CONDITION ASSESSMENT & ASSET PERFORMANCE GUIDELINES

Practice Note 7

WATER SUPPLY & SEWERAGE

IPWEA

INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

CONDITION ASSESSMENT AND
ASSET PERFORMANCE GUIDELINES

PRACTICE NOTE 7 – WATER SUPPLY AND SEWERAGE ASSETS

IPWEA NAMS.AU has recognised the need for industry guidelines to assist practitioners with Asset Management and Financial Planning. A number of Practice Notes have already been developed for Condition Assessment and Asset Performance of various asset classes, Financial Management and AM for Small Communities. This Practice Note deals with Water Supply and Sewerage Assets. A series of further Practice Notes is being researched and will be published to assist with the important task of how best to carry out condition assessments for various other classes of assets as well as other important aspects of asset and financial management.

The aim is to foster a national approach and encourage consistency of data and outputs. These documents will be subject to review and updated as further and better information comes to hand.

Practice Notes may be Purchased

Six Practice Notes are available and more are being developed to provide guidance to practitioners in the field for carrying out condition assessment inspections on a range of physical infrastructure asset types including:

- PN1 Footpaths (published Nov 2007)
- PN2 Kerb and Channel(Gutter) (published June 2008)
- PN3 Buildings (published June 2009)
- PN4 Asset Management for Small, Rural or Remote Communities (AM4SRRC) (published March 2011) (only available for AU councils < 5000 population)
- PN5 Stormwater Drainage 2011
- PN6 Long-term Financial Planning (LTFP) 2012

Other Practice Notes are also being developed to give nationally consistent guidelines on:

- Level of Service (LoS)
- Roads Pavements Assets
- Parks and Recreation Assets

Order Forms. To purchase your copy of the individual Practice Notes, as they become available, visit www.ipwea.org/practicenotes.

Enquiries. IPWEA National p: +61 (2) 8267 3001; e: national@ipwea.org

A Preamble Document is also available Complimentary (no charge)

A complimentary Preamble Document that sets out the generic principles applicable to all the above and other types of assets is also available. It covers the basic concepts of condition assessment, performance measurement, risk and data management. Practice Notes expand on each asset class. Visit www.ipwea.org/practicenotes.

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Note to Readers

While information contained in these Practice Notes is believed to be correct at the time of publication, the Institute of Public Works Engineering Australasia and its NAMS.AU Group, Working Parties and other contributors to these Practice Notes, do not accept any liability for its contents or for any consequence arising from its use.

These are Condition Assessment and Asset Performance Guidelines and in no way replace nor obviate normal maintenance and management procedures to address any immediate loss of service, public safety or environmental damage concern.

The Guidelines provide a basis for assessing the condition and performance of Water Supply and Sewerage assets and to determine the whole of life cost impacts for these assets and through that, an ability to budget for the longer term renewal and replacement costs likely to be incurred as well as whole-of -life costs arising from any decisions to build new assets.

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In particular, these Guidelines have incorporated material kindly provided by Cardno, resulting from their work with many Water and Waste Water Utilities around Australia, and we are indebted to them for their expertise on various field inspection processes and translating condition data into decision making tools.

The Guidelines also refer to the WSAA "Conduit Inspection Reporting Code of Australia" and we are indebted to the Water Services Association of Australia for making their Code readily available as a reference source.

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QUICK GUIDE

INTRODUCTION

This Section of the Guidelines is designed to give Practitioners a quick overview of the more detailed content included in the complete document. It is also designed to assist those who may be looking for a very basic approach to commence the journey towards improving their asset management performance for WS&S assets.

The main purpose of these Guidelines is to provide direction in the process of carrying out condition and performance assessment for WS&S assets. This cannot successfully be carried out without an appreciation of how the process sits within the overall framework of good asset management.

Condition and performance assessment is proposed to be undertaken at three levels:

- **Level 1 Routine operation and maintenance data assessment**. Relevant data captured as part of the on-going operation and maintenance process is analysed to gain an understanding of asset condition and performance;
- **Level 2 Formalised asset inspection/ condition assessment**. This will include a planned and structured inspection of the asset portfolio which should include a representative sample and a risk-based sample of the portfolio; and
- **Level 3 Detailed investigation, undertaken** as required and where shown to be cost-effective.

Core and Advanced Approaches

These Guidelines are designed to cover the needs of 'core' (those beginning the process) and 'advanced' users. A move from a 'core' to an 'advanced' approach is one of continuous improvement. It will be noted that throughout the document, reference is made to both 'core' and 'advanced' approaches. It is wise to start with a simple 'core' approach rather than trying to commence on a more ambitious process.

Core Approach

A 'core' asset management approach would make use of the operation and maintenance collected data and also use the asset valuation process to indicate need to undertake Level 2 activities.

For the 'core' approach, select those WS&S assets that are considered to be most critical to the business of the organisation. Concentrate on these to carry out an initial condition assessment inspection.

Identify any hazards with a high or very high risk that may require immediate rectification. Collect basic data on the condition that will enable analysis of longer-term renewal or replacement works required. This then provides the basic financial data to inform the long-

term (10 Year) financial plan. Immediate and future projects, can then be bundled into both maintenance and capital programs to be carried out. Regularly repeating these basic steps with appropriate refinement of the process as resources permit is part of the continuous improvement process, leading to a more advanced asset management.

Advanced Approach

An 'advanced' approach would monitor more Level 1 parameters, and have a greater investment (extent and frequency) in Level 2 and 3 assessments.

As organisations move into a more 'advanced' phase, the whole portfolio of WS&S assets is included. Risk management principles are applied to better determine the frequency and scope of condition assessment inspections. More detailed data is collected with greater breakdown into various components. Quality standards are applied to test the level of service being provided. This is used to assist the condition assessment process to decide on future needs.

The resultant data is more rigorously analysed and optimised decision-making employed to determine priorities for works. The analysis gives a more accurate picture on the remaining life of the assets down to their various components, their current replacement cost and their depreciated replacement cost.

Most importantly, organisations will be able to demonstrate sustainable management of their WS&S assets by providing the necessary funds through their long-term financial plans to meet the planned expenditures for replacement, renewal, upgrade and new assets. An iterative process will provide for continuous improvement over time.

KEY PRINCIPLES OF WS&S ASSET MANAGEMENT

Section 1 of the Guidelines provides details on the scope, as to which WS&S assets, the Guidelines can be applied.

Section 2 of the Guidelines begins with a brief outline of the Purpose of the Guidelines relating to WS&S assets. This can be summarised as follows:

- Review and update the register of WS&S system assets.
- Analyse the operational and maintenance data to assess asset performance/ condition and undertake condition assessment as part of routine operation and maintenance activities.
- Do a formalised condition assessment program based on risk profile and sampling to rate each component inspected and enable an estimate of remaining useful life.
- Do more detailed assessment of critical assets and undertake risk analysis based on condition to predict the timing of future renewals and replacements.
- Providing information on the remaining life of the assets and their rate of deterioration.
- Develop a prioritised renewals capital investment program and maintenance program and financial planning for the funding and implementation of the programs.

Section 3 defines what we mean by performance and condition assessment and how these fit into the asset management planning framework. It outlines the various processes that can be involved in undertaking condition assessment, which can include;

- Being part of routine operations and maintenance processes;
- Undertaking detailed investigations in response to an observed defect (e.g cracking of a reinforced concrete structure or inspecting a failed section of water main);
- As part of complying with technical regulatory requirements (e.g. dam safety surveillance, lifting equipment compliance, electrical safety etc.);
- Complying with financial regulatory requirements; and
- A formalized asset inspection/ condition assessment program.

Section 4 outlines the function of WS&S assets in terms of the critically important role they play in meeting community demand. It sets the scene for why condition assessment is so important.
For water supply assets, the aim is to make sure that the community is supplied with a potable water supply that is of suitable quality, quantity, reliability and pressure. Sewerage assets are provided to collect, transfer, treat and dispose of a community's wastewater.

Level of Service

Key Points

The reason that assets exist is to provide services at the required levels of service Level of Service is the basis for how assets need to be managed by the WS&S Utility. The condition and performance assessment processes outlined in these Guidelines are to help practitioners better manage and achieve the levels of service.

The factors that need to be considered include:

- *Service standards dictated by legislation and regulation;*
- *Community expectations and willingness to pay;*
- *Resources and budgetary constraints;*
- *Seek to apply a continuous improvement approach moving from 'core' to 'advanced' over time;*
- *The goal is to demonstrate long term sustainability in the management of meeting levels of service.*

Section 5 highlights that condition assessment and performance measurement must not only look at the physical condition of the WS&S system and its components, but more importantly, how well the system is meeting the needs of all who use it. Therefore the need to agree the level of service required of the system with all stakeholders, now and into the future. It provides a 'core' and 'advanced' view of dealing with these aspects, recognising the legislative and regulatory drivers as well as customer expectations.
The section gives a range of typically applicable standard specifications.

Asset Owner's Duty of Care

Key Points

As stewards of vital infrastructure, WS&S Utility owners have significant responsibilities and obligations to demonstrate;

- *compliance with all statutory regulations and standards;*
- *appropriate adherence to relevant Guidelines, codes of practice, operating manuals etc.;*
- *the ability to meet expectations of the community by way of due diligence in providing for public safety, financial prudence and good corporate governance.*

Section 6 introduces the concept of duty of care owed by WS&S Utilities. This is part of their stewardship role including their legal and regulatory obligations and their general obligation to the public at large. This involves an obligation to act diligently, with appropriate expertise to provide for public safety, environment protection and financial prudence. It has a bearing on frequency and scope of inspections. It will lead to the way in which outcomes are decided as well as what and when action needs to be initiated. This is largely a risk management issue.

Risk and Consequence of Failure

Key Points

A risk-based condition/performance assessment is proposed.
This includes:

- *Determining the likelihood of failure. Initially a coarse condition rating may need to be adopted based on asset age (refer to Table 7.2 for indicative ratings). This will then be refined over time based on condition and performance assessments.*
- *Determining the consequence of failure. This would be estimated based on a range of criteria such as asset capacity, location, customers impacted and cost of repair etc. Table 7-1 provides indicative consequence ratings. These will need to be modified to suit individual WS&S Utilities;*

From the above, calculate the risk score (likelihood/ consequence matrix consistent with AS/NZ ISO 31000. The risk score will allow the WS&S Utility to determine the priority for condition assessment, and intervention (improved maintenance, rehabilitation or replacement.

Section 7 goes on to address risk and consequence of failure.
It gives more attention to those assets assessed as being the most critical to the business of the organisation. This does not mean that an asset with a low consequence of failure is unimportant or should be ignored. It does mean that it has a lower priority when assigning resources within a constrained budget. Methods of determining consequence of failure and likelihood of failure are provided. Indicative rating Tables for each are provided with ratings of 1 to 5 (5 being the highest). Traditional risk analysis methodology which uses matrices to assist in prioritising actions arising from such analysis is provided.

The process involves:

- Fully understanding the risk management framework that will be used;
- Knowing which adverse events (identifying the risks) that need to be controlled;
- Scoring the likelihood of the adverse events occurring;
- Understanding the full consequences of the adverse events;
- Analysing with due consideration of critical WS&S assets;
- Establishing and prioritising programs and projects to manage the likelihood and consequences of adverse events associated with critical assets.

The section emphasises the need for ongoing monitoring and review of risk management plans.

Information Management

Key Points

Develop an information management strategy (IMS) to address the significant amount of data likely to be generated as part of the condition and performance assessment process.

Make sure that:

- *appropriate resourcing is available to manage information and there is commitment from the organisation for its long term funding;*
- *data is aligned with the needs of the organisation's planning and operational processes, i.e. if the planning, management or operational process doesn't need data, avoid collecting it;*
- *the computer system used for data collection and analysis is aligned with the overall process and data needs;*
- *operation and maintenance data is reliable through having documented procedures for consistent data capture, reliable measuring equipment and appropriately trained staff;*
- *the information management system integrates with the organisation's corporate systems such as financial and spatial;*
- *how the data has been gathered is recorded - GPS, Surveyed, Taped, Aerial photo measured, plan/map measured, or approximation and by whom the data has been gathered;*
- *that the results of the data capture process are fed back to field staff and others involved in collecting the data; and*
- *appropriate data maintenance procedures are documented and resourced in long-term, because data becomes outdated and can cast doubt on the financial forecasts.*

Section 8 highlights the importance of consideration of the information management issues right at the outset. Condition assessment processes generate large volumes of data and unless careful consideration is given prior to commencing the process, management of that data can be challenging. There needs to be confidence in the quality of the data. Collect only that data that is necessary to meet the organisation's needs. Set up a pilot program to test the data

collection, data management and subsequent analysis processes. This is to make sure that it all works and the outcomes generated are in accordance with needs.

Start with a 'core' approach and avoid collecting unnecessary data. Recognise that data needs to be kept up-to-date to be of value so factor that into the process. Make sure that the computer software used will perform the desired task – whether it is with simple spreadsheets or a more sophisticated dedicated asset management system. Finally, make sure that the organisation is prepared to commit sufficient resources in people and equipment to the information management task.

Rating Systems for Condition Assessment

Key Points

- *A 1 to 5 condition rating is proposed where 1 is very good and 5 is very poor;*
- *Tables are provided in this Section with descriptions of asset condition to allow users to rate the condition of assets. These Tables cover generic assets, water main, sewerage mains, mechanical and electrical assets;*
- *For a more advanced approach the WS&S Utility could use a multi-criteria system with less subjective measures to determine the condition of an asset. The multi-criteria system will allow for a broader range of aspects to be assessed, increasing confidence;*
- *WS&S Utilities undertaking advanced asset management will develop deterioration curves to allow forecasting of asset condition in the medium to long term. Consequence of failure will also be quantified in dollar terms.*

Rating systems are often one of the most debated points – Should it be 1 to 5, 1 to 10 or something else?? We follow the IIMM approach of preferring the 1 to 5 – 1 being Very Good Condition and 5 being Very Poor Condition.

Section 9 details this with a 'core' and 'advanced' approach. The 5 Tables in this Section are very comprehensive and provide a description for each grading along with a suggested response and indication of remaining useful life as a percentage of design life. The tables cover both structural and serviceability issues for sewer mains and generic condition grades for other assets. An illustrative condition deterioration curve for WS&S assets is provided.

Appendix 3 gives example of Multi- Criteria Condition Grading for WS&S assets components.

Appendix 5 provides photo examples of condition gradings for a range of typical WS&S assets.

Key Points

It is proposed that the condition assessment is undertaken at three levels:

- ***Level 1*** ***Routine operation and maintenance data assessment****. Relevant data captured as part of the on-going operation and maintenance process is analysed to gain an understanding of asset condition and performance.*
- ***Level 2*** ***Formalised asset inspection/ condition assessment****. This will include a planned and structured inspection of the asset portfolio which should include a representative sample and a risk-based sample of the portfolio.*
- ***Level 3*** ***Detailed investigation,*** *as required and where shown to be cost-effective.*

A 'core' asset management approach would make as much use of the operation and maintenance collected and also utilise the asset valuation process to indicate need to undertake Level 2 activities. A more advanced approach would monitor more Level 1parameters, and have a greater investment (extent and frequency) in Level 2 and 3 assessments.

- *This section includes tables that provide guidance on the condition assessment methods (Levels1, 2 and 3) that could be considered for the various asset types within a WS&S system.*

Section 10 outlines the various sources of condition data typically available, including:

- Data from daily operational monitoring ;
- Water quality monitoring data at source, treatment and distribution;
- Wastewater composition monitoring data (;
- Opportunistic condition assessment (e.g. assessing the condition of a burst water main);
- Detailed investigation in response to failures or a pro-active assessment of a critical asset; and
- A formalised asset inspection/ condition assessment program.

This Section outlines the three categories of assessment (Levels 1,2 and 3). A detailed *Table 10.1* summarises how data can be collected for the various components of pipe networks at each level of assessment. *Table 10.2* does likewise for non- pipe assets, which are able to be visibly assessed.

WS&S System Inspection Process

Key Points

The inspection process for these level two and three assessments is one of the main outcomes addressed in these Guidelines. The process involves the following:

- *Using a risk based approach to prioritise which assets should be targeted for condition assessments first;*
- *Factors to consider, in deciding on the level of sophistication to apply for the level and type of inspections to be carried out;*
- *The steps that need to be followed pre-inspection to ensure all pre-existing available data is gathered and the subsequent inspection process efficiency is maximised;*
- *The importance of using appropriately qualified and competent inspection personnel and their obligations with respect to ensuring complete, reliable and accurate data as well as occupational health and safety issues;*
- *Suggested frequency of inspections based on risk criteria as well as sampling methodologies and other factors;*
- *The typical data that will be collected as part of the inspection process, including details of the assets involved, their condition grade, defects recorded, remaining useful life, photographs and procedures for dealing with any defects needing urgent attention.*

Section 11 begins with application of the risk management principles from *Section 7.* to tailor the asset inspection program to suit the organisation's needs and the level of sophistication to apply, taking into account the following:

- What is the most appropriate inspection technology to use;
- What measures provide the best indication of an asset's condition;
- What resources are available - skills of existing staff or external organisations;
- How repeatable and appropriate is the process to ensure consistency over time;
- Will the cost involved be warranted for the importance and value of the assets;
- What data is already being collected;
- What level of condition data is needed to improve decision making for the particular assets;
- How will the information be collected.

This Section highlights the important steps that should be taken before going on-site to do the actual survey. Gathering as much data as possible into a "Survey Pack" through desktop analysis of already available records makes good sense. It deals with selecting the assets to be surveyed, interviewing relevant staff and what should be included in the Survey Pack.

A logical starting place for the process is to make sure the asset register for WS&S assets is up to date. Be warned – this is often not the case. Ideally there should only be the one register utilised by all stakeholders – financial, insurance, maintenance sections etc. Multiple registers lead to inconsistency between those registers.

This Section addresses the desirable attributes for those doing the survey, to make sure that the data is:

- Complete – appropriate levels of detail and data are captured and each relevant component of the WS&S system has a rated condition;
- Reliable – the data collected should adhere to the criteria provided so that there is consistency between surveys and between inspectors; and
- Accurate – measurements and assessments are made with accuracy in mind.

It emphasises the importance of Inspectors being appropriately trained and accredited under the WSA Code and other regulatory codes. It provides guidance on suggested frequency of surveys. Occupational Health and Safety issues associated with the survey processes, are also highlighted.

This Section goes into detail describing the condition survey data to be collected for each of the WS&S system components. Examples of data collection sheets are included in *Appendix 2*. As well as the condition rating, surveyors are required to record defects and may assist in advising asset managers on an estimate of remaining life. Advice is provided on recording photos of the assets and various components and the potential of mapping defects for analysis.

The section covers writing of works orders that will arise for immediate maintenance needs or any hazardous issues.

Data Analysis

Key Points

Turning the data gathered into information to assist in decision-making is a critical outcome of a successful assessment process, involving the following:

- *Defining the outcomes that the WS & S Utility is seeking to achieve from the analysis process. These outcomes would include:*
  - *An updated register and condition rating of each asset and estimate of the remaining useful life.*
  - *A risk rating for each asset.*
  - *Predictions of timing of future renewals and replacements of various components, and maintenance frequencies.*
  - *Work schedules (maintenance), Capital Works Programs (renewals, refurbishments and upgrades) and a financial plan showing funding needs.*
- *Utilising a risk based process to prioritise the recommended actions arising out of the data analysis phase.*
- *How the data analysis should best be reported with tools like expenditure profile spreadsheets that detail Capex and Opex projections over a long term financial planning horizon appropriate to the utilities needs.*
- *Financial reporting information that can be derived from the process, such as:*
  - *Renewal costs and timing for identified parts of the asset system.*

The value derived from the whole process begins, as we start to analyse the data. Using a risk based process to prioritise activities, ***Section 12*** outlines the various outcomes expected of the analysis phase including financial data such as the Current Replacement Cost (CRC) and assistance in calculating Depreciated Replacement Cost (DRC) at both a component level and network level. Estimates of remaining useful life of the components and a schedule of replacement/renewal works to feed into the long-term financial plan are developed. Work schedules for both short-term maintenance and longer-term capital expenditure similarly allow for budgeting and financial planning. These draw on risk based prioritisation and should utilise construction rates relevant to the organisation's location.

Reporting the outcomes of the analysis is the next important step and the spreadsheets, as demonstrated in the ***Toolkit Section,*** provide for a simple, easy to interpret collation of all the necessary relevant data. This format means data is also easily transferred into other formats such as for the long-term financial plan.

This Section concludes with discussion on future data analysis, as more information is gathered. Plotting condition rating against age and reviewing the deterioration curves for the various WS&S asset types is a means of validating useful lives and optimal intervention periods.

Lifecycle Analysis and Long-Term Financial Planning

Key Points

Life-cycle costing analysis and long-term financial planning are important financial information outcomes from applying these Guidelines. They provide the following:

- *Short term, urgent maintenance expenditure needs;*
- *Follow up pro-active maintenance planning and budget needs;*
- *Longer term capital expenditure for:*
    - *Renewals or replacement of assets;*
    - *Upgrades to meet changing levels of service;*
    - *New work to cater for growth, et cetera.*

Section 13 deals with the analysis outcomes to ensure sustainable management of the WS&S assets to deliver the required levels of service. It considers planned expenditures arising from the analysis, for both capital and operational budgeting. Categories of expenditure include:

- Short-term reactive maintenance to address immediate concerns identified.
- Longer-term pro-active planned maintenance activities.
- Long-term capital expenditure for replacement or renewal of various components.
- Longer-term expenditures for construction of 'new assets'.

Renewals expenditure is at the component level and caters for replacement of components of the WS&S system asset to return its service potential to the original level. This might include works such as replacing a reservoir roof. Replacement of special components such as fixed plant and equipment is another common activity covered in this Section.
This is the logical conclusion in travelling down the path of sustainability. An organisation can demonstrate responsible asset management of its WS&S assets if it has a properly developed asset management plans that inform its overall ten-year long-term financial plan.

This Section explains the process for calculating the Current Replacement Cost (CRC) for the WS&S system both for the gross replacement cost of all of the surveyed components and the CRC of the whole system based on schedules of unit rates for construction, applicable for the organisation in question.

Work Schedules and Programs

Key Points

Arising from the condition and performance assessment process, a number of actions will arise, resulting in the need to produce:

- *Works orders to initiate reactive maintenance activities of those defects requiring attention as part of the current maintenance program, including timelines for completion;*
- *Capital expenditure projects for both renewals/replacement and new/upgrade, that address, project planning criteria including;*
    - *Priorities based on risk;*
    - *Bundling of projects into annual works programs;*
    - *Smoothing expenditures to avoid "lumpiness" in the budget allocations over future years, where possible;*
- *Liaison with other stakeholders on potential impacts of WS & S asset works to ensure coordination of projects;*
- *Addressing new capital works impacts arising from both the WS & S Utility projects and development projects to make sure they are incorporated into the organisations asset management programs for ongoing operation, maintenance and financial management.*

Section14 deals with the important task of translating all of the foregoing analysis into action on the ground. It begins with the treatment of works orders for reactive maintenance requiring 'urgent' attention. Then it addresses the planning for proactive maintenance that is necessary to build into regular annual maintenance programs to make sure the planned life of the asset is achieved. Next it focuses on capital expenditure projects for renewals and replacements, that are above the capitalisation threshold set by the organisation.

Based on data input from the earlier work, factors such as criticality, risk etc can be used to assist in prioritising and developing a smoothed program of various projects across the whole WS&S portfolio for each year.

Simple Renewals Forecasting *Toolkit*

A simple spreadsheet-based tool to assist a WS&S Utility develop a 20 year condition and consequence-of-failure renewals forecast has been developed as a companion to this Practice Note.

The Toolkit allows a WS&S Utility to select the priority and timing of renewals based on the condition and consequence-of-failure of the assets. The Tool also includes some generic deterioration curves which can be adjusted by a WS&S Utility.

Whilst a simple renewals forecasting model such as this has a number of limitations, it nevertheless can form a useful starting point to WS&S Utilities which are commencing the asset management journey.

Improvement Plan

Key Points

Carrying out condition and performance assessments over time will lead to improvements in your processes. Lessons will be learned and improvements identified that can lead to better outcomes in the future. These improvement opportunities will involve:

- *Analyses to identify scope for improving between current practice and future desired most appropriate practice;*
- *Identifying and documenting these improvement opportunities;*
- *Prioritising any proposed actions based on risks, costs, and availability of resources;*
- *Monitoring and reporting on the improvement program adopted.*

As part of any good asset management planning process, ***Section 15*** concludes with a discussion on the need to include continuous improvement into condition assessment. In this way, as better information is gathered over time, skills are enhanced, and greater confidence in the data is built up. Organisations can then look forward to more complete and meaningful asset management plans for their WS&S assets.

References, Further Reading and Appendices

This final part of the Guidelines provides a comprehensive list of further readings for those seeking more in depth information on various elements of the processes highlighted throughout. It also focuses on a number of resources available through the Appendices which include the following:

APPENDIX 1 –EXAMPLE – ASSIGNING A CONSEQUENCE SCORE TO AN ASSET

APPENDIX 2 - EXAMPLE OF DATA COLLECTION SHEETS

APPENDIX 3 - EXAMPLE OF MULTI- CRITERIA CONDITION GRADING

APPENDIX 4 - TYPICAL DISTRESS MODES FOR WS&S ASSETS

APPENDIX 5 - PORTFOLIO OF PHOTOS TO DEMONSTRATE THE DIFFERENT CONDITION GRADES FOR THE MAJOR COMPONENTS OF THE WS&S SYSTEM ASSETS.