CONDITION ASSESSMENT FOR STORMWATER DRAINAGE ASSETS

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Abstract

This Paper describes the Practice Note - Condition and Performance Assessment Guidelines for Stormwater Drainage developed by the National Asset Management Strategy Group (NAMS.AU) of the Institute of Public Works Engineering Australia (IPWEA). This SWD Practice Note is the latest in a series of Practice Notes to assist practitioners in applying best practice for condition assessment for various asset classes. The aim is to draw together most appropriate contemporary practice into a national approach and encourage consistency of data collection and outputs.

This Guideline fills a gap by focusing especially on SWD systems including pipes and culverts, lined open channel systems and the various collection devices such as gully pits and field inlets and structures for access to buried assets. Structures for accepting inflow into or outflow from detention basins into some form of conduit or channel can also be assessed under these Guidelines as can structures acting as gross pollutant traps. The Guidelines adopt a risk management approach to condition assess a network of SWD assets and arrive at proposed actions from maintenance to long term remedial works.

With the assistance of the expertise and technology being employed by Geospatial Data Services and Pipe Solutions who have provided valuable input to the Guidelines, this Paper also highlights some of the innovative and cost effective options available to practitioners to gather camera survey data of pipe and conduit condition and link these to GIS and other software.

For further information on obtaining a copy of the SWD Practice Note, go to www.nams.au.com

Key Words: Asset Management, Condition Assessment, Stormwater Drainage, Camera survey, Data Management

Introduction

Condition assessments are technical inspections carried out by competent assessors to evaluate the physical state of SWD components and their ability to deliver the services required.

Condition assessment generally comprises and results in:

- physical inspection of SWD systems to assess the actual condition of the assets in comparison with the asset owner's desired standard of service;
- identification of both short-term maintenance works and longer-term renewals or refurbishments, required to bring the condition of the SWD system up to, or maintain it at, an agreed condition

standard to provide the required level of service;
- ranking of these maintenance works and longer-term renewals in order of priority;
- determination of actions by suitably qualified/experienced personnel to mitigate any immediate risk until remedial works (or other actions) can be taken to address problems.

Condition assessment is but one aspect of SWD management. It is vitally important to have a good knowledge and understanding of the condition of the assets to then develop appropriate strategies and actions for maintenance, major replacements, refurbishments and possible future investment on new works.

Scope and Purpose of the Guidelines

The Guidelines are applicable for a variety of SWD systems including traditional underground conduit systems (pipes, culverts) as well as lined open channel systems. These systems include the various collection mechanisms such as gully pits and field inlets and structures for access to buried assets. The Guidelines do not cover unlined channels, natural waterways, constructed wetlands, other stormwater quality improvement devices (SQIDS) (except for gross pollutant traps or screens) nor detention basins and the like, which are deemed to be more in the province of other documents that address open space or WSUD management.
Structures or conduits associated with detention basins can however be assessed under these Guidelines.
All of the usual materials one would expect to find in these assets are covered with the exception of brick lined conduits which are deemed to be a specialist (possibly heritage listed) category however it is intended to add these in later editions.
The intention of these Guidelines is to provide Practitioners with the necessary principles and procedures to enable the condition and performance assessment of SWD with the main outcomes being:

- Reviewing and updating the register of SWD system assets and breaking these assets into appropriate components;
- Condition Assessment based on risk profile and sampling to rate each component inspected and enable an estimate of remaining useful life;
- Risk analysis based on condition and criticality to predict the timing of future renewals and replacements of SWD components;
- Reporting including a SWD summary report, component schedule, valuation report, and an expenditure profile.
- Work schedules (maintenance, renewals and new works) and financial planning.

Levels of Service

An important part of managing SWD, particularly when considering long term implications, is to assess the desired level of service the community expects of the SWD network which may require periodic consultation. This is particularly important for the setting of design standards for future construction either by developers or by asset owners.
When considering levels of service and the outcomes from the condition assessment process, a number of other critical issues may well have significant bearing on the actions subsequently being planned. These issues include, but may not be limited to, the following:-

- Development occurring in the catchment that may require future upgrading of the existing SWD system.
- Changing standards such as rainfall intensity data, runoff co-efficients, design return periods for rainfall events, pollution control measures, etc.
- New technology impacting on materials being utilized.
- Changing community standards for safety, amenity, flood immunity etc.
- Climate change impacts – varying rainfall intensities, sea level rise and the consequence of increased tailwater levels etc.

Risk and Criticality

The Guidelines follow the risk management principles as generally outlined in AS/NZ ISO Standard 31000 and in documents such as the International Infrastructure Management

Manual (IIMM). This involves the steps of risk identification, risk analysis, risk treatment, and a risk mitigation plan.

As part of the risk assessment process, it is important to understand how SWD systems and components of those systems, may fail in their ability to deliver the service required of them. Such failure can range from fairly minor diminution in capacity of operation through to full collapse or failure due to blockage or the like, resulting in catastrophic impacts on the surrounding property and the broader community. These adverse impacts can include:

- Flooding of property
- Flooding of roads, pathways or other public space
- Hazards to traffic
- Hazards to the public - community users
- Environmental damage including erosion, scour, pollution

The Guidelines address the various ways in which the SWD components might begin to show some form of "distress" that then impedes their ability to perform to their design level of service delivery capacity, leading ultimately to potential full failure of the system. Examples for say pipelines can be listed as:

- Structural Defects
  - Collapse
  - Displaced joint
  - Cracking
  - Fracturing
  - Surface damage
  - Breaking or deformation
- Serviceability and other Defects
  - Siltation or Debris
  - Erosion of the invert
  - Acid – sulphate attack
  - Defects in lining where applicable
  - Obstruction
  - Root intrusion
  - Vermin
  - Aesthetics – graffiti etc

For SWD systems, the seriousness of risks associated with these assets can vary, making some parts of the system more critical than others.

It is important to identify which elements are most critical as well as the possible ways in which they might fail to meet their service standards. It is then possible to target and refine maintenance plans, capital expenditure plans, and investigative activities focused on these more critical elements of the system.

The intent in assigning criticality to SWD assets is to allow the appropriate development of priorities through risk mitigation plans and to incorporate the results of these plans into the intervention process.

The Guidelines provide a Criticality Rating Table which gives an indication of how to prioritise investigative effort initially, the frequency of follow up inspections and also subsequent action that might then be determined as necessary. Criticality scores of 1 to 5 are assigned with 5 being deemed to be the most critical level. Refer Appendix A.

Having addressed the question of Criticality, this can then be considered with the key concepts of asset based risk management.

As part of the continuous improvement process and to ensure currency of the risk management process, there needs to be a system in place for monitoring and review of this process.

Rating System for SWD Condition Assessment

The Guideline uses the most commonly adopted condition rating system across many asset classes, being the basic 0 or 1 to 5 where Condition (0 is not rated), 1 is very good or as new and Condition 5 is very poor and approaching being unserviceable.

In the interests of promoting national consistency, the Guideline uses a tabulation (Refer Appendix B), which provides detailed descriptions for each level of rating for SWD

and has been developed from two leading documents being the IIMM Appendix B Condition Grading Standards with some modification to reflect the Condition Grading applied by the WSAA Conduit Inspection Reporting Code of Australia. It is proposed that this rating system be subject to ongoing peer review as the Guideline becomes widely used with a view to future adoption of an agreed national rating system specific to SWD.
(Ingenium and IPWEA 2006 Page B.2)
(WSAA 05-2008 Appendix E)

To further assist practitioners in rating the various components condition grades, a series of photographs are included in the Appendices to the Guidelines to indicate examples of condition grade from 1 to 5 for a variety of typical components.

Example of a condition 5 rated section of pipe

Data Collection

The Guidelines identify a number of typical sources of data, but this Paper focuses on formal inspection programs.

Most SWD system condition assessments involve a large number of the assets that are largely inaccessible due to the sizes of the pipes or culverts or restricted entry conditions. In these cases, closed circuit television (CCTV) is commonly employed. Because of the cost involved, it is then prudent to consider a sampling of the assets based on age, material types, soil conditions and location as well as the criticality scores to determine the sample mix.

Another technique now gaining momentum is to utilise the latest camera technology with tools like Quickview cameras which utilise a camera lowered into an access chamber that can then take a zoom sequence of photos along each pipe entering that chamber and identify sections that might then warrant closer CCTV inspection. This process can achieve full system coverage at a fraction of the cost of full CCTV and link results through the organisation's GIS or other asset systems. A GIS based plot of survey data is invaluable for a range of possible activities including maintenance planning through to future hydraulic analysis.

Options such as initial CCTV camera survey followed by cleaning of the SWD system with follow up camera survey, which is the most common technique, versus a clean/camera sequence versus the Quickview approach, have been assessed and modelled for cost comparison and the Quickview approach shows considerable cost benefit. Refer Appendix C.

The Inspection Process

A plan of action for inspection of the network involves deciding on particular catchments or parts of catchments and the extent of survey inspection to be carried out in that catchment. Will it be the whole network for that catchment or discrete parts or a sample? The risk management principles outlined previously are utilized to assist make these decisions.

In deciding on the level of inspection sophistication to apply, various factors need to be weighed up, as follows:

- What resources are available in terms of skills of existing staff or external specialist firms?
- Possible use of Closed Circuit Television (CCTV) or other camera technology such as Quickview to provide meaningful condition data?
- How repeatable is the process to ensure consistency over time for subsequent inspections?
- Will the cost involved be warranted for the importance of the assets involved?

- What level of condition data is needed to improve decision making for the particular assets?

Typically, the aim is for a 2-step outcome:

- Firstly, a plan of action through Works Orders for any short-term remedial work (to be updated following each inspection cycle); and
- Secondly, a network assessment of overall condition to inform long-term planning for management of the SWD network and any modification necessary in terms of design, materials utilised and the like. Such long-term planning includes setting of budgets to maintain desired levels of service through replacements, upgrades and the like.

The Guideline spells out in detail the various steps involved in a typical inspection process beginning with preparing a pre-inspection survey pack, the role of the Inspector, setting inspection frequencies, occupational health and safety issues, the condition survey data to be collected including confidence grades, and finally any works orders that might be generated to deal with urgent issues.

Data Analysis

Significant cost and effort is typically invested in gathering condition assessment and performance measurement data. This data however is worthless unless it is then utilised for analysis and derivation of the necessary asset management information for the SWD assets concerned.

Those carrying out the data analysis phase need to be appropriately qualified and competent to interpret the information from the inspection reporting process and to manage the data so generated. The WSAA Code gives some indications of appropriate qualifications that are necessary.

The following outcomes should be available from the data analysis phase:-

- A register of surveyed SWD system assets and their components;.
- Condition Assessment rating of each component and estimate of the remaining useful life;.
- Depreciated Replacement Cost (DRC) valuation of the SWD system inspected, (if required); Subject to extent of financial data required from process.
- Current Replacement Cost (CRC) of the SWD system involved, (if required); Subject to extent of financial data required from process.
- An analysis that predicts the timing of future renewals and replacements of various components;
- A Summary Report on the system, listing component schedule, valuation report, and an expenditure profile;
- Work schedules (maintenance and renewals) and a financial plan showing funding needs.

Note that the question of whether the SWD System performs to required levels, such as whether the hydraulic capacity is appropriate etc. is the subject of separate analysis but this is flagged as an issue needing consideration before costly rehabilitation or renewal is decided upon.

Once all the data is uploaded and validated, the analysis can then be run and reports generated.

Long Term Financial Planning

The Guidelines data analysis generates a wealth of asset management and financial planning data, that can be used in several ways, as follows:-

- Short-term maintenance needs that require ‘urgent’ attention to address glaring hazardous situations that might involve public safety, workplace health and safety or some other defect that cannot be ignored.
- Subsequent proactive maintenance budgeting that is identified through these processes whereby additional maintenance expenditure on a scheduled maintenance activity is deemed beneficial to defer or reduce potential higher future

capital expenditure for replacement if maintenance is not enhanced.

- Longer term capital expenditure:-
    - That will be required to replace or renew components or even for complete asset replacement where it is deemed that the current asset will not be fit for purpose at some future time. (Typical obsolescence)
    - That will be required for new assets that have been assessed as necessary by the organisation arising out of rigorous strategic planning processes that demonstrate the need for such new SWD assets.

The challenge for asset managers is to utilise all the available data flowing from these Guideline processes to inform their organisations and promote good practice with development of appropriate long-term financial management plans that optimise the solutions for achieving the desired level of service required from the SWD assets over their whole lifecycle.

Works Scheduling

A number of different work schedules will potentially be derived from the whole process. These begin with various Works Orders that will be initiated as part of the Condition Assessment Survey through to the long-term capital renewal and replacement programs alluded to in the previous Section.

The Guidelines outline the various typical work schedules that are expected will be generated.

Improvement Planning

The Guidelines promote a process of continuous improvement. This is typically achieved as more of the SWD system portfolio proceeds through the condition assessment and performance measurement process. In this way greater knowledge of the way in which the assets are performing will be developed and all stakeholders will gain a better appreciation of how the adoption of a robust asset management process can deliver better outcomes in terms of matching intervention and actions to the desired levels of service that is sought from the particular SWD asset.
The improvement plan must also be consistent with the organisation's overall corporate strategic plan and be realistic in terms of the resources available and the timeline expected for measurable results.

Conclusion

These Guidelines for SWD Condition and Performance Assessment fill an important gap in assisting practitioners to carry out regular inspection surveys of SWD assets using a risk based approach that encourages an initial focus on the more critical assets. The Guidelines provide a straightforward process to determine condition gradings and performance assessment on a uniform nationally consistent basis that can then be analysed to develop further information on short term maintenance needs, pro-active maintenance planning and most importantly, long term asset renewal and replacement programs. Financial related information such as valuation based on depreciated replacement cost and remaining useful life all are outputs achievable as well.

The Guidelines also provide information on innovative survey techniques to get best value from utilisation of the latest technology available in camera survey tools that greatly assist in electronically collecting the condition data, all linked to GIS and asset management systems.

Acknowledgements

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survey techniques and the many photos used in the Guidelines.

References

1. Australian Standard AS/NZS ISO 31000:2009 Risk Management, SAI Global, Sydney 2011
2. INGENIUM and IPWEA 2006 "International Infrastructure Management Manual", Association of Local Government Engineering New Zealand Inc. and National Asset Management Steering Group, Thames, New Zealand (IIMM)
3. WSA 05 – 2008 "Conduit Inspection Reporting Code of Australia" Second Edition, Water Services Association of Australia, Melbourne 2008. (WSAA)

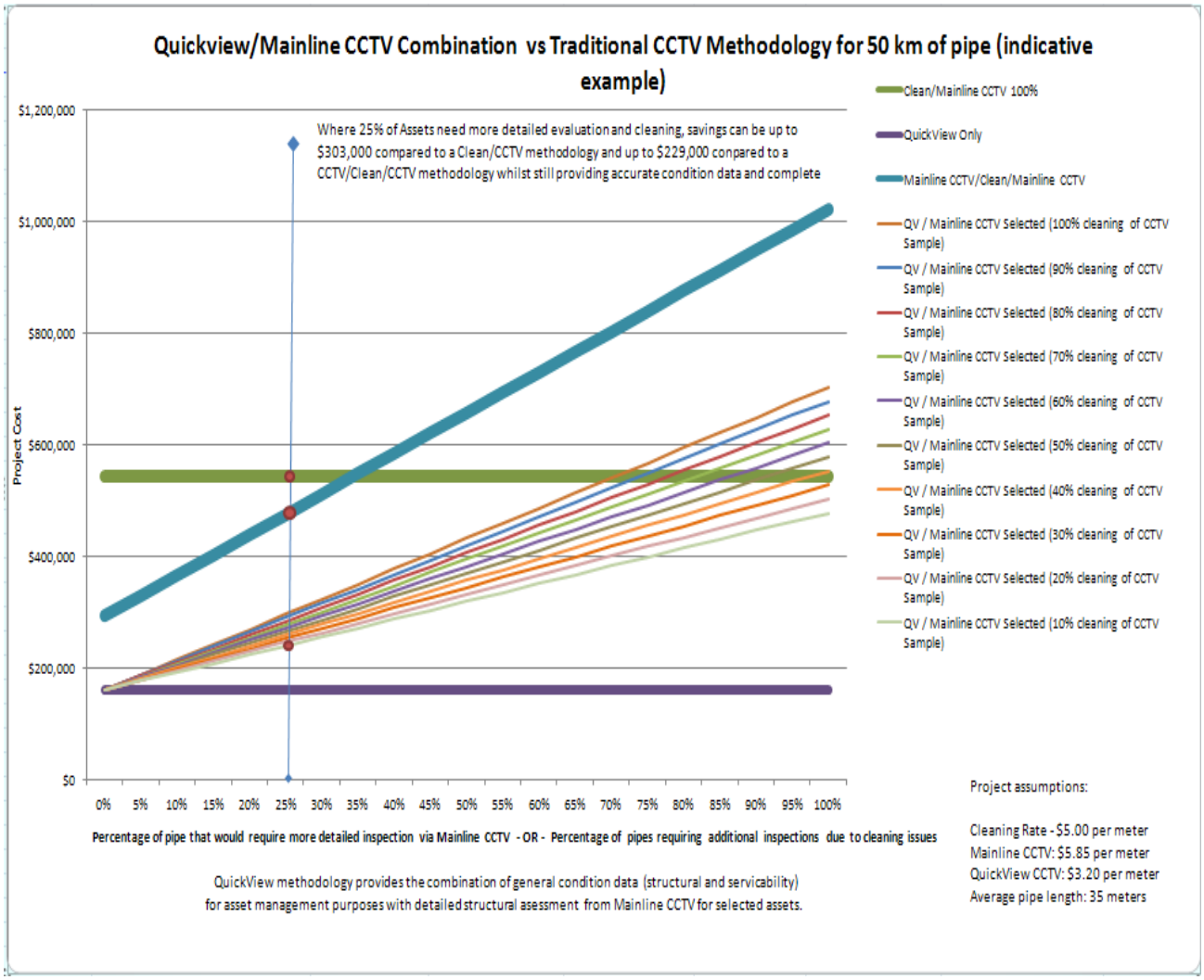
Appendix A - Criticality Rating Table

Description	CR	Insp. Freq.
These are SWD Systems where failure is the most disruptive and expensive to the community. They should be subject to more frequent and rigorous inspection to enable the organization to proactively plan any identified maintenance or remedial activities. The following are examples of such criticality: • Aged SWD systems (>50 years) under buildings or providing drainage to built-up commercial precincts or major transport corridors – road and rail. • SWD systems incorporating steel lined conduits.	5	5 years
These are SWD Systems where failure is likely to be less disruptive but still of significance to the affected community. They require less frequent inspection which again should drive proactive maintenance and remedial action. The following are examples of such criticality: • SWD systems of an age <50 years or any material located under buildings or providing drainage to built-up commercial precincts or major transport corridors – road and rail. • SWD systems in any location comprising earthenware or AC materials	4	10 Years
These are SWD Systems where failure is likely to be moderately disruptive to the affected community. They require even less frequent inspection however such should still drive proactive maintenance and remedial action. The following are examples of such criticality: • SWD systems of any age or material providing drainage to moderate density urban development or sub-arterial transport corridors. • SWD systems with pipes >900 mm diameter • SWD systems with depth >3 metres	3	15 Years
These are SWD Systems where failure is likely to be of low significance in terms of disruption to the affected community. They require even less frequent inspection however such should still drive proactive maintenance and remedial action. The following are examples of such criticality: • SWD systems of any age or material providing drainage to low density urban development or collector/distributor and local road transport networks.	2	20 Years
These are SWD Systems where failure is likely to be of very low significance in terms of disruption to the affected community. They require infrequent inspection, triggered by complaint or evidence of a problem. The following are examples of such criticality: • SWD systems of any age or material providing drainage to parks and open space where overland flow escape paths exist that reduce any hazard to property or community users.	1	As needs basis

Appendix B - Rating System for SWD Assets

Grade	**Condition**	**Description**	Response
0	Not Rated	Asset has been properly decommissioned, no longer exists (or should be removed from inaccurate plans), has not been condition rated (or assigned an extrapolated condition), or is unable to be rated due to serviceability issues.	Response will vary subject to circumstances. Eg. An abandoned asset may experience infiltration, voids, collapse etc, and pose a real danger that should be both monitored and managed.
1	Very Good	Sound physical condition. Insignificant deterioration. Asset likely to perform adequately without major work for 25 years or more. No or insignificant loss of hydraulic capacity.	No immediate action required. Maintain standard programmed condition assessment.
2	Good	Acceptable physical condition; minor deterioration/minor defects evident, minor loss of hydraulic performance, minimal short-term failure risk but potential for deterioration in long-term (10 years plus). Only minor work required (if any).	No immediate action required. Maintain standard programmed condition assessment.
3	Fair	Moderate to significant deterioration evident; moderate loss of hydraulic performance, failure unlikely within next 2 years but further deterioration likely and major replacement likely within next 10 years. Minor components or isolated sections of the asset need replacement or repair now but asset still functions safely at adequate level of service. Work required but asset is still serviceable.	Take immediate action as appropriate with cleaning, silt removal, root cutting. Monitor with programmed condition assessment for rehabilitation and/or renewal in medium term.
4	Poor	Serious deterioration and significant defects evident. Significant loss of hydraulic performance. Failure likely in short-term. Likely need to replace most or all of asset within 2 years. No immediate risk to health or safety but works required within 2 years to ensure asset remains safe. Substantial work required in short-term, asset barely serviceable.	Take immediate action as appropriate to address the defects. Immediately undertake risk assessment and further investigate options. Schedule appropriate action – rehabilitation or renewal in short term.
5	Very Poor	Failed or failure imminent. Immediate need to replace most or all of asset. Health and safety hazards exist which present a possible risk to public safety, or asset cannot be serviced/operated without risk to personnel. Major work or replacement required urgently.	Take immediate action as appropriate to address the defects. Immediately undertake risk assessment and further investigate options. Schedule appropriate action – immediate rehabilitation or renewal.

Appendix C – Cost Comparisons Quickview vs Traditional CCTV



Author Biography

Having “semi-retired” from Logan City Council after some 30 years in local government engineering, Peter Way is now devoting his time to advancing asset management on the national front in his role as Chair of the Institute of Public Works Engineering Australia’s National Asset Management Strategy Group (NAMS.AU). Peter has been the principal author of a number of the Practice Notes developed to assist practitioners carry out condition and performance assessment on key asset classes. Peter has also been the principal author of the study material based on the IIMM and the AIFMG for the new Graduate Certificate and Diploma Courses in Infrastructure Asset Management recently launched through the University of Tasmania.