CCTV INSPECTION OF SEWERS AND STORMWATER DRAINS, TRAINING OF OPERATORS AND MANAGERS, AND THE CONDUIT INSPECTION REPORTING CODE OF AUSTRALIA

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ABSTRACT

CCTV acceptance inspection of new sewers and stormwater drains is standard practice for many water authorities and councils in Australia. The Conduit Inspection Reporting Code of Australia WSA05-2008, published by the Water Services Association of Australia, provides guidance to CCTV operators and asset owners in determining the acceptability of defects and features of sewers and drains. Unit *NWP331B Inspect conduit and report on condition and features* from the National Water Training Package NWP07 provides the basis for training, assessment and credentialing of operators involved in CCTV inspection of new and existing sewers and stormwater drains.

1.0 BACKGROUND

In 1977 I became responsible for the testing and inspection of new sewers in the Hunter District Water Board (now Hunter Water Corporation). We had a crew of two people who used the low pressure air test to determine the integrity of the new pipelines and mirrors to inspect the line from the manholes.

We also inspected manholes for leaks, channel configuration and other aspects of construction.

After a while in this role my boss approached me and said that the University of Newcastle has designed and built a closed circuit television (CCTV) camera system for the inspection of Hunter Water's sewers.

The system was crude by today's standards. It was developed from a Cannon black and white surveillance camera which was fitted into a water tight capsule along with a small motor and 'rubber band' to handle focussing. Lighting was provided by a single quartz halogen 12V bulb encapsulated in a high temperature and thermal shock resistant glass capsule. We broke this capsule very quickly and ran with a naked quartz halogen bulb until the system was scrapped.

The cable was made up with a permanent connection to the camera body and consisted of a soft PVC conduit containing lighting and focus control cables as well as coaxial video cable and steel wire for strength. The camera was supplied with skids for DN150 and 225 pipes and was to be towed through the pipes.

My job was to make all the bits and pieces into an operational tool. This required the manufacture of winches, cable sheaves and a measuring system. We also needed a generator, a way of recording a video of the inspection, a system for capturing still photographs of defects, a reporting procedure for logging of the observations and a van to house the operator, control and recording equipment as well as transporting this bulky gear around.

We eventually settled on a Bedford van for our 'office on wheels' and transport of most of the gear. It was fitted it out with a bench ('work station' sounds a bit grand), TV monitor, SLR camera for capturing still images from the monitor, a massive 'Umatic" video recorder and numerous dials and switches. On 9 December 1977 we undertook out first inspection.

Over the following months and years we learnt a lot about our gear, we modified bits and pieces, created new gadgets, added more lights for larger conduits, tried rafts and floats in high flow sewers and developed a rough system for recording the distance of the camera in the sewer from the starting point. **In recent times this starting point has become an issue of concern because we know that records could be at least 0.5m in error if care is not taken in setting up.** (I can't remember being too worried at the time but we were still novices in this new specialisation of CCTV sewer inspection.)

It was what we learned about the condition of our sewers and what workers had managed to do to them that blew our minds in those early days. Cracking, fracturing, breaks and collapsed pipes were, of course, common in old earthenware and vitrified clay (VC) pipes. The work done on the sewers by our own workers was something else and I still cannot understand how they managed to botch things up so often.

We also used our CCTV to inspect newly constructed sewers and found some unexpected defects. (Little did I know that 25 years later I would be involved in a National Code that included CCTV acceptance inspection criteria.)

After several years involved in testing and inspecting old and new sewers I became interested in training and standards. I was offered a position as Engineer for Technical Training and went on to develop standard construction practice drawings and specifications as a basis for training. I gained more staff and we set up training programmes based on the novel idea (at the time) of assessing competency at the end of training.

Move on ten years or so and after a few years with Tubemakers Water Training I found myself working as a casual trainer at Sydney Water's Training Centre at Birrong. My main role there was training of contractors to Sydney Water to enable them to meet the accreditation requirements for water supply and sewerage construction. Fortunately this time coincided with the development of Water Services Association of Australia's Codes for water supply and sewerage design and construction and I was able to contribute.

For some years prior to my involvement at Sydney Water a course had been conducted on CCTV inspection of sewers and drains using the Australian Conduit Condition Evaluation Manual (ACCEM), however the trainer for that course had left the organisation.

I was asked to resurrect the course and with some help from a respected CCTV inspection operator we conducted several courses based on the 1991 ACCEM Code. This Code did not address the inspection of new sewers or drains but was aimed at the condition assessment of existing assets and setting a procedural/technical standard for inspection.

Sydney Water adopted CCTV acceptance inspection of sewers in new subdivision developments in about 1998 in response to poor workmanship being discovered in

contract work.
CCTV inspection was formalised with a specialist accreditation for 'Field Testers' undertaking CCTV inspections. The 'Field Tester' accreditation also had specialisations for low pressure air testing and for vacuum testing of manholes (as well as pressure testing of water mains).

The acceptance criteria used by 'Field Testers' however seems somewhat vague. They were required to submit reports and a video of the inspection to Water Servicing Coordinators who were responsible for that particular development and for accepting the new asset on behalf of Sydney Water. This was seen as a way of verifying the workmanship of pipeline construction along with low pressure air tests.

2.0 National Qualifications for CCTV Operators and Supervisors

Around 2000 the National Water Training Package was under review. John Allen and Stan Stringer, who had previously collaborated on the Sydney Water course, proposed a new Unit of competency for operators of CCTV conduit inspection systems. This Unit became 'NWP331A Perform conduit condition assessment' and provided a nationally recognised basis for training, assessment and the awarding of a Statement of Attainment. This Unit was subsequently modified in the recent revision of the Training Package NWP07. We also proposed an additional Unit for those supervising/managing CCTV inspections and it was included in NWP07. The elements of the two Units are shown below.

NWP331B - Inspect conduit and report on condition and features (for operators)

- Plan and prepare for conduit inspection
- Operate and maintain equipment
- Identify and code defects and other features observed during conduit inspection
- Withdraw inspection equipment and reinstate system operation
- Review, record and report work

NWP440A - Supervise conduit inspection and reporting (for supervisors and managers)

- Determine inspection reporting requirements
- Review video images, data and reports from inspections
- Identify and code defects and features from video images of conduit inspection
- Prepare conduit inspection reports for client

Streamline Learning has been conducting training in these Units for operators, supervisors, council managers, water agency staff and others since 2004 in several centres in Australia including East Ringwood (Victoria), Adelaide, Sydney, Darwin, Mackay, Bega, Moss Vale, Gosford and others.

The course is conducted over four days for operators and supervisors/managers attend the first three days of that course. A preliminary assessment is part of the course and this is followed by workplace practice then submission of workplace evidence for final assessment and or feedback.

Streamline Learning works under the auspices of Goulburn-Murray Water which is a Registered Training Organisation.

3.0 National Code for Inspection and Reporting on the Condition of Sewers and Drains

Through my involvement with CCTV training at Sydney Water, I became aware that the Water Services Association of Australia (WSAA) was undertaking a revision of the 1991 ACCEM code. I somehow managed to get to the revision working party meetings and was able to make a contribution to this Code which became the Sewer Inspection Reporting Code of Australia, WSA05-2002.

The rationale for the new Code was to expand condition and feature reporting to create a more comprehensive basis for asset management. It was also decided to base the Code on the European standard for sewer and drain condition reporting - EN 13508-2 Establishment of the condition of Drain and Sewer Systems Outside Buildings. The new Code retained some of the ACCEM features but was a substantial departure in terms of structure which followed the European Standard.

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 'hearting' 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.

Figure 1: ***Page from WSAA Compendium***

For the first time the Code included an appendix tabling acceptance criteria in relation to new sewers.

Unfortunately the take up of the 2002 Code was slowed because of the lag time in the redevelopment of reporting software and ACCEM, with its Sewrat DOS based software for reporting, continued to be used. Some still use it.

Figure 2: ***Broken rubber ring - defect in new stormwater drain***

Streamline Learning began delivering training in accordance with WSA05-2002 in 2004. We soon realised that there were some shortfalls in the Code and began to document suggested changes and additions.

A substantial revision of WSA05-2002 got underway early 2005 and I was engaged by the Water Services Association of Australia (WSAA) to assist in that process. Part of this work was to produce guidance coding and commentary for typical and non typical defects in sewers and drains which was to form a 'Compendium' available on the WSAA website. One page from the Compendium is shown to the right.

Around this time I heard of some failures in new concrete stormwater pipes constructed in a new development in Mornington Peninsula Shire, Victoria. After seeing photographs of these defects in new pipe (example on right) I decided to draft a more comprehensive acceptance criteria for new sewers and drains to be incorporated in the revised Code. The revised Code became the Conduit Inspection and Reporting Code of Australian, WSA05-2008.

The new acceptance criteria went from one page to 18 and incorporated rigid and flexible pipes for sewer and stormwater installations. Detailed criteria are in a tabular form in an appendix titled, Specification for CCTV Inspection Acceptance Criteria for Newly Constructed Sewers and Stormwater Drains'.

Included in this specification is the requirement that the operator holds a Statement of Attainment and required aspects of the inspection and reporting are specified.

Part of Table F1 (rigid stormwater drains) from WSA05-2008 is shown below.

TABLE F1

ACCEPTANCE CRITERIA FOR RIGID STORMWATER DRAINS – STEEL REINFORCED CONCRETE, FIBRE REINFORCED CEMENT

Defect/Feature	Characterisation 1	Characterisation 2	Quantification 1	Acceptance determination and explanation
Cracking C	L, C, S, or M	S		Surface cracking is common in concrete and is usually not of concern since it is usually of limited extent and not related to structural failure. However, surface cracking that is extensive may indicate a problem with concrete quality and should be reported in remarks for the asset owner to review
	L, C, S, or M	W		Not acceptable – subject to asset owner review. All of these types of cracking are indicative of poor handling and/or 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			Describe, identify if possible, report in remarks and refer to asset owner for acceptance determination
	AP, AM, RC, CP, H or WS			Not acceptable – should not be observed in new construction
	RV or RVP			Not acceptable – cover to reinforcement is clearly less than specified in relevant pipe standard
Deposits on wall or in invert DE	E			Not acceptable - should not occur in new pipeline
	S or R		>10%	Not acceptable
	C		>5%	Not acceptable
	W or Z			Describe, identify if possible, report in remarks and refer to asset owner for acceptance determination
Exfiltration EX				Not acceptable. Exfiltration is most likely associated with a joint defect or broken pipe

There are good reasons to inspect new assets -

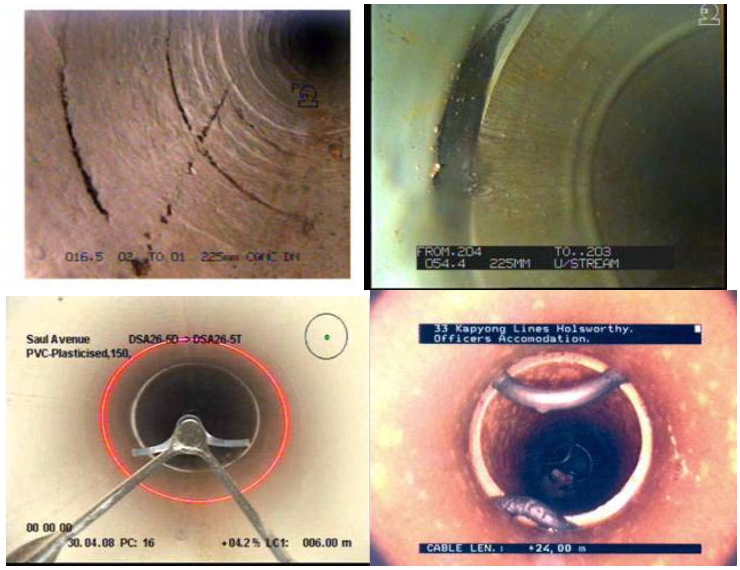
- One study determined that the majority of sewer defects are a 'result of poor workmanship' – WRC report 1983
- Another study based on the assessment of 180km of sewers determined that 'many defects arise during or shortly after construction' – UK Dept Transport & Road Research Laboratory 1989
- Mornington Peninsula Council found many defects in newly constructed stormwater drains - 2005

Why wouldn't an agency want to inspect their new asset? Acceptance inspection is critical if you want to:

- Identify defects in conduits that are likely to reduce the service life of the asset or contribute to high maintenance costs
- Identify conduits with manufacturing defects not detected before installation
- Identify poor workmanship
- Verify that the configuration of the asset is in accordance with design and construction standards
- Provide supplementary information for work-as-constructed data.

To do this work effectively CCTV operators and managers need to aware of the requirements of various codes and specifications and should have the appropriate qualification.

The following examples show some defects that were built in to new assets and can only be detected by CCTV inspection



<u>Figure 4:</u> ***Examples of defects in new sewer and stormwater installations***

4.0 CONCLUSION

The technology for CCTV inspections of sewers and conduits has come a long way. It is a tool that must be used to confirm the integrity of new sewers and stormwater drains.

Operators and those using the data from inspections and reports must also be trained and qualified to ensure new assets are constructed to appropriate standards and in accordance with designs.