NEW ZEALAND INFRASTRUCTURE ASSET GRADING GUIDELINES

WATER ASSETS

nzwwa
New Zealand Water & Wastes Association
Wairora Aotearoa

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Beca Steven staff, Chris Jenkins and Mike Leicester compiled this document. John Ashworth (Beca Steven), Tony Urquhart (Worley GHD), Rob Lorden (North Shore City Council) and Boyd Miller (Watercare Services Ltd) undertook document review.

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New Zealand Water and Wastes Association Inc
P O Box 1316
Wellington 6140
NEW ZEALAND
Phone: 04 472 8925
Fax: 04 472 8926
Email: water@nzwwa.org.nz
Website: www.nzwwa.org.nz

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A. Introduction

The *Infrastructure Asset Grading Guidelines - Water Assets* have been commissioned jointly by the Water Supply Managers Group (WSMG) and the Drainage Managers Group (DMG) within the New Zealand Water and Wastes Association Inc. The first draft of this document was prepared with the assistance of Napier City Council.

They are intended to be used alongside the *New Zealand Infrastructure Asset Management Manual*, in particular Section 4.5, "Asset Condition and Performance Grading", and to form part of the suite of documents that provide information for the preparation of Asset Management Plans.

The *Guidelines* have been compiled to provide practical methods for assessing the condition and performance of infrastructure assets, and for determining long-term investment needs for maintaining, enhancing and extending those assets to meet defined service standards.

They are designed to provide Utility Network Owners and other asset managers with a consistent and straightforward method for producing information on water supply, wastewater and stormwater infrastructure assets. This information can then be used to develop detailed statements of asset condition and performance, and to establish a consistent means of making comparisons between different Utility Network Owners.

The *Guidelines* also serve as an essential tool for Utility Network Owners to develop information on asset status, renewal requirements, backlog, and expenditure needs for their Asset Management Plans (AMPs). The information obtained by use of these *Guidelines* will also support the development of Asset Valuations.

The *Guidelines* provide a mechanism for the determination of condition and performance assessment proposed by the *New Zealand Infrastructure Asset Management Manual*.

Two complementary approaches for assessing asset condition and performance are explained in the *Guidelines*:

- **"Top Down" Approach**, which is based on simple statistical methods to provide an overview of asset condition and performance at a particular time. This can be used to target further investigations and studies as part of the AMP process.

- **"Bottom Up" Approach**, which creates a long-term infrastructure database built on information collected over a number of years on the detailed performance and condition of individual assets.

While the two approaches can be implemented separately, they are designed to work together, providing robust support to Utility Network Owners in their asset management planning.

Part B of these *Guidelines* introduces the two approaches, provides background information on the need for accurate assessments of infrastructure assets, and defines key terms such as "asset condition" and "asset performance".

Part C explains how asset condition and performance should be measured and graded, and defines what assets are covered by these *Guidelines* and what is meant by "critical assets".

Part D develops the "Top Down" methodology, and explains what is meant by "zones" and "strata", and how key data should be collected using this approach.

Part E develops the "Bottom Up" methodology, and explains how a comprehensive database of asset information is built up using this approach.

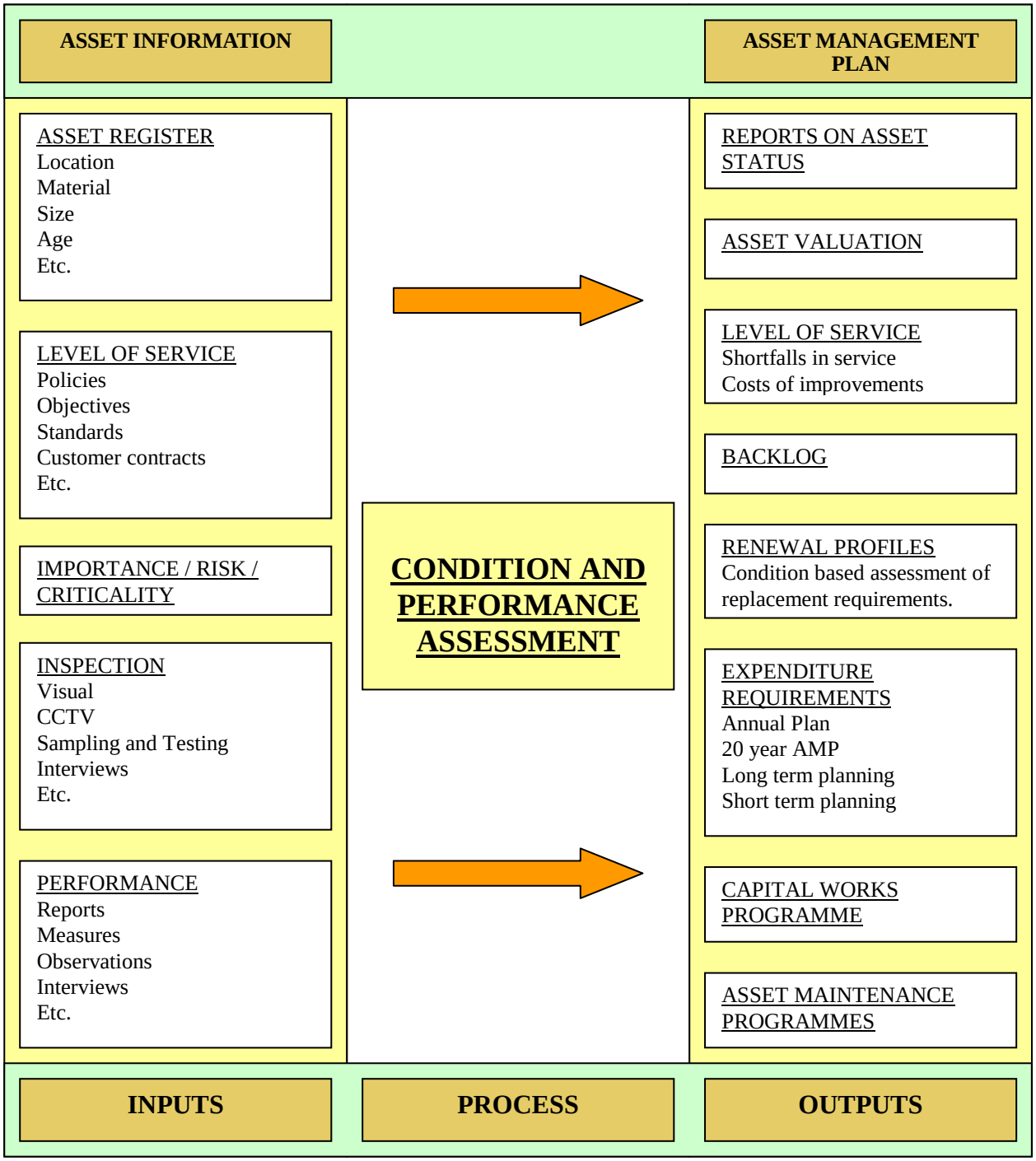

FIGURE 1 CONDITION AND PERFORMANCE PROCESS

B. Background and Approach

Contents

B.1 Rationale

B.2 Scope

B.3 Implementation

Overview

- Why have these *Guidelines* been produced?
- What are "asset condition" and "asset performance"?
- What do you need to know about Central Government and Audit Office requirements?
- Which service standards are obligatory by law and which are discretionary?
- What assets and types of assets are covered by these *Guidelines*?
- What are the "Top Down" and "Bottom Up" approaches?

B.1 Rationale

Objectives

The *Guidelines* have been compiled to provide Utility Network Operators and other asset managers with a consistent and straightforward method for producing information on the condition and performance of water supply, wastewater and stormwater infrastructure assets.

This information is an essential element in the preparation of Asset Management Plans (AMPs).

It also enables Utility Network Operators asset managers to establish better standards of benchmarking, and allows more accurate comparisons between different Utility Network Operators.

Asset Condition and Performance

To assess the long-term investment required to maintain infrastructure assets, information is needed on their condition and performance. We can then define problems, develop solutions and calculate costs accordingly.

The "condition" of an asset refers to its structural integrity.

"Performance" refers to the ability of an asset or system to meet defined service criteria.

Detailed definitions of asset condition and performance are contained in Part C of these *Guidelines*.

Asset Management Concerns

As asset managers develop their systems they will recognise that some information and procedures required to support the long-term management of the assets are limited or not in place.

The areas of main concern are:

- that there is limited knowledge and information available on the condition of assets;
- that present financial provisions may be insufficient to meet long-term expenditure requirements for capital maintenance and eventual replacement of assets;
- that asset valuation provides a statement of current replacement cost and depreciated value, but only provides a rough indication of the size of likely problems, rather than the sort of accurate information required;
- that methods used to determine renewal expenditure must reflect the way assets are "consumed" over time;
- that Utility Network Operators need to be able to apply a long-term perspective to the issue of asset management to ensure no undue burden is borne by one generation over another.

Establishing and tracking the condition and performance of assets is a prime responsibility of Utility Network Operators, and supports key operational tasks such as measuring the effectiveness of maintenance programmes or justifying funding requests.

Utility Network Operators need to provide *assurance* that well prepared, long-term plans are in place for maintaining assets, and that robust estimates of long-term expenditure, quantification of uncertainties within investment plans, and annual "infrastructure renewals" charges, have all been derived on a sound basis.

These estimates of capital expenditure should be integrated, along with estimates of operating costs and likely revenues, into a strategic business. Options for the funding of capital can then be addressed and modelled, along with impacts of changing standards.

B.2 Scope

Condition and Performance Grading

The *Guidelines* are intended to cover condition and performance grading for above and below ground infrastructure assets that comprise water supply, sewerage and stormwater networks.

These assets include treatment, pumping, storage and other facilities along with all pipelines, channels, manholes and other structures that comprise the water supply, sewerage and stormwater networks.

Condition and Performance grading tables are provided for the primary components of these asset groups.

Other Assets not Listed

The asset grading tables provided a format for developing gradings for assets not listed.

Exclusions

Infiltration

The *Guidelines* do not address infiltration, which is covered by the *New Zealand Inflow and Infiltration Control Manual (NZIICM)* prepared for NZWWA in August 1995.

NZIICM provides guidance for the examination and remediation of infiltration and inflow into sewerage and stormwater systems.

Distribution Losses

Investment requirements for the implementation of leak detection programmes to reduce distribution losses would normally be part of an economic assessment covering:

- the capital cost of reducing leakage;
- the cost of maintaining the reduced leakage level;
- the costs of supplying the water;
- the range of demand forecasts applicable to the planning period.

B.3 Implementation

Two approaches can be used for assessing the condition and performance of assets: the "Top Down" Approach and the "Bottom Up" Approach. Each can be applied separately, although they are most effective when used together to provide a comprehensive assessment of asset performance and condition.

"Top Down" Approach

This is a statistical approach, conducted every three to five years, which provides a one-off assessment of the performance and condition of assets within targeted zones. The data is then extrapolated, using robust statistical methodology, to provide estimates of long-term expenditure needed to maintain, improve and extend networks of assets.

The practical application of the "Top Down" Approach is detailed in Part D of these *Guidelines*.

"Bottom Up" Approach

This method builds up information, in a live database, on the detailed performance and condition of individual assets. It typically takes three to ten years to build up the base level of information required to enable Utility Network Operators to record, collate and report on specific assets.

Details of the "Bottom Up" Approach are contained in Part E of these *Guidelines*.

Outcomes

By applying the two approaches, two key outcomes will be achieved:

1. the base condition and performance of assets will be established
2. the rate of asset deterioration will be determined over time, although this is a more subjective estimate than performance assessment

The relationship between these two methodologies is set out in Figure 2.

Audit Checks are Recommended

1. Internal audit checks to ensure that grading assessments are carried out on a consistent basis across assessors.
2. External checks from the Audit office to ensure consistency across different Utility Network Owners.

Reporting Asset Status

Figure 5 provides an example of reporting asset condition and performance status. Often reporting the information community by community provides a means of focusing attention on areas where deficiencies need attention.

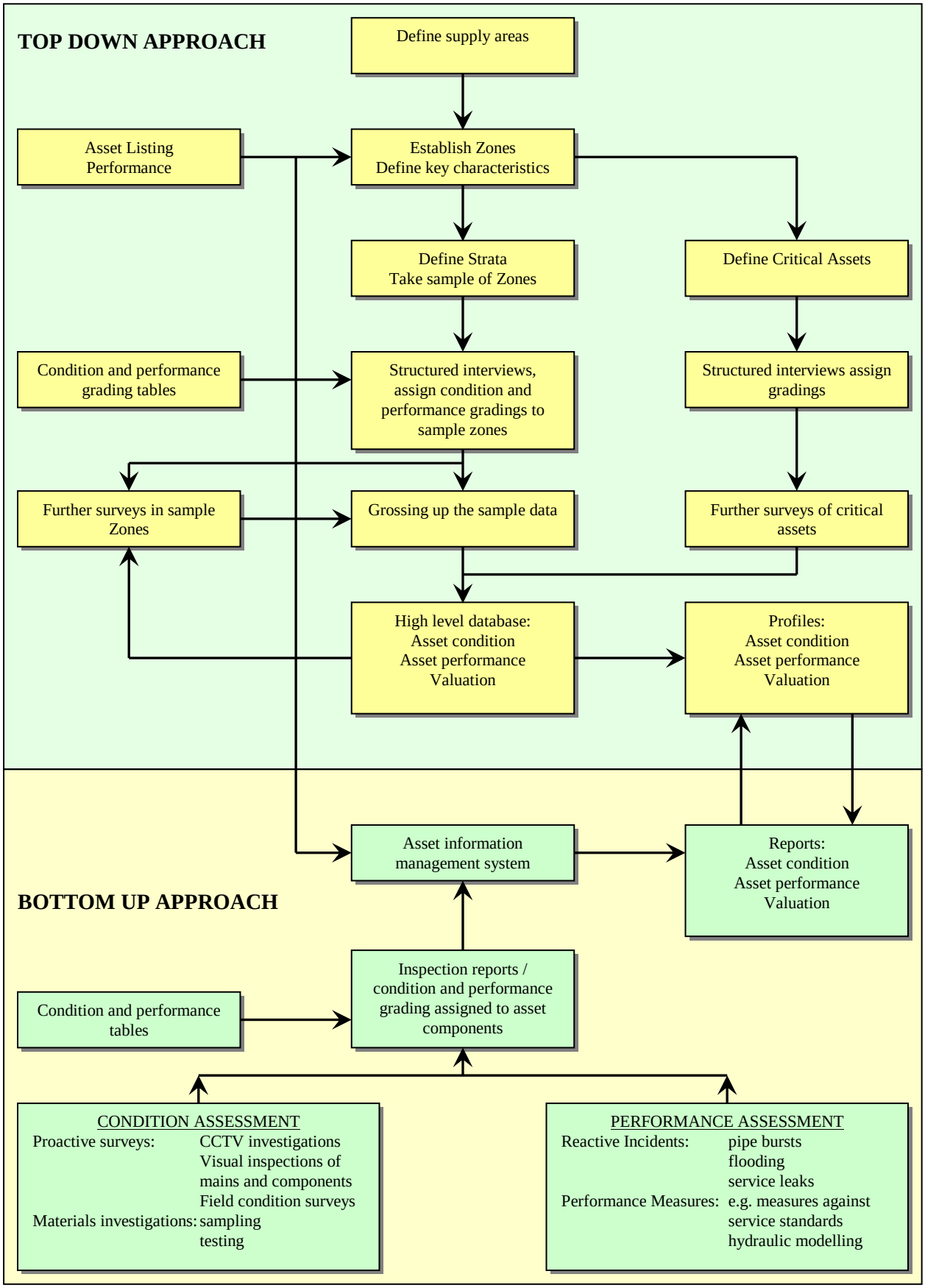

FIGURE 2 FLOW CHART FOR BOTH "TOP DOWN" AND "BOTTOM UP" METHODOLOGIES

Reporting Cost of Asset Replacement

Asset replacement can be driven by condition or performance, or by external demands such as growth or adjacent projects. The asset manager must be certain to ensure that double counting does not occur when reporting the costs of asset replacement.

C. Definitions of Asset Condition and Performance

Contents

C.1 Performance Measures

C.2 Activity Measures

C.3 Condition Grading

C.4 Performance Grading

C.5 Critical Assets

C.6 Data Confidence Grades

Overview

- What are “performance measures” and “activity measures” and how should they be applied?
- How are asset condition and performance graded?
- What are “critical assets”?
- What is “data confidence” and how should it be graded?

C.1 Performance Measures

Definitions

Performance measures should be established as a basis for monitoring the effectiveness of the system networks in delivering service to customers. These may be system or asset related. Common definitions will allow performance to be monitored over time and compared between Utility Network Operators on a consistent basis. Generally these performance measures are embodied in the levels of service standards.

For each measure we need to define:

- what is to be measured
- how and where it should be measured
- the value of an "acceptable" reference level of service
- a "target" for achieving the reference level

Some performance measures are established by external standards, such as the Drinking Water Standards for New Zealand 1995 and the Code of Practice for Fire Fighting Water Supplies.

Other performance measures are discretionary (or customer requirements), where Utility Network Operators may wish to consult with customers on the level of service required. In this case, Utility Network Operators need to balance the benefits of achieving desired standards against the cost (hence the level of charge and affordability) of doing so.

This is an iterative process. While the performance measure is defined, the value of the reference level and the target for achieving it can be varied to meet whatever financial constraint may be imposed.

The performance of existing assets can then be assessed against these measures and any shortfalls identified. The cost of improving assets or groups of assets, to achieve the reference level can be estimated.

In addition, desired targets, in terms of the scale of the performance measure and the timetable for achieving it, can be established.

Serial Codes

The serial codes W1 etc, S1 etc and D1 etc. (water supply, sewerage and stormwater respectively) are provided for ease of cross-reference in this document. The asset manager will choose a coding system that more closely reflects management needs, ledger codes etc.

Examples of Performance Measures for Water Assets

Examples of indicative performance measures for water, wastewater and stormwater networks are set out in Tables 1 and 2. They comprise the main performance measures commonly applied, although there is scope to include additional measures or delete others as appropriate.

The principal performance measures are set out below. These are included for indicative purposes only. Further development will be needed to provide definitions in the levels of service standards.

Water quality (W1)

Performance measures for water quality are stated by the Ministry of Health in *Drinking Water Standards for New Zealand, 1995*. Some Utility Network Operators may already be achieving 100% compliance with all requirements. Others may have elements of non-compliance and may set a target for compliance within a particular timescale.

Pressure (W2)

Pressure monitoring provides a good indication of the behaviour of the distribution systems, taking into account daily and seasonal variations, as well as long term trends resulting from a general increase in demand from existing and new customers.

The pressure and flow standard should be measured at the boundary of the property, where the responsibility of the customer begins. The following is a useful reference level to apply:

- 9 litres/minute at a minimum head of 10 metres (100 kPa) measured at the boundary stop tap on the customer's side of any meter or other fitting.

This applies only to single properties. Where more than one property is served by a single boundary stop-tap, the flow rate must be increased appropriately. It may be easier to monitor pressure at an adjacent point in the distribution system, in which case a higher "surrogate" pressure reference would be appropriate.

Fire fighting (pressure and flow) (W3)

Water taken from hydrants for fire fighting purposes needs to be at a defined flow and residual pressure, with reserve storage capacity for a specified risk classification.

Availability (W4)

This is a measure of the water available to meet customers' demands, calculated as a ratio of supply and demand over peak demand periods during 'drought' conditions. This is more a driver for resource development, treatment and trunk mains.

Interruptions (W5)

This is the measurement of interruptions to customers' supplies (measured in hours where no water is available) as a result of planned or unplanned work (eg. bursts) on the distribution system. It can be expressed as the number of affected properties in various duration bands, eg. between 8 and 12 hours, more than 12 hours, and more than 24 hours.

Leakage (W6)

This measurement is a useful indicator and comparator. Utility Network Owners should develop their leakage strategy through economic analysis.

Discharge to ground. (S1)

This measures the number of gardens, berms and areas adjacent to properties at risk of flooding - from wastewater sewers or combined sewers due to hydraulic inadequacy or blockages - more frequently than the reference level of service prescribes.

The suggested reference level is the annual (100% AEP) flood.

Overflow operation (S2)

This measures the number of sewer overflows on the drainage system the performance of which, in terms of frequency of operation and duration, is considered unsatisfactory when compared with the reference level of service.

Unsatisfactory performance can be defined as situations where consent conditions are breached, where discharge occurs in dry weather or where discharge causes complaints.

Inflow and Infiltration (S3)

This measures the occurrences or quantities where flows at the measuring point (pump station, flow gauge) exceed the design flow values defined in the reference levels of service.

This measurement is a useful indicator and comparator. Utility Network Owners should develop their inflow and infiltration strategy through economic analysis.

Flooding of properties (D1)

This measures the number of properties at risk of flood damage - from stormwater drains due to hydraulic inadequacy or blockages - more frequently than the reference level of service prescribes.

The recommended reference level is a once-in-ten-years (10% AEP) flood causing actual damage to the property, or a once-in-one-hundred-years (1% AEP) flood causing damage to habitable floors. This can be measured by catchment analysis.

Flooding of roads and open areas (D2) and (D3)

This measures areas at risk of flooding - from stormwater drains due to hydraulic inadequacy or blockages - more frequently than the reference level of service prescribes, where such flooding causes inconvenience (nuisance) to traffic or people.

The recommended reference level is a once-in-five-years (20% AEP) flood.

Other Performance Measures/Base Data

Other more general output measures exist which are collected as part of overall business reporting, and which are related to asset performance in various ways. These include data on:

- populations
- properties
- commercial supplies
- total water delivered

- unaccounted for water (leaks, illegal use, firefighting etc.)
- wastewater collection

Examples of such data are contained in Table 3.

NB. A driver for stormwater drainage, and not necessarily an activity under control of the Utility Network Owner, is the extent of paved area contributing to surface drainage systems. Reference should be made to the District Plans.

TABLE 1 PERFORMANCE MEASURES - WATER ASSETS						
Serial	**Measure**	**Asset Performance**	**System Performance**	**Standard/Reference Level**	**Location of Measure**	**Measurement**
W1	Water Quality		x	Drinking Water Standards for New Zealand 1994 - selected parameters	Customer's internal tap	Population/properties receiving water below standard
W2	Pressure		x	9 litres/minute at 10 Metres head [or surrogate measure]	Customer boundary [or surrogate?]	Properties below reference level
W3	Fire fighting		x	200 to 25 litres/second - Class A to E (code of practice for firefighting water supplies)	[In distribution system] hydrant	N^{o} of hydrants/properties below reference level
W4	Availability		x	Supply/demand balance in drought year	Entry to distribution system	Population below reference level
W5	Interruptions	x		Loss of supply say > 8 or 12 hours	Customer's internal tap	Properties by duration band
W6	Leakage	x		Developed through economic analysis	Water balance analysis Distribution losses = Input - Water delivered to customers	Volume, or litres/pr/hour, or %

TABLE 2 PERFORMANCE MEASURES - SEWERAGE AND DRAINAGE ASSETS						
Serial	**Measure**	**Asset Performance**	**System Performance**	**Standard/Reference Level**	**Location of Measure**	**Measurement**
S1	Discharge to ground	x [Pipe failure]	x [Hydraulic]	Frequency/duration [annual event]	Ground adjacent to sewer	Occurrences
S2	Overflow operation	x [Pipe failure]	x [Hydraulic]	Frequency or duration/year	Overflow	Occurrences
S3	Inflow and Infiltration	x	x	Peak flow/dry weather flow	Pumping station / Gauging station	[Litres/second per kilometre], or [percent dry weather flow]
D1	Flooding properties	x [Pipe failure]	x [Hydraulic]	Frequency/duration [1 in 10 yrs] / [1 in 100 years]	Property	Properties / Dwellings
D2	Flooding gardens	x [Pipe failure]	x [Hydraulic]	Frequency/duration [1 in 5 yrs]	Property	Properties
D3	Flooding roads or streets	x [Pipe failure]	x [Hydraulic]	Frequency/duration [1 in 5 yrs]	Road or street	Locations

TABLE 3: EXAMPLES OF OUTPUT MEASURES, BASE DATA			
Serial	**Parameter**	**Unit**	**Comparative Index**
	Water Delivered		
B1	Population connected to water	thousands	Percent connected
B2	Domestic properties connected to water	thousands	Percent connected
B3	Non-domestic properties connected to water	thousands	Percent connected
	Water Delivered		
B4	Total water into distribution	m^3/day	
B5	Water delivered to domestic properties	m^3/day	Per capita consumption
B6	Water delivered - non domestic properties	m^3/day	Percent
B7	Water delivered - other	m^3/day	Percent
B8	Distribution losses	m^3/day	Percent or litres/p/day
B9	Extent of domestic metering	thousands	Percent
	Sewerage population		
B11	Population connected to sewerage	thousands	Percent connected
B12	Properties connected to sewerage	thousands	Percent connected
B13	Non-domestic properties connected to sewerage	thousands	Percent connected
	Sewerage Flows		
B14	Volume returned to sewer	m^3/day	Percent returned average BOD g/m^3
B15	Infiltration	multiplier of yearly ave DWF	Percent, litres/second/kilometre
B16	Trade effluent load	m^3/day	
B17	Storm overflows operation	[frequency duration]	
	Stormwater		
B21	Total properties connected	thousands	Percent connected
B22	Extent of impermeable area by centre, urban, semi urban areas	[hectares]	Area/Property

C.2 Activity Measures

Activities are defined as works undertaken on assets to maintain outputs to customers, either by operational or capital expenditure. These include most routine activities undertaken by Utility Network Operators and provide a very useful surrogate indicator on the condition and performance of assets.

A range of activities is shown in Table 4, although this is not intended to be exclusive. Information on many of these activities may have been collected already using the IMS database.

TABLE 4: EXAMPLES OF ACTIVITY MEASURES WATER AND SEWERAGE ASSETS

Serial	Measure	Unit	Comparative Index
	Water Distribution		
A1	Mains renewed	metre	m/total length
A2	New mains	metre	m/property
A3	Burst Mains	N^{o}	Bursts/100 kilometres
A4	Mains repair	N^{o}	Repairs/100 kilometres
A5	Service Replacement	N^{o}	Service/total connections
A6	Service Repair	N^{o}	Service/total connections
A7	Meter replacement	N^{o}	Service/total connections
A8	Meter repairs	N^{o}	Service/total connections
	Sewerage		
A11	New sewers	metre	m/property
A12	Blocked sewer	N^{o}	Blockage/100 kilometres
A13	Collapsed Sewers	N^{o}	Collapse/100 kilometres
A14	Blocked collector	N^{o}	Blockage/total connections
A15	Collapsed collector	N^{o}	Collapses/total connections
A16	Manholes	N^{o}	Blockage/total connections
	Stormwater Drainage		
A21	New storm drains	metre	m/property
A22	Blocked drain	N^{o}	Blockage/100 kilometres
A23	Collapsed drain	N^{o}	Collapse/100 kilometres
A24	Blocked collector	N^{o}	Blockage/total connections
A25	Collapsed collector	N^{o}	Collapse/total connections

C.3 Condition Grading

The following example sets out a common approach to assessing the condition of assets. This approach provides consistency across and within Utility Network Operators, and allows consistent comparison of the current 'base condition' of assets with their condition in future assessments. This approach also provides an effective way to present data in an understandable way to third parties.

A generic '1 to 5' grading system is proposed which is applicable to either "Top Down" or "Bottom Up" approaches. This system has been developed from extensive experience and application in other parts of the world.

TABLE 5 CONDITION CLASSIFICATION

Grade	Classification
1	Very Good
2	Good
3	Moderate
4	Poor
5	Very Poor

Examples of the '1 to 5' gradings are provided in the Tables in Section G

C.4 Performance Grading

"Performance" relates to the capability of assets to meet defined service criteria. It can relate to systems, or groups of assets, as well as individual assets.

As with the assessment of asset condition, a grading system provides consistency across and within Utility Network Operators, and allows consistent comparison of the current 'base performance' of assets with their performance in future assessments. This approach also provides an effective way to present data in an understandable way to third parties.

The same generic '1 to 5' grading system is proposed, and this is applicable to either "Top Down" or "Bottom Up" approaches. This system has been developed from extensive experience and application in other parts of the world.

TABLE 6 PERFORMANCE CLASSIFICATION

Grade	Classification
1	Very Good
2	Good
3	Moderate
4	Poor
5	Very Poor

Examples of the '1 to 5' gradings are provided in the Tables in Section H.

C.5 Critical Assets

A concept of 'critical assets' has been developed to help Utility Network Operators and asset managers identify assets with high strategic importance. These are assets for which the financial, business or service level consequences of failure are sufficiently severe to justify more rigorous policies for proactive inspection, maintenance and renewal.

Critical assets are defined as follows:

> *"... an asset where failure would have significant consequences, either in the ability of the system to provide services to customers or the effect on the environment ..."*

Identification

Identification of critical assets is a matter for individual Utility Network Owners to undertake, based on the detailed knowledge they have of their own systems. There are no specific rules for identification of critical assets. It is a matter of technical assessment and judgement, based on the level of risk to be taken and the consequences of failure.

A comprehensive assessment to determine critical assets is undertaken by a detailed risk analysis of all assets and asset components in the network. This is often termed a "criticality" study.

Examples

Typical examples of critical assets may include those that are essential for the operation of the system, in particular:

- pumping stations - water, sewerage and stormwater
- service reservoirs
- trunk water mains
- major collector sewers
- pipe bridges
- rising mains
- storm overflows

In addition, certain water mains or sewers laid under or crossing main highways or railways, or situated in city centres, could also be considered critical, because failure of such assets could have serious consequences on public safety, public health and property. This is also true of sewer pipeline bridges at risk of seismic action.

Assessing Consequences of Failure (risk)

In practice, critical assets imply a higher level of inspection and proactive maintenance and rehabilitation than other assets.

Critical assets would normally be maintained at a higher condition or performance grade (e.g. grade 2 or 3) than less important assets (e.g. grade 4 or 5), where the consequences of failure are less severe.

For example, major trunk mains serving large cities have significantly high consequences of failure, in terms of the inability to supply a large number of customers, and therefore require a high level of planned maintenance to keep assets in a condition of at least grade 2. Similarly, large sewage pumping stations and rising mains, where there are significant environmental and public health consequences of failure, would also be assessed and classified as critical assets.

Conversely, non-critical sewers may be left to collapse before action is taken, because the consequences of failure are less severe. If such failures are systematic, causing frequent disruption, there would be a case for further investigation and possible targeted work.

Random failures would be less significant, and a lower condition or performance grading (eg. grade 4 or 5) would be applied.

C.6 Data Confidence Grades

The application of asset management planning requires the collection of data from many sources and of varying quality. For example, there is a great deal of valuable knowledge and information held by operating staff which may not be written down. Alternatively, surveys and investigations on some assets may have generated detailed reports which are available for consultation.

It is important to assess the quality and reliability of data being collected. A system of data confidence grading, using A to D bands, has been developed which can be applied to all data presented. This is an effective means of communicating the confidence in the data and outcomes of AMP to stakeholders.

Examples of data confidence gradings are set out in Table 7.

It is important that the data confidence gradings represent a level of fact, as data are now, and should be no reflection on the opinions of staff expressed at structured interviews.

The methodology used in assigning grades according to the quality and reliability of data is necessarily subjective and depends on interpretations of engineers preparing AMPs within Utility Network Owners. Consistency across Utility Network Operators is more difficult to achieve and there may be a need to develop additional meanings for confidence grades for specific data.

For this methodology to be effective, Utility Network Operators and asset managers need to provide honest opinions on what is required. Although we all like to feel we have the best systems in place, and deserve an 'A', it is important for any limitations to be realistically recognised.

The following is an example of how this approach can be applied:

Water Mains Records

A. Sound records of all water mains that have been prepared in a quality assured manner and verified by site checking. Data may be on GIS or database.

B. Sound records of most water mains prepared in a quality assured manner, with the greater proportion verified by site checking. Some minor shortcomings such as incomplete records or uncertainties in pipe materials. Information may be on database.

C. Sound records of some water mains prepared in a quality assured manner, although incomplete or not verified or with totals extrapolated from a sample of sound and verified records. Some shortcomings such as incomplete records or uncertainties in pipe materials. Some information may be on database.

D. Some data on water mains available, although it may be incomplete, or of uncertain quality and not verified by site checks.

TABLE 7 DATA CONFIDENCE GRADING	
Confidence Grade	**General Meaning**
A	**Highly Reliable** Data based on sound records, procedures, investigations and analysis which is properly documented and recognised as the best method of assessment.
B	**Reliable** Data based on sound records, procedures, investigations and analysis which is properly documented but has minor shortcomings; for example the data is old, some documentation is missing and reliance is placed on unconfirmed reports or some extrapolation.
C	**Uncertain** Data based on sound records, procedures, investigations and analysis which is incomplete or unsupported, or extrapolation from a limited sample for which grade A or B data is available.
D	**Very Uncertain** Data based on unconfirmed verbal reports and/or cursory inspection and analysis.

D. The "Top Down" Methodology

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D.6 Data Collection

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D.8 Further Studies in Sample Zones

Overview

- How does the "Top Down" approach work?
- How does the method apply to above and below ground assets?
- How are "zones" defined?
- How are "strata" defined?
- What sort of data should be collected?

D.1 Rationale

The "Top Down" methodology is a statistical approach to asset management planning, whereby estimates of the long term expenditure needed to maintain, improve and extend networks of assets is presented within a stated range of variability. The assessment of condition and performance and the grading standards applied, form the basis for subsequent investment assessment.

The reason why the "Top Down" approach has been developed is that examination of a Utility Network Operator's entire asset stock would be a major exercise and is generally not feasible given the constraints of available time and resources. In fact, the value of such detailed results would be limited because of uncertainties in other aspects of the Asset Management Plan, including the identification of work that needs to be done to bring assets up to defined performance levels, the unit costs to be applied, the rate of asset deterioration, and many other issues.

'One-Off' Statement

The primary technique of the 'Top Down' approach is the production of a 'one-off' statement of asset condition and performance, using a robust statistical methodology. This approach relies to a large extent on information already available, supplemented by further targeted studies and investigations to improve the quality of data.

The quality and depth of information will steadily improve over time as good quality data is collected as part of normal operations, with findings collected in the IMS database. The ongoing collection of this data is what is meant by the 'Bottom Up' approach. The two approaches are complementary, with the IMS database providing improved data quality over the long term, to be fed into the "Top Down" approach on a periodic basis.

Base Condition

Initial assessments of condition and performance provide us with a 'base condition' statement, in relation to which changes can be monitored over time. This statement should be updated from time to time. Annual assessments are likely to be too frequent, due to the low rate of change in assets. Assessments every three years are probably more appropriate, as this corresponds to other timeframes, activities and financial planning reviews.

Key Steps of the 'Top Down" Approach

This approach can be broken down into the following key steps:

- establishing zones and strata
- defining critical assets
- stratification of zones and sampling
- data collection
- grossing up initial results of condition and performance
- further surveys in sample zones and on critical assets

These steps are set out in Figure 3, and developed in detail in the following sections.

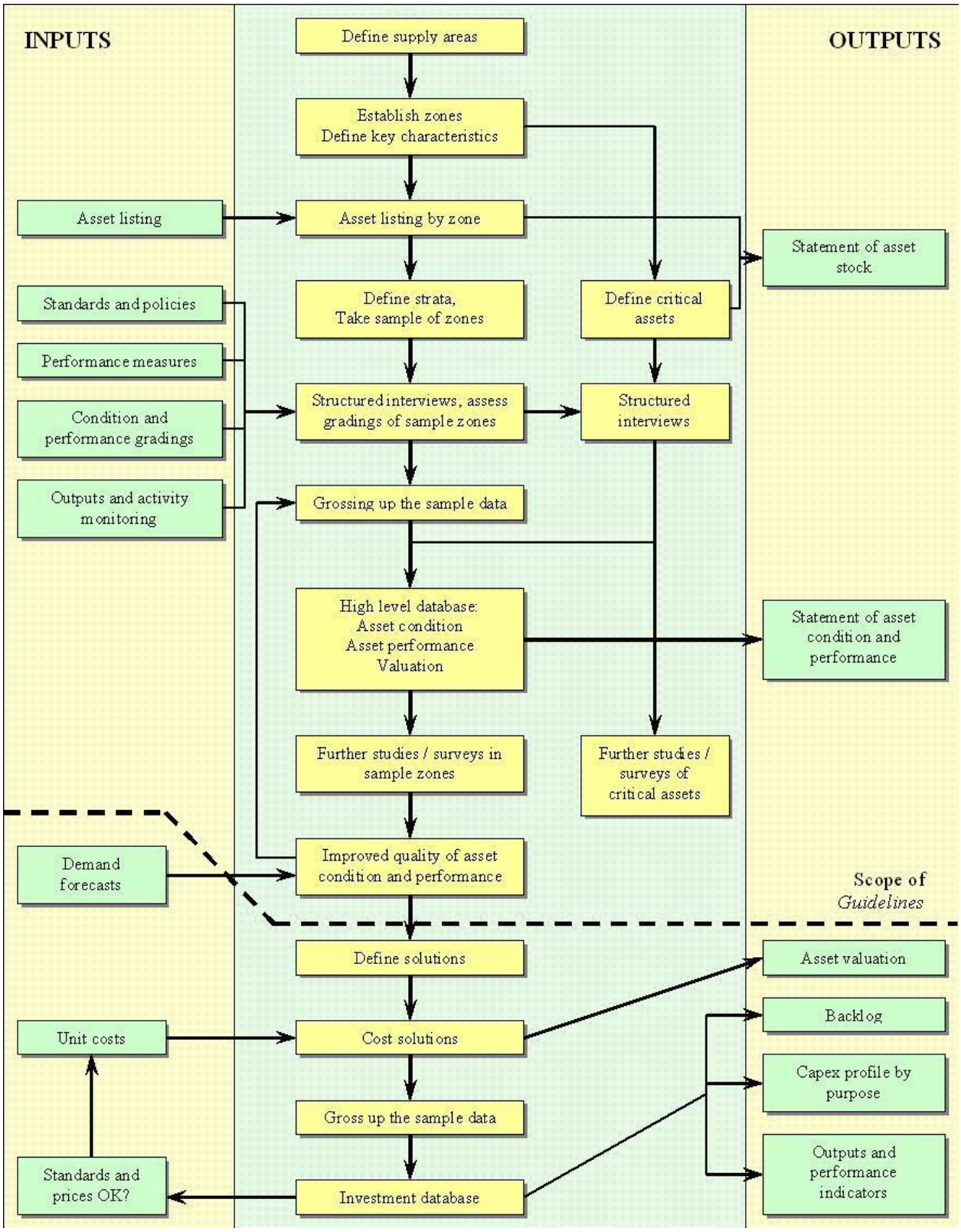


FIGURE 3 THE "TOP DOWN" METHODOLOGY FOR CONDITION AND PERFORMANCE ASSESSMENT

D.2 Above and Below Ground Assets

Grading Classifications

The condition and performance grading tables provided in Sections G and H of these *Guidelines* provide descriptions that enable grading of typical water assets into the grading classifications described in Sections C.3 and C.4. These tables provide classification descriptions for both above ground and below ground assets.

The condition and performance grading tables do not represent an exhaustive listing of assets. Sufficient tables are provided to enable the asset manager to follow the format and general descriptions to develop additional tables specific to the particular assets under consideration.

Assigning Grading Classifications to Assets

Sections D.3 through D.8, following describe a statistical methodology for assigning condition and performance grading classifications to assets. For the purposes of providing clarity of describing the methodology all discussion and examples relate to the grading of below ground assets, in particular the pipeline assets. The asset manager should not be discouraged by the apparent oversight of the above ground assets, or other types of below ground assets. The methodology applies equally to all asset types and groups.

Collection of Condition and Performance Information

The amount of effort undertaken to collect condition and performance data on assets will relate to the time available and cost of data collection. The asset manager will also be aware that measured data rapidly goes out of date and therefore to be meaningful to the process must be regularly reviewed to keep current. This raises again the question of cost of collecting the data. The cost of asset data collection must be measured against the asset management benefits achieved. There is often little benefit gained from regular measurement of condition (by CCTV for example) of pipeline assets in Grade 1. There will be some time before these assets will be replaced or have an impact on the renewal expenditure predictions. The low cost "structured interview" approach described, supported by selective inspections, will be adequate for most "hidden" assets where the cost of collecting measured data is high.

Condition and performance assessment of above ground assets benefits from the generally low cost of undertaking regular visual inspections of each asset component. This enables direct assignment of measured condition and performance to each asset component on a regular cycle of inspections. The asset manager will often have a better understanding of the behaviour of these assets.

The level of detail in collecting and assigning condition and performance grades therefore relates to the cost of the data collection and the benefit to the asset management process. Older, or rapidly deteriorating, or critical assets may require a higher level of detail, as the expenditure consequences of failure of these assets may be significant.

Application of Zones and Strata

Sections D.3 through D.8, following describe a process of grouping assets into zones and strata. This process is important as it enables the asset manager to analyse and report the condition and performance data in a meaningful way. Whether the assets are above ground, and individually assessed, or below ground and statistically assessed, the grouping into like deterioration processes or reporting requirements will greatly assist the asset manager in determining asset needs.

Asset Components

The number of asset components to be separately considered should be related to the level at which items would normally be replaced. For example valves, meters, hydrants, service connections and the like would normally be considered separately from the water pipeline assets. Water pipelines of different diameters and materials would also be considered separately.

Again the level of detail should relate to the cost of collecting data on a regular basis and the benefits accrued to the asset management process.

D.3 Establishing Zones

The water distribution system, sewerage networks and stormwater drainage areas, which together form a Utility Network Operator's area of responsibility, should be divided into appropriate zones. These zones (related to the water or drainage service) act as the basic building blocks for the AMP studies.

In defining zone boundaries, Utility Network Operators may wish to follow the already-existing demarcation of census area units, as data on population and properties will be important factors in determining the statistical size of a zone and will also assist in data reporting.

Zone boundaries can be defined on the basis of discreet water pressure zones (or parts of pressure zones where areas are large), sewerage areas and natural drainage areas. Zones should be relatively similar in size, small enough to be identified as a distinct unit or area, but not so large as to lose the variability of characteristics within each.

Different zone boundaries may be established for water, drainage and stormwater assets.

The number of zones will depend on the layout and characteristics of asset networks and the size of each network. Twenty to thirty zones would be appropriate for a typically sized Utility Network Owner, with fewer for smaller owners.

Examples of zones and zone boundaries for Napier City are shown in Figure 4. These were based on the already existing demarcation of the Census Area Units. This enables reporting by population or property. Further it enables comparators to be prepared which compare areas within the city and with like areas in other communities.

Base Data for Each Zone

For each zone, base data needs to be assembled which defines the size and characteristics of each zone. Base data needs to include the following information:

- population and properties
- area
- type and age of development - eg. centre, suburban, industrial, commercial, rural
- ground conditions and groundwater levels
- asset listing - eg. material, diameter
- water source type
- topography - eg. flat, undulating, steep/propensity to flood
- maintenance history - eg. high/moderate/low level of problems
- customer complaints - eg. high/medium/low level of complaints

The relative influence of these factors will depend upon the particular configuration and environment of the Utility Network Owner's networks.

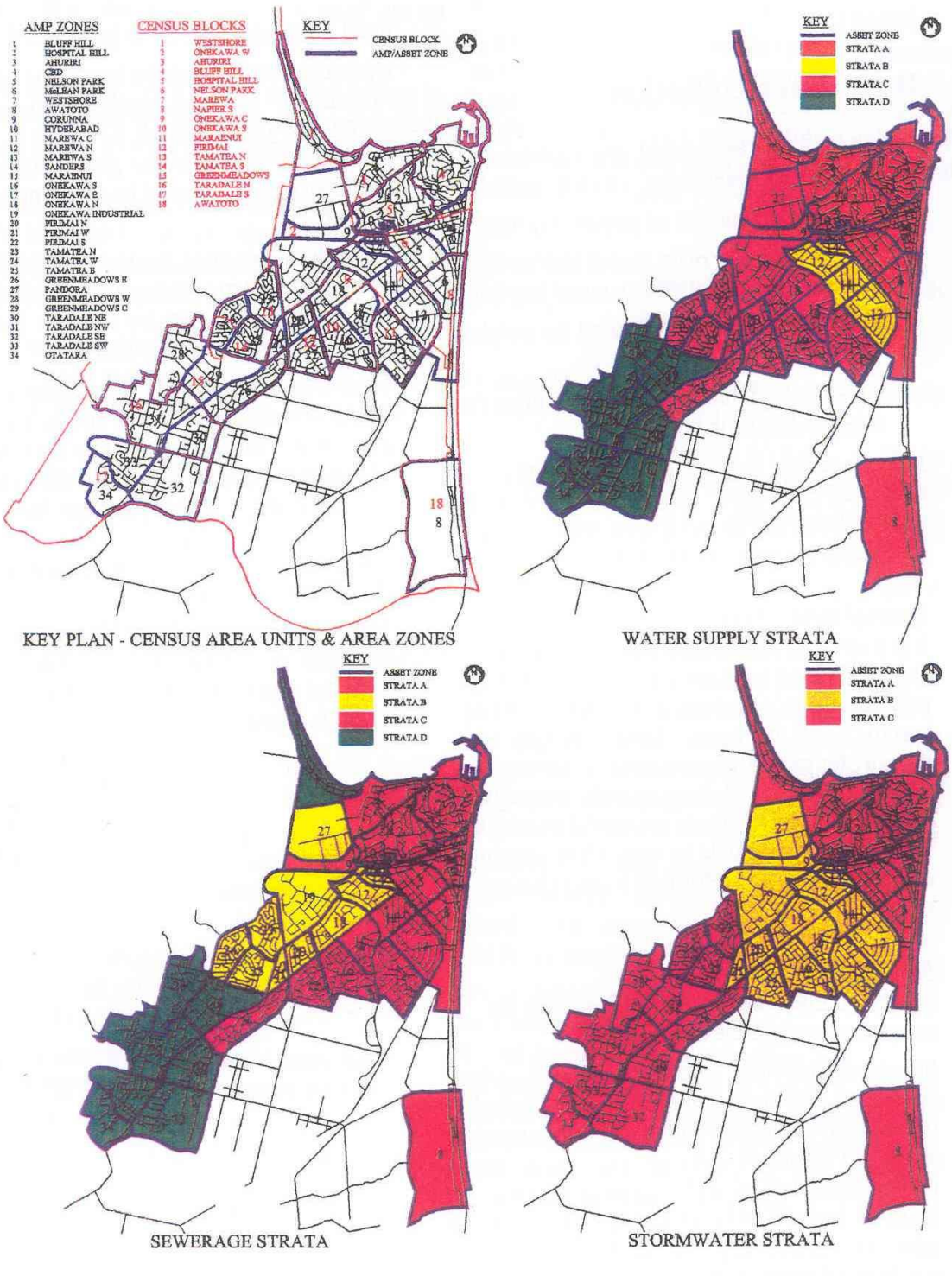


FIGURE 4 NAPIER CITY COUNCIL - KEY PLAN CENSUS AREA UNITS AND AMP ZONES

D.4 Critical Assets

Characteristics that define a 'critical asset' are set out in Section C.5.

Critical assets identified by the process set out in Section C.5 should be excluded from zone asset listings and treated as individual assets.

Data on all critical assets should be collected through the structured interviews described in Section D.6. The standard condition and performance grading criteria should be applied.

It is important to obtain more detailed information on critical assets than other assets. Section D.7 sets out further investigations that can be used for this.

D.5 Stratification and Selection of Sample Zones

Whereas the zone has been chosen for reporting purposes, the strata are selected to represent groups of assets that will deteriorate in a like manner. Choosing strata requires an examination of the influences on the assets behaviour that impact on its remaining life. Examples of these influences could be:

- current age (predominant age of assets in the zone)
- materials (zones with predominantly asbestos cement, galvanised iron, concrete etc.)
- ground conditions (zones where the predominant soil type is rock, peat, aggressive, clay etc.)
- substances carried (industrial zones may discharge aggressive substances into the network)
- installation contractor or method (may relate to age of asset or historical standards in certain areas)
- pressure (zones of high or low pressure may influence risk of failure or remaining life)
- customers served (may represent different levels of service and hence time to replacement)
- specific problem experienced.

A number of zones will exhibit similar influences on remaining life. These are grouped into strata. It may be that the over-riding influence is ground condition, type of pipe material (often linked with age of development), urban/rural areas, or type of problem experienced. For example:

Water Stratum

Stratum 1	Urban area with predominantly cast iron mains in aggressive ground.
Stratum 2	Urban area with predominantly asbestos cement mains in aggressive ground.
Stratum 3	Urban area with predominantly asbestos cement mains in good ground.
Stratum 4	Rural area with predominantly polyvinyl chloride mains in good ground.

The grouping of zones into sub-groups called ‘strata’ is an effective method for reducing sampling error. Strata can be chosen in several ways, as set out above, but for the methodology to be effective, zones within any particular stratum should have relatively similar characteristics.

The number of strata assigned to each service (water, sewerage, and stormwater) should not exceed 6 or 8. Any more than this, and the benefits of sampling are reduced.

Having defined zones that have like characteristics it is not necessary to undertake a detailed assessment of the condition and performance of all assets in all zones. A random selection of zones for assessment purposes is undertaken. This needs to be done randomly; otherwise results could be biased. Not less than two and preferably three zones per strata should be selected.

By using a random sampling approach, and selecting a reasonable number of sample zones, sampling error can be kept to the same minimal level as other sources of error.

Figure 4 contains examples of stratification in Napier City.

D.6 Data Collection

Base data should be collated into a database or spreadsheet. For each zone, data will include:

- population/number of properties connected
- length of water main (sewer and surface drain) by material and diameter banding
- unit costs for valuation (used for weighting purposes)
- number and material for service pipes (and sewer connections)

Data for sample zones will be used in the structured interviews. Other data will be needed for weighting and grossing up to provide overall statements of condition and performance.

General Data

It is likely that each Utility Network Operator will already have on hand condition (e.g. CCTV) and performance (e.g. incidence records) reports on specific assets and zones. These may also include, for example consultants' reports on drainage system modelling, specific water quality surveys, and so on. These are useful sources of information, and should be used when deriving an overall view of the performance and condition of the systems.

Structured Interviews

Structured interviews should address only the sampled zones and the critical assets.

Structured interviews with engineers and operations staff are designed to collect detailed information on the condition and performance of assets in a consistent and quality controlled way. For example, data on water mains and sewers, based on material and diameter, can be elicited by interview. As well as getting opinions on the condition of assets, further source information and reports may be identified.

Experience has shown that operations staff respond well to this method, and feel they make a positive contribution to the exercise while getting good feedback at the same time.

Operations staff should be briefed on what the "Top Down" approach involves, and how the data confidence gradings work, as set out in Section C.6. Copies of the grading tables and confidence grades should be tabled at the interviews.

For each sample zone, basic data should be inserted in the top section of the table. Data on pipe material and length by diameter band should also be entered before the interview.

Where this information is not available, estimates should be made based on the operator's experience. Operators should be asked to state an opinion on asset condition and performance based on material and diameter - this can then be apportioned by percentage across the five gradings. The opinion should reference the relevant asset grading table.

There is room to record specific comments made at the interview. Examples of completed structured interview forms for Napier City are shown in Tables 8, 9 and 10.

TABLE 8 SAMPLE OF INTERVIEW RESULTS. WATER SUPPLY - NAPIER CITY COUNCIL -

ASSET MANAGEMENT PLANNING	**KEY DATA**		**ZONE DATA**		**INTERVIEW DATA**	
STRUCTURED INTERVIEW	COUNCIL	Napier	POPULATION	2856	INTERVIEWEE	Wood/Hammond
CONDITION ASSESSMENT	SERVICE	Water	AREA (ha)	138	INTERVIEWER	Spencer-Jones
	ZONE	Hospital Hill	DOMESTIC PROPERTIES	1047	DATE	26 04 95
	STRATUM	A	GROUND CONDITIONS	Limestone / Good	LOCATION	Napier City
			WATER QUALITY	Poor		

Pipe Material Type	Length By Diameter Band (m)						Totals	Condition Grade (%)					Condition Grade (Length)						Confidence Grade	Comments
	< 100	100	150	200	300	> 300		1	2	3	4	5	1	2	3	4	5	Total		
Asbestos	37							100					37	0	0	0	0	37	D	
Cement		177						100					177	0	0	0	0	177		
			1024					100					1024	0	0	0	0	1024		
				1480				100					1480	0	0	0	0	1480		
					1092			100					1092	0	0	0	0	1092		
						0							0	0	0	0	0	0		
							3810						3810	0	0	0	0	3810		
Cast Iron	4825									100			0	0	4825	0	0	4825	D	
		2712								100			0	0	2712	0	0	2712		
			3043							100			0	0	3043	0	0	3043		
				163						100			0	0	163	0	0	163		
					598					100			0	0	598	0	0	598		
						0							0	0	0	0	0	0		
							11341						0	0	11341	0	0	11341		
u PVC	1500							100					1500	0	0	0	0	1500	D	
		400						100					400	0	0	0	0	400		
			532					100					532	0	0	0	0	532		
				16				100					16	0	0	0	0	16		
					0								0	0	0	0	0	0		
						0							0	0	0	0	0	0		
							2448						2448	0	0	0	0	2448		
Galvanised Iron	116									50	50		0	0	58	58	0	116	D	
		0											0	0	0	0	0	0		
			0										0	0	0	0	0	0		
				0									0	0	0	0	0	0		
					0								0	0	0	0	0	0		
						0							0	0	0	0	0	0		
							116						0	0	58	58	0	116		
Steel	0												0	0	0	0	0	0	D	
		0											0	0	0	0	0	0		
			0										0	0	0	0	0	0		
				386					100				0	386	0	0	0	386		
					318				100				0	318	0	0	0	318		
						367			100				0	367	0	0	0	367		
							1071						0	1071	0	0	0	1071		
TOTALS	6478	3289	4599	2045	2008	367	18786						6258	1071	11399	58	0	18786		
													33.3%	5.7%	60.7%	0.3%	0.0%	100%		

TABLE 9 SAMPLE OF INTERVIEW RESULTS. WASTEWATER - NAPIER CITY COUNCIL

ASSET MANAGEMENT PLANNING	**KEY DATA**	**ZONE DATA**	**INTERVIEW DATA**
STRUCTURED INTERVIEW	COUNCIL: Napier	POPULATION: 2856	INTERVIEWEE: Tittler / Johnstone
CONDITION ASSESSMENT	SERVICE: Sewerage	AREA (ha): 138	INTERVIEWER: Spencer-Jones
	ZONE: Hospital Hill	DOMESTIC PROPERTIES: 1047	DATE: 27 04 95
	STRATUM: A	GROUND CONDITIONS: Limestone / Good	LOCATION: Napier City
		WATER QUALITY	

Pipe Material Type	Length By Diameter Band (m) < 100	100	150	200	300	> 300	Totals	Condition Grade (%) 1	2	3	4	5	Condition Grade (Length) 1	2	3	4	5	Total	Confidence Grade	Comments
Earthenware	0												0	0	0	0	0	0	D	
(Compo Joints)		1659							10	80	8	2	0	166	1327	133	33	1659		
			7692						10	80	8	2	0	769	6154	615	154	7692		
				2212					10	80	8	2	0	221	1770	177	44	2212		
					38				10	80	8	2	0	4	30	3	1	38		
						0							0	0	0	0	0	0		
							11601						0	1160	9281	928	0	11601		
Concrete	0												0	0	0	0	0	0	D	
(RR Joints)		0											0	0	0	0	0	0		
			41						15	80	5		0	6	33	2	0	41		
				306					15	80	5		0	46	245	15	0	306		
					0								0	0	0	0	0	0		
						0							0	0	0	0	0	0		
							347						0	52	278	17	0	347		
Asbestos Cement	0												0	0	0	0	0	0	D	
		0											0	0	0	0	0	0		
			10					100					10	0	0	0	0	10		
				0									0	0	0	0	0	0		
					0								0	0	0	0	0	0		
						0							0	0	0	0	0	0		
							10						10	0	0	0	0	10		
u PVC	0												0	0	0	0	0	0	D	
		0											0	0	0	0	0	0		
			0										0	0	0	0	0	0		
				78				100					78	0	0	0	0	78		
					0								0	0	0	0	0	0		
						0							0	0	0	0	0	0		
							78						78	0	0	0	0	78		
Steel	0												0	0	0	0	0	0	D	
		0											0	0	0	0	0	0		
			0										0	0	0	0	0	0		
				0									0	0	0	0	0	0		
					0								0	0	0	0	0	0		
						0							0	0	0	0	0	0		
							0						0	0	0	0	0	0		
TOTALS	0	1659	7743	2596	38	0	12036						88	1212	9558	945	232	12036		
													0.7%	10.1%	79.4%	7.9%	1.9%	100%		

TABLE 10 SAMPLE OF INTERVIEW RESULTS. STORMWATER - NAPIER CITY COUNCIL

ASSET MANAGEMENT PLANNING	**KEY DATA**	**ZONE DATA**	**INTERVIEW DATA**
STRUCTURED INTERVIEW	COUNCIL: Napier	POPULATION: 2856	INTERVIEWEE: Tittler / Johnstone
CONDITION ASSESSMENT	SERVICE: Stormwater	AREA (ha): 138	INTERVIEWER: Spencer-Jones
	ZONE: Hospital Hill	DOMESTIC PROPERTIES: 1047	DATE: 28 04 95
	STRATUM: A	GROUND CONDITIONS: Limestone / Good	LOCATION: Napier City
		WATER QUALITY: No ground water	

Pipe Material Type	Length By Diameter Band (m) < 100	100	150	200	300	> 600	Totals	Condition Grade (%) 1	2	3	4	5	Condition Grade (Length) 1	2	3	4	5	Total	Confidence Grade	Comments
Earthenware	0												0	0	0	0	0	0	D	
		59							95	5			0	56	3	0	0	59		
			0										0	0	0	0	0	0		
				0									0	0	0	0	0	0		
					1368				75	5	20		0	1026	68	274	0	1368		
						0							0	0	0	0	0	0		
							1427						0	1082	71	274	0	1427		
Concrete	0												0	0	0	0	0	0	D	
		0											0	0	0	0	0	0		
			0										0	0	0	0	0	0		
				1729					100				0	1729	0	0	0	1729		
					1575				100				0	1575	0	0	0	1575		
						364			100				0	364	0	0	0	364		
							3668						0	3668	0	0	0	3668		
Asbestos cement	0												0	0	0	0	0	0	D	
		0											0	0	0	0	0	0		
			469						100				0	469	0	0	0	0		
				0									0	0	0	0	0	0		
					0								0	0	0	0	0	0		
						0							0	0	0	0	0	0		
							469						0	469	0	0	0	0		
u PVC	0												0	0	0	0	0	0		
		0											0	0	0	0	0	0		
			0										0	0	0	0	0	0		
				0									0	0	0	0	0	0		
					0								0	0	0	0	0	0		
						0							0	0	0	0	0	0		
							0						0	0	0	0	0	0		
Brick	0												0	0	0	0	0	0		
		0											0	0	0	0	0	0		
			0										0	0	0	0	0	0		
				0									0	0	0	0	0	0		
					0								0	0	0	0	0	0		
						0							0	0	0	0	0	0		
							0						0	0	0	0	0	0		
TOTALS	0	59	469	1729	2943	364	5564						0	5219	71	274	0	5564		
													0%	93.8%	1.3%	4.9%	0%	100%		

D.7 Grossing Up Sample Data and Presentation of Results

The data collected from sample zones is extrapolated (grossed up) to all asset data in the zones relating to each stratum. The resulting information is used to represent:

- the stratum total
- the profile for the whole network

An assumption is made, at this initial stage, that condition and performance gradings of all pipes within the same stratum will be related to the sample zones where data has been collected. The information can be aggregated to provide an overall condition profile by stratum and total.

A simple database or spreadsheet format should be developed to enable basic data handling, and to allow overall statements to be made on asset condition and performance (these are best presented graphically).

Figure 5 shows the sorts of typical profiles that would be produced.

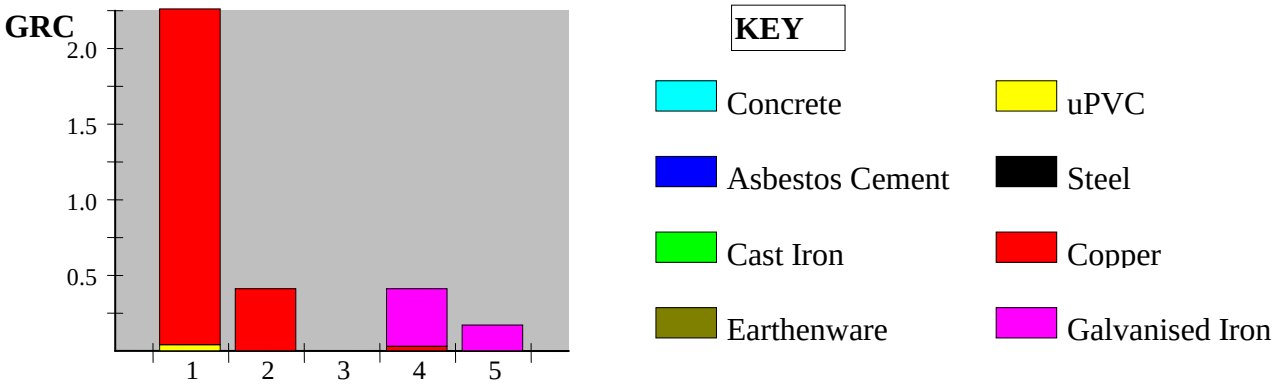
In reference to Figure 5 it is observed that asset performance is generally not related to asset length or value. Therefore asset performance reported by this method becomes an indicator on the overall ability of the asset to meet service standards. Asset performance can also be reported according to the pass/fail criteria for defined policies and standards.

Critical Assets

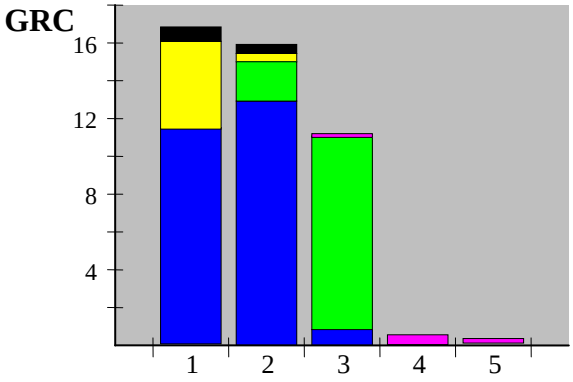
Reporting on critical assets should be done separately, against whatever higher pass/fail criteria (level of service standard) may have been established.

The condition and performance assessment through the structured interview process for the critical assets will have been undertaken for each like component of the critical assets. Therefore the grossing up process described above will only apply to assigning the interview data to all like components of the critical assets.

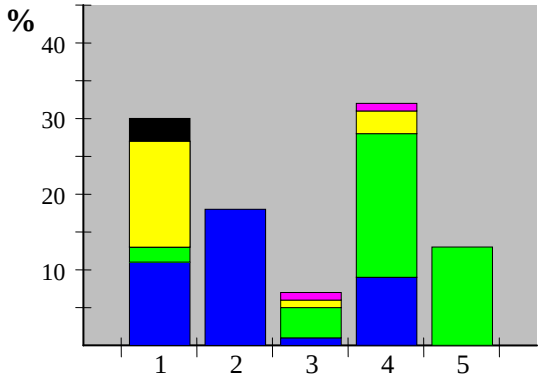
Note critical assets have been excluded from the assessments for remaining assets.



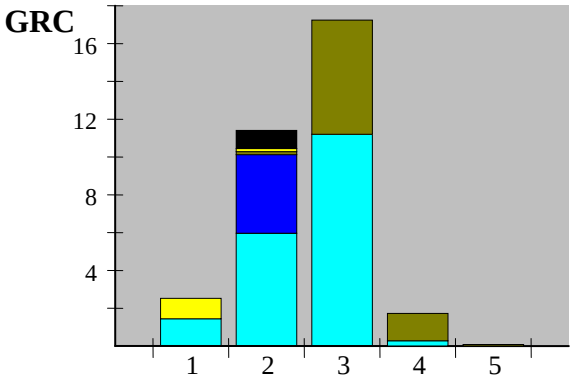
Water Connections Condition Grade



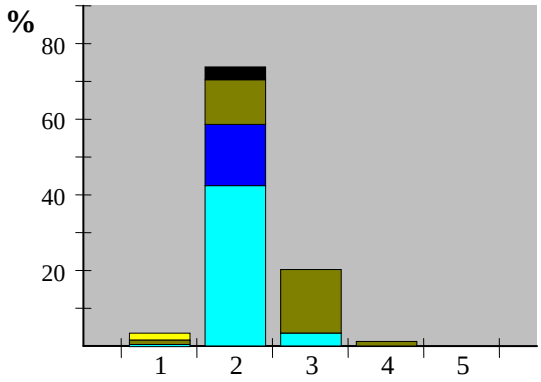
Water Condition Grade



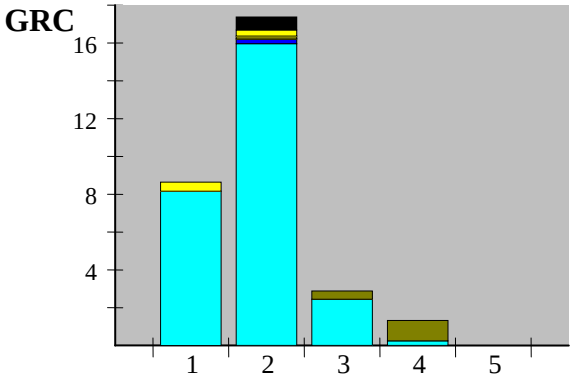
Water Performance Grade



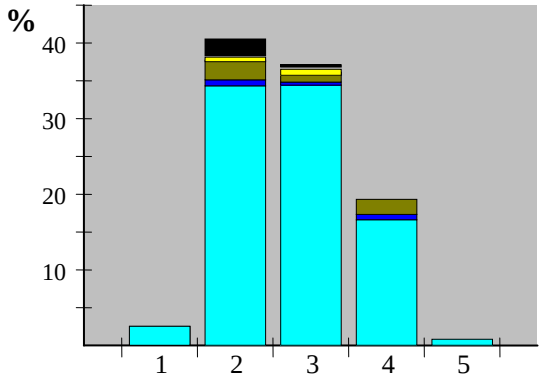
Wastewater Condition Grade



Wastewater Performance Grade



Stormwater Condition Grade



Stormwater Performance Grade

FIGURE 5 NAPIER CITY COUNCIL
ASSET CONDITION AND PERFORMANCE GRADES

D.8 Further Studies in Sample Zones

The first stage of the "Top Down" approach is the collection of data on critical assets and sample zones on the basis of information readily available, either in report or database format, or elicited from operations staff. This identifies areas where there are known problems in asset condition or system performance, although the extent of problem, and the solution to remedy it, might be uncertain.

Further studies can then be targeted at those areas that have the greatest impact on a Utility Network Operator's ability to meet performance and condition targets.

Scope of Surveys

The scope and extent of surveys is dependent on the relative impact on performance. Different methods might include:

- more frequent monitoring - eg. Water quality, pressure, sewer flows, overflow frequency
- hydraulic modelling - eg. Water networks, sewer systems, surface water drainage
- inspections and system testing - eg. Closed circuit television surveys, hydrant testing, resistivity, non destructive testing
- sampling and testing - eg. Pipe sampling, inspection and destructive testing.

Data from all detailed surveys will provide an assessment of condition (for an asset), or performance profile for a zone or part zone. The approach is discussed in Section E.

E. The "Bottom Up" Methodology

Contents

E.1 Rationale

E.2 Performance Monitoring

E.3 Reactive Incidents

E.4 Proactive Surveys and Modelling

E.5 Material Testing

Overview

- Some useful definitions
- What performance measures should be used?
- What are "reactive incidents"?
- How should Field Record Cards be used?
- How should surveys and modelling be used?
- How should testing be carried out?

E.1 Rationale

The underlying rationale of the "Bottom Up" approach (see Figure 2) is to provide a long term information database on the condition and performance of assets which can be updated as further information, or better quality information, becomes available.

Monitoring performance and activity data over time will provide useful information on the long-term deterioration of assets. This approach provides robust support to the "Top Down" approach, by collecting detailed information from all activities carried out on assets, whether planned or unplanned, and collating information from studies and surveys.

Definitions

The G*uidelines* are designed to provide a consistent approach to asset grading, both in time and across Network Utility Operators.

In this context, is important to define three terms:

- ***Incident*** - this is an unplanned event, such as a leak, burst main or sewer collapse where part of an asset has failed. This will lead to the completion of a record card (see Appendix C) by the operatives, although no asset condition grading will be given. This is because the incident, an asset failure, may not be representative of the asset as a whole.
- ***Asset*** - the basic 'building block' or 'component' of the water, sewerage or drainage systems for the "Bottom Up" approach.
- ***Zone*** - this is the 'building block' for the "Top Down" approach and comprises a group of assets with generally similar characteristics located in a similar environment. The condition grade of a zone may be presented as a profile, with a proportion of assets in the 1 to 5 range.

There needs to be a link between assets and specific zones, defined in the IMS or individual Utility Network Operator's databases, to provide a key link between the two processes.

Data Collection

Data can be collected from reactive incidents, from planned modelling and studies, and, at a more detailed stage, from material testing.

It is important that information from reactive incidents is balanced with data from other sources, as the former is usually related to the failure of assets. If reporting is based on such failures alone, biased views will result.

There may be good quality records available from previous years that will be helpful in trend analysis. The IMS, or supporting databases, will provide a sound base to collect data, which in time will provide useful trends in performance and condition.

Relationship with the "Top Down" Approach

Please refer to Figure 2 for a graphic representation of how the various activities in the "Bottom Up" approach relate to those in the "Top Down" approach.

E.2 Performance Monitoring

Performance Measures

Performance is an important driver for investment. For long life assets issues of poor performance driven by addition of new customers or network expansion etc. will often overtake condition-based replacement.

Detailed information on asset performance is therefore an important requirement, not only to define the current 'base' position of assets, but also to monitor changes over time in a consistent and robust manner.

By establishing a base performance position, and then monitoring it over time, Utility Network Operators will be able to develop essential data to assess long term performance, as well as any medium to long term deterioration which might be occurring.

Typical performance measures have been defined in Part C.

In addition, base data should be collected on the overall effectiveness of the systems, monitoring for example the delivery of water to domestic households, non-domestic use, distribution losses, sewage collected and contributing impermeable areas etc. This should be measured on a regular basis.

Activity measures, such as leaks, pipe bursts, sewer collapses, service repairs and replacements should also be monitored.

E.3 Reactive Incidents

It is important to record data covering incidents such as pipe bursts, sewer collapses and surface flooding. Record cards (See Tables 11, 12, 13, and 14 for example) should be completed for each incident and data added to the IMS.

Field Record Cards

Field Record Cards have been designed to collect key information in a straightforward and manageable way. They need to be completed wherever work or inspections are carried out on the networks, enabling sound records to be made, and improving the long-term quality and accuracy of data.

The Field Record Cards are designed for simplicity and consistency. Operators are required simply to tick or circle boxes, without needing to remember specific coding. The cards can therefore be completed quickly and with confidence.

The main fields on the record card, as shown in Tables 11, 12, 13, and 14 for example, cover:

- location
- asset type, diameter and depth
- customer information
- environment - eg. Surface use, ground type and surface material using standard descriptions
- pipe or fitting detail - eg. Material, joint, bedding, surround, external and internal protection
- data on failure type, surface condition and internal bore, generally on a 1 to 5 grading
- data on any samples taken

Any one of the above factors is considered to influence pipe failure and is therefore recorded. As more data from record cards becomes available over time, it may be possible to develop correlations between these factors.

The Field Record Cards do not require an assessment of condition grading, only an opinion from the operator of the asset's condition.

To ensure a high standard of quality control, it is recommended that the forms are signed and dated by the operator.

Data can then be input into the IMS. It is helpful if the record cards are laid out to match the manner of data entry into the IMS. This will assist in reduction of data entry errors.

Links to Condition Assessment

Incident reporting provides a very useful link to condition assessment of the related asset. Examples of how this works are shown in Figures 6 and 7 for a burst main and a collapsed sewer respectively.

After the record card data has been input to the IMS, it is necessary to define the appropriate measure (eg. Bursts per kilometre length of main, collapses per kilometre of sewer). Condition

grade definitions can be extended to include these measures to enable an overall grading to be assessed by an experienced engineer.

For example, in the case of the collapsed sewer outlined in Figure 8, where the sewer had already been subject to closed circuit television inspection, the collapse would be added to the points system on record to give a condition grade.

To keep this approach reasonably simple, a single asset condition grade is applied to an asset.

This approach would be applied to both critical and non-critical assets.

TABLE 11 WATER UTILITY FIELD INSPECTION CARDS

LOCATION		
Number		
Street		
Suburb		
Other Features		sketch plan

Date			**ASSET TYPE**	
Job Nº/Ref Nº			Water main	1
Leading hand			Service	2
Planned	1		Valve	3
Unplanned	2		Hydrant	4
Reason			Other	5

CUSTOMER INFORMATION						
SUPPLY CUT OFF	YES	1	NO	2		
Customer pre-notified	YES	1	NO	2	REPORTED BY:	
Time supply off					Customer	1
Time supply restored					NCC staff	2
Properties affected (no)					Other	3

SURFACE USE		GROUND TYPE		SURFACE MATERIAL	
Heavy traffic	1	Limestone	1	Asphalt	1
Light traffic	2	Gravel	2	Chipseal	2
Berm	3	Sand	3	Concrete	3
Field	4	Sandy clay	4	Grass	4
Other, specify	5	Clay	5	Paving	5
		Silt	6	Other	6

PIPE OR FITTING DETAIL

MATERIAL		JOINT		BEDDING AND SURROUND		EXTERNAL PROTECTION		INTERNAL PROTECTION	
Copper	1	Lead	1	Sand	1	Bitumen	1	Cement	1
Gun metal	2	Flanged	2	Pea metal	2	Wrapped	2	Bitumen	2
Cast iron	3	Rubber ring	3	Silt	3	None	3	Epoxy	3
Steel	4	Gibault	4	As ground	4	Other (specify)	4	None	4
AC 5 GI	6	Welded	5	Other (specify)	5			Not seen	5
PVC 7 DI	8	Solvent welded	6					Other (specify)	6
MDPE	9	Not seen	7						
Other (specify)	10	Other (specify)	8						

INTERNAL DIAMETER (callipered)	(mm)	**EXTERNAL DIAMETER (callipered)**	(mm)	**DEPTH OF COVER**	(m)

TABLE 12 WATER UTILITY FIELD INSPECTION CARDS							
FAILURE				YES 1		NO 2	
TYPE				**LEAKAGE RATE**			
Circular fracture	1			None	1		
Longitudinal fracture	2			Slight	2		
Pipewall softening	3			Moderate	3		
Pinhole	4			Severe	4		
Large hole	5			**OTHER COMMENTS**			
Joint	6						
Tapping	7						
Toby	8						
Other (specify)	9						
EXTERNAL SURFACE CONDITION GRADING							
CORROSION		**PITTING**		**SOFTENING**		**COATING**	
Excellent	1	Excellent	1	Excellent	1	Excellent	1
Good	2	Good	2	Good	2	Good	2
Moderate	3	Moderate	3	Moderate	3	Moderate	3
Poor	4	Poor	4	Poor	4	Poor	4
Very poor	5	Very poor	5	Very poor	5	Very poor	5
						None	6
INTERNAL BORE							
Inspection of:			YES 1			NO 2	
INTERNAL SURFACE		**TUBERCULATION**				**DEPOSITION/SLIMING**	
Excellent	1	None	1			None	1
Good	2	Slight	2			Slight	2
Moderate	3	Up to 20% loss of area	3			Moderate	3
Poor	4	20% to 40% loss of area	4			High	4
Very poor	5	> 40% loss of area	5			Severe	5
SURFACE FITTING							
Fire hydrant	1			Repair	1		
Valve	2			Replace	2		
Meter	3						
Toby	4						
Chamber	5						
Sample taken				**Comments**			
Sample ref Nº							
Leading Hand				**Supervisor**			
……				……			
Sign and date				Sign and date			

TABLE 13 SEWER UTILITY FIELD INSPECTION CARDS

LOCATION		
Number		
Street		
Suburb		
Other Features		sketch plan

Date		**ASSET TYPE**	
Job Nº/Ref Nº		Surface fitting	1
Leading hand		Sewer gravity	2
Planned	1	Sewer pumping main	3
Unplanned	2	Property connection	4
Reason		Manhole	5
		Other (specify)	6

CUSTOMER INFORMATION			
SURCHARGE	1	REPORTED BY:	
OVERFLOW	2	Customer	1
BLOCKAGE	3	NCC staff	2
		Other	3

SURFACE USE		GROUND TYPE		SURFACE MATERIAL	
Heavy traffic	1	Limestone	1	Asphalt	1
Light traffic	2	Sand	2	Chipseal	2
Berm	3	Sandy clay	3	Concrete	3
Field	4	Clay	4	Grass	4
Other, specify	5	Silt	5	Paving	5
				Other	6

PIPE OR FITTING DETAIL

MATERIAL		JOINT	JOINT MATERIAL		BEDDING AND SURROUND		EXTERNAL PROTECTION		INTERNAL PROTECTION	
AC	1	Spigot and socket	Mortar	1	Sand	1	Bitumen	1	Cement	1
Cast iron	2	Sleaved	Rubber ring	2	Pea metal	2	Wrapped	2	Bitumen	2
Concrete	3	Gibault	Solvent	3	Silt	3	None	3	None	4
RC pipe	4	Flanged	Welded	4	As ground	4	Other	4	Not seen	5
GRP	5	Other	Lead	5	Other	5			Other	6
PVC	6		Not seen	6	Not seen	6				
HDPE	7									
Steel	8									

DEPTH OF COVER

INTERNAL DIAMETER (callipered)	(mm)	**EXTERNAL DIAMETER (callipered)**	(mm)	**GROUND WATER AT**	(m below gl)

TABLE 14 SEWER UTILITY FIELD INSPECTION CARDS

FAILURE					
BLOCKAGE	1	STRUCTURAL	2	PREVIOUS REPAIRS	3

IF STRUCTURAL		IF BLOCKAGE	
Circular fracture	1	Settlement	1
Longitudinal fracture	2	Debris	2
Pipewall softening	3	Grit	3
Large hole	4	Roots	4
Joint	5	**OTHER COMMENTS**	
Saddle	6		
Service pipe	7		
Settlement	8		
Other (specify)	9		

EXTERNAL SURFACE CONDITION GRADING					
Inspection of		Full circle	1	Seen 1	Not seen 2
		< 50%	2		

CORROSION		PITTING		SOFTENING		COATING	
Excellent	1	Excellent	1	Excellent	1	Excellent	1
Good	2	Good	2	Good	2	Good	2
Moderate	3	Moderate	3	Moderate	3	Moderate	3
Poor	4	Poor	4	Poor	4	Poor	4
Very poor	5	Very poor	5	Very poor	5	Very poor	5
ANY OTHER OBSERVATIONS						None	6

INTERNAL BORE				
Seen	1	Not seen		
Inspection of:		Full circle 1	< 50%	2

INTERNAL SURFACE		DEPOSITION
Excellent	1	None
Good	2	Slight (_)
Moderate	3	Moderate (¼)
Poor	4	High (_)
Very poor	5	Severe (½)
Sample taken		**Comments**
Sample ref Nº		
Leading Hand …….. Sign and date		**Supervisor** …….. Sign and date

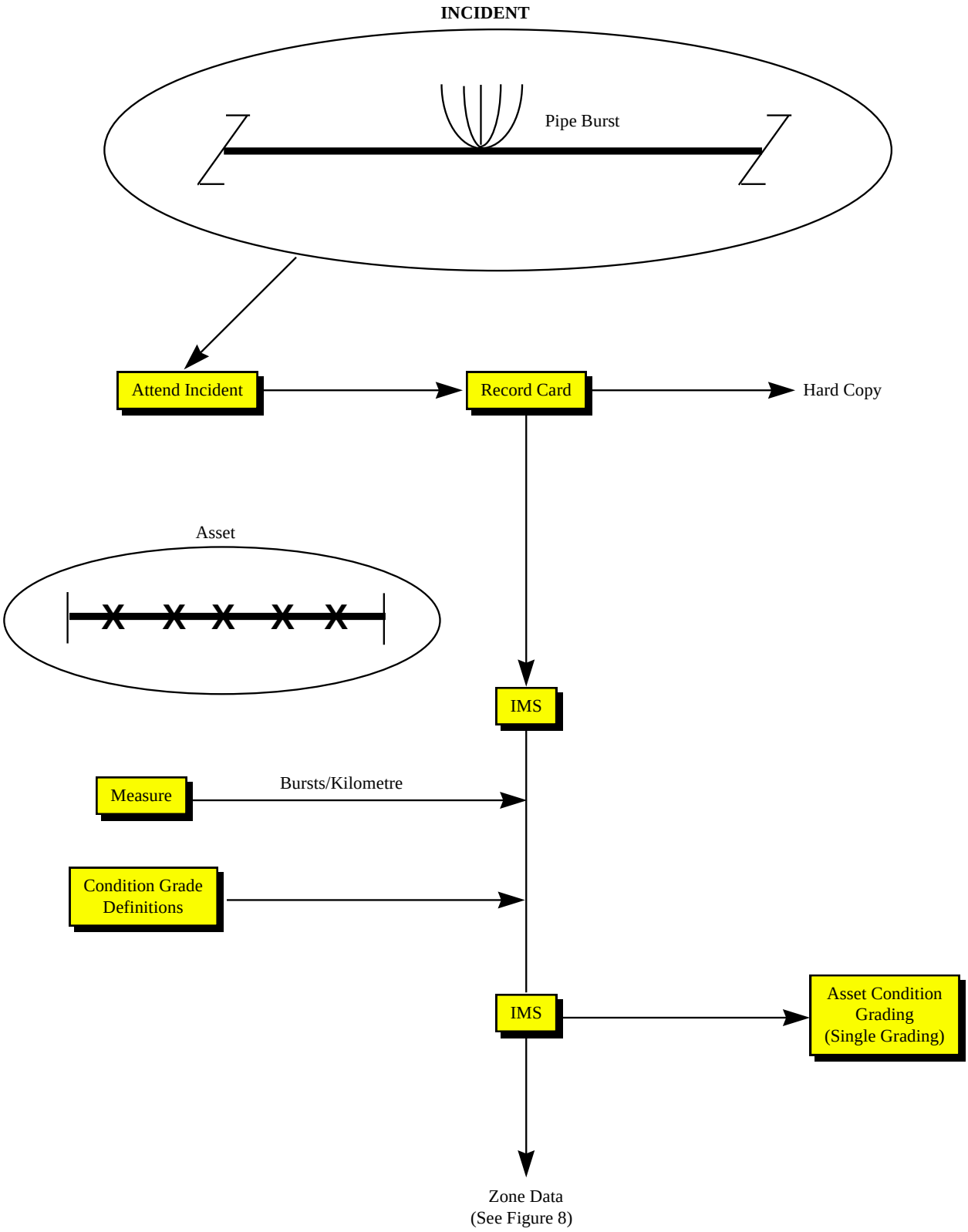


FIGURE 6 ASSET CONDITION FLOW CHART
EXAMPLE: PIPE BURST INCIDENT

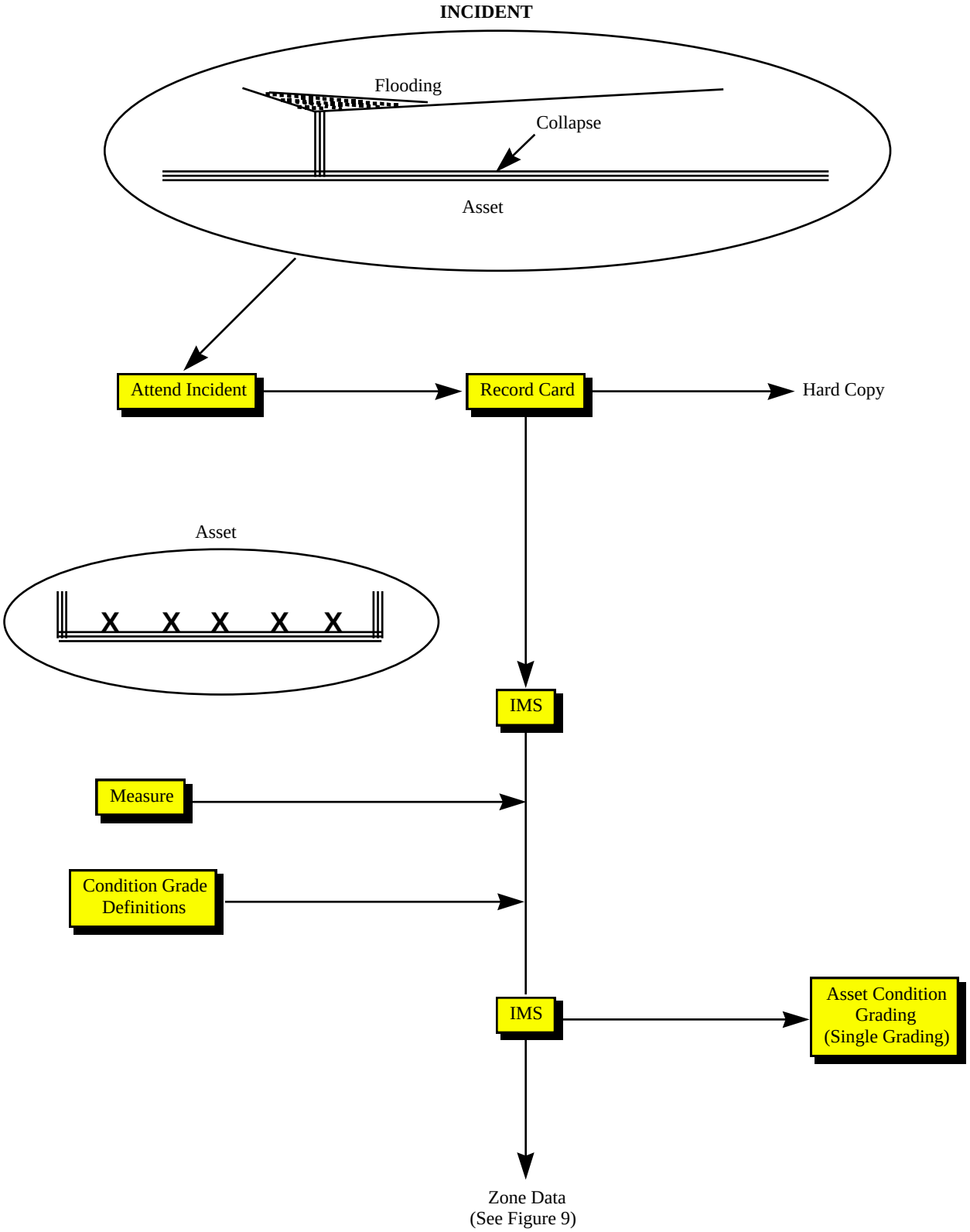


FIGURE 7 ASSET CONDITION FLOW CHART EXAMPLE: SEWER COLLAPSE

E.4 Proactive Surveys and Modelling

Approach to Surveys

The primary objective of surveys and modelling studies is to identify any shortfalls in an asset's performance against defined performance standards.

Studies may relate to existing performance monitoring work, or be implemented to supplement that work. In some cases, studies will be wholly independent of existing work.

For example, water quality sampling and testing might rely on the existing sampling and testing programme underway. Pressure logging may need to be supplemented to provide greater coverage of the area. A new hydraulic model of the drainage system may be needed to assess performance.

Where possible, surveys should be linked to established Manuals, for example the *New Zealand Pipeline Inspection Manual* (CCTV inspection) for sewers, infiltration surveys and so on.

Links to Performance Assessment

The two examples shown in Figures 8 and 9 for water and drainage zones respectively show how the results of surveys in zones (or for critical assets) can be used to derive performance grade profiles.

The survey results are compared with the measures and the performance reference level. For example, the measure for pressure is the pressure and flow at a customer's boundary. The reference level is, for the purposes of the example, 10 metres. Results of pressure monitoring may show that 10% of properties are *estimated* to be below this reference level. The performance grade definitions can then be applied, to provide an overall performance grade profile, grossing up the results for the whole zone on the basis of population or properties.

This creates a performance grade profile for the *zone*, rather than for individual assets.

Pass/Fail Criteria

The next step is to consider the pass/fail criteria as defined in the appropriate Level of Service standard. Clearly, critical assets will have higher criteria for replacement (eg. Grade 2 or 3) than non-critical assets, which may be grade 4 or 5. The criteria need to be carefully considered and related to the risk and consequences of any failure.

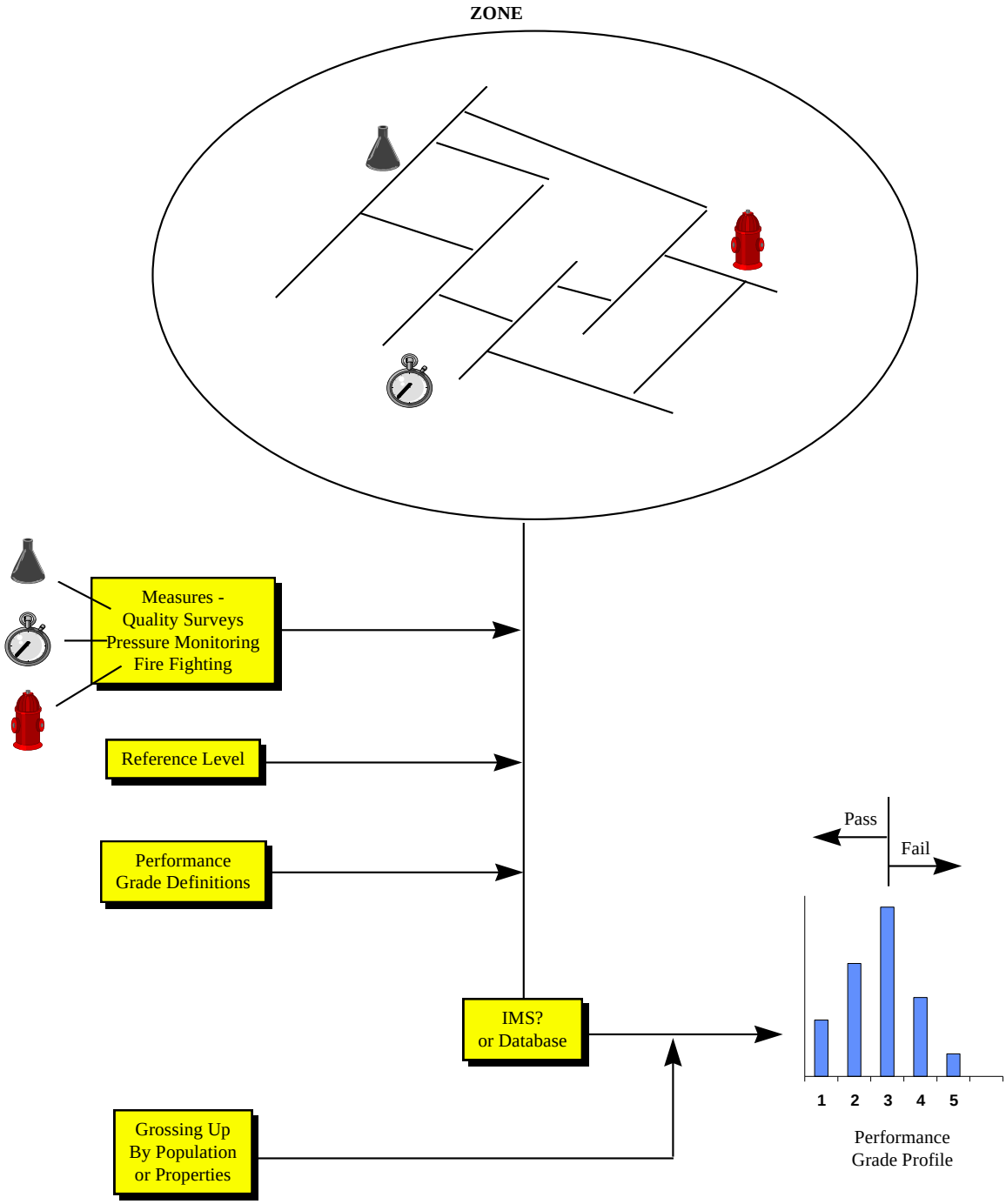


FIGURE 8 ASSET PERFORMANCE FLOW CHART WATER ZONE SURVEY

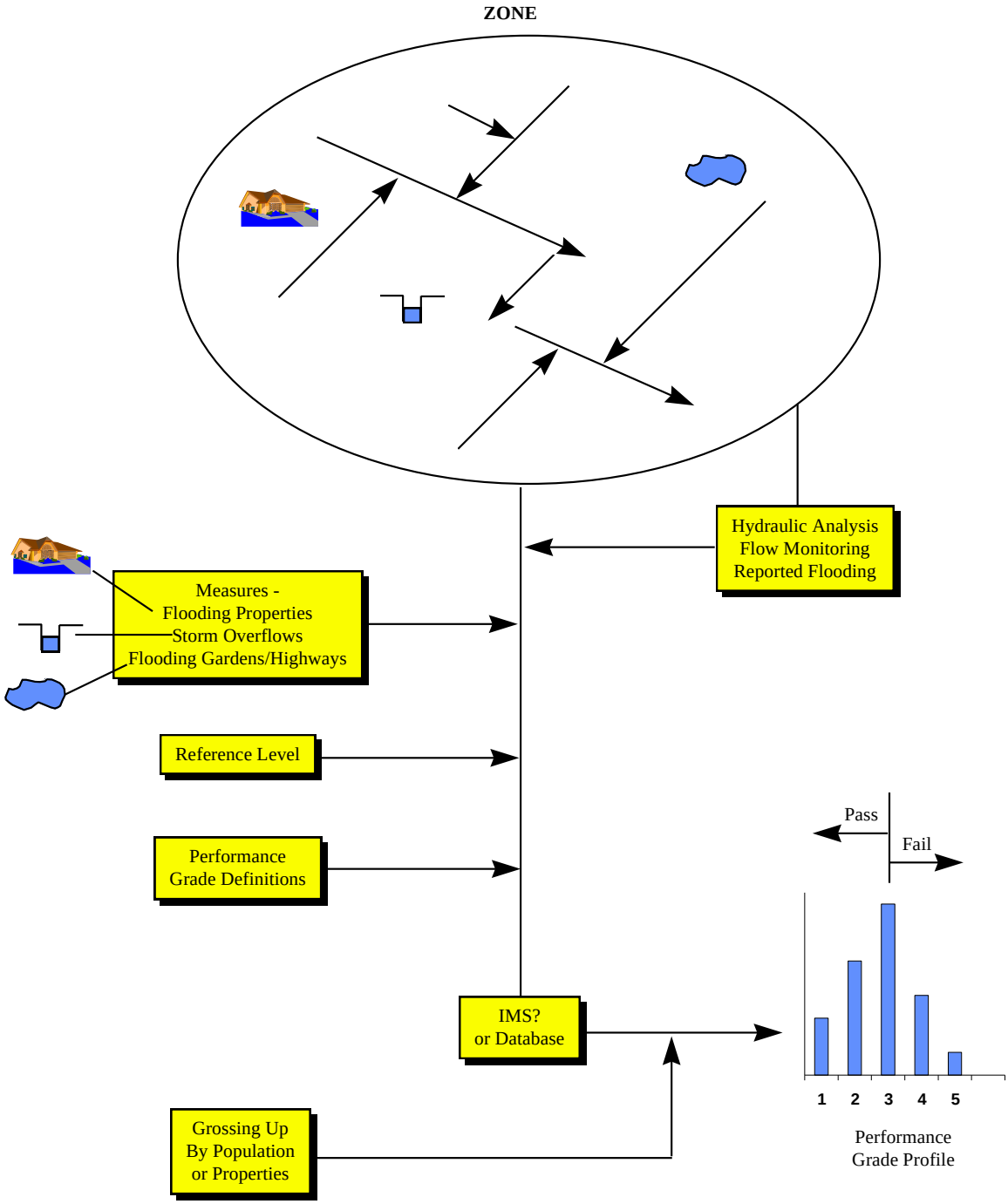


FIGURE 9 ASSET PERFORMANCE FLOW CHART SEWERAGE/DRAINAGE ZONE SURVEY

E.5 Material Testing

Material testing will also be driven by the "Top Down" approach and the need to target areas of poor data quality that might have a significant effect on investment needs. Testing will also be done on an opportunistic basis, but care is needed in the statistical significance of such results.

Material testing aims to provide detailed reports on the condition of samples to support the condition assessment of assets and zones. Three main steps are followed:

1. Sampling
2. Testing
3. Reporting results

Sampling

Samples should be representative of the asset characteristics being examined. For example, where cast iron pipe samples are being selected from a zone, all cast iron pipe assets in the zone should be identified. Grouping, or stratification, of the assets by diameter should be helpful in this regard. Samples should be selected on a random basis from the stratified assets.

The number of samples taken is a matter of judgement. With the high cost of obtaining and testing samples, it is unlikely that a statistically representative number will be possible, and engineering judgement will be needed in the interpretation of results.

Testing requirements should be specified.

Links to Condition Assessment

Figure 10 demonstrates how material testing can be used to determine asset condition. After selecting samples for testing, a measure of the testing work needs to be defined (for example, for cast iron mains this could be residual wall thickness). Condition grade definitions can be extended to take these measures into account, and enable an overall grading to be assessed by an experienced engineer.

Data can then be used to assess asset condition for the zone as a whole.

The following are examples of typical testing criteria:

- physical examination and record
- chemical analysis of pipe bedding material and assessment of aggressive ground conditions
- metallographic examination of cast iron pipes for wall thickness loss
- bursting pressure test for asbestos cement pipes to assess remaining working life
- chemical analysis of concrete pipes for latents, chloride, sulphate, sulphide and magnesium sulphate levels in the concrete matrix

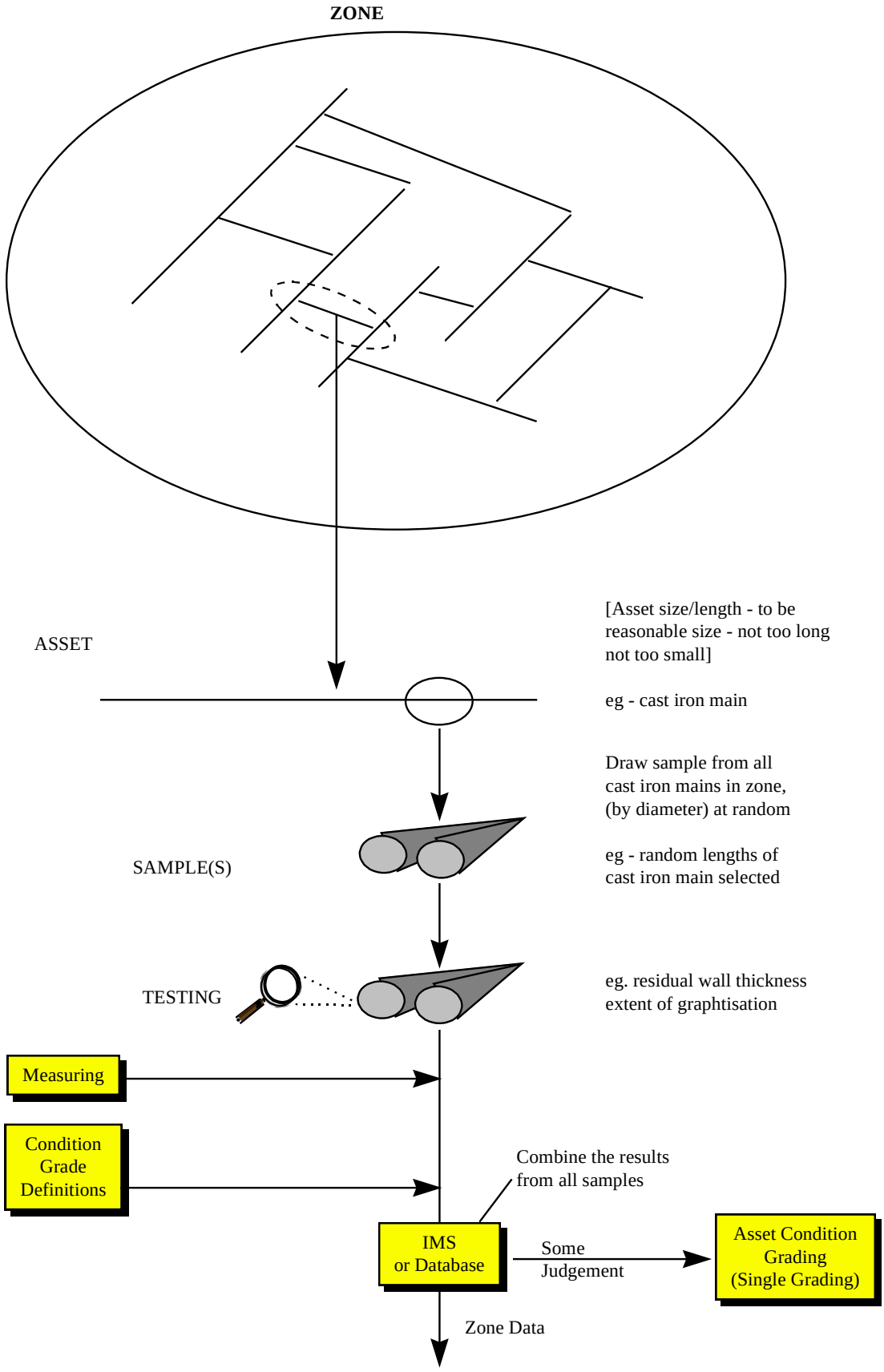


FIGURE 10 ASSET CONDITION FLOW CHART FOR MATERIAL TESTING

F. Glossary of Terms

ACTIVITY

An activity is the work undertaken on an asset or set of assets to achieve a change in performance level.

ASSET MANAGEMENT PLAN (AMP)

A long term expenditure plan for the management of an asset or group of assets. It applies various management techniques - including technical, financial planning and cashflow projection - over the life cycle of the asset to achieve specified levels of service.

BACKLOG EXPENDITURE

Expenditure required to bring assets from their current position to the optimised replacement cost in line with the standards set by Utility Network Operators.

CAPITAL EXPENDITURE (CAPEX)

Expenditure used to create new assets or to increase the capacity of existing assets beyond their original design capacity or service potential. CAPEX increases the value of an asset.

CCTV

Closed circuit television.

CONDITION

Condition relates to the structural integrity of an asset.

CRITICAL ASSETS

Assets for which the financial, business or service level consequences of failure are sufficiently severe to justify proactive inspection and rehabilitation (eg. A burst water main). Critical assets require more detailed attention with lower thresholds for action than 'non-critical' assets.

DRY WEATHER FLOW (DWF)

The wastewater flow during a normal working day, including wastewater flow and groundwater infiltration.

GROSS REPLACEMENT COST (GRC)

The cost of replacing an existing asset with a new asset providing the same level of service.

IMS

Information Management System

INFILTRATION/INFLOW (I/I)

A combination of groundwater inflow, stormwater inflow and rainfall-dependent infiltration measured over the course of a year to include variations in summer and winter weather conditions and seasonal wastewater.

PERFORMANCE

Performance relates to the capability of the systems/assets to meet defined level of service criteria.

PERFORMANCE MEASURE

A measure that allows the performance of an asset or set of assets to be measured over time.

REFERENCE LEVEL OF SERVICE

A reference level of service is set by Utility Network Operators from the analysis of the charging implications of the discretionary standards derived from public consultation. If there is no governmental obligation for common levels of service, each Utility Network Operator may choose to set its own "acceptable" reference levels.

SAMPLED ZONE

A sampled zone is a randomly selected zone taken from a chosen stratum. Typically 2 or 3 zones will be selected per stratum.

STANDARD

A standard is a statement of intent by a Utility Network Operator to deliver a particular service to a given quality within stated target levels. Standards are derived from national obligations and customer-driven (or discretionary) levels of service.

STRATUM

A stratum consists of several zones that have 'relatively similar characteristics' and can be grouped together to enable a reduction in the sampling effort by use of the stratified random sampling approach.

TARGET

A target is the time-related element of a standard.

UTILLITY NETWORK OPERATOR

This term has been used to describe the owner of a water, or wastewater, or stormwater network. The owner may be a Council, a Local Authority Trading Enterprise (LATE), a Stand Alone Business Unit, a Franchise Holder, a Private Company, or an alternative entity that has been established to manage the network assets in a community.

ZONE

A zone is defined as a discrete operational block of infrastructure assets, typically water pressure zones and drainage areas. The choice of zonal boundary will be established from pipe material, age and soil conditions, or operational reporting requirements.

G. Condition Grading Tables

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TABLE C.1 WATER MAINS AND SEWAGE PUMPING MAINS	
Condition Grade	**General Meaning**
1	**Very Good** Modern pipe material designed to current standards with no pipewall or joint failures and no evidence of internal or external degradation.
2	**Good** As condition 1 but not designed to current standards in respect of pressure ratings, design specification, jointing or corrosion protection. Deterioration causing minimal influence on performance.
3	**Moderate** Water mains or sewage pumping mains which are generally sound, although with a few pipewall or joint failures or evidence of some external or internal degradation. Some deterioration beginning to be reflected in performance.
4	**Poor** Water mains or sewage pumping mains with a significant level of pipewall or joint failures or evidence of significant external or internal degradation causing, or likely to cause a marked deterioration in performance in the medium term. Some asset replacement or rehabilitation needed within the medium term.
5	**Very Poor** Unsound water mains or sewage pumping mains with extensive pipewall or joint failures, or significant external or internal degradation, which has failed or about to fail in the near future, causing unacceptable performance. No life expectancy, requiring urgent replacement or rehabilitation.

TABLE C.2 SERVICE PIPES	
Condition Grade	**General Meaning**
1	**Very Good** Modern pipe material designed to current standards with no evidence of internal or external degradation.
2	**Good** As condition 1 but not designed to current standards. Deterioration causing minimal influence on performance.
3	**Moderate** Service pipes which are generally sound, although with a few failures requiring replacement or repair. Some deterioration beginning to be reflected in performance.
4	**Poor** Service pipes with a significant level of failures requiring replacement or repair or with significant internal or external corrosion and likely to cause a marked deterioration in performance in the medium term. Some asset replacement or rehabilitation needed within the medium term.
5	**Very Poor** Unsound service pipes with high level of failure or significant external or internal degradation, which has failed or about to fail in the near future, causing unacceptable performance. No life expectancy, requiring urgent replacement or rehabilitation.

TABLE C.3 WASTEWATER AND STORMWATER DRAINS	
Condition Grade	**General Meaning**
1	**Very Good** Modern pipe material designed to current standards with no structural defects and no evidence of internal or external degradation.
2	**Good** As condition 1 but not designed to current standards in respect of manufacturer's specification, jointing or corrosion protection. Some deterioration, for example, circumferential cracking or minor joint defects causing minimum influence on performance
3	**Moderate** Sewer pipes which are generally sound, although with some defects (for example deformation 0% to 5% and cracked or fractured or longitudinal/ multiple cracking or occasional fractures or external pipewall degradation) over not more than 25% of the length. Some deterioration beginning to be reflected in performance.
4	**Poor** Sewer pipes with a significant level of defects (for example, deformation 5% to 10% and cracked or fractured or broken or serious loss of level or external pipewall degradation) over not more than 50% of the length causing, or likely to cause, a marked deterioration in performance in the medium term. Some asset replacement or rehabilitation needed within the medium term.
5	**Very Poor** Unsound Sewer pipes with a high level of defects (for example, deformation > 10% and cracked or fractured or broken, already collapsed or extensive areas of missing fabric), or grade for over > 50% of length, causing unacceptable performance. No life expectancy, requiring urgent replacement or rehabilitation.

TABLE C.4 WASTEWATER AND STORMWATER - MANHOLES	
Condition Grade	**General Meaning**
1	**Very Good** Sound modern structure well maintained with no problems with the manhole structure, invert, pipe entries, manhole cover or manhole cover frame.
2	**Good** As 1, but showing minor wear and tear and minor deterioration. Some surface damage to the structure but no corrosion staining, cracking or loss of stability.
3	**Moderate** Functionally sound structure but showing some signs of wear and tear. Some minor cracking, staining or signs of vegetation.
4	**Poor** Structure functioning but with problems due to significant infiltration, loss of stability or deformation. Manhole cover or frame showing signs of corrosion causing difficulties for man entry. Step irons showing signs of corrosion.
5	**Very Poor** Serious structural problems having a detrimental effect on the performance of the manhole structure.

TABLE C.5 SURFACE OPERATIONAL ASSETS - CIVIL STRUCTURES	
Condition Grade	**General Meaning**
1	**Very Good** Sound structure designed to current standards, well maintained
2	**Good** As condition 1 but not designed to current standards or showing minor wear and tear and minor deterioration of surfaces. Some spalling but with no corrosion staining, needs to be inspected in the medium term. Deterioration causing minimal influence on performance.
3	**Moderate** Functionally sound structure, but appearance affected by minor cracking, staining, vegetation or minor leakage, or structure is marginal in its capacity to prevent contamination of potable water. Some deterioration beginning to be reflected in performance.
4	**Poor** Structure functioning but with problems due to significant cracking, spalling, cracking, loss of stability, deformation or corrosion or high risk of contamination of potable water, causing, or likely to cause a marked deterioration in performance in the medium term. Some asset replacement or rehabilitation needed within the medium term.
5	**Very Poor** Structure has serious problems and has failed or is about to fail in the near future, causing unacceptable performance. For example, contamination of potable water has been known to occur on more than one occasion. No life expectancy, requiring urgent replacement or rehabilitation.

TABLE C.6 SURFACE OPERATIONAL ASSETS - ELECTRICAL AND MECHANICAL PLANT	
Condition Grade	**General Meaning**
1	**Very Good** Sound plant designed to current standards, all operable and well maintained
2	**Good** As condition 1 but not designed to current standards or showing wear and tear. For example, minor oil leaks or gland wear evident although protective coatings intact and efficiency undiminished. Requires major overhaul within the medium term. Deterioration causing minimal influence on performance.
3	**Moderate** Functionally sound plant and components, acceptable but showing some wear and tear with minor failures and some diminished efficiency. For example, bearing and gland wear becoming more evident and corrosion of metal components becoming more evident. Deterioration beginning to be reflected in performance and a higher attendance for maintenance
4	**Poor** Plant and components function but require a high level of maintenance to remain operational. Likely to cause a marked deterioration in performance in the medium term. Some asset replacement or rehabilitation needed within the medium term.
5	**Very Poor** Plant and component effective life exceeded and excessive maintenance costs incurred. A high risk of breakdown with a serious impact on performance. No life expectancy, requiring urgent replacement or rehabilitation.

This covers structures whose main function is to provide a secure, weather proof housing for equipment or personnel. It also covers access, site security and safety.

TABLE C.7 BUILDINGS	
Condition grade	**General meaning**
1	**Very Good** Secure weatherproof structure, well maintained. Good access and secure. Safe site.
2	**Good** As 1 but showing signs of superficial wear and tear. Normal maintenance needed to prevent initial stages of decay or dereliction commencing. Needs to be re-inspected in the medium term.
3	**Moderate** Functionally sound structure but appearance affected by staining, peeling paintwork, overgrowth, etc. Some minor problems with access or site. Early stages of decay or dereliction are becoming evident.
4	**Poor** Building not functioning properly due to leakage; rising damp; rotting woodwork; decayed brickwork; inadequate security. Access in poor condition or site not secure. Some safety problems. Structural integrity becoming affected. Will need major overhaul/replacement within medium term.
5	**Very Poor** Serious structural problems having a detrimental effect on the performance of the building. Access extremely poor or hazardous. Site safety at risk. Will require major overhaul/replacement in the short term.

This covers all works whose main function is structural, particularly water retaining structures such as dams, reservoirs and tanks. Also tunnels, whether housing pipes or acting directly as aqueducts and pipe bridges.

TABLE C.8 CIVIL STRUCTURES	
Condition grade	**General meaning**
1	**Very Good** Sound modern structure. Well maintained.
2	**Good** As 1 but showing signs of superficial wear and tear. Minor deterioration of surfaces. Some spalling but with no corrosion staining. Needs to be re-inspected in the medium term.
3	**Moderate** Functionally sound structure but appearance affected by minor cracking, staining, vegetation or minor leakage. Structure is marginal in its capacity to prevent contamination of potable water.
4	**Poor** Structure functioning but with problems due to significant leakage, cracking, spalling, loss of stability or deformation, corrosion substantially reducing size of structural member. Possibility of regular contamination of potable water. Will require major overhaul/replacement within the medium term.
5	**Very Poor** Serious structural problems having a detrimental effect on the performance of the structure. Contamination of potable water has been known to occur on more than one occasion. Will require major overhaul/replacement in the short term.

This covers pumps, motors, generators, transformers, switchgear, cabling, telemetry, automatic controls, process plant, reticulating sand filters etc.

TABLE C.9 ELECTRICAL AND MECHANICAL EQUIPMENT	
Condition grade	**General meaning**
1	**Very Good** Sound modern structure. Well maintained.
2	**Good** As 1 but showing signs of superficial wear and tear. Major overhaul/replacement not needed in the medium term. Efficiency undiminished. Minor oil leaks and gland wear becoming more evident. Corrosion of metal components starting to become evident. Protective coating still evident.
3	**Moderate** All components functioning acceptably but showing significant wear and tear. Minor failures. Efficiency has diminished. Bearing and gland wear becoming more evident. Corrosion of metal components starting to become evident.
4	**Poor** Parts and components function but require significant maintenance to remain operational. Will require overhaul/replacement within the medium term.
5	**Very Poor** Effective life exceeded and incurring excessive costs compared to replacement costs due to unreliability. Will require major overhaul/replacement in the short term.

This covers the above ground pipework associated with pumping stations and all valves and meters. In addition the table will apply to gates, penstocks, lifting gear, etc.

TABLE C.10 PIPEWORK AND VALVES	
Condition grade	**General meaning**
1	**Very Good** Sound modern components all operable and well maintained.
2	**Good** As 1 but showing signs of superficial wear and tear. Fittings unlikely to require replacement within 10 years.
3	**Moderate** All components operable but appearance shows signs of minor leakage, peeling paintwork, staining or minor corrosion. Pipework unlikely to require replacement within 10 years.
4	**Poor** Operation affected due to significant leakage, heavy corrosion, difficulty in operation or minor components inoperable. Pipework and fitting likely to require major overhaul/ replacement in the medium term.
5	**Very Poor** Effective life exceeded and incurring excessive costs compared to replacement costs due to unreliability. Will require major overhaul/replacement in the short term.

TABLE C.11 PIPED STORMWATER DRAINS	
Condition Grade	**General Meaning**
1	**Very Good** Modern pipe material designed to current standards with no structural defects and no evidence of internal or external degradation.
2	**Good** As condition 1 but not designed to current standards in respect of manufacturer's specification, jointing or corrosion protection. Some deterioration, for example, circumferential cracking or minor joint defects causing minimum influence on performance.
3	**Moderate** S/W pipes which are generally sound, although with some defects (for example deformation 0 to 5% and cracked OR fractured OR longitudinal multiple cracking OR occasional fractures OR external pipe wall degradation) over not more than 25% of the length. Some deterioration beginning to be reflected in performance.
4	**Poor** S/W pipes with a significant level of defects (for example, deformation 5 to 10% and cracked OR fractured OR broken OR serious loss of level OR external pipe wall degradation) over not more than 50% of the length causing, or likely to cause, a marked deterioration in performance in the medium term. Some asset replacement or rehabilitation needed within the medium term
5	**Very Poor** Unsound s/w pipes with a high level of defects (for example, deformation >10% and cracked OR fractured OR broken, already collapsed or extensive areas of missing fabric), or grade for over >50% of length, causing unacceptable performance. No life expectancy, requiring urgent replacement or rehabilitation.

TABLE C.12 DETENTION PONDS	
Condition Grade	**General Meaning**
1	**Very Good** No evidence of bed or bank scour Stable banks Ready access for maintenance Storage area free of trees, weed growth or debris Inlet structure and outlet and overflow structures show no signs of wear and tear
2	**Good** Little evidence of bed or bank scour Banks showing minor signs of instability Accessible for maintenance Storage area free from trees encroaching with little weed growth or debris Inlet, outlet and overflow structures show little signs of wear and tear
3	**Moderate** Noticeable bed or bank scour, capacity not impeded Some bank instability Reasonable access for maintenance Storage areas have some trees encroaching, with moderate weed growth or debris Satisfactory inlet outlet and overflow structure - some wear and tear
4	**Poor** Scouring the pond banks, some capacity restricted Poor bank stability Poor access for maintenance Storage areas have trees, weeds and debris encroaching Poor inlet, outlet and overflow structure Major rehabilitation or replacement in short term (structure)
5	**Very Poor** Major bed or bank scouring evident Unsatisfactory bank stability Difficult and poor access for maintenance Storage have many encroaching trees and vegetation combined with overgrown weeds and debris Unsatisfactory inlet outlet or overflow structures Structures replaced immediately

TABLE C.13 STORMWATER CESSPITS	
Condition Grade	**General Meaning**
1	**Very Good** Sound modern structure well maintained with no problems with the cesspit structure, invert or pipe entries.
2	**Good** As 1, but showing minor wear and tear and minor deterioration. Some surface damage to the structure but no corrosion staining, cracking or loss of stability.
3	**Moderate** Functionally sound structure but showing some signs of wear and tear. Some minor cracking, staining or signs of vegetation.
4	**Poor** Structure functioning but with problems due to significant infiltration, loss of stability or deformation. Replacement in short term.
5	**Very Poor** Serious structural problems having a detrimental effect on the performance of the cesspit. Replacement necessary now.

TABLE C.14 STORMWATER MANHOLES	
Condition Grade	**General Meaning**
1	**Very Good** Sound modern structure well maintained with no problems with the manhole structure, invert pipe entries, manhole cover or manhole cover frame.
2	**Good** As 1, but showing minor wear and tear and minor deterioration. Some surface damage to the structure but no corrosion staining, cracking or loss of stability.
3	**Moderate** Functionally sound structure but showing some signs of wear and tear. Some minor cracking, staining or signs of vegetation.
4	**Poor** Structure functioning but with problems due to significant infiltration, loss of stability or deformation. Manhole cover or frame showing signs of corrosion causing difficulties for man entry. Step irons showing signs of corrosion.
5	**Very Poor** Serious structural problems having a detrimental effect on the performance of the manhole structure.

TABLE C.15 STORMWATER DETENTION TANKS	
Condition Grade	**General Meaning**
1	**Very Good** Sound modern structure well maintained with no problems with the structure, pipe entries or outlets, concrete not cracked. Access to tanks easy and safe.
2	**Good** As 1, but showing minor wear and tear and minor deterioration. Some surface damage to the structure but no corrosion staining, cracking or loss of stability. Some hair line cracking of concrete. Access safe.
3	**Moderate** Functionally sound structure but showing some signs of wear and tear. Some minor cracking, staining or signs of vegetation. Access impeded or not easily accomplished.
4	**Poor** Structure functioning but with problems due to significant infiltration, loss of stability or deformation. Access badly impeded causing difficulties for man entry. Step irons showing signs of corrosion.
5	**Very Poor** Serious structural problems having a detrimental effect on the performance of the structure. Access very difficult and dangerous. Replacement or major rehabilitation required immediately.

TABLE C.16 STORMWATER INLETS AND OUTLETS	
Condition Grade	**General Meaning**
1	**Very Good** Sound structure designed to current standards, well maintained.
2	**Good** As condition 1 but not designed to current standards in OR showing minor wear and tear and minor deterioration of structure. Some spalling but with no corrosion staining; needs to be inspected in the medium term. Deterioration causing minimal influence on performance. Grille in good repair and alignment.
3	**Moderate** Functionally sound structure, but showing signs of minor cracking, staining, vegetation or minor leakage. Grille requiring minor repair but substantially in line. Some deterioration beginning to be reflected in performance.
4	**Poor** Structure functioning but with problems due to significant cracking, spalling, cracking, loss of stability, deformation or corrosion. Condition likely to cause a marked deterioration in performance in the medium term. Some asset replacement or rehabilitation needed within the medium term.
5	**Very Poor** Structure has serious problems and has failed or is about to fail in the near future, causing unacceptable performance. No life expectancy, requiring urgent replacement or rehabilitation.

TABLE C.17 STORMWATER PUMP STATION - CIVIL STRUCTURE	
Condition Grade	**General Meaning**
1	**Very Good** Sound structure designed to current standards, well maintained.
2	**Good** As condition 1 but not designed to current standards OR showing minor wear and tear and minor deterioration of surfaces. Some spalling but with no corrosion staining; needs to be inspected in the medium term. Deterioration causing minimal influence on performance.
3	**Moderate** Functionally sound structure, but appearance affected by minor cracking, staining, vegetation or minor leakage. Some deterioration beginning to be reflected in performance.
4	**Poor** Structure functioning but with problems due to significant cracking, spalling, cracking, loss of stability, deformation or corrosion. Condition likely to cause a marked deterioration in performance in the medium term. Some asset replacement or rehabilitation needed within the medium term.
5	**Very Poor** Structure has serious problems and has failed or is about to fail in the near future, causing unacceptable performance. No life expectancy, requiring urgent replacement or rehabilitation.

TABLE C.18 STORMWATER PUMP STATION - ELECTRICAL AND MECHANICAL COMPONENTS	
Condition Grade	**General Meaning**
1	**Very Good** Sound plant designed to current standards, all operable and well maintained.
2	**Good** As condition 1 but not designed to current standards OR showing minor wear and tear. For example, minor oil leaks; gland wear evident although protective coatings intact and efficiency undiminished requires major overhaul within the medium term. Deterioration causing minimal influence on performance.
3	**Moderate** Functionally sound plant and components, acceptable but showing significant wear and tear with minor failures and some diminished efficiency. For example, bearing and gland wear becoming more evident and corrosion of metal components becoming more evident. Deterioration beginning to be reflected in performance.
4	**Poor** Plant and components function but require significant maintenance to remain operational. Likely to cause a marked deterioration in performance in the medium term. Some asset replacement or rehabilitation needed within the medium term.
5	**Very Poor** Plant and component effective life exceeded and excessive maintenance costs incurred. A high risk of breakdown with a serious impact on performance. No life expectancy, requiring urgent replacement or rehabilitation.

TABLE C.19 CONCRETE LINED CHANNELS	
Condition Grade	**General Meaning**
1	**Very Good** No evidence of displaced jointing or scour under concrete elements. Ready access for maintenance. Channel maintained free of siltation, weeds and debris. Adjoining land regularly mowed and/or maintained free of weeds and debris. Side channel/pipe entries well formed, no evidence of scour under concrete channel, or displaced jointing. Concrete not cracked alignment good.
2	**Good** Minor evidence of displaced jointing or scour under concrete elements. Accessible for maintenance. Channel maintained with minor siltation, weeds and debris. Adjoining land regularly mowed but some weeds and debris. Side channel/pipe entries well formed, with minor scour under concrete channel, or displaced jointing. Concrete hairline cracks alignment good.
3	**Moderate** Noticeable displaced jointing or scour under concrete elements. Reasonable access for maintenance. Moderate siltation in channel with weeds and debris occasionally cleared. Adjoining land occasionally mowed with long grass, weeds and debris present. Satisfactory side channel/pipe entries, with moderate scour under concrete channel, or displaced jointing.
4	**Poor** Many points of noticeable displaced jointing or scour under concrete elements. Poor access for maintenance. High siltation in channel with irregular maintaining of weeds and debris. Adjoining land has weed and debris impeding flow. Poor side channel/pipe entries, resulting in significant scour under concrete. Poor side channel/pipe entries, resulting in significant scour under concrete channel, or displaced jointing. Concrete significant cracking alignment - some displacement
5	**Very Poor** Unsatisfactory displaced jointing or scouring under concrete elements. Difficult and poor access for maintenance. Large quantities of siltation in channel with no maintenance of weeds and debris. Adjoining land has overgrown weeds and significant debris impeding the flow. Unsatisfactory side channel/pipe entries, resulting in major scouring under concrete channel, or displaced jointing. Concrete cracked and displaced.

TABLE C.20 NATURAL CHANNELS	
Condition Grade	**General Meaning**
1	**Very Good** No evidence of bed or bank scour. Stable channel banks. Ready access for maintenance. Channel and banks free f trees, weed growth or debris. Side channel/pipe entries well formed, no evidence of bed or bank scour.
2	**Good** Little evidence of bed or bank scour. Channel banks showing minor signs of instability. Accessible for maintenance. Channel and banks free from trees encroaching, with little weed growth or debris. Side channel/pipe entries well formed, with minor signs of bed or bank scour.
3	**Moderate** Noticeable bed or bank scour, flow capacity not impeded. Some channel bank instability, less than 10% of bank length. Reasonable access for maintenance. Channel and banks have some trees encroaching, with moderate weed growth or debris. Satisfactory side channel/pipe entries, with signs of bed or bank scour.
4	**Poor** Scouring of the channel bed or banks, flow capacity restricted. Poor bank stability, up to 20% of banks slumped into channel. Poor access for maintenance. Channel and banks have trees, weeds and debris impeding flow. Poor channel/pipe entries, resulting in significant bed or bank scouring.
5	**Very Poor** Major bed or bank scouring evident. Unsatisfactory bank stability, greater than 25% of banks slumped into channel. Difficult and poor access for maintenance. Channel and banks have many encroaching trees and vegetation combined with overgrown weeds and debris. Unsatisfactory channel/pipe entries resulting in major scouring. Concrete cracked and displaced.

H. Performance Gradings Tables

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TABLE P.1 WATER MAINS	
Performance Grade	**General Meaning**
1	**Very Good** Smooth bored mains not subject to degradation with sound factory applied linings; no measurable deterioration in pipe bore; no performance problems.
2	**Good** As grade 1 but with loose deposits that are noticeable under abnormal flow conditions or slight deterioration of internal bore but with no significant reduction in cross sectional area; occasional flushing and/or scouring required to maintain adequate water quality, but with no significant effect on performance.
3	**Moderate** Some problems with loose deposits or deterioration of linings or water quality (resulting from the pipework system configuration or pipewall deposits) leading to occasional complaints or inadequate design capacity for occasional peak demands or some deterioration of internal bore. Regular flushing or air scouring required.
4	**Poor** Frequent problems with loose deposits or deterioration of linings or water quality (resulting from the pipework system configuration or pipewall deposits) leading to regular complaints or inadequate design capacity for regular peak demands or some deterioration of internal bore. Regular flushing or air scouring required.
5	**Very Poor** Severe problems with deposits, deterioration of linings or water quality resulting from the pipework system configuration or pipewall deposits. Water quality cannot be assured or inadequate design capacity for average flows or significant deterioration of internal bore.

TABLE P.2 SEWAGE PUMPING MAINS	
Performance Grade	**General Meaning**
1	**Very Good** Smooth bored mains not subject to degradation with sound factory applied linings; no measurable deterioration in pipe bore; no performance problems
2	**Good** As grade 1 but with loose deposits that are noticeable under abnormal flow conditions or slight deterioration of internal bore which gives a rough surface but with no significant reduction in cross sectional area; occasional flushing and/or desilting.
3	**Moderate** Some problems with loose deposits or deterioration of linings leading to occasional blockages. History of occasional pipe blockage with tuberculation causing up to 20% blockage by encrustation. Regular flushing or air scouring required.
4	**Poor** Frequent problems causing blockage on more than one occasion under normal operating conditions during the previous 12 months or mains with tuberculation causing up to 20% to 40% blockage by encrustation. Frequent flushing or air scouring required.
5	**Very Poor** Severe problems causing regular blockage and pumping performance cannot be assured or mains with tuberculation causing greater than 40% blockage by encrustation. Very frequent flushing or air scouring required.

TABLE P.3 SERVICE PIPES	
Performance Grade	**General Meaning**
1	**Very Good** Smooth bored service pipes not subject to degradation. No performance problems.
2	**Good** As grade 1 but with loose deposits, slight tuberculation which might give a rough surface or sliming but with no significant reduction in cross sectional area. No performance problems.
3	**Moderate** Some problems with loose deposits or sliming/ tuberculation of the internal causing up to 20% loss of bore or water quality (attributed to the service pipe) leading to occasional complaints.
4	**Poor** Frequent problems with loose deposits or sliming/ tuberculation of the internal causing up to 40% loss of bore or water quality (attributed to the service pipe) leading to regular complaints.
5	**Very Poor** Severe problems with loose deposits or sliming/ tuberculation of the internal causing greater than 50% loss of bore or water quality (attributed to the service pipe) leading to a high level of complaints.

TABLE P.4 WASTEWATER AND STORMWATER - DRAINS	
Performance Grade	**General Meaning**
1	**Very Good** Sewers designed to acceptable standards with adequate self-cleansing velocity; no problems with deposition; no performance problems.
2	**Good** As Performance 1 but with some sliming or minor deposition causing minor loss of hydraulic capacity but not affecting performance.
3	**Moderate** Sewers with sliming and deposition requiring occasional cleaning or minor backfalls causing a reduction in pipe capacity or inadequate design capacity and surcharging of the sewer at times of high flows, although no surface flooding.
4	**Poor** Sewers with significant sliming and deposition requiring regular cleaning or backfalls causing a marked reduction in pipe capacity, risk of blockages or inadequate design capacity causing frequent flooding to gardens and highways or occasional flooding to properties or restricted toilet use.
5	**Very Poor** Sewers with a high level of sliming and deposition requiring a high frequency of cleaning or maintenance or backfalls causing a serious reduction in pipe capacity or serious inadequate design capacity, risk of blockages or hydraulic restrictions causing regular flooding to gardens and highways or frequent flooding to properties or restricted toilet use.

TABLE P.5 WASTEWATER AND STORMWATER - MANHOLES	
Performance Grade	**General Meaning**
1	**Very Good** No problems with the manhole structure, cover and frame, step irons, invert and benching or pipe entries into manholes. Fully compliant with safety regulations. No infiltration.
2	**Good** Some indications of structural problems with no effect on the functional performance of the manhole.
3	**Moderate** Problems exhibited under conditions of high flows that affect the functional performance of the manhole.
4	**Poor** Significant problems with either man entry or the functional performance of the manhole such as lack of benching.
5	**Very Poor** Significant infiltration causing increased surcharging within the network. Non compliant safety aspects such as corroded or broken step irons resulting in unsafe man entry. No benching to the invert with significant damage affecting the flow.

TABLE P.6 CIVIL STRUCTURES - WATER STORAGE	
Performance Grade	**General Meaning**
1	**Very Good** Meets all design and statutory requirements at all times and in all demand conditions. For example, good circulation of stored water (separate inlet/outlet), sections can be isolated without causing supply problems to properties, storage volume > 30 hours at average demand and complies with microbiological quality at all times.
2	**Good** As grade 1 but with some minor shortcomings in non-critical aspects or under extreme demand conditions. For example, storage of 24 to 30 hours at average demand.
3	**Moderate** Asset with occasional failures in performance criteria under normal conditions. For example, limited capacity may cause supply to properties to occasionally fail defined standards for pressure or flow during high demands, storage volume > 16 to 24 hours at average demand; complies with microbiological quality at all times.
4	**Poor** Asset with frequent failures in performance criteria under normal conditions. For example, limited capacity may cause supply to properties to frequently fail defined standards for pressure or flow during high demands, storage volume > 8 to 16 hours at average demand; some 'trivial' failures against the microbiological quality standards.
5	**Very Poor** Asset substantially unable to meet performance criteria. For example, limited capacity may cause supply to properties to frequently fail defined standards for pressure or flow during high demands, storage volume <8 hours at average demand; fails to comply with the microbiological quality standards

TABLE P.7 PUMPING STATIONS	
Performance Grade	**General Meaning**
1	**Very Good** Meets all design and statutory requirements at all times and in all demand conditions. For example, capacity exceeds maximum design demand or flow, adequate standby plant facilities, emergency sewage overflow provided. No known flooding or surcharging upstream as a result of pump station constraints.
2	**Good** As grade 1 but with some minor shortcomings in non-critical aspects or under extreme demand or climatic conditions. For example capacity equals maximum design demand or flow, adequate standby plant facilities. No known flooding upstream as a result of pump station constraints.
3	**Moderate** Asset generally meeting design requirements with occasional failures in performance criteria under normal conditions. For example capacity less than maximum design demand or flow, adequate standby plant facilities, some known flooding upstream as a result of pump station constraints, occasional operation of storm overflow, or a few reported complaints of noise or smells, or minor shortcomings in design - pipework, sump, electrics etc.
4	**Poor** Asset with frequent failures in performance criteria under normal conditions. For example capacity significantly less than maximum design demand or flow, standby plant facilities not fully adequate, regular known flooding upstream as a result of pump station constraints, frequent operation of storm overflow, or regular reported complaints of noise or smells, or shortcomings in design - pipework, sump, electrics etc.
5	**Very Poor** Asset substantially unable to meet performance criteria with very frequent failures against defined standards. For example capacity significantly less than maximum design demand or flow, standby plant facilities not adequate, frequent known flooding upstream as a result of pump station constraints, frequent operation of storm overflow, or regular reported complaints of noise or smells, or shortcomings in design - pipework, sump, electrics etc.

See following page for further details.

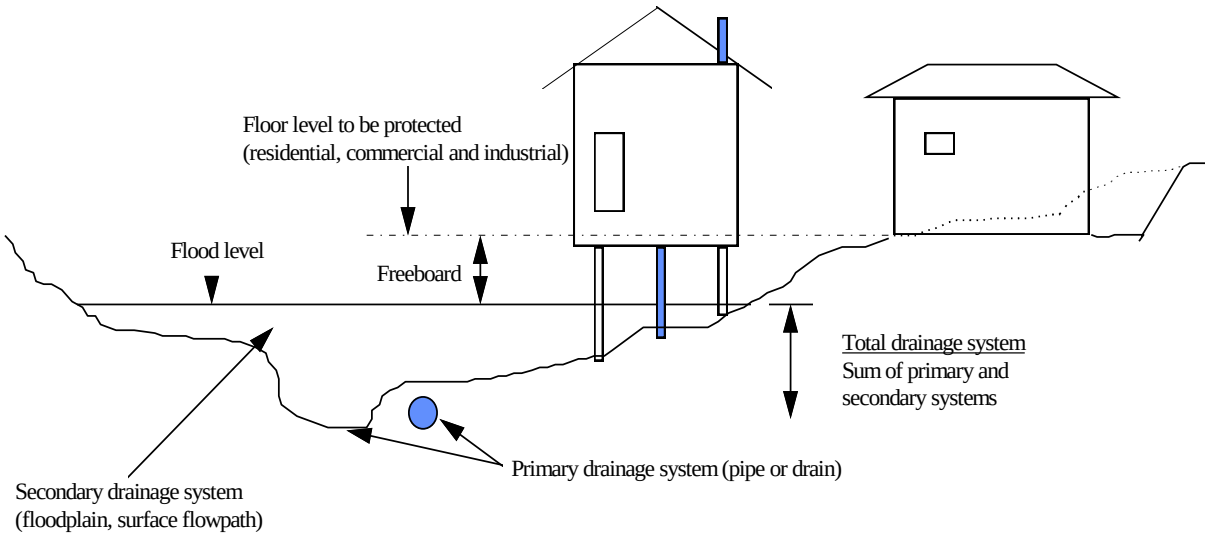
TABLE P.8 STORMWATER PIPED SYSTEMS, OPEN DRAINS AND CHANNELS	
Performance Grade	**General Meaning**
1	**Very Good** Stormwater drainage systems where all adjacent residential, commercial and industrial floors are known (or are anticipated) to be sited with an adequate freeboard above the largest recorded storm (1% AEP storm if known) secondary flowpath flood levels; or drains with a minimal risk of blockage and cleaning or maintenance is limited to vegetation control and cesspit cleaning.
2	**Good** Stormwater drainage systems where all adjacent residential, commercial and industrial floors are known (or are anticipated) to be sited above the largest recorded storm (1% AEP storm if known) secondary flowpath flood levels, but one or more has a reduced freeboard; or drains with a low risk of blockage and cleaning or maintenance is limited to vegetation control and cesspit cleaning.
3	**Moderate** Stormwater drainage systems where one or more adjacent residential, commercial and industrial floors are known (or would be anticipated) to have been flooded in the largest recorded storm secondary flowpath flood levels but otherwise flooding is rarely experienced (ie flooding is anticipated in approximately the 2% AEP storm); or drains with a low risk of blockage and requiring infrequent cleaning or maintenance in addition to vegetation control and cesspit cleaning.
4	**Poor** Stormwater drainage systems where one or more adjacent residential, commercial and industrial floors are known (or are anticipated) to flood in large storms secondary flowpath flood levels (ie flooding is anticipated in approximately the 10% AEP storm); or drains with a moderate risk of blockage and requiring periodic (seasonal) cleaning or maintenance in addition to vegetation control and cesspit cleaning.
5	**Very Poor** Stormwater drainage systems where one or more adjacent residential, commercial and industrial floors are known (or are anticipated) to flood frequently (ie flooding is anticipated in approximately the 20% AEP storm); or drains with a high risk of blockage and requiring a high frequency (several times a year) of cleaning or maintenance in addition to vegetation control and cesspit cleaning

Note: The performance of a stormwater drainage system is a function of the total drainage system capacity (refer diagram). The total drainage system capacity is the sum of the primary system (the pipe or open drain) capacity and the secondary system (the flowpath taken by flows in excess of the primary system capacity) capacity. The secondary system may include the floodplain associated with flows in excess of the capacity of a watercourse.

The total drainage system capacity is distinctly different from the `design standard' used for the design of the primary system. This `design standard' used typically in subdivisional standards to size the pipes varies between Authorities, typically in the range from 50% AEP to 5% AEP (2 year to 20 year Return Period).

The total drainage system will perform well when the flood levels associated with the secondary system arising from the 1% AEP (100 year Return Period) rainstorm event do not cause damage to buildings or facilities adjacent to the flowpaths.

Buildings with a freeboard allowance above the secondary system flood level will have a greater security against damage. The freeboard requirements are a function of the hydraulics of the secondary flowpath (ie its sensitivity to changes in flow parameters, eg: roughness or blockage) and are typically in the range of 300mm (minimum) to 1000mm.



STORMWATER DRAINAGE - DEFINITION OF TERMS

TABLE P.9 RAW WATER STORAGE	
Performance grade	**General meaning**
1	**Very Good** Flexible draw off arrangements for easy selection of different strata where stratification causes problems. De-stratification equipment provides good circulation. Few problems in preventing or diminishing algal growths. Smaller reservoirs have effective scour valve(s). Compensation volumes easily controlled/measured.
2	**Good** Flexible draw off arrangements for easy selection of different strata. De-stratification equipment provides reasonable circulation. A few problems in eliminating algal growths. Smaller reservoirs have effective scour valve(s). Compensation volumes easily controlled/measured.
3	**Moderate** Some cause for concern. Limited flexibility in draw off arrangements causing occasional problems. Some de-stratification equipment in place but may be inadequate under more severe conditions. In some seasons mobile plant may be required. A few problems in eliminating algal growths. On smaller reservoirs the scour valve(s) may not be fully effective. Compensation volumes reasonably controlled/measured.
4	**Poor** Cause for concern. Minimal flexibility in draw off arrangements. Problems with algal growths that are hard to control. De-stratification may often require mobile plant. Inadequate scour valves on smaller reservoirs. Compensation water volumes are not easily controlled and there is no on line measurement. Raw water quality is problematic and variable causing treatment problems.
5	**Very Poor** Raw water quality is problematic and variable causing treatment problems. Regular problems with algal growths or Eutrophication requires removal from use. Typically inadequate means of de-stratification. Inadequate scour arrangements and little or no compensation water control or measurement.

TABLE P.10 SURFACE WATER INTAKES	
Performance Grade	**General meaning**
1	**Very Good** Structure hydraulically adequate for all flows at all levels. Pump capability and standby adequate for all conditions. Efficient removal of floating debris and adequate disposal route. No siltation problems. Efficient exclusion of surface films/blocks by booms, bubble screens or surface sprays. Full on line quality monitoring. Easy isolation of wells, not impacting on capacity.
2	**Good** Structure, pumps and standby hydraulically just adequate for all conditions. Efficient removal of floating debris but disposal route not fully acceptable. Very occasional siltation problems. Efficient exclusion of surface films/slicks. Full on-line quality monitoring. Easy isolation of wells but may impact on capacity.
3	**Moderate** Some cause for concern: Structure hydraulically adequate at most flows but becomes limited at low water levels. Pump capability just adequate but restricted standby capacity. Moderate removal of floating debris, evidence of material passing forward. Poor disposal route. Fixed screens may become obscured at times. Recurring siltation problems inside or outside intake. Partial on line quality monitoring. Isolation of wells significantly limits capacity.
4	**Poor** Cause for concern: Pumps and/or structure hydraulically adequate only under favourable conditions. Very poor removal of gross floating debris which are returned to river. Frequent siltation problems inside or outside intake. Ineffectual coarse and/or fine screens. Poor ineffectual boom protection from surface films/slicks. Minimal on-line quality monitoring.
5	**Very Poor** Pumps and/or structural hydraulic problems restrict capacity even under most favourable conditions. Ineffectual or no fine screening of flows. Severe siltation problems inside or outside of intake. No protection against surface films/slicks. Little quality monitoring equipment and no on-line facilities.

TABLE P.11 CHEMICAL DOSING PLANT	
Performance Grade	**General meaning**
1	**Very Good** Plant able to dose at all required rates retaining standby capability. Full automatic control. Above minimum storage. Minimal blockage of dosing lines. Full flow diagrams and identification markers. Acceptable delivery and handling areas.
2	**Good** Plant just able to dose at all required rates retaining standby capability. Full automatic control on variable raw water or full manual control on constant quality raw water. Minimum economic storage. Occasional blockage of storage lines. Full flow diagrams and identification markers. Acceptable delivery and handling areas.
3	**Moderate** Some cause for concern. Part automatic part manual control. Occasional difficulties in regulating dosages with changeable raw water quality. Minimum storage. Occasional blockages require regular cleansing. Full flow diagrams and identification markers. Acceptable delivery and handling areas.
4	**Poor** Cause for concern. Minimal automatic control requiring frequent manual adjustment. Process difficult to control to consistent standards. Significant raw water quality variations. Poor flow diagrams and identification markers. Spillage has some potential to cause pollution incident.
5	**Very Poor** No fail safe control systems. No automatic controls. Process almost impossible to control within standards. Significant quality variations. Poor flow diagrams and identification markers. Spillage has potential to cause pollution incident.

TABLE P.12 DISSOLVED AIR FLOTATION	
Performance grade	**General meaning**
1	**Very Good** Hydraulically adequate at all flows and capable of dealing with all qualities of raw water. Efficient generation and even distribution of air saturated water with little or no solids deposition. Effective surface skimmer. Consistently achieves required standards by a good margin.
2	**Good** Hydraulically just adequate at all flows and just capable of dealing with all qualities of raw water. Even distribution of air saturated water with minimal solids deposition. Effective surface skimmer. Consistently achieves required standards.
3	**Moderate** Some cause for concern. Hydraulically adequate at most flows but working above optimum loading at peak flows. Some solids deposition. Requires in excess of 10% air saturated/throughput ratio. Occasionally just fails to achieve required standards.
4	**Poor** Cause for concern. Hydraulically overloaded at moderate flow rates. Solids deposition excessive. Requires increased air saturator output to achieve only moderate performance. Frequently fails to achieve required standards.
5	**Very Poor** Hydraulically overloaded. Solids deposition excessive. Ineffectual surface skimmer with excessive build up of flocculant and solids. Excessive demands on saturator output with extremely poor distribution. Ineffectual treatment.

TABLE P.13 CLARIFICATION	
Performance Grade	**General meaning**
1	**Very Good** Hydraulically adequate at all flows and capable of dealing with all qualities of raw water. Good mixing and flocculation retentions prior to tank entry. Upward Flow Tanks have stable blanket easily maintained and controlled. Efficient sludge removal facilities. Full turbidity and pH measurement systems in place. Consistently achieves high standards under all weather conditions.
2	**Good** Hydraulically just adequate at all flows and just capable of dealing with all qualities of raw water. Good mixing and flocculation retentions prior to tank entry. Upward Flow Tanks have stable blanket easily maintained and controlled. Efficient sludge removal facilities. Full turbidity and pH measurement systems in place. Consistently achieves required standards.
3	**Moderate** Some cause for concern. Hydraulically adequate at most flows but working above optimum at peak flows. Reasonable mixing and flocculation retentions prior to tank entry. Upward Flow Tanks the sludge blanket tends to become unstable at peak flows with some visible solids carry over. Reasonable sludge removal facilities. Turbidity and pH measurement systems partially in place. Occasionally just fails to achieve required standards.
4	**Poor** Cause for concern. Hydraulically overloaded at moderate flow rates. Upward Flow sludge blankets difficult to control. Frequent visible solids carry over. Sludge accumulates in corners of Flat Bottom Clarifiers. Accelerator mixer/transfer impellers inefficient. Frequently fails to achieve required standards.
5	**Very Poor** Hydraulically overloaded. Substantial solids carry over to filters. Little or no control of sludge blankets with difficult sludge removal. Ineffectual treatment.

TABLE P.14 FILTRATION	
Performance grade	**General meaning**
1	**Very Good** Can deal with water from marginally inefficient or overloaded clarification stage. Produces clear water well within required standards at maximum design flow with one filter off-line being washed. Filter run times easily achieved. Each filter has a tubidimeter. Full automatic operation on turbidity, loss of head or on a time basis. Good even backwash. No signs of media growth.
2	**Good** Clarification stage totally efficient in solids removal. Produces clear water within required standards at maximum design flow with one filter off-line being washed. Acceptable run-times. Each filter has a tubidimeter. Full automatic operation on turbidity, loss of head or on a time basis. Good even backwash. No signs of media growth.
3	**Moderate** Some cause for concern. Very dependent on performance of clarification stage. May not always achieve required output rates. Each filter has its own turbidimeter. Full automatic operation on turbidity, loss of head or on a time basis with reasonable efficient backwash. May require occasional off-line repeated washing. Acceptance run times only just achieved. Reasonably even backwash. Signs of media growth.
4	**Poor** Cause for concern. Significantly overloaded. Only just produces water of required standards at significantly lowered output rates. Each filter has its own turbidimeter. Full automatic operation on turbidity, loss of head or on a time basis with reasonable efficient backwash. May require occasional off-line repeated washing. Acceptance run times never achieved. Excessive solids removal load.
5	**Very Poor** Heavily overloaded. Standards not achieved. No automation of backwashing. Repeated off-line washing, fails to clean media, significant growth. Significant breakthroughs of media with quality problems.

TABLE P.15 WASHWATER AND SLUDGE REMOVAL	
Performance grade	**General meaning**
1	**Very Good** Good washwater settlement facilities producing supernatant water for discharge within consent standards. Good sludge withdrawal and consolidation facilities. Returned supernatant does not affect the main process flow. Facilities in place to divert flow at times of quality risk. Sludge dewatering plant produces stabilised sludge for disposal. High degree of automation.
2	**Good** Good washwater settlement facilities producing supernatant water for discharge within consent standards. Good sludge withdrawal and consolidation facilities. Returned supernatant does not affect the main process flow. Facilities in place to divert flow at times of quality risk. Sludge dewatering plant produces stabilised sludge for disposal. Partly automated.
3	**Moderate** Some cause for concern. Limited settlement facilities producing supernatant water for discharge just within consent requirements. Moderate sludge withdrawal and consolidation facilities. Returned supernatant may cause disturbance to the main process flow. Facilities in place to divert flow at times of quality risk. Inadequate dewatering plant or all or some sludge is sent to lagoons or drying beds.
4	**Poor** Cause for concern. Inadequate settlement facilities producing supernatant water for discharge within consent requirements most of the time. Poor sludge withdrawal and consolidation facilities. Returned supernatant may cause disturbance to the main process flow. Limited facilities in place to divert flow at times of quality risk. Limited lagoons or drying bed dewatering facilities available.
5	**Very Poor** Limited/inefficient settlement facilities. Little or no provision for separation of supernatant water. Non conforming discharge. Totally inadequate lagooning or other dewatering or disposal facilities.

TABLE P.16 INTER STAGE PUMPING	
Performance grade	**General meaning**
1	**Very Good** Hydraulically adequate at all flows with some margin of capacity for increased flows. Has capability to deal with varying rates of flow allowing downstream process to operate optimally.
2	**Good** Hydraulically adequate at all flows. Performs at maximum capability therefore depends on prior process to limit peak flows. Has capability to deal with varying rates of flow allowing downstream process to operate optimally.
3	**Moderate** Some cause for concern. Can become overloaded at maximum flows. Has step changes in capacity which may affect the downstream process.
4	**Poor** Cause for concern. Can become overloaded at maximum flows. Has step changes in capacity at medium to low flows significantly affecting performance of downstream process. Likely to be the main cause poor overall plant performance at or above required capability. Causes other process to be unstable and difficult to control.
5	**Very Poor** Hydraulically overloaded at normal flow rates and causes backing up and premature discharge of storm overflows. At medium or low flows the output rates are erratic causing the works to be in performance grade 4 or 5.

TABLE P.17 GENERAL PROCESS	
Performance grade	**General meaning**
1	**Very Good** Hydraulically adequate at all flows. Has capacity to deal with marginally inefficient or overloaded prior process. Good distribution between units. Good mixing and optimum process retention times.
2	**Good** Hydraulically adequate at all flows. Performing at maximum capability depends on prior process being at least performance grade 2. Good distribution between units. Good mixing and optimum process retention times.
3	**Moderate** Some cause for concern. Process overloaded at maximum flows affecting downstream process. At other flow rates deficiencies in capability may affect downstream processes. Process may be unstable and difficult to control. Some problems with ensuring even distribution between units. Poor mixing and below optimum process retention times.
4	**Poor** Cause for concern. Process overloaded at medium to high flow rates. Has significant impact on downstream processes. Likely to be the main cause for poor overall plant performance. Process may be unstable and difficult to control. Difficult to achieve a reasonable distribution between units. Inadequate mixing or process retention times.
5	**Very Poor** Process overloaded at normal flow rates. May be the main cause of works being in performance grade 4 or 5. Process may be very unstable and beyond control. Difficult to achieve even a reasonable distribution between units. Completely inadequate mixing or process retention times.

TABLE P.18 DISTRIBUTION PUMPING OR BOOSTING	
Performance grade	**General meaning**
1	**Very Good** Output maintained in excess of Utility Network Owner's thresholds for both pressure and interruptions in supply.
2	**Good** Output maintained at Utility Network Owner's thresholds for pressure and interruptions in supply.
3	**Moderate** Some cause for concern. Output causes occasional failures below the Utility Network Owner's thresholds for pressure and interruptions in supply.
4	**Poor** Cause for concern. Output causes frequent failures below the Utility Network Owner's limits for either pressure or interruptions to supply. Properties may be on an at risk register.
5	**Very Poor** Restricted output limits pressure or causes interruptions in supply below the Utility Network Owner's thresholds. Cause of reportable failures.

TABLE P.19 INLET WORKS	
Performance grade	**General meaning**
1	**Very Good** Structure hydraulically adequate for all flows. Mechanically raked screens not overtopped during storm flush. Manual screens not overtopped Efficient grit removal from flow and organic separation No downstream blockages.
2	**Good** Structure hydraulically adequate for all flows. Mechanically raked screens not overtopped during storm flush. Occasional blockages downstream Reasonably efficient grit removal from flow, some organic not returned to flow Manual screens are not overtopped except during exceptional flows if cleaned at set frequency.
3	**Moderate** Some cause for concern. Structure hydraulically adequate for most flows. Under storm flows screens can be overtopped. Blockages occur from time to time downstream Poor organics separation and some grit passing to settlement stage. Manual screens require attendance more than set frequency.
4	**Poor** Cause for concern Structure hydraulically adequate for most flows. Under storm flows screens and structure can be overtopped. Regular blockages in desludging of settlement or holding tanks. Undue amounts of grit causing disposal problems. Manual screens are frequently overtopped.
5	**Very Poor** Screens frequently blocked and overtopped and/or frequent blockages downstream. Screens undersized, over fine or over coarse Little or no grit removal or organics separation. Frequent downstream blockages from screenings and/or grit Frequent spillage outside structure.

TABLE P.20 PRIMARY SETTLEMENT	
Performance grade	**General meaning**
1	**Very Good** Tank(s) working well. No carry-over of solids and efficient scum trap/removal. No backing up of inlet or outlet channels. Produces sludge thicker than Dry Solids target and is easy to control. No rising sludges at any flow rate or signs of septicity/rising gases. Even distribution over weirs at low flows.
2	**Good** Only occasional minor problems. No backing up of inlet or outlet channels. Produces sludge at Dry Solids target. Tank(s) working at optimum rate hydraulically Usually no rising sludges at any flow rate or signs of septicity/rising gases Even distribution over weirs at low flows
3	**Moderate** Some cause for concern Occasional problems with solids carry-over and/or rising sludges. Tank(s) hydraulically overloaded at maximum flow rates and some strain on downstream process, or is underloaded at normal flows causing similar problems. Desludging difficult to control to produce consistently thick sludge.
4	**Poor** Cause for concern. Visible solids carry-over at moderate flow rates Tank(s) hydraulically overloaded at medium flow rate Causes overloading on downstream process. Backing up of inlet or outlet channels at maximum flow rates but not quite affecting upstream or downstream units. Difficult to control desludging and produces thin sludges below target. Uneven flow distribution over weirs at any flow rate. Tank(s) is significantly underloaded causing problems at normal flows with lack of feasibility in isolating excess capacity.
5	**Very Poor** Visible solids carry-over Tank overloaded and inlet/outlet channels backed up at most times. Causes significant downstream process problems. Septicity problems due to difficulties with clearing sludge from tank. Difficult desludging and produces erratic thicknesses. Requires frequent emptying to clear out sludge and/or grit. Total lack of flexibility between tanks.

TABLE P.21 BIOLOGICAL FILTERS	
Performance grade	**General meaning**
1	**Very Good** Media in good condition Good distribution and ventilation. No ponding at any time. Performance is such that it can deal with effluent from marginally inefficient or overloaded primary settlement stage. Film in good condition at all times.
2	**Good** Media in good condition. Good distribution and ventilation. No ponding at any time While able to produce excellent results, its own performance depends on primary settlement stage being totally efficient in solids removal.
3	**Moderate** Some cause for concern. Reasonable distribution but some ponding occurs at times. Maybe causing or contributing to the overall works performance being grade 3, or worse. Its own performance is very dependent on the performance of the primary settlement stage being better than that required to meet design parameters and/or because there is a need for recirculation.
4	**Poor** Cause for concern. Significantly overloaded and/or poor recirculation or dosing control allowing intermittent drying out of the film. Poor distribution. Poor ventilation. Odour problems. Quite severe ponding occurs for parts of the year and there are significant amounts of growth on the media. It is a main cause for the poor overall works performance to the poor performance of the Final Settlement Tanks or Tertiary stage.
5	**Very Poor** Heavily overloaded. Very uneven distribution. Little ventilation. Severe ponding all year long. Media almost blocked by growth or has crumbled causing blockages. Water flows across parts of the surface of the bed to a point where it can escape. Irrespective of the efficiency of other parts of the plant it is the main cause of the overall works performance being grade 4 or 5. Performance can not be rectified by any improvements upstream. Main cause of the failure of the Final Settlement Tanks or Tertiary stage.

TABLE P.22 SECONDARY SETTLEMENT	
Performance grade	**General meaning**
1	**Very Good** Tank working well. No carry-over of solids and efficient scum trap/removal. No backing up of inlet or outlet channels. Even sludges and easy to control. No rising sludges, signs of septicity/rising gases. Copes with seasonal solids flushes from Bacteria Beds. Even distribution over weirs at low flows. Good clear effluent.
2	**Good** Only occasional minor problems. No backing up of inlet or outlet channels. Even sludges usually easy to control. Tank working at optimum rate hydraulically but depends on efficiency of upstream treatment stages. Just copes with seasonal solids flushes from Bacteria Beds but may occasionally fail. Usually no rising sludges or gases, septicity. Even distribution over weirs at low flows. Good clear effluent.
3	**Moderate** Some cause for concern. Occasional problems with rising sludges. Tank hydraulically overloaded at maximum flow rates with visible solids carry-over at times of overloading of downstream process or is overloaded at normal flows also causing problems. Difficulty with seasonal solids flushes from Bacteria Beds and may fail. Desludging difficult to control. Uneven sludges. Distribution over weirs may break down at low flows.
4	**Poor** Cause for concern. Solids carry-over at higher flow rates. Tank hydraulically overloaded at medium flow rate overloading downstream process. Backing up of inlet/outlet channels at maximum flow. Difficult to control desludging and produces thin sludges. Uneven flow distribution over weirs. Tank(s) is significantly underloaded causing problems at normal flows with lack of feasibility in isolating excess capacity.
5	**Very Poor** Almost continuous visible solids carry-over. Tank overloaded and causing downstream process problems. Inlet/outlet channels backed up at most times. Septicity problems due to difficulties with clearing sludge from tank. Difficult desludging and produces erratic thicknesses. Requires frequent emptying to clear out sludges. Total lack of flexibility between tanks.

TABLE P.23 ACTIVATED SLUDGE PLANT	
Performance grade	**General meaning**
1	**Very Good** Efficient mixing of settled sewage and Returned Activated Sludge (RAS). Efficient mixing throughout with even distribution of air/oxygen. Efficient aeration control and easily maintained level of Mixed Liquor Suspended Solids (MLSS). Can deal with effluent from marginally inefficient or overloaded primary settlement stage.
2	**Good** Good mixing of settled sewage and RAS. Good mixing throughout with even distribution of air/oxygen. Good aeration control and easily maintained level of MLSS. Tank running at maximum hydraulic load. While able to produce good results, its own performance depends on primary settlement stage being totally efficient in solids removal and there being control on RAS.
3	**Moderate** Some cause for concern. Hydraulically overloaded at maximum flow rates and/or inadequate mixing throughout and/or difficult to optimise air /oxygen inputs. MLSS in poor condition and not easy to control concentration. May be causing or contributing to overall works performance being Grade 3, or worse. Placing some strain on downstream process.
4	**Poor** Cause for concern. Hydraulically overloaded at moderate flow rates and/or poor mixing throughout and very difficult to control air/oxygen inputs. Control of MLSS erratic. It is a main cause for the poor overall performance of Final Settlement Tanks or Tertiary stage.
5	**Very Poor** Hydraulically overloaded and with totally inadequate mixing throughout. Incapable of satisfying aeration demands and/or totally incapable of controlling air/oxygen inputs. MLSS out of control. It is the main cause for the overall works performance being Grade 4 or 5.

TABLE P.24 ACTIVATED SLUDGE - SECONDARY SETTLEMENT AND SLUDGE RETURN	
Performance grade	**General meaning**
1	**Very Good** Tank working well. No carry-over of solids and efficient scum trap/removal. No backing up of inlet or outlet channels. Consistent sludges and easy to control RAS/Surplus sludges. No rising sludges, signs of septicity/rising. Even distribution over weirs at low flows. Good clear effluent.
2	**Good** Only occasional minor problems. No backing up of channels. Sludges easy to control. Tank working at optimum rate hydraulically but depends on efficiency of upstream treatment stages. Usually no rising sludges, gases or septicity. Even distribution over weirs at low flows. Good clear effluent. Slight colour. Reasonable control of RAS/Surplus sludges.
3	**Moderate** Some cause for concern. Occasional problems with rising sludges. Tank hydraulically overloaded at maximum flow rates or is underloaded at normal flows also causing problems. Very dependent on upstream performance. Desludging difficult to control. Distribution over weirs may break down at low flows. Reasonable effluent with some colour and slight fines. Erratic control of RAS/Surplus sludges.
4	**Poor** Cause for concern. Solids carry-over at higher flow rates. Tank hydraulically overloaded at medium flow rate overloading downstream process. Backing up of at maximum flows. Difficult to control desludging and RAS/Surplus sludges affecting performance of Activated Sludge Tanks. Uneven flow distribution over weirs. Slightly cloudy effluent with visible solids and colour. Tank(s) is significantly underloaded causing problems at normal flows with lack of flexibility in isolating excess capacity.
5	**Very Poor** Tank overloaded and causing downstream process problems. Inlet/outlet channels backed up at most times. Septicity problems from difficulties with clearing sludge from tank. Requires frequent emptying to clear out. Difficult desludging and difficult to control RAS/Surplus sludges. Has a major impact on performance of Activated Sludge Tanks. Cloudy effluent with visible solids and colour. Total lack of flexibility between tanks.

TABLE P.25 TERTIARY TREATMENT	
Performance grade	**General meaning**
1	**Very Good** Performance is such that it can deal with effluent from marginally inefficient or overloaded secondary settlement stage. Produces sparkling clear effluent with no visible solids. Nitrifying Filter media and film in excellent condition. Excellent distribution and ventilation. No ponding at any time. Physical filters achieve acceptable run-times. Good even, efficient backwash/solids removal. No signs of media "growth". Vegetation in good healthy condition with no short-circuiting.
2	**Good** Able to produce good results operating at capacity. Performance depends on secondary settlement stage being totally efficient in solid removal. Produces sparkling clear effluent with no visible solids. Nitrifying Filter media in good condition. Good distribution and ventilation. No ponding at any time. Physical filters achieve acceptable run-times. Good even, efficient backwash/solids removal. No signs of media "growth" or "balling". Vegetation in good healthy condition with no short-circuiting.
3	**Moderate** Some cause for concern. Causing or contributing to the overall works performance being graded 3. Performance is very dependent on the performance of the secondary settlement stage. Reasonable effluent with no visible solids. Nitrifying Filter media in reasonable condition. Some ponding occurs at times. Physical filters only just achieve acceptable run-times. Reasonably even and efficient backwash/solids removal. Some signs of media "growth". Vegetation in moderate condition with no significant short-circuiting.
4	**Poor** Cause for concern. It is a main cause for the poor overall assessment of performance against consent. Significantly overloaded. Produces poor quality effluent with some visible solids. Nitrifying Filters have poor distribution and/or poor ventilation. Quite severe ponding occurs for parts of the year. Physical filters do not achieve acceptable run-times. Excessive solids removal load and media "growth". Frequently off-line to remedy performance. Vegetation in poor condition with short circuiting.
5	**Very Poor** Heavily overloaded. Irrespective of the efficiency of other parts of the plant it is the main cause of the overall assessment of performance being grade 4 or 5. Performance can not be rectified by upstream improvements. Nitrifying Filters media almost blocked by "growth" or has crumbled causing blockages. Very uneven distribution. Little ventilation. Severe ponding all year. Water flows across parts of the surface of the beds to a point where it can escape. Physical filters do not achieve desired run-times. Media very dirty and has "grown" significantly. Significant "mud-balling" and "cracking" of media with short-circuiting. Vegetation scours with significant "channelling" of flows and in very poor condition with no improvement in quality.

TABLE P.26 INTER-STAGE PUMPING	
Performance grade	**General meaning**
1	**Very Good** Hydraulically adequate at all flows with still some margin of capacity for increased flows. Has capability to deal with varying rates of flow allowing downstream process to operate optimally.
2	**Good** Hydraulically adequate at all flows. Performing at maximum capability therefore depends on prior process to limit peak flows. Has capability to deal with varying rates of flow allowing downstream process to operate optimally. Has capability to deal with varying rates of flow allowing downstream process to operate optimally.
3	**Moderate** Some cause for concern. Can become overloaded at maximum flow and/or has large increments of capacity which may affect effectiveness of downstream process.
4	**Poor** Cause for concern. Can become overloaded at maximum flow and/or has large increments of capacity at which at medium and low flows significantly affects performances of downstream process. Likely to be main cause for poor overall plant performance even if other processes are performing at or above normal required capability. Causes other process to be unstable and difficult to control.
5	**Very Poor** Hydraulically overloaded at normal flow rates and causes backing up and premature discharge of storm overflows, or at medium or low flows the output rates are so erratic as to be the main cause of works being in performance grade 4 or 5.

TABLE P.27 GENERAL PROCESS	
Performance grade	**General meaning**
1	**Very Good** Hydraulically adequate at all flows. Has capacity to deal with marginally inefficient or overloaded prior process, or permits downstream deficient process to operate at a grade above its notional capability. Good distribution between units. Good mixing and optimum process retention times.
2	**Good** Hydraulically adequate at all flows. Performing at maximum capability therefore depends on prior process being at least performance grade 2. Good distribution between units. Good mixing and optimum process retention times.
3	**Moderate** Some cause for concern. Process overloaded at maximum flows thus affecting downstream process. At other flow rates, deficiencies in capability may still have slight impact on downstream processes. Process may be slightly unstable and difficult to control. Some problems in ensuring even distribution between units. Poor mixing and below optimum process retention times.
4	**Poor** Cause for concern. Process overloaded at medium and high flow rates or process is ineffectual in performance. Has significant impact on downstream processes. Likely to be main cause for poor overall plant performance even if other processes are performing at or above normal required capability. Process may be unstable and difficult to control. Difficult to achieve even a reasonable distribution between units. Inadequate mixing or process retention times.
5	**Very Poor** Hydraulically overloaded at normal flow rates and/or process extremely ineffectual. May be main cause of works being in performance grade 4 or 5 where the efficiency of other stages partly compensates. Process may be very unstable and may be virtually beyond control. Difficult to achieve even a reasonable distribution between units. Completely inadequate mixing or process retention times.

TABLE P.28 OPERATIONAL SECURITY	
Performance grade	**General meaning**
1	**Very Good** Two grid supplies or standby generation. Manned site with full monitoring and/or fail safe systems on key plant/processes. Unmanned sites with full monitoring local plc control and telemetry. Non conforming water can be isolated and disposed with minor disruption to receiving waters or customers.
2	**Good** Secure grid supply or standby generation. Manned site with full monitoring and/or fail safe systems on key plant/processes. Unmanned sites with full monitoring local plc control and telemetry. Non conforming water can be isolated and disposed with minor disruption to customers.
3	**Moderate** Some cause for concern. Single grid supply or standby generation. Manned site with full monitoring and/or fail safe systems on key plant/processes. Unmanned sites with full monitoring local plc control and telemetry but not conforming to current standards. Non conforming water can be isolated and disposed with interruption to customers.
4	**Poor** Cause for concern. Single grid supplies. Several interruptions each year causing failure to levels of service or pollution. Manned site without full monitoring and/or fail safe systems on key plant/processes. Unmanned sites with rudimentary telemetry. Non conforming water can only be isolated and disposed with difficulty and interruption to customers.
5	**Very Poor** Single grid supplies. Frequent interruptions causing failure to levels of service or pollution. Manned site without full monitoring and/or fail safe systems on key plant/processes. Unmanned sites without telemetry. Non conforming water can not be isolated and disposed of.

TABLE P.29 BUILDINGS	
Performance grade	**General meaning**
1	**Very Good** Effective working areas with demountable partitions, suspended ceilings and floors where appropriate. Different activities segregated where appropriate. Capable of accommodating current and future occupancy, storage and plant. Effective lighting, power, ventilation and heating systems. Good support and amenities including restrooms, washrooms, shower and drying facilities.
2	**Good** Effective working areas with demountable partitions, suspended ceilings and floors where appropriate. Different activities segregated where appropriate. Capable of accommodating current occupancy, storage and plant. Effective lighting, power, ventilation and heating systems. Satisfactory support and amenities including restrooms, washrooms, shower and drying facilities.
3	**Moderate** Some cause for concern. Existing working areas are not fully effective. Different activities not fully segregated. Generally capable of accommodating current occupancy, storage and plant. Moderately effective lighting, power, ventilation and heating systems. Some shortfalls in support and amenity facilities.
4	**Poor** Cause for concern. Significant sections of the works are ineffective. Different activities rarely segregated. Accommodation often inadequate. Lighting, power, ventilation and heating systems ineffective. Significant shortfall in support and amenities.
5	**Very Poor** Existing works areas are inefficient resulting in serious deterioration in performance. Different activities not segregated. Accommodation inadequate. Lighting, power, ventilation and heating systems ineffective. Support and amenities facilities are not available.

TABLE P.30 GROUNDS	
Performance grade	**General meaning**
1	**Very Good** Access to the site is excellent for all operational requirements. Car parking available for current and future use. Excellent security system with appropriate high security fencing, detection/alarm systems.
2	**Good** Access to the site is satisfactory for all operational requirements. Car parking are satisfactory for current use. Good security system with appropriate high security fencing, detection/alarm systems.
3	**Moderate** Access to the site is generally satisfactory for all operational requirements except when severe conditions. Car parking occasionally difficult. Security systems have some shortfalls.
4	**Poor** Site is frequently only accessible with specialist vehicles. Car parking frequently inadequate. Security system have significant shortfalls.
5	**Very Poor** Site is frequently inaccessible. Car parking facilities are inadequate for essential operational requirements. Site security systems have significant shortfalls with risk to visitors or the public.