes)		
	Addit	Additional Information	
		acterisation 1—Nature of start feature rd the type of feature as follows:	
	AC	Access cover	
	В	<u>B</u> enching	
	FSL	<u>F</u> inished <u>s</u> urface <u>l</u> evel	
	L	<u>L</u> anding	
	RS	Reducing or conversion slab	
	Z	Other—record details in remarks	

3.7.11.2 INSPECTION COMPLETED—HFH

Code	Description	
HFH	Records information about the node at the finish of the inspection	
	Additional Information	
	Characterisation 1—Nature of finish feature Record the type of feature as follows:	
	AC Access cover	
	B <u>B</u> enching	

Code	Desc	Description	
	FSL	<u>F</u> inished <u>s</u> urface <u>l</u> evel	
	L	<u>L</u> anding	
	RS	Reducing or conversion slab	
	Z	Other—record details in remarks	

3.7.11.3 INSPECTION (SURVEY) ABANDONED—HSA

Code	Description	
HSA	The inspection has been terminated before completion. Where this is due to an obstruction it shall be coded separately using the appropriate main code.	
	Additional Information	
		acterisation 1—Reason rd the reason for the termination using the following codes:
	EF	Equipment failure
	HW	High water level
	ОВ	<u>O</u> bstruction
	R	<u>R</u> oots
	Z	Other—record details in remarks

3.7.12 CODES FOR CHANGING HEADER INFORMATION DURING AN INSPECTION

3.7.12.1 CHANGE OF MATERIAL—HMC

Code	Description			
HMC Allows updating of code CCD when the material used to form the maintenance structure changes				
	Additional Information			
	Characterisation 1—Material			

3.7.12.2 CHANGE OF CROSS SECTION—HCC

Code	Description				
HCC	Allows for recording changes of horizontal cross section and shape of the structure during inspection on descent or ascent (depending on the direction of inspection). Update header codes CCA, CCB, CCC, CCF, CCH and CCI if appropriate				
	Additional Information				
	Characterisation 1—New cross section shape Record the change in cross section and shape of the structure				
	CC <u>C</u> ircular and <u>c</u> ylindrical				

Code	Description				
	CO <u>Circular and conical</u> 1,2				
	R Rectangular, and including square				
	X Local section—record details in remarks				
	Z Other—record details in remarks				
	Quantification 1—Width/diameter Largest horizontal dimension of the new cross section in mm				
	Quantification 2—Breadth The minimum horizontal dimension of the new cross section in mm – do not record if shape is circular or square				

APPENDICES

APPENDIX A — SPECIFICATION FOR SOFTWARE

A1 OVERVIEW

The aim of this specification is to:

- (a) Provide a standardised application of the Code, such that all software produced to report on features and defects of **conduit** and maintenance structures are consistent in relation to the reporting parameters and the scoring and condition grading of assets;
- (b) Provide inspection reporting software that facilitates the efficient recording of observations by operators and assessors/coders;
- (c) Ensure software will produce inspection reports in an easily understood and usable format for agencies undertaking **conduit** inspections; and
- (d) Ensure inspection data can be assessed readily by the engaging agencies.

This specification has been structured in four sections:

- (i) Scoring and Data;
- (ii) Reporting;
- (iii) Required Software Functionality; and
- (iv) XML Transfer Format.

A2 SCORING AND DATA

A2.1 DATA INTEROPERABILITY

A fundamental requirement for assessing <u>conduit</u> and maintenance structures is the ability to use collected data for analysis and modeling of the condition of these assets. To ensure this requirement is met any database used to record CCTV vision and observations shall be one of the following:

- (a) A well-documented industry standard or non-proprietary format such as 'Access' (.mdb), 'SQL', 'SQLlite', 'Excel', 'CSV' etc.; or
- (b) A propriety format that has a comprehensive and freely available published data specification that would allow third party developers to implement an interoperability plugin.

In addition to these requirements:

- (i) Inspection data shall not be encrypted, obfuscated, or password protected in any way;
- (ii) A field structure shall be used that enables ready retrieval of all header data, inspection data, and observations;
- (iii) Video and still images shall be adequately referenced to the inspection/location to which they relate.

To assist in the data transfer process and provide a standard point of reference, an XML schema has been developed, and included in this document. This format has been chosen as it is extensible, ubiquitous, easy to manipulate, transmit and convert, and is well catered for in all major programming languages.

This protocol will replace the EN13508 data transfer format detailed in previous versions of this Code.

WSAA intends that this protocol will be the default method of cross program/system interoperability and requires all software developers to provide import and export functionality in the software.

The eXtensible Markup Language (XML) protocol is outlined in XML Transfer Format in this appendix, along with xsd schema, and sample inspection.

A2.2 INSPECTION REPORT AND DATA FILENAMES

Software shall provide facility to customise media file names to asset owner's specification. The default file naming conventions should conform to 1.14.1 General.

A2.3 MEDIA FORMATS

It is essential that the inspection 'video' record is easily playable, transferable and accessible. Standard formats should conform to 1.14.3 Video record.

For 3D optical scanners, the 'video' format may be unpublished and proprietary, however, a restricted capability viewer shall be available to allow viewing of all 'video' files associated with inspection reports without additional fees or software.

A2.4 ABBREVIATION OF CODES AND CONSISTENCY WITH WSA 05

Software shall use the codes specified in the Code in pull-down menus for report header fields and feature and defect codes. Any abbreviations of the definitions/descriptions shall convey the intent of those definitions or descriptions.

Reports likewise, shall incorporate abbreviated definitions/descriptions of codes that are consistent with intent of this Code.

Where the software developer is unsure that the abbreviation adequately reflects the intent of the text in the Code, the developer should seek clarification from the Water Services Association of Australia.

Modification or customising of software catalogues, templates, condition algorithms and report formats by operators, assessors, asset managers or others shall not be permitted beyond the options specified in the Code or this specification.

A2.5 APPLYING SCORING AND GRADING OF CONDUITS

Defects are categorised as:

- (a) Structural affecting the structural integrity of the conduit; or
- (b) Service affecting the operational performance of the sewer or stormwater conduit.

Each defect, structural or service, has been given a notional 'score' which is indicative of the relative risk associated with that defect. Some defects are considered both a structural and service defect.

Structural scoring shall be applied appropriately for the material of the <u>conduit</u> or structural lining to determine structural condition grading of the conduit. <u>APPENDIX B — MATERIALS AND ACRONYMS</u> lists the structural characteristics of conduit materials and structural lining materials and techniques as:

- (i) Rigid;
- (ii) Flexible; or
- (iii) Masonry.

To apply scoring, the **conduit** inspection length shall be divided into 1 m intervals starting at zero (Longitudinal Reference Point).

Defects observed within an interval shall be reported at the distance at which it is first observed. The scores for the defects observed shall be assigned to the interval in which they occur. For continuous defects, the score shall be allocated proportionally to the metre division in which it first occurs and for each metre division until the continuous defect finishes. Where it finishes within the metre division, the score shall be allocated proportionally.



In the Code, a 'specified length' of one metre has been adopted. Asset owners or others may wish to change this length, but this Code's scoring and condition grading has been developed based on a one metre specified length.

The peak score (structural or service) indicates the worst metre in terms of defects in the **conduit** between the nodes. It is the maximum of the summed scores for all defects that occur within a one metre division of the conduit.

The mean score is the total of all defect scores divided by the **conduit unit length**. The mean score is expressed as XX/ metre and is used to give an indication of the overall condition of the conduit.

Peak and mean scores are determined separately for the service and structural condition of the <u>conduit</u>. The condition grades of the conduit (structural and service) are determined from the algorithms specified in <u>C8 REFINING SCORES AND GRADING</u>.

Software shall automatically calculate scores and grades when FN (Finish Node) or SA (Survey Abandoned) codes are entered. Failure to end continuous defect codes before FN or SA is entered shall trigger a screen warning that the continuous codes must be closed before scoring and grading can be completed.

Structural scoring shall be applied differently for **conduit** of **rigid materials**, **flexible materials** and **masonry construction** to reflect the different levels of risk associated with a specific defect in conduits of that material/construction. Software shall automatically apply the appropriate scores by referencing tables in **APPENDIX B**—

MATERIALS AND ACRONYMS for structural characteristics, and **APPENDIX C**— **SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF THE APPARENT CONDITION OF OPERATIONAL SEWERS** for defect scores in sewers and **APPENDIX D**— **SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF OPERATIONAL STORMWATER DRAINS**D for defect scores in stormwater conduits. **A2.6 Conduit usage explanation** below tabulates the appropriate appendix based on the header field ACK.

Where the **conduit** material changes (MC) or structural lining changes (LC), the scoring of any defects shall be applied for that material/lining for the extent of the new material. Any subsequent change of material/lining shall be applied in the same way.

The condition grade shall be determined using the peak and mean scores for the total length of the asset comprising different materials.

A2.6 CONDUIT USAGE EXPLANATION

Selection of scoring from APPENDIX C — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF THE APPARENT CONDITION OF OPERATIONAL SEWERS or APPENDIX D — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF OPERATIONAL STORMWATER DRAINS shall be determined from Table A.1.

Table A.1 SELECTION OF APPROPRIATE APPENDIX FOR SCORING OF CONDUITS

Use of Conduit (ACK)	Description	Appendix	
СОМ	combined system (sewage and surface water combined)	Appendix C	
CUL	Culverted watercourse (e.g. a short buried section for a road crossing or similar)	Appendix D	
D	A drain designed to carry only surface water	Appendix D	
S	The installation is designed to carry only Sewage	Appendix C	
TW	Trade effluent sewer (e.g. trade waste)	Appendix C	
Z	Other	User selectable Defaults to Appendix C	

Where the material of the **conduit** or lining cannot be identified the software shall provide the option to nominate the structural characteristics of the conduit to facilitate appropriate scoring and grading determination.

In some cases it may not be applicable to use the automatic structural condition algorithms for a **conduit**. The option to turn off the grading calculation shall be provided, and any reports produced provided with an advisory note 'Structural condition grading may not be appropriate for this conduit using the scores and grading algorithm. Alternative condition assessment techniques should be considered'. 'Turning off' the scoring and grading function shall require the approval of the engaging agency.

A2.7 SOFTWARE VERSION CONTROL

Software vendors shall identify the reporting software version with a unique, vendor selected, alphabetic and numeric character set, and in addition require:

- (a) The version of the Code for which the software complies, e.g. WSA 05-2020:4.1
- (b) The version of the scoring values and grading ranges for which the software complies using the following protocol App C 2020-V1.0; App D 2020-V1.0; App E 2020-V1.0 or a similar recognisable format.

The compliance of the software with the Code and Appendix version shall be recorded and stored in header field 'ABA' for each inspection. This will take the form of a semicolon delimited string:

WSA 05 Revision: Scoring Appendix: Scoring Appendix Version

So for a sewer inspection according to WSA 05-2020:4.1, using the first revision of Appendix C, the string would be:-4.1;C;1.0

A2.8 INTERFACE WITH CAMERA HARDWARE, SOFTWARE AND OTHER INPUTS

conduit inspection software shall provide:

(a) The ability to record video from a live camera feed;

- (b) Ability to interface with the Camera's meter counter via the manufacturer supplied interface (usually via RS232 or USB);
- (c) Distance input automatically recorded for an observation with an option to manually override that value;
- (d) The ability to control or read data from all standard and optional hardware devices for the camera systems listed as supported;
- (e) The ability to provide on-screen text, overlaid and recorded onto the video record. This may take the form of Software On Screen Display (OSD) or control of a hardware unit (usually via RS232 or USB);
- (f) The facility to allow text display of selected parameters from the header fields in the inspection video title frame and continuous display;
- (g) For operator generated text, to describe or add information to the vision of specific defects/features and an on or off option to display observations on the screen;
- (h) A default setting off for display of observations;
- (i) Customisable (OSD) text (location, colour, background, font) to give clear on-screen data without compromising the details of the specific feature in the image; and
- (j) All directives specified in 1.9 DATA DISPLAY DURING VIDEO PLAYBACK OR DIGITAL IMAGE ANALYSIS implemented and be available to operators.

A2.9 COMPARISON WITH EN-13508

EN 13508-2:2003 Conditions of drain and sewer systems outside buildings Part 2: Visual inspection coding system provided the initial template for this Code.

Whilst there are significant variations, there is a considerable volume of codes and protocols that are consistent with EN13508. One significant difference in the two Codes is the use of mnemonic defect and feature codes to reflect the English descriptions and make memorising the codes easier.

A2.10 ERRORS, AMBIGUITIES, INCONSISTENCIES OR OMISSIONS IN THE CODE AND APPENDICES

WSAA welcomes suggestions for improvements, and encourage Users to notify us immediately of any apparent inaccuracies or ambiguities. Users may use the feedback link on the side menu of this Code to submit comments or suggested improvements. Alternatively you can also contact us via email at codes@wsaa.asn.au, or write to the National Codes Manager, Suit 8.02, Level 8, 401 Docklands Drive, Docklands, 3008.

A3 REPORTING

A3.1 REPORT FORMAT

Experience of inspection reporting over previous iterations of the Code has revealed a multitude of different formats and presentation styles of asset and inspection data. This has been unhelpful for the industry and has lead to errors and misinformation in reporting. Of particular significance has been the failure to identify the coding standard used for reporting. This omission can create significant differences in the interpretation of reports and grades. It is not possible for most asset owners or others involved in reviewing reports to easily identify the Code being used unless this field is incorporated in the report header. The following requirements are designed to address these issues.

The inspection report header shall incorporate the following:

- (a) All mandatory report header fields;
- (b) All optional report header fields where specified by the engaging agency;
- (c) Condition statistics; and
- (d) All user defined header fields where specified by the engaging agency.

In the body of the report, the defects and features the **conduit** being inspected shall be shown in a graphical format, longitudinally scaled and with appropriate graphics to represent features such as junctions, connections, maintenance structures, nodes etc.

For maintenance structures a graphic depiction of the structure is desirable.

The observation for a feature or defect shall be shown on the graphic representation at a scaled location and linked to the code, abbreviated description and remarks.

The feature or defect code shall be shown on the report. Scores for the defect shall be shown on the report and on the input screen.

Photographs shall be included in reports with a caption that includes the distance of the observation and abbreviated description of the defect or feature. Up to two photographs at each observation shall be allowed.

Any video clips of features or defects shall be accessible from the digital report screen.

User defined colour coding of different defects or defect categories may be provided in the software.

To ensure the correct and latest report is verifiable, the report shall include a date and time in the file name. This information shall also be incorporated into any printed or PDF versions of the report.

A3.2 PRESENTATION OF SERVICE AND STRUCTURAL SCORES FOR CONDUITS

Scores, grade and statistics as identified in the report header in 2.6.7 Header codes for structural and service condition statistics shall also be tabulated in the inspection report. To facilitate simple review of conduit structural and service condition and highlight to asset owner the potential need for rehabilitation/repair, the software shall provide an option to display graphically the scores allocated to defects along the full length of the asset inspected.

The graphic output shall be scaled appropriately for length and score values. Typically the graphic will be in the form of a histogram, with user selectable colours for service and structural scoring.

Although scoring and condition grading of maintenance structures have not been finalised for this version of the Code, allowance should be made to present information in a similar way for parameters of structural integrity, operational performance and access/safety.

A3.3 LATERAL CONDUITS

Scores associated with defects in laterals (the connecting <u>conduit</u> at junctions and connections), documented in <u>Table</u> <u>C.5</u>, shall be reported separately to the scores and grading for the main conduit unless the inspection of the lateral is undertaken with 'satellite' inspection technology.

Ideally, the scores for defects in laterals should be aggregated and reported as a guide to asset owners on actual or potential problems with property connection sewers or stormwater lateral pipework. <u>APPENDIX K — MANUAL CODING SHEETS</u> provides an example report for defects affecting laterals as a guide (sheet K3). Other presentations that include the same data may be acceptable.

A3.4 EMERGENCY CONDITIONS FOR CONDUITS AND MAINTENANCE STRUCTURES

Some defects or combination of defects in a sewer or stormwater **conduit** or associated maintenance structure may constitute an emergency condition where service failure is likely with impacts on the environment, public safety and/or property.

The follow table shall be used to trigger a visual and text flag in the report that indicates an emergency situation.

Description	Code	Ch1	Ch2	Q1	Q2
Collapse	х				
Obstruction greater than 50%	ОВ	All		>50%	
Obstruction – gas pipe or electricity cable/duct	ОВ	P			U
Missing masonry unit with no further layers visible	MMU	NV			
Masonry conduit collapse	XM				
Structural lining collapse	LD	Х			
Surface damage concrete – hole and	SC	н			
void visible	VV				

Description	Code	Ch1	Ch2	Q1	Q2
Surface damage asbestos cement –	SAC	Н			
hole and void visible	VV				
Surface damage asbestos cement – delamination	SAC	DI, DM, DX			
Surface damage other – hole and	SO	н			
void visible	VV				
Broken – missing and void visible	В	М			
and void visible	VV				
Ingress of soil in conduit	ING	All			
Collapsed structure	нх				
Ingress of soil in maintenance structure	HING	All			
Breaking – missing and void visible	НВ	М			
and void visible	VV				
Surface damage concrete – hole and	HSC	н			
void visible	VV				
Surface damage other – hole and	HSO	н			
void visible	VV				
Masonry maintenance structure collapsed	HXM				
Missing masonry units – no further layer visible	НММИ	NV			
Defective cover and/ or frame – cover missing	HCF	СМ			
Hydraulic performance – obstruction	HHP	ОВ			
Obstruction – gas pipe or electricity cable/duct	НОВ	Р			

A4 REQUIRED SOFTWARE FUNCTIONALITY

A4.1 INPUT OPTIONS

Input of observation codes shall be facilitated by:

(a) Pull down menus using mouse, key pad, touch screen or other control hardware; and

(b) Direct keyboard entry of the defect or feature codes.

Up to two photographs appended to each observation shall be provided. In addition, provision shall be made for one video clip, as specified in the Code, to be appended to an observation.

To facilitate verification of the inspection site or to capture surface features of maintenance structures at the inspection site the software shall provide for import of photographs or video clips from hand held cameras or USB flash drive. Any such images shall be appended to the 0.0 m observation.

In addition to 'live' observation recording during inspections, the software shall facilitate post-inspection observation recording of features and defects using visual images from video or continuous 'stitched' still images of the inspection. Still photographs shall be extractable from the inspection image file to illustrate observations as required and include in reports.

For post-inspection reporting or editing of reports, a video clip to illustrate a feature or defect may be provided as an optional function of the software by the developer.

A4.2 RECORDING OF REGULARLY OCCURRING FEATURES

During inspections it is extremely likely that similar defects or features will occur along the length (or depth) of the asset being inspected. The features or defects reoccurring may only differ in one or two parameters but are essentially the same type of defect/feature. Cracking for example may change in clock position and/or crack width.

To facilitate the efficient recording of these recurring defects/features, the software shall ensure that the reporting software provides a ready reference of previously used codes updated continuously to a maximum of the last ten observations, including characterisations, quantifications, clock references and remarks. The operator, assessor or coder shall then have the opportunity of selecting one of these previous observations and changing, as required, the parameters relevant to the new observation to be recorded at the new or same distance.

A4.3 COMMON COMBINATIONS OF FEATURES AND DEFECTS

Some features and defects are associated and occur at the same location. To enable efficient recording of data in these circumstances, the software shall provide for the following 'short cuts':

- (a) The recording of a Junction (JN) shall be automatically followed by an option to record Defective Junction (JX) at the same location. A null field for JX may be possible.
- (b) Recording of a Connection (CN) shall be followed automatically by an option to record Intruding Connection (CI) and then Defective Connection (CX). A null field for CI or CX may be possible.
- (c) Broken Displaced (BD) shall be followed automatically by an option to record Deformation (D). A null field for D may be possible.
- (d) Connection type (HCN) shall be followed automatically by Connecting Conduit (HCP) and then followed by Defective Connecting Conduit (HDC). A null field for HDC may be possible.

A4.4 TERMINATING AND CHANGING CONTINUOUS FEATURES

The software shall provide a ready reference of all continuous codes including characterisations, quantifications, clock references and remarks. When the feature or defect finishes, or the parameters of the feature or defect change, the operator, assessor or coder shall have the opportunity of selecting the appropriate continuous feature and ending or changing the parameters of the feature or defect at the appropriate distance.

A4.5 DATA LOSS PREVENTION

The software shall incorporate measures to prevent loss or corruption of data through:

- (a) Operator error;
- (b) Loss of power supply; and
- (c) Hardware malfunction.

A4.6 INCOMPLETE MANDATORY HEADER FIELDS

Where mandatory header data fields cannot be filled due to absence of data, the software shall flag on the input screen an absence of all mandatory fields.

Reports shall show the missing fields shaded grey.

A4.7 RECALCULATION OF STATISTICS AND CONDITION GRADES

Inspection data may be revised following initial input and production of an inspection report. When any observation data or other parameters are revised the software shall invite recalculation of structural and or service statistics to produce revised statistics and condition grading.

To ensure the correct and latest report is verifiable the report shall include a date and time of recalculation in the file name. This information shall also be incorporated into any printed or PDF versions of the report.

A4.8 REVIEWING AND NAVIGATING THROUGH PROJECT INSPECTION DATA

To facilitate review of project data the software shall provide tools to navigate through project data that enables engaging agencies or customers to view the following:

- (a) Reports of each inspection length;
- (b) Reports of supplementary data such as inclination reports;
- (c) Graphic displays;
- (d) Video record of the inspection;
- (e) Any video clips of specific defects;
- (f) Photographs; and
- (g) Database of observations.

Data shall be extractable for analysis or transmission.

In addition, the software shall provide tools to produce reports that identify conduit lengths or maintenance structures, within a project, that exhibit user defined parameters. These parameters could include but are not limited to:

- (i) For conduits, structural or service condition grades at a range of levels in the order of severity or at one level;
- (ii) For maintenance structures, the structural, operational performance, or safety/access condition grades at a range of levels in the order of severity or at one level;
- (iii) Several or individual defect codes in the order of severity;
- (iv) Operator, coder, assessor;
- (v) Location;
- (vi) Conduit size;
- (vii) Asset material; and
- (viii) Depth of asset.

A4.9 SOFTWARE ENHANCEMENTS BY DEVELOPER

The developer may include enhancements in the software not required by this specification or Code. Any such enhancements shall not be a substitute, obfuscate or negate the mandatory aspects of this specification.

A5 XML TRANSFER FORMAT

XML has been chosen as it is ubiquitous and extensible. As such, the supplied schema represents the minimum data required to communicate survey information.

Developers should add to this as required for proprietary technology such as laser, 360 degree, new and alternative sensor technology etc.

All identifiers (ID) should be a system-generated globally unique identifier (GUID).

A5.1 DATA STRUCTURE

An example of the general structure for recording each conduit inspection can be depicted as shown in <u>Figure A.1</u>. This applies to conduits only, and the methodology should be applied for maintenance structures.

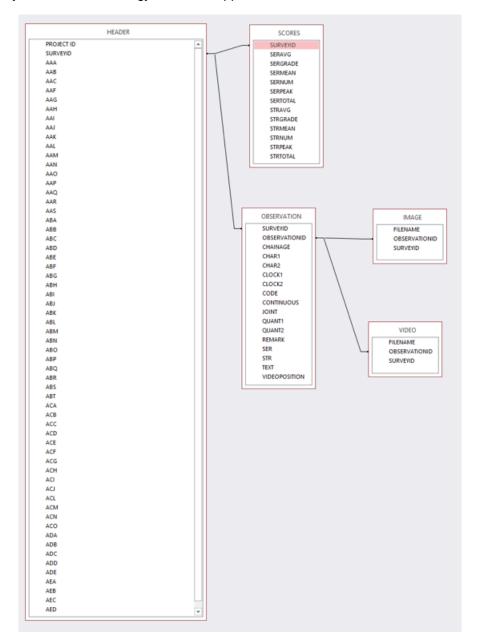


Figure A.1 DATA STRUCTURE FOR EACH INSPECTION

The following sections provide further information on the metadata within each element.

A5.1.1 < PROJECT />

Project is the root element, and stores metadata relating to the grouping of inspections. It contains the following subelements:

(a) <PROJECTID /> – A globally unique identifier for the package of inspections;

- (b) <SOFTWAREVENDOR /> The software used to generate the inspection data (e.g. Pipe-Tech/Auscodes/Wincan);
- (c) <SOFTWAREVERSION /> The software version used to generate the inspection data;
- (d) <NAME /> A descriptive name for the grouping of inspections;
- (e) <CREATED /> Date in DateTime format;
- (f) <CREATEDBY /> Name of user to create or last modify project;
- (g) <MODIFIED /> Date in DateTime format; and
- (h) <MODIFIEDBY /> Name of user to last modify project.

A5.1.2 <SURVEYS />

Surveys is a container for all inspections in the data package. Each individual inspection is held in a sub-element <SURVEY />.

A5.1.3 <SURVEY / >

Container for a single inspection. It contains the following sub-elements:

- (a) <SURVEYID/> A globally unique identifier, linking the observation to a inspection;
- (b) <HEADER /> This element is populated with all header codes as per 2.6 CONDUIT HEADER CODES;
- (c) <OBSERVATIONS /> A container for observed codes;
- (d) <SCORES /> Calculated structural/serviceability scores as per <u>APPENDIX C SCORING OF DEFECTS</u> <u>AND THE PRELIMINARY GRADING OF THE APPARENT CONDITION OF OPERATIONAL SEWERS or APPENDIX D — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF OPERATIONAL STORMWATER DRAINS;</u>
- (e) <IMAGES /> A container for captured still images. This structure allows unlimited photographs to be associated with an observation;
- (f) <VIDEOS /> A container for captured video clips and complete inspection video record. This structure allows unlimited video clips to be associated with an observation;
- (g) <LASER /> A container for vendor-specific laser scan information;
- (h) <SCAN /> A container for vendor-specific 360, or other, scan information; and
- (i) <EXT /> A container for vendor specific information.

A5.1.4 < OBSERVATION />

Holds a single observation. It contains the following sub-elements:

- (a) <OBSERVATIONID />- A globally unique identifier, uniquely referencing the observation;
- (b) <DISTANCE /> The distance from the zero point of the inspection in metres;
- (c) <CODE /> Base code as per 2.7 CODES FOR REPORTING THE INSPECTION OF CONDUITS;
- (d) <CHAR1 /> Characterisation 1;
- (e) <CHAR2 /> Characterisation 2;
- (f) <QUANT1 /> Quantification 1;
- (g) <QUANT2 /> Quantification 2;
- (h) <CLOCK1 /> Clock reference of observation, or (start clock reference);
- (i) <CLOCK2 /> Finish clock reference of observation (if required);
- (j) <REMARK /> Free text operator comment;
- (k) <JOINT /> Indicated if observation is located at a joint;
- (I) <CONTINUOUS /> A marker for continuous code. This should take the form of an auto-incrementing number prefixed by "S" for Start, "F" for Finish, e.g. "S1", "F1", "S2", "F2";

- (m) <STR /> Structural score as per APPENDIX C SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF THE APPARENT CONDITION OF OPERATIONAL SEWERS OF APPENDIX D SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF OPERATIONAL STORMWATER DRAINS;
- (n) <SER /> Service score as per APPENDIX C SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF THE APPARENT CONDITION OF OPERATIONAL SEWERS OF APPENDIX D — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF OPERATIONAL STORMWATER DRAINS;
- (o) <VIDEOPOSITION /> video position as per Header Code AAM; and
- (p) <TEXT /> descriptive text formatted for display.

A5.1.5 < SCORES />

For both service and structural defect/feature scores. It contains the following sub-elements:

- (a) <SERTOTAL />/<STRTOTAL /> Total score (i.e. sum of all structural or service defect scores);
- (b) <SERPEAK />/<STRPEAK /> Peak score (i.e. maximum of summation of scores in a specific length);
- (c) <SERMEAN />/<STRMEAN /> Total score divided by survey length;
- (d) <SERNUM />/<STRNUM /> Number of scoring defects (structural or service);
- (e) <SERAVG />/<STRAVG /> Total score divided by number of defects; and
- (f) <SERGRADE />/<STRGRADE /> Coarse condition grade as per APPENDIX C SCORING OF DEFECTS
 AND THE PRELIMINARY GRADING OF THE APPARENT CONDITION OF OPERATIONAL SEWERS OF
 APPENDIX D SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION
 OF OPERATIONAL STORMWATER DRAINS

A5.1.6 < IMAGE />

Holds a still image, allowing it to be related back to a defect. It contains the following sub-elements:

- (a) <OBSERVATIONID /> Allows the image to be related back to an observation; and
- (b) <FILENAME /> Filename of captured image (refer to 1.14.1 General).

A5.1.7 < VIDEO />

Holds a still image, allowing it to be related back to a defect. It contains the following sub-elements:

- <OBSERVATIONID /> Indicates the point at which the video was started (may be left blank); and
- <FILENAME /> Filename of captured video clip (refer to 1.14.1 General).

APPENDIX B — MATERIALS AND ACRONYMS

The following header and observation codes require reference to the reporting codes of this Appendix:

Table B.1 HEADER AND OBSERVATION CODES

Code	Description
ACD	Conduit material
ACF	Conduit lining material
MC	Change of conduit material
CCD	Material of the fabric of maintenance structure
CCO	Material of cover on maintenance structure
CCS	Material of steps or ladders
CCT	Material of lining
НМС	Change material of fabric of maintenance structure

Table B.2 MATERIAL ACRONYMS - CONDUITS

Acrylonitrile butadiene styrene Aluminium alloy Aluminium alloy Asbestos cement Cast iron (type unknown) Clay—vitrified VC Concrete reinforced RC	- C M	Flexible Flexible Rigid Rigid Rigid
Asbestos cement AC Cast iron (type unknown) AM Clay—vitrified VC	C C C C C C C C C C C C C C C C C C C	Rigid Rigid
Cast iron (type unknown) Clay—vitrified VC	M C	Rigid Rigid
Clay—vitrified VC		Rigid
Concrete reinforced RC		Digid
		Rigid
Concrete segments CS	8	Rigid
Concrete sprayed GU	J	Rigid
Concrete unreinforced CP		Rigid
Ductile cast iron DI		Flexible
Fibre reinforced cement FC		Rigid
Fibre reinforced plastics ³	RP	Flexible
Galvanised iron or steel GI		Flexible
Glass reinforced plastics ³ GR	RР	Flexible
Grey cast iron CI		Rigid
Masonry – brick (coursed) MB	ВС	Masonry
Masonry – bluestone/basalt (coursed) MB	BSC	Masonry
Masonry – other stone (coursed) MO	OSC	Masonry

Material	WSA 05	Assumed Structural Characteristics 1,2
Masonry – bluestone/basalt (uncoursed)	MBSU	Masonry
Masonry – other stone (uncoursed)	MOSU	Masonry
Masonry-concrete composite ⁴	MCON	Masonry
Pitch fibre ⁵	PF	Rigid
Plastics (type unknown)	Р	Flexible
Polyethylene	PE	Flexible
Polypropylene	PP	Flexible
Polyvinylchloride	PVC	Flexible
Stainless steel	SS	Flexible
Steel	S	Flexible
Unidentified type of concrete or cement mortar	AG	Assume rigid
Unidentified type of steel	AQ	Assume flexible
Unidentified type of plastics	AY	Assume flexible
Unidentified material	ZZ	Assume rigid
Other—record details in remarks	Z	Assume rigid

Notes

- (1) For correct condition assessment, the structural characteristics of the conduit need to be taken into account. For simple analysis, conduits have been categorized as rigid, flexible, or masonry.
- (2) Not every conduit will fit into the structural categories nominated above. Asset owners are advised to consider the attributes of such conduits and make an informed judgement about the condition.
- (3) FRP and GRP are often synonymous acronyms.
- (4) Masonry (brick) and concrete composite conduits usually consist of a concrete invert and brick soffit in circular or ovoid shape. For simplicity, the structural characteristics of these composite conduits shall be regarded as masonry.
- (5) Not a common pipe material in Australia.

Table B.3 LINING MATERIALS - CONDUITS AND MAINTENANCE STRUCTURES

Code	Lining material		Lining technique ¹	Assumed Structural Characteristics ²
CL	Cement (mortar) lining	MFL, SPL		N/A
E	Ероху	MFL, SPL		N/A
FRP	Fibre reinforced plastics	SEG, LDP		Flexible
GRC	Glass fibre reinforced cement	SEG, LDP		N/A

Code	Lining material		Lining technique ¹	Assumed Structural Characteristics ²
GRP	Glass fibre reinforced plastics	SEG, LDP		Flexible
PE	Polyethylene	MFL, SEG, LCP, CFL		Flexible ³
PIS	Plastics (thermosetting) impregnated felt or woven sock	CIP		Flexible
PU	Polyurethane	MFL, SPL		N/A
PUA	Polyurea	MFL, SPL		N/A
PVC	Polyvinylchloride	SEG, CFL, SWL		Flexible ³
Z	Other—record details in remarks			Requires input

Notes -

- (1) Lining technique acronyms explained below.
- (2) Structural liner characteristic.
- (3) These linings may be structural or non-structural in terms of structural condition assessment. Lining techniques LCP, LDP, SEG and SWL are considered to be structural.
- (4) Although the structural lining material may be regarded as flexible, in some installations the liner is surrounded with a cement grout creating a somewhat more complex structural characteristic than those assumed in this Appendix.

Table B.4 ACRONYMS AND APPLICABLE LINING TECHNIQUES

Code	Lining technique acronyms
CFL	Close fit lining
CIP	<u>C</u> ured <u>in p</u> lace lining
LCP	Lining with a continuous pipeline, also called slip lining, i.e. a pipe string welded on the surface prior to insertion
LDP	Lining with discrete pipes, also called slip lining, i.e. short pipes jointed underground
MFL	Lining inserted during manufacture (Manufacturer's factory lining)
SEG	<u>Segmental linings</u>
SPL	Sprayed lining
SWL	Spirally wound lining
Z	Other—report other techniques not described above or the absence of lining

Table B.5 MATERIAL ACRONYMS - MAINTENANCE STRUCTURE FABRIC AND COMPONENTS

Material	WSA 05
Acrylonitrile butadiene styrene	ABS
Asbestos cement	AC
Cast iron (type unknown)	AM
Precast reinforced concrete	PRC
Concrete segments	CS
Concrete sprayed (shotcrete)	GU
In situ concrete unreinforced	СР
Ductile cast iron	DI
Fibre reinforced cement	FC
Fibre reinforced plastics ¹	FRP
Galvanised iron or steel (galvanised steel common for step irons)	GI
Glass reinforced plastics ¹	GRP
Grey cast iron	CI
Masonry – brick (coursed)	MBC
Masonry – bluestone/basalt (coursed)	MBSC
Masonry – other stone (coursed)	MOSC
Masonry – bluestone/basalt (uncoursed)	MBSU
Masonry – other stone (uncoursed)	MOSU
Masonry (uncoursed)	MAR
Plastics (type unknown)	P
Plastics encapsulated metal ²	PM
Polyester	PY
Polyethylene	PE
Polypropylene – solid or profiled	PP
Polypropylene – expanded	EP
Polyvinylchloride	PVC
Stainless steel	SS
Steel	S
Unidentified type of concrete or cement mortar	AG
Unidentified type of iron or steel	AQ
<u> </u>	

Material	WSA 05
Unidentified material	ZZ
Other—details recorded in remarks	Z

✓ Notes

- (1) FRP and GRP are often synonymous acronyms.
- (2) When uncertain, record as plastics.

APPENDIX C — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF THE APPARENT CONDITION OF OPERATIONAL SEWERS

C1 BACKGROUND

CCTV inspection of sewers can provide a wealth of information on the condition of these assets. Since 1991 this information has been codified, initially in the Australian Conduit Condition Evaluation Manual (ACCEM), so that a range of common defects can be readily identified and recorded in a systematic way.

However, the overall condition of a sewer cannot be determined easily from inspection reports listing the codified defects and locations. As a guide to determining the condition of assets ACCEM also allocated scores for defects and a simple arithmetic formula to produce a grading for the structural and service condition of conduits. With this guidance, asset managers were able to make informed decisions on what assets needed attention and those that were operationally and structurally sound.

The scoring and grading concept initiated in ACCEM was followed in all versions of WSA 05 from the first published edition in 2002.

In this edition the scores, grading ranges and grade descriptions have been adjusted to reflect changes in the defect codes and analysis of scoring of defects in a range of sample conduits. These adjustments should lead to more meaningful structural and service grades for most sewers inspected and reported in accordance with this Code.

C2 APPLICABILITY OF SCORING AND GRADING

The scoring of defects and determination of a condition grade for a sewer is not intended to be used for acceptance evaluation of new assets. There may be several unsatisfactory features and or defects that may not generate a score or grade to trigger rejection of a new asset. APPENDIX J — GUIDE FOR INTERNAL INSPECTION OF NEWLY CONSTRUCTED SEWERS OR STORMWATER CONDUITS AND CRITERIA FOR ACCEPTANCE provides criteria that can be used in association with the inspection reports to judge the suitability of new assets for acceptance by asset owners.

Condition grading may not be accurate in every circumstance and asset managers are advised to review carefully those assets showing a high grading, indicating risk of imminent structural or service failure, before initiating rehabilitation or other actions.

C3 SCORES AND CONDITION GRADE

Asset management takes account of many factors, other than the apparent condition of a sewer as determined by an internal visual inspection, when determining the most appropriate action for the asset. Factors such as the criticality, hydraulic performance, structural condition and environmental circumstances of the sewer, as well as the economic needs of the asset owner/operator and the customers serviced by the sewer, must also be considered. There are a number of established asset management manuals that cover the situation fully, one particularly pertinent reference being the Sewerage Rehabilitation Manual 2001 published by WRc plc.

As a first step in the process, Tables C1 to C4 set out a scoring system for defects and features that can be used to calculate peak and mean scores. Tables C6 and C7 use the peak and mean scores to estimate the structural and service condition grades of sewers along with some typical asset management responses.

The scores allocated to the service and structural defects are derived from Australian experience. They are intended to provide a relative measure of the likelihood of service or structural failure. The scores only apply to gravity sewers and sanitary drains. In some instances, defects may be scored as both a structural defect and service defect. For example, tuberculation of unlined cast iron sewers indicates a loss of structural integrity due to graphitisation of the pipe wall and also causes a loss of hydraulic performance due to the reduced cross section. Hence it is scored as a structural defect and a service defect.

A severity factor may be nominated by the asset owner or utility service provider to apply to particular defects to take account of the impact on serviceability and its consequences with respect to an operating licence, customer contract and/or treatment impacts. While the default severity factor is 1, where, for example, a sewer system is licensed for no dry weather overflows the severity factor for the defect roots may be increased to say 1.5. Where a sewer transports sewage that will be used for recycling and the system is subject to salt water infiltration, defects and features that will lead to or exacerbate infiltration may adopt a severity factor of 2.

If applying the scores to stormwater drains, refer to <u>APPENDIX D — SCORING OF DEFECTS AND THE PRELIMINARY</u> <u>GRADING OF APPARENT CONDITION OF OPERATIONAL STORMWATER DRAINS</u>. For other conduits, the asset manager should review the scores and make any necessary adjustments to reflect their asset management needs.

C4 APPLYING SCORES AND DETERMINING CONDITION GRADE

In this Code a 'specified length' of one metre has been adopted. Asset owners may wish to change this length, but this Code's scoring and condition grading has been developed on the basis of a one metre specified length.

To apply scoring, the conduit inspection length is divided into 1 m intervals starting at zero (Longitudinal Reference Point).

Defects observed within an interval shall be reported at the distance at which it is first observed. The scores for the defects observed shall be assigned to the interval in which they occur. For continuous defects, the score shall be allocated proportionally to the metre division in which it first occurs and for each metre division until the continuous defect finishes. Where it finishes within the metre division, the score shall be allocated proportionally.

Recording of each defect where multiple structural defects occur within a metre division may not be required unless the 'lesser' defects are substantially different to the more 'extreme' defects.

For example, cracking may be associated with breaking of a <u>conduit</u> but only breaking should be recorded and not the individual cracks associated with breaking; where deformation is measured >25% within a metre division, only collapse should be recorded; where coarse aggregate is visible and also projecting from the surface within a metre division, only aggregate projecting should be recorded.

The peak score indicates the worst metre in terms of defects in the sewer between the nodes. It is the maximum of the summed scores for all defects that occur within a one metre division of the sewer.

The mean score is the total of all defect scores divided by the **conduit unit length**. The mean score is expressed as XX/ metre and is used to give an indication of the overall condition of the sewer.

Peak and mean scores are determined separately for the service and structural condition of the sewer.

Structural scoring is applied differently for **conduit** of rigid materials, flexible materials and masonry construction to reflect the different levels of risk associated with a specific defect in sewers of that material/construction.

Where the **conduit** material changes, the scoring of any defects shall be applied for that material and incorporated into the condition grading determination for the full length of the conduit.

C5 LATERAL SCORES

Scores associated with defects in laterals (the connecting **conduit** at junctions and connections) shall be reported separately to the scores and condition grading for the main conduit. However, where inspection of a lateral is undertaken with 'satellite' inspection technology, a separate report shall be produced with scores and grade applied in a similar way to the main conduit.

Where lateral defects are identified with the codes CX (refer to <u>2.7.6.3 Defective connection—CX</u>) or JX (refer to <u>2.7.6.5 Defective junction—JX</u>) the scores for service and structural defects in laterals shall be aggregated and reported separately to the main <u>conduit</u> at the distance of the lateral observation.

The purpose of this procedure is to provide a guide to asset owners on actual or potential problems with property connection sewers separate to the main <u>conduit</u>. It also avoids the prospect of distorting the condition grade of the main conduit by including scores relating to the lateral.

C6 FIXED ZOOM CAMERAS

Inspection and reporting with a fixed zoom camera has significant limitations in determining a condition grading of an asset. The measurement of crack widths, identification of missing pieces of **conduit**, longitudinal joint displacements and so on cannot be achieved accurately with this technology.

As a result, any scoring and grading of the asset condition generated by the software may not be valid. Asset owners considering such reports shall take into account the shortcomings of the fixed zoom camera technology in producing valid indications of condition grades.

C7 REPORTING ACCURACY

The veracity of the condition grades calculated from the defect scores and arithmetic algorithms will depend on the considered reporting of defects by operators. To ensure useful data on condition grades are produced from inspection reporting, operators and contracting organisations need to be competent in correctly identifying and coding defects in a range of assets. Likewise, asset managers need to be fully conversant with the Code and regularly check the accuracy of reports.

Any reports with significant coding errors should be identified and feedback provided to the operator and/or contracting organisation.

C8 REFINING SCORES AND GRADING

WSAA will continue to review the scoring and grading to improve the functionality of the condition grading of sewers. Changes to scoring and grading will be published in updates of this document.

WSAA will also advise software providers and developers of the updated measures to be incorporated in software as default values.

Users of this Code are invited to advise of any misleading grading of structural or service condition that is discovered during use of this Code.

Table C.1 STRUCTURAL DEFECT SCORES—PIPE SEWERS—RIGID MATERIALS 1

Defect	Code	Ch1	Ch2	Q1	Q2	Score
Cracking	С	С		#1 mm		1
				>1 mm and #3 mm		5
				>3 mm and #6 mm		10
				>6 mm		20
		L		#1 mm		1
				>1 mm and #3 mm		5
				>3 mm and #6 mm		14
				>6 mm		20
		М		#1 mm		2
				>1 mm and #3 mm		20
				>3 mm and #6 mm		40
				>6 mm		80
		S		#1 mm		1.5
				>1 mm and #3 mm		10
				>3 mm and #6 mm		28
				>6 mm		40
Breaking	В	D		#100 mm		18
				>100 mm and #500 mm		40
				>500 mm and #1000 mm		55
		M, E		#100 mm		20
				>100 mm and #500 mm		50

Defect	Code	Ch1	Ch2	Q1	Q2	Score
				>500 mm and #1000 mm		80
Deformation	D	H, M, V		5%	#500 mm	0.5
					>500 mm and #1000 mm	1
				10%	#500 mm	2
					>500 mm and #1000 mm	5
				15%	#500 mm	10
					>500 mm and #1000 mm	20
				20%	#500 mm	30
					>500 mm and #1000 mm	60
				25%	#500 mm	60
					>500 mm and #1000 mm	90
Collapsed conduit	х					165
Surface damage concrete	SC	AV				2
		AP, Z				54
		AM		Observed (no measurement capability)		20
				10 mm		15
				15 mm		20
				20 mm		25
				25 mm		30
				>25 mm		35
		CP, RV, RVP				15
		Н				80
		JR, RS				10
		RC		Observed (no measurement capability)		65
				10 mm		25
				15 mm		35

Defect	Code	Ch1	Ch2	Q1	Q2	Score
				20 mm		45
				25 mm		55
				>25 mm		65
		S		Observed (no measurement capability)		10
				10 mm		5
				15 mm		10
				20 mm		15
				25 mm		20
				>25 mm		25
Surface damage asbestos cement	SAC	СР				15
		DI				15
		DM				30
		DX				50
		S		Observed (no measurement capability)		10
				10 mm		5
				15 mm		10
				20 mm		15
				25 mm		20
				>25 mm		25
		Н				80
		Z				5 ⁴
Surface damage other (VC, metals)	so	Н				80
		S			Observed (no measurement capability)	10
					10 mm	5
					15 mm	10
					20 mm	15
					25 mm	20
					>25 mm	25

Defect	Code	Ch1	Ch2	Q1	Q2	Score
		T ²		#20%		10
				>20%		20
		Z				5 ⁴
Soil visible ⁵	SV					55
Void visible ⁵	VV			>50 mm		65
Porous conduit	PP					5
Ingress of soil	ING	S, F, G, Z				70
Displaced joint	JD	А			>30 mm	5
		L		>30 mm		5
		R		>20 mm		15
Defective connection ⁶	СХ	G				5
Defective junction ⁶	JX	JC				5
Lining defective (structural)	LD	D		Deformation, code	D, from this table is	to be applied.
		H, M, RC, WD, Z				5 ^{3,4}
		SJ				25
		Х				165
Lining defective (non-structural) ³	LD	H, M, RM, RMCP, WD				2
Point repair (defective)	PR	H, I, IS, L, R, RE, S, Z	D			2
			Р			15
			Z			5 ⁴

✓ Notes

- (1) Scoring is based on pipe conduits but may be used as a guide for reinforced concrete box sections.
- (2) Scores for cast iron and steel conduits are to be applied based on the loss of cross section before nodules of rust are removed.
- (3) Scores have been attributed for these defects because of the potential future impact on the structural integrity of the conduit.
- (4) Notional score of 5 given for Other.
- (5) The scores for soil visible or void visible associated with breaking or other defect are added to the scores for those defects.
- (6) These defects are adjacent to the main conduit and may contribute to loss of support around the main conduit. It is given a notional score of 5 to indicate a Structural Grade 2.

Table C.2 STRUCTURAL DEFECT SCORES—PIPE SEWERS—FLEXIBLE MATERIALS

Defect	Code	Ch1	Ch2	Q1	Q2	Score
Cracking	С	C, L, M, S		#1 mm		10
				>1 mm to #3 mm		20
				>3 mm to #6 mm		40
				>6 mm		50
Breaking	В	D		#100 mm		20
				>100 mm to #500 mm		40
				>500 mm to #1000 mm		55
		M, E		#100 mm		25
				>100 mm to #500 mm		50
				>500 mm to #1000 mm		80
Deformation (pipe age = 2 years) ^{1,2,3}	D	H, M, V		5%	#500 mm	4
					>500 mm and #1000 mm	8
				10%	#500 mm	15
					>500 mm and #1000 mm	25
				15%	#500 mm	35
					>500 mm and #1000 mm	50
				20%	#500 mm	60
					>500 mm and #1000 mm	85
				25%	#500 mm	90
					>500 mm and #1000 mm	125
Deformation (pipe age = 10 years) ^{1,2,3}	D	H, M, V		5%	#500 mm	2
					>500 mm and #1000 mm	4
				10%	#500 mm	6
					>500 mm and #1000 mm	10

Defect	Code	Ch1	Ch2	Q1	Q2	Score
				15%	#500 mm	15
					>500 mm and #1000 mm	30
				20%	#500 mm	35
					>500 mm and #1000 mm	60
				25%	#500 mm	65
					>500 mm and #1000 mm	90
Deformation (pipe age = 50 years) ^{1,2,3}	D	H, M, V		5%	#500 mm	0.5
					>500 mm and #1000 mm	1
				10%	#500 mm	2
					>500 mm and #1000 mm	4
				15%	#500 mm	6
					>500 mm and #1000 mm	10
				20%	#500 mm	20
					>500 mm and #1000 mm	30
				25%	#500 mm	50
					>500 mm and #1000 mm	65
Collapsed conduit	х					165
Surface damage other	SO	Н				80
		MD, Z				5 ⁴
		T ²		#20%		10
				>20%		20
Soil visible ⁵	SV					55
Void visible ⁵	VV			>50 mm		65
Ingress of soil	ING	S, F, G, Z				70
Defective joint weld	DJW	C, E				10

Defect	Code	Ch1	Ch2	Q1	Q2	Score
		P, Z				5 ⁴
Defective connection ⁶	СХ	G				5
Defective junction ⁶	JX	JC				5
Lining defective (structural)	LD	D		Deformation, code D, from this table is to be applied.		
		H, M, RC, WD, Z				5 ⁴
		SJ				25
		Х				165
Lining defective (non-structural)	LD	H, M, RM, RMCP, WD				2
Point repair (defective)	PR	H, I, IS, L, R, RE, S, Z	D			2
			Р			10
			Z			54

Notes

- (1) Where the date of installation is not known, assume the pipe has been installed for 10 years.
- (2) Where the pipe has been installed for an intermediate number of years adjust the score to suit, e.g. for a PE pie installed for 35 years with 20% deformation adopt a score of 40.
- (3) Although the behaviour of metallic flexible pipes is not exactly the same as that of plastics, the same scoring for deformation of all pipes has been adopted.
- (4) Notional score of 5 given for Other.
- (5) The scores for soil visible and void visible associated with breaking or other defect are added to the scores for those defects.
- (6) These defects are adjacent to the main conduit and may contribute to loss of support around the main conduit. It is given a notional score of 5 to indicate a Structural Grade 2.

Table C.3 STRUCTURAL DEFECT SCORES—MASONRY SEWERS

Defect	Code	Ch1	Ch2	Q1	Q2	Score
Deformation	D	H, M, V		5%	#500 mm	2
					>500 mm to #1000 mm	5
				10%	#500 mm	10
					>500 mm to #1000 mm	15
				15%	#500 mm	20
					>500 mm to #1000 mm	40

Defect	Code	Ch1	Ch2	Q1	Q2	Score
				20%	#500 mm	60
					>500 mm to #1000 mm	90
				25%	#500 mm	100
					>500 mm to #1000 mm	125
Soil visible	SV					55
Void visible	VV			>50 mm		65
Masonry dropped invert	MDI			10 mm to #20 mm		15
				>20 mm		60
Masonry conduit collapsed	XM					165
Ingress of soil	ING	S, F, G, Z				70
Lining defective (structural)	LD	D		Deformation, cod	e D, from this table	is to be applied.
		Н				40
		М				90
		SJ				50
		RC				5
		WD				20
		Х				165
Point repair (defective)	PR	H, I, L, RE, S, Z	D			2
			Р			10
			Z			5 ⁴

Defect	Code	Ch1	Q1				Score		,	,
					Circumfere	ential extent	of defect - H	ours of cloc	k reference	
				Single point	1	2	3	4	5	6
Missing mortar	ММ		10 mm to #20 mm	0.5	1	2	5	10	15	20
			>20 mm to #50 mm	10	15	20	25	30	35	40
			>50 mm to #100 mm	30	35	40	45	50	55	60

Defect	Code	Ch1	Q1				Score			
					Circumfere	ential extent	of defect - H	ours of cloc	k reference	
				Single point	1	2	3	4	5	6
Displaced masonry units	DMU	I, O	10 mm	0.2	0.5	1	1.5	2.0	3	4.5
			20 mm	1	2	5	7	10	15	20
			30 mm	2	5	10	15	20	30	45
			40 mm	5	10	20	25	40	50	60
			50 mm	7	15	30	40	60	75	90
Masonry (brick) cracking	MBC	C, L	#3 mm	2	5	15	20	25	30	40
Masonry unit separation	MUS		5 mm	1	2	4	6	8	10	15
			10 mm	4	6	8	10	15	20	25
			15 mm	6	8	10	15	20	25	30
			20 mm	10	15	20	25	30	35	40
			25 mm	20	25	30	35	40	45	50
Missing masonry units	MMU	NV		40	60	80	100	120	145	165
		Р		20						
		V		5	10	15	20	30	40	55
Masonry spalling	MS			2	5	15	20	25	30	40

Table C.4 SERVICE DEFECT SCORES—ALL SEWERS

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
Deformation	D	H, M, V		10%		5
				15%		10
				20%		20
				25%		45
Collapsed conduit	Х					80
Surface damage (other)	SO	Т		<5%		5
				10%		10

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
Porous conduits	PP					5
Masonry conduit collapsed	XM					80
Deposits on wall and invert	DE	F, G, E, S, R, C, Z		<5%		5
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
Exfiltration	EX	J, D				40
Infiltration	I	S				1
		D				5
		R				20
		G				40
Obstruction	ОВ	B, C, I, J, M, S, Z		<5%		5
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
		P ²				60
Ingress of soil	ING	S, F, G, Z				40
Roots	R	F		<5%		2
		T, M		<5%		5
				10%		10

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
		RT, RB		<5%		5
		RF		<5%		1
Displaced joint	JD	L		10 mm to #20 mm		1
				>20 mm to #30 mm		2
				>30 mm		5
		R		<5 mm to #10 mm		1
				>10 mm to #20 mm		2
				>20 mm		16
Defective joint seal	DJS	R	N			2
			HH, HL, B			20
		Z		<5%		5
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
Intruding connection	CI			<5%		5
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
Defective connection ³	СХ	TD			<5%	5
					10%	10
					20%	30
					30%	40
					40%	50
					50%	60
					#60%	80
Defective junction ²	JX	TD			<5%	5
					10%	10
					20%	30
					30%	40
					40%	50
					50%	60
					#60%	80
Lining defective (structural and non-structural)	LD	B, BU, E, RC, SJ, W, WD, Z			<5%	5
					10%	10
					20%	30
					30%	40
					40%	50
					50%	60
					#60%	80
		D	H, M, V	Deformation, code	D, from this table is	to be applied.
		Н				20
		Х				80
Point repair (defective)	PR	H, I, IS, L, R, RE, S, Z	D, P, Z	<5%		5
				10%		10
				20%		30
				30%		40
				40%		50

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
				50%		60
				#60%		80
			В			5
Flow in connecting conduits	IF	C, SW, T	ST	>5% to #10%		10
				>10% to #30%		20
				>30%		50
Water level	WL	Р		#20%		2
				>20% to #30%		5
				>30%		10
Vermin	V	R, Z	S, C, J, Z	1		2
				2 to #5		10
				>5		20

Notes

- (1) Scores indicated are per occurrence applied in accordance with <u>2.5 ENCODING OF OBSERVATIONS</u>.
- (2) Breaking exceptional associated with this code will also trigger a structural score.
- (3) Defects in junctions and connections that do not impact on the main sewer are to be scored and reported separately in accordance with <u>Table C.5</u>.

Table C.5 SERVICE AND STRUCTURAL DEFECT SCORES ONLY AFFECTING CONNECTING CONDUITS (PROPERTY CONNECTION SEWERS)

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
Defective connection	СХ	B, SR, Z		<5%		5
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
		D, G, JD, LD, SE, TD				30
		Р				15
Defective junction	JX	B, SR, Z		<5%		5

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
		D, JD, LD, SE, TD				30
		JC				50
		Р				15

Notes

(1) The scores for service and structural defects in connecting conduits (laterals) shall be aggregated and reported separately to the main conduit at the distance of the lateral observation.

Table C.6 STRUCTURAL GRADING OF SEWERS

Grading	Description	Appropriate response in normal circumstances ¹	Peak score ²	Mean score
1	Insignificant deterioration of the sewer has occurred. Appears to be in good condition	No immediate action required—Standard programmed condition assessment	#5	0 to #1.0
2	Minor deterioration of the sewer has occurred. Minor defects are present	No immediate action required—Standard programmed condition assessment	>5 to #15	>1.0 to #3.0
3	Moderate deterioration of the sewer has occurred. Developed defects are present but not affecting short term structural integrity	Monitor with programmed condition assessment for rehabilitation and/or renewal in medium term	>15 to #40	>3.0 to #5.0
4	Significant deterioration of the sewer has occurred. Defects are present affecting structural integrity	Take immediate action as appropriate to the defects e.g. temporary supports Immediately undertake risk assessment and further investigate as required As appropriate to outcomes of above, schedule appropriate action which may include rehabilitation and/or renewal in the short term	>40 to #60	>5.0 to #10.0

Grading	Description	Appropriate response in normal circumstances ¹	Peak score ²	Mean score
5	Failure of the sewer has occurred or is imminent and there is a high risk of service failure and/or property damage and/or injury to the public	Take immediate action as appropriate Immediately undertake risk assessment and further investigation, and, as necessary, take appropriate action which may include immediate rehabilitation and/or renewal	>60	>10.0

✓ Notes

- (1) The actual action to be taken for any sewer system will depend on the asset management policies and procedures of the asset owner/operator.
- (2) Rounded to the nearest whole number.

Table C.7 SERVICE GRADING OF SEWERS

Grading	Description	Appropriate response in normal circumstances ¹	Peak score ²	Mean score
1	No or insignificant loss of hydraulic performance has occurred. Appears to be in good condition and there is little likelihood of sewage pollution ³	No immediate action required—Standard programmed condition assessment	#5	0 to #1.0
2	Minor defects are present causing minor loss of hydraulic performance and/or minor likelihood of sewage pollution	No immediate action required—Standard programmed condition assessment	>5 to #10	>1.0 to #3.0
3	Developed defects are present causing moderate loss of hydraulic performance and/or moderate likelihood of sewage pollution	Take immediate action as appropriate to the defect e.g. cleaning, root cutting, point repair Monitor with programmed condition assessment for rehabilitation and/or renewal in medium term	>10 to #40	>3.0 to #5.0
4	Significant defects are present causing serious loss of hydraulic performance and/or significant likelihood of sewage pollution	Take immediate action as appropriate to the defect e.g. root cutting, point repair, vermin treatment Immediately undertake risk assessment and further investigate as required As appropriate to outcomes of above, schedule appropriate action which may include	>40 to #60	>5.0 to #10.0

Grading	Description	Appropriate response in normal circumstances 1	Peak score ²	Mean score
		rehabilitation and/or renewal in the short term		
5	Failure of the sewer or pollution ³ of the environment has occurred or is imminent	Take immediate action as appropriate e.g. temporary support Immediately undertake risk assessment and further investigation, and, as necessary, take appropriate action which may include immediate rehabilitation and/or renewal	>60	>10.0

Notes

- (1) The actual action to be taken for any sewer system will depend on the asset management policies and procedures of the asset owner/operator.
- (2) Rounded to the nearest whole number.
- (3) Pollution may occur through a sewage spill (overflow), exfiltration through a defect or cross-connection between the sewerage and stormwater systems.

APPENDIX D — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF OPERATIONAL STORMWATER DRAINS

D1 BACKGROUND

CCTV inspection of stormwater drainage <u>conduit</u> can provide a wealth of information on the condition of these assets. Since 1991 this information has been codified, initially in the Australian Conduit Condition Evaluation Manual (ACCEM), so that a range of common defects can be readily identified and recorded in a systematic way.

However, the overall condition of a stormwater drainage <u>conduit</u> cannot be determined easily from inspection reports listing the codified defects and locations. As a guide to determining the condition of assets ACCEM also allocated scores for defects and a simple arithmetic formula to produce a grading for the structural and service condition of conduits. With this guidance, asset managers were able to make informed decisions on what assets needed attention and those that were operationally and structurally sound.

The scoring and grading concept initiated in ACCEM was followed in all versions of WSA 05 from the first published edition in 2002.

In this edition the scores, grading ranges and grade descriptions have been adjusted to reflect changes in the defect codes and analysis of scoring of defects in a range of sample **conduit**. These adjustments should lead to more meaningful structural and service grades for most stormwater drainage conduits inspected and reported in accordance with this Code.

This Appendix, in addition to listing the defect scores and condition grading of stormwater **conduit**, provides information relating specifically to the inspection, interpreting and reporting on features and defects observed in stormwater drains.

D2 OVERVIEW STORMWATER DRAINAGE CONDUITS

Stormwater conduits are almost universally larger than gravity sewer conduits serving equivalent catchments. Although both gravity systems have many similarities there is a general perception, supported by data from thousands of inspections of stormwater drains across Australia, that the standard of construction of these assets has been much lower than for sewers constructed in the same era. Fortunately, this situation is mostly no longer applicable to construction of new stormwater assets.

Inspecting existing stormwater assets will reveal an amazing range of construction techniques and materials from rectangular stone masonry culverts with rock slab for a roof and little or no mortar between the stone pieces; circular or ovoid brick masonry; woodstave in one rare example; cast in-situ concrete; mixed materials comprising brick masonry and reinforced concrete; vitrified clay; reinforced concrete pipe; corrugated galvanised steel; thin gauge profiled steel; corrugated aluminium; PVC, polyethylene, polypropylene and more. Additional information on the inspection of stormwater infrastructure is outlined in <u>D4 SCORES AND CONDITION GRADE</u> and <u>D5 COMMON FEATURES AND DEFECTS IN STORMWATER CONDUITS</u>

This Appendix has been developed in collaboration with the Institute of Public Works Engineering Australia through their NAMS.AU Group because of its work in developing Practice Notes including the Condition Assessment and Asset Performance Guidelines on Stormwater Drainage – PN5. For more information see www.ipwea.org.au.

D3 APPLICABILITY OF SCORING AND GRADING

The scoring of defects and determination of a condition grade for a stormwater **conduit** is not intended to be used for acceptance evaluation of new assets. There may be several unsatisfactory features and or defects that might not generate a score or grade to trigger rejection of a new asset. **APPENDIX J — GUIDE FOR INTERNAL INSPECTION OF NEWLY CONSTRUCTED SEWERS OR STORMWATER CONDUITS AND CRITERIA FOR ACCEPTANCE** provides criteria that can be used, in association with the inspection reports, to judge the suitability of new assets for acceptance by asset owners.

Condition grading may not be accurate in every circumstance and asset managers are advised to review carefully those assets showing a high condition grading, indicating risk of imminent structural or service failure, before initiating rehabilitation or other actions.

In some stormwater <u>conduit</u> the defect and feature codes may not be adequate to describe the observation. Where this is the situation a general comment must be used and the asset manager reviewing the inspection data needs to determine the condition of the asset using other techniques.

The condition grading may be influenced adversely if incorrect coding and/or quantification of a feature or defect is reported. In stormwater **conduit** some features observed are inherent in the construction techniques used at the time and although it does not 'look good' the conduit or joint is actually sound. As such it is important that CCTV operators, others gathering condition data as well as asset managers are aware of these common features of stormwater conduit construction.

D4 SCORES AND CONDITION GRADE

D4.1 GENERAL

The ultimate goal of applying scores to the observed defects is to arrive at coarse condition grades indicating the structural and service performance of the **conduit**. These coarse condition grades give a basis for an asset manager to group and prioritise asset works, give an indication of remaining life, urgency of service repairs, can be used in condition-based valuation exercises, provide mathematical data for statistical models, and allow hotspot mapping via GIS systems.

The coarse condition grade is arrived at, supported by and further enhanced by the consideration of 'peak' and 'mean' scores. These scores indicate severity of issues, along with the observed extent. Examining these scores can indicate localised or sustained degradation along the length of a **conduit**.

For each conduit length inspected, the peak and mean scores are calculated for both structural and service defects.

As a first step in the process Tables D1 to D5 set out a scoring system for defects and features that can be used to calculate these scores. Tables D6 and D7 use the peak and mean scores to estimate the overall condition grades of stormwater drains along with some typical asset management responses.

The scores allocated to the service and structural defects are derived from Australian experience. They are a relative measure of the likelihood of service or structural failure only. In some instances, defects may be scored as both a structural defect and service defect.

If applying the scores to other <u>conduit</u> such as irrigation drains, the asset manager should review the scores and make any necessary adjustments to reflect their asset management needs.

Structural scoring is applied differently for conduit of rigid materials, flexible materials and brick/masonry construction to reflect the different levels of risk and severity associated with a given defect in drains of that material/construction.

The asset owner may apply additional risk factors in relation to financial, legal, environmental, injury etc. consequences of structural and/or service failure of a stormwater drainage asset. Some of these risk factors are influenced by:

- (a) The size of the asset (catchment);
- (b) The location of the asset (under a major road or railway);
- (c) Soil types;
- (d) Environmental sensitivity;
- (e) Depth of the asset; and
- (f) Potential for flooding of critical infrastructure.

D4.2 APPLYING SCORES AND DETERMINING CONDITION GRADE

In this code a 'specified length' of one metre has been adopted. Asset owners may wish to change this length, but this code's scoring and condition grading has been developed on the basis of a one metre specified length.

To apply scoring, the **conduit** inspection length is divided into 1 m intervals starting at zero (Longitudinal Reference Point).

Defects observed within an interval shall be reported at the distance at which it is first observed. The scores for the defects observed shall be assigned to the interval in which they occur. For continuous defects, the score shall be allocated proportionally to the metre division in which it first occurs and for each metre division until the continuous defect finishes. Where it finishes within the metre division, the score shall be allocated proportionally.

Recording of each defect where multiple structural defects occur within a metre division may not be required unless the 'lesser' defects are substantially different to the more 'extreme' defects.

For example, cracking may be associated with breaking of a <u>conduit</u> but only breaking should be recorded and not the individual cracks associated with breaking; where deformation is measured >25% within a metre division, only collapse

should be recorded; where coarse aggregate is visible and also projecting from the surface within a metre division, only aggregate projecting should be recorded.

The peak score indicates the worst metre in terms of defects in the stormwater <u>conduit</u> between the nodes. It is the maximum of the summed scores for all defects that occur within a one metre division of the stormwater conduit.

The mean score is the total of all defect scores divided by the **conduit unit length**. The mean score is expressed as XX/ metre and is used to give an indication of the overall condition of the stormwater **conduit**.

Peak and mean scores are determined separately for the service and structural condition of the stormwater conduit.

Structural scoring is applied differently for conduits of rigid materials, flexible materials and masonry construction to reflect the different levels of risk associated with a specific defect in stormwater conduits of that material/construction.

Where the *conduit* material changes, the scoring of any defects shall be applied for that material and incorporated into the grading determination for the full length of the conduit.

D5 COMMON FEATURES AND DEFECTS IN STORMWATER CONDUITS

Experience has shown that construction practices, particularly in the most common materials of reinforced concrete pipe and fibre reinforced concrete for stormwater drainage, have not always resulted in perfectly laid pipes.

Problems that have been identified in the past include pipes cracked due to excessive compaction loadings during the laying process, damaged pipe ends due to poor handling, poorly jointed segments with either inordinate gaps and/ or misplaced rubber rings and damage at the lifting holes or unplugged lifting holes. Some other features of earlier construction practices have included the bashing in of lifting holes in reinforced concrete pipe when the holes were omitted in manufacture, cutting pipes with a sledgehammer and patching the joint with concrete or bashing holes for connections with resultant spalling and other damage around the opening.

Manufacturing defects, such as 'reinforcement visible', may also be revealed in existing concrete drains during CCTV inspections. Reporting these defects with a code and supplemented with a general comment if needed is important for complete reporting on the condition of the asset.

D6 NON-FACTORY MANUFACTURED STORMWATER CONDUITS

D6.1 GENERAL

This part is intended to provide an interim guide into the understanding, survey, condition grading and coding, together with the ongoing operation and asset management of stormwater conduits that were not manufactured in a factory.

It attempts to demystify heritage, non-factory manufactured conduits, and to encourage asset managers to approach assessment of such assets with confidence.

D6.2 SCOPE

Non-factory manufactured stormwater conduits exist in a variety of cross-sectional shapes, and are constructed of a range of materials, including but not limited to the following:

- (a) Tunnels hewn from solid rock;
- (b) Stone masonry (as in hewn stone) tunnels, either non-mortar or mortar jointed;
- (c) Brick masonry conduits, either non-mortar or mortar jointed;
- (d) Brick/stone masonry composite conduits; and
- (e) Brick masonry/concrete conduits.

D6.3 BACKGROUND

Non-factory stormwater conduits were the only closed form of large section stormwater drain available until factory-manufactured pipes and conduit sections became available. These early pipes were normally of vitrified clay, cast or wrought iron, of circular section, and became available in the latter half of the 19th Century.

The introduction of reinforced concrete pipes under the Monier-patented manufacturing system in the early 20th Century substantially replaced in-situ constructed stormwater conduits for all excepting very large stormwater conduits.

Many early trunk stormwater conduits remain in service today. Most non-factory manufactured conduits observed in the field are being evaluated and coded as being in good to very good condition, a testament to the build quality and structural properties of such drains.

However, some conduits have featured structural deterioration and, in some instances, major collapse. Typically installed in now dense urban areas, non-factory conduits are also now being affected by construction, road and other works and may have experienced external trauma, rehabilitation by various methods, and partial reconstruction/replacement.

With non-factory conduits now largely confined to large diameter trunk systems and high-density urban areas (running under busy roadways and properties), the criticality of such drains is typically very high.

D6.4 CONSTRUCTION MATERIALS

There are many forms of construction in non-factory manufactured conduits.

Conduits constructed of a homogeneous material such as brick or masonry appear to be the most common. Bricks were typically laid in one or two courses, with the latter providing additional strength to the arch.

There are many examples of non-factory manufactured conduits that feature a number of construction materials. Some were constructed with certain media such as stones of high hardness index being utilised as inverts to resist abrasion, while softer brick arches were utilised to complete the upper section.

Some buried conduits were originally constructed as open stormwater drains with stone inverts and side walls, with the upper sections being constructed of a wide range of construction media and designs at much later times as land became valuable and open drains considered to be a low value use of sites.

Very early, high construction quality masonry and some brick arch drains were constructed of stones hewn to require minimal or no mortar jointing. This form of construction remains stable even after the loss of mortar.

D6.5 CROSS-SECTION FORMS

There are many variations on standard cross-sectional forms, with the most common being:

- (a) Circular;
- (b) Ovoid;
- (c) Vee-floor with arch wall and roof;
- (d) Vee-floor with parallel sides and arched roof; and
- (e) Vee-floor as per last two sections but with roof constructed of various structural spanning systems to carry applied dead and live loadings.

D6.6 STRUCTURAL DETERIORATION AND DEFECTS

Combinations of invert, wall, and roof media and forms of construction make structural assessment complex and difficult.

Some conduits will display forms of construction that will have been completed over periods of in excess of 100 years.

Few if any records of the form of construction will exist.

D6.7 UNDERTAKING CONDITION EVALUATION SURVEYS

D6.7.1 PERSON ENTRY

Large section conduits may have sufficient person access points such as to be able to be inspected by Confined Spaces Regulations and safe work method compliant person entry.

Person entry enables inspection to proceed beyond simple visual inspection. Person entry surveys enable:

- (a) Brick and masonry mortar to be scratch-tested for hardness, and to obtain a sample core section for calcium fraction analysis;
- (b) Bricks to be rung with a suitable hammer to check for degree of embedment;
- (c) Loose bricks to be checked for the status of the mortar and the likelihood that bricks will begin to fall out under gravity and water flow effects;

- (d) Where concrete (unreinforced and reinforced) surfaces are present, to undertake cores, or to use a dynamic hammer to assess residual strength;
- (e) Dimensional checks to be undertaken of the conduit cross-section to assess whether arches or other critical sections are moving towards an unstable state; and
- (f) Invert pools to be checked for depth to determine the severity of the invert loss and the likelihood of wall movement

✓ Notes

Before taking core samples of possibly frail or critically deteriorated conduits and structures, the risk of collapse or failure should be firstly assessed by a competent structural engineer or trained inspector.

D6.7.2 NON-PERSON ENTRY

Access to such conduits may be impractical or impossible given dimensions that prohibit human entry or may be such that safe access and third-party rescue is not possible given provisions of the Confined Spaces Regulations.

In fact, most conduits will not be accessible to persons for inspection, leaving a remote vehicle with tractor-mounted CCTV or fixed zoom (Quickview) CCTV camera systems, laser scanning, and ground penetrating Radar (GPR) equipment as the primary means of condition assessment.

D6.8 LATERAL SCORES

Laterals in stormwater conduits may not be the responsibility of the main conduit owner. However, defects in the lateral do need to be addressed.

Scores associated with defects in laterals (the connecting conduit at connections or junctions) shall be reported separately to the scores and condition grading for the main conduit. Where inspection of a lateral is undertaken with 'satellite' inspection technology, however, a separate report shall be produced with scores and grade applied in a similar way to the main conduit.

Where lateral defects are identified with the codes CX (refer to <u>2.7.6.3 Defective connection—CX</u>) or JX (refer to <u>2.7.6.5 Defective junction—JX</u>) the scores for service and structural defects in laterals shall be aggregated and reported separately to the main conduit at the distance of the lateral observation.

The purpose of this procedure is to provide a guide to asset owners on actual or potential problems with lateral conduits separate to the main conduit. It also avoids the prospect of distorting the condition grade of the main conduit by including scores relating to the lateral.

D6.9 FIXED ZOOM CAMERAS

Inspection and reporting with a fixed zoom camera has significant limitations in determining a condition grading of an asset. The measurement of crack widths, identification of missing pieces of conduit, longitudinal joint displacements and so on cannot be achieved accurately with this technology.

As a result, any scoring and grading of the asset condition generated by the software may not be valid. Asset owners considering such reports shall take into account the shortcomings of the fixed zoom camera technology in producing valid indications of condition grades.

D6.10 REPORTING ACCURACY

The veracity of the condition grades calculated from the defect scores and arithmetic algorithms will depend on the considered and accurate reporting of defects by operators. To ensure useful data on condition grades are produced from inspection reporting, operators and contracting organisations need to be competent in correctly identifying and coding defects in a range of assets. Likewise, asset managers need to be fully conversant with the Code and regularly check the accuracy of reports.

Any reports with significant coding errors should be identified and feedback provided to the operator and or contracting organisation.

D6.11 REFINING SCORES AND GRADING

WSAA in collaboration with IPWEA will continue to review the scoring and grading of defects in stormwater conduits to improve the functionality of the condition grading. Changes to scoring and grading will be published in updates of this document.

WSAA will also advise software providers and developers of the updated measures to be incorporated in software as default values.

Users of this Code are invited to advise of any misleading grading of structural or service condition that is discovered during its use.

Table D.1 STRUCTURAL DEFECT SCORES—PIPE STORMWATER CONDUITS—RIGID MATERIALS 1

Defect	Code	Ch1	Ch2	Q1	Q2	Score
Cracking	С	С		#1 mm		1
				>1 mm and #3 mm		5
				>3 mm and #6 mm		10
				>6 mm		20
		L		#1 mm		1
				>1 mm and #3 mm		5
				>3 mm and #6 mm		14
				>6 mm		20
		М		#1 mm		2
				>1 mm and #3 mm		20
				>3 mm and #6 mm		40
				>6 mm		80
		S		#1 mm		1.5
				>1 mm and #3 mm		10
				>3 mm and #6 mm		28
				>6 mm		40
Breaking	В	D		#100 mm		18
				>100 mm and #500 mm		40
				>500 mm and #1000 mm		55
		M, E		#100 mm		20
				>100 mm and #500 mm		50

Defect	Code	Ch1	Ch2	Q1	Q2	Score
				>500 mm and #1000 mm		80
Deformation	D	H, M, V		5%	#500 mm	0.5
					>500 mm and #1000 mm	1
				10%	#500 mm	2
					>500 mm and #1000 mm	5
				15%	#500 mm	10
					>500 mm and #1000 mm	20
				20%	#500 mm	30
					>500 mm and #1000 mm	60
				25%	#500 mm	60
					>500 mm and #1000 mm	90
Collapsed conduit	Х					165
Surface damage concrete	SC	AV, JR				1
		AP				3
		AM		Observed (no measurement capability)		20
				10 mm		15
				15 mm		20
				20 mm		25
				25 mm		30
				>25 mm		35
		СР				15
		Н				80
		RC		Observed (no measurement capability)		30
				10 mm		20
				15 mm		25
				20 mm		30

Defect	Code	Ch1	Ch2	Q1	Q2	Score
				25 mm		35
				>25 mm		40
		RV, RVP				10
		S		Observed (no measurement capability)		5
				10 mm		2
				15 mm		5
				20 mm		10
				25 mm		15
				>25 mm		20
		RS, Z				5 ^{3,4}
Surface damage asbestos cement	SAC	СР				15
		DI				15
		DM				30
		DX				50
		S		Observed (no measurement capability)		10
				10 mm		5
				15 mm		10
				20 mm		15
				25 mm		20
				>25 mm		25
		Н				80
		Z				5 ⁴
Surface damage other (VC, metals)	SO	Н				80
		S			Observed (no measurement capability)	10
					10 mm	5
					15 mm	10
					20 mm	15

Defect	Code	Ch1	Ch2	Q1	Q2	Score
					25 mm	20
					>25 mm	25
		T 2		#20%		10
				>20%		20
		Z				5 ⁴
Soil visible	SV					55
Void visible	VV			>50 mm		65
Porous conduit	PP					5
Ingress of soil	ING	S, F, G, Z				70
Displaced joint	JD	А			>30 mm	2
		L		>30 mm		2
		R		>20 mm		15
Defective connection ⁵	CX	G				5
Defective junction ⁵	JX	JC				5
Lining defective (structural)	LD	D		Deformation, code	D, from this table is	to be applied.
		H, M, RC, WD, Z				5 ^{3,4}
		SJ				25
		Х				165
Lining defective (non-structural) ³	LD	H, M, RM, RMCP, WD				2
Point repair (defective)	PR	H, I, IS, L, R, RE, S, Z	D			2
			Р			10
			Z			5 ⁴
Lifting hole	LH	В	U, S			5

- (1) Scoring is based on pipe conduits but may be used as a guide for reinforced concrete box sections.
- (2) Scores for cast iron and steel conduits are to be applied based on the loss of cross section before nodules of rust are removed. Because of the larger diameter of stormwater pipes, tuberculation is not anticipated to significantly impact the cross sectional area even in cast iron. With the combined effects of corrosion and erosion the more likely defect may be holes in the cast iron or steel pipe.
- (3) Scores have been attributed for these defects because of the potential future impact on the structural integrity of the conduit.

- (4) Notional score of 5 given for Other.
- (5) These defects are adjacent to the main conduit and may contribute to loss of support around the main conduit at that location. It is given notional score of 5 indicating a Structural Grade 2.

Table D.2 STRUCTURAL DEFECT SCORES—PIPE STORMWATER CONDUITS—FLEXIBLE MATERIALS

Defect	Code	Ch1	Ch2	Q1	Q2	Score
Cracking	С	C, L, M, S		#1 mm		10
				>1 mm to #3 mm		20
				>3 mm to #6 mm		40
				>6 mm		50
Breaking	В	D		#100 mm		20
				>100 mm to #500 mm		40
				500 mm to #1000 mm		55
		M, E		#100 mm		25
				>100 mm to #500 mm		50
				500 mm to #1000 mm		80
Deformation (pipe age = 2 years) ^{1,2,3}	D	Н, М, V		5%	#500 mm	4
					>500 mm and #1000 mm	8
				10%	#500 mm	15
					>500 mm and #1000 mm	25
				15%	#500 mm	35
					>500 mm and #1000 mm	50
				20%	#500 mm	60
					>500 mm and #1000 mm	85
				25%	#500 mm	90
					>500 mm and #1000 mm	125
Deformation (pipe age = 10 years) ^{1,2,3}	D	H, M, V		5%	#500 mm	2

Defect	Code	Ch1	Ch2	Q1	Q2	Score
					>500 mm and #1000 mm	4
				10%	#500 mm	6
					>500 mm and #1000 mm	10
				15%	#500 mm	15
					>500 mm and #1000 mm	30
				20%	#500 mm	35
					>500 mm and #1000 mm	60
				25%	#500 mm	65
					>500 mm and #1000 mm	90
Deformation (pipe age = 50 years) ^{1,2,3}	D	H, M, V		5%	#500 mm	0.5
					>500 mm and #1000 mm	1
				10%	#500 mm	2
					>500 mm and #1000 mm	4
				15%	#500 mm	6
					>500 mm and #1000 mm	10
				20%	#500 mm	20
					>500 mm and #1000 mm	30
				25%	#500 mm	50
					>500 mm and #1000 mm	65
Collapsed conduit	Х					165
Surface damage other	SO	Н				80
		MD, Z				5 ⁴
		T ²		#20%		10
				>20%		20
Soil visible ⁵	SV					55

Defect	Code	Ch1	Ch2	Q1	Q2	Score	
Void visible ⁵	VV			>50 mm		65	
Ingress of soil	ING	S, F, G, Z				70	
Defective joint weld	DJW	C, E				10	
		P, Z				5 ⁴	
Defective connection ⁶	СХ	G				5	
Defective junction ⁶	JX	JC				5	
Lining defective (structural)	LD	D		Deformation, code D, from this table is to be applied.			
		H, M, RC, WD, Z				5 ⁴	
		SJ				25	
		Х				105	
Lining defective (non-structural)	LD	H, M, RM, RMCP, WD				2	
Point repair (defective)	PR	H, I, IS, L, R, RE, S, Z	D			2	
			Р			10	
			Z			5 ⁴	

- (1) Where the date of installation is not known, assume the pipe has been installed for 10 years.
- (2) Where the pipe has been installed for an intermediate number of years, adjust the score to suit e.g. for a PE pipe installed for 35 years with 20% deformation adopt a score of 40.
- (3) Although the behaviour of metallic flexible pipes is not exactly the same as that of plastics, the same scoring for deformation of all pipes has been adopted.
- (4) Notional score of 5 given for Other.
- (5) The scores for soil visible or void visible associated with breaking or other defect are added to the scores for those defects.
- (6) These defects are adjacent to the main conduit and may contribute to loss of support around the main conduit at that location. It is given notional score of 5 indicating a Structural Grade 2.

Table D.3 STRUCTURAL DEFECT SCORES—MASONRY STORMWATER CONDUITS

Defect	Code	Ch1	Ch2	Q1	Q2	Score
Deformation	D	H, M, V		5%	#500 mm	2
					>500 mm to #1000 mm	5
				10%	#500 mm	10

Defect	Code	Ch1	Ch2	Q1	Q2	Score
					>500 mm to #1000 mm	15
				15%	#500 mm	20
					>500 mm to #1000 mm	40
				20%	#500 mm	60
					>500 mm to #1000 mm	90
				25%	#500 mm	100
					>500 mm to #1000 mm	125
Soil visible	SV					55
Void visible	VV			>50 mm		65
Masonry dropped invert	MDI			10 mm to #20 mm		15
				>20 mm		60
Masonry conduit collapsed	XM					165
Ingress of soil	ING	S, F, G, Z				70
Lining defective (structural)	LD	D		Deformation, code	D, from this table is	to be applied.
		Н				40
		М				90
		SJ				50
		RC				5
		WD				20
		Х				165
Point repair (defective)	PR	H, I, L, RE, S, Z	D			2
			Р			10
			Z			5

Defect	Code	Ch1	Q1		Score					
				Circumferential extent of defect - Hours of clock reference						
				Single point	1	2	3	4	5	6
Missing mortar	ММ		10 mm to #20 mm	0.5	1	2	5	10	15	20

Defect	Code	Ch1	Q1				Score			
					Circumfere	ential extent	of defect - H	ours of cloc	k reference	-
				Single point	1	2	3	4	5	6
			>20 mm to #50 mm	10	15	20	25	30	35	40
			>50 mm to #100 mm	30	35	40	45	50	55	60
Displaced masonry units	DMU	I, O	10 mm	0.2	0.5	1	1.5	2.0	3	4.5
			20 mm	1	2	5	7	10	15	20
			30 mm	2	5	10	15	20	30	45
			40 mm	5	10	20	25	40	50	60
			50 mm	7	15	30	40	60	75	90
Masonry (brick) cracking	MBC	C, L	#3 mm	2	5	15	20	25	30	40
Masonry unit separation	MUS		5 mm	1	2	4	6	8	10	15
			10 mm	4	6	8	10	15	20	25
			15 mm	6	8	10	15	20	25	30
			20 mm	10	15	20	25	30	35	40
			25 mm	20	25	30	35	40	45	50
Missing masonry units	MMU	NV		40	60	80	100	120	145	165
		Р		20						
		V		5	10	15	20	30	40	55
Masonry spalling	MS			2	5	15	20	25	30	40

Table D.4 SERVICE DEFECT SCORES—ALL STORMWATER CONDUITS

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
Deformation	D	H, M, V		10%		5
				15%		10
				20%		20
				25%		45

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
Collapsed conduit	Х					80
Surface damage (other)	SO	Т		<5%		5
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
Porous pipe	PP					5
Masonry conduit collapsed	XM					80
Deposits on wall and invert	DE	C, E, F, G, R, S, Z		5%		5
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
Exfiltration	EX	J, D				40
Infiltration	I	S				1
		D				5
		R				20
		G				40
Obstruction	ОВ	B, C, I, J, M, S, Z		<5%		5
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
		P ²				60

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
Ingress of soil	ING	S, F, G, Z				40
Roots	R	F		<5%		2
		M, T		<5%		5
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
		RT, RB		<5%		5
		RF		<5%		1
Displaced joint	JD	L		10 mm to #20 mm		1
				>20 mm to #30 mm		2
				>30 mm		5
		R		<5 mm to #10 mm		1
				>10 mm to #20 mm		2
				>20 mm		16
Defective joint seal	DJS	R	N			2
			HH, HL, B			20
		Z		<5%		5
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
Intruding connection	CI			<5%		5
				10%		10
				20%		30

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
				30%		40
				40%		50
				50%		60
				#60%		80
Defective connection ³	сх	TD			<5%	5
					10%	10
					20%	30
					30%	40
					40%	50
					50%	60
					#60%	80
Defective junction ²	JX	TD			<5%	5
					10%	10
					20%	30
					30%	40
					40%	50
					50%	60
					#60%	80
Lining defective (structural and non-structural)	LD	B, BU, E, RC, SJ, W, WD, Z			<5%	5
					10%	10
					20%	30
					30%	40
					40%	50
					50%	60
					#60%	80
		D	H, M, V	Deformation, code	D, from this table is	to be applied.
		Н				20
		х				80
Point repair (defective)	PR	H, I, IS, L, R, RE, S, Z	D, P, Z	<5%		5

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
			В			5
Flow in connecting conduits	IF	C, T	SE	>5% to #10%		20
				>10% to #30%		45
				>30%		65
Water level	WL	Р		#20%		2
				>20 to #30%		5
				>30%		10
Vermin	V	R, Z		1		2
				2 to #5		10
				>5		20
Lifting hole	LH	M, B	U			40

- (1) Scores indicated are per occurrence applied in accordance with 2.5 ENCODING OF OBSERVATIONS.
- (2) Defects in junctions and connections that do not impact on the main sewer are to be scored and reported separately in accordance with <u>Table D.5</u>.
- (3) The presence of graffiti etc. may be an indication of risk of unauthorised person entry. Whilst this is recognised as not really a structural or serviceability issue, it does indicate a legitimate risk (which could be mitigated by locking or securing an access point). It is suggested these should be recorded as a 'General Comment' and include a 'General Photograph', but do not score as a defect.

Table D.5 SERVICE AND STRUCTURAL DEFECT SCORES ONLY AFFECTING CONNECTING CONDUITS (LATERALS OR PROPERTY CONNECTION STORMWATER CONDUITS)

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
Defective connection	сх	B, SR, Z		<5%		5
				10%		10
				20%		30
				30%		40

Defect	Code	Ch1	Ch2	Q1	Q2	Score ¹
				40%		50
				50%		60
				#60%		80
		D, G, JD, LD, SE, TD				30
		Р				15
Defective junction	JX	B, SR, Z		<5%		5
				10%		10
				20%		30
				30%		40
				40%		50
				50%		60
				#60%		80
		D, JC, JD, LD, SE, TD				30
		Р				15

(1) The scores for service and structural defects in connecting conduits (laterals) shall be aggregated and reported separately to the main conduit at the distance of the lateral observation.

Table D.6 STRUCTURAL GRADING OF STORMWATER CONDUITS

Grading	Description	Appropriate response in normal circumstances ¹	Peak score ²	Mean score
1	Insignificant deterioration of the stormwater drain has occurred. Appears to be in good condition.	No immediate action required—Standard programmed condition assessment	#5	0 to #1.0
2	Minor deterioration of the stormwater drain has occurred. Minor defects are present.	No immediate action required—Standard programmed condition assessment	>5 to #15	>1.0 to #3.0
3	Moderate deterioration of the stormwater drain has occurred. Developed defects are present but not affecting short term structural integrity.	Monitor with programmed condition assessment for rehabilitation and/or renewal in medium term	>15 to #40	>3.0 to #5.0
4	Significant deterioration of the stormwater drain	Take immediate action as appropriate to the	>40 to #60	>5.0 to #10.0

Grading	Description	Appropriate response in normal circumstances ¹	Peak score ²	Mean score
	has occurred. Defects are present affecting structural integrity.	defects e.g. temporary supports Immediately undertake risk assessment and further investigate as required As appropriate to outcomes of above, schedule appropriate action which may include rehabilitation and/or renewal in the short term		
5	Failure of the stormwater drain has occurred or is imminent and there is a high risk of service failure and/or property damage and/or injury to the public	Take immediate action as appropriate Immediately undertake risk assessment and further investigation, and, as necessary, take appropriate action which may include immediate rehabilitation and/or renewal	>60	>10.0

✓ Notes

- (1) The actual action to be taken for any drainage system will depend on the asset management policies and procedures of the asset owner/operator.
- (2) Rounded to the nearest whole number.

Table D.7 SERVICE GRADING OF STORMWATER CONDUITS

Grading	Description	Appropriate response in normal circumstances ¹	Peak score ²	Mean score
1	No or insignificant loss of hydraulic performance has occurred. Appears to be in good condition.	No immediate action required—Standard programmed condition assessment	#5	0 to #1.0
2	Minor defects are present causing minor loss of hydraulic performance	No immediate action required—Standard programmed condition assessment	>5 to #10	>1.0 to #3.0
3	Developed defects are present causing moderate loss of hydraulic performance but asset still functions safely at adequate level of service	Take immediate action as appropriate to the defect e.g. cleaning, root cutting, point repair Monitor with programmed condition assessment for rehabilitation and/or renewal in medium term	>10 to #40	>3.0 to #5.0
4	Significant defects are present causing serious loss of hydraulic performance. No	Take immediate action as appropriate to the defect e.g. root cutting,	>40 to #60	>5.0 to #10.0

Grading	Description	Appropriate response in normal circumstances 1	Peak score ²	Mean score
	immediate risk for flooding, health and safety or damage to property if weather conditions are favourable.	point repair, vermin treatment Immediately undertake risk assessment and further investigate as required As appropriate to outcomes of above, schedule appropriate action which may include rehabilitation and/or renewal in the short term		
5	Failure of the stormwater drain has occurred or is imminent. Potential for significant flooding, property damage, and/ or health and safety hazards exist.	Take immediate action as appropriate e.g. temporary support and/or removal of blockages Immediately undertake risk assessment and further investigation, and, as necessary, take appropriate action which may include immediate rehabilitation and/or renewal	>60	>10.0

- (1) The actual action to be taken for any stormwater system will depend on the asset management policies and procedures of the asset owner/operator.
- (2) Rounded to the nearest whole number.

APPENDIX E — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF MAINTENANCE STRUCTURES

E1 INTRODUCTION

✓ Notes

The revised version of this code incorporates several changes that are aimed at improving the coding of defect and feature observations in maintenance structures and incorporating data from technologies that are now more readily available than in previous versions. In doing so, several codes have been introduced, removed or modified and these changes will impact the application of the scoring and grading system that was developed for the 2013 edition (and as outlined in the following sections).

WSAA at this point does not have sufficient information on the efficacy of the scoring and grading system that was proposed in the 2013 edition. As a result, this appendix is still a work-in-progress and requires further consultation with industry and software developers.

Preliminary review of a grading system for maintenance structure suggest that the following condition grade categories are applicable to maintenance structures:

- (a) Structural integrity;
- (b) Operational performance (defects that affect the performance of the sewer or stormwater system); and
- (c) Access and safety (those aspects of the structures condition/location or similar that affect personnel access and safety as well as public safety).

These categories are similar to the ones used inGerman DWA Rules and Standards, 'Advisory Leaflet DWA-M 149-3, Conditions and Assessment of Drain and Sewer Systems Outside Buildings, Part 3: Condition Classification and Assessment', which are:

- (i) Leak tightness;
- (ii) Stability; and
- (iii) Operational safety.

WSAA invites those who are actively engaged in maintenance structure inspection, reporting and evaluation of condition to provide detailed comments on the suggestions above and applicability of the 2013 scoring and grading protocol.

Responsible asset management takes account of many things other than the apparent condition of a maintenance structure as determined by an internal visual inspection. The asset manager must also consider factors such as the criticality, hydraulic performance, structural condition, and environmental circumstances of the sewerage or stormwater drainage system, as well as the economic and social circumstances of the asset owner/operator. Public, operator and contractor safety is particularly relevant with respect to access frames and covers. Operator and contractor safety is particularly relevant with respect to steps, ladders, staging bars and platforms.

As a first step in the process, this appendix sets out a scoring and grading process that can be used as an initial indicator of likelihood of service or structural failure of maintenance structures.

The method proposed is somewhat of a hybrid of existing aggregate systems outlined in the 2009 American Society of Civil Engineering (ASCE), Manhole Inspection and Rehabilitation manual, the SCREAM™ system proposed by CH2M Hill and defect codes used in this code. In this way, the scoring and grading method uses the selected WSAA codes and acts to apply these codes to specific, standardized locations within the maintenance structure, thus considering an aggregate of scores throughout the maintenance structure to come up with a single maintenance structure score. The proposed maintenance structure scoring system further takes advantage of that adopted for sewers and stormwater drains (refer to APPENDIX C — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF THE APPARENT CONDITION OF OPERATIONAL SEWERS and APPENDIX D — SCORING OF DEFECTS AND THE PRELIMINARY GRADING OF APPARENT CONDITION OF OPERATIONAL STORMWATER DRAINS) in that it identifies peak and average scores within the maintenance structure for structural and service codes.

E2 MAINTENANCE STRUCTURE DEFECT REVIEW

The asset manager should undertake a review of maintenance structure defects before undertaking detailed scoring and grading of structures. To begin the process, operational and inspection staff members should review all the defect codes and prepare a list of defect codes relevant to the needs of the inspection. Often, only a subset of the entire list of defect codes is required for purposes of scoring and rating. <u>Table E.1</u> shows a list of all defect codes that are available for use in the maintenance structure scoring and grading system.

Calibration from ongoing inspections should be undertaken so that asset managers can add additional codes for use in scoring and grading maintenance structures to make better-informed decisions. For this reason, current inspections should use all available defect codes, even though only selected codes will be scored for grading purposes. It may also be necessary to adjust individual scores for defects along with severity weighting factors for particular defect locations.

E3 OVERVIEW OF AGGREGATE SCORING SYSTEM

The proposed aggregate system acts to collect defect information located at a specific depth, taken from top down, identifying and recording each specific defect location within the maintenance structure, as standardised in <u>Figure E.1</u> for MHs (manholes or maintenance holes). Asset managers can develop similar figures for other maintenance structures such as maintenance chambers (MCs) and maintenance shafts (MSs). Once the inspection reaches the bottom of the MH, code HFH (<u>3.7.11.2 Inspection completed—HFH</u>), is entered with the depth recorded. A peak score is calculated by looking at the total of scores (separated into 'Service' and 'Structural) located in a one metre 'band', starting from the top to the bottom of the MH, in 0.2 m intervals. The average score is calculated by totalling all scores (again, separated into 'Service' and 'Structural') within the MH and dividing by the depth of the MH. This method of peak and average scoring is similar to the WSAA scoring mechanism of conduit scoring, while also applying the notion of assessing the condition of specific maintenance structure elements, at a specific depth, similar to the ASCE and SCREAM™ methods.

Table E.1 shows the list of selected defect codes, each of which are assigned 1 to 10 score based on its location within the maintenance structure. It also includes an assigned severity rating for the defect code selected in the review process, later used as a weighting factor. In addition to listing the same selected defect codes in Table E.1, Table E.2 lists all possible combinations of each code, whether the code is a service code 'SRV' or a structural code 'STR', and shows a cross reference between the code and the defect location (as standardised in Figure E.1). In addition, each combination of code and defect location has the 1 to 10 score as taken from Table E.1, multiplied with the severity weighting factor assigned to it. Many combinations of defect code and defect location do not have a score assigned, as certain codes only pertain to certain defection locations.

As <u>Table E.2</u> can also act as a lookup in the asset management database, the asset manager can expand, or update in the future, the list of codes and scores, as needed. These scores represent the Water Corporation's best estimate of relative severity, on a 1 to 10 scale for each code, at each location, 1 being best and 10 being worst. The severity weighting factor (from 0 to 1.5, 1.0 being no change to the scores), again, is based on the Water Corporation's best estimate of the relative severity of each defect code.

The proposed aggregate scoring system also required modifications to the proprietary software maintenance structure template and catalogue files. Specifically, any of the defect codes selected should be set up in the proprietary software such that each code requires a specific location within the structure where the defect is found. Also required for each maintenance structure is the specific element functional location, which is recorded in the proprietary software header, and then later used in the upload process to the asset management system.

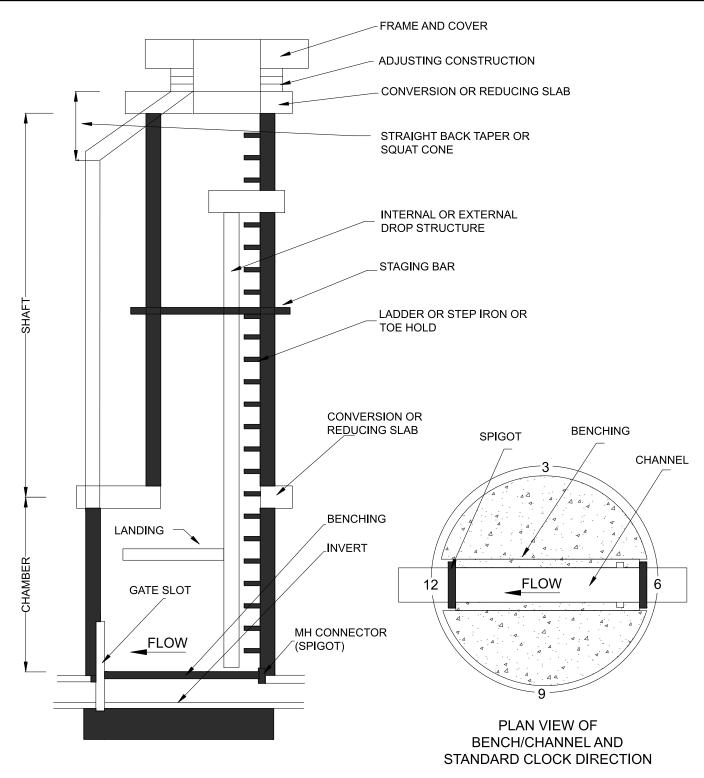


Figure E.1 ILLUSTRATION OF TYPICAL MH FEATURES

- (1) This figure is for general illustrative purposes only and is not technically correct with regard to location and scale of labelled MH features. The terms are consistent with Figure 3.1 of AS 4198—1994.
- (2) When there is one or less 'REDUCING SLAB' use 'CHAMBER' for the location of any wall defects.
- (3) Any defects for a landing structure (not shown in <u>Figure E.1</u>) should use the 'STEP/LADDER/TOE HOLD/ STAGING BAR' location and should be recorded as 'a landing' in the comments

Table E.1 SELECTED DEFECT CODES AND RELATIVE SCORING

Defect	Code	Ch1	Ch2 S	Severity eightir	/ Q	1 (hann B	ench i R	educin slab	Frame Cover	Steps/kaddenos	djustin istruct	Shaft	hambe	MH I	nterna pework	Stagino bars	Flow contro	Safety bars
				Factor		Value					Toe holds					Drop tructur	(devices	
Crack	ir lg C			1.15	Max crack width				1			1	1	2		5			
				1.25		2	1	1	4			4	2	5		10			
						4	3	3	6			4	3	6		10			
						6	4	4	8			8	4	8		10			
Break	ir lg B	D		1.4	Max break length or depth mm		1	1	2			2	5	6	2	2			
						200-4	03	3	3			3	6	7	3	3			
						#500	4	4	4			4	7	8	4	4			
		M		1.5	Max break length or depth mm		3	3	5			5	8	9	5	5			
						200-4	100	4	6			6	9	10	6	6			
						#500	5	5	7			7	10	10	7	7			
Defor	ml altD on			1	% chang in diame							6	6	6	6	6			
						10						7	7	7	7	7			
						15						8	8	8	8	8			
						20						10	10	10	10	10			
						25						10	10	10	10	10			
Collar struct				2.0			8	8	10			10	10	10	10	10			
Surfaction	ceHSC ge ete	A		1.25				3	4			3	4	5					
		СР		1.0				2	4			3	4	5					
		Н		1.5				7	8			6	7	10					
		RE		1.4				5	6			5	6	8					
		S		0.8				2	2			2	2	4					

Defect	Code	Ch1		Severity		1 (hanr B	ench i R	educin	Frame	Steps/	djustin	ShaftC	hambe	MH I	nterna	Staging	Flow	Safety
				eightir Fact D e		Value			slab	Cover	add ercs Toe holds	nstruct		Co		bework Drop tructur		devices	bars and chains
Surfa dama other	eHSO ge	В		1	% chang in diame							6	6	6	6	6			
						10						7	7	7	7	7			
						15						8	8	8	8	8			
						20						10	10	10	10	10			
						25						10	10	10	10	10			
		Н		1.5				7	8			6	7	10	10	10			
		MD		1.25								3	4	5	5	5			
		S		8.0								2	2	4					
Roots	HR	F		1			4	5	4	2		3	4	5	5	3		3	3
		М		1.2	% obstru	10-20 iction	4					4	4	4	4	4		4	4
						30-50	8					6	6	6	8	8		8	8
						50-70	10					8	8	8	10	10		10	10
						80-10	010					10	10	10	10	10		10	10
		RB		0.8			4					1	1	2	4	4		4	4
		Т		1.1			6	7	6	3		4	5	6	6	4		4	4
Missir maso units	ng-IMU nry		layer		ent ng		1				1	1	1						
					2-3		1				2	2	2						
					4-6		2				4	4	4						
					7-10		4				8	8	8						
					#11		8				10	10	10						
Maso units separ	ntyMS ation			1.25	Sepai of maso cours mm	nry		1				1	1	1					
						10		2				2	2	2					
						15		4				4	4	4					

Defect	Code	Ch1	W	Severity eightir Fact b e	a		Chann is	ench i R	educir slab	Frame, Cover	Steps/kaddexos Toe	djustin struct	Shaft	hambe	MH onnept	nterna pework Drop	bars	Flow contro devices	bars
				i acupe	Scripti	value					holds				s	tructur	'		chain
						20		8				8	8	8					
						25		10				10	10	10					
Missir morta	ngHMM r			1.1	Typica depth of morta loss, mm			2				2	2	2					
						20		4				4	4	4					
						30		6				6	6	6					
						40		8				8	8	8					
						50		10				10	10	10					
Maso struct collap	nt y lXM ure se			2.0				8				10	10	10					
Defec conne	ti l/t CX ction	В		1											4	6			
		D		1											3	4			
		GA		1											3	4			
		I		1	Lengt of intrud conne mm										1	1			
						100									2	2			
						150									3	6			
						200									4	8			
		Р		1											1	1			
Corro barrie defec	si bli CB r	В		1			2	2				3	4	4	3				
		С		0.6			1					1	1	1	1				
		SF		1.25	Densi of star fractu n/ m ²		1					2	3	3	2				
						3-5	2					4	6	6	4				
						6-10	3					6	8	8	6				

Defect	Code	Ch1	Ch2 S	everit	, Q	1 (hann B	ench i R	educin	Frame	Steps/	djustin	Shaft	hambe	МН	nterna	Staging	Flow	Safety
			W	eightir Fact D e	· C		ł		slab	Cover	add ercs Toe holds	nstruct		Co	nne pt	pework Drop tructur	bars	contro devices	bars
						#11	4					8	10	10	8				
Defection cover and/ or frame		СВ	1.4 non- traffic 1.6 traffic						6										
		CD	1.25 n-t 1.6 t						4										
		СН	1 n-t 1.2 t	Level differe mm	10 ence,				1										
					20				2										
					30				3										
					40				4										
		CL	1 n-t 1.4 t	Level differe mm					1										
					20				2										
					30				3										
					40				4										
		СМ	2						10										
		CR	0.6 n-t 1 t						4										
		FB	1.4 n-t 1.6 t						6										
		FD	1 n-t 1.4 t						4										
		FL	1 n-t 1.4 t						4										
		FM	2						8										
		G	1.1						1										
		HD	1 n-t						3										

Defect	Code	Ch1		Severity		1 (hann B	ench i R	educin	Frame	Steps/	djustir	Shaft	hambe	MH I	nterna	Staging	Flow	Safety
			W	eightir Fact o e	scripti	Value			slab	Cover	add exs Toe holds			Co		pework Drop tructur	(devices	bars and chains
			1.5 t																
		S	0.8 n-t 1.2 t						2										
Defect step, ladde or stagir bar		ED		1							1						1		
		НС		0.8							1								
		LC		1							4								
		LCC		0.8							1								
		LCL		1							2								
		LCM		1.1	Numb of suppo clips missir	orts/					1								
						2-5					2								
						6 or more					4								
		LRM		1.5	Numb of rungs missir						4								
						2					5								
						3					6								
						4 or more					7								
		RC		0.8							1								
		SB		0.8							1						1		
		sc		0.8							1						1		
		SL		1							2						2		
		SM		1.5	Numb of steps or stagir bars missir	g					4						2		

Defect	Code	Ch1	Ch2 Sever	ty C	21 (Chann B	ench i R	educir	Frame	Steps/	djustin nstruct	ShaftC	hambe	MH I	Internat	Stagino	Flow	Safety
			Fact	escripti	Value			Siau	COVE	Toe holds					Drop tructur		devices	and chains
					2					5						3		
					3					6						4		
					4 or more					7						5		
		TH	1.25	Numb of toe holds defec						2								
					2					3								
					3					4								
					4 or more					5								
Displa joint	acleld D	А	1	Max length of displa mm							1	1	1	2	1			
					30-40						3	3	3	4	3			
					#50						5	5	5	6	5			
		Н	1	of	h 10-20						1	1	1	2	1			
					30-40						2	2	2	3	2			
					#50						3	3	3	4	3			
		V	1		10-20						1	1	1	2	1			
					30-40						2	2	2	3	2			
					#50						3	3	3	4	3			
Defectioning or coating	ti ₩å LD g	В	1					1			1	1	1	1	1			
		D	1.25	% chang in diame				1			6	6	6	6	6			
					10			2			7	7	7	7	7			
					15			3			8	8	8	8	8			
					20			4			10	10	10	10	10			
					25			5			10	10	10	10	10			

Defect	Code	Ch1	Ch2 S	Severit	, Q	1 (hann B	ench i R	educin	Frame	Steps/	djustin	Shaft	hambe	МН	nterna	Staging	Flow	Safety
			W	eightir Fact o e	scripti	Value			slab	Cover	add eics Toe holds			C		pework Drop tructur		devices	
		Н		1.1					2			2	2	2	2	1			
		I		0.6					1			1	1	1	1	1			
		L		1					3			3	3	3	3	1			
		М		1.5					5			5	5	5	5	3			
		R		1.1					4			4	4	4	4	4			
		RM		0.8								2	2	2					
		Т		1					3			3	3	3	3	3			
		U		1.1					4			4	4	4	4	4			
		WD		1					4			4	4	4					
		Х		2					5			10	10	10	10	10			
repair or	ti lvé RX ilitation	С		1.25				4	4			4	4	4					
		I		1				4				4	4	4	4				
		PR		1				3				3	3	3					
		R		1.25								4	4	4					
Chan	n e HCH	D		1			5												
		Т		1			3												
Defection flow control devices	ti lve FX	D		1														3	
		М		1														5	
Safety bars and chains	/ HSX	BB																	
		вс																	
		BL																	
		ВМ																	
		СС																	
		CL																	
		СМ																	
Depos	si ts DE	E		1	Thick of	n elsΩ +20						1	1	2		1			

Defect	Code	Ch1	Ch2 S	Severity	, Q	1 (hann	ench i	educir	Frame	Steps/	djustin	Shaft	hambe	MH I	nterna	Staging	Flow	Safety
			' \	eightir Fact o e	scripti	Value			SIAD	Cover	add ercs Toe holds	istruct		Co		Drop tructur		contro devices	and chains
					depos	its,													
						30-50						2	2	4		2			
						#60						3	3	6		3			
		F		0.8		10						1	1	2		1			
						20						2	2	4		2			
						30						3	3	6		3			
		G		1.1		10-50						2	3	3		1			
						60-10	0					4	5	5		2			
						#110						6	7	7		3			
		W		1		10-50						2	3	3		1			
						60-10	0					4	5	5		2			
						#110						6	7	7		3			
			С	1.2		10-20	3								3			3	
						30-50	4								4			4	
						#60	5								5			5	
			R	0.8		10-20	1								1			1	
						30-50	1								1			1	
						#60	2								2			2	
			s	0.8		10-20	1								1			1	
						30-50	1								1			1	
						#60	2								2			2	
Exfiltr	a ti-tb EnX	D		1.2			5	5							5			5	
		YY		1.0			3	3							3			3	
Infiltra	atil o lih	D		1			1	8		7		7	8	8	8			8	
		G		1.2			2	9		8		8	9	9	9			9	
		R		1			3	10		9		9	10	10	10			10	
		S		0.8			4	10		10		10	10	10	10			10	
Obstr	u ddiOnB s			1			5	3	1						5			5	
		С		1											5	5			
		I		1.2								2	3	4					
		J		1						2			2	2	4	4		4	

Defect	Code	Ch1	W	everity eightir Fact o e	· a		-	ench i R			Steps/kaddecs Toe holds	struct			nne pí	Interna pework Drop tructur	bars	contro devices	
		М		1			2	1	1						2			2	
		0		1.2								3	4	5					
		Р		1.5								5	5	5					
		SM		0.8						1		1	1	1	3	2		3	
Vermi	nHV	R		1.5	Numb of roden		3	3	3						3				
						2-5	5	5	5						5				
						#6	10	10	10						10				

Table E.2 SELECTED DEFECT CODES, WEIGHTED SCORING AND STRUCTURAL AND/OR SERVICE DESIGNATION

Code		Severity /eightin Factor			Chann €	enchin	educin slab	Frame/ Cover	Steps/A Ladd eo / Toe	djustin nstructi	Shaft			Internal ipework Drop	bars	Flow control devices	
		ractor	STR	SVR					holds				s	tructur			chains
НС	0 mm	1.15	STR				1.15			1.15	1.15	2.3		5.75			
	2 mm	1.25	STR		1.25	1.25	5			5	2.5	6.25		12.5			
	4 mm	1.25	STR		3.75	3.75	7.5			5	3.75	7.5		12.5			
	6 mm	1.25	STR		5	5	10			10	5	10		12.5			
HBD	100 mm	1.4	STR		1.4	1.4	2.8			2.8	7	8.4	2.8	2.8			
	200-40 mm	01.4	STR		4.2	4.2	4.2			4.2	8.4	9.8	4.2	4.2			
	#500 mm	1.4	STR		5.6	5.6	5.6			5.6	9.8	11.2	5.6	5.6			
НВМ	100 mm	1.5	STR		3	3	5			5	8	9	5	5			
	200-40 mm	01.5	STR		4	4	6			6	9	10	6	6			
	#500 mm	1.5	STR		5	5	7			7	10	10	7	7			
HD	5%	1	STR							6	6	6	6	6			
	10%	1	STR							7	7	7	7	7			
	15%	1	STR							8	8	8	8	8			

Code		Severity /eightin Factor			Chann €	enchin	educin slab		Steps/A Ladd eo / Toe			hambe C		Internal ipework Drop	bars	Flow control devices	
		actor	STR	SVR					holds				s	tructur			chains
	20%	1	STR							10	10	10	10	10			
	25%	1	STR	SVR						10	10	10	10	10			
НХ		2	STR	SVR	16	16	20			20	20	20	20	20			
HSCA		1.25	STR			3.75	5			3.75	5	6.25					
HSCC	P	1.0	STR			2	4			3	4	5					
HSCH		1.5	STR			10.5	12			9	10.5	15					
HSCR	E	1.4	STR			7	8.4			7	8.4	11.2					
HSCS		0.8	STR	1		1.6	1.6			1.6	1.6	3.2					
HSOB	5%	1	STR							6	6	6	6	6			
	10%	1	STR							7	7	7	7	7			
	15%	1	STR							8	8	8	8	8			
	20%	1	STR							10	10	10	10	10			
	25%	1	STR	SVR						10	10	10	10	10			
HSOH		1.2	STR			8.4	9.6			7.2	8.4	12	12	12			
HSOM	D	0.8	STR							2.4	3.2	4	4	4			
HSOS		1.1	STR							2.2	2.2	4.4					
HRF		1	SVR		4	5	4	2		3	4	5	5	3		3	3
HRM	10-209	61.2	SVR		4.8					4.8	4.8	4.8	4.8	4.8		4.8	4.8
	30-509	61.2	SVR		9.6					7.2	7.2	7.2	9.6	9.6		9.6	9.6
	50-709	61.2	SVR		12					9.6	9.6	9.6	12	12		12	12
	80-100	%1.2	SVR		12					12	12	12	12	12		12	12
HRRB		0.8	SVR		3.2					0.8	0.8	1.6	3.2	3.2		3.2	3.2
HRT		1.1	SVR		6.6	7.7	6.6	3.3		4.4	5.5	6.6	6.6	4.4		4.4	4.4
HMB (single layer)		1.2	STR			1.2				1.2	1.2	1.2					
	2-3	1.2	STR	,		1.2				2.4	2.4	2.4					
	4-6	1.2	STR			2.4				4.8	4.8	4.8					
	7-10	1.2	STR			4.8				9.6	9.6	9.6					
	#11	1.2	STR			9.6				12	12	12					
HMB (anoth	1 er	0.8	STR			0.8				0.8	0.8	0.8					

Code		Severity /eightin Factor			Chann ∉	enchin	leducin slab	Frame/ Cover	Steps/A Ladd eo / Toe	djustin nstructi	Shaft			Internal ipework Drop	bars	Flow control devices	bars
			STR	SVR					holds				s	tructur			chains
layer visible)																
	2-3	0.8	STR			0.8				1.6	1.6	1.6					
	4-6	0.8	STR			1.6				3.2	3.2	3.2					i
	7-10	0.8	STR			3.2				6.4	6.4	6.4					
	#11	0.8	STR			6.4				8	8	8					
HBS	5 mm	1.25	STR			1.3				1.3	1.3	1.3					
	10 mm	1.25	STR			2.5				2.5	2.5	2.5					
	15 mm	1.25	STR			5				5	5	5					
	20 mm	1.25	STR			10				10	10	10					
	25 mm	1.25	STR			12.5				12.5	12.5	12.5					
НММ	10 mm	1.1	STR			2.2				2.2	2.2	2.2					
	20 mm	1.1	STR			4.4				4.4	4.4	4.4					
	30 mm	1.1	STR			6.6				6.6	6.6	6.6					
	40 mm	1.1	STR			8.8				8.8	8.8	8.8					
	50 mm	1.1	STR			11				11	11	11					
НХВ		2	STR	SVR		16				20	20	20					
нсхв		1	SVR										4	6			
HCXD		1	SVR										3	4			
HCXG	A	1	SVR										3	4			i
HCXI	50 mm	1	SVR										1	1			
	100 mm	1	SVR										2	2			
	150 mm	1	SVR										3	6			
	200 mm	1	SVR										4	8			
НСХР		1	SVR										1	1			

Code		Severity Veightin			Chann €	enchin	leducin slab		Ladd eo			Chambe C		Internal ipework	bars	control	bars
		Factor	STR	SVR					Toe holds				:	Drop tructure		devices	and chains
НСВВ		1	STR		2	2				3	4	4	3				
НСВС		0.6	STR		0.6					0.6	0.6	0.6	0.6				
HCBS	F1-2 per m ²	1.25	STR		1.25					2.5	3.75	3.75	2.5				
	3-5 per m ²	1.25	STR		2.5					5	7.5	7.5	5				
	6-10 per m ²	1.25	STR		3.75					7.5	10	10	7.5				
	#11 per m ²	1.25	STR		5					10	12.5	12.5	10				
HCFC	В	1.4 n-t 1.6 t	STR	SVR*				8.4 n-t 9.6 t									
HCFC	D	1.25 n-t 1.6 t	STR	SVR*				5 n-t 6.4 t									
HCFC	H10 mm	1 n-t 1.2 t	SVR*	•				1 n-t 1.2 t									
	20 mm	1 n-t 1.2 t	SVR*					2 n-t 2.4 t									
	30 mm	1 n-t 1.2 t	SVR*					3 n-t 3.6 t									
	40 mm	1 n-t 1.2 t	SVR*					4 n-t 4.8 t									
n-t = n frames	on-traffi and co	ll cable, t = vers.	= traffica	able * W	I here this	s also inc	cludes s	afety, a	revised	severity	weighti	ing factor	r may be	adopte	d for all	<u> </u>	
HCFC	L 10 mm	1 n-t 1.4 t	SVR*					1 n-t 1.4 t									
	20 mm	1 n-t 1.4 t	SVR*					2 n-t 2.8 t									
	30 mm	1 n-t 1.4 t	SVR*					3 n-t 4.2 t									
	40 mm	1 n-t 1.4 t	SVR*					4 n-t 5.6 t									
HCFC	М	2	STR	SVR*				20									
HCFC	R	0.6 n-t 1 t	SVR*					2.4 n-t 4 t									

Code		Severity Veightin		ect gory	Chann€	enchi r	educin slab			djustin nstructi				Internal ipework		Flow control	Safety bars
		Factor	STR	SVR					Toe holds				_	Drop tructure		devices	
HCFFI	3	1.4 n-t 1.6 t	STR	SVR*				8.4 n-t 9.6 t									
HCFFI)	1 n-t 1.4 t	STR					4 n-t 5.6 t									
HCFFI	-	1 n-t 1.4 t	STR					4 n-t 5.6 t									
HCFFI	И	2	STR	SVR*				16									
HCFG		1.1	STR					1.1									
HCFH	D	1 n-t 1.5 t	SVR					3 n-t 4.5 t									
n-t = n	on-traffi	cable, t =	= traffica	able * W	here this	also in	cludes s	afety, a	revised	severity	weightii	ng factoi	may be	e adopte	d.		
HCFS		0.8 n-t 1.2 t	STR	SVR*				1.6 n-t 2.4 t									
HSLEI		1	STR						1						1		
HSLH		0.8	STR						0.8								
HSLLC	;	1	STR						4								
HSLLC	c	0.8	STR						0.8								
HSLLC	L	1	STR*						2								
HSLLC	CMI	1.1	STR*						1.1								
	2-5	1.1	STR*						2.2								
	#6	1.1	STR*						4.4								
HSLLF	RMI	1.5	STR*						6								
	2	1.5	STR*						7.5								
	3	1.5	STR*						9								
	#4	1.5	STR*						10.5								
HSLR	C	0.8	STR						0.8								
HSLSI	В	0.8	STR*						0.8						0.8		
HSLS		0.8	STR						0.8						0.8		
n-t = n	on-traffi	cable, t =	= traffica	able * W	here this	s also in	cludes s	afety, a	revised	severity	weighti	ng facto	may be	e adopte	d.		
HSLSI	-	1	STR*						2						2		
HSLSI	И1	1.5	STR*						6						3		
	2	1.5	STR*						7.5						4.5		

Code		Severity /eightin Factor	Def g cate		Chann€	enchin				djustin nstructi				Internal ipework Drop	bars	Flow control devices	Safety bars and
		ractor	STR	SVR					holds				s	tructur		hevices	chains
	3	1.5	STR*						9						6		
	#4	1.5	STR*						10.5						7.5		
HSLTI	11	1.25	STR*						2.5								
	2	1.25	STR*						3.75								
	3	1.25	STR*						5								
	#4	1.25	STR*						6.25								
HJDA	10-20 mm	1	SVR							1	1	1	2	1			
	30-40 mm	1	SVR							3	3	3	4	3			
	#50 mm	1	SVR							5	5	5	6	5			
HJDH	10-20 mm	1	SVR							1	1	1	2	1			
	30-40 mm	1	SVR							2	2	2	3	2			
	#50 mm	1	SVR							3	3	3	4	3			
HJDV	10-20 mm	1	SVR							1	1	1	2	1			
	30-40 mm	1	SVR							2	2	2	3	2			
	#50 mm	1	SVR							3	3	3	4	3			
* Wher	e this al	so inclu	des safe	ety, a re	vised se	verity we	eighting	factor m	ay be a	dopted.							
HLDB		1	SVR				1			1	1	1	1	1			
HLDD	5%	1.25	STR	SVR			1.25			7.5	7.5	7.5	7.5	7.5			
	10%	1.25	STR	SVR			2.5			8.75	8.75	8.75	8.75	8.75			
	15%	1.25	STR	SVR			3.75			10	10	10	10	10			
	20%	1.25	STR	SVR			5			12.5	12.5	12.5	12.5	12.5			
	25%	1.25	STR	SVR			6.25			12.5	12.5	12.5	12.5	12.5			
HLDH		1.1	STR				2.2			2.2	2.2	2.2	2.2	1.1			
HLDI		0.6	STR				0.6			0.6	0.6	0.6	0.6	0.6			
HLDL		1	STR				3			3	3	3	3	1			
HLDM		1.5	STR				7.5			7.5	7.5	7.5	7.5	4.5			

Code C	V	Severity /eightin Factor			Chann€	enchi r	educin slab		Steps/A Ladd eo / Toe					Internal ipework Drop	bars	Flow control devices	
		ractor	STR	SVR					holds				s	tructur		devices	chains
HLDR		1.1	SVR				4.4			4.4	4.4	4.4	4.4	4.4			
HLDR	М	0.8	STR							1.6	1.6	1.6					
HLDT		1	STR				3			3	3	3	3	3			
HLDU		1.1	STR	SVR			4.4			4.4	4.4	4.4	4.4	4.4			
HLDW	D	1	STR				4			4	4	4					
HLDX		2	STR	SVR			5			10	10	10	10	10			
HRXC		1.25	STR	SVR		5	4			5	5	5					
HRXI		1	SVR			4				4	4	4	4				
HRXP	?	1	STR			3				3	3	3					
HRXR		1.25	STR							4	4	4					
HCHD		1	STR	SVR	5												
нснт		1	SVR		3												
HGXG	D	1	SVR*													3	
HGXG	М	1	SVR*													5	
HGXS	D	1	SVR*													3	
HGXS	М	1	SVR*													5	
HSXB	3	1	SVR*														3
нѕхв	С	1	SVR*														1
HSXB	-	1	SVR*														3
нѕхв	M	1.5	SVR*														7.5
нѕхс	С	1	SVR*														1
HSXC	_	1	SVR*														3
HSXC	М	1.5	SVR*														7.5
** Whe	ere this a	also inclu	udes saf	ety, a re	evised se	everity w	eighting	factor r	may be a	adopted.							
HDEE	10-20 mm	1	SVR							1	1	2		1			
	30-50 mm	1	SVR							2	2	4		2			
	#60 mm	1	SVR							3	3	6		3			
HDEF	10 mm	0.8	SVR							0.8	0.8	1.6		0.8			

Code Quantity		Severity /eightin			Chann€	enchin	educin slab		Steps/A Ladd eo /					Internal ipework	Flow control	Safety bars
	-	Factor	STR	SVR	-		O.a.D	0010	Toe holds	ion don				Drop tructur	devices	
	20 mm	0.8	SVR							1.6	1.6	3.2		1.6		
	30 mm	0.8	SVR							2.4	2.4	4.8		2.4		
HDEG	10-50 mm	1.1	SVR							2.2	3.3	3.3		1.1		
	60-100 mm	1.1	SVR							4.4	5.5	5.5		2.2		
	#110 mm	1.1	SVR							6.6	7.7	7.7		3.3		
HDEW	10-50 mm	1	SVR							2	3	3		1		
	60-100 mm) 1	SVR							4	5	5		2		
	#110 mm	1	SVR							6	7	7		3		
HDEC	10-20 mm	1.2	SVR		3.6								3.6		3.6	
	30-50 mm	1.2	SVR		4.8								4.8		4.8	
	#60 mm	1.2	SVR		6								6		6	
HDER	10-20 mm	0.8	SVR		0.8								0.8		0.8	
	30-50 mm	0.8	SVR		0.8								0.8		0.8	
	#60 mm	0.8	SVR		1.6								1.6		1.6	
HDES	10-20 mm	0.8	SVR		0.8								0.8		0.8	
	30-50 mm	0.8	SVR		0.8								0.8		0.8	
	#60 mm	0.8	SVR		1.6								1.6		1.6	
HEXD		1.2	SVR		6	6							6		6	
HEXY	Y	1	SVR		3	3							3		3	
HID		1	SVR		1	8		7		7	8	8	8		8	
HIG		1.2	SVR		2.4	10.8		9.6		9.6	10.8	10.8	10.8		10.8	
HIR		1	SVR		3	10		9		9	10	10	10		10	
HIS		0.8	SVR		3.2	8		8		8	8	8	8		8	

Code	V	Severity /eightin Factor			Chann €	enchi n				djustin nstructi				Internal ipework Drop	bars		bars
		actor	STR	SVR					holds					tructur			chains
НОВВ		1	SVR		5	3	1						5			5	
новс		1	SVR										5	5			
нові		1.2	SVR							2.4	3.6	4.8					
НОВЈ		1	SVR					2			2	2	4	4		4	
нови		1	SVR		2	1	1						2			2	
ново		1.2	SVR							3.6	4.8	6					
НРВР		1.5	SVR							7.5	7.5	7.5					
HOBS	М	0.8	SVR					0.8		0.8	0.8	0.8	2.4	1.6		2.4	
HV	1	1.5	SVR		4.5	4.5	4.5						4.5				
	2-5	1.5	SVR		7.5	7.5	7.5						7.5				
	#6	1.5	SVR		15	15	15						15				

E4 EXAMPLE OF THE AGGREGATE SCORING SYSTEM

To better demonstrate the proposed scoring system, an example is given in <u>Table E.3</u> showing the initial scoring and a general summary of sample inspection data for each defect code at a specific defect location and depth. For purposes of this example, defect categorisation, i.e. service (SRV) or structural (STR), defect quantification (if applicable) and the score from **Table E.2** is also shown.

Table E.3 EXAMPLE DEFECT SUMMARY DATA

Function location	Depth m	Defect code and relevant remark	SRV/STR	Location	Quantification	Score
S2014817	0.12	HCFCB trafficable	STR	Frame/Cover		9.6
S2014817	0.46	HC	STR	Shaft	6	5.0
S2014817	0.95	НВМ	STR	Reducing slab	200-400 mm	6.0
S2014817	1.45	HSCRE	STR	Reducing slab		8.4
S2014817	1.67	HSCA	STR	Chamber		6.25
S2014817	2.58	HMB another layer visible	STR	Benching	#11	9.6
S2014817	2.62	НОВВ	SRV	Benching		3.0
S2014817	2.72	HIS	SRV	Benching		8.0
S2014817	2.85	HFH	N/A	N/A		N/A

In order to calculate a peak score for both the structural and service designation, a 1 metre depth range of scores is calculated, and then recalculated at 200 mm intervals. Each depth range then has associated with it, a summation of all the service or structural scores within that range. The largest of all the 1 metre ranges is then determined to be the peak structural and service score for the maintenance structure. <u>Table E.4</u> shows an overview of this scoring system. For this example, the peak structural score is 20.65 and the peak service score is 11.0.

Table E.4 DEPTH RANGE SUMMARY SCORES FOR STRUCTURAL AND SERVICE DESIGNATION

SCORES									
Depth Range	STR	SRV							
0-1	20.6	0							
0.2-1.2	11	0							
0.4-1.4	11	0							
0.6-1.6	14.4	0							
0.8-1.8	20.65*	0							
1.0-2.0	14.65	0							
1.2-2.2	14.65	0							
1.4-2.4	14.65	0							
1.6-2.6	15.85	0							
1.8-2.8	9.6	11							
2.0-2.85	0	11*							



^{*} Peak scores

An average score is calculated by summing all of the structural and service scores and dividing by the depth (i.e. the depth at code HFH (refer to 3.7.11.2 Inspection completed—HFH). Table E.5 is a summary of the peak and average scores for this example.

Table E.5 SUMMARY OF PEAK AND AVERAGE SCORES

Description	Score
Peak Structural	20.65
Average Structural	15.7
Peak Service	11.0
Average Service	3.9

E5 OVERVIEW OF RATING SYSTEM

A default structural and service rating system may be applied as shown in <u>Table E.6</u>. However, asset owners are encouraged to develop their own rating system to meet their corporate objectives, licensing conditions etc. based on the peak structural and service scores.

The peak ranges shown in <u>Table E.6</u> for each grade are yet to proven, as the rating system is new and has yet to be validated by asset owners. The next step in this process will require asset managers thoroughly analysing actual CCTV footage and scorings determined by the inspectors and calibrating both the scoring and rating systems. For example in Water Corporation, it is currently planned that after the FY2012 inspection program is complete, there will be more than 300 maintenance structure inspections that can be used to calibrate the scoring and rating systems.

Table E.6 STRUCTURAL AND SERVICE GRADES

Structura	al grading	Service grading				
Peak score	Grade	Peak score	Grade			
0 to #3	1	0 to #3	1			
>3 to #7	2	>3 to #7	2			
>7 to #12	3	>7 to #12	3			
>12 to #17	4	>12 to #17	4			
>17	5	>17	5			

E6 FUTURE DEVELOPMENT—WHERE TO NEXT?

An obvious evolution for this system will involve the automation of gap treatments, cost estimation, recommended timing of repair/refurbishment and timing of subsequent inspections. Given the significant quantity and quality of data that will be generated from this scoring and rating method, it is anticipated that a standardised decision flow diagram could be agreed upon that would dictate repair methodologies, timing and costing.

At present, this proposed system can be applied to all maintenance structure defect codes by assigning a peak and average score and grade based on what are essentially arbitrary numbers. Despite the lack of calibration to real-world inspection data, while arbitrary, the scoring and rating system will provide an 'apples with apples' comparison in terms of the relative condition between structures. However, in order to bring the reality of the inspection and actual condition to life within the confines of this proposed method, a review of defect codes and, in particular, how they can be practicably quantified, as well as the scoring, severity weighting factors along with the analysis of data collected using this method, will need to be done.

Unlike the conduit module, the maintenance structure scoring and rating method outlined herein has not been codified into the WinCan software at this point. Instead, the Water Corporation has chosen for it to be programmatically implemented within their SAP database environment. However, it may make sense, (perhaps within the context of a WSAA-endorsed review/calibration process of the 300+ chambers currently underway in the Perth Region), for WSAA to work with WinCan/SECA to officially codify the scoring and rating system within the WinCan maintenance structure module environment.

APPENDIX F — CRACKING, BREAKING, DEFORMATION, CORROSION AND COLLAPSE OF RIGID, FLEXIBLE AND MASONRY CONDUITS

F1 INTRODUCTION

This appendix provides an explanation for many of the structural defects observed in the inspections of rigid, flexible and masonry **conduit**. Sewerage and stormwater drainage systems comprise a variety of conduit types each with characteristic failure patterns. It is likely that defects observed during inspections will be a combination of the mechanisms illustrated. Alternatively, it may be that the defects observed don't seem to fit any pattern!

Rigid <u>conduit</u> tend to exhibit cracking in the first instance, leading to more serious defects depending on the type of ground, the soundness of joints, depth, hydraulic loading etc. Concrete, asbestos cement and fibre reinforced concrete pipes maybe also be affected by corrosion and loss of fabric before cracking.

Flexible <u>conduit</u> exhibit deformation soon after construction if little attention has been given to adequate support for the pipe. Deformation tends to increase with time until some equilibrium is established in the 'pipe-soil' structure.

Masonry <u>conduit</u> are mostly constructed from clay bricks but many stone conduits still exist. The classic structure for brick conduits is circular or ovoid (egg shaped) which uses the arch structure. With appropriate ground support, this ensures the whole structure remains in compression. Loss of mortar between brick courses, a common defect, may trigger further defects such as displaced bricks, loss of bricks and loss of soil support, leading to deformation, and in some situations, complete collapse of the conduit.

F2 RIGID PIPES

Earthenware, vitrified clay, cast iron, unreinforced concrete, reinforced concrete, asbestos cement and fibre (cellulose) reinforced concrete are considered rigid pipes from a structural viewpoint. Typically, these pipe types deform very little before cracking occurs. The causes of cracking can be from:

- (a) excessive vertical load during or after construction;
- (b) inadequate pipe strength class for the load and conditions;
- (c) poor construction practice such as inadequate pipe support;
- (d) ground movements associated with mining or other activities;
- (e) leaking joints;
- (f) manufacturing defects that create a weak zone or microscopic fissure that opens under load;
- (g) damage during transport and handling prior to installation;
- (h) damage during operational activities; and
- (i) damage caused by third parties.

Cracking/failure patterns of rigid pipes can be categorised as follows:

- (i) Ring failure;
- (ii) Joint failure;
- (iii) Beam failure; and
- (iv) Shear failure.

Cracking patterns and deterioration of rigid conduits often do not exist in isolation. The cracking and breaking patterns observed will most likely be a combination of the patterns described in the following sections.

F2.1 RING FAILURE PATTERN

F2.1.1 STAGE 1

Pipe cracking could be caused by poor installation, subsequent overloading or disturbance. The conduit remains supported and held in position by the surrounding soil. Pipes at this stage may be stable depending on the surrounding ground and hydraulic performance of the conduit. Cohesive soils surrounding the conduit generally reduce the risk of further deformation. Refer to Figure F.1.

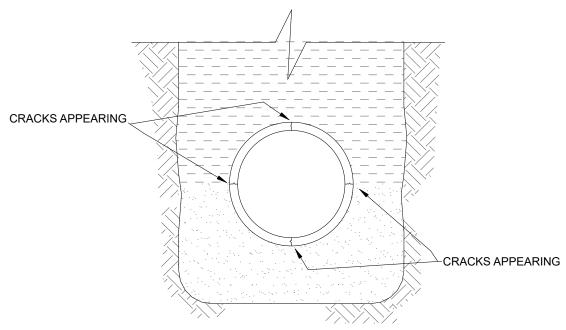


Figure F.1 STAGE 1 RING FAILURE PATTERN

- (a) Cracks at soffit, invert and spring line; and
- (b) Slight infiltration and or encrustation may also be visible.

F2.1.2 STAGE 2

Infiltration through cracks. Cycles of hydraulic overloading (surcharging) cause exfiltration/ infiltration in which the surrounding soil becomes saturated and then allows ingress of soil when surcharging subsides. Side support is reduced allowing some movement and further deformation.

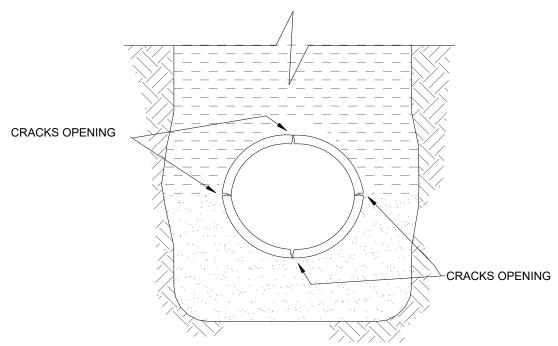


Figure F.2 STAGE 2 RING FAILURE PATTERN

Visible defects include:

- (a) Cracks will be opening in the soffit and invert;
- (b) Some noticeable deformation; and
- (c) Infiltration, ingress of soil and encrustation may be visible.

F2.1.3 STAGE 3

Loss of side support allows side of pipe to move further outwards and the soffit to drop. It is considered broken at this stage or collapsed depending on percentage deformation. Once deformation exceeds 10%, the pipe becomes increasingly likely to collapse.

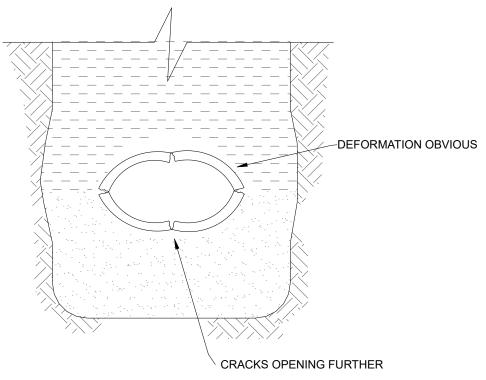


Figure F.3 STAGE 3 RING FAILURE PATTERN

Visible defects include:

- (a) Cracks opening further in soffit and invert with pipe pieces misaligned;
- (b) Deformation is obvious; and
- (c) Spalling likely along the crack lines.

Actual cracking patterns are likely to be an irregular approximation of the geometric design depicted in <u>Figure F.1</u> to <u>Figure F.3</u>, and is shown in <u>Figure F.4</u>. There will also be another crack in the invert.

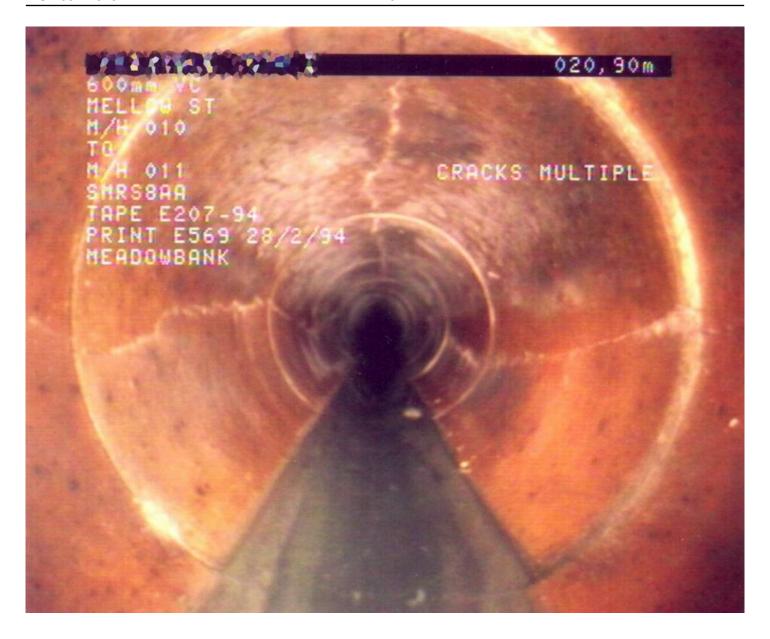


Figure F.4 EXAMPLE OF CRACKING THROUGH RING FAILURE PATTERN

Another example of this form of cracking is in <u>Figure F.5</u>, which also shows staining from past infiltration along the crack lines.



Figure F.5 EXAMPLE OF CRACKING WITH STAINING THROUGH RING FAILURE PATTERN

In this example shown in <u>Figure F.6</u>, side support has been lost, the joint has failed and the conduit is regarded as collapsed; overloading, poor construction and or inadequate pipe class may be the key factors in the collapse of this recently constructed stormwater drain.



Figure F.6 EXAMPLE OF CRACKING THROUGH RING FAILURE PATTERN DUE TO LOSS OF SIDE SUPPORT

F2.2 JOINT FAILURE PATTERN

This defect pattern and progressive deterioration may also be associated with circumferential cracking of a rigid pipe.

F2.2.1 STAGE 1

There is a gap in the seal at the joint – cement mortar lost, rubber ring pinched or broken allows exfiltration and infiltration. Cycles of exfiltration and infiltration with ingress of soil takes support away from the pipe at the joint.

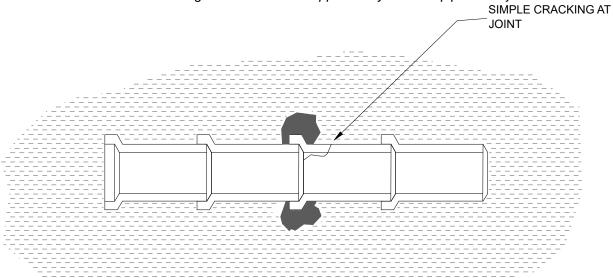


Figure F.7 STAGE 1 JOINT FAILURE PATTERN

Visible defects include:

- (a) Some signs of exfiltration of infiltration at joint;
- (b) Ingress of fine soil particles may be apparent;
- (c) Joint displacement may be apparent; and
- (d) Simple cracking originating from the joint.

The simple cracking phenomenon is shown in <u>Figure F.8</u>. It is typically associated with the socket end of the pipe in earthenware, vitrified clay and concrete pipes.

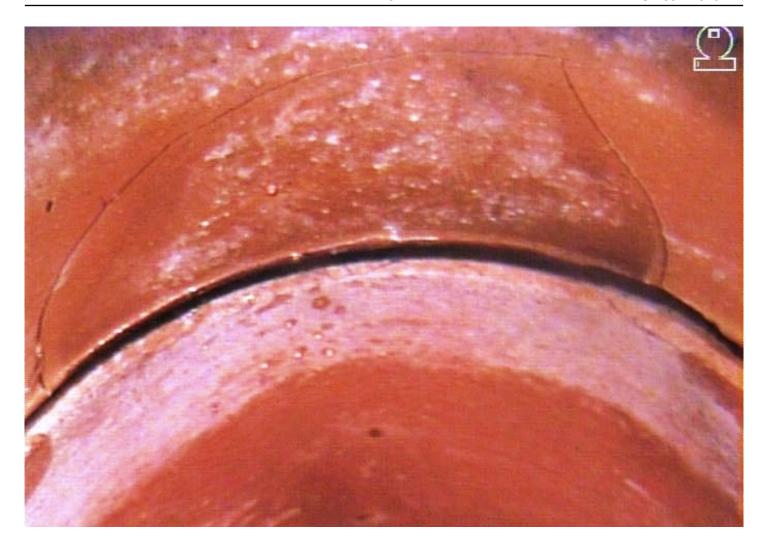


Figure F.8 EXAMPLE OF SIMPLE CRACKING THROUGH JOINT FAILURE PATTERN

F2.2.2 STAGE 2

Lack of support allows the pipe to assume an angular deflection at several joints. Simple cracks may open, and additional cracking in the stress zones may become obvious. In some situations, there may be no support left in the socket to restrain the spigot which would allow it to deflect radially.

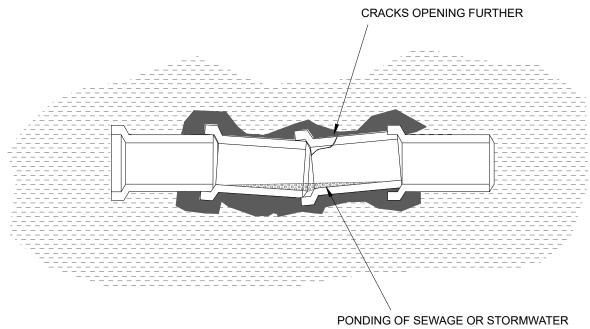


Figure F.9 STAGE 2 JOINT FAILURE PATTERN

- (a) Angular deflection at joints with simple cracking opening and other cracks appearing;
- (b) Ponding will be obvious with grade disrupted;
- (c) Spalling likely as pipe pieces move out of alignment; and
- (d) Soil visible or ingress of soil likely.

F2.2.3 STAGE 3

Continuing loss of support allows the pipes to assume more extreme angular deflections at several joints, and joint integrity is lost. Simple cracking may allow a piece of pipe to be dislodged. Cracking in the stress zones likely. Spigots may move radially, with voids visible coupled with ingress of soil and/or exfiltration likely.

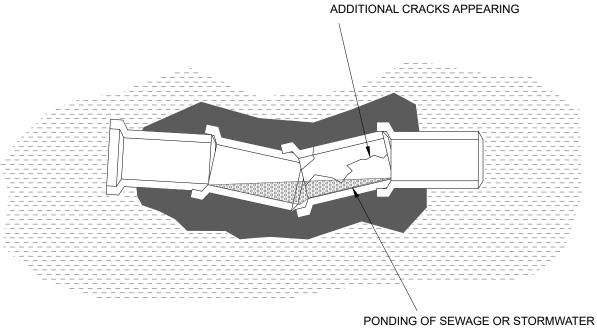


Figure F.10 STAGE 3 JOINT FAILURE PATTERN

Visible defects include:

- (a) Extreme angular deflection at joints with pieces of pipe displaced;
- (b) Ponding may still be obvious or water may have been absorbed into the soil;

- (c) Spalling likely as pipe pieces move out of alignment;
- (d) Void visible and/or ingress of soil likely; and
- (e) Radial displacement of the pipe possible.

F2.3 BEAM FAILURE PATTERN

Rigid pipes are not designed to act as beams, but some do because of poor pipelaying practices or changes in ground support due to subsidence. Smaller diameter pipes are more likely to exhibit cracking patterns consistent with beam action. It may occur in earthenware, vitrified clay, cast iron, asbestos cement and fibre reinforced concrete. However, where significant surface damage has occurred in cast iron, concrete or asbestos cement it may be difficult to identify such cracking.

Two examples are illustrated to show how cracking can be introduced when a pipe does not have uniform support along the barrel of the pipe. In extreme cases of these examples, pipes may exhibit cracking that opens sufficiently to allow infiltration, exfiltration and or ingress of soil – then potentially triggering the failure similar to the joint failure pattern described in the previous section.

F2.3.1 EXAMPLE 1

In this example, as shown in <u>Figure F.11</u>, the pipe is only supported on the ends; pipes are laid with support only at the sockets and gaps below the pipe. Trench backfill and surface loads are exerted on the pipe, causing it to act as a beam. Circumferential cracking originates at the invert and extends towards the spring line. Cracking is generally concentrated at midpoint of the pipe.

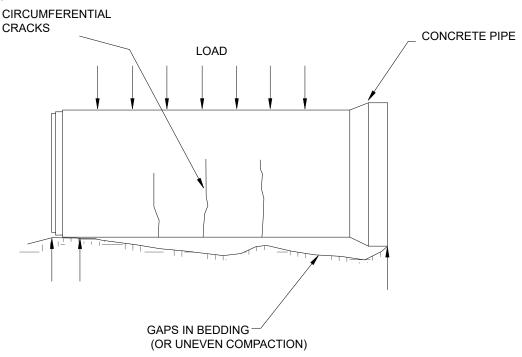


Figure F.11 BEAM FAILURE - SUPPORTED AT THE ENDS ONLY

Visible defects include:

- (a) Circumferential cracking originating at the invert where the largest gap would be observed;
- (b) Cracking in the invert may not be visible if the water level is high or deposits are present; and
- (c) Infiltration may not be visible.

F2.3.2 EXAMPLE 2

In this example there is uneven support; the pipe has limited contact with the trench bottom, typically near the centre of the pipe. Trench backfill and surface loads are exerted on the pipe, causing it to act as a cantilever beam. Circumferential cracking originates at the soffit and extends towards the spring line. Cracking is generally concentrated at midpoint of pipe and is often seen to propagate from the lifting hole in stormwater conduits.

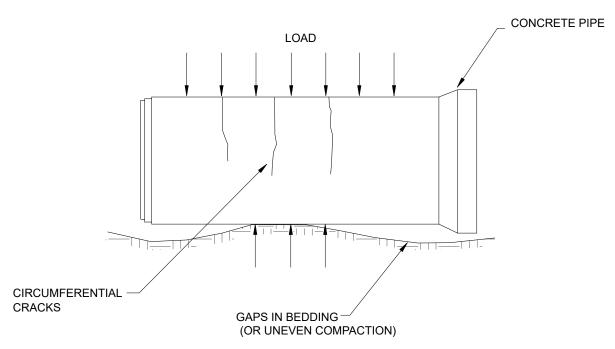


Figure F.12 BEAM FAILURE - UNEVEN SUPPORT ALONG THE PIPE

- (a) Circumferential cracking originating at the soffit where the largest gap would be observed;
- (b) Infiltration and encrustation may be observed; and
- (c) Some spalling may be evident associated with the cracks.

Figure F.13 provides an example of circumferential cracking originating from the soffit. Spalling is apparent at 12 o'clock.

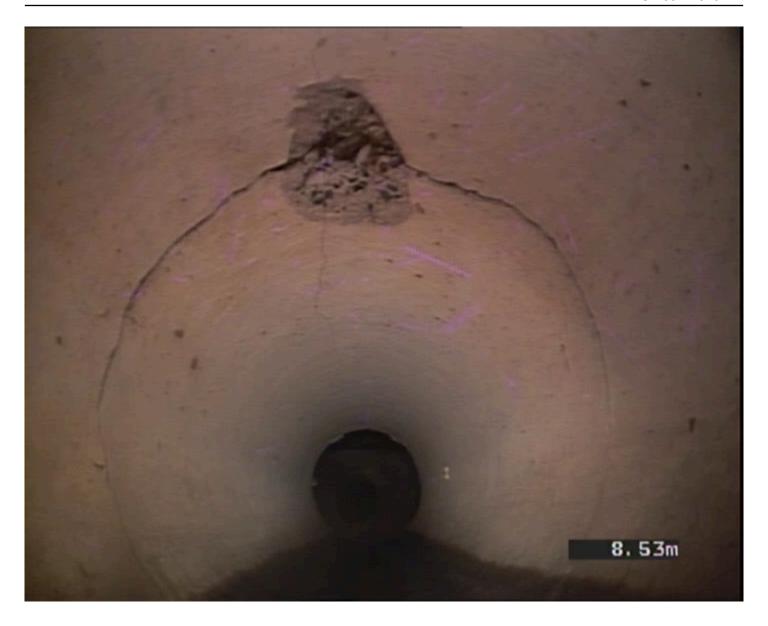


Figure F.13 EXAMPLE OF CIRCUMFERENTIAL CRACKING AS A RESULT OF UNEVEN SUPPORT ALONG THE PIPE

F2.4 SHEAR FAILURE PATTERN

When rigid pipes are partly restrained by a structure such as a pit, concrete encasement or maintenance hole, the pipe is effectively a cantilever. When backfill and surface loads are exerted on the pipe circumferential cracking may be initiated similar to <u>F2.3.2 Example 2</u>.

Cracking will change to a shear action if support for the embedded pipe in the structure or the 'free' pipe allows for differential movement. <u>Figure F.14</u> illustrates a defect that may be observed adjacent to maintenance structures or concrete encasement. In the scenario depicted the structure has settled relative the pipework.

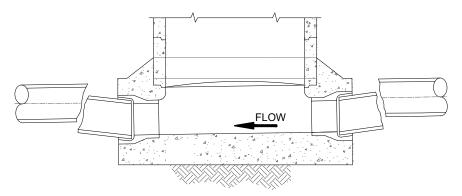


Figure F.14 SHEAR FAILURE PATTERN

F3 STRUCTURAL CONSEQUENCES OF CORROSION OF CONCRETE AND ASBESTOS CEMENT PIPES

The generation of hydrogen sulphide in sewers is usually detrimental to cement based pipe products like concrete and asbestos cement.

The generation of hydrogen sulphide in sewers is usually detrimental to cement-based pipe products like concrete and asbestos cement. It is formed under anaerobic conditions at low flow velocities, extended storage in the system and warm temperatures. The rate of release is increased at points of high turbulence, the outlets of inverted siphons and downstream of rising main discharge points.

The anaerobic bacteria present on the walls of the pipe and structures oxidises the hydrogen sulphide dissolved in the moisture on the pipe walls and produces sulphuric acid. The acid gradually corrodes the cement-based matrix of concrete and asbestos cement above the usual water line, as shown in **Figure F.15**.

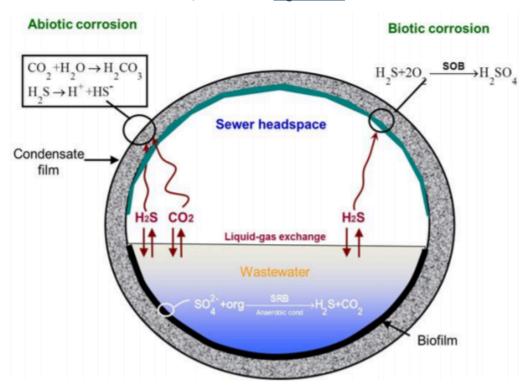


Figure F.15 MECHANISM OF CORROSION FROM SULPHURIC ACID

As the process progresses, a layer of corrosion products, consisting of gypsum and moisture, is produced on the surface of the pipe. This expands into the concrete as more and more acid is produced and reacts with the cement matrix. The formation of ettringite during the acid reaction process adds another problem; ettringite is expansive and causes internal cracking and pitting, which provides an even larger surface area for the chemical reaction to progress.

Following this stage, it is likely that concrete pipes will exhibit aggregate protruding and/or aggregate missing. Where the pipe has steel reinforcement it can be severely corroded or may even be missing in parts of the pipe above the water

line. The loss of pipe fabric increases towards the soffit. The pipe may survive structurally, depending on the surrounding ground, even though the pipe thickness may only be a few millimetres, but collapse is likely at some point.

Figure F.16shows a concrete pipe that has disintegrated completely above the normal water level. At the joint, a rubber ring is visible in the soffit. This is an indicator that the fabric of the conduit has completely disappeared. From 8 to 4 o'clock in the pipe are the skeletal remains of the concrete pipe in a thin veneer of corrosion by-products (in parts) over the surrounding soil. A 'veneer' of corrosion products will often be a feature in concrete pipes subject to H₂S corrosion, and its presence can disguise the underlying condition of the concrete.



Figure F.16 EXAMPLE OF CORROSION IN A CONCRETE PIPE

This concrete sewer was on a steep grade and downstream of a rising main discharge point, which can influence the rate of corrosion in concrete sewer pipes.

Corrosion of asbestos cement pipe has similar characteristics to concrete, but because of the binding effect of the asbestos fibres, the loss of fabric occurs through delamination as illustrated in <u>Figure F.17</u>.



Figure F.17 EXAMPLE OF CORROSION IN AN ASBESTOS CEMENT PIPE

F3.1 FURTHER DETAILS ON CORROSION IN SEWER SYSTEMS

It is proposed to develop a web-based knowledge management system to make the findings of the research into corrosion and odour in sewer systems that have come from the ARC Sewer Corrosion and Odour Research (SCORe) Linkage Project (LPO882016) readily available to the water industry. This will include:

- (a) A decision tree that will aid users find the information they require;
- (b) Fact sheets that will be organised into convenient titles linked to the decision tree;
- (c) Direct outputs from the SCORe Project including final reports, literature reviews, publications, case studies, etc;
- (d) Related manuals, reports and other relevant literature that is free of copyright;

- (e) Links to other relevant literature, models, etc. that are available on other internet sites; and
- (f) A search engine to allow easy direct retrieval of any documents.

It is expected that most of these documents will be pdf files.



Details of the home page for the SCORe knowledge management system will be advised to registered code holders as soon as it becomes available.

F4 FLEXIBLE PIPES

Unplasticised polyvinyl chloride (uPVC), polypropylene (PP), polyethylene (PE), acrylonitrile butadiene styrene(ABS), glass reinforced plastic (GRP), polymer concrete, steel, and ductile iron are all considered flexible conduits from a structural viewpoint. These pipe types initially deform elastically in response to backfill and surface loads. Vertical deformation is resisted by the side support provided by the embedment material and walls of the trench in a reaction to the slight horizontal outward movement of the pipe.

Where side support is poor due to inadequate embedment compaction and/or migration of fines from the trench wall into the embedment gravel, the resistance to horizontal outward movement is not activated and the pipe will lose its circular shape, as shown in **Figure F.18**. For many flexible pipes this will be a common issue.

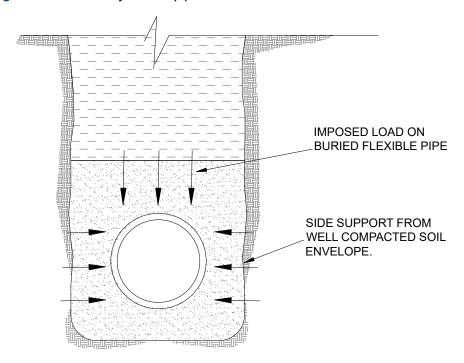
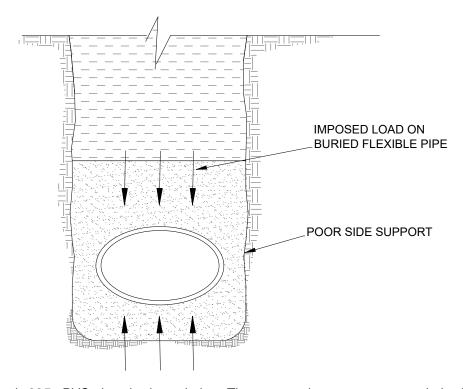


Figure F.18 SUPPORT OF FLEXIBLE PIPES; a) adequate support and b) inadequate support resulting in deformation



Significant deformation in 225 uPVC pipes is shown below. These examples are stormwater drains in private developments.

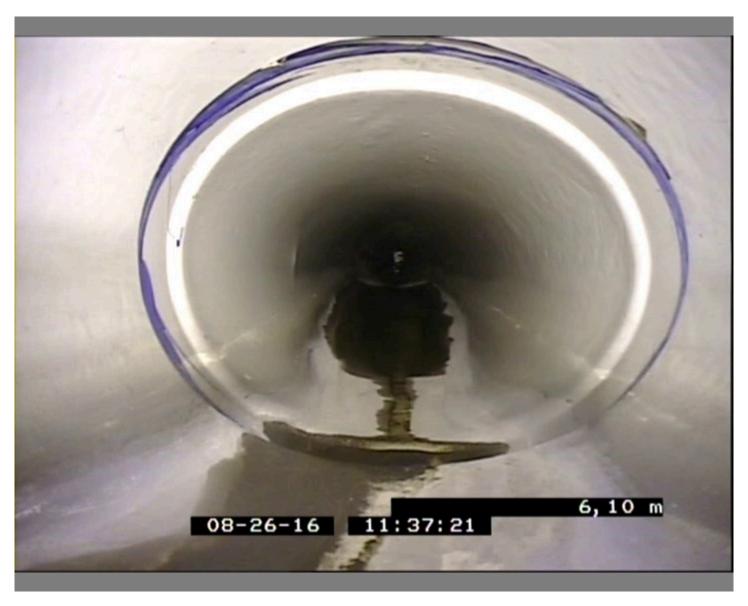


Figure F.19 A - EXAMPLES OF DEFORMATION IN uPVC PIPES



Figure F.19 B - EXAMPLES OF DEFORMATION IN uPVC PIPES

For plastics pipes creep contributes to deformation. Creep of plastics pipes occurs when the material is under constant stress and will allow further deformation to occur beyond the initial elastic response. The creep phenomenon is most noticeable when there are external concentrated loads, caused typically by an object like a boulder in the backfill or a load is imposed by the arrangement of fittings, where a local deformation will be manifested, as shown in **Figure F.20**.



Figure F.20 EXAMPLE OF CREEP AND DEFORMATION

Although not common, cracking of plastics may also occur associated with these local deformations. <u>Figure F.21</u> shows deformation and cracking in the junction fitting. The lateral configuration incorporates a bend fitting off the junction branch and a vertical riser. The shear earth loading on the vertical riser may be the contributing cause of the deformation and cracking. This defect would be recorded as broken displaced in the main conduit, and the defective junction code would need to be applied for the defects occurring in the lateral.



Figure F.21 EXAMPLE OF DEFORMATION AND CRACKING

F5 MASONRY - BRICK

The classic structure for brick conduits is circular or ovoid (egg shaped). These shapes use the arch principle and with appropriate ground support, the whole structure remains in compression. The structure may be built with one, two or more layers of brick. Composite structures with concrete invert section and brick soffit also exist.

Brick masonry sewers and stormwater drains have been in existence in Australia for over one hundred years and in other countries for much longer. Many are still in good condition and still in service, but a significant proportion have a range of defects that will compromise the structural integrity and service performance if not addressed.

Loss of mortar between brick courses, a common defect, may trigger further defects such as displaced bricks, loss of bricks, loss of soil support leading to deformation, dropped invert and in some situations complete collapse of the conduit. Added to these defects is the condition of ceramic growth that occurs to varying degrees in fired clay products. Although ceramic growth is infinitesimally small for a single brick in the whole length of brick conduit the growth could be significant.

Some of the characteristic failure modes for brick masonry sewers are illustrated in the following sections.

F5.1 LOSS OF SIDE SUPPORT

F5.1.1 STAGE 1

The conduit has poor mortar joints, attributable to the original construction and/or mortar loss, as the mortar deteriorates through corrosion and erosion.

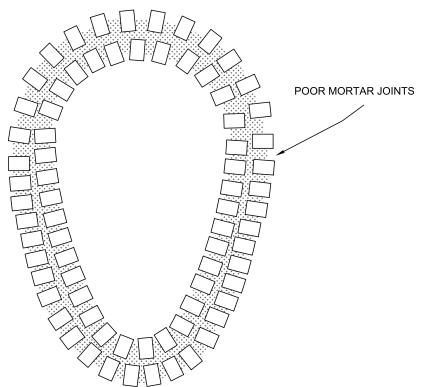


Figure F.22 STAGE 1 LOSS OF SIDE SUPPORT

Visible defects include:

- (a) Mortar loss; and
- (b) Signs of infiltration.

F5.1.2 STAGE 2

The loss of mortar in some joints particularly at mid-height allows for infiltration. Cycles of hydraulic overloading (surcharging) cause exfiltration and infiltration, where the surrounding soil becomes saturated and then allows ingress of soil when surcharging subsides. This reduces the side support, as shown in <u>Figure F.23</u>, allowing outward movement of the bricks into the lower density soil. As the sides move out, the crown tends to drop with brick separation and or cracking appearing at the soffit.

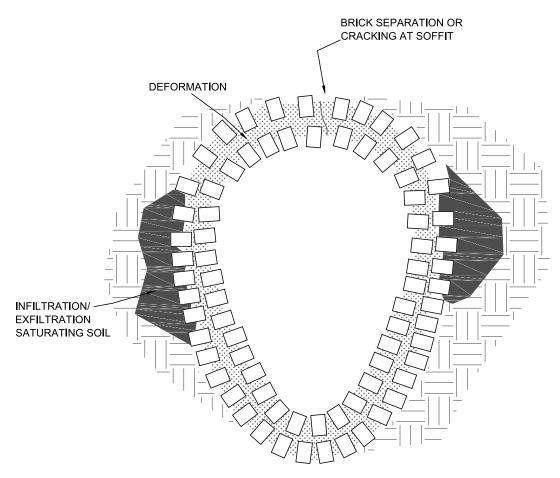


Figure F.23 STAGE 2 LOSS OF SIDE SUPPORT

- (a) Deformation;
- (b) Brick separation or cracking at the soffit; and
- (c) Closing of the gap between brick courses at the haunches where mortar has been lost.

F5.1.3 STAGE 3

There is continuing vertical deformation as the side support diminishes, and the structure moves outward at mid-height. Brick separation increases in the soffit with the structure forming a 'heart' shape, as shown in <u>Figure F.24</u>. There may be loss of bricks from the soffit and spalling at the haunches. Collapse is imminent without remedial action.

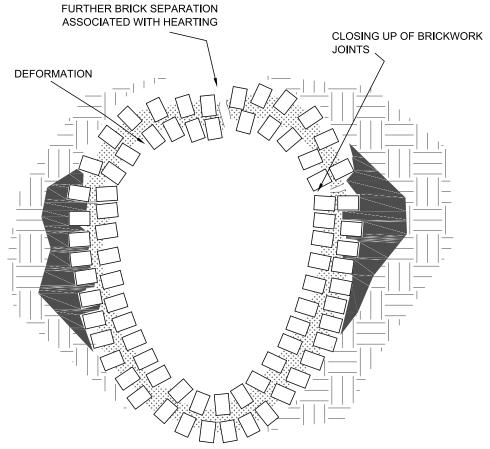


Figure F.24 STAGE 3 LOSS OF SIDE SUPPORT

- (a) Deformation;
- (b) Pronounced brick separation at the soffit associated with hearting;
- (c) Closing up of brickwork joints in the haunches;
- (d) Possible spalling; and
- (e) Possible loss of bricks from the crown.

<u>Figure F.25</u> shows an example of the loss of side support associated with the loss of mortar. However, the same progression of structural deterioration may occur without significant loss of mortar if the soil surrounding the conduit is unable to resist the outward thrust transferred from loading on top of the conduit.

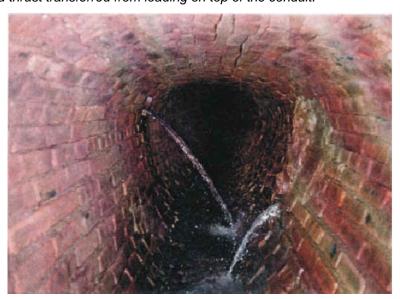


Figure F.25 EXAMPLE OF LOSS OF SIDE SUPPORT

F5.2 LOSS OF BRICKS AT SOFFIT

F5.2.1 STAGE 1

The conduit has poor mortar joints, attributable to the original construction and/or mortar loss, as the mortar deteriorates through corrosion and erosion. This is occurring predominantly in the soffit. The side support is retained throughout, with no outward movement of the structure at mid-height.

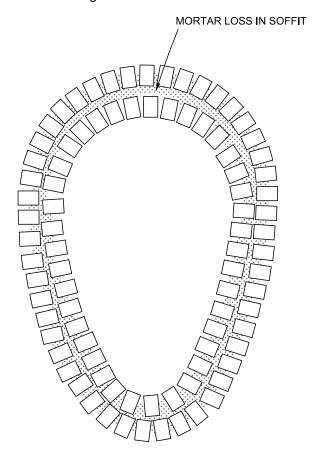


Figure F.26 STAGE 1 LOSS OF BRICKS AT SOFFIT

Visible defects include:

(a) Mortar loss in the soffit.

F5.2.2 STAGE 2

There is loss of mortar between bricks in soffit, which allow joints to close and the inner ring of bricks at soffit to separate from outer ring, as shown in <u>Figure F.27</u>.

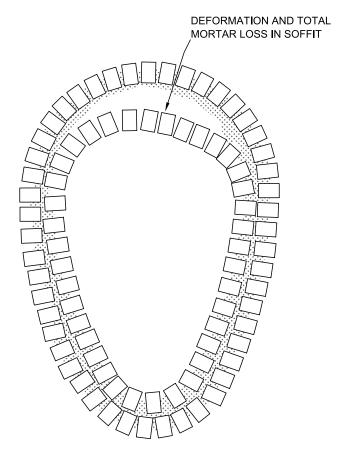


Figure F.27 STAGE 2 LOSS OF BRICKS AT THE SOFFIT

- (a) Total mortar loss apparent in soffit;
- (b) Deformation limited to soffit bricks; and
- (c) Some displaced bricks in the soffit.

F5.2.3 STAGE 3

There is a loss of compressive load on inner ring of bricks in crown, which allows bricks to be dislodged and fall, as shown in <u>Figure F.28</u>. This causes the progressive collapse of the inner ring.

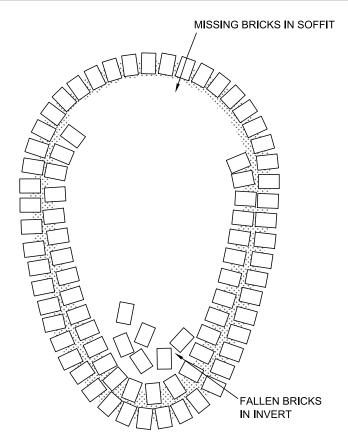


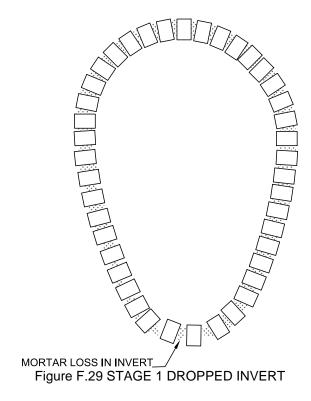
Figure F.28 STAGE 3 LOSS OF BRICKS AT SOFFIT

- (a) Missing bricks in soffit, bricks in invert; and
- (b) Structural deterioration may occur in single ring conduits leaving soil visible if the surrounding ground is a stiff cohesive clay.

F5.3 DROPPED INVERT

F5.3.1 STAGE 1

Loss of mortar in the invert allows infiltration or exfiltration, and possibly ingress of soil.



- (a) Mortar loss in invert, but may be obscured by water level; and
- (b) Infiltration, exfiltration and ingress of soil, but may be difficult to observe.

F5.3.2 STAGE 2

Ingress of soil increases through gaps in the invert as a result of lost mortar. This causes voids to form below the structures' invert.

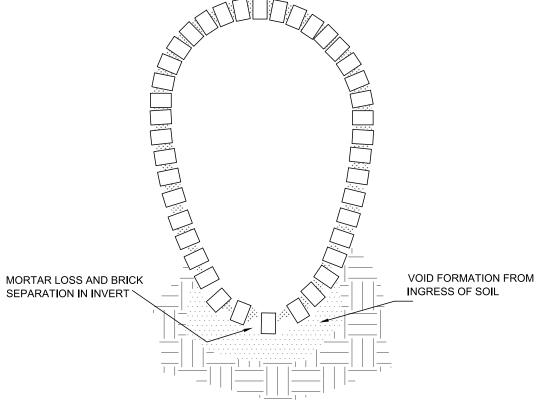


Figure F.30 STAGE 2 DROPPED INVERT

Visible defects include:

(a) Mortar loss in invert, but may be obscured by water level;

- (b) Deposits in invert; and
- (c) Brick separation near water level.

F5.3.3 STAGE 3

Loss of support below the structure allows the invert to drop into the void. The side walls may also drop, or they may be held in place by mortar or friction.

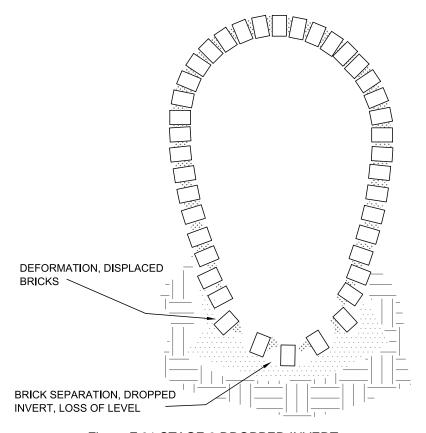


Figure F.31 STAGE 3 DROPPED INVERT

Visible defects include:

- (a) Brick separation around water line;
- (b) Dropped invert;
- (c) Missing bricks in invert;
- (d) Displaced bricks in walls;
- (e) Deformation; and
- (f) Loss of level.

An example of a dropped invert is shown in Figure F.32.



Figure F.32 EXAMPLE OF A DROPPED INVERT

F5.4 CERAMIC GROWTH

Ceramic growth occurs to varying degrees in fired clay products. Although ceramic growth is infinitesimally small for a single brick, over the whole length of brick conduit the growth could be significant. However, brick conduits cannot increase its length overall due to the restraint from the soil surrounding it and maintenance structures.

Because of this restraint, ceramic growth results in massive longitudinal stresses in the bricks. These stresses may contribute to the following defects:

- (a) Spalling of bricks in zones of high compressive stress;
- (b) Cracking of bricks; and
- (c) Displacement of bricks inwards or outwards as the stress is relieved.

<u>Figure F.33</u> depicts photographs of a shallow brick stormwater conduit where the bricks have been displaced outwards as if the conduit has buckled under the compressive load imposed by ceramic growth.



Figure F.33 A - EXAMPLES OF BRICK DISPLACEMENT



Figure F.33 B - EXMAPLES OF BRIKCK DISPLACEMENT

<u>Figure F.34</u> illustrates the relieving of ceramic growth stresses by the displacement of bricks along with spalling or crushing of some bricks in the vicinity. These defects are likely to be observed in sections where zones of high stress have developed.



Figure F.34 EXAMPLE OF BRICK DISPLACEMENT WITH SPALLING AND CRACKING

REFERENCES

(2001) Sewer Rehabilitation Manual, (4th Ed), WRc Publications, Blagrove, UK

APPENDIX G — SUMMARY OF MAIN CODES FOR DESCRIBING CONDUIT CONDITION

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
2.7.2.1	С	Cracking	С	Circumferential			Maximum width, mm	
			L	Longitudinal			Maximum width, mm	
			М	Multiple/ complex			Maximum width, mm	
			S	Single			Maximum width, mm	
2.7.2.2	В	Breaking	D	Displaced			Extent, mm in longitudinal dimension	
			М	Missing			Extent, mm in longitudinal dimension	
			Е	Exceptional			Extent, mm in longitudinal dimension	
2.7.2.3	D	Deformation	Н	Horizontal			Magnitude, maximum % change in dimension	Extent, mm longitudinal dimension
			М	Mixed			Magnitude, maximum % change in dimension	Extent, mm longitudinal dimension
			V	Vertical			Magnitude, maximum % change in dimension	Extent, mm longitudinal dimension
2.7.2.4	Х	Collapsed conduit						
2.7.2.5	SC	Surface damage concrete	AV	Aggregate visible			N/A	
			AP	Aggregate projecting			Maximum loss of wall thickness, mm	
			AM	Aggregate missing			Maximum loss of wall thickness, mm	
			СР	Corrosion products visible			N/A	

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			Н	Hole in conduit			N/A	
			JR	Joint ends rounded			N/A	
			RC	Reinforcement corroded			Maximum loss of wall thickness, mm	
			RV	Reinforcement visible with little or no corrosion			N/A	
			RVP	Reinforcement visible with little or no corrosion and projecting			N/A	
			S	Spalling			Maximum loss of wall thickness, mm	
			RS	Reinforcement staining			N/A	
			Z	Other			N/A	
2.7.2.6	SAC	Surface damage asbestos cement	СР	Corrosion products			N/A	
			DI	Initial delamination			Maximum loss of wall thickness, mm	
			DM	Moderate delamination			Maximum loss of wall thickness, mm	
			DX	Extreme delamination			Maximum loss of wall thickness, mm	
			S	Spalling			Maximum loss of wall thickness, mm	
			Н	Hole in conduit			N/A	
			Z	Other			N/A	

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
2.7.2.7	so	Surface damage other	Н	Hole in conduit			N/A	N/A
			MD	Mechanically damaged			N/A	N/A
			S	Spalling			N/A	Maximum loss of wall thickness, mm
			Т	Tuberculation			Obstruction, % reduction cross sectional area	N/A
			Z	Other			N/A	N/A
2.7.2.8	SV	Soil visible through defect						
2.7.2.9	VV	Void visible through defect					Void dimensions, mm	
2.7.2.10	PP	Porous conduits						
2.7.3.1	ММ	Missing mortar					Depth of missing mortar, mm	
2.7.3.2	DMU	Displaced masonry units	I	Inwards			Maximum displacement, mm	
			0	Outwards			Maximum displacement, mm	
2.7.3.3	MBC	Masonry (brick) cracking	С	Circumferentia or inclined	I		Maximum width, mm	
			L	Longitudinal			Maximum width, mm	
2.7.3.4	MUS	Masonry unit separation					Typical separation width, mm	
2.7.3.5	мми	Missing masonry units	NV	No further layer visible				
			Р	Penetrated				
			V	Another layer visible				

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
2.7.3.6	MDI	Masonry dropped invert					Depth of drop, mm	
2.7.3.7	MS	Masonry conduit spalling					Loss of fabric, mm	
2.7.3.8	XM	Masonry conduit collapsed						
2.7.4.1	DE	Deposits on the wall and/or in the invert	F	Fouling			Obstruction, % reduction cross sectional area	
			G	Grease			Obstruction, % reduction cross sectional area	
			E	Encrustation			Obstruction, % reduction cross sectional area	
			S	Sand			Obstruction, % reduction cross sectional area	
			R	Rubble			Obstruction, % reduction cross sectional area	
			С	Compacted			Obstruction, % reduction cross sectional area	
			Z	Other			Obstruction, % reduction cross sectional area	
2.7.4.2	EX	exfiltration	J	Visible through joint				
			D	Visible through defect				
2.7.4.3	I	Infiltration	S	Seepage				
			D	Dripping				

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			R	Running				
			G	Gushing				
2.7.4.4	ОВ	Obstruction	В	Dislodged brick in invert			Obstruction, % reduction cross sectional area	Hazard warning, "H"
			С	Object entering from connection or junction			Obstruction, % reduction cross sectional area	Hazard warning, "H"
			I	Object intruding through wall			Obstruction, % reduction cross sectional area	Hazard warning, "H"
			J	Object wedged in joint			Obstruction, % reduction cross sectional area	Hazard warning, "H"
			М	Conduit material fragments present or protruding			Obstruction, % reduction cross sectional area	Hazard warning, "H"
			P	Cables or pipes through conduit			Obstruction, % reduction cross sectional area	Hazard warning, "H"
			S	Structure built into conduit			Obstruction, % reduction cross sectional area	Hazard warning, "H"
			Z	Other			Obstruction, % reduction cross sectional area	Hazard warning, "H"
2.7.4.5	ING	Ingress of soil	S	Sand				
			F	Fine material				
			G	Gravel				
			Z	Other				
2.7.4.6	R	Roots	Т	Tap roots			Obstruction, % reduction cross	

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
							sectional area	
			F	Fine roots			Obstruction, % reduction cross sectional area	
			М	Mass of roots			Obstruction, % reduction cross sectional area	
			RT	Recently cut tap roots			Obstruction, % reduction cross sectional area	
			RF	Recently cut fine roots			Obstruction, % reduction cross sectional area	
			RB	Recently cut leaving beard of roots			Obstruction, % reduction cross sectional area	
2.7.5.1	JD	Displaced joint	А	Angular displacement			Angle, degrees	Maximum gap width, mm
			L	Longitudinal displacement			Displacement, mm	N/A
			R	Radial displacement			Displacement, mm	N/A
2.7.5.2	DJS	Defective joint seal	R	Sealing ring	N	Seal not intruding		
					НН	Seal hanging high		
					HL	Seal hanging low		
					В	Seal is broken		
			Z	Other			Obstruction, % reduction cross sectional area	
2.7.5.3	DJW	Defective joint weld	С	Cracked				

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			Е	Electrofusion incomplete				
			Р	Cured pool of excess solvent				
			Z	Other				
					х	Weld bead intrusion		
2.7.6.1	CN	Connection	С	Connection closed or capped			Diameter/ height, mm	Width, mm
					Т	T-seal or top hat liner used	Diameter/ height, mm	Width, mm
			0	Connection open			Diameter/ height, mm	Width, mm
					L	Connecting conduit lined	Diameter/ height, mm	Width, mm
					Т	T-seal or top hat liner used	Diameter/ height, mm	Width, mm
2.7.6.2	CI	Intruding connection					Obstruction, % reduction cross sectional area	
2.7.6.3	СХ	Defective connection	В	Blocked			Obstruction, % reduction cross sectional area in connecting conduit	N/A
			D	Damaged			N/A	N/A
			G	Unsealed gap			N/A	N/A
			JD	Joint(s) defective			N/A	N/A
			LD	Lining damaged or detached			N/A	N/A
			Р	Position incorrect			N/A	N/A
			SE	Soil entering			N/A	N/A
			SR	Some roots			Obstruction, % reduction cross sectional	Obstruction, % reduction cross sectional

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
							area in connecting conduit	area in main conduit
			TD	T-seal or top hat liner damaged			Obstruction, % reduction cross sectional area in connecting conduit	Obstruction, % reduction cross sectional area in main conduit
			Z	Other			Obstruction, % reduction cross sectional area in connecting conduit	Obstruction, % reduction cross sectional area in main conduit
2.7.6.4	JN	Junction	С	Junction closed			Diameter/ height, mm	Width, mm
					Т	T-seal or top hat liner used	Diameter/ height, mm	Width, mm
			0	Junction open			Diameter/ height, mm	Width, mm
					L	Lined	Diameter/ height, mm	Width, mm
					Т	T-seal or top hat liner used	Diameter/ height, mm	Width, mm
2.7.6.5	JX	Defective junction	В	Blocked			Obstruction, % reduction cross sectional area in connecting conduit	N/A
			D	Damaged			N/A	N/A
			JC	Junction cracked			N/A	N/A
			JD	Joint(s) defective			N/A	N/A
			LD	Lining damaged			N/A	N/A
			Р	Position incorrect			N/A	N/A
			SE	Soil entering			N/A	
			SR	Some roots			Obstruction, % reduction cross sectional	Obstruction, % reduction cross sectional

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
							area in connecting conduit	area in main conduit
			TD	T-seal or top hat liner damaged			Obstruction, % reduction cross sectional area in connecting conduit	Obstruction, % reduction cross sectional area in main conduit
			Z	Other			Obstruction, % reduction cross sectional area in connecting conduit	Obstruction, % reduction cross sectional area in main conduit
2.7.7.1	LD	Lining defective	В	Blistered			Magnitude, % reduction cross sectional area	
			BU	Bulged (non- structural)			Magnitude, % reduction cross sectional area	
			D	Deformed (structural)			Magnitude, % reduction cross sectional area	
			Н	Holes or perforations			N/A	
			Е	End or edge of lining			Magnitude, % reduction cross sectional area	
			М	Detached and missing in sections			N/A	
			RC	Re- establishment of customer connection			N/A	
			RM	Rendered cement mortar loss			N/A	
			RMCP	Corrosion products on surface of rendered			N/A	

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
				cement mortar				
			SJ	Joints in spiral liner separated			N/A	
			W	Wrinkled			Magnitude, % reduction cross sectional area	
			WD	Weld defective			Magnitude, % reduction cross sectional area	
			Х	Collapsed (structural)			Magnitude, % reduction cross sectional area	
			Z	Other			Magnitude, % reduction cross sectional area	
2.7.7.2	PR	Point repair	Н	Hole repaired			Length, mm	N/A
					Z	Other	Length, mm	Magnitude, % reduction cross sectional area
			I	Injected cementitious material			Length, mm	N/A
					Z	Other	Length, mm	Magnitude, % reduction cross sectional area
			IS	Internal stainless steel sleeve			Length, mm	N/A
					S	Sleeve is damaged or defective	Length, mm	Magnitude, % reduction cross sectional area
			L	Localised CIPP lining			Length, mm	N/A
					Р	Lining patch defective	Length, mm	Magnitude, % reduction

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
								cross sectional area
			R	Conduit unit replaced			Length, mm	N/A
					В	Bellies in line	Length, mm	N/A
					G	Gap at transition	Length, mm	N/A
			RE	Defects rendered			Length, mm	N/A
					D	Delaminating	Length, mm	Magnitude, % reduction cross sectional area
			S	Injected sealing material			Length, mm	N/A
					Z	Other	Length, mm	Magnitude, % reduction cross sectional area
			Z	Other			Length, mm	N/A
					Z	Other	Length, mm	Magnitude, % reduction cross sectional area
2.7.8.1	GAS	Atmosphere in the conduit	HS	Hydrogen sulphide			Concentration, %	Concentration ppm
			со	Carbon monoxide			Concentration, %	Concentration ppm
			ME	Methane			Concentration, %	Concentration ppm
			0	Oxygen			Concentration, %	Concentration ppm
			OF	Other flammable gas			Concentration, %	Concentration ppm
			Z	Other			Concentration, %	Concentration ppm
2.7.8.2	IF	Flow in incoming connecting conduit	С	Clear flow			Depth, % vertical dimension of connecting conduit	

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
					SE	Sewage	Depth, % vertical dimension of connecting conduit	
					ST	Stormwater or sea water	Depth, % vertical dimension of connecting conduit	
			SW	Sea water			Depth, % vertical dimension of connecting conduit	
					ST	Stormwater or sea water	Depth, % vertical dimension of connecting conduit	
			Т	Turbid			Depth, % vertical dimension of connecting conduit	
					SE	Sewage	Depth, % vertical dimension of connecting conduit	
					ST	Stormwater or sea water	Depth, % vertical dimension of connecting conduit	
2.7.8.3	WL	Water level	F	Flow	С	Clear	Depth of water, % vertical dimension	N/A
					Т	Turbid	Depth of water, % vertical dimension	N/A
			N	No water flow			N/A	N/A
			Р	Ponding	С	Turbid	N/A	Maximum depth of water, % vertical dimension
					Т	Turbid	N/A	Maximum depth of water, %

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
								vertical dimension
2.7.8.4	L	Line of conduit deviates	L	Left				
					D	Down		
					U	Up		
			R	Right				
					D	Down		
					U	Up		
2.7.8.5	V	Vermin	R	Rodent	S	In the conduit	Number	
					С	In a connection	Number	
					J	In an open joint	Number	
					Z	Other	Number	
			Z	Other	S	In the conduit	Number	
					С	In a connection	Number	
					J	In an open joint	Number	
					Z	Other	Number	
2.7.8.6	LH	Lifting hole	М	Manufacturing	U	Unsealed		
					S	Sealed		
			В	Bashed	U	Unsealed		
					S	Sealed		
2.7.9.1	ST	Start node	В	Bend in line			Node reference or easting coordinate	Grid reference o northing coordinate
			С	Major connection			Node reference or easting coordinate	Grid reference o northing coordinate
			СМ	Change in conduit material			Node reference or easting coordinate	Grid reference o northing coordinate
			DE	Dead end			Node reference	Grid reference o

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
							or easting coordinate	northing coordinate
			GJP	Grated junction pit			Node reference or easting coordinate	Grid reference or northing coordinate
			GSP	Grated side entry pit			Node reference or easting coordinate	Grid reference or northing coordinate
			Ю	Inspection opening			Node reference or easting coordinate	Grid reference or northing coordinate
			IS	Inspection shaft			Node reference or easting coordinate	Grid reference or northing coordinate
			J	Junction			Node reference or easting coordinate	Grid reference or northing coordinate
			LH	Lamphole			Node reference or easting coordinate	Grid reference or northing coordinate
			МС	Maintenance chamber			Node reference or easting coordinate	Grid reference or northing coordinate
			МН	Maintenance hole			Node reference or easting coordinate	Grid reference or northing coordinate
			MS	Maintenance shaft			Node reference or easting coordinate	Grid reference or northing coordinate
			0	Outfall			Node reference or easting coordinate	Grid reference or northing coordinate
			RE	Rodding eye			Node reference or easting coordinate	Grid reference or northing coordinate
			SP	Side entry pit			Node reference or easting coordinate	Grid reference or northing coordinate

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			TMS	Terminal maintenance shaft			Node reference or easting coordinate	Grid reference or northing coordinate
			VD	Vertical drop			Node reference or easting coordinate	Grid reference or northing coordinate
			z	Other			Node reference or easting coordinate	Grid reference or northing coordinate
2.7.9.2	FH	Finish node	В	Bend in line			Node reference or easting coordinate	Grid reference or northing coordinate
			С	Major connection			Node reference or easting coordinate	Grid reference or northing coordinate
			СМ	Change in material			Node reference or easting coordinate	Grid reference or northing coordinate
			DE	Dead end			Node reference or easting coordinate	Grid reference or northing coordinate
			DJ	Drop junction			Node reference or easting coordinate	Grid reference or northing coordinate
			GJP	Grated junction pit			Node reference or easting coordinate	Grid reference or northing coordinate
			GSP	Grated side entry pit			Node reference or easting coordinate	Grid reference or northing coordinate
			Ю	Inspection opening			Node reference or easting coordinate	Grid reference or northing coordinate
			IS	Inspection shaft			Node reference or easting coordinate	Grid reference or northing coordinate
			J	Junction			Node reference or easting coordinate	Grid reference or northing coordinate

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			LH	Lamphole			Node reference or easting coordinate	Grid reference or northing coordinate
			МС	Maintenance chamber			Node reference or easting coordinate	Grid reference or northing coordinate
			МН	Maintenance hole			Node reference or easting coordinate	Grid reference or northing coordinate
			MS	Maintenance shaft			Node reference or easting coordinate	Grid reference or northing coordinate
			0	Outfall			Node reference or easting coordinate	Grid reference or northing coordinate
			RE	Rodding eye			Node reference or easting coordinate	Grid reference or northing coordinate
			SP	Side entry pit			Node reference or easting coordinate	Grid reference or northing coordinate
			TMS	Terminal maintenance shaft			Node reference or easting coordinate	Grid reference or northing coordinate
			VD	Vertical drop			Node reference or easting coordinate	Grid reference or northing coordinate
			Z	Other			Node reference or easting coordinate	Grid reference or northing coordinate
2.7.9.3	GC	General comment					Urgency warning, "U"	
2.7.9.4	GP	General photograph	В	Pointing backward	D	Pointing down		
					Н	Pointing horizontally		
					U	Pointing up		
			F	Pointing forward	D	Pointing down		

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
					Н	Pointing horizontally		
					U	Pointing up		
			L	Pointing left	D	Pointing down		
					Н	Pointing horizontally		
					U	Pointing up		
			R	Pointing right	D	Pointing down		
					Н	Pointing horizontally		
					U	Pointing up		
2.7.9.5	LOV	Loss of vision	D	Debris				
			F	Unable to focus				
			L	Line deviates				
			LI	Light source insufficient				
			s	Steam				
			UW	Camera under water				
			Z	Other				
2.7.9.6	SA	Inspection (Survey) abandoned	D	Debris				
			EC	End of cable				
			EF	Equipment failure				
			F	Unable to focus				
			HW	High flow (water) level				
			L	Line deviates				
			LI	Light source insufficient				
			ОВ	Obstruction				
			R	Roots				

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			Z	Other				
2.7.10.1	LC	Change of lining	CFL	Close fit lining		Record new material using codes in Table B2 of Appendix B		
			CIP	Cured in place lining		Record new material using codes in Table B2 of Appendix B		
			LCP	Lining with continuous pipes		Record new material using codes in Table B2 of Appendix B		
			LDP	Lining with discrete pipes		Record new material using codes in Table B2 of Appendix B		
			MFL	Lining inserted during manufacture		Record new material using codes in Table B2 of Appendix B		
			SEG	Segmental lining		Record new material using codes in Table B2 of Appendix B		
			SPL	Sprayed lining		Record new material using codes in Table B2 of Appendix B		
			SWL	Spirally wound lining		Record new material using codes in Table B2 of Appendix B		
			Z	Other		Record new material using codes in Table B2 of Appendix B		

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
2.7.10.2	MC	Change of conduit material		Record new material using codes in Table B1 of Appendix B				
2.7.10.3	PC	Change in conduit unit length					New length, m	
2.7.10.4	СС	Change of cross section	А	Arch shaped			New diameter/ height, mm	New width, mm (if necessary)
			С	Circular			New diameter/ height, mm	New width, mm (if necessary)
			E	Oviform (egg shaped)			New diameter/ height, mm	New width, mm (if necessary)
			0	Oval			New diameter/ height, mm	New width, mm (if necessary)
			R	Rectangular			New diameter/ height, mm	New width, mm (if necessary)
			U	U-shape			New diameter/ height, mm	New width, mm (if necessary)
			Z	Other			New diameter/ height, mm	New width, mm (if necessary)

APPENDIX H — SUMMARY OF MAIN CODES FOR DESCRIBING MAINTENANCE STRUCTURES

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
3.7.2.1	НС	Cracking	V	Vertical			Width, mm	
			Н	Horizontal			Width, mm	
			М	Multiple			Width, mm	
			I	Inclined			Width, mm	
			S	Helical (spiral)			Width, mm	
3.7.2.2	НВ	Breaking	D	Displaced			Length (vertical), mm	
			М	Missing			Length (vertical), mm	
			E	Exceptional			Length (vertical), mm	
3.7.2.3	HD	Deformation					Magnitude, % reduction in diameter or shear displacement	
3.7.2.4	НХ	Collapsed structure						
3.7.2.5	HSC	Surface damage concrete	AV	Aggregate visible			Maximum loss of wall thickness, mm	
			AP	Aggregate projecting			Maximum loss of wall thickness, mm	
			AM	Aggregate missing			Maximum loss of wall thickness, mm	
			СР	Corrosion products			N/A	
			Н	Hole in wall			N/A	
			RC	Reinforcement corroded			Maximum loss of wall thickness, mm	
			RV	Reinforcement visible			N/A	

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			RVP	Reinforcement visible, projecting			N/A	
			S	Spalling			Maximum loss of wall thickness, mm	
			RS	Reinforcement staining			N/A	
			Z	Other			Maximum loss of wall thickness, mm	
3.7.2.6	HSO	Surface damage other	Н	Hole in wall			N/A	
			MD	Mechanically damaged			N/A	
			S	Spalling			Maximum loss of wall thickness, mm	
			СВ	Damaged corrosion barrier in GRP structure			N/A	
			Z	Other			Maximum loss of wall thickness, mm	
3.7.2.7	HSV	Soil visible through defect						
3.7.2.8	HVV	Void visible through defect					Void dimensions, mm	
3.7.2.9	HPW	Porous wall						
3.7.3.1	НММ	Missing mortar					Depth, mm	
3.7.3.2	НМС	Masonry (brick) cracking	С	Circumferential			Maximum width, mm	
			L	Longitudinal			Maximum width, mm	
3.7.3.3	НММИ	Missing masonry units	NV	No further layer visible				

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			Р	Penetrated				
			V	Another layer visible				
3.7.3.4	HMS	Masonry unit separation	С	Circumferentia	I		Typical separation, mm	
			L	Longitudinal			Typical separation, mm	
3.7.3.5	нхм	Masonry maintenance structure collapsed						
3.7.4.1	HING	Ingress of soil	S	Sand				
			F	Fine material				
			G	Granular				
			Z	Other				
3.7.4.2	Н	Infiltration	S	Seepage				
			D	Dripping				
			R	Running				
			G	Gushing				
3.7.4.3	HEX	Exfiltration						
3.7.5.1	HCN	Connection type	В	Benching			Connecting conduit reference	
					IC	Intruding connection	Connecting conduit reference	Length, mm
			BD	Backdrop			Connecting conduit reference	
					IC	Intruding connection	Connecting conduit reference	Length, mm
			DC	Drop chamber			Connecting conduit reference	
			DP	Internal drop pipe			Connecting conduit reference	

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			FD	Free drop			Connecting conduit reference	
					IC	Intruding connection	Connecting conduit reference	Length, mm
			PM	Pressure main discharge			Connecting conduit reference	
					IC	Intruding connection	Connecting conduit reference	Length, mm
			RC	Ramp connection			Connecting conduit reference	
					IC	Intruding connection	Connecting conduit reference	Length, mm
			VP	Ventilation pipe			Connecting conduit reference	
					IC	Intruding connection	Connecting conduit reference	Length, mm
			Z	Other			Connecting conduit reference	
					IC	Intruding connection	Connecting conduit reference	Length, mm
3.7.5.2	НСР	Connecting conduit	А	Arch shaped	I	Inlet	Diameter/ height, mm	Width, mm
					0	Outlet	Diameter/ height, mm	Width, mm
					S	Sealed/ closed	Diameter/ height, mm	Width, mm
			С	Circular	I	Inlet	Diameter, mm	N/A
					0	Outlet	Diameter, mm	N/A
					S	Sealed/ closed	Diameter, mm	N/A
			Е	Oviform (egg shaped)	I	Inlet	Diameter/ height, mm	Width, mm
					0	Outlet	Diameter/ height, mm	Width, mm

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
					S	Sealed/ closed	Diameter/ height, mm	Width, mm
			0	Oval	I	Inlet	Diameter/ height, mm	Width, mm
					0	Outlet	Diameter/ height, mm	Width, mm
					S	Sealed/ closed	Diameter/ height, mm	Width, mm
			R	Rectangular	1	Inlet	Diameter/ height, mm	Width, mm
					0	Outlet	Diameter/ height, mm	Width, mm
					S	Sealed/ closed	Diameter/ height, mm	Width, mm
			U	U-shape	I	Inlet	Diameter/ height, mm	Width, mm
					0	Outlet	Diameter/ height, mm	Width, mm
					S	Sealed/ closed	Diameter/ height, mm	Width, mm
			Z	Other	I	Inlet	Diameter/ height, mm	Width, mm
					0	Outlet	Diameter/ height, mm	Width, mm
					S	Sealed/ closed	Diameter/ height, mm	Width, mm
3.7.5.3	HDC	Defective connecting conduit	В	Blocked			Obstruction, % reduction cross sectional area in connecting conduit	Distance to defect, m
			D	Damaged			N/A	Distance to defect, m
			DS	Deposits of sand, silt, gravel, grout etc			Obstruction, % reduction cross sectional area in connecting conduit	Distance to defect, m
			DW	Deposits on wall			Obstruction, % reduction cross sectional area in	Distance to defect, m

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
							connecting conduit	
			GA	Unsealed gap between conduit and structure			N/A	Distance to defect, m
			JD	Joints defective			N/A	Distance to defect, m
			LD	Lining damaged			N/A	Distance to defect, m
			Р	Position incorrect			N/A	N/A
			SE	Soil entering			Obstruction, % reduction cross sectional area in connecting conduit	Distance to defect, m
			SR	Some roots			Obstruction, % reduction cross sectional area in connecting conduit	Distance to defect, m
			IN	Infiltration			N/A	Distance to defect, m
			Z	Other			Obstruction, % reduction cross sectional area in connecting conduit	Distance to defect, m
3.7.5.4	HDP	Defective drop pipe	В	Blocked				
			С	Cracked				
			D	Deformed				
			М	Missing				
			R	Severly rusted or corroded				
			Т	Misdirected causing turbulence				
			Х	Collapsed				
			Z	Other				

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
3.7.5.5 HIF	HIF	Flow in connecting conduit	С	Clear			Depth, % vertical dimension of connecting conduit	
					SE	Sewage		
					ST	Stormwater or sea water		
			SW	Sea water			Depth, % vertical dimension of connecting conduit	
					ST	Stormwater or sea water		
			Т	Turbid			Depth, % vertical dimension of connecting conduit	
					SE	Sewage entering		
					ST	Stormwater or sea water		
3.7.5.6	HSP	Sealed conduit through maintenance structure	СМ	Covers missing				
			cs	Covers sealed				
			NA	No access				
3.7.6.1	HCF	Defective cover and/or frame	СВ	Cover cracked or broken			N/A	
					S	Subsidence around frame/ structure	Difference in levels, mm	
					Z	Other	N/A	
			CD	Cover deformed			N/A	
					s	Subsidence around frame/ structure	Difference in levels, mm	
					Z	Other	N/A	

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			СН	Cover above (higher) surface level			Difference in levels, mm	
					S	Subsidence around frame/ structure	Difference in levels, mm	
					Z	Other	N/A	
			CL	Cover below surface level			Difference in levels, mm	
					S	Subsidence around frame/ structure	Difference in levels, mm	
					Z	Other	N/A	
			СМ	Cover missing			N/A	
					S	Subsidence around frame/ structure	Difference in levels, mm	
					Z	Other	N/A	
			CR	Cover rocking			N/A	
					S	Subsidence around frame/ structure	Difference in levels, mm	
					z	Other	N/A	
			FB	Frame cracked or broken			N/A	
					S	Subsidence around frame/ structure	Difference in levels, mm	
					z	Other	N/A	
			FD	Frame displaced			N/A	
					S	Subsidence around frame/ structure	Difference in levels, mm	
					Z	Other	N/A	
			FL	Frame loose			N/A	

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
					S	Subsidence around frame/ structure	Difference in levels, mm	
					Z	Other	N/A	
			FM	Frame missing			N/A	
					S	Subsidence around frame/ structure	Difference in levels, mm	
					Z	Other	N/A	
			G	Gap between frame and chamber, shaft etc			N/A	
					S	Subsidence around frame/ structure	Difference in levels, mm	
					Z	Other	N/A	
			HD	Holding down bolts missing or defective			N/A	
					S	Subsidence around frame/ structure	Difference in levels, mm	
					Z	Other	N/A	
			Z	Other	В	Buried	N/A	
					S	Subsidence around frame/ structure	Difference in levels, mm	
					Z	Other	N/A	
3.7.6.2	HSL	Defective step, ladder, handrail or staging bar	ED	Plastics encapsulation damaged			Number defective	
			HC	Handrail corroded			N/A	
			LC	Ladder cracked			N/A	
			LCC	Ladder support			Number defective	

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
				(clip) corroded				
			LCL	Ladder support (clip) loose			Number defective	
			LCM	Ladder support (clip) missing			Number defective	
			LRM	Ladder rung missing			Number defective	
			RC	Ladder runner corroded			N/A	
			SB	Step or staging bar bent			Number defective	
			SC	Step or staging bar corroded			Number defective	
			SL	Step or staging bar loose			Number defective	
			SM	Step or staging bar missing			Number defective	
			ТН	Defective toe hole			Number defective	
			Z	Other			Number defective or N/A	
3.7.6.3	HLAN	Landing details and condition	RC	Reinforced concrete				
					AP	Aggregate projecting		
					АМ	Aggregate missing		
					СР	Corrosion products		
					RC	Reinforcement corroded		
					RV	Reinforcement visible		
					Z	Other		
			GG	Galvanised steel				

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
				support, with grid decking				
					MC	Support with minor corrosion		
					SC	Support severely corroded		
					Z	Other		
			GC	Galvanised steel support, with checkerplate decking				
					MC	Support with minor corrosion		
					SC	Support severely corroded		
					Z	Other		
			GP	Galvanised steel support, with GRP grid decking				
					MC	Support with minor corrosion		
					SC	Support severely corroded		
					Z	Other		
			SG	Stainless steel support, with grid decking				
					MC	Support with minor corrosion		
					SC	Support severely corroded		
					Z	Other		
			SC	Stainless steel support, with stainless steel				

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
				checkerplate decking				
					МС	Support with minor corrosion		
					SC	Support severely corroded		
					Z	Other		
			SP	Stainless steel support, with GRP grid decking				
					МС	Support with minor corrosion		
					SC	Support severely corroded		
					z	Other		
			Z	Other				
					Z	Other		
3.7.6.4	HGT	Devices under cover or grate	AB	Access barrier				
					D	Defective		
					М	Missing		
					U	Unlocked		
			MW	Maintenance warning marker				
					D	Defective		
	1				М	Missing		
			SD	Sensing device				
					D	Defective		
					М	Missing		
					U	Unlocked		
			ST	Sediment or litter trap				
					D	Defective		

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
					М	Missing		
			z	Other				
					D	Defective		
					М	Missing		
					U	Unlocked		
3.7.6.5	HSC	Safety bars and chains	CG	Chain good				
			СМ	Chain missing				
			CD	Chain defective				
			СС	Chain covered - can't determine condition				
			BG	Bar good				
			ВМ	Bar missing				
			BD	Bar defective				
			BC	Bar covered - can't determine condition				
3.7.7.1	HJD	Displaced joint	А	Angular			Maximum displacement, mm	
			Н	Horizontal			Displacement, mm	
			V	Vertical			Displacement, mm	
3.7.7.2	HDJS	Defective joint seal	R	Ring	N	Ring displaced, not intruding	N/A	
					Н	Ring hanging	N/A	
					В	Ring hanging, broken	N/A	
			М	Mastic			Projection, mm	
			Z	Other			Projection, mm	

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
3.7.8.1	HLD	Defective lining or coating	В	Lining blistered			Projection, mm	
			BU	Non- structural liner bulged			Projection, mm	
			D	Structural lining deformed			N/A	
			Н	Holes or perforations			N/A	
			E	End of lining defective			N/A	
			М	Sections missing			N/A	
			Р	Lining peeling			N/A	
			RM	Rendered mortar missing			N/A	
			W	Lining wrinkled			Projection, mm	
			WD	Weld defective			N/A	
			Х	Structural lining collapsed			N/A	
			z	Other			N/A	
3.7.8.2	HPR	Point repair	W	Whole compenent				
					CD	Compenent dislodged		
					Z	Other		
			I	Injected (cementitious)				
					G	Injected sealing material defective		
					Z	Other		
			L	Localised patch lining				
					Р	Peeling or dislodged		

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
					Z	Other		
			LR	Lining point repaired (structor non- structural)	tural			
					RD	Lining repair defective		
					Z	Other		
			R	Part structure replaced or patched				
					W	Part structure repair defective		
					Z	Other		
			S	Injected sealing (chemical grout)				
					G	Injected sealing material defective		
					Z	Other		
			Z	Other				
					Z	Other		
3.7.9.1	НВЕ	Benching	D	Defective				
			ND	Not defective				
			NB	No benching				
3.7.9.2	НСН	Channel	D	Defective			Width, mm	Height, mm
			ND	Not defective			Width, mm	Height, mm
			NC	No channel			N/A	N/A
3.7.9.3	HR	Roots	Т	Tap roots			Obstruction, % reduction cross sectional area in channel	Obstruction, % reduction cross sectional area in chamber or shaft
			F	Fine roots			Obstruction, % reduction	Obstruction, % reduction

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
							cross sectional area in channel	cross sectional area in chamber or shaft
			М	Mass			Obstruction, % reduction cross sectional area in channel	Obstruction, % reduction cross sectional area in chamber or shaft
			RT	Recently cut tap roots			Obstruction, % reduction cross sectional area in channel	Obstruction, % reduction cross sectional area in chamber or shaft
			RF	Recently cut fine roots			Obstruction, % reduction cross sectional area in channel	Obstruction, % reduction cross sectional area in chamber or shaft
			RB	Recently cut beard			Obstruction, % reduction cross sectional area in channel	Obstruction, % reduction cross sectional area in chamber or shaft
3.7.9.4	HHP	Hydraulic performance	D	Outlet drowned				
			S	Splashing and turbulence				
			ОВ	Obstruction				
3.7.9.5	HFC	Flow control	FL	Float operated valve	CF	Continuation flow		
					OF	Overflow		
			FV	Flap valve	CF	Continuation flow		
					OF	Overflow		
			G	Gauge and canister - sewer gauging station	CF	Continuation flow		
					OF	Overflow		

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			MF	Measuring flume	CF	Continuation flow		
					OF	Overflow		
			ОР	Orifice plate	CF	Continuation flow		
					OF	Overflow		
			Р	Penstock, gate stop, valve	CF	Continuation flow		
					OF	Overflow		
			S	Syphon	CF	Continuation flow		
					OF	Overflow		
			SS	Special structure	CF	Continuation flow		
					OF	Overflow		
			TR	Trash rack, screens	CF	Continuation flow		
					OF	Overflow		
			V	Vortex flow control	CF	Continuation flow		
					OF	Overflow		
			W	Weir	CF	Continuation flow		
					OF	Overflow		
			Z	Other	CF	Continuation flow		
					OF	Overflow		
3.7.9.6	HFX	Defective flow control device	D	Defective				
			М	Missing, or parts missing				
			Z	Other				
3.7.9.7	HDE	Deposits	Е	Encrustation on wall			Obstruction, mm thickness	
			F	Fouling on wall			Obstruction, mm thickness	

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			G	Grease on wall			Obstruction, mm thickness	
			W	Other on wall			Obstruction, mm thickness	
					С	Compacted material on benches, landings, channels	Obstruction, mm thickness	
					R	Rubble on benches, landings, channels	Obstruction, mm thickness	
					s	Sand or silt on benches, landings, channels	Obstruction, mm thickness	
					Z	Other on benches, landings, channels	Obstruction, mm thickness	
3.7.9.8	НОВ	Obstructions	В	Object(s) on benches			N/A	Obstruction, % reduction cross sectional area in chamber or shaft
			С	Object entering through connection			Obstruction, % reduction cross sectional area in channel	N/A
			F	Formwork/ construction materials remaining			Obstruction, % reduction cross sectional area in channel	Obstruction, % reduction cross sectional area in chamber or shaft
			I	Object intruding through wall			N/A	Obstruction, % reduction cross sectional area in chamber or shaft
			J	Object wedged in joint			Obstruction, % reduction cross sectional	Obstruction, % reduction cross sectional

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
							area in channel	area in chamber or shaft
			М	Fragment conduit material in channel			Obstruction, % reduction cross sectional area in channel	N/A
			MU	Masonry unit(s) in channel			Obstruction, % reduction cross sectional area in channel	N/A
			0	Object built into structure			N/A	Obstruction, % reduction cross sectional area in chamber or shaft
			Р	External pipe or cable present in structure			N/A	Obstruction, % reduction cross sectional area in chamber or shaft
			Z	Other			Obstruction, % reduction cross sectional area in channel	Obstruction, % reduction cross sectional area in chamber or shaft
3.7.9.9	HTS	Silt trap in invert	TP	Trap is present with no defects				
			TC	Trap is covered with debris				
			TD	Trap is damaged				
			TF	Trap is full				
			ТМ	Trap is missing				
3.7.9.10	HWL	Water level	А	Above benching				
			В	Below benching				

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
3.7.10.1 HO	HGA	Atmosphere within the maintenance structure	СО	Carbon monoxide			Concentration, %	Concentration ppm
			HS	Hydrogen sulphide			Concentration, %	Concentration ppm
			ME	Methane			Concentration, %	Concentration ppm
			0	Oxygen			Concentration, %	Concentration ppm
			OF	Other flammable gas			Concentration, %	Concentration ppm
			Z	Other			Concentration, %	Concentration ppm
3.7.10.2	HGC	General comment					Urgency warning, "U"	
3.7.10.3	HGP	General photograph	D	Camera looking downwards				
			U	Camera looking upwards				
			Z	Other, at an angle to the horizontal				
3.7.10.4	HV	Vermin	R	Rodent	А	In access structure	Number	
					С	In a connection	Number	
					J	In an open joint	Number	
					Z	Other	Number	
			Z	Other	А	In access structure	Number	
					С	In a connection	Number	
					J	In an open joint	Number	
					Z	Other	Number	
3.7.11.1	HST	Start feature	AC	Access cover				
			В	Benching				

Clause	Main Code	Main Description	Ch1	Description	Ch2	Description	Q1	Q2
			FSL	Finished surface level				
			L	Landing				
			RS	Reducing or conversion slab				
			Z	Other				
3.7.11.2	HFH	Inspection completed	AC	Access cover				
			В	Benching				
			FSL	Finished surface level				
			L	Landing				
			RS	Reducing or conversion slab				
			Z	Other				
3.7.11.2	HSA	Inspection (survey) abandoned	EF	Equipment failure				
			HW	High water level				
			ОВ	Obstruction				
			R	Roots				
			Z	Other				
3.7.12.1	НМС	Change of material		Record new material using codes in Table B1 of Appendix B				
3.7.12.2	HCC	Change of cross section	СС	Circular and cylindrical			Diameter, mm	N/A
			со	Circular and conical			Diameter, mm	N/A
			R	Rectangular			Width, mm	Breadth, mm
			Х	Local section			Width/ diameter, mm	Breadth, mm
			Z	Other			Width/ diameter, mm	Breadth, mm

APPENDIX I — COMPENDIUM OF DEFECTS AND FEATURES

This compendium of photographs, diagrams and video clips has been prepared to provide guidance and instruction to users of the Conduit Inspection Reporting Code and to facilitate accurate reporting of defects and features. The range of photographs and video clips is limited by the availability of suitable images. All defects and features have been coded in line with this Code. The diagrams provide guidance in estimating defect quantifications.

Usually several defects or features are reported from the same observation position. You may not find the same defects and features associated in your inspections.

The coding and abbreviated descriptions allow quick navigation to the example that includes the defects and/or features in which you are interested, or you can simply scroll through each section of the compendium.

Many of the photographs are close-ups of features, which limits full coding that would occur in a real life inspection. Not all sub-codes are given in the coding tables. The symbol 'A, B, C …' has been used with sub-codes where data that would be required in any real reporting situation, as appropriate to the circumstances and location of the particular location.

The symbol '-' indicates data fields that are not required for the particular type of defect illustrated.

To view the video clips included in this Compendium, you will need QuickTime. For a free download of this program, go to www.apple.com/quicktime.

FEEDBACK IS INVITED

Feedback on the photographs, coding and commentary included in this Compendium is invited. We will update the Compendium from time to time with additional photographs and video clips. You can send images of features, especially those not currently illustrated to codes@wsaa.asn.au. We will acknowledge your contributions when added to the Compendium.

ACKNOWLEDGEMENTS

The organisations and individuals listed below have contributed photographs, video clips and other information for this Compendium and WSAA would like to thank them for their assistance.

- Aqua Assets
- Barwon Water
- Hunter Water
- MidCoast Water
- Mornington Peninsula Shire Council
- Perth Pressure Jet Services
- Pipe Solutions
- Queensland Urban Utilities
- R J Allen's Training & Assessment Services
- Rangedale Drainage Services
- · Sewer Services Pty Ltd
- South East Water
- Streamline Learning
- Sydney Water
- Underground Photographic Surveys
- Veolia Environmental Services
- Wannon Water
- Water Corporation
- Yarra Valley Water

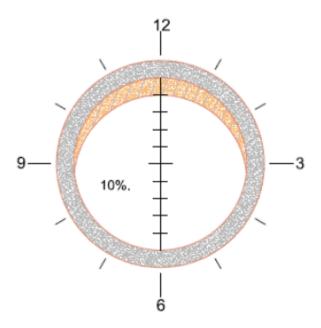
11 ESTIMATING GUIDANCE FOR DEFECT QUANTIFICATION

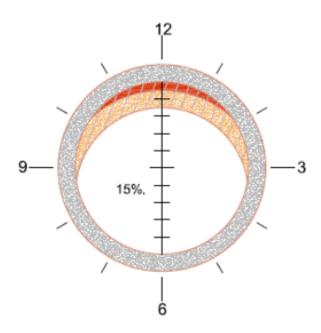
11.1 ESTIMATING EXTENT OF BREAKING FROM SHEAR DISPLACEMENT (BD)

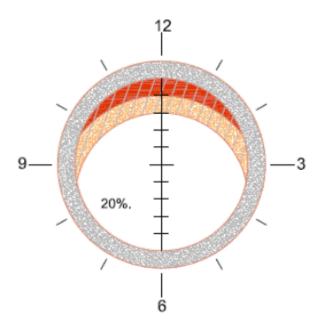
I1.1.1 APPLICATION

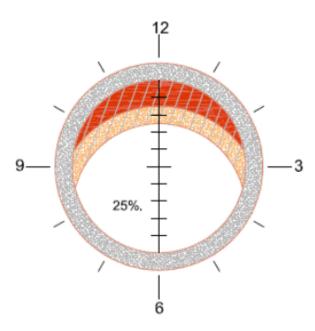
The following figures provide a guide to estimating the magnitude of vertical/shear displacement of a rigid **conduit** at a failed joint or where circumferential cracking has allowed the 'ends' of the pipe to move significantly from alignment. The feature will be described as broken displaced BD with Quantification 2 recording the magnitude of displacement to the nearest 5%.

Where shear displacement is associated with a joint it should be recorded as a displaced joint, radial displacement (refer to <u>2.7.5.1 Displaced joint—JD</u>). Further, where radial displacement at a joint is such that a void or soil is visible, the defect is recorded as broken displaced or collapsed depending on the magnitude of the displacement. (Refer to Note 7 of <u>2.7.5.1 Displaced joint—JD</u>).





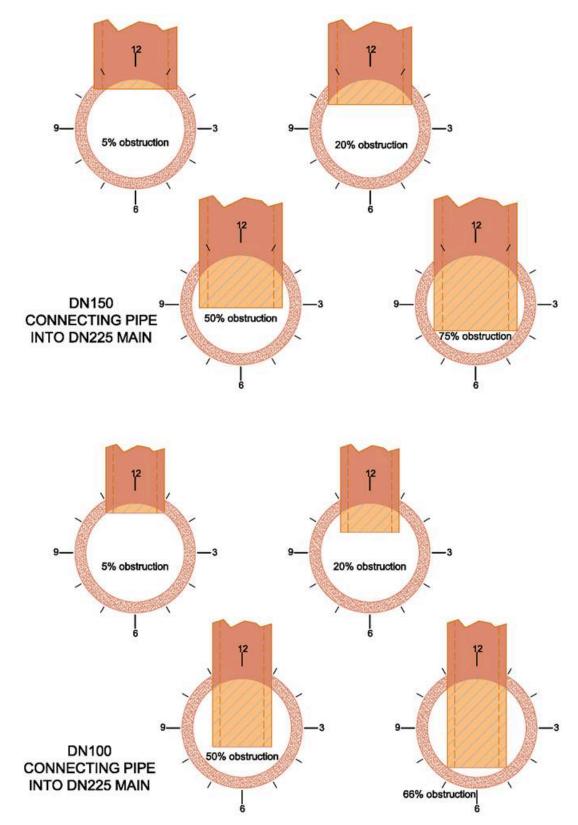


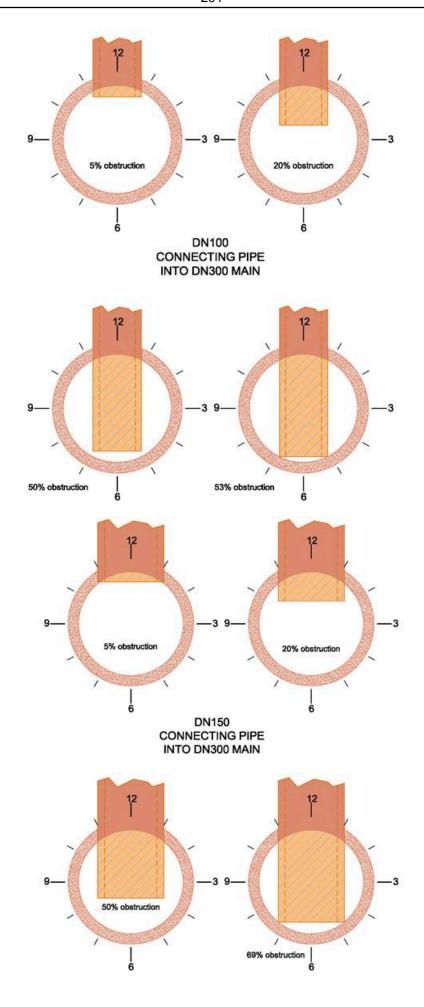


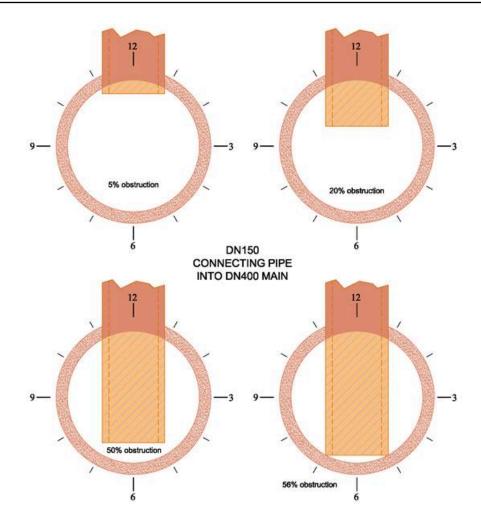
11.2 ESTIMATING MAGNITUDE OF INTRUSION (OBSTRUCTION) FROM INTRUDING CONNECTION (CI)

I1.2.1 APPLICATION

The following figures provide a guide to estimating the magnitude of intrusion (obstruction) where a connecting **conduit** is projecting into the conduit being inspected. The applicable code is Intruding Connection - **CI**.



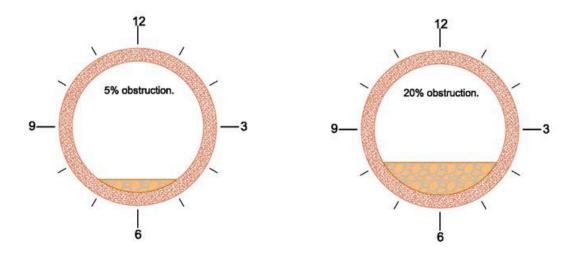


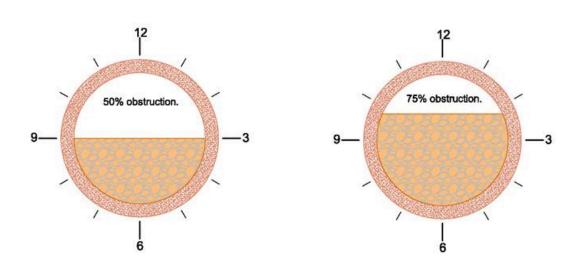


11.3 ESTIMATING OBSTRUCTION FROM DEPOSITS IN THE INVERT (DE)

I1.3.1 APPLICATION

The following figures provide a guide to estimating the magnitude of an obstruction from deposits in the invert measured as a percentage reduction in cross sectional area of the **conduit**. The applicable codes are **DEC**, **DER**, **DES** and maybe **DEZ**.

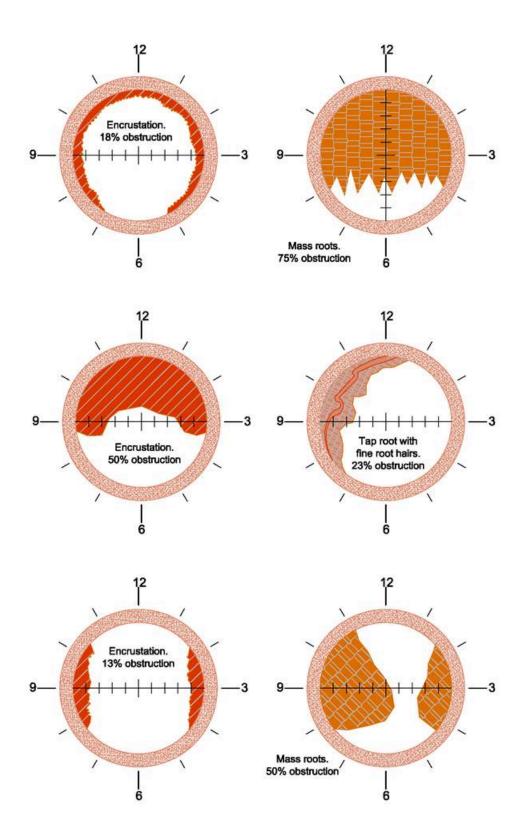




11.4 ESTIMATING OBSTRUCTION FROM DEPOSITS ON WALLS AND ROOTS (DE_R)

11.4.1 APPLICATION

The following figures provide a guide to estimating the magnitude of an obstruction from deposits (encrustation, fouling, grease) on the walls and roots measured as a percentage reduction in cross sectional area of the **conduit**. The applicable codes are **DEE**, **DEF**, **DEW**, **RM** and **RT**.



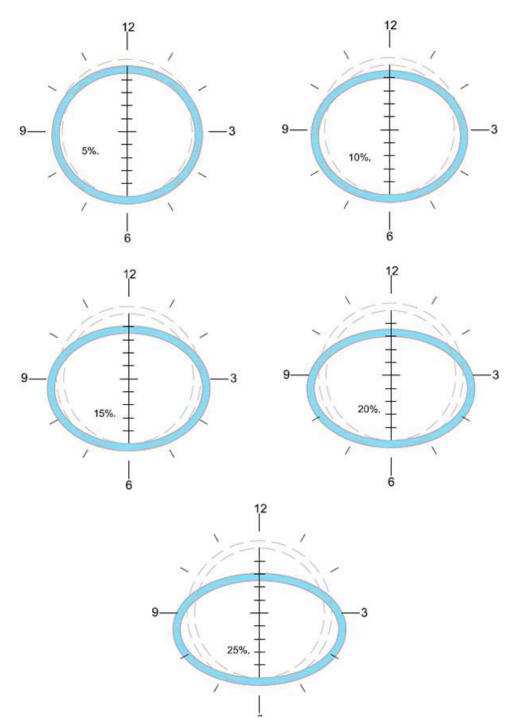
I1.5 ESTIMATING DEFORMATION (D)

11.5.1 APPLICATION

The following figures provide a guide to estimating the magnitude of deformation of pipes. The example shows vertical deformation but it could be oriented horizontally or is another direction. The actual shape of a deformed flexible pipe may differ from these diagrams, which approximate elastic deformation of a flexible pipe with vertical loading.

'Deformation' of a rigid pipe will also be substantially different, as several hinges have to form to allow movement. Nevertheless, estimation of the magnitude of deformation will be similar and the diagrams may be used for estimating of deformation for all pipes.

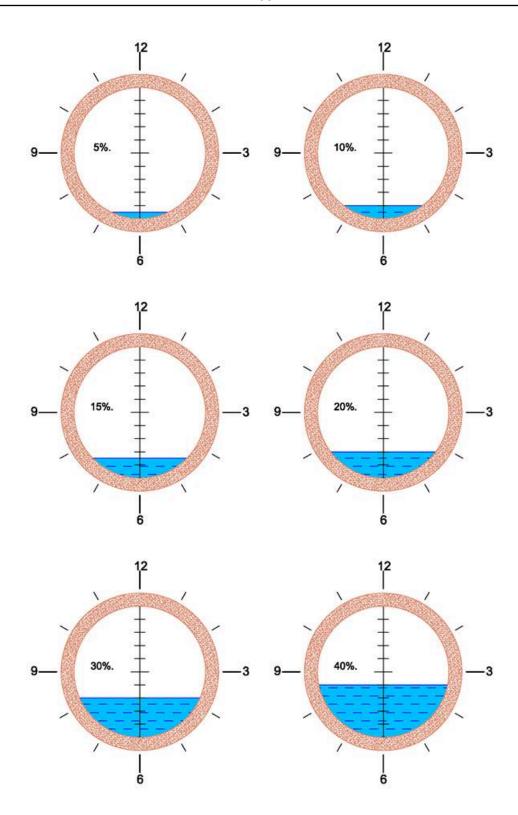
The applicable code is **DV**.



I1.6 ESTIMATING WATER LEVEL (WL)

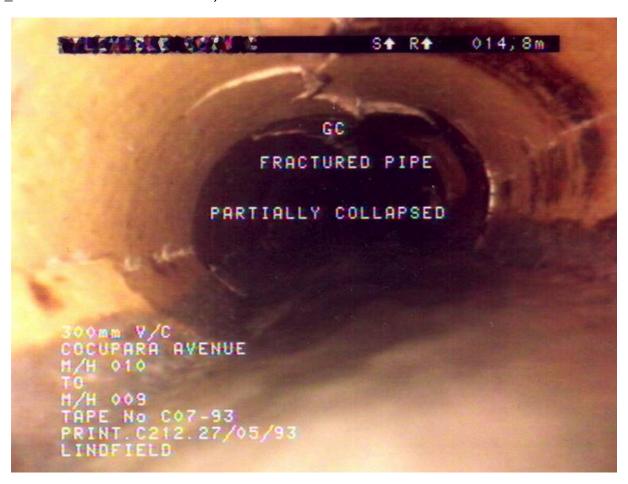
I1.6.1 APPLICATION

The following figures provide a guide to estimating the water level of flow and flow in connecting $\underline{\text{conduit}}$. Applicable codes include $\underline{\text{WL}}$ and $\underline{\text{IF}}$.



12 EXAMPLES OF CONDUIT DEFECTS AND FEATURES

12.1 BD_DV - BREAKING DISPLACED, DEFORMATION VERTICAL



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
В	D		900		12	12				
D	V		15		12					

I2.1.1 COMMENTARY

This VC pipe has broken with the pieces of pipe being visibly displaced (**B-D**) which is typical for a rigid pipe undergoing structural failure. While the length of the break is approximately 900 mm, this is less than the pipe length and not labelled as continuous. The circumferential location is from **12 to 12** o'clock as the breaking involves the whole cross section.

There is no need to report the cracking.

There is some deformation of the pipe cross section. This is recorded with the code **D-V**, for deformation–vertical, with a reduction in diameter reported as **15**%. The apparent direction of maximum deformation is **12** o'clock.

This defect could get worse and further deformation producing a reduction of diameter of 25% or more would accord the defect the collapsed code (X).

The screen captured general comment in the photograph is misleading. The 'fracturing' is not important at this location and 'partially collapsed', although conveying the appearance of the structural failure and progression towards collapse, conflicts with the codes which do not record 'partial collapse'.

12.2 BM - BREAKING MISSING



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
В	М		300		9	1	J			

I2.2.1 COMMENTARY

This VC conduit is breaking from **9 to 1** o'clock adjacent to the joint for a distance of about 300 mm. Although most pieces are still present there is an area with some pieces missing and as such the broken missing (**B-M**) observation is the most appropriate.

12.3 BM VV - BREAKING MISSING, VOID VISIBLE



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
В	М		600		10	2				
vv			Α		10	2				

I2.3.1 COMMENTARY

This VC pipe has broken with the pieces of pipe missing in the soffit (**B-M**). The adjoining pipes are showing some deterioration suggesting that the breaking is not due to an exceptional event such as third-party intrusion, e.g. a post hole digger. While the length of the break is approximately 600 mm, this is less than the pipe length and not labelled as continuous. The circumferential location is from **10 to 2** o'clock.

A significant void is visible (VV) from 10 to 2 o'clock. The soil visible is not recorded. The void dimensions should also be estimated and reported at Q1.

Further investigation may be undertaken to determine the exact extent of the void using laser profiling or ground penetrating radar.

12.4 BM_VV_EX - BREAKING MISSING, VOID VISIBLE, EXFILTRATION



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
В	М		400		4	7	J			
vv			Α		6	7				
EX					4	7				

12.4.1 COMMENTARY

The predominant defect at this location is breaking with a piece of conduit missing in the invert, which is coded **B-M**. Since the defect is associated with the joint, record **J** in the joint field. The estimated extent of the defect is **400** mm

There is a void visible (**VV**) from **6** to **7** o'clock. The presence of a void on the other side of the missing piece should also be investigated.

With the flow in the pipe and the void at the water level, exfiltration (**EX**) is occurring. Video clips of such observations are valuable.

The joint field is not completed for **VV** and **EX** observations because these features are not specifically 'influenced in magnitude or nature by the presence of a conduit joint'.

12.5 CL - CRACKING LONGITUDINAL



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
С	L		0.5		9				S1	
С	L		1		12	12			S2	
С	L		0.5		3				S3	
С	L		1		6				S4	

I2.5.1 COMMENTARY

This is a classic example of a rigid conduit, in this case VC, failing in ring compression. In effect, the pipe forms four longitudinal hinges, three of which can be seen, the fourth being under the flow.

Although three longitudinal cracks (**C-L**) at **9**, **12** and **3** o'clock are immediately evident, this mode of failure must also have a fourth crack at **6** o'clock. In this case, careful examination of the invert will reveal that crack.

The maximum width of cracks is reported as 1 mm at 12 and 6 o'clock and a smaller crack of 0.5 mm at 9 and 3 o'clock.

It is important to identify each of the longitudinal cracks to correctly convey the structural condition of the conduit.

Since the longitudinal cracking clearly continues for the next two pipes or more, report the continuous start codes for **each** crack.

12.6 CM - CRACKING MULTIPLE



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
С	М		2		11	1	J			

I2.6.1 COMMENTARY

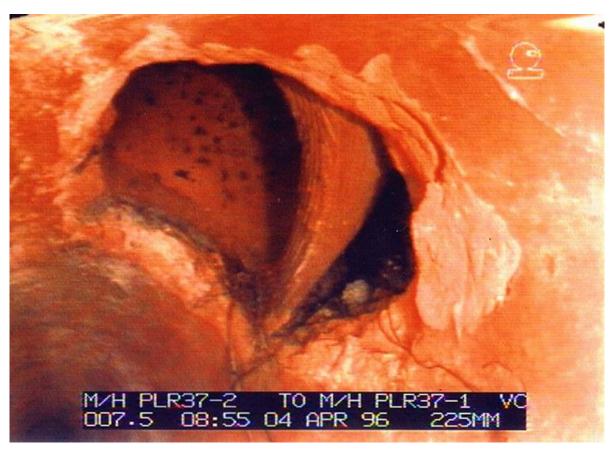
This photograph is from the acceptance inspection of a new reinforced concrete stormwater drain.

Multiple or complex cracking (**C-M**) extends from 11 to 1 o'clock with a maximum crack width of **2 mm**. However, it may extend further than shown in this photograph. Since the defect is associated with the joint, record **J** in the joint field.

Some very minor spalling also evident but this does not warrant reporting.

It is not clear what the cause of the damage is, but it may be from poor handling during transportation to site, from excessive external loading through poor installation or site management practices.

12.7 CNO_CXP_VV_RF - CONNECTION OPEN, DEFECTIVE CONNECTION INCORRECT POSITION, VOID VISIBLE, ROOTS FINE



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
CN	0		100		1					
сх	Р			50						
vv			Α		2	3				
R	F				3					

I2.7.1 COMMENTARY

A **DN 100** connection at **1** o'clock has been poorly constructed with unsealed gaps and misalignment (incorrect position) of the connecting conduit, which is open (**CN-O**).

The connection is defective because of the misalignment of the connecting pipe with the hole in the main pipe (**CX-P**), which could restrict flow down the connecting pipe into the sewer. The loss of cross section in the connecting pipe is reported as **50**% in Q2.

There is a void visible (**VV**) because of the misalignment of the connecting pipe. The void dimensions should also be estimated and reported at Q1.

Fine roots (RF) are also evident in the connecting pipe at 6 o'clock and through the void.

12.8 CNO_CXSR - CONNECTION OPEN, DEFECTIVE CONNECTION SOME ROOTS



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
CN	0		A		Α					
сх	SR		A	Α						

I2.8.1 COMMENTARY

The open connection to this conduit (**CN-O**) is defective due to roots growing down the connecting conduit (**CX-SR**). Quantifications and circumferential locations are unable to be determined from this photograph, and the fields have been populated with **A** for applicable.

12.9 CS - CRACKING SIMPLE



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Joint	Long loc'n	Cont	Remarks
С	s		0.5		11	1	J			

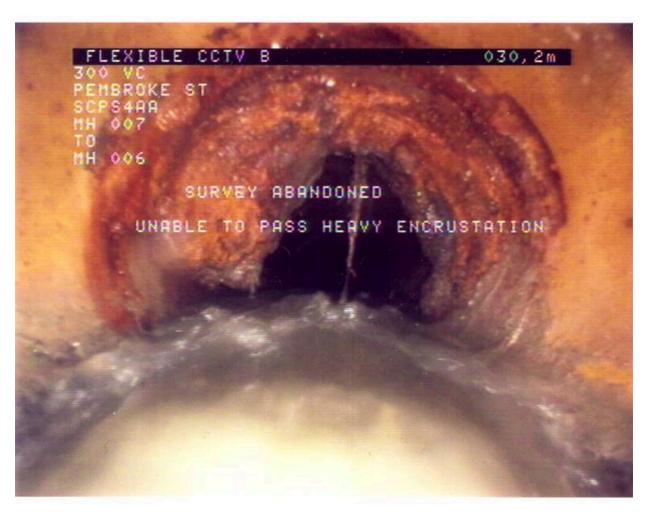
I2.9.1 COMMENTARY

This defect is the classic simple crack (**C-S**) in a VC sewer where the crack appears to start and return to the same joint between **11 and 1** o'clock. Since the defect is associated with the joint, record **J** in the joint field. The crack width is estimated at **0.5** mm.

The cracking in this case is one continuous crack with no branches. In other examples the crack may branch to create a few separate pieces of pipe.

This type of cracking will most commonly occur on the downstream side of joints as it is associated with damage of the VC pipe socket.

12.10 DEE SAOB - DEPOSITS ENCRUSTATION WALLS, SURVEY ABANDONED OBSTRUCTION



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
DE	E		50		8	4				
SA	ОВ									Heavy encrustation

I2.10.1 COMMENTARY

The deposits on the walls and soffit of the conduit above the water line can be classified as encrustation (**DE-E**) from **8** to **4** o'clock. It is the result of water seeping through a defect (which cannot be determined from this photograph) leaving an accumulation of minerals on the wall of the conduit. The build-up of encrustation, which reduces the cross section is reported as **50%** obstruction.

The inspection was abandoned (**SA-OB**) due to the obstruction caused by the encrustation, which is reported in the remarks field. Any continuous codes should be closed before coding SAOB.

The reflected light on the encrustation is a sign of infiltration. Encrustation of this type will often have seepage, dripping or running infiltration associated with it. In this case it is not necessary to code this feature given that conduit should be cleaned, after which the extent of infiltration and other defects will become clearer.

12.11 DES - DEPOSITS FINE SEDIMENT (EXAMPLE 1)



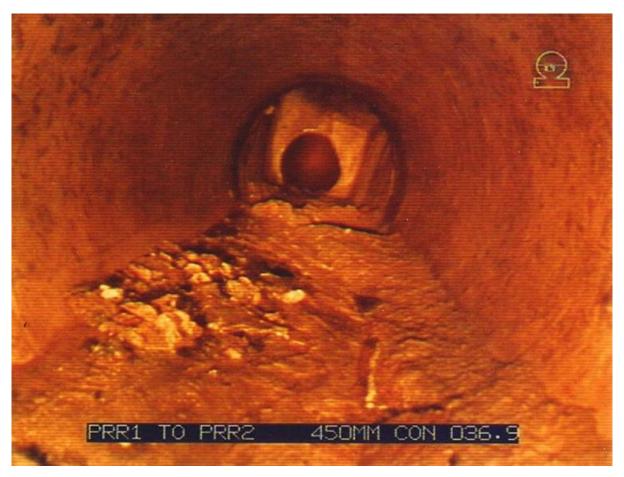
Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Joint	Long loc'n	Cont	Remarks
DE	s		10		5	7			S1	

I2.11.1 COMMENTARY

Sand has been deposited in the invert of this conduit (**DE-S**). The obstruction caused by the sand, which is estimated to reduce the cross sectional area available by **10%**. The sand is a continuous feature (**S1**).

The operator should record any probable sources of the sand in general comment (GC).

12.12 DES - DEPOSITS FINE SEDIMENT (EXAMPLE 2)



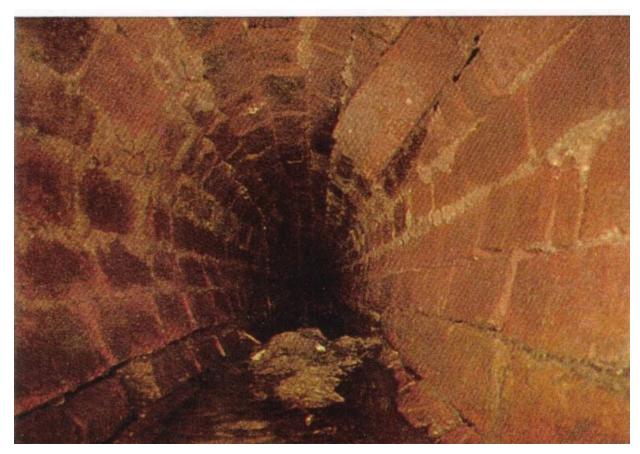
Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
DE	S		10		5	7			S1	Some rubble at 8 o'clock

I2.12.1 COMMENTARY

Sand with some rubble has been deposited in the invert of this conduit (**DE-S**). The obstruction caused by the deposits, which are estimated to reduce the cross-sectional area available by **10%**. The deposits are a continuous feature (**S1**).

The operator should record any probable sources of the sand in general comment (GC) or if there is a visible ingress of soil (ING).

I2.13 DMU_DH_MUS_DER - DISPLACED MASONRY UNITS MOVED INWARDS, DEFORMATION HORIZONTAL, MASONRY UNIT SEPARATION, DEPOSITS COARSE SEDIMENT INVERT



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
DMU	ı		70		1					
D	н		5		3	5				
MUS			10		8				S1	
DE	R		10		5	7				Rags present

I2.13.1 COMMENTARY

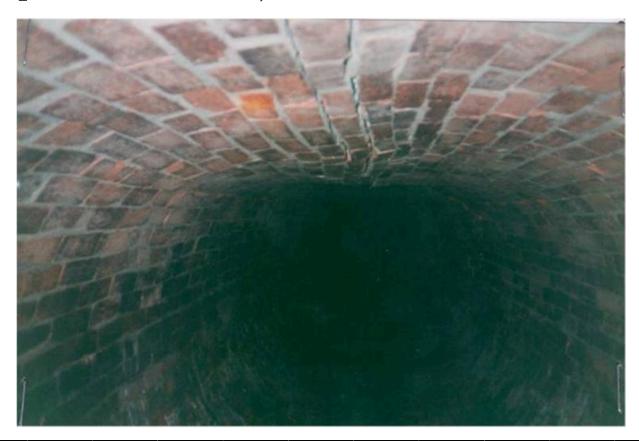
There are several defects in this brick oviform (ovoid) conduit to report.

There is a brick at 1 o'clock displaced inwards (**DMU**) with a maximum displacement of about **70 mm**. There are also appears to be a horizontal deformation (**D-H**) occurring between **3** and **5** o'clock with a maximum deformation of about 5%.

The separated jointing (**MUS**) at **8** o'clock, which is reported as **10 mm** in Q1 and also as a continuous feature (**S1**). The same defect is suspected at 5 o'clock, but the position of the camera and the debris in the invert does not allow its confirmation. If further investigation also revealed similar brick separation at 4 o'clock, it would be appropriate to code the defect as a dropped invert (DI).

The debris in the invert appears is coarse sediment and rags, which has been coded **DE-R** with a comment in the remarks field. The debris reduces the cross section and is reported as **10%**.

12.14 DV MUS - DEFORMATION VERTICAL, MASONRY UNIT SEPARATION



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
D	V		10		12				Α	
MUS			10		12				A	Separation along mortar joints on each side of the central brick course

I2.14.1 COMMENTARY

The brick courses at the soffit of this oviform (ovoid) brick conduit have deformed vertically (**D-V**) and is reported as **10%** deformation. To permit such a deformation the walls must have moved outwards slightly due to loss of ground (side-wall) support. The resultant feature is sometimes referred to as 'hearting' failure of brick conduits.

As far as we can see the deformation is continuous in both directions so 'A' (applicable) is noted in the continuous field.

Brick separation (**MUS**) at the crown (**12** o'clock) is also evident. Separation along mortar joints on each side of the central brick course is reported in the remarks. The typical width of the separation is reported as **10 mm** separation. The separation is also continuous.

12.15 FHC - FINISH NODE MAJOR CONNECTION





(Code	Ch1	Ch2	Q1	Q2	Circ lo	oc'n	Joint	Long loc'n	Cont	Remarks
	FH	С		A							Entry to 1295 oviform

I2.15.1 COMMENTARY

The camera is approaching the entry to a larger 1295 mm oviform sewer. This entry point is regarded as a node and is the end of the inspection at the red arrow in the asset plan (above right). It is coded as **FH-C** which is the finish node - 'major connection without a maintenance structure'. The remark 'Entry to 1295 oviform' is recorded to explain the end of the inspection.

Also see 12.22 for the start of the curve of the 840 mm oviform sewer.

12.16 GPFU_GC - GENERAL PHOTOGRAPH, GENERAL COMMENT





Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
GP	F	U								Brick conduit constructed without mortar
GC									A	Brick conduit constructed without mortar

I2.16.1 COMMENTARY

The interesting feature of this brick construction is the close fitting of bricks apparently without mortar. This is unusual and may indicate that bricks were dry placed on formwork and the joints mortar filled from the outside. In the bottom part of the conduit the construction is not obvious but investigation by the operator could provide useful information for the asset owner.

Nevertheless, the total absence of mortar between the bricks should be reported using the general photograph (**GP**) and the general comment (**GC**) codes. The absence of mortar should not be coded as a defect in this instance.

The feature appears to be continuous and probably started some distance before 25.7 m so 'A' (applicable) has been recorded in the continuous field. The oddly shaped brick at 12 o'clock at distance 25.7 m is probably from rough cutting to get it to fit as a keystone and not from damage.

Some bricks may have moved inwards, or they may have been constructed that way. Further investigation would be required to confirm before reporting this feature.

12.17 JDL - DISPLACED JOINT LONGITUDINAL



Code	Ch1	Ch2	Q1	Q2	Circ	Circ loc'n		Long loc'n	Cont	Remarks
JD	L		30				J	1.4		



Refer to applicable code, standard or specification to determine jointing acceptance tolerance.

I2.17.1 COMMENTARY

This photograph is from the acceptance inspection of a newly constructed reinforced concrete stormwater drain.

At this joint there is a longitudinal displacement (**JD-L**) estimated to be about **30** mm. The gap seems wide for a new asset and is likely to be unacceptable.

Close examination is required to determine the integrity of the joint.

I2.18 JDL_ING_IR_VV_GCU - DISPLACED JOINT LONGITUDINAL, INGRESS OF SOIL, INFILTRATION DRIPPING, INFILTRATION RUNNING, VOID VISIBLE, GENERAL COMMENT URGENT



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
JD	L		70				J			
ING	F				11		J			Small lumps of clay observed falling
ı	R				11		J			
vv			Α		9	3	J			

Code	Ch1	Ch2	Q1	Q2	Circ loc'n	Joint	Long loc'n	Cont	Remarks
GC			U						Urgent review required

I2.18.1 COMMENTARY

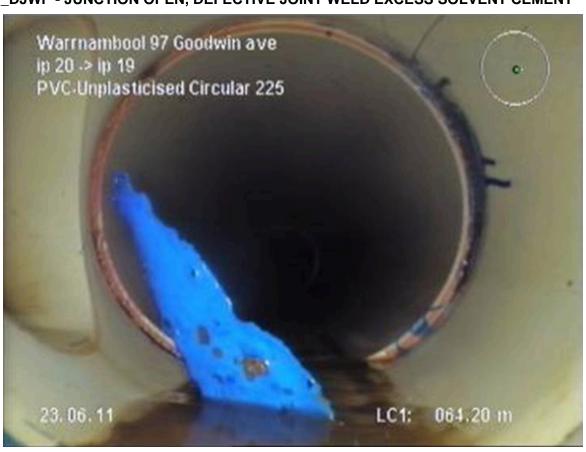
The multiple observations at this location could have been missed if the operator had not examined the longitudinal joint displacement (**JD-L**) in detail. The displacement is estimated to be **70** mm. The joint appears to be a butt joint with no collar or socket visible. Alternatively the socket may have been broken and dislodged.

Ingress of soil (ING-F), probably clay, at a joint (J) and associated with an infiltration runner (I-R) has been recorded separately.

Although soil is visible (SV) through the joint, void visible (**VV**) is reported as it is the more serious defect. It is not possible to estimate the void dimensions, which may not be relevant given the active nature of void formation.

The active ingress of soil and the growing void outside the conduit may present a substantial risk for the asset owner and should be reported as soon as possible by the operator, as well as using the **GC-U** code to alert the asset owner.

12.19 JNO DJWP - JUNCTION OPEN, DEFECTIVE JOINT WELD EXCESS SOLVENT CEMENT



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Joint	Long loc'n	Cont	Remarks
JN	O		150		9			64.2		
DJW	P				6			64.2		150 mm of hardened solvent flap is a

Code	Ch1	Ch2	Q1	Q2	Circ loc'n	Joint	Long loc'n	Cont	Remarks
									potential snag

I2.19.1 COMMENTARY

The solvent cement joint in the PVC-U pipe has been made with excess solvent applied. This has hardened and detached from the conduit to form a flap that could initiate a blockage and is reported as (**DJW_P**). A 150 mm open PVC-U junction (**JN-O**) is also reported.

12.20 JNO_JXB - JUNCTION OPEN, DEFECTIVE JUNCTION BLOCKED



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
JN	0		100		9			Α		Assumed open
JX	В		80	20	9			A		Lateral blocked with unidentifiable mass and impacting on main sewer

I2.20.1 COMMENTARY

There is some object or growth protruding from the junction (**JN**) to a VC sewer. It could be mass roots covered with some yeast growth, concrete covered with slimes or something else. Whatever the material, it is creating blockage

(JX-B) in the connecting pipe (80%) and in the main sewer (20%). The junction (JN) is estimated to have a 100 mm connecting conduit at 9 o'clock.

The junction is assumed to be open.

12.21 JNO_JXJC - JUNCTION OPEN, DEFECTIVE JUNCTION CRACKED



Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
JN	O		150		9			9.2		
JX	JC				9			9.2		Repair required

I2.21.1 COMMENTARY

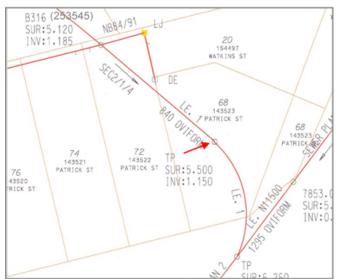
This is an open junction fitting (JN-O) with an estimated connecting pipe diameter of 150 mm at 9 o'clock.

The junction has a large circumferential crack near the joint with the main part of the fitting (JX-JC).

If this junction was below the water table or subjected to surcharge conditions for periods of its operation, infiltration and/or soil entry and/or exfiltration could occur. Depending on the location of the sewer, e.g. in an environmentally sensitive area, a remark suggesting that 'repair required' could be warranted.

12.22 LR DEE - LINE OF CONDUIT DEVIATES RIGHT, DEPOSITS ENCRUSTATION WALL





Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Joint	Long loc'n	Cont	Remarks
L	R								S1	
DE	E		10		7	5			J	

I2.22.1 COMMENTARY

This concrete oviform sewer is beginning to curve to the right (L-R). This location coincides approximately with the tangent point (TP) shown with a red arrow on a copy of the asset plan (above right). The curve to the right obviously extends beyond one metre so **S1** is recorded in the continuous features column.

Encrustation deposits (**DE-E**) on the wall above the water line at the joint are evident between **7 to 5** o'clock. The encrustation is estimated to reduce the cross section by **10%**. Since the feature is associated with the joint (a concrete construction joint in this case), record **J** in the joint field.

See also **12.15 FHC - Finish node major connection** for the end of the curve.

12.23 MM MM - MISSING MORTAR, MISSING MORTAR SUSPECTED



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Joint	Long loc'n	Cont	Remarks
ММ			20		8	4		Α	S1	
ММ					4	8		A	S2	Missing mortar below water line is highly likely. Further investigation at low flow to confirm suggested.

I2.23.1 COMMENTARY

This photograph, inside a brick ovoid sewer, shows a still camera and flash unit on a float system.

The brick conduit appears to be in reasonably good condition except that there appears to be some loss of mortar (MM) which is continuous and estimated at (20mm) depth of mortar loss between 8 and 4 o'clock.

It is likely that the mortar missing defect continues below the water level but that cannot be reported as observed. There are two options to report a likely defect that cannot be directly observed.

In this example it has been reported as **MM** between **4 and 8** o'clock with a remark suggesting further investigation. The benefit of this approach is that the suspected defect will contribute a score to the condition grading.

The alternative approach is to note that the missing mortar may exist under the water in the remarks (in the first observation) or as a General Comment (GC). However, either of these options will not generate a score for the underwater defect.

I2.24 MMUV_SOS_RF - MISSING MASONRY UNIT ANOTHER LAYER VISIBLE, MASONRY VISIBLE, SURFACE DAMAGE OTHER SPALLING, ROOTS FINE



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Joint	Long loc'n	Cont	Remarks
MMU	V		400		1					
so	S				1					
R	F				1	2				

I2.24.1 COMMENTARY

There are missing bricks at 1 o'clock in this brick conduit, which has another layer of bricks (MMU-V) behind the missing bricks.

Also associated with the missing bricks is spalling of the adjacent brickwork (SO-S).

Fine roots (R-F) are growing through the roof from 1 to 2 o'clock.

The subject area of this photograph appears to be one of high compressive stresses that have contributed to the loss of bricks as well as the spalling of surrounding brickwork.

12.25 SC H SV - SURFACE DAMAGE CONCRETE, HOLE IN WALL, SOIL VISIBLE



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Joint	Long loc'n	Cont	Remarks
sc	Н		30		8	4			S1	Wall missing
sv					8	4			S2	

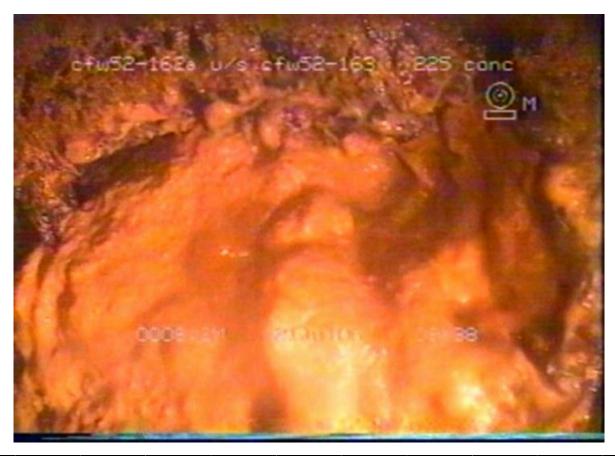
I2.25.1 COMMENTARY

This DN 300 concrete sewer was in service for eight years. Two pumping stations discharged into the system upstream. The pipe was inspected with mirrors from manholes about every two years and in one of these inspections it was noticed that the rubber rings were hanging down from the soffit. This could have been coded as defection joint seal hanging high (DJS-HH). The explanation for the hanging rings is that the pipe wall from 8 to 4 o'clock had completely disintegrated allowing the rubber ring (normally on the outside of the pipe) to fall unrestrained into the 'pipe space'. The rubber ring, during the life of the pipeline, prevents the corrosive gases reaching the socket component of the pipe on the outside. Hence the only part of the pipe remaining intact were the sockets and an undamaged invert.

The pipe was exhumed to reveal the situation in the photograph. Fortunately, there was no collapse because the trench backfill was well compacted cohesive soil and remained intact over the void left by the corroding pipe allowing the invert to remain functional.

Assuming this conduit was inspected prior to excavation, the top part of the concrete pipe has completed corroded away (SC-H) from 8 to 4 o'clock with soil visible (SV), both of which would be continuous.

12.26 SCH_ING_GCU - SURFACE DAMAGE CONCRETE HOLE, INGRESS OF SOIL, GENERAL COMMENT URGENT



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Joint	Long loc'n	Cont	Remarks
sc	н		25		2			Α		
ING	F				2			A		Clayey soil oozing in continuously
GC		U						A		Urgent review required

I2.26.1 COMMENTARY

Inspection of this concrete conduit revealed the pipe to be in relatively poor condition. At the start of the inspection surface damage, aggregate projecting (SC-AP) was obvious above the waterline. Further along this deteriorated to aggregate missing.

At **2 o'clock** a hole (**SC-H**) through the wall of the pipe is evident. This has been caused by loss of aggregate/pipe fabric due to concrete corrosion. Through the hole fine material (clayey soil) is entering continuously (**ING_F**). Operators need to be mindful that if ingress of soil is occurring, as in this example, that there is a defect through which the soil is entering.

The presence of a hole means that the loss of fabric in the pipe wall is total. Q1 may be used to show the full wall thickness has been removed which is estimated at **25** mm.

The active ingress of soil and the growing void outside the conduit may present a substantial risk for the asset owner and should be reported as soon as possible by the operator, as well as using the **GC-U** code to alert the asset owner.

12.27 SCRV - SURFACE DAMAGE CONCRETE REINFORCEMENT VISIBLE (EXAMPLE 1)



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Joint	Long loc'n	Cont	Remarks
SC	RV				A	A				ircumferential and longitudinal einforcement visible

I2.27.1 COMMENTARY

This photograph is from the acceptance inspection of a new reinforced concrete stormwater drain.

Steel reinforcement is visible with some minor corrosion evident (**SC-RV**) due to insufficient cover. As this is a close up view it is not possible to determine the full extent of the defect circumferentially or longitudinally. The operator would report such information and describe the defect in remarks.

The reason for the visible steel reinforcement seems to be a manufacturing fault that has resulted in the reinforcement having negligible concrete cover.

12.28 SCRV - SURFACE DAMAGE CONCRETE REINFORCEMENT VISIBLE (EXAMPLE 2)



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Joint	Long loc'n	Cont	Remarks
SC	RV				A	A		64.7	S1	No loss of concrete obvious

I2.28.1 COMMENTARY

Steel reinforcement is visible with some corrosion evident (**SC-RV**) due to insufficient cover. As this is a partial view of the conduit internal surface it is not possible to determine the full extent of the defect circumferentially or longitudinally. The operator would report such information and describe the defect in remarks.

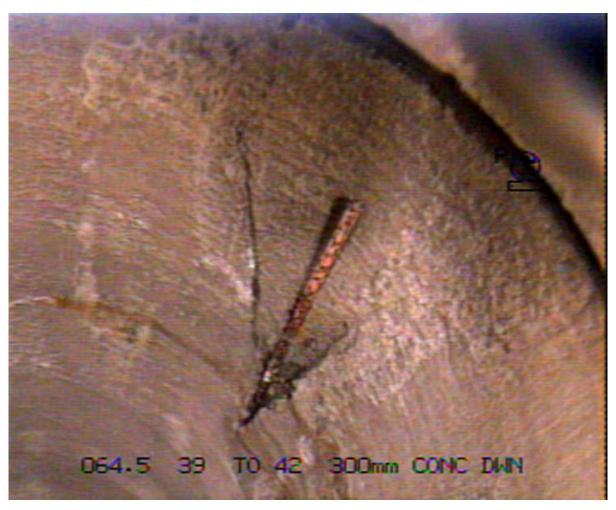
Despite the reinforcement corrosion, this concrete pipe appears to be in reasonable condition.

Normally exposed reinforcement is associated with loss of concrete through corrosion spalling, erosion or some other process. In this case there is no obvious reason and a remark to that effect helps to explain the observation.

The reason for the visible steel reinforcement seems to be a manufacturing fault that has resulted in the reinforcement having negligible concrete cover.

Typically, the code (SC-RC) would be used to report on the loss of concrete from approximately 8-4 o'clock, with maximum loss at the obvert and significant corrosion of the steel reinforcement. However, in this photo, there is no apparent loss of concrete at the obvert.

I2.29 SCRVP_CL - SURFACE DAMAGE CONCRETE REINFORCEMENT VISIBLE AND PROJECTING, CRACKING LONGITUDINAL



Code	Ch1	Ch2	Q1	Q2	2 Circ loc'n		Joint	Long loc'n	Cont	Remarks
sc	RVP				2			64.5		
С	L		1		2			64.5		

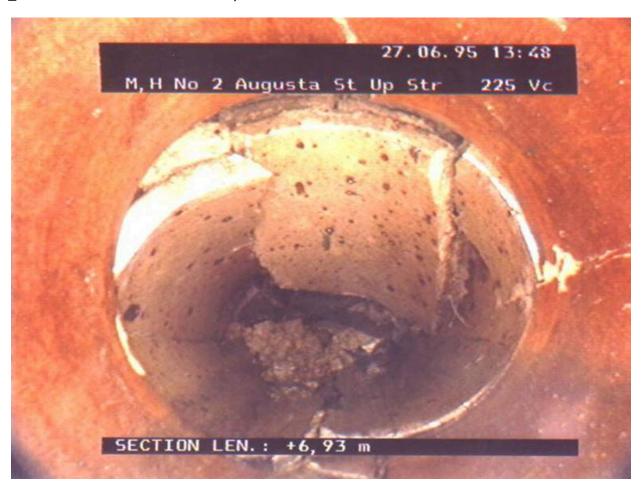
I2.29.1 COMMENTARY

This photograph is from the acceptance inspection of a new reinforced concrete stormwater drain.

Steel reinforcement is visible and projecting from the surface (**SC-RVP**) at **2** o'clock. The reason for the projecting steel reinforcement is lack of process control during manufacture.

In addition, a longitudinal crack (C-L) at with a width of about 1 mm is propagating from the 'root' of the reinforcement towards the joint.

12.30 X SAOB - COLLAPSED CONDUIT, SURVEY ABANDONED OBSTRUCTION



Code	Ch1	Ch2	Q1	Q2	Circ lo	oc'n	Joint	Long loc'n	Cont	Remarks
х										Localised to 600 mm length
SA	ОВ									Conduit collapsed

I2.30.1 COMMENTARY

The conduit has broken with all displaced pieces present, but sufficiently for it to be reported as a collapse (**X**). Individual pieces of conduit have dropped to reduce the diameter by more than 25%. Reporting broken displaced is not required. The collapse distance estimated at **600** mm is recorded in the remarks.

This is obviously the end of the inspection as the camera can progress no further. The inspection has to be abandoned due to the obstruction caused by the collapse (**SA-OB**). Conduit collapsed is recorded in the remarks.

12.31 X VV SAOB - COLLAPSED CONDUIT, VOID VISIBLE, SURVEY ABANDONED OBSTRUCTION



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Joint	Long loc'n	Cont	Remarks
х			900					A		Collapsed conduit length undamaged and repairable
vv					10	4		Α		
SA	ОВ									

I2.31.1 COMMENTARY

The defect at this location is an extreme radial displacement at a joint. It appears that the whole conduit length has been displaced and that the displacement is so large a void is visible (**VV**) outside the conduit.

Because of the magnitude of the displacement is estimated to be more than 25% of the conduit diameter, the conduit can be considered as collapsed (**X**). The length affected by the collapse appears to be one conduit length estimated to be **900** mm and which appears to be undamaged.

This is obviously the end of the inspection as the camera can progress no further. The inspection has to be abandoned due to the obstruction caused by the collapse (**SA-OB**).

I3 EXAMPLES OF MAINTENANCE STRUCTURE DEFECTS AND FEATURES

13.1 HCH_D_HBE_D - CHANNEL DEFECTIVE, BENCHING DEFECTIVE



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Desc loc'n	Vert loc'n	Remarks
нсн	D		A	A	9	12	ı	3.3	Loss of render on side of channel
НВЕ	D				9	12	н	3.3	Adjacent to loss of render in channel

I3.1.1 COMMENTARY

Part of the rendered cement mortar over 'infill' brickwork in the channel, descriptive location **I**, is missing (**HCH-D**). The missing mortar extends to the part of the bench and that is reported with a remark. The lining defective code (HLD-RM) could have been used but the defect is so specific to the channel that it is more appropriate to code as above.

To illustrate complete coding the benching condition coding is (**HBE_D**) has been included to report on minor loss of rendering on the benching.

Channel dimensions Q1 and Q2 are not available, and are given the value A for applicable in this example.

13.2 HDER - DEPOSITS COARSE SEDIMENTS



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Desc loc'n	Vert loc'n	Remarks
HDE	-	R	20		12		_	A	Main channel – ponding at outlet

I3.2.1 COMMENTARY

Gravel deposits are evident in the main channel invert (**HDE-R**) to a depth of **20** mm. Ponding is also evident at the downstream outlet.

The observation is recorded as being at the channel, which is descriptive location **I.** The vertical location (distance) is not recorded but is applicable and noted as **A.**

13.3 HGC - GENERAL COMMENT



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Desc loc'n	Vert loc'n	Remarks
HGC									MH constructed from four make- up rings on top of squat cone

I3.3.1 COMMENTARY

This MH is constructed with a squat cone extended to the surface with four make-up rings. This construction was found during an audit and was not marked on the as-constructed plans. It included an inlet from an unmarked line that was found to have 8 upstream MHs, none of which were shown on the plans.

The general comment about the construction of this maintenance hole is warranted. However, a complete inspection would have revealed precise record of the construction and other features.

13.4 HGTAB - DEVICE UNDER COVER ACCESS BARRIER



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Desc loc'n	Vert loc'n	Remarks
HGT	AB								Safety barrier

I3.4.1 COMMENTARY

An access barrier is present under the cover (**HGT-AB**). The device provides a risk control measure for ensuring the safety of those who must enter or carry out tasks associated with a confined space.

13.5 HGTSD - DEVICE UNDER COVER SENSING DEVICE





Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Desc loc'n	Vert loc'n	Remarks
HGT	SD								Level sensing device

I3.5.1 COMMENTARY

A sensing device is present under the cover (**HGT-SD**). The level sensors at the bottom of the MH are used to provide information on when discharge to an overflow (obscured at bottom of MH) will occur. The cables are attached to the monitor (yellow pod) that communicates via SCADA when certain levels have been reached.

13.6 HLDP - DEFECTIVE LINING COATING PEELING OFF









Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Desc loc'n	Vert loc'n	Remarks
HLD	P				12	12	A	A	Benching, shaft sections, make- up rings

I3.6.1 COMMENTARY

This lining (coating) is peeling from the internal concrete surfaces of the MH (**HLD-P**). It has been assumed that this lining was applied at the time of construction and not to rehabilitate the MH.

This coding entry is indicative only. The peeling coating would most likely be first reported immediately below the cover frame descriptive location B (adjusting construction). If extending over one metre, it would be recorded as continuous. Aggregate projecting (HSCAP) would also need to be reported where the coating had been lost.

13.7 HLDRM - DEFECTIVE LINING RENDERED MORTAR MISSING



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Desc loc'n	Vert loc'n	Remarks
HLD	RM				Α	A	F	A	Rendering missing with cracking in remaining mortar

I3.7.1 COMMENTARY

Part of the rendered cement mortar of this brickwork is cracked and missing (**HLD-RM**). It is not clear where in the circumference that the defect occurs, so the circumferential extent has been noted as **A** for applicable, as is the vertical location. The descriptive location is **F**, the chamber.

I3.8 HMM_HSOS_HSLSB_HSLSC - MISSING MORTAR, SURFACE DAMAGE OTHER SPALLING, DEFECTIVE STEP BENT, DEFECTIVE STEP ENCAPSULATION DAMAGED





Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Desc loc'n	Vert loc'n	Remarks
нмм			20		12	12	F	Α	
нѕо	S				12	12	F	A	Spalling on edges of bricks around full circumference
HSL	SB		1		A		F	1.1	Severely corroded step iron
HSL	sc		1		Α		F	1.1	

I3.8.1 COMMENTARY

The brickwork of this MH exhibits missing mortar (**HMM**) and spalling (**HSO-S**). The step iron is bent (**HSL-EB**) and is also severely corroded (**HSL-SC**). The missing mortar and spalling most likely could have been recorded as a continuous defect in this maintenance hole.

13.9 HRM_HRF - ROOTS MASS, ROOTS FINE



Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Desc loc'n	Vert loc'n	Remarks
HR	М		100		12	8	ı	А	Roots blocking outlet and extending in channel to inlet at 8 o'clock
HR	F			<5	A	A	В	A	Roots coming through joints in make- up rings

I3.9.1 COMMENTARY

A mass of mostly fine roots (**HR-M**), which has developed into an interwoven clump, is causing a **100%** obstruction of the channel from the outlet to an inlet at 8 o'clock. Fine roots (**HR-F**) are also entering the MH through joints in make-up rings and cover frame.

Observations have omitted values for vertical location and for roots coming through make up rings the circumferential, and the extent is indicated by **A** for applicable.

13.10 HSCAP - SURFACE DAMAGE CONCRETE AGGREGATE PROJECTING



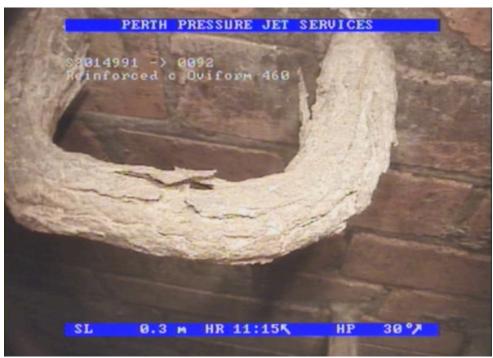
Code	Ch1	Ch2	Q1	Q2	Circ	loc'n	Desc loc'n	Vert loc'c	Remarks
HSC	AP				Α	Α	E	0.3	

I3.10.1 COMMENTARY

The concrete surface of the reducing slab has been corroded with coarse aggregate projecting (HSC-AP).

Circumferential location cannot be identified from photo, and is recorded as **A** for applicable.

I3.11 HSLSC - DEFECTIVE STEP CORRODED





Code	Ch1	Ch2	Q1	Q2	Circ loc'n		Desc loc'n	Vert loc'n	Cont	Remarks
HSL	sc		6		12		F	0.3	S1	

I3.11.1 COMMENTARY

The 6 step irons in this MH are corroded (**HSL-SC**). The continuous notation has been used in this case to indicate the corroded step irons extend over a significant part of the structure. In this example the defect step irons extend over one metre.

The continuous notation may also be used for defects similar to the step irons depicted, even though the extent may be less than one metre.

APPENDIX J — GUIDE FOR INTERNAL INSPECTION OF NEWLY CONSTRUCTED SEWERS OR STORMWATER CONDUITS AND CRITERIA FOR ACCEPTANCE

J1 INTRODUCTION

This appendix provides guidance for the internal acceptance inspection and reporting for newly constructed rigid and flexible sewers or stormwater conduits. It is not intended to override specifications for acceptance of new assets issued by water agencies, councils or other organisations but in the absence of such specifications provides a resource that can be applied by the owner of the new assets before acceptance.

This guide is not applicable for acceptance inspection of rehabilitated conduits or maintenance structures. It is applicable to conduits/pipes that have been lined during manufacture e.g. plastiline.

This guide should be applied in conjunction with design, specifications and construction drawings for the assets being inspected and the relevant codes and standards for those assets as well as other acceptance testing techniques such as low pressure air testing, vacuum testing, backfill compaction testing etc. Some of these reference documents could include, but not limited to:

- (a) The Gravity Sewerage Code of Australia WSA 02;
- (b) Sewer Acceptance Testing Specification, MRWA Specification 13-01.1;
- (c) Brisbane City Council, Reference specifications for Civil Engineering Work S160 Drainage; and
- (d) Australian Standards.

Inspections may be undertaken by personnel entry, with appropriate recording and measuring devices in large diameter conduits; or more commonly in smaller conduits by CCTV camera or 3D optical pipeline scanner. Data from visual inspections may be supplemented with other technologies, such as laser scanning, to provide precise measures of acceptance parameters.

Inspection of new conduits provides visual and other data that enables the ultimate owner of the new assets to identify unacceptable defects and features that can shorten the life of the asset and/or lead to operational problems and high ongoing maintenance costs.

In general, the defects or unacceptable features observed during an inspection relate to:

- (i) the design, pipe class and specification compliance;
- (ii) the configuration of pipes and fittings;
- (iii) themanufacture of the pipes and fittings;
- (iv) storage, handlingandinstallationof the pipes; and
- (v) damage from subsequent events after the asset was constructed.

All new sewer and stormwater conduits warrant inspection and assessment of structural and operational integrity before the intended owner accepts the responsibility for these assets.

J2 INSPECTION REQUIREMENTS

Inspection of **conduit** shall be undertaken in accordance with the requirements of this code. In addition, the inspector shall investigate, describe, identify and report on the defects or features in accordance with the criteria in this appendix. Where required, specialised instruments, apparatus and/or software shall be used to facilitate measurement of various **conduit** parameters. Hardware and software used in measuring the parameters shall be correctly calibrated for each application using the manufacturer's recommended methods. The organisation responsible for inspections shall provide a record or other documentation that the measuring devices are correctly calibrated for the asset being inspected.

J3 QUALIFICATIONS OF INSPECTORS AND ACCEPTANCE ASSESSORS

For key personnel the following qualifications are applicable:

- (a) A Statement of Attainment in Unit *NWPNET016 Inspectsewer or stormwater line*, (or equivalent credential) awarded by a Registered Training Organisation is required for all CCTV operators. In addition, operators shall also hold appropriate credentials in:
 - (i) OHS industry induction;
 - (ii) Traffic control implementation; and
 - (iii) Confined space entry.
- (b) A Statement of Attainment in Unit *NWPNET017 Supervise and report on conduit inspections* (or equivalent credential) awarded by a Registered Training Organisation is required for all acceptance assessors, supervisors, reviewers or managers of the CCTV work, including those who prepare inspection reports from data supplied by qualified CCTV operators.

Different technologies and software are available for deformation measurement by laser profiling and there is currently no recognised training for operators of this service. As such, those contractors seeking to provide laser profiling of new assets must demonstrate to the owner's satisfaction that they have undergone training in the use of the laser profiler and are competent in its use.

J4 WORK AS CONSTRUCTED

Inspection and reporting of features in sewer and stormwater <u>conduit</u> provides supplementary information to confirm work as constructed records. In particular, the distance to junctions, connections, bends and other features measured during inspection may be used to verify their correct location. The distance measurements recorded for these features must follow consistent protocols so that they can be replicated on work as constructed plans with the accuracy specified by this code.

Inspection should confirm the size, material and class of **conduit** where this can be determined. In addition, any variations to the design should be drawn to the attention of the asset owner for their determination of acceptance.

J5 REPORTING SUMMARIES

The summary report shall be prepared by the Consultant/Project Manager/Acceptance Assessor, with the purpose of providing an overview of all features or defects identified in the internal inspection that do not meet the criteria defined in the Tables J2 – J4 for sewers or Tables J5 – J7 for stormwater conduits (refer to <u>J14 ACCEPTANCE PARAMETERS</u> for tables).

The summary report shall be provided in PDF format with a filename of the following convention:

Project File Number_Internal_Inspection_Summary_Report.pdf e.g. 13PD1234_Internal_Inspection_Summary_Report.pdf

The summary report shall be included on the submitted digital media of project conduit inspections and also submitted with other applicable documentation.

Where previous acceptance inspections in the project have resulted in rework or rectification of defects this shall be noted in the final inspection report of that asset length and in the summary report.

Information to be included in the summary report shall be as shown in the format below, which is best presented in landscape format.

CCTV Acceptance Inspection Summary Report

Project Description: Riverview Estate Stage 4

Project File Number: 13PD1234
Project Consultant: Smith Group
Acceptance Assessor: Pipe View

Construction Contractor: John Constructions

Dates of inspections: 26-27 August 2018

Defect ID	Inspection Report Section No.	Inspection Video Ref	Photo Ref	Construction Date	Design Line No.	DN	Material	Start Node	End Node	Distance	Defect/ Feature Code	Description and Quantifications	Threshold Quantification	Acceptance Determination	Comments
1	1	1_26082018 _13PD1234	10_1_260820 18_13PD1234	July 2017	1	375	PVC	CMP1-2	CMP1-3	3.86	JDR	Joint displaced radially, 15- 20mm	> 10 mm	Not acceptable	Repair coupling used to join pipe
2	1	1_26082018 _13PD1234	15_1_260820 18_13PD1234	July 2017	1	375	PVC	CMP1-2	CMP1-3	42.55	DV	Deformation 10%	> 6% @ 12 months	Not acceptable	Confirmed by laser profile
3	2	2_26082018 _13PD1234	5_2_2608201 8_13PD1234	July 2017	1	300	PVC	CMP1-3	CMP1-4	9.19	DJSN	Seal visibly displaced		Not acceptable	Pinched ring

Figure J.1 Summary Report Template (blue text is example only)

J6 ACCEPTANCE INSPECTION REPORTS

The CCTV contractor shall produce inspection reports for each **conduit** in the project in accordance with the reporting format specified in this code. The following fields shall be completed accurately:

- (a) Project File Number;
- (b) Project name;
- (c) Code version being applied;
- (d) CCTV contractor's name and operator's name;
- (e) Date and time of inspection;
- (f) Suburb and closest street;
- (g) Section description;
- (h) Names of upstream and downstream nodes (maintenance structures or other features specified in the design);
- (i) Depth to inverts of maintenance structures;
- (j) Direction of inspection (upstream or downstream);

- (k) Longitudinal reference point;
- (I) Purpose of inspection (new construction);
- (m) Use of conduit;
- (n) Type of conduit;
- (o) conduit shape, diameter and material; and
- (p) Each observation, with its code and position set out in sequential order in the direction of the CCTV inspection.

In addition, the following information shall be recorded and incorporated into the inspection report:

- (i) Photographs of each defect or feature considered to have failed acceptance criteria;
- (ii) Photographs of any internal markings that identify the size, class, material, origin etc; and
- (iii) Video clips of any feature or defect that cannot be adequately shown with a still photograph.

Notes

The preliminary grading of the structural and service condition of the **conduit**, as set out in this code, is not intended to be used for the purpose of acceptance of new assets and is not required to be included in the assessment reports.

A separate file shall be provided for each sewer line inspected, in PDF format, with a filename of the following convention:

Project File Number_YYYYMMDD_HHMM_Section number_Start Node_End Node.pdf
e.g. 13PD1234_20180828_1430_Section02_CMP1-2_CMP1-3.pdf

For those agencies and contractors using Wincan software it is recommended that Wincan Viewer be used to package digital inspection reports and video record. This provides a format that is very user friendly and allows access to all inspection reports and videos and other information on one platform. The ultimate asset owner may specify that all digital data is provided in Wincan Viewer format.

All results and reports from the CCTV inspection are to be submitted to the Asset Owner in digital form on single or multiple DVDs (as necessary), or a portable hard drive. The digital media shall be accompanied with a transmittal form outlining their contents as follows:

- (a) Project File Number;
- (b) Project Name:
- (c) Consultant's name;
- (d) Construction Contractor's name;
- (e) Acceptance Assessor's name;
- (f) Date or period of CCTV inspection(s);
- (g) Line or part line numbers included in the data package; and
- (h) Line or part line numbers in the project that are not included in the data package.

J7 MATERIALS

The use of CCTV camera or 3D optical pipeline scanner inspection maybe limited by the internal characteristics of somematerials. For example, blackPE pipes may be very difficult to inspectand identify defects. Similarly, this limitation may apply to steel or ductile iron pipes that are lined or coated with black or dark colouredPE or other black or dark coloured plastics material. In such installations it is recommended that atrial inspection be undertakento determine if the inspection technique canreliably identify defects and features.

The inspector is also dependentonmaterials beingcorrectly nominated sincesome materialsmaybeverydifficulttoidentifyfrominternalinspection. However, it is critical that the operator/acceptance assessor considers all the indicators of **conduit** material and class such as internal markings, characteristic features and pipe unit length in identifying the conduit material. Any variation of conduit material and or class from the design shall be noted on the acceptance report.

J8 STEEL REINFORCED CONCRETE PIPE

Steel reinforced concrete pipe presents some difficulties in determining the acceptability of cracking in new assets.

In essence the permitted cracking will depend on:

- (a) crack width;
- (b) pattern of cracking;
- (c) size of asset;
- (d) cover to the reinforcement; and
- (e) operational conditions conveying sewage, low pH water from acid sulphate soil catchments, in a marine environment or rainwater.

Surface cracks <0.15 mm are not generally classified as defects. Where there is doubt, the existence of such cracking should be reported for assessment by the asset owner or engaging agency.

Various agencies, such as the Concrete Pipe Association of Australia, concrete pipe manufacturer Humes Pipeline Systems, Standards Australia, Brisbane City Council, ACT Government - Territory and Municipal Services and others have provided guidelines on cracking acceptability relating to the criteria above. Reference to those guidelines may be helpful in ensuring that the new asset will give the optimum service life for the conditions under which the asset will operate.

The values given in this appendix are indicative of the cracking thresholds for acceptance advised in those resources.

J9 DEFORMATION OF FLEXIBLE CONDUITS

Deformation measurement provides a valuable method of detecting that the specified embedment placement and compaction for flexible conduits has been correctly or poorly implemented. Deformation measurement using lasers should be conducted in accordance with 1.10 LASER PROFILING OF CONDUITS.

Deformation measurement may be undertaken using:

- (a) Physical measurement in large diameter conduits;
- (b) Laser measurement technologies; and
- (c) An ovality proving tool.

This code does not advocate proving tools which may damage the conduit if not correctly sized.

To ensure a valid measure of deformationdo not conductmeasurement/ inspectionuntilatleast14daysaftercompletionofplacementand compactionoftrenchand embankmentfillmaterial.

Refer to <u>Table J.1</u> for the limiting deformation thresholds for acceptance or sewers and stormwater pipes. These values are based on the figure provided in Table 21.6 of WSA-02:2014 Version 3.1.

Table J.1 MAXIMUM ALLOWABLE SHORT-TERM PIPE DEFORMATION FOR FLEXIBLE PIPE

Pipe material		Maximum allowable short term vertical pipe deflection %									
	3 d*	7 d*	14 d	30 d	3 mth	1 yr					
Plastics											
ABS, PE, PP, PVC	3.8	4.3	4.8	5.0	5.5	6					
GRP	3.0	3.4	3.8	4.0	4.4	4.8					
Metallic											
Ductile iron	0.8	0.9	1.0	1.0	1.1	1.2					

Pipe material		Maximum allowable short term vertical pipe deflection %									
	3 d*	7 d*	14 d	30 d	3 mth	1 yr					
Steel welded joint with:											
—No cement mortar lining	2.3	2.6	2.9	3.0	3.3	3.6					
—Cement mortar lining	1.5	1.7	1.9	2.0	2.2	2.4					
Elastometric joint	0.8	0.9	1.0	1.0	1.1	1.2					



*for information purposes only

J10 LATERAL INSPECTION

This appendix is also applicable to the acceptance inspection of laterals (property connection sewers) from junctions or connections where that is part of the new asset to be taken over. Inspection may be effected using push rod camera from a property access point or from the main **conduit** using satellite inspection technology.

However, some defects requiring measurement may not be able to be quantified accurately.

J11 INSPECTION AT THE END OF DEFECTS LIABILITY PERIOD

It is recommended that final visual and deformation inspections of new assets are undertaken at the end of the defects liability period to ensure that latent conditions, not affecting the **conduit** immediately after construction, have not contributed to defects that would be unacceptable. Such inspections will also detect any damage from the installation of other utilities and enable repairs to be undertaken.

J12 MANUFACTURING DEFECTS

Some new conduits may exhibit manufacturing and/or handling defects. Use an appropriate code to report the defect(s) where possible and add in remarks 'Possible Manufacturing Defect'. If a defect code does not appear to describe the observed defect record details using code GC (refer to 2.7.9.3 General comment—GC).

J13 RISK ASSESSMENT AND RECTIFICATION

The final decision to accept a new asset lies with the ultimate asset owner. Reports based on this appendix will provide significant data and evidence on which the asset owner can make decisions regarding the life of the new asset, potential operational performance issues as well as the risks associated with premature structural or operational failure.

Rectification of defects needs to take into account many factors:

- (a) Can the defect/s be repaired without compromising the service life of the asset?
- (b) Does the repair introduce an acceptable loss of operational performance?
- (c) What are the consequences and likelihood of failure associated with accepting a defect or repairing?
- (d) Was there a problem in the design in regard to pipe class, soil type, embedment selection etc?
- (e) Was there a problem with installation that may manifest in other defects at a later date?

Any section of new asset that is repaired, re-laid or rehabilitated must also be inspected again with a supplementary report submitted.

J14 ACCEPTANCE PARAMETERS

The configuration of elements in a new sewer is usually defined in design drawings, standard drawings and specifications. Compliance with some of these requirements may be determined by inspection.

The inspector/operator and acceptance assessor shall have a copy of design drawings, standard drawings and specifications applicable to the works being inspected for reference in determining the acceptance of nominated and other features.

The following tables describe nominated features that are to be reported to the engaging agency.

Table J.2 ACCEPTANCE PARAMETERS FOR RIGID SEWERS - VITRIFIED CLAY, STEEL REINFORCED CONCRETE

Defeat	Ol-4	Oho	04/0	Damada
Defect	Ch1	Ch2	Q1/2	Remarks
Cracking (Vitrified Clay)	L, C, S, M			Not acceptable - all of these cracking patterns are generally indicative of poor handling, unsatisfactory installation and or overloading. Any cracking is likely to lead to crack propagation and ultimate failure. In identifying cracking it
				is critical that occasional minor manufacturing irregularities or superficial marks are not reported as cracking.
Cracking (Concrete)	C, S, M		>0.5 mm	Not acceptable – these cracking patterns are likely to be associated with mishandling or poor installation. Water Agency should review all cracking and crack dimensions.
				In identifying cracking it is critical that occasional minor manufacturing irregularities such as cracking of limited extent or superficial marks are not reported as cracking.
Cracking (Concrete)	L (most commonly appearing at 12 o'clock and 6 o'clock, and smaller possibly insignificant cracking at 3 o'clock and 9 o'clock)		>0.5 mm	Not acceptable – this cracking pattern may be associated with proof loading, overloading, poor installation or inadequate pipe class. Water agency should review all cracking and crack dimensions.
				In identifying cracking it is critical that occasional minor manufacturing irregularities such as cracking of limited extent or superficial marks are not reported as cracking.
Breaking	D, M, E			Not acceptable

Defect	Ch1	Ch2	Q1/2	Remarks
Deformation	V, H, M			Not acceptable
Collapsed				Not acceptable
Porous conduit				Not acceptable
Surface damage concrete	S		Significant spalling >20 mm loss fabric	Not acceptable – asset owner to review for determination based on reinforcement cover and wall thickness of asset.
	AP, AM, RC, CP, H, JR			Not acceptable – unlikely to be observed in new construction
	RV, RVP, RS, and evidence of reinforcement close to the surface (shadowing)			Not acceptable – cover to reinforcement is clearly less than specified in the relevant standard. Indicative of a manufacturing defect, damage or evident in spalling.
				Note: Reinforcement that is close to the surface but covered by a thin layer of concrete, sometimes referred to as shadowing where the circumferential and longitudinal reinforcement is clearly visible just under the surface, is generally not reportable using the defect codes. This feature should be reported using the General Comment code with the remark of 'possible manufacturing defect'.
	Z			Refer to asset owner for determination
Surface damage other	S		Significant spalling >20 mm loss of fabric	Not acceptable – asset owner to review for determination based on wall thickness of asset
	Н			Not acceptable
	Z			Refer to asset owner for determination
Lining defective (plastic lined concrete pipes only)	B, BU, H, WD			Not acceptable
	Z			Identify defect, report in remarks for asset owner's determination
Deposits on wall or invert	E, S, R, C, W, Z			Not acceptable – can disguise defects and

Defect	Ch1	Ch2	Q1/2	Remarks
Delect	OIII	One	WIIZ	should not occur in a new sewer. Asset owner to consider need for cleaning and reinspection
	W, Z			Not acceptable – identify material and report in remarks
Exfiltration	J, D			Not acceptable
Infiltration	S, D, R, G			Not acceptable
Ingress of soil	S, F, G, Z			Not acceptable
Roots	T, F, M, RT, RF, RB			Not acceptable
Joint displacement	L		>15 mm	Refer to asset owner for determination based on pipe and joint seal characteristics
	R		>5 mm for pipe sizes #DN 250 >10 mm for pipe sizes >DN 250 to #DN 500 >20 mm for pipe sizes >DN 500	Not acceptable – for some pipe systems with separate collars incorporating two rubber seals, such as Hepworth Superseal, achieving these tolerances may be difficult. For those pipe systems the integrity of the seal may be sound despite apparent radial displacements exceeding the given acceptance thresholds.
	A			Angular deflection cannot be readily measured by the operator. It can be estimated by the assessor if the camera operator sets the camera in a position to view consecutive joints from a straight ahead camera view and then the offset measured at the furthest joint. Applying some trigonometry allows an approximate angle to be calculated. (For pipe unit lengths greater than 2 metres this technique may not be applicable.) Alternatively the maximum gap at the joint Q2 >30 mm may be used. The capacity of the pipe joint to facilitate angular deflection should be determined by the asset

Defect	Ch1	Ch2	Q1/2	Remarks
				owner and applied to acceptance criteria.
Defective joint seal	R	N, HH, HL, B		Not acceptable
	Z			Report and refer to asset owner for determination
Point repair	H, I, IS, L, R, RE, S			Identify all repairs observed and refer to asset owner for determination. (Some techniques may not be acceptable in new sewers.)
	Z			Identify repair technique, report in remarks. Refer to asset owner.
Point repair (defects)		B, D, G, P		Not acceptable – determine extent of 'bellies' and refer to asset owner for determination
		Z		Identify defect and refer to asset owner for determination
Obstruction	B, C, I, J, M, P, S			Not acceptable
	Z			Not acceptable – identify obstruction and refer to asset owner
Water level	F	С, Т		Should not occur in new sewer but may be operational or indicates failure in part of the system. Investigate and refer to asset owner.
	Р	С, Т	>5%	Not acceptable – report on extent of ponding due to vertical misalignment (sag) in line
Defective junction	B, D, JC, JD, P, SE, SR			Not acceptable if lateral is part of new construction and the responsibility of the asset owner. Otherwise refer to asset owner to determine.
	Z			As above
Connection				Should not occur in new sewer. Report unexpected or poorly constructed connections in remarks and refer to the Water Agency for acceptance determination.
Intruding connection				As above

Defect	Ch1	Ch2	Q1/2	Remarks
Lifting hole	M, B	U, S		Not acceptable – lifting holes, plugged or otherwise are not acceptable in sewerage pipes

Table J.3 ACCEPTANCE PARAMETERS FOR FLEXIBLE SEWER PIPES – PLASTICS (PVC, PE, PP, GRP), DUCTILE IRON AND STEEL

Defect	Ch1	Ch2	Q1/2	Remarks
Cracking	L, C, S, M		Any value	Not acceptable
Breaking	D, M, E			Not acceptable
Deformation	V			Refer to Table J1 for acceptance parameters for different materials
	Н, М			As above – in addition, investigate and report on the likely cause for the deformation in other than vertical direction
Deformation Local or point deformation	V, H, M			Not acceptable - an unusual but not uncommon feature mostly occurring in plastics pipes. Usually associated with poor backfill control with rocks or other objects deposited adjacent to the pipe. The deformations appear some time after backfill and increases with time.
Collapsed				Not acceptable
Porous conduit				Not acceptable – not likely to be a feature of these pipes
Surface damage other	H, MD, S, T			Not acceptable – not likely defects in new flexible pipe but any surface damage defect identified should be referred to the asset owner for determination
	Z			Identify defect, report in remarks for asset owner's determination
Lining defective	H, E, M, RM, RMCP, B			Not acceptable – one or more of the defects could be associated with cement mortar lined ductile iron or steel pipes polyethylene, thermal bonded polymeric, fusion bonded epoxy or other

Defect	Ch1	Ch2	Q1/2	Remarks
				internal coating of ductile iron and steel pipes; or defects of internal corrosion barrier in GRP pipes
	Z			Identify defect, report in remarks for asset owner's determination
Deposits on wall or in invert	E, S, R, C, W, Z			Not acceptable – can disguise defects and should not occur in new sewer. Asset owner to consider need for cleaning and reinspection.
Exfiltration	J, D			Not acceptable
Infiltration	S, D, R, G			Not acceptable
Ingress of soil	S, F, G, Z			Not acceptable
Roots	T, F, M, RT, RF, RB			Not acceptable
Joint displacement	L		>15 mm	Refer to asset owner for determination based on pipe and joint seal characteristics
	R		>5 mm for pipe sizes #DN 250 >10 mm for pipe sizes >DN 250 to #DN 500 >20 mm for pipe sizes >DN 500	Not acceptable – the pipe types described as flexible do not have jointing systems that would permit any significant radial displacements. Any radial displacement would most likely be associated with a joint effected with a repair coupling.
	A			Angular deflection cannot be readily measured by the operator. It can be estimated by the assessor if the camera operator sets the camera in a position to view consecutive joints from a straight ahead camera view and then the offset measured at the furthest joint. Applying some trigonometry allows an approximate angle to be calculated. (For pipe unit lengths greater than 2 metres this technique may not be applicable.) Alternatively the maximum gap at the joint Q2 >30 mm may be used.

Defect	Ch1	Ch2	Q1/2	Remarks
				Most joint types in plastics pipes have limited capacity for angular deflection. Any angular deflection of these pipes should be identified and referred to the asset owner for acceptance determination.
				The capacity of the pipe joint to facilitate angular deflection should be determined by the asset owner and applied to acceptance criteria.
Defective joint seal	R	N, HH, HL, B		Not acceptable
	Z			Report and refer to asset owner for determination
Point repair	H, I, IS, L, R, RE, S			Identify all repairs observed and refer to asset owner for determination. (Some techniques may not be acceptable in new sewers.)
	Z			Identify repair technique and report in remarks. Refer to asset owner.
Point repair (defects)		B, D, G, P		Not acceptable – determine extent of line deviation and refer to asset owner for determination
		Z		Identify defect and refer to asset owner for determination
Obstruction	B, C, I, J, M, P, S			Not acceptable
	Z			Not acceptable – identify obstruction and refer to asset owner
Flow (water) level	F	C, T		Should not occur in new sewer but may be operational or indicates failure in part of the system. Investigate and refer to asset owner.
	Р	C, T	>5%	Not acceptable – report on extent of ponding due to vertical misalignment (sag) in line
Defective junction	B, D, JC, JD, P, SE, SR			Not acceptable if lateral is part of new construction and the responsibility of the asset owner.

Defect	Ch1	Ch2	Q1/2	Remarks
				Otherwise refer to asset owner to determine action.
	Z			As above
Connection				Should not occur in a new sewer. Report unexpected or poorly constructed connections in remarks and refer to the Water Agency for acceptance determination.
Intruding connectio	n			As above

Table J.4 ACCEPTANCE CRITERIA - CONFIGURATION OF PIPEWORK AND FITTINGS - ALL SEWERS

Feature	Description	Remarks
Rocker pipes	These are shorter pipes than the normal unit pipe length and are required, by some Water Agencies, adjacent to structures such as maintenance holes, other structures and concrete encasement.	The required length of rocker pipe and the configuration of pipes at the structure are specified in design drawings, standard drawings and or specifications for particular pipe materials.
	The purpose is to allow for differential settlement between the structure and the pipeline without cracking or distortion of the pipe adjacent to the structure.	The inspector should record the distance at each joint adjacent to the structure to determine the length of the rocker pipe and report it in remarks.
Bends (line deviations) LR, LL, LU, LD or compound bends	Bends occur in some sewers at changes of direction and or grade. In some cases compound bends (vertical and horizontal) may be encountered. Long radius bends in polyethylene may extend for several metres and accommodate significant changes in horizontal direction and level. In small diameters up to DN 225 bends are likely to be moulded or post-formed long radius. For DN 225 it is likely that bends will be fabricated in a 'lobster back' with a series of mitre cuts and the pipes joined with epoxy, hot air welding or some other technique.	The distance at the start and finish of bends shall be recorded in the inspection report along with a description of the form of the bend i.e. lobster back, moulded.
JDA continuous	Long radius curves in sewers may be constructed by successive angular deflections at joints (within the tolerance of the joint). Such a requirement will be clearly indicated in design drawings with possibly the offset required for each pipe to align with the designed curve.	Report the start and finish of continuous angular deflections.
Junction	A junction is a prefabricated fitting installed as part of the original construction or post construction by inserting the junction fitting in the pipeline.	All junctions for direct customer connection should be provided with a PVC plain wall solvent weld socket with screwed cap or for VC, a plugged VC to PVC plain wall adaptor.
	Junctions are provided to allow customers to connect house drains directly to the sewer or allow a property connection sewer to be extended to the customer's property.	Inspect each junction lateral and report compliance with regard to configuration of fittings in accordance specifications and standard drawings.

Feature	Description	Remarks
	Acceptable configurations of junctions with associated fittings should be specified by the Water Agency.	
Maintenance shafts and chambers	Provide access to the sewer for maintenance equipment but not person entry. May have an integral bend or may have an adjoining (generally upstream) long radius bend. Can have up to three inlets.	Report if the inspection equipment and/or transportation unit cannot traverse through the maintenance shaft. The transition to maintenance shaft from bend or straight line must not exceed the angular deflection for the joint system used. Record joint deflection if observable.
Orientation of concrete pipes	Steel reinforced concrete pipes DN 600 and above typically have 'elliptical' circumferential reinforcement to resist vertical loads. These pipes have a designated top which is stamped on the inside of the pipe.	The location of the 'TOP' mark is to be checked on each pipe unit. Where the 'TOP' mark is not within 10 ⁰ of vertical, report 'Not acceptable' and refer to asset owner.

The configuration of elements in new stormwater drainage assets is usually defined in design drawings, standard drawings and specifications. Compliance with some of these requirements may be determined by inspection The inspector/operator and acceptance assessor shall have a copy of design drawings, standard drawings and specifications applicable to the works being inspected for reference in determining the acceptance of nominated and other features.

The following tables describe nominated features that are to be reported to the asset owner/engaging agency.

Table J.5 ACCEPTANCE PARAMETERS FOR RIGID STORMWATER DRAINAGE PIPES – VITRIFIED CLAY, STEEL REINFORCED CONCRETE, FIBRE REINFORCE CONCRETE (CEMENT)

Defect	Ch1	Ch2	Q1/2	Remarks
Cracking (Vitrified Clay)	L, C, S, M			Not acceptable - all of these cracking patterns are generally indicative of poor handling, unsatisfactory installation and or overloading. Any cracking is likely to lead to crack propagation and ultimate failure.
				In identifying cracking it is critical that occasional minor manufacturing irregularities or superficial marks are not reported as cracking.
				Note: Unlikely to be use for new stormwater drainage.
Cracking (Fibre Reinforced Concrete)	L, C, S, M			Not acceptable - all of these cracking patterns are generally indicative of poor handling, unsatisfactory installation and or overloading. Any cracking is likely to lead to crack propagation and ultimate failure. In identifying cracking it is critical that occasional

Defect	Ch1	Ch2	Q1/2	Remarks
				minor manufacturing irregularities or superficial marks are not reported as cracking.
Cracking (Concrete)	C, S, M		>0.5 mm	Not acceptable – these cracking patterns are likely to be associated with mishandling or poor installation.
				In identifying cracking it is critical that occasional minor manufacturing irregularities or superficial marks are not reported as cracking.
Cracking (Concrete)	L (most commonly first appearing at 12 and 6 o'clock and smaller possibly insignificant cracking at 3 and 9 o'clock)		>0.5 mm	Not acceptable – this cracking pattern may be associated with proof loading, overloading, poor installation or inadequate pipe class.
				In identifying cracking it is critical that occasional minor manufacturing irregularities or superficial marks are not reported as cracking.
				The cracking threshold may be reduced for concrete pipes that convey low pH water and or operate in marine environments
Breaking	D, M, E			Not acceptable
Deformation	V, H or M			Not acceptable
Collapsed				Not acceptable
Porous conduit				Not acceptable
Surface damage concrete	S		Significant spalling >20 mm loss fabric	Not acceptable – Asset owner to review for determination based on wall thickness of asset.
	AP, AM, RC, CP, H, JR			Not acceptable - unlikely to be observed in new construction
	RV, RVP, RS and evidence of reinforcement close to the surface (shadowing)			Not acceptable – cover to reinforcement is clearly less than specified in the relevant standard. Indicative of a manufacturing defect, damage or evident in spalling.
				Note: Reinforcement that is close to the

				_
Defect	Ch1	Ch2	Q1/2	surface but covered by a thin layer of concrete, sometimes referred to as shadowing where the circumferential and longitudinal reinforcement is clearly located just under the surface, is generally not reportable using the defect codes. This feature should be reported as a 'Manufacturing Defect' using the General Comment code.
	Z			Refer to asset owner for determination.
Surface damage asbestos cement/fibre reinforced concrete	CP, DI, DM, DX			Not acceptable – unlikely in new stormwater drainage assets
	н			Not acceptable – unlikely in new stormwater drainage asset
	Z			Identify defect and refer to asset owner
Surface damage other	S		Significant spalling >20 mm loss of fabric	Not acceptable – Asset owner to review for determination based on wall thickness of asset
	Н			Not acceptable
	Z			Refer to asset owner for determination.
Lining defective (plastic lined concrete pipes only)	B, BU, H, WD			Not acceptable – unlikely feature of stormwater drainage pipes
	Z			Identify defect, report in remarks for asset owner's determination.
Deposits on wall or invert	E, S, R, C, W, Z		> 5%	Not acceptable – can disguise defects and should not occur in new stormwater drainage pipe. Asset owner to consider need for cleaning and reinspection.
Exfiltration	J, D			Not acceptable
Infiltration	S, D, R, G			Not acceptable
Ingress of soil	S, F, G, Z			Not acceptable
Roots	T, F, M, RT, RF, RB			Not acceptable
		'	'	

Defect	Ch1	Ch2	Q1/2	Remarks
Joint displacement	L		>15 mm	Refer to asset owner for determination based on pipe and joint seal characteristics
	R		>5 mm for pipe sizes #DN 250 >10 mm for pipe sizes >DN 250 to #DN 500 >20 mm for pipe sizes >DN 500	Not acceptable – for some pipe systems with separate collars incorporating two rubber seals, such as VPIPE +, achieving these tolerances may be difficult. For those pipe systems, the integrity of the seal may be sound despite apparent radial displacements exceeding the given acceptance thresholds.
	A			Angular deflection cannot be readily measured by the operator. It can be estimated by the assessor if the camera operator sets the camera in a position to view consecutive joints from a straight ahead camera view and then the offset measured at the furthest joint. Applying some trigonometry allows an approximate angle to be calculated. (For pipe unit lengths greater than 2 metres this technique may not be applicable.) Alternatively the maximum gap at the joint Q2 >30 mm may be used. The capacity of the pipe joint to facilitate angular deflection should be determined by the asset owner and applied to acceptance criteria.
Defective joint seal	R	N, HH, HL, B		Not acceptable
	Z			Report and refer to asset owner for determination
Point repair	H, I, IS, L, R, RE, S			Identify all repairs observed and refer to asset owner for determination. (Some techniques may not be acceptable in new sewers.)

Defect	Ch1	Ch2	Q1/2	Remarks
	Z			Identify repair technique, report in remarks. Refer to asset owner.
Point repair (defects)		B, D, G, P		Not acceptable - determine extent of 'bellies' and refer to asset owner for determination
		Z		Identify defect and refer to asset owner for determination
Obstruction	B, C, I, J, M, P, S			Not acceptable
	Z			Identify obstruction and refer to asset owner
Water level	F	C, T		Generally not an issue for acceptance of a stormwater drain
	Р	C, T	> 5%	Not acceptable – report on extent of ponding due to vertical misalignment (sag) in line
Defective junction	B, D, JC, JD,P, SE, SR			Not acceptable if lateral is part of new construction and the responsibility of the asset owner. Generally not a feature of stormwater drains.
	Z			As above
Connection				Not acceptable if configuration, size and others features of installation do not comply with asset owner specifications
Defective connection	Any			Not acceptable if lateral is part of new construction and the responsibility of the asset owner
Intruding connection			>5%	Not acceptable
Lifting hole	В	U		Not acceptable – either feature is not acceptable

Table J.6 ACCEPTANCE PARAMETERS FOR FLEXIBLE STORMWATER DRAINAGE PIPES – PLASTICS (PVC, PE, PP, GRP), DUCTILE IRON AND STEEL

Defect	Ch1	Ch2	Q1/2	Remarks
Cracking	L, C, S, M		Any value	Not acceptable
Breaking	D, M, E			Not acceptable

Defect	Ch1	Ch2	Q1/2	Remarks
Deformation	V			Refer to Table J1 for acceptance parameters for different materials
	Н, М			As above – in addition, investigate and report the likely cause for deformation in other than vertical direction
Deformation Local or point deformation	V, H, M			Not acceptable – an unusual but not uncommon feature mostly occurring in plastics pipes. Usually associated with poor backfill control with rocks or other objects deposited adjacent to the pipe. The deformations appear some time after backfill and increases with time.
Collapsed				Not acceptable
Porous conduit				Not acceptable – not likely to be a feature of these pipes
Surface damage other	H, MD, S, T			Not acceptable – not likely defects in new flexible pipe but any surface damage defect identified should be referred to the asset owner for determination
	Z			Identify defect, report in remarks for asset owner's determination
Lining defective	H, E, M, RM, RMCP, B			Not acceptable – one or more of the defects could be associated with cement mortar lined ductile iron or steel pipes; polyethylene, thermal bonded polymeric, fusion bonded epoxy or other internal coating of ductile iron and steel pipes; or defects of internal corrosion barrier in GRP pipes.
				Manufactured lining not usually a feature of stormwater drains.
	Z			Identify defect, report in remarks for asset owner's determination
Deposits on wall or in invert	E, S, R, C, W, Z		>5%	Not acceptable – can disguise defects

Defect	Ch1	Ch2	Q1/2	Remarks
				and should not occur in new stormwater drainage pipe. Asset owner to consider need for cleaning and reinspection.
Exfiltration	J, D			Not acceptable
Infiltration	S, D, R, G			Not acceptable
Ingress of soil	S, F, G, Z			Not acceptable
Roots	T, F, M, RT, RF, RB			Not acceptable
Joint displacement	L		>15 mm	Refer to asset owner for determination based on pipe and joint seal characteristics
	R		>5 mm for pipe sizes up to DN 250 >10 mm for pipe sizes from above DN 250 to DN 500 >20 mm for pipe sizes above DN 500	Not acceptable – the pipe types described as flexible do not have jointing systems that would permit any significant radial displacements. Any radial displacement would most likely be associated with a joint effected with a repair coupling.
	A			Angular deflection cannot be readily measured by the operator. It can be estimated by the assessor if the camera operator sets the camera in a position to view consecutive joints from a straight ahead camera view and then the offset measured at the furthest joint. Applying some trigonometry allows an approximate angle to be calculated. (For pipe unit lengths greater than 2 metres this technique may not be applicable.) Alternatively the maximum gap at the joint Q2 >30 mm may be used. Most joint types in plastics pipes have limited capacity for angular deflection. Any angular deflection of these pipes should be identified and referred to the asset owner for acceptance determination.

Defect	Ch1	Ch2	Q1/2	Remarks
				The capacity of the pipe joint to facilitate angular deflection should be determined by the asset owner and applied to acceptance criteria.
Defective joint seal	R	N, HH, HL, B		Not acceptable
	Z			Report and refer to asset owner for determination
Point repair	H, I, IS, L, R, RE, S			Identify all repairs observed and refer to asset owner for determination. (Some techniques may not be acceptable in new assets.)
	Z			Identify repair technique, report in remarks. Refer to asset owner.
Point repair (defects)		B, D, G, P		Not acceptable – determine extent of 'bellies' and refer to asset owner for determination
		Z		Identify defect and refer to asset owner for determination
Obstruction	B, C, I, J, M, P, S			Not acceptable
	Z			Identify obstruction and refer to asset owner
Flow (water) level	F	С, Т		Generally not an issue for acceptance of a stormwater drain
	Р	С, Т	> 5%	Not acceptable – report on extent of ponding due to vertical misalignment (sag) in line
Defective junction	B, D, JC, JD,P, SE, SR			Not acceptable if lateral is part of new construction and the responsibility of the asset owner. Otherwise refer to asset owner to determine action.
	Z			As above
Connection				Should not occur in new sewer. Report unexpected or poorly constructed connections in remarks and refer to the Water Agency for acceptance determination.

Defect	Ch1	Ch2	Q1/2	Remarks
Intruding connection				As above

Table J.7 ACCEPTANCE CRITERIA - CONFIGURATION OF PIPEWORK AND FITTINGS - ALL STORMWATER DRAINAGE PIPES

Feature	Description	Remarks
Rocker pipes	These are shorter pipes than the normal unit pipe length and are required, by some asset owners, adjacent to structures such as maintenance holes, other structures and concrete encasement.	The required length of rocker pipe and the configuration of pipes at the structure are specified in design drawings, standard drawings and or specifications for particular pipe materials.
	The purpose is to allow for differential settlement between the structure and the pipeline without cracking or distortion of the pipe adjacent to the structure.	The inspector should record the distance at each joint adjacent to the structure to determine the length of the rocker pipe and report it in remarks.
Bends (line deviations) LR, LL, LU, LD or compound bends	Bends may be constructed in some drains without a maintenance structure. In some cases compound bends (vertical and horizontal) may be encountered. Long radius bends in polyethylene may extend for several metres and accommodate significant changes in horizontal direction and level.	The distance at the start and finish of bends shall be recorded in the inspection report.
	It is likely that bends for stormwater drainage will be fabricated in a 'lobster back' configuration with a series of mitre cuts and the pipes joined with epoxy, hot air welding or some other technique.	
JDA continuous	Long radius curves in stormwater drains may be effected by successive angular deflections at joints (within the tolerance of the joint). Such a requirement will be clearly indicated in design drawings with possibly the offset required for each pipe to align with the designed curve.	Report the start and finish of continuous angular deflections.
Connection	Connections to stormwater assets are provided to allow drainage of surface water from public and private properties. They are constructed by cutting a hole in the stormwater pipe, after it has been laid, and fixing into place a connecting pipe or fitting of the required size for the development. Some agencies responsible for stormwater	Report on the compliance of the connection with the specification in regard to - products, finish, configuration.
	assets specify a certain product and procedure for installation.	
Orientation of concrete pipes	Steel reinforced concrete pipes #DN 600 typically have 'elliptical' circumferential reinforcement to resist vertical loads. These pipes have a designated top which is stamped on the inside of the pipe.	The location of the 'TOP' mark is to be checked on each pipe unit. Where the 'TOP' mark is not within 10 ⁰ of vertical, report 'Not acceptable' and refer to asset owner.

APPENDIX K — MANUAL CODING SHEETS

The manual coding sheets are provided for instructional purposes and in exceptional circumstances where electronic reporting is unavailable. It is not intended that they are used under normal circumstances.

These sheets incorporate all defect scoring headers, some of which may not be relevant for the system being scored.

The manual coding sheets provided are:

- (a) K1 Conduit Manual Coding Sheet (applicable to both sewers and stormwater conduit);
- (b) K2 Maintenance Structure Manual Coding Sheet; and
- (c) K3 Laterals Manual Coding Sheet.

Notes

The scoring and statistics fields in *K*2 – *Maintenance Structure Manual Coding Sheet* are suggested condition parameters at this stage.

Definitions

Adjusting construction

Component of a maintenance hole between the cover and frame and the shaft used to adjust the surface level of the maintenance hole cover

Aggregate missing

Damage has extended sufficiently for several pieces of large aggregate to have been removed and loss of conduit or maintenance structure fabric is leading to hole formation

Aggregate projecting

Coarse aggregate is projecting from the concrete surface after the surrounding cement-sand matrix has been removed

Aggregate visible

Some coarse aggregate in the concrete is visible or exposed

Assessor

The person identifying and coding features and defects observed during a conduit inspection. This process may occur during the inspection and be carried out by the Operator or it may be conducted by the Coder/Assessor from images recorded during the conduit inspection

Asset owner

The Agency, Authority, Board, Company, Controlling Authority, Corporation, Council, Department, Individual, Regulator, Utility or other legal entity who is the owner of the asset and/or who has responsibility for the asset

Benching

Near horizontal surface adjacent to the channel in a maintenance hole

Blister

A bubble on the surface of an asset particularly an asset's gel coat or liner. A blister is smaller than a bulge and more likely to occur in a group

Breaking

The breaking of an asset into a few or many separate pieces where there is significant movement of some or all of the pieces resulting in measurable local or general distortion from the original conduit cross section. Pieces of asset may be missing or sections of the asset may have been displaced through shear action such that soil or a void is visible.

Breaking-missing

A broken asset where one or more of the broken pieces is no longer present in the wall of the asset. It is probable that soil or a void is visible through the missing structure

Bulge

A liner which could be incorporated in the manufacture or construction of the asset or is installed to rehabilitate an asset has formed a significant convex bulge intruding into the conduit or structure. A bulge is larger than a blister and may occur in isolation

Chamber

Part of a maintenance structure providing working space above the channel and benching

Chamber unit

Component part of a maintenance structure manufactured as a single entity and intended to be joined with other chamber units

Coder

The person identifying and coding features and defects observed during a conduit inspection. This process may occur during the inspection and be carried out by the Operator or it may be conducted by the Coder/Assessor from images recorded during the conduit inspection

Collapse

A complete loss of structural integrity or continuity measured as a deformation or displacement resulting in a >25% reduction of a conduit's diameter or in the case of a maintenance structure >50% of the chamber unit or largest cross section element in the structure

Combined system

Sewer system designed to carry both sewage and surface water in the same conduit(s)

Conduit

A pipe or other closed passage for the conveyance of liquids

Conduit unit length

The length of a typically manufactured conduit unit used in the construction of a conduit

Conduit units

Component part of a conduit manufactured as a single entity and intended to be joined with other conduit units

Exfiltration

Escape of sewage from a sewer into the surrounding ground

Infiltration

Ingress of groundwater into a sewer system

Inflow

Ingress of stormwater into a sewer system

Inspection length

The length of conduit continuously inspected between consecutive nodes or from a node to a point in the asset where inspection needs to be terminated

Inspection opening

A fitting with provision for visual inspection and limited access to facilitate inspection and testing and/or clearing of obstructions, but not human access

Inspection shafts

See terminal maintenance shafts

Invert

Lowest point of the internal surface of a pipe or channel at any cross-section

Joint

A connection between the ends of two pipeline components including the means of sealing

Junction

A junction is a manufactured (moulded or fabricated) fitting provided to enable flow from a minor conduit (usually a property connection) to enter the main conduit

Maintenance chamber

Structure with a moulded and channelled base with up to three inlets #DN 225 (inlets at the base only), a shaft of nominal shaft size DN 450 – DN 600 and a removable cover constructed on a conduit that allows limited change of grade and/or direction and provides access to the conduit for inspection and most maintenance equipment, but which does not permit entry of a person

Maintenance hole

Structure with a channelled base with multiple inlets at base and above (drop inlets), a shaft of nominal shaft size DN 1050 – DN 1500 with a removable cover #600 mm clear opening constructed on a conduit that allows limited change of grade and/or direction and provides person and equipment access to a (typically buried) conduit; abbreviation MH retains the abbreviation for the traditional term "Manhole".

Maintenance shaft

Structure with a moulded and channelled or spherical base with up to three inlets #DN 225 (inlets at the base only), a shaft of nominal shaft size DN 225 – DN 450 and a removable cover constructed on a conduit that allows limited change of grade and/or direction and provides access to the conduit for inspection and some maintenance equipment, but does not permit entry of a person

Operator

The person controlling the inspection and making recordings required by this Code. This person may also make the observations, or this could be done by the Coder/Assessor

Surface water

Water from rainfall or other source is discharged to the stormwater drainage or sewerage system directly from the ground or from exterior building surfaces via a range of appurtenances or defects

Terminal maintenance shaft

A structure at the end of a reticulation sewer to allow insertion into the sewer of equipment for inspection and maintenance. See also <u>maintenance shaft</u>