



**CCTV acceptance inspection of
sewers and stormwater drains**

in accordance with

**Conduit Inspection Reporting Code
of Australia WSA05-2008**

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**First presented at the
WIOA Conference, Tamworth, April 2009**

streamline learning

A stack of US coins, likely quarters, is shown on a blue background. The coins are stacked vertically, with the top coin clearly visible. The background is a solid blue color.

**Pipes for sewers and stormwater
drains are expensive**

**Putting those pipes in the ground
is even more expensive**

**Repairing or rehabilitating those
new sewers or drains may be
more expensive again**

Would you like your new assets
to look like these?



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003.2 22 TO 21 300mm CONC DUN

P
2

016.5 02 TO 01 225mm CONC DN



006.6 23 TO 24 2006-12-15

10

002.6 35 TO 34 300mm 6000-UP

C510 -> C509 750



C510 -> C509 750

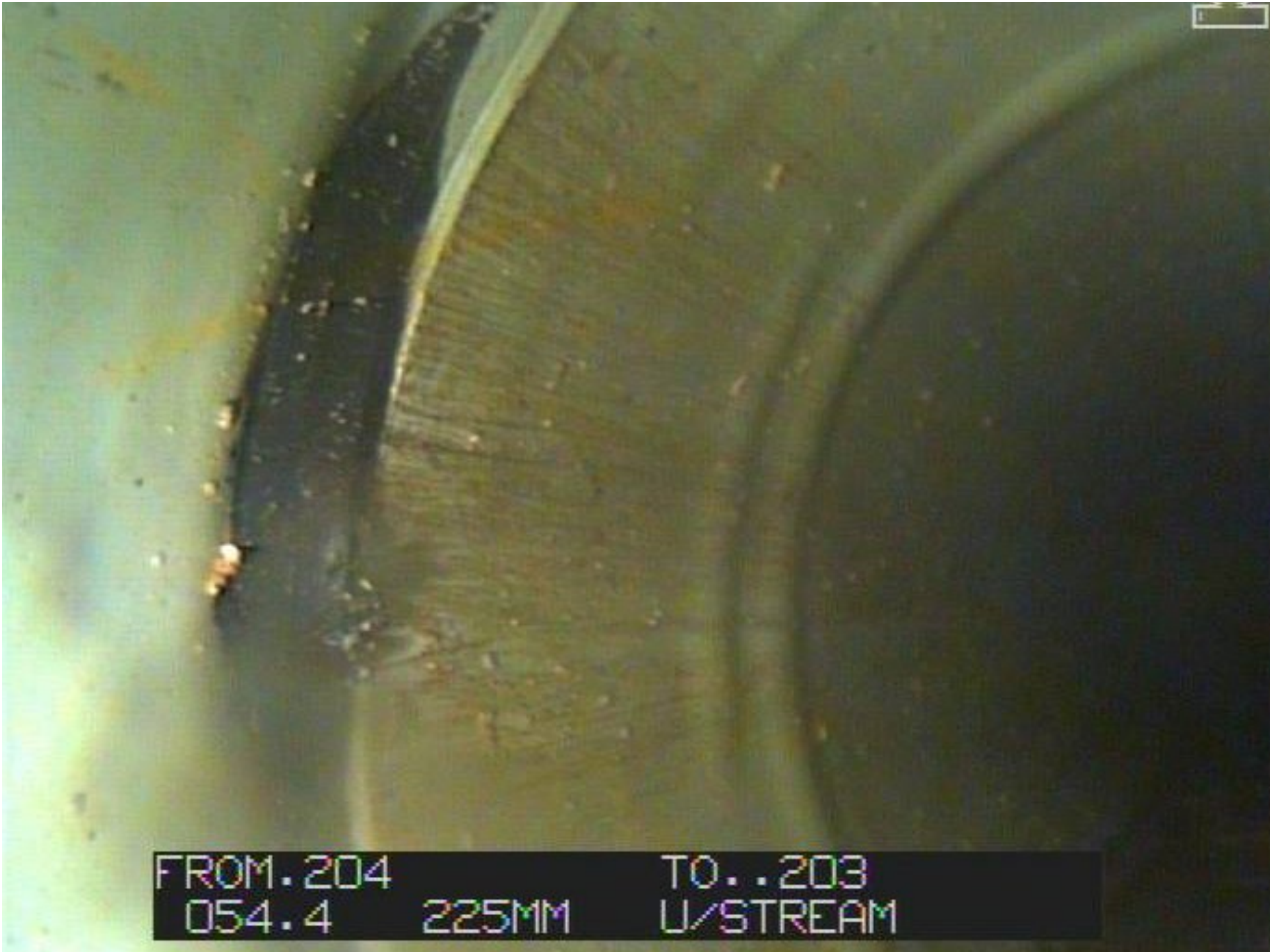
2°

166.30m



33 Kapyong Lines Holsworthy.
Officers Accommodation.

CABLE LEN. : +24, 00 m



FROM.204

054.4

225MM

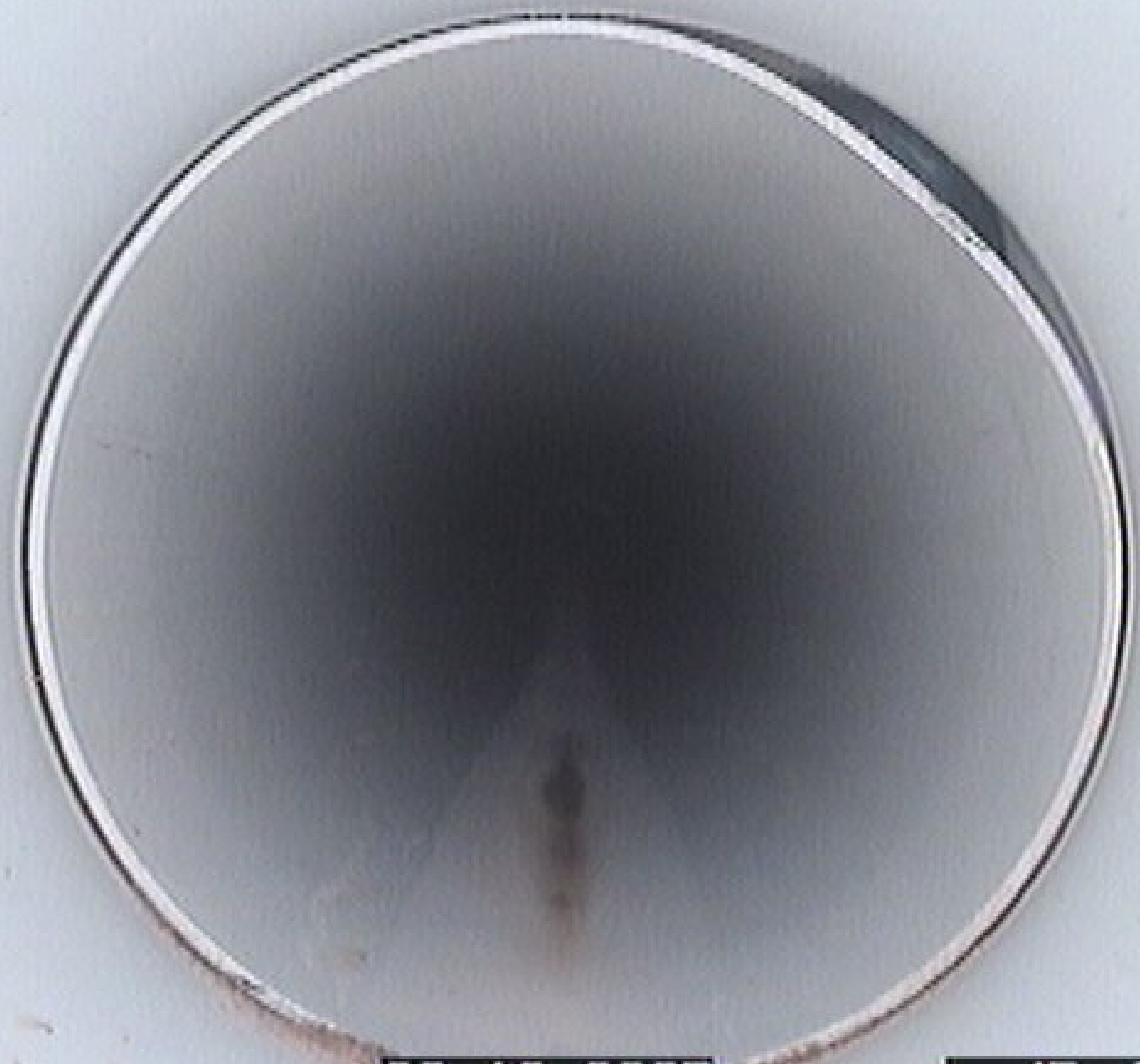
TO..203

U/STREAM

Defective junction, at 02 o'clock, diameter
dia 100 mm

09.10.2007

13.91m



09.10.2007

47.46m



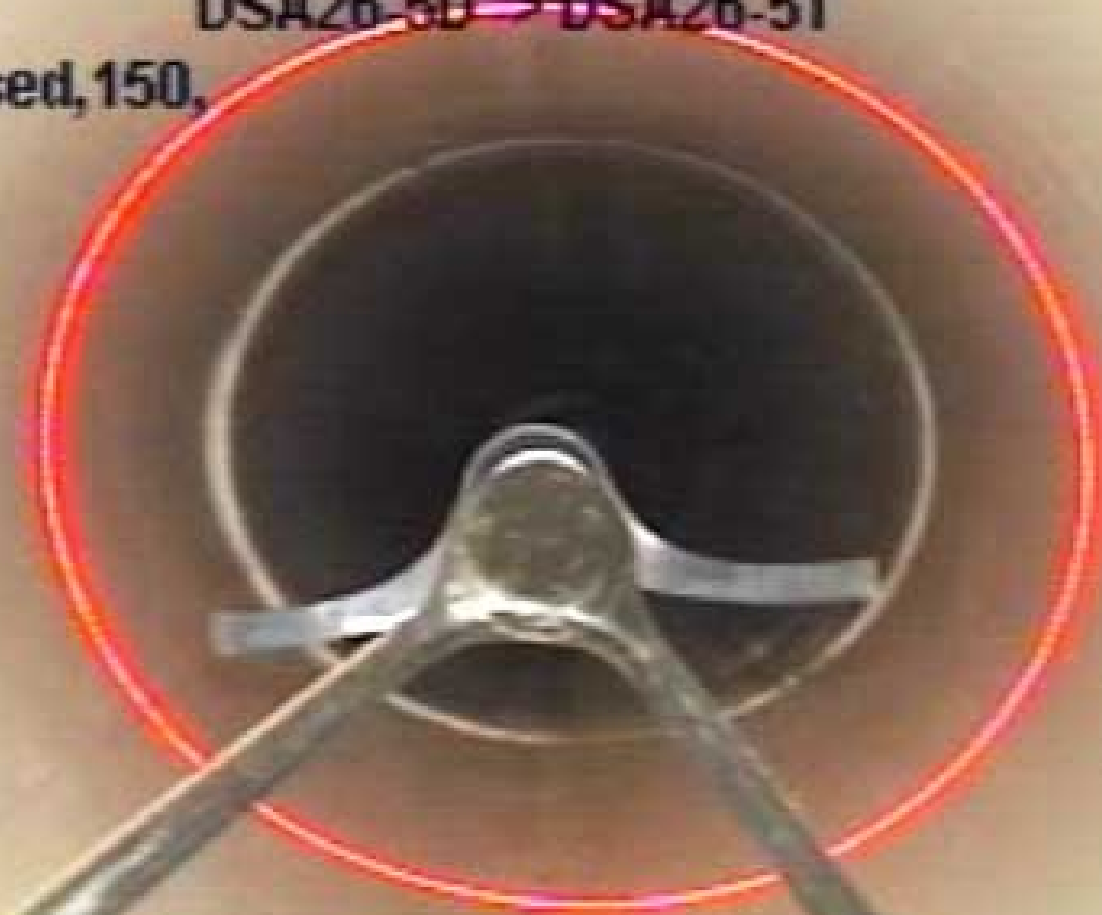
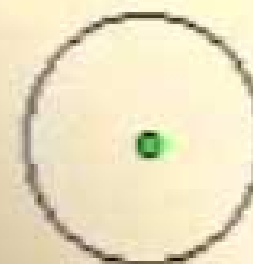
Debris (silt), 0-10 % cross-sectional area
loss, start

12. 10. 2007

0. 00m

Saul Avenue
PVC-Plasticised, 150,

DSA26-5D → DSA26-5T



00 00 00

30.04.08 PC: 16

+04.2 ‰ LC1: 006.00 m

All of these defects were built
into new sewers or drains.

They are not uncommon!



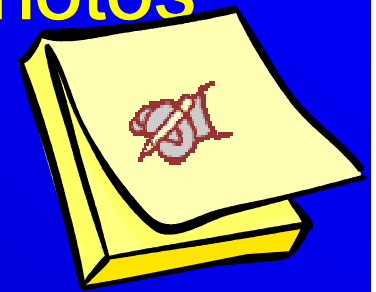
Some good reasons to inspect new lines

- A study by WRC (UK) in 1983 determined that the majority of sewer defects are a result of poor workmanship
- A Dept Transport & Road Research UK Laboratory 1989 study based on the assessment of 180km of sewers determined that many defects arise during or shortly after construction
- In 2005 Mornington Peninsula Shire Council (Victoria, Australia) found many defects in newly constructed stormwater drains



Prompted into action

- In 2005 I was involved in the revision of the Sewer Inspection Reporting Code of Australia WSA05 2002 when the photos from a CCTV inspection of new stormwater drains at Mornington Peninsula came to light
- It was clear that in the revision of the Code a much expanded section on acceptance criteria was necessary



Problems in new assets

- Unacceptable damage or defects from poor installation
- Unacceptable manufacturing defects in the installed pipe
- Pipework and fitting arrangements not in accordance with design, codes or specifications
- Damage from the installation of other utilities



Acceptance/rejection criteria drafted

- Tables listing defects considered unacceptable in new construction
- Specification for the inspection and reporting on features and defects in new assets including
 - standard of operation during inspection
 - requirement for the CCTV operator to be 'qualified'
 - reporting requirements



Inspection requirements from WSA02

22.7 CCTV INSPECTION

Carry out a CCTV inspection of specified sewers and maintenance structures in accordance with WSA 05. Use data capture software authorised by the Water Agency.

Apply the following requirements to the CCTV inspection:

- Use certified CCTV operators.
- Only accept CCTV videotapes of such quality that an accurate assessment of the internal condition of the sewer can be made.
- Provide the CCTV records to the Superintendent as specified.
- Apply the acceptance / rejection criteria of Appendix F of WSA 05.
- Rectify all defects prior to conducting any further inspection.

If CCTV equipment used to conduct the inspection is not calibrated to NATA's requirements for quantifying observations, record the estimated value as an addendum to the test report.

The Water Agency may specify alternative verification of the result prior to determining whether remedial action is required.



Some agencies that use CCTV acceptance inspections

- Sydney Water
- Mornington Peninsula Shire Council
- Darwin City Council
- ACTEWAGL
- South East Water (Victoria)
- Coffs Harbour City Council
- Mackay Regional Council
- and many others



Mackay Regional Council

- Inspects new sewers constructed by contractors using Council's own CCTV system and staff
- Provide a comprehensive report on defects that are unacceptable
- Report work as constructed data that differs from design or contractor supplied information



Example CCTV audit reports



AS CONSTRUCTED SEWER CCTV INSPECTION SUMMARY

AUDIT FILE REF: Removed for privacy
reasons

works req
Line 7, 4 to
line junction
required
Line 7, 5 to
Line 7, 5 to
apparent: 1
works req
Line 7, 5 to
indicates in
conductor
Line 7, 5 to
Line 14, 11
cunage: L
38.5m u/sr
Line 14, 11
quality test
Line 14, 11
indicates in
conductor
Line 1, 7 to
Line 1, 7 to
u/sr of



AS CONSTRUCTED FIELD AUDIT SEWER CCTV INSPECTION SUMMARY

AUDIT FILE REF: Removed for privacy
reasons MW JOB #: Removed for pri
reasons

Line 1, 3 to 4 - H.C.P for lot 10 - Design shows 20m, survey indicates 25
amendment to as con plans.
Line 1, 3 to 4 - H.C.P for lot 9 - Design shows 40m, survey indicates 43m
amendment to as con plans.
Line 1, 3 to 4 - H.C.P for lot 8 - Design shows 60m, survey indicates 63m
amendment to as con plans.
Line 1, 3 to 4 - Silt Sediment in line, requires flushing and extraction of
PVC effluents in line approx 65m u/sr of MH 4/1.
Line 1, 4 to 5 - Silt Sediment in line, requires flushing and extraction of
Line 1, 4 to 5 - H.C.P for lot 12 Vista Lane, design plan indicates manhole
connection with chainage of 31.5m, survey indicates line junction with ch
approx 77m u/sr of centre of MH 5/1.
Line 1, 5 to 6 - Silt Sediment in line, requires flushing and extraction of
Line 1, 5 to 6 - Grade of sewer reversed immediately downstream of MH
approx 1.5m, requires rectification works.
Line 12, 1 to 2/13 - H.C.P for lot 41 shown in design plan as MH stub s
indicates junction approx 1.7m u/sr of MH 2/13. Amendment to as
constructed plans required.
Line 13, 2 to 3 - Silt Sediment in line, requires flushing and extraction of
Line 13, 2 to 3 - H.C.P for lot 38 Vista Lane on design plan shows MH s
connection, survey indicates approx 2m u/sr of MH 3/13. Amendment
constructed plan required.
Line 13, 3 to 4 - H.C.P for lot 20 Vista Lane on design plan shows 20.3m



AS CONSTRUCTED FIELD AUDIT SEWER CCTV INSPECTION SUMMARY

AUDIT FILE REF: Removed for privacy
reasons MW JOB #: Removed for privacy
reasons

NATURE OF WORKS	
NEW DEVELOPMENT	<input checked="" type="checkbox"/> UPGRADE OR REPLACEMENT
ON MAINTENANCE	<input checked="" type="checkbox"/> OFF MAINTENANCE
OWNER COST <input type="checkbox"/> OTHER <input type="checkbox"/>	
<input checked="" type="checkbox"/> As Appropriate	

PROJECT DETAILS	
DEVELOPMENT NAME & STAGE	Removed for privacy reasons
STREET/ROAD	Removed for privacy reasons
TOWN/CITY	Removed for privacy reasons

CONTACTS	
CONTRACTOR	Removed for privacy reasons
Name	Removed for privacy reasons
Ph	Removed for privacy reasons



3 CONSTR SEWER CCT DIIT FILE REF

CONFORM
S Team Leader
Mackay Water Superv
ng Network Manag



AS CONSTRUCTED FIELD AUDIT SEWER CCTV INSPECTION SUMMARY

AUDIT FILE REF: Removed for privacy
reasons MW JOB #: Removed for privacy
reasons

survey indicates line junction approx 2m d/stream of MH 4/8. Amendments on as
constructed plans required.
Line 8, 6 to 13/1 - Silt/ sediment in line, requires flushing and extraction of debris.
Line was resurveyed 12.06.37, line flooded with water - suggested plug in line.
Line 8, 6 to 13/1 - H.C.P for lot 107 Firefly Crescent shows line junction at 10m,
survey indicates line junction approx 2.6m u/sr of MH 13/1. Amendments on
as constructed plans required.
Line 8, 6 to 13/1 - H.C.P for lot 108 Firefly Crescent shows line junction at 30m,
survey indicates line junction approx 24.5m u/sr of MH 13/1. Amendments on
as constructed plans required.
Line 8, 6 to 13/1 - H.C.P for lot 109 Firefly Crescent shows line junction at 50m,
survey indicates line junction approx 44.8m u/sr of MH 13/1. Amendments on
as constructed plans required.
Line 8, 6 to 13/1 - H.C.P for lot 110 does not have any detail on location. Need to
check with as constructed plan to ensure stub exists in MH-68.
MH 13/1 - Inlet stub leaking badly, requires repair. MH base leaking badly,
requires repair.
Line 11, 1 to 2 - Conduit shape deformed at approx 7.5m u/sr of MH 2/11,
contractor to perform quality test.
Line 11, 1 to 2 - H.C.P for lot 74 Milda Lane design plan show MH stub connection,
survey indicates line junction approx 1.6m u/sr of MH 2/11.
Line 3, 1 to 2 - Conduit lining damaged/ defective, (holes in lining) along

Line 1, 11 to 12 - H.C.P for lot 106 Firefly Crescent, design plan shows M/H stub connection, survey indicates line junction at approx 1.7m u/stream of M/H 12/1. Amendments to as constructed plan required.

Line 1, 12 to 13 - Silt/ sediment in line, requires flushing and extraction of debris.
Line 1, 12 to 13 - Rubber ring protruding approx 2.5m d/stream of M/H 12/1, contractor to repair.

Line 1, 13 to 14 - H.C.P for lot 107 Firefly Crescent, design plan show no connection (but has chainage of 10m), survey indicates line junction approx 2.6m d/stream of M/H 13/1.

ent,
is incorrect,
along
on, survey
provide
MH 3/3,
MH stub
M/H 3/3,
lock, contractor
in of debris.
line junction
4/11/1
as MH stub
M/H 12/1.
n of debris
4/12/1,
y no
approx 2.6m



How are repairs done on your
assets?




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12 KALLEY DR To 16 HELEN ST Lm
19/10/1999 08:35 225mm PVC 41.99m



020-1 MW TO 01 300mm CONC UP

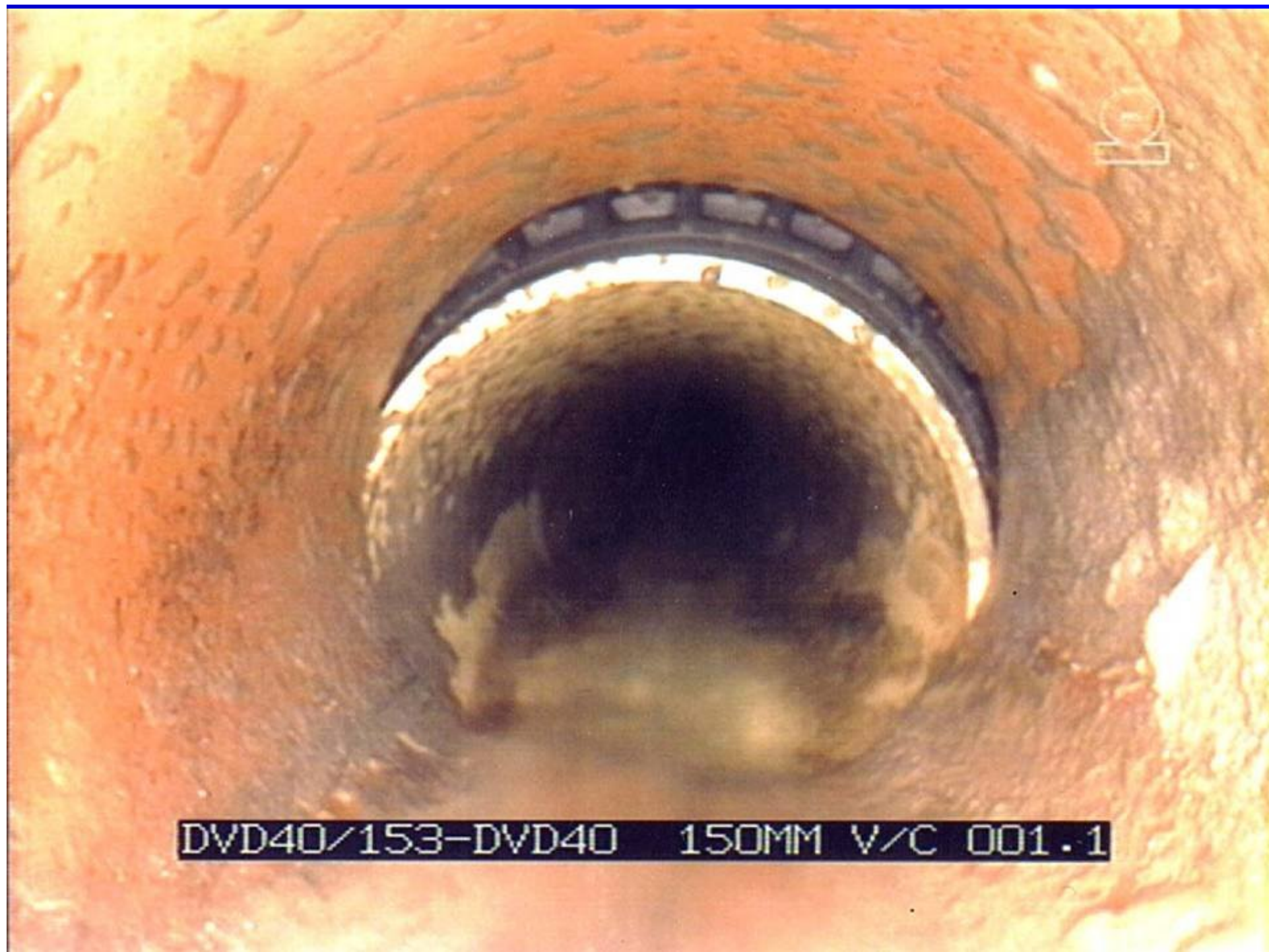


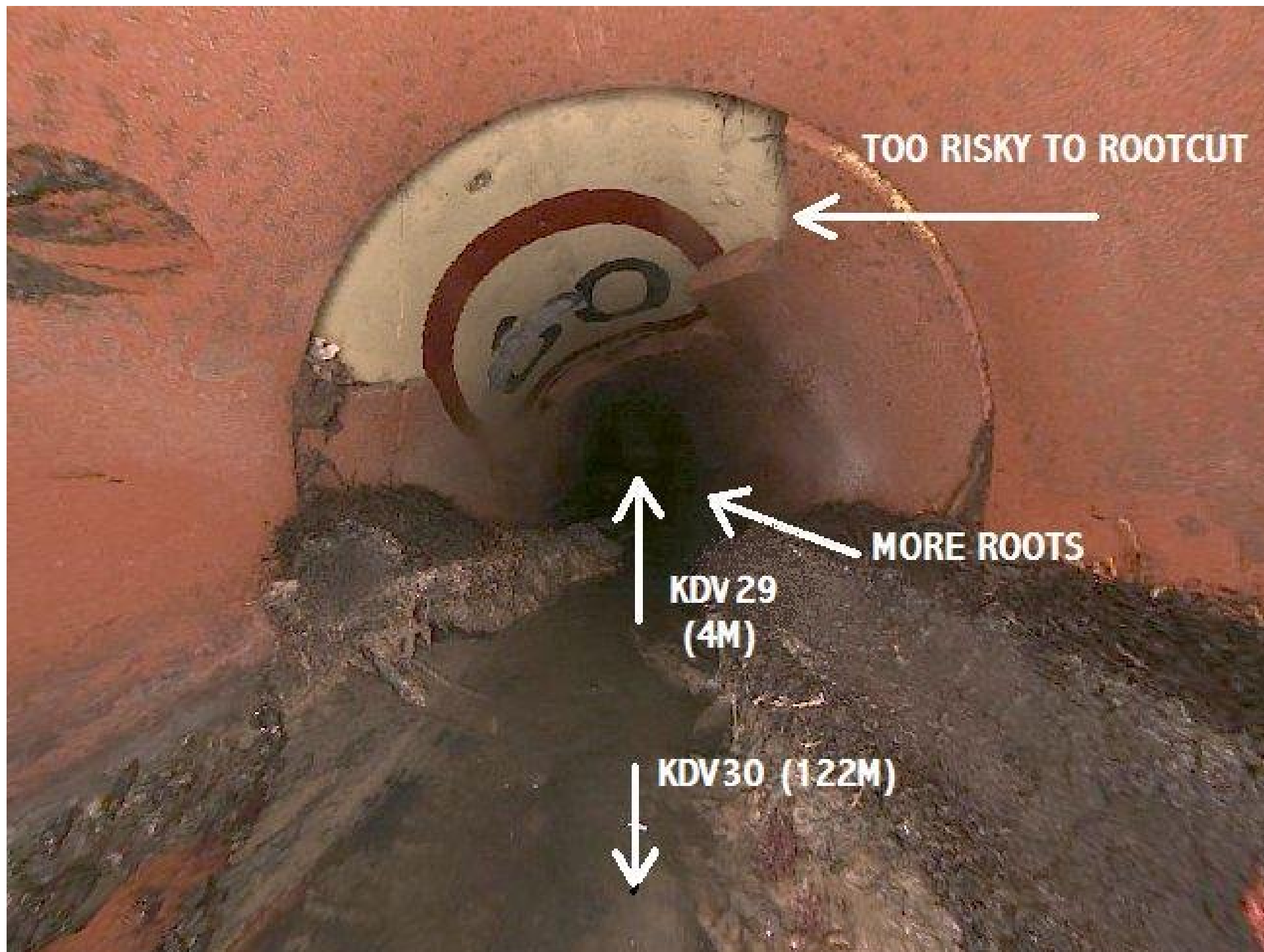
FROM.FLM-1 TO..NMB-17A
069.5 300mm D/STREAM

02 JUL 03



021.7 19408 - 19409 225mm VC DN





TOO RISKY TO ROOTCUT

MORE ROOTS

KDV 29
(4M)

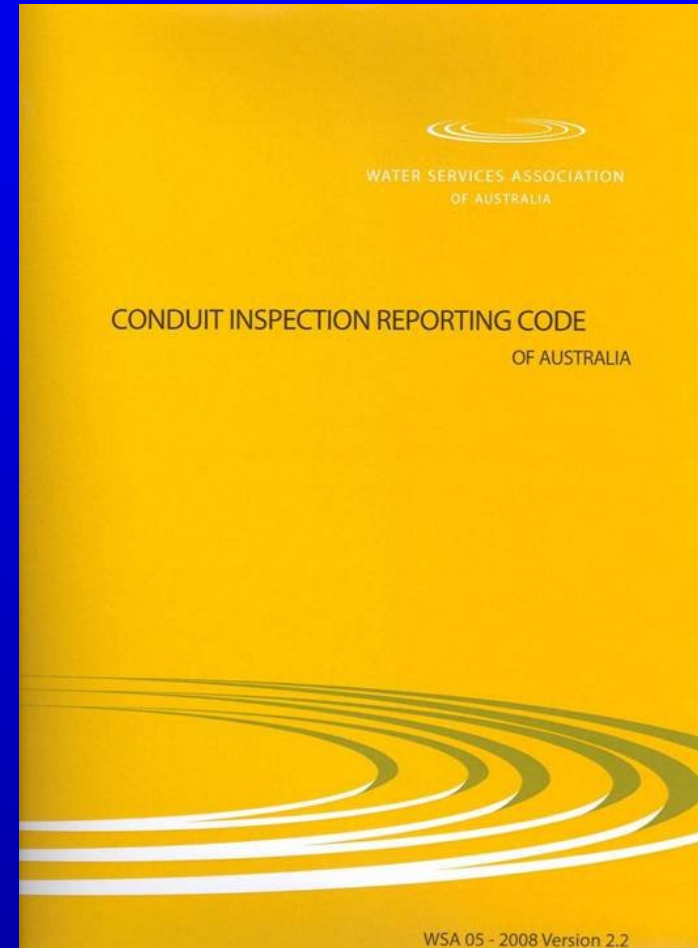
KDV 30 (122M)

CCTV inspections can be used
to verify the integrity and
standard of repairs!



Conduit Inspection Reporting Code of Australia WSA05-2008

- First published in 2006 by the Water Services Association of Australia
- Based on the European Code and the Australian Conduit Condition Evaluation Manual (1991)
- Replaced the Sewer Inspection Reporting Code of Australia WSA05-2002
- Incorporates input from Water Agencies and operators across Australia



Conduit Inspection Reporting

Code of Australia WSA05 - 2008

- Provides a simple coding system for defects and other features of conduits to describe:
 - structural defects
 - service conditions
 - construction, repair and rehabilitation features
- Incorporates a compendium of typical defects and features on WSAA website



Conduit Inspection Reporting

Code of Australia WSA05 - 2008

- Incorporates preliminary grading of structural and service conditions of the conduit
- Includes acceptance standards for new sewers
- Provides operational standards that include
 - camera speed
 - linear measurement
 - data display
 - requirements for recording images



Appendix F WSA05-2008

TABLE F4

ACCEPTANCE CRITERIA FOR RIGID SEWERS – VITRIFIED CLAY, STEEL REINFORCED CONCRETE

Defect/Feature	Characterisation 1	Characterisation 2	Quantification 1	Acceptance determination and explanation
Cracking C	L, C, S, or M	S		<p>Surface cracking is common in concrete and is usually not of concern. Such cracking is usually of limited extent and does indicate structural failure. However, surface cracking that is extensive may indicate a problem with concrete quality. Reported in remarks for the asset owner to review</p> <p>Surface cracking is unlikely in VC products currently on the market although it should be noted that internally glazed VC pipes are now again available. If surface cracking is observed report in remarks for the asset owner to review</p>
	L, C, S, or M	W		Not acceptable – all of these types of cracking are indicative of poor handling, unsatisfactory installation and/or overloading
Fracturing F	L, C, S, or M			Not acceptable
Breaking B	D, M, or E			Not acceptable
Deformation D				Not acceptable
Collapsed X				Not acceptable
Porous conduits (pipes) PP				Not acceptable
Surface damage S	S, AV*, or W			Report and refer to asset owner for acceptance determination
	Z			Identify, report and refer to asset owner for acceptance determination
	AP*, AM*, RC*, CP*, H* or WS*			Not acceptable – unlikely to be observed in new construction
	RV* or RVP*			Not acceptable – cover to reinforcement is clearly less than specified in relevant pipe standard

* Not applicable to VC

continued

Defect/Feature	Characterisation 1	Characterisation 2	Quantification 1	Acceptance determination and explanation
Joint displacement JD	L			Not acceptable – if joint displacement exceeds maximum specified by manufacturer for the joint
	R		>5 mm for pipe sizes up to DN250 >10 mm for pipe sizes from above DN250 to DN500 >20 mm for pipe sizes above DN500	Not acceptable
	A			Normally unacceptable on 'straight' pipelines (see maximum limits for 'curved' pipelines below). Report deflection and refer to asset owner for acceptance determination For 'curved' pipelines using 'pulled' pipes the distance between the end of spigot and end of socket (adjoining pipe) at worst point and the angular deflection at the joint shall be within the range specified by manufacturer for the joint. Refer to asset owner for acceptance determination
Joining material (seal) intrusion) JI	R	N, HH, HL or B		Not acceptable
	Z			Report and refer to asset owner for acceptance determination
Point repair RP	L, I, S, H or IC			Some techniques may not be acceptable in new pipelines. Report and refer to asset owner for acceptance determination
	Z			Identify repair technique, report in remarks and refer to asset owner for acceptance determination
Defective repair RX	M or P			Not acceptable
	B or Z			Determine extent of 'bellies' or other defects, report and refer to asset owner for acceptance determination
Obstruction OB	B, M, I, J or C			Not acceptable
	Z			Report and refer to asset owner for acceptance determination
	P or S			Report and refer to asset owner for acceptance determination



TABLE F6

ACCEPTANCE CRITERIA PIPE AND FITTING CONFIGURATION – ALL SEWERS

The configuration of pipes and fittings in a new sewer is usually defined in design drawings, standard drawings and specifications. Compliance with some of these requirements may be determined by CCTV inspection.

The operator 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 table describes nominated features that are to be examined for acceptance.

Feature	Description	Acceptance determination and explanation
Rocker pipes	<p>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.</p> <p>The purpose is to allow for differential settlement between the structure and the pipeline without cracking, fracturing or distortion of the pipe adjacent to the structure.</p>	<p>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.</p> <p>The operator should record the distance at each joint adjacent to the structure to determine the length of the rocker pipe and report it in remarks.</p> <p>Length outside of tolerance of ± 150 mm of required length not acceptable – refer to asset owner for acceptance determination.</p>
Bends	<p>Bends occur in some sewers at changes of direction and/or grade. In some cases compound bends (vertical and horizontal) may be encountered.</p> <p>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.</p>	<p>Not acceptable if the camera unit cannot pass through the bend. In stormwater drains the bends must be traversable by the CCTV camera and transportation unit.</p> <p>Not acceptable if jointing materials at mitres intrude more than 10 mm into the pipe.</p> <p>The transition to bend from straight line must not exceed the angular deflection for the joint system used. Record joint deflection if observable and refer to asset owner to assess for acceptance determination.</p> <p>Where the installation of the bend results in ponding the acceptance criteria applied for maximum water level in the previous tables shall also be applied.</p> <p>The distance at the start and finish of bends shall be recorded in the inspection report.</p>
Connections	<p>This is where another sewer to provide a service for a customer has been connected to the pipeline being inspected after the pipeline has been installed. The connection is formed by making a hole in the original pipe and setting the connecting pipe in place.</p> <p>This feature is not part of new sewer construction.</p>	Not acceptable

continued



Inspection requirements

F2 CCTV INSPECTION REQUIREMENTS

CCTV acceptance inspection of conduits shall be conducted in accordance with the requirements of [Clause 2.5](#). In addition, the operator 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 parameters to determine acceptance. Hardware and software used in measuring the parameters shall be correctly calibrated for each application using the manufacturer's recommended methods.



CCTV operator 'Qualifications'

F3 QUALIFICATIONS OF CCTV OPERATORS

CCTV operators shall hold a Statement of Attainment in

NWP331B *Inspect conduit and report on condition and features*

and recognised qualifications in:

- (a) Occupational health and safety;
- (b) Traffic control; and
- (c) Confined space entry.



Reporting

F4 ACCEPTANCE REPORTING

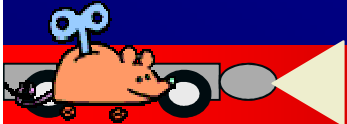
As well as the reporting in accordance with [Clause 2.6](#), the acceptance determination for each defect or feature nominated in the following tables **shall be noted in the remarks section** of the inspection report for each such defect or feature observed in the new construction.

Still photographs shall have a resolution of 640 X 480 pixels and be captured with the camera stationary.

A still photograph along the axis of the conduit at the defect shall be captured and at least one photograph of the defect centred in the picture shall be captured.

Video clips shall be captured as required to illustrate features with movement.

Reports shall be prepared and submitted in hard copy with photographs and include a summary of all recorded defects and observations where the asset owner is required to make a determination for acceptance.



Compendium

WSAA C1



Code	Ch1	Ch2	Q1	Q2	Circ Loc'n	Long'l	Cont	Remarks
JN		O	150		9	9.2		
JX	BC					9.2		Repair required

Commentary

This is a junction fitting which appears to be open (JN-O) with an estimated lateral (connecting pipe) diameter of 150 mm at 9 o'clock.

The connecting pipe or junction lateral has a large circumferential fracture near the joint with the main part of the fitting (JX-BC).

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 is required' could be warranted.

WSAA C1



Code	Ch1	Ch2	Q1	Q2	Circ Loc'n	Long'l	Cont	Remarks
D	V		11-15	12		A	A	Arching support lost
BS			<10	12		A	A	RHS of central brick
BS			<10	12		A	A	LHS of central brick

Commentary

The crown of this oviform (ovoid) brick conduit has deformed vertically (D-V) by an estimated 11-15%. 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 'heating' failure of brick conduits.

As far as we can see the deformation is continuous so 'A' (applicable) is noted in the continuous field.

Brick separation in the crown (BS) is also evident. Two observations are reported to record the separation on both sides of the central brick course both with the 12 o'clock location reference. The width of the separation is estimated to be less than 10 mm. Both of these defects are continuous.

Brick conduits exhibiting this feature are at risk of imminent failure and the asset owner should be advised immediately.

WSAA C1



Code	Ch1	Ch2	Q1	Q2	Circ Loc'n	Long'l	Cont	Remarks
X			900			A		Collapsed conduit length undamaged and repairable
VV					9	5	A	

Commentary

The defect at this location is a massive radial displacement at a joint. It appears that the whole conduit length has been displaced and that the displacement is so large a void visible (VV) outside the conduit. This defect has gone beyond 'joint displaced, radial' as well as beyond 'broken - displaced' conduit.

The conduit can be considered as collapsed (X) because there is less than 75% of the diameter of the pipe available. The length affected by the collapse appears to be one conduit length estimated to be 900 mm and which appears to be undamaged. For this reason it is worthwhile noting to the asset owner that the collapse is repairable.

UNCONTROLLED IF PRINTED

File Name: JN_JXBC_1
Doc Name: Compendium of Conduit Features
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Issue 1
10 October 2006
Page 1 of 1

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File Name: DV_BS_1
Doc Name: Compendium of Conduit Features
Copyright
Issue 1
19 October 2006
Page 1 of 1

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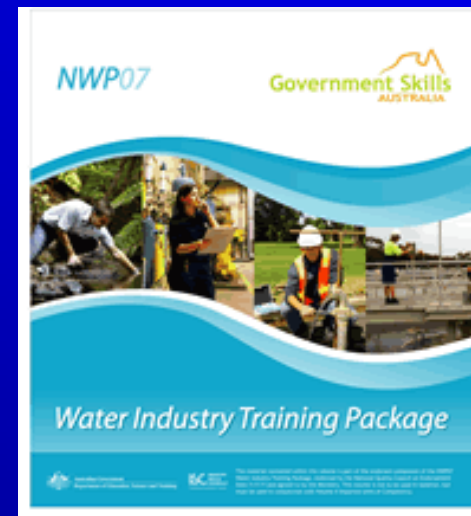
File Name: X_VV_1
Doc Name: Compendium of Conduit Features
Copyright
Issue 1
19 October 2006
Page 1 of 1



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'Qualifications' are essential for CCTV operators and supervisors/managers

- Statement of Attainment in –
 - *NWP331B - Inspect conduit and report on condition and features for camera operators*
 - *NWP440A - Supervise conduit inspection and reporting for supervisors/managers*



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Training

- Our training for supervisors/managers and operators brings them together on the same course
- Supervisors/managers attend the first 3 days covering theory and practical exercises



Training

- Operators cover the same content but have a camera operation practical session and spend an additional day on inspection techniques and maintenance
- Both groups complete a preliminary assessment during the course
- Final assessment is based on defined evidence from the workplace on actual work assignments carried out by the candidate



Peter Slingsby at Ringwood explaining the importance of good connections



Participants at work in Darwin course



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Conclusion 1

- CCTV inspections of new and repaired sewers and stormwater drains *will* find unacceptable defects and features that may
 - reduce asset life
 - impair operational performance
 - increase maintenance costs



Conclusion 2

- CCTV operators must have a Statement of Attainment in *NWP331B Inspect conduit and report on condition and features*
- Supervisors and managers must also have Statement of Attainment in *NWP440A Supervise conduit inspection and reporting*



Conclusion 3

- The Conduit Inspection and Reporting Code of Australia WSA05 - 2008 is an essential reference standard for the inspection and reporting of the condition and features of new and existing sewers and stormwater drains
- Appendix F of that Code provides guidance for the acceptance of new assets using CCTV systems.



End



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