Road Transportation Asset Management Guidelines

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AECOM

ACKNOWLEDGEMENTS

This guide relies on information detailed in the International Infrastructure Management Manual (IIMM) 2011, and in some instances earlier versions of that manual. It is intended to supplement rather than supersede or replace the IIMM and provides more details and a more road-centric view of asset management than the IIMM.

SOURCES

A number of published and unpublished sources were drawn on for the preparation of this guide. Published sources were principally the International Infrastructure Management Manual – 2011 © NZ National Asset management Steering Group, the AASHTO Transportation Asset Management Guide A Focus on Implementation.© American Association of State Highway Officials 2011 and Guidelines for the Application of Asset Management in Railway Infrastructure Organisations © International Union of Railways (UIC) September 2010.

ABBREVIATIONS AND ACROYNYMS

AADT	Average Annual Daily Traffic
AM	Asset Management
AMIS	Asset management information system
AMP	Asset Management Plan
BCR	Benefit Cost Ratio
DoC	Department of Conservation
DRC	Depreciated replacement costs
dTIMS	Deighton's Total Infrastructure Management System
FWP	Forward Work Programme
GIS	Geographical information System
IIMM	International Infrastructure Management Manual
KPI	Key Performance Indicator
KPM	Key Performance Measure
LGA 2002	Local Government Act 2002 (as amended)
LoS	Level/s of Service
LTP	Long term plan, generally the LTP required by the LGA
MIS	Maintenance Intervention Strategies
NPV	Net Present Value
NZTA	NZ Transport Agency
O&M	Operations and Maintenance
ODM	Optimised Demand management
RAMM	Road Asset and Maintenance Management (system)
RCA	Road Controlling Authority
SCADA	Supervisory control and data acquisition (system/s)
SMART	specific, measurable, achievable, relevant, time bound
SMARTER*	(specific, measurable, achievable, relevant and time-bound (SMART), evaluated and reassessed (ER) regularly and often
TSA	RAMM Treatment Selection Algorithm

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1. Introduction

1.1 WHAT IS ASSET MANAGEMENT?

Asset management (AM) is a formal approach to managing infrastructure to provide services in the most cost-effective manner for the benefit of present and future customers, and to demonstrate this to customers, investors and stakeholders.

AM's goal seeks[1] :

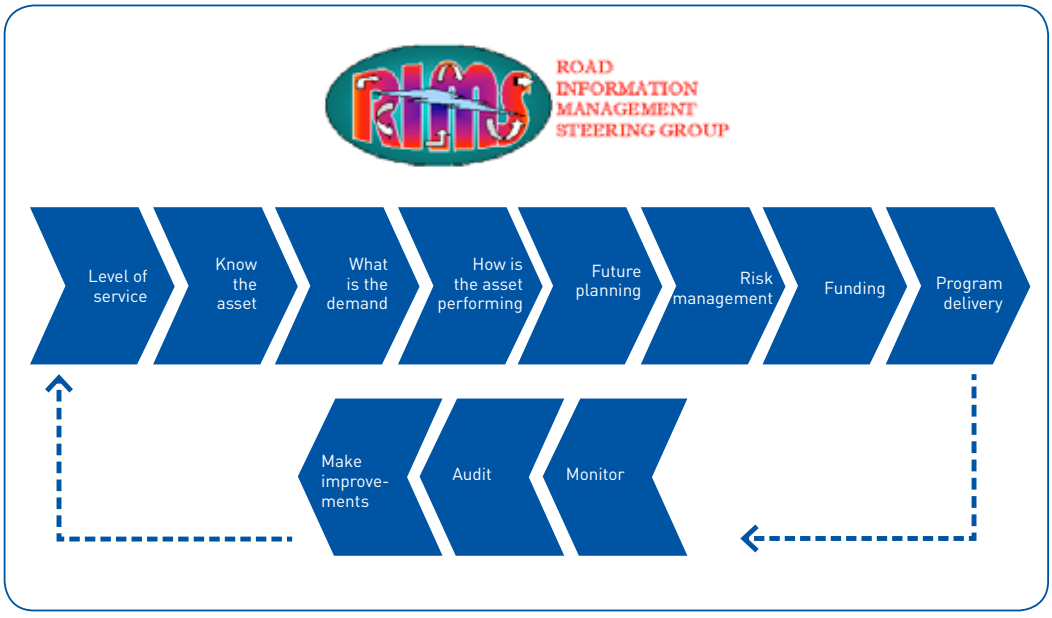
» *To provide a desired level of service in the most cost effective manner for present and future customers.*

This goal clearly states the key position levels of service (LoS) have in Asset Management. LoS are the standards which the asset owner agrees with the users for the supply of services. They are the key to successfully developing and implementing good AM practices and Asset Management Plans (AMPs). They are also the foundation upon which all recommendations, conclusions, decisions and budgets developed in the AMP should be based. This means agreeing standards, such as smoothness or ride, with road users and other customers. Once these standards (which are called performance measures) have been agreed, the goal of the asset manager is to sustain the necessary assets, to provide those LoS. LoS may be fixed or may vary over time.

"Cost effective" in the goal implies the work will be done efficiently, but more importantly it means the right work is done. The inclusion of "present and future customers" introduces the concept of "Intergenerational Equity", which means the solution must not only be cost effective for present users, it must be cost effective for future users too. Intergenerational Equity also implies each generation pays a fair share of the costs for the assets they use.

The paramount position of LoS in the AM process is illustrated in the following diagram.

Figure 1.1 1: The asset management process.



[1] *This statement differs slightly from that in the 2011 version of the IIMM; it is based on an earlier version of the IIMM. The difference in that it does not include the 2011 words "through management of assets"*

AM should be driven from the top of the organisation and integrated into its practices at all levels. The following diagram expands on the allocation of AM responsibilities in a hierarchical organisation.

Figure 1.1 2: The asset management hierarchy.

1.2 PURPOSE OF THIS GUIDE

This guide is written to:

- Put into context the full cycle of asset management (AM) practices for roads in terms of the respective areas (such as planning processes) and its purpose
- Link the different stages of AM through providing guidance on how to establish the links on both operational and strategic levels
- Assist in the implementation of the different AM stages, such as for example "What do I need to include in my AMP"?

1.3 DRIVERS FOR ASSET MANAGEMENT

If infrastructure assets are not delivered or made available in the most cost effective manner, society will bear unnecessary costs and may make decisions it would not have made otherwise, or suffer other adverse consequences. The principal drivers that lead to adopting and continued development of AM practices are society's desires for:

- Improved governance of and accountability for its essential infrastructure
- Enhanced service management and customer satisfaction
- Improved risk management
- Improved financial efficiency
- Sustainable management of assets, resources and the environment.

1.4 EXPECTED OUTCOMES OF SOUND AM PLANNING

The expected outcome of best practice AM on a road network is that "the required levels of service are delivered to present and future customers in the most cost effective manner". This is a very high-level outcome. Intermediate-level outcomes delivered by best practice AM include:

- Organisational recognition of AM, support of its processes and acceptance of it outputs
- Meaningful , current, LoS that are understood by decision makers and customers, and adopted at the highest possible level in the organisation
- Comprehensive and accurate asset knowledge
- Growth (positive or negative) and its underlying influences being understood throughout the organisation; all parts of the organisation use the same agreed growth assumptions, which are updated to reflect the most recent reliable information
- Asset risks being understood and managed appropriately
- Lifecycle Management Plans being clear, sound and costed. They and other information in the AMP, such as LoS, are used to inform the detail in the contracts that deliver and maintain the assets
- Optimised decision making (ODM) tools being understood and used routinely at all levels
- Planning assumptions and confidence levels being reasonable and stated clearly
- Financial outputs of the AM planning processes being sound, adopted as the authoritative base for budgetary planning, and budgets not being finalised until their effects on the assets are accepted
- AM improvement programmes being detailed, funded and implemented.

The expected outcomes are described in greater detail in Section 4.

1.5 THE ASSET MANAGEMENT FRAMEWORK

Developing and adopting a clear, logical and straight-forward AM framework is a key step in demonstrating the links between AM activities and the organisation's strategic objectives. An AM framework is a proven means of ensuring that AM is driven from the top of the organisation, which is one of the principal requirements for its success.

An AM Framework at the very least includes the documents and links illustrated in Figure 1.1 2. It is discussed in more detail in Section 2.

1.6 ASSET MANAGEMENT PLANS

Asset management planning is an essential part of AM – you cannot undertake good infrastructural AM without planning for it. Written AMPs are developed to facilitate sound, efficient and effective asset management.

The AMP is a written presentation of intended AM practices and programmes for managing assets. It is based on the organisation's understanding of the current and desired LoS the assets provide. It encapsulates summarises and records all the data and reasoning that has been used to develop the detailed intervention proposals and financial programmes required to provide the desired LoS. It also describes how they will be met and how they will be provided at the lowest long-term cost. In some respects the AMP can be regarded as a business case for the long term financial forecasts it develops.

Because it is adopted at the highest level in an organisation, the AMP becomes an authoritative statement about the management of the network. It shows the public and other stakeholders how the organisation is managing its assets and provides a link between the organisation's vision, strategic goals and operations and maintenance practices.

AMPs are not necessarily one document; they may span several volumes or can even occupy entire bookcases. Their essential feature is that they establish what, when, why and how assets are to be acquired, maintained, renewed, and disposed of to provide the required LoS and how much this is expected to cost now and in the future.

1.7 RELATIONSHIP WITH OTHER GUIDELINES

This guide relies greatly on information detailed in the International Infrastructure Management Manual 2100 (IIMM), and in some instances earlier versions of that manual. It is intended to supplement rather than supersede or replace the IIMM and provides more details and a more road-centric view of AM than the IIMM does.

The American Association of State Highway and Transportation Officials (AASHTO) published a comprehensive AM guide, AASHTO Transportation Asset Management Guide A Focus on Implementation© in 2011. It is a substantial volume (500 pages plus) providing some information relevant to New Zealand.

1.8 AN OVERVIEW OF CURRENT PRACTICE

The level of AM maturity adopted by an organisation and reflected in its AMPs and practices should be appropriate, practical and affordable. It may be helpful to consider the AASHTO scale when determining at the appropriate level of AM maturity to which an organisation aspires.

There are two common models of AM maturity in use: the one in the IIMM 2011 and the other in the AASHTO Manual. They are summarised below.

Figure 1.8 1: Asset management maturity models.

IIMM MATURITY LEVELS[2]	
AM Maturity Scale Level	**Description — AM Structures and Capability**
Minimum	AM allocated primarily to one or two people who have AM experience
Core	Cross-[organisation] co-ordination occurs through a Steering Group or Committee The executive team have considered options for AM functions and structures.
Intermediate	All staff in the organisation understand their role in AM. It is defined in their job descriptions, and they receive supporting training aligned to that role. A person on the Executive Team has responsibility for delivering the AM Policy or Strategy
Advanced	A formal AM capability building programme is in place and routinely monitored. The AM structure has been formally reviewed, with considerationof the benefits and costs of options.

AASHTO MATURITY LEVELS	
AM Maturity Scale Level	**Generalised Description**
Initial	No effective support from strategy, processes, or tools. There can be lack of motivation to improve.
Awakening	Recognition of a need, and basic data collection. There is often reliance on the heroic effort of individuals.
Structured	Shared understanding, motivation, and co-ordination. Development of processes and tools.
Proficient	Expectations and accountability drawn from AM strategy, processes, and tools.
Best Practice	AM strategies, processes, and tools are routinely evaluated and improved.

The level at which you are striving to manage your assets will depend on your organisation's stated objectives and its length of experience. All New Zealand local government organisations should be, at worst, at the Intermediate/Structured level of AM maturity.

Most Road Controlling Authorities (RCAs) have moved to, or are at, the intermediate stage of AM maturity and many are advancing all or part of their AM practices further towards advanced AM. Basic AM, purely based on existing LoS, no longer meets legislative requirements or Audit New Zealand guidelines for many activities, especially roading. This said, it may not be appropriate or cost-effective for an authority to attain and maintain full advanced AM capabilities, or AASHTO Best Practice.

[2] *IIMM Sect 4.1 p 4 | 2*

2. Stages in the asset management process

2.1 KNOW YOUR PRESENT AND FUTURE ASSET DEMANDS – LEVELS OF SERVICE

Section 1.1 emphasises the importance of LoS as the basis for modern and effective infrastructural AM. LoS are key business drivers and should influence all AM decisions.

Without a good understanding of customers' needs and wants there are a number of significant risks to the organisation:

- Services will be provided for which there is no demand or need
- The right services may be applied in the wrong places
- The LoS is insufficient to meet the need/is far higher than the need
- Genuine needs of parts of the community may be submerged in the statement of wants from sections that are more vociferous
- There will be no direction or planning of the services required now and in the future
- Services will be more expensive and there will be reduced customer satisfaction with them.
- LoS statements are the foundations upon which good AM is built; they encapsulate the purposes of owning and managing the assets. LoS statements:
- Describe the outputs the organisation intends to deliver
- Commonly relate to service attributes such as quality, reliability, responsiveness, sustainability, timeliness, accessibility
- Should be written in terms the audience can understand. Customer LoS must be understandable by most members of the general public. Technical LoS must be understood by those responsible for managing the assets, maintaining and developing them, including those who write the specifications for works and supervise contracts.
- Should drive the selection of performance measures
- Must be clearly linked to the organisation's strategic plan and objectives
- Must be SMART (specific, measurable, achievable, relevant and time-bound)
- Are not statements of user satisfaction or user satisfaction targets.

Another factor must also be managed and balanced with LoS on every road network: the costs of delivery. Good AM focuses on establishing and maintaining the relationships between cost and level of service them.

Well defined LoS are used to:

- Inform customers of what will be provided and any proposed changes to those provisions
- Develop strategies for delivering the services
- identify the costs and benefits of the services
- Provide a basis for reporting service delivery performance
- Allow customers to assess the suitability, affordability, sustainability and equity of the services offered.

Customer LoS focus on how customers receive services (process related), and are expressed in "customer-speak". These include, for example, ease of dealing with the RCA, appearance of facilities, ride comfort, congestion, availability of directions, and staff attitude.

Technical LoS relate to the service the physical asset provides, focussing on what the customer receives. These LoS are typically expressed using technical language such as, for example, average network travel speeds, crashes per hundred thousand kilometres travelled, and roughness levels. They are technical interpretations of the plain language statements in the customer LoS.

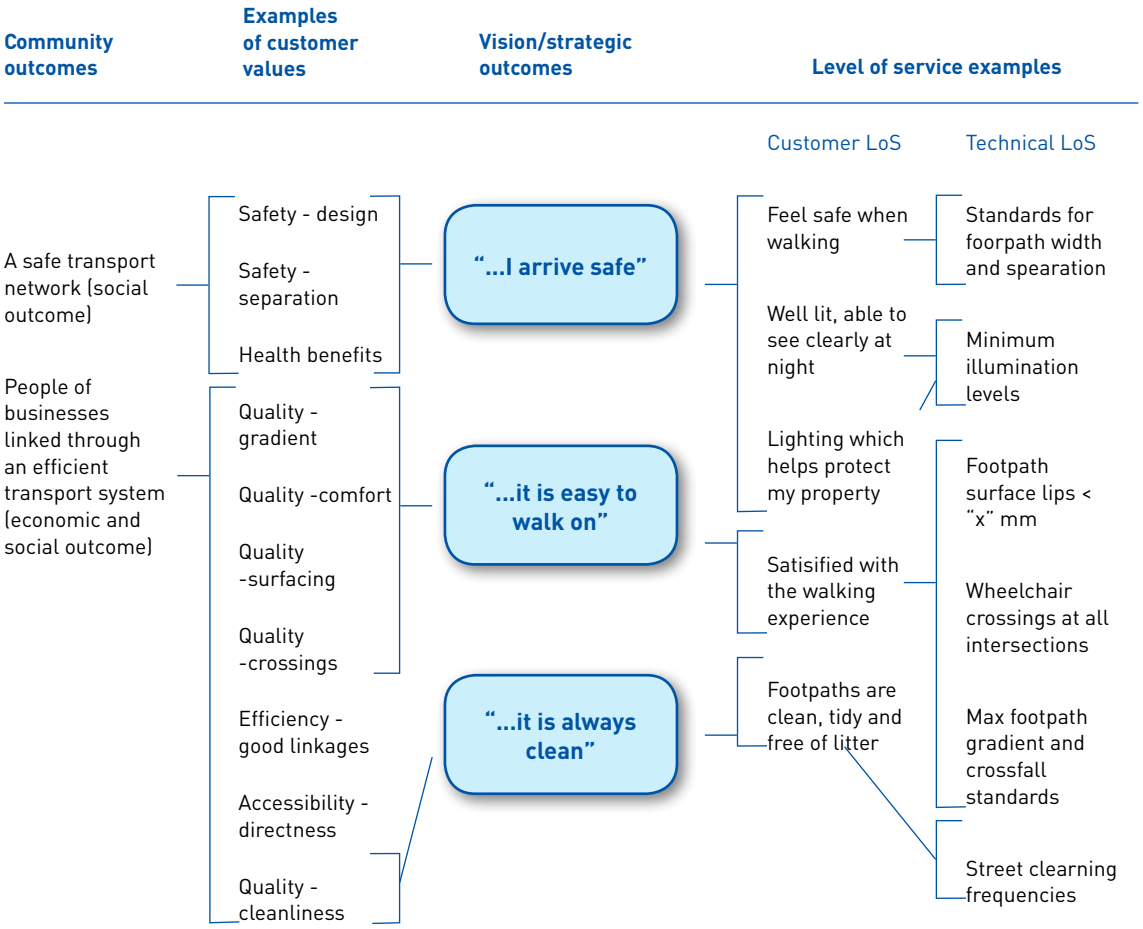
LoS should be based on:

- Legislative requirements – these provide the basis for the absolute minimum standards
- The asset's minimum needs – the minimum 'technical standard' (e.g. need to reseal a footpath before it 'crumbles and falls apart'). This is also an economics issue
- The organisation's strategic and corporate goals as expressed in its Long Term Plan
- Customer expectations (e.g. smoother footpaths)
- Financial constraints.

Mature levels of AM practice will seek to deliver well stated customer LoS through clearly defined technical LoS. "Core values" or "key service criteria" describe the types of attributes that LoS will be developed for. The overall linkage between the drivers of LoS can be summarised in various ways. The following is one example[3] .

[3] *This is believed to be from an early New Plymouth District AM Plan. Confirmation or correction of this attribution to george.jasonsmith@aecom.com would be appreciated.*

Figure 2.1 1: LoS linkages.



2.2 KNOW YOUR ASSET – THE ASSET REGISTER

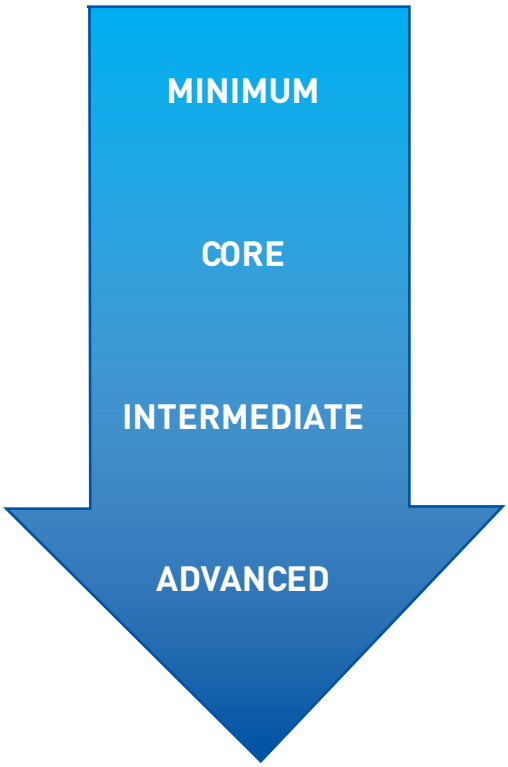
You cannot provide an agreed LoS or manage your assets properly if you do not know what assets you have. Asset data is thus a key enabling most AM functions.

In addition to data that identifies and locates an asset, information is required on its size, materials, whether it is separately maintained or replaced components, its creation date, life expectancy, condition, value, maintenance history, capacity, loading, function, ownership, and so on.

All RCAs in New Zealand adopted RAMM software as their roading database in the early 1990s. It is still in use in this role although some are known to be looking at other systems. RAMM was developed under the auspices of the RIMS group, and while this guide recognises the presence of other systems, it discusses data only in a RAMM context.

Data needs are summarised in the following diagram from the IIMM 2011.

Figure 2.2 1: AM data needs.



Basic physical information recorded in a spreadhseet or similar (eg location, size, type) but may be based on broad assumptions or not complete

Sufficient information to complete asset valuation - as for 'minimum' plus replacement cost and asset age/life. Asset hierarchy, asset identification and asset attribute systems documented.

A reliable register of physical and financial attributes recorded in an information system with data analysis and reporting functionality. Systematic and documented data collection process in place. High level of confidence in critical asset data.

Information on work history type and cost, condition, performance, etc recorded at asset component level. Systematic and fully optimised data collection programme. Complete database for ciritical assets; minimal assumptions for non-critical assets.

2.2.1 Data collection and recording

RAMM has provision to store photographs and other information against individual assets. This function is not widely used but has significant potential. It can even store scanned construction drawings, with obvious benefits in terms of data redundancy and resilience.

When the recorded data is assumed, or based on an assumption, this must be recorded. The most common means of doing this is seen in creation dates that are either 1 January or 25 December. AMPs should detail the standard assumptions the RCA has adopted and the AM Improvement Plan should include steps to clarify the "missing data" at appropriate times, or detail why it is not necessary to do so.

The need for adequate ownership data is often overlooked. Not all assets in a roadway are necessarily owned by the RCA. Failure to properly record ownership can result in:

- Over or under valuation of the assets, with consequential effects on the organisation's financial position and funding requirements
- Maintaining assets the organisation does not own or neglecting those that belong to it
- Lack of disaster insurance or payment of premiums for assets that are not covered by the insurance policies
- Possible creation of a maintenance precedent that has legal and/or financial implications.

JOINT OWNERSHIP

Joint ownership is requires particular attention. It usually occurs at or adjacent to local authority boundaries, including boundaries with the Department of Conservation (DoC). All aspects of ownership and management responsibility for these assets should be covered by a written agreement and both the agreement and the ownership details (e.g. proportion) recorded in the databases of all the owners. Examples where joint ownership arises are:

- A bridge across a river that is the boundary between two RCAs; this will generally be the joint property and funding responsibility of both, in agreed proportions, but will only be the management responsibility of one
- A local authority boundary that runs along the centre-line of a road. The maintenance, renewal and management responsibilities should be dealt with as described for bridges
- Where a DoC or an airport authority road is maintained by the RCA or vice versa.

NON-RCA ASSETS

Non-RCA assets are assets in road reserves that are there "as of right" or with permission but are not owned by the same RCA as that section of road. They include:

- Local authority street name blades on State Highways
- Most kerb, channel and footpaths on State Highways
- Stock underpasses and overpasses
- Railway overbridges
- Streetlight supports when they are also power or telephone poles.

UN-USED ASSETS

A third ownership category that must be recorded, for similar reasons to the above, and to allow disposal plans to be prepared as required, covers all assets belonging to the organisation but not in use. The most common examples of these are unformed legal roads, or unformed sections of otherwise formed legal roads.

2.2.2 Data maintenance

Data about an asset changes continually throughout its life. The principal changes are in its condition but others include replacement, the performance of maintenance and renewal/rehabilitation. It is imperative asset data is maintained or it will rapidly lose its value and after time, it will become worthless.

Modern tools such as RAMM Contractor, Mobile RAMM and GIS mapping have greatly simplified the collection and maintenance of road asset information and reduced the costs of these operations. They should be used wherever possible.

2.3 KNOW YOUR ASSET – ASSET VALUATION

We need to know the current and replacement values of roading assets for a variety of reasons, including:

- AM decision making
- Risk management and insurance
- Financial reporting and auditing
- Measuring loss of service potential (degradation)
- Pricing and funding
- Determining the owners' equity
- Benchmarking
- Sale and purchase, takeovers, and mergers.

In addition, private roading companies may need the information for taxation.

A significant issue for local authorities is they are required by legislation to fund the "decline in service potential" of infrastructural assets (unless it is "prudent to do otherwise"). This means that the Annual Plan or Long Term Plan must show the cost of depreciation, or loss in service potential, and how this is to be paid for, whether through rates, debt or some other means. Furthermore, local authorities are required every three years to prepare a long-term financial strategy (covering at least the next 10 years), that predicts all financial requirements, including service potential funding requirements.

Two very useful AM applications of a good infrastructural valuation are:

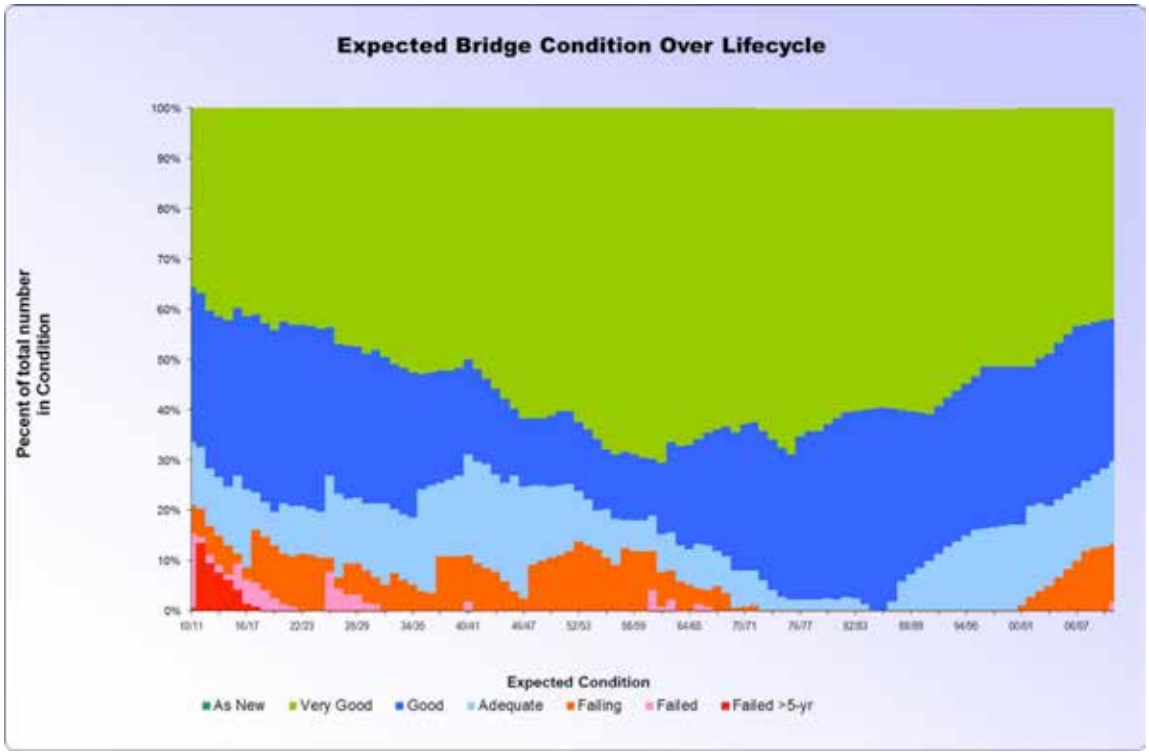
- Determining the change in service potential of a group or class of assets
- Determining long-term annual renewal budgets.

Straight line depreciation is used, but the expected remaining useful life of each asset can be modified to reflect its condition.

New Zealand's infrastructural asset valuations are controlled by the "New Zealand Equivalent to International Accounting Standard 16" (NZ IAS 16). This is a statutory regulation issued by the Financial Reporting Standards Board of the New Zealand Society of Accountants and approved under the Financial Reporting Act 1993. *The New Zealand Infrastructure Asset Valuation and Depreciation Guidelines* detail the processes required.

Condition-based asset valuation can be used to produce useful aids to long-term asset planning, such as the following chart, which contains real information from a New Zealand roading authority. It shows the expected condition of an organisation's bridging assets in each year of a 100 year period (one complete standard lifecycle) after the proposed budgets have been applied. (Green is "as new" and red is "overdue for replacement".)

Figure 2.3 1: Example of predicted bridge condition for a particular budget scenario.



2.4 KNOW YOUR ASSET – CONDITION AND PERFORMANCE MONITORING

Understanding an asset's current condition and performance is essential to understanding how and when it might fail.

Condition relates to the asset's structural integrity. Condition can be measured with instruments or visually. Asset condition will always deteriorate over time through use and weathering. Asset condition information:

- Underpins effective, proactive AM programmes by enabling prediction of maintenance, rehabilitation and renewal requirements
- Is critical to management of asset risk because it enhances understanding of the likelihood of asset failure
- Improves the robustness of asset valuations as outlined above.

Performance relates the systems' or assets' ability to meet defined service criteria or a defined LoS e.g. whether a bridge is one-way or two-way. Measuring asset performance:

- Allows comparison of achieved and agreed/desired LoS
- Is essential to the consideration and timing of asset upgrade of improvement programmes
- Underpins effective, proactive AM programmes by enabling knowledge of an asset's capacity limitations to be used to determine its remaining useful life and manage its maintenance, rehabilitation, renewal and disposal
- Provides essential information into the processes around creation of major new network links or components e.g. the need for a new four-lane route between A and C.

Condition and performance measures should be **SMARTER** (specific, measurable, achievable, relevant and time-bound (SMART), evaluated and reassessed (ER) regularly and often. Each measure should be directly related to a Technical or Customer LoS or to an organisational strategic objective.

It can be useful for reporting, and in some management processes, to combine some measures into a consolidated rating, which allows better comparisons to be made across a range of different factors that are usually all present. Examples of combined or consolidated indices include the NZTA Pavement Condition Index (PCI) and numerous organisation-specific weighted indices.

The principal factors to be considered when developing performance measures are:

- As performance measurement is expensive maximum use should be made of available data and obligatory external performance measures
- Each measure must be relevant -
  - If a performance measure does not relate to a LoS it should be deleted, or an appropriate LoS developed and agreed
  - If a performance or condition measure does not help in the management of the asset class now, or is unlikely to in the future, it should be abandoned.

Asset failure, or more particularly attempting to understand how assets fail and when that failure may occur, is another principal reason for collecting condition and performance data. An understanding of how assets fail, particularly important in the following AM processes:

- Determining asset lives for valuation and depreciation
- Establishing how to monitor condition, performance, LoS – so appropriate programmes can be put in place to enable the progression towards failure to be measured over time
- Understanding the effects and criticality of an asset failure – so risk exposure can be determined.

Asset failure is assessed against two factors:

- **LoS**, customer and technical – the asset does not achieve the required condition or performance
- **Economic** criteria – it is more cost effective to replace rather than repair the asset.

Failure against each of these factors is assessed using four failure modes. All of them must be considered on each occasion. They are:

- **Condition** failure
- **Capacity** failure – such as insufficient space, too small or narrow, not enough assets to deliver the service
- **Reliability** failure – cannot consistently achieve the required performance
- **Obsolescence** – although the asset functions satisfactorily, changes in technology have made it too expensive to repair or remaining lifecycle costs too great.

2.5 KNOW HOW THE ORGANISATION IS PERFORMING – OPERATIONS PERFORMANCE MANAGEMENT

Both operational and organisational performance are quite distinct from asset performance. For example, a network might be in excellent condition and running at the lowest lifecycle cost but customer calls are not answered, internal and external reporting deadlines are not met and statutory information is not provided.

Most organisations have LoS, which can (confusingly) also be called Customer LoS, that state the desired performances in these areas. These Customer Service LoS and Reporting LoS must be reflected in the Customer LoS and Technical LoS agreed for inclusion in the AMP and in the day to day management practices for the assets.

2.6 KNOW FUTURE NEEDS – DECISION SUPPORT PROCESSES AND DEMAND

2.6.1 Demand management

Providing LoS in the most cost effective manner to present and future customers requires forecasting of both what the required LoS might be and how many customers may be requiring these services. These two unknowns (future LoS and future customer numbers) are collectively known as "demand".

Demand can be for increased or decreased services (e.g. we no longer need road-side water troughs for horses). Demand for new or increased services or for increased numbers to use an existing service does not necessarily have to be met; it can be "managed down" even to the point of elimination through provision of alternatives, disincentives and other demand management techniques.

Demand management (which is a non-asset solution) is active intervention in the market to influence demand for services and assets, with forecast consequences. The objective of demand management is to influence the demand for services and assets to avoid or defer asset investment by:

- Altering customers' expectations of the service they will receive
- Optimising asset utilisation/performance
- Reducing demand for new/replaced assets
- Involving consumers in determining selected services and standards
- Separating proven needs from expectations.

Successful demand management should increase economic and social benefits to the community. Historically, service providers have attempted, with varying degrees of success, to meet demand for services without questioning or attempting to modify demand. This approach tends to raise customer expectations and invariably leads to even further demand. Increasing focus on strategic planning, fiscal responsibility, user pays, and core service reviews has created greater awareness of the need to consider demand management.

Demand management may be considered as having up to four major components, with each of these having a number of implementation options:

- Demand Substitution – provide alternatives such as incentives pricing structures, metered use and subsidies, for instance
- Restrictions – restrict type of use, time of use and methodology
- Education – change habits, increase understanding, and promote alternatives.

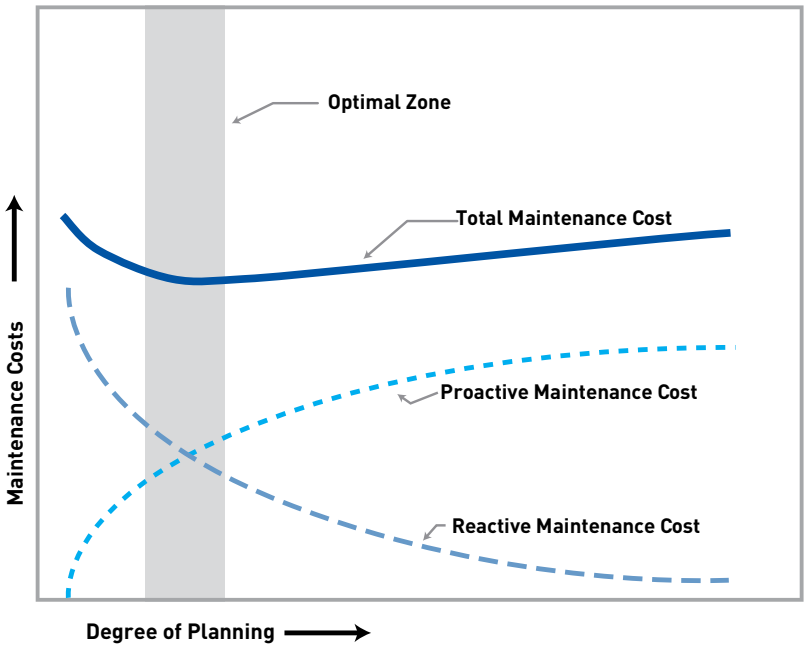
2.6.2 Maintenance management

Maintenance can be defined as "all actions necessary for retaining an asset as near as practical to its original condition, but excluding rehabilitation or renewal." It is important to remember that some assets will and should fail.

There are two major categories of maintenance:

- Planned (proactive) – work that delays or prevents a known failure mode, e.g. the painting of bridge beams will delay the onset of rusting and possible structural failure
- Unplanned (Reactive) – when a fault is identified and is fixed but is not part of the planned maintenance programme e.g. a dangerous pothole is identified and filled.

Figure 2.6 1: Relationships between maintenance planning costs and work costs.



This figure highlights the need to balance the amount of reactive and planned maintenance work. Relying on reactive maintenance only would result in higher total costs. The task of the maintenance manager is to achieve the right mix so that total costs lie in the optimal band.

Some practices that help to manage maintenance effectively include those listed below.

Maintenance engineering analysis, which is a process of logical evaluation to determine the maintenance needs relevant to the operating environment and the organisation's objectives. A reliability-centred maintenance approach provides the optimal blend of planned and unplanned maintenance, especially for critical assets. In this process, the following questions are addressed:

- What is the asset's required function?
- How does it fail?
- What causes it to fail?
- What happens when it fails?
- What can be done to prevent failure?
- What action is required if failure cannot be prevented?

Pavement Maintenance Management Systems These build on analysis performed to identify those items or assets that display specific or likely failure modes but generally do not identify all possible failures for all items. Because of their roles in meeting objectives or a defined level of facility function, these systems can be very worthwhile, but pre-adoption analysis should be subject to the same Optimised Decision Making routines as other asset management decisions.

dTIMS (Deighton's Total Infrastructure Management System), or more correctly NZ dTIMS, uses highway deterioration models to optimise pavement renewal programmes. As part of this process it also calculates broad maintenance costs for networks and at project level for individual road sections. dTIMS does not yet cover metal roads.

RAMM Treatment Selection Algorithm (TSA) The outputs from the TSA are lists of road sections (treatment lengths) with an indication of the road maintenance treatments required on each section, with the financial costs and user benefits of carrying out the pavement maintenance treatment indicated. These are calculated from the condition of the sections recorded in RAMM during the condition evaluation inspections.

The TSA allows you to set a financial performance level in terms of Benefit:Cost (B:C) ratio, above which a shape correction treatment is selected. The B:C ratio represents the ratio of benefits (i.e. road user benefits obtained from roughness reduction) to construction costs (i.e. the shape correction treatment cost less maintenance savings). If all the shape correction treatments selected were actioned by the RCA this would limit the roughness of all roads in the network categorized by traffic volume. The B:C ratio chosen is therefore also a de-facto functional performance level for the road network.

The TSA applies user input maintenance and renewal costs and produces reasonably accurate results in the short term (one to three years). It is not as accurate over longer periods and does not consider unsealed roads at all.

Maintenance Intervention Strategies (MIS) A MIS is a detailed statement of the type of maintenance activity that should be targeted to the treatment lengths identified in the forward work programme (FWP). It is the principal method of conveying the appropriate maintenance activities to all parties involved in the maintenance of an asset. A MIS can be developed for any asset class.

MIS are designed to ensure the optimum use of maintenance funding by ensuring that routine activities are appropriate, given the programmed treatments.

Maintenance Intervention Exceptions These are a sub-set of full intervention strategies. They are used by some authorities to document exceptions to normal maintenance practices, such as pothole repairs before overlays, without developing a full MIS. They should be regarded as the first step on the road to MIS development and not an end-point in themselves. Like MIS, Maintenance Intervention Exceptions can be developed for any asset class.

2.6.3 Renewal management

Pavement renewals in the short term can be forecast using RAMM, TSA or dTIMS. The best forecaster of pavement renewals beyond three years is dTIMS. However, it may not be an economically viable tool on lightly trafficked networks, because the costs of collecting and analysing the data on roads with Annual Average Daily Traffic (AADT) counts of below about 500 vehicles/day may not be balanced by the greater precision and certainty dTIMS can provide when compared with other techniques. The use of dTIMS should be subject to an Optimized Decision Making (ODM) process.

Although dTIMS can be used to model longer periods, its default setups are for 20 years, which is shorter than the lifecycle of all but the busiest pavements. Renewal requirements for longer periods can be modelled in dTIMS by "banding" years (e.g. in threes to coincide with the Long Term Plan Cycle).

Another technique for estimating long term renewal needs for pavements and all other roading assets is to use a soundly based asset valuation, ideally a condition based one, to establish the base-year's need, then aging and renewing the assets using spread sheet techniques to forecast annual renewals. While it is generally not a suitable tool for network level investigation or justification of projects, Net Present Value (NPV) analysis and its sibling, B:C ratio analysis (BCR) can be very useful at the option section stage of projects. NZTAs Project Evaluation Manual should be used as the basis for this work.

Before embarking on any renewal project, the need for the renewal should be tested against the required LoS and justified by the asset failure risk.

2.6.4 Management of improvements and new work needs

New works and improvements can only be properly justified by referral to the required LoS. However, LoS can often be affected by projected changes to other assets or services outside the roadway. For example, a new university would generate needs for new facilities across the whole nearby road network.

2.7 UNDERSTANDING WHAT COULD GO WRONG – RISK MANAGEMENT AND CRITICAL ASSETS

Knowing and understanding the risks faced by assets and the organisation facilitates the management of those risks in ways that help produce and maintain the desired LoS for present and future customers at the lowest lifecycle cost.

Infrastructure risk management is the process of identifying risks that may affect the assets' on-going service delivery. Risk management is often considered a core activity that influences the way the principal asset-based activities (creation, maintenance, renewal and disposal) are carried out. For this reason, although section 4.2.6 of the IIMM 2011 suggests risk be considered in the AMPs Lifecycle Management section, many RCAs consider it separately, along with growth and other asset drivers, before they detail their lifecycle management plans.

The RIMS Group has published a risk management guide," Best-practice Guidelines for risk management on road networks". This is available from the RIMS website at ***RIMS.org.nz > RIMS Knowledge > Best Practice Guideline for Risk Management on Road Networks.*** The RIMS Knowledge site requires a log-in.

A consistent risk management framework should be applied within each organisation, across all its sectors or divisions so risks can be compared and addressed appropriately. Recommended processes for risk identification and evaluation are described in the RIMS manual, along with suggested risk frameworks and registers.

The risk analysis output should be a table of the asset-based risks faced by the organisation.

An AMP should discuss risk. Good practice is for:

- Risks to be incorporated into the AMPs considerations and processes
- Outcomes from the risk management process to be integrated throughout the AMP and reflected in its maintenance, renewal and improvement programmes
- Any innovations linking the risk management framework and other organisational systems to be included in the AM Improvement Plan and implemented as appropriate.

2.7.1 Identification of critical assets

Identifying critical assets and vulnerabilities is an important step to understanding and improving resilience to adverse events.

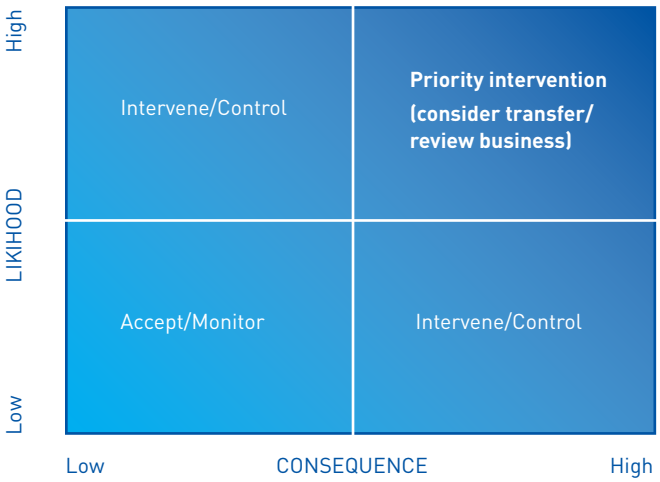
Critical assets are usually defined as those that have high consequences of failure, even though there may not be very high probabilities of this occurring. Similarly, the critical failure modes of an asset are those with the highest consequences of failure. Bridges over major rivers are often critical assets because there are few alternative routes and these usually require a long deviation. For example; there are only two bridges over the Rakaia River; if the SH1 Bridge fails, the eight-km drive between Rakaia and Bankside becomes a 102-km journey.

Critical risks should be noted or differentiated clearly in the risk table. They will often be extracted from the table and given special consideration in the risk reduction strategy or plan.

2.7.2 Risk treatment

As the purpose of risk evaluation is to allow risk to be managed, treatments or actions to address the risks after must also to be considered. The following treatment matrix can be used for this purpose. The organisation's risk management policy should contain information that provides similar guidance to this.

Figure 2.7 :1 Example risk treatment matrix.



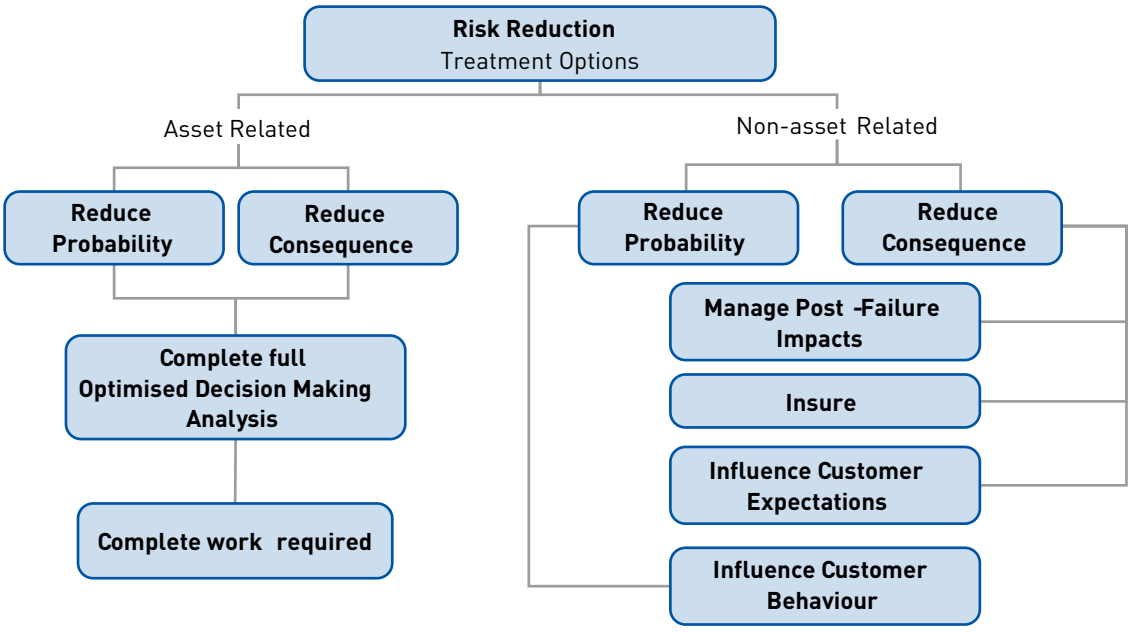
- Low consequence–high likelihood risks can often be managed though maintenance contracts
- High consequence–high likelihood events need to be prioritised for more detailed analysis and intervention
- High consequence–low likelihood events need to be evaluated; although they may be unlikely to occur, they have a high impact when they do occur
- Low consequence–low likelihood events will generally be monitored.

Risk can be managed using one or a combination of the following options:

- Accepting the risk
- Reducing the likelihood of a failure
- Reducing the consequences of a failure.

Individual risk reduction interventions can be asset related or non-asset related. The following figure outlines these.

Figure 2.7 2: Risk treatment options.



2.7.3 Risk prioritisation

There are likely to be a large number of identified risks. As they will almost never be able to be addressed at the same time it is necessary to prioritise the interventions. Risk reduction options for individual assets, within specific asset classes (such as bridges or roads) within an activity (e.g. transportation/roading) and within the organisation can be managed using the same techniques as other AM decisions. These include b:c analyses and multi-criteria analyses.

Some people believe prioritising risk interventions should be based on the risk score (i.e. the higher the risk scores, the higher the priority). This may not be best way to prioritise risks. For example, a natural disaster risk may have the highest score, but any amount of proposed action may not appreciably affect the total risk of the event. A more appropriate method of prioritising asset-risk interventions may be to consider the reductions in risk that would be achieved by the proposed interventions, and rank them accordingly.

The NZTA Deficiency Database and Prioritisation Process (DDPP)[4] contains a risk-based prioritisation process.

Further information on project evaluation and prioritisation is contained in the IIMM and the RIMs, "Best-practice Guidelines".

2.7.4 Outputs from risk analysis process

Sound and effective risk analysis should produce the following outputs or inform the following processes:

- Prioritised lists of asset improvements/alterations and new works required to reduce risk exposure, plus the works' estimated costs
- Changes to current practices to reduce risk exposure
- Asset maintenance procedures, priorities and practices
- Asset renewal priorities and standards
- Asset development (new work and improvement) strategies, priorities and standards
- Details of accepted or acceptable risks
- Asset disposal priorities, standards and practices.

2.8 KNOW FUTURE NEEDS – FINANCIAL FORECASTS

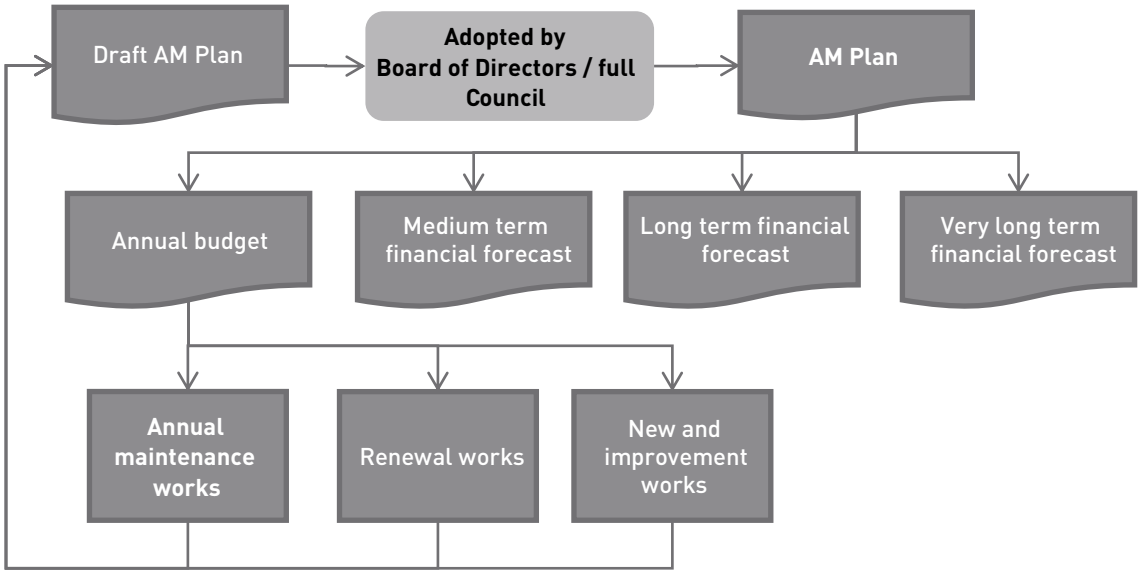
2.8.1 Financial linkages

Well researched and soundly based maintenance, renewal, improvement and disposal plans that will provide the required LoS at the lowest lifecycle costs for current and future customers are virtually useless unless they are funded. In an agency with mature AM practices fully integrated into its organizational systems and processes, budgets will usually be set on the basis of the AM needs developed through the AM process. At less developed levels of maturity, budgets will often be set with varying degrees of relationship to the assets' needs, or their ability to deliver specified LoS. However, even in agencies exhibiting the highest levels of AM maturity there will be occasions when the assets' immediate needs cannot be met by available funding.

The relationships between the AMP and its annual, medium and long term financial forecasts will ideally be straight forward and direct, with the budgets, financial plans and forecasts repeating the information in the AMP.

[4] *http://www.nzta.govt.nz/resources/sms/deficiency-database checked on 9 May 2012.*

Figure 2.8 1: Ideal AMP/financial linkages.



The ideal case shown in Figure 2.8-1 above is not achievable in practice because the influences affecting the annual budgets and financial forecasts cover many things that are beyond an AMPs compass. Therefore, annual plans and financial forecasts that do not meet the assets' full needs will often be proposed and be given effect. In reality, resource allocation and budgeting are components of the continuum illustrated in Figure 2.8 2 below. Changing any part of this continuum will affect all the other parts.

Figure 2.8 2: The budgeting continuum.

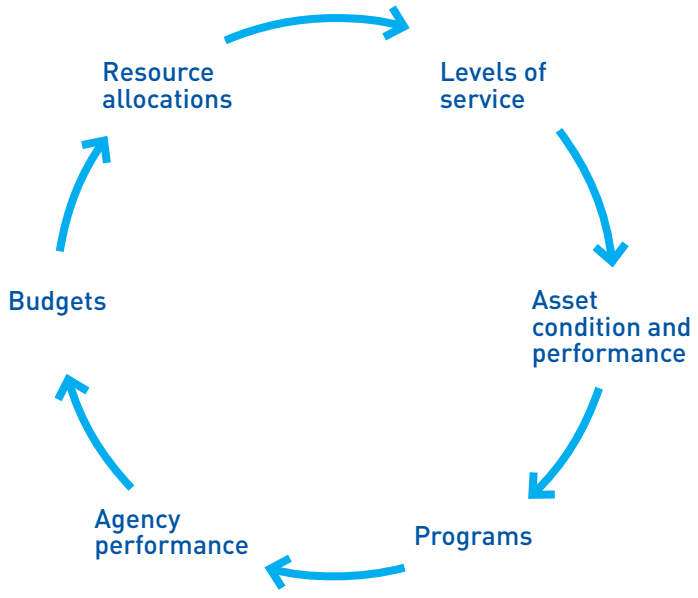


Figure 2.8 2 and the following two paragraphs are courtesy of the AASHTO Transportation Asset Management Guide A Focus on Implementation © 2011 by the American Association of State Highway and Transportation Officials:

This continuum shows resource allocation is immediately affected by a change in budget. A change in budget influences LoS, and the asset's expected end-of-period condition and performance. A change in budget will affect the agency's performance. Section 3.5.6 of the IIMM includes a subsection on dealing with financial constraints.

These considerations provide the basis for appropriate AM recognition of a reduced or increased budget. The appropriate response is to:

- Review planned resource allocations
- Determine the effects these will have on agreed LoS
- Assess how these changes in LoS will be reflected in the end of period asset condition and performance
- Adjust the work plan as necessary to achieve the best possible life cycle asset condition and performance within the available budget (this may mean leaving some assets' condition to decline to the extent that they require more expensive actions later)
- Assess the effects of the revised programmes on the agency's performance targets
- Report the anticipated effects on the targets to senior management.

Long term assessments of the asset's financial needs and funding requirements are crucial outputs from AMP, and their associated financial management practices.

- These forecasts should bring together all relevant data from all AM processes
- They should be underpinned by clearly articulated assumptions and confidence factors
- The forecast period for local authorities must be at least ten years. Local authorities are also required to forecast the first three years "in detail".

The main elements of financial forecasts should:

- Include
  - New works and improvements, sometimes called development
  - Maintenance and operations
  - Renewals
  - Disposals
  - Forecast future depreciation needs and changes in network service potential
- Forecast for a significant period, at least 10 years
- Include the financial outcomes of the AM strategies and programmes derived in the AMP
- Be based on provable data, recorded key assumptions and have defined confidence levels
- Be updated annually.

2.8.2 Inflation

The Audit Office has advised local authorities that their financial forecasts must include the effects of forecast inflation. However, this is unhelpful from an AM view as the effects of inflation are usually greater than any other influences on asset budgets, and thus can mask or hide useful AM information.

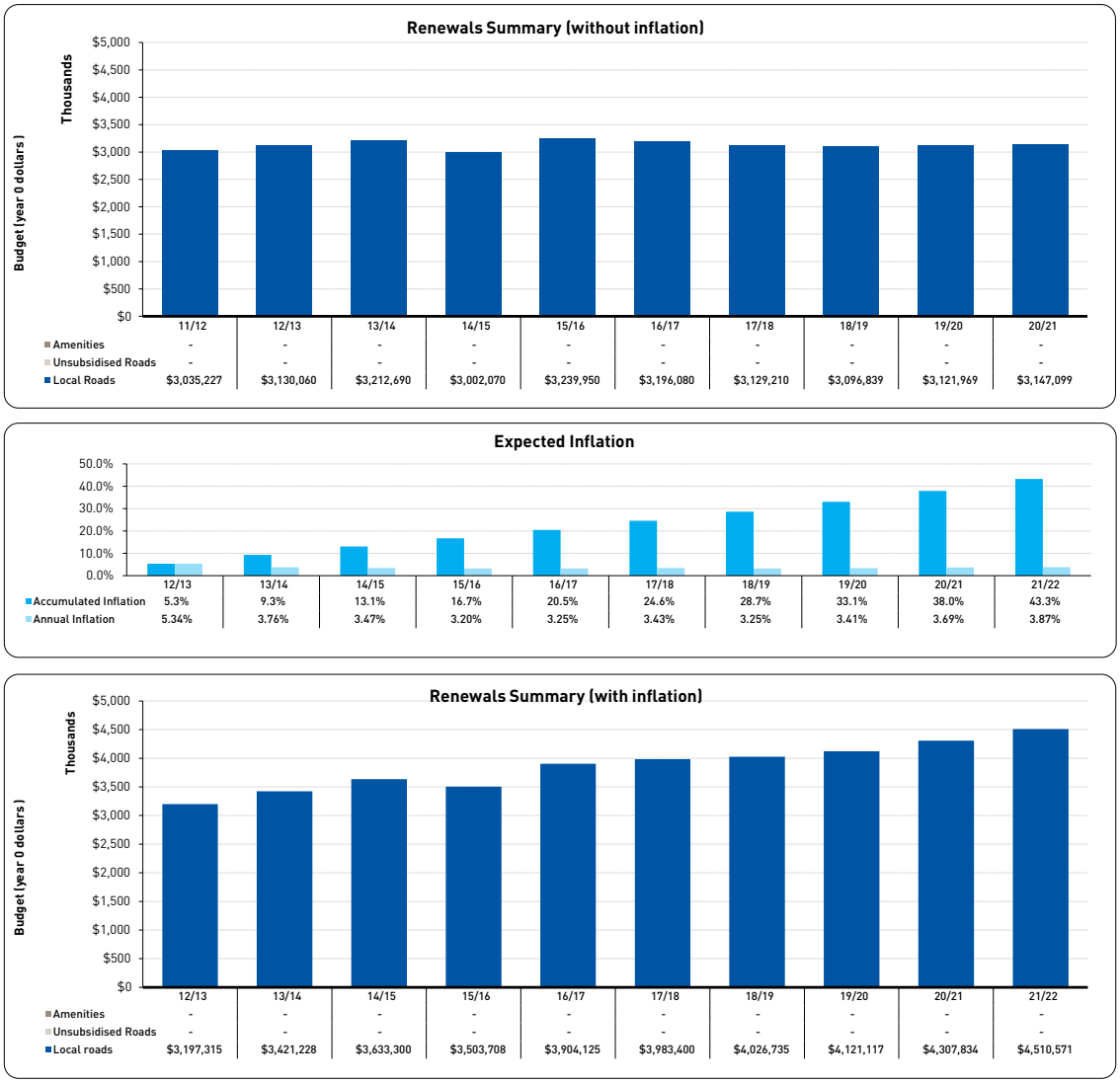
The most practical means of addressing this dilemma is to:

- Prepare all estimates and forecasts in the AMP on a no inflation basis
- Detail the forecast inflation in a separate sub-section of the AMP dedicated to financial forecasts
- Assemble the financial information that is to go forward to the financial forecasts/budget approval process in "constant dollar" and "including inflation" forms.

The NZ Society of Local Government Managers (SOLGM) commissions an independent forecast of expected inflation annually.

Examples of financial forecasts on these bases are shown below. It can be seen that although the forecast without inflation (constant-dollar forecast) shows costs to be almost constant in real terms, rising only 3.7 % in 10-years the forecast including inflation gives an impression of costs rising by 41%.

Figure 2.8 3: Comparison of financial forecasts.



2.8.3 Forecasting approach

Financial forecasts can be prepared and presented using either straightforward or complex approaches. It is helpful to consider the results required which will invariably be required to be clear and straightforward.

Clear and straightforward forecasts can be prepared in detail or at any desired macro level. However, while it can be relatively quick and simple to produce a macro-level estimate, to do so with any degree of accuracy usually requires a degree of hidden complexity and hidden assumptions. These forecasts can become complex to use when it becomes necessary to make changes during the budgeting process and the assumptions and linkages between items are not apparent or established.

When preparing financial forecasts and estimates, it is often simpler to prepare them to one level of detail below the lowest used in the financial system. While this may initially appear complex, the additional certainty and changeability of the data, together with the ability to record specific assumptions and projects and trace different aspects of the same project (e.g. income and expenditure or "subsidised" and "unsubsidised" renewals) often makes this approach simpler to use in the long term and easier to follow when the forecasts are revisited. The renewals' summaries illustrated above appear very simple and straightforward. They are the results of the summation of forecasts prepared this way.

Data presentation is another important aspect of the forecasting approach. Financial staff will obviously need detailed numbers. However, many users, including AM staff, can often get more information from a chart than a table. The ability to combine both charts and tables, as is done in the example above, provides an effective solution for most potential users.

2.9 KNOW WHAT YOU DON'T KNOW – ASSET MANAGEMENT IMPROVEMENT

It is important to realize that all the information you require or obtain and all the data you need or want to effectively and efficiently manage the assets is unlikely to be readily available, and there will always be a need for new or updated information to inform the Asset Manager's decisions. AM Improvement is therefore a continuous process. All AMPs should contain an improvement section that provides a single place in which to identify and prioritise the tasks that will contribute to the improvement of the organisation's AM practices. This section is sometimes called the Improvement Plan or Continuous Improvement Plan, but a less confusing name is the AM Improvement Section.

AM Improvement must not be confused with an Asset Improvement Plan (i.e. new works, development and asset improvements). This is a common confusion and the reason behind the suggested name for this section.

The principal output of the AM Improvement Section is an improvement plan that identifies the resources required to enhance existing elements of the business, or to implement new elements to deliver the longer-term strategic goals and objectives of the organisation. The AM Improvement Plan should prioritise the steps or tasks, allocate resources to them and programme them. A typical improvement plan is developed through the following steps or processes:

- Identify corporate needs for AM planning
- Assess the current status of the AM practices
- Evaluate the gaps between current and desired needs and practices
- Develop an optimised improvement programme to close those gaps, considering options, risks, costs and availability of resources
- Specify AMP improvement outcomes for each task and allocate responsibilities and resources
- Include a system for continuous review and monitoring of the AMP's effectiveness.

The AM Improvement section of the AMP should summarise current and assess future AM practices, providing an understanding of how AM decisions are made and how AM practices will be improved. It should also provide details on monitoring the AMPs performance and any improvements to AM systems that will improve the level of confidence in the AMP.

3. Linking stages and implementation

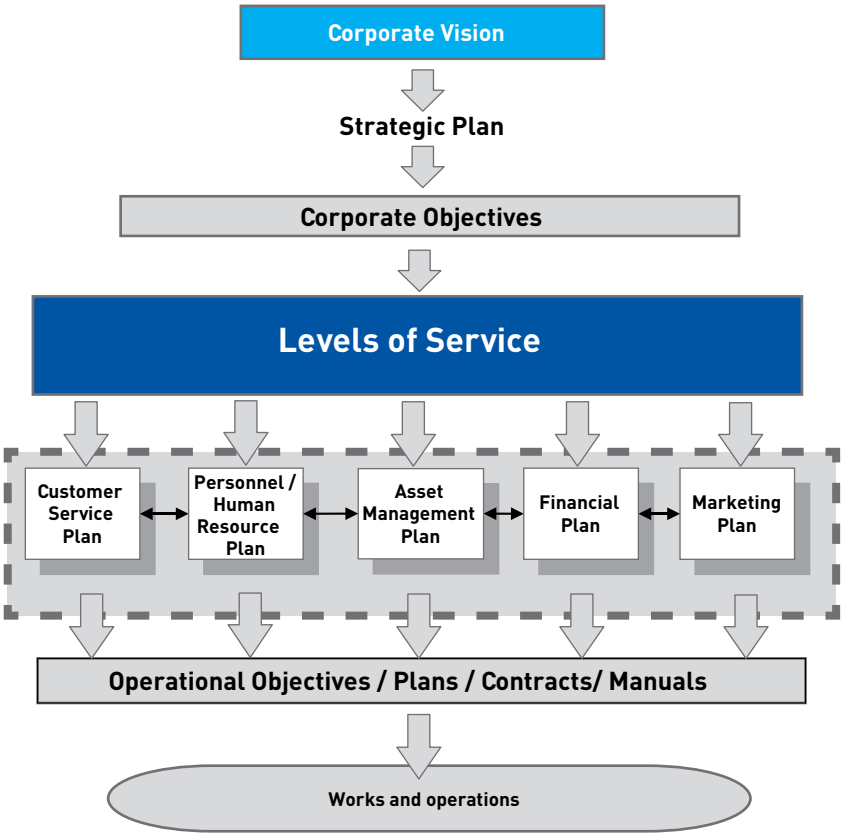
3.1 LINKING STRATEGIC LEVELS WITH OPERATIONAL LEVELS

One of the principles behind sound infrastructure AM is that the links between works that are carried out on individual assets and the organisation's highest level goals and objectives should be very clear and appropriately understood by all those involved in maintaining, procuring or providing the assets.

We have seen that the objective of infrastructural AM is to provide the desired LoS in the most cost effective manner for present and future customers, and that achieving this objective requires an understanding of LoS.

LoS are the link between an organization's vision and its tactical and operational plans and thus to activities "on the road". Figure 3.1 1 illustrates the position of LoS. They sit between high-level corporate objectives and the more detailed operational plans and procedures.

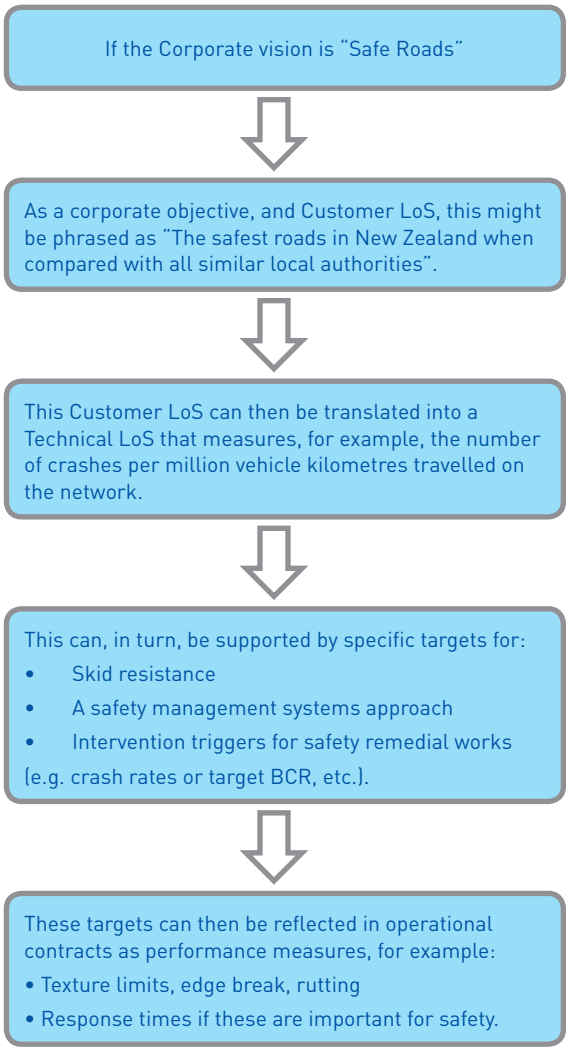
Figure 3.1 1: Linking works and operations with the corporate vision.



The vision and high level corporate objectives or strategic outcomes are often stated in relatively vague terms, for example:

- Safe roads
- A resilient and secure transport network
- Easing of severe urban congestion
- Reductions in deaths and serious injuries from road crashes.
- As we move down through the 'hierarchy of documents and procedures outlined in Figure 3.1 1 we become much more specific about what is to be done to achieve these goals. The corporate vision could be "Safe Roads", for example.

Figure 3.1 2: Works and operations activities linked to the corporate vision.



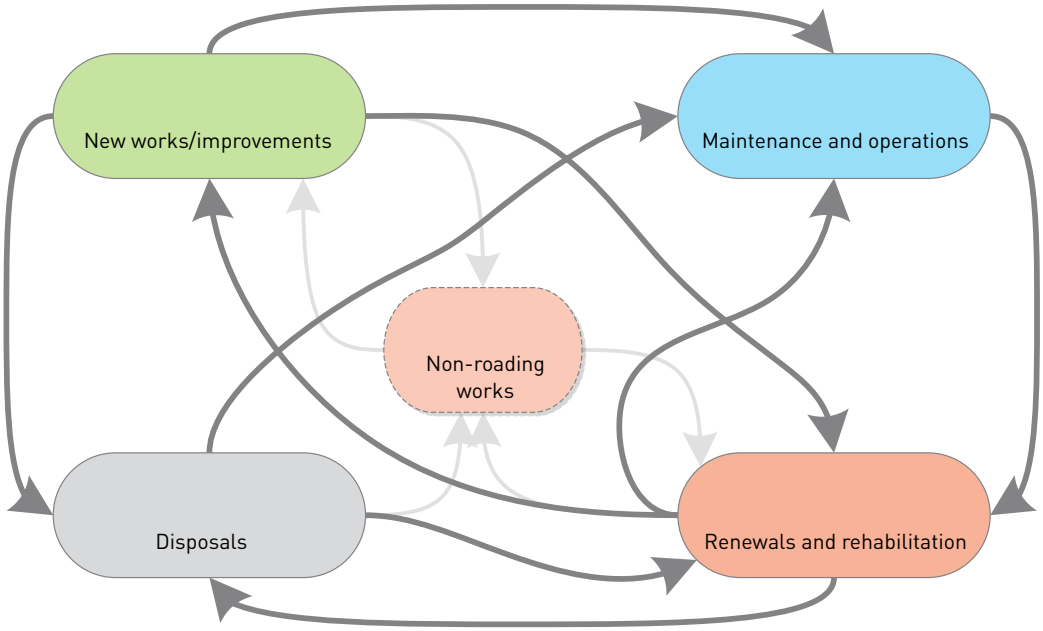
3.2 LINKING DIFFERENT PLANNING STAGES

One person is unlikely to be responsible for all aspects of a network's maintenance, operation, renewal, development, AM and project management. People at different levels within an organisation may be jointly involved with similar stages. Bringing these different levels together may be difficult, or in some cases one level may overshadow another. It is therefore necessary to design and implement processes that collect all the appropriate inputs, resolve differences and any conflicts, and then produce sound, effective and widely supported plans and programmes that will provide the agreed LoS to present and future customers for the lowest lifecycle costs.

The parties involved in this planning may not all be direct employees of the organisation that owns the assets. The discussions on maintenance, operations and renewals should involve selected staff from the maintenance contractors who can contribute to the discussions, help optimise and co-ordinate programmes, and contribute to discussions on better ways of doing things and removing impediments or bottlenecks. There is also a strong likelihood that internal supervisory staff and contractors will be able to provide useful feedback and suggestions for standards of new works and improvements and difficulties or problems encountered with recent new works. This latter point is particularly relevant in areas subject to growth where new subdivision roads are designed and built by developers.

The Figure 3.2 1 illustrates linkages between the different asset activities or stages of an assets lifecycle that need to be considered at all times. They are explained further below.

Figure 3.2 1: Linkages between asset activities.



While some of these linkages will require immediate or prompt recognition, others require longer-term recognition. For example, reflection of the future reseal needs of a new road in the renewals budget maybe seven or more years in the future. This is not a valid reason to ignore them; rather, it is a good reason to extend the forecasting period. However, extension beyond 20-years is likely to be only of academic interest unless very long term forecasting is being done.

3.2.1 New works and improvements links

LINKS WITH MAINTENANCE AND OPERATIONS

The greatest influence on the lifecycle costs of infrastructural assets occurs in the asset creation stage. This is not simply because of the cost of construction but because of the influences and effects that the location, design, materials and construction standards will have on the frequency, cost and levels of maintenance and renewals required throughout its life.

The links described below must be made:

- Maintenance and operations budgets and budget forecasts must reflect known and planned additions to the network. It is easy to dismiss additional maintenance cost and operational costs; for example, inspections and cleaning costs for one kilometre of new street or a new bridge. However, the effects of all such works are obviously cumulative, and failure to recognise the effects of individual changes will usually have two adverse effects on the network:
  - The budget available for maintenance and operations will be effectively reduced on a per km or per unit basis. Forcing more to be done with less is not viable when optimal maintenance systems have been developed, as such changes are by definition sub-optimal or less economic in the long term
  - The time will come when it is necessary to increase the budgets, because they will be obviously inadequate to maintain desired standards. These increases are also likely to be large, controversial and financially painful.
- Maintenance and operations contracts for all the asset elements must be altered to include the new or altered assets
- Construction standards and designs for new works and improvements must reflect the need to provide LoS at the lowest lifecycle costs. This can be a particular issue in new subdivisions as there is incentive for the developers to produce "window dressing" enhancements that have high lifecycle costs and avoid hidden works that will reduce those costs. Some examples are:
  - Extensive use of interlocking concrete blocks and asphaltic concrete as carriageway surfaces but resistance to construction of adequate base and sub-base layers
  - Use of expensive, unique streetlight poles and fittings, to provide a "marketing edge" with no thought to maintenance, replacement of damaged poles in-service life and need for eventual renewal
  - Erection of ornamental walls, often with "fancy" signage, on what will become road reserve, also to provide a "marketing edge". These walls and the attached signage usually become maintenance liabilities for the ultimate road owner, do not deliver any agreed LoS, can increase the likelihood of injury in traffic crashes and become difficult for the RCA to remove because residents value them.

LINKS WITH RENEWALS AND REHABILITATION

The linkages between new works, and renewals and rehabilitation needs are twofold:

- Budgetary, but on longer timeframes and for higher individual amounts than the maintenance effects
- Programme related, as it is often more economical for some asset improvements to be carried out at the same time as renewal works or just ahead of them, e.g. sealed widening, in conjunction with a pavement renewal. Establishing the most appropriate timeframe and scheduling requires consideration of lifecycle costs and design options. Similarly it may be appropriate to delay a planned renewal, such as a resurfacing, until after a planned new work has occurred.

LINKS WITH NON-ROADING WORKS

New works can influence non-roading assets because so many of them are located in the road reserve, including under the carriageway. While the influences run both ways, as indicated in Figure 3.2 1, the responsibility for carrying out the co-ordination lies fully on the party proposing the work; e.g. a major road realignment and new bridge may require co-ordination with operators of the following utilities:

- Water supply
- Sewerage
- Stormwater
- Reticulated gas
- Electricity
- Telecommunications
- Railways.

LINKS WITH DISPOSALS

If the new work is not to be a permanent feature of the network then its disposal should be included in forward programmes. Its disposal cost should also be included in the consideration of the project's lifecycle costs and economic viability.

Disposals also need to be considered when construction of a new asset removes the need for the services provided by an existing asset in a different location e.g. a road realignment may remove the need for a bridge and its approaches.

Disposal costs must be fully programmed, either as part of the construction project's cost or separately. Disposal costs include:

- Consultation
- Removing the asset that is no longer required
- The costs of preparation for sale, such as surveying, fencing or conversion to another use
- Costs of sale
- Making the site safe after the asset has been removed.

Disposal income should similarly be programmed. It is good practice to programme the income and expenditure associated with each disposal as separate budget items, although they will usually be summed to give a net result. Separate programming ensures all the steps needed to safely dispose of the redundant asset are fully considered and provided for.

3.2.2 Maintenance and operations links

Although maintenance and operations practices should influence the standards and specifications for new works and improvements, there are no major effects that maintenance and operations decisions should have on new works programmes.

Similarly, there are no significant links required between maintenance programmes and disposal programmes. Those links run the other way with maintenance programmes reflecting decisions to dispose of assets. The influence of inadequate maintenance on the life and eventual disposal of assets is indirect, through renewal and rehabilitation.

LINKS WITH RENEWALS AND REHABILITATION

Sub-optimal maintenance practices can adversely affect the service lives of road components, thus requiring more frequent renewals. However, unless there is a deliberate decision made to reduce maintenance on an asset and the effects of the reduction can be reliably estimated at the time, the renewal programming and budgeting link is usually indirect. The more significant effect is from the operations side of this activity.

Operations affect renewal and rehabilitation works through the results of the inspections and condition measurement. Failure to programme or fund levels of inspection and asset monitoring appropriate to each asset element will result in less efficient and effective renewal and rehabilitation programmes. This may force abandonment of some programmed renewals, and consequent increases in costs and reductions in levels of service, so reactive works can be carried out to respond to unpredicted failures.

3.2.3 Renewals and rehabilitation links

LINKS WITH NEW WORKS AND IMPROVEMENTS

The need to carry out renewals can influence the timing of improvements and renewals. The New Works and Improvements programme and the Renewal and Rehabilitation programmes require careful co-ordination to ensure optimal decisions are made.

LINKS WITH NON-ROADING WORKS AND OTHER ROADING RENEWAL PROGRAMMES

In roading authorities where only one or two people are involved in all the renewal decisions it is relatively simple to co-ordinate the renewal of different roading assets. However, in larger authorities this is not so straightforward and particular attention is required to ensure that the right works are done at the right time, in the right order, so lifecycle costs can be reduced and disruption of customers minimised. The need to co-ordinate renewal programmes for the different segments of the road renewal programme is really no different from the need to co-ordinate with other utility operators.

An example requiring such co-ordination, which also includes non-roading assets, is reconstruction of streets in residential areas. In many cases all the services in these streets were all installed about the same time, and although many have different lifecycles, eventually there are a number of major elements that will need renewing over a relatively short period, of say 10 to 15 years. Other assets that are further removed from the ends of their lives may also be present but, in terms of the overall cost effectiveness of combining works, it may be better to curtail their lives and replace them early as part of a major reconstruction project. In this way the need to replace the sewer, pavement or kerb and channel can drive rebuild of a street that renews:

- Berms
- Footpaths
- Kerbs and channels
- Water supply sub-mains
- Water supply mains
- Sewers
- Electrical reticulation
- Street lighting
- Gas reticulation
- Pavement layers
- Pavement surface
- Telecommunications cables and facilities including on-street cell-phone towers.

3.2.4 Disposals links

There are no significant direct links between disposals and new works; the link is in the reverse direction.

LINKS WITH MAINTENANCE AND OPERATIONS

When an asset disposal is planned the maintenance needs of that asset should reduce to the minimum level to adequately provide the required levels of service, including safety, for the balance of the assets life. If the disposal date is some years away, amendment to the Maintenance Intervention Strategy or Maintenance Intervention Exceptions List are usually appropriate

The maintenance and operations programmes, contracts and associated systems must also be adjusted to reflect the reduction in the asset base caused by the disposal. Budgets may be adjusted but, as disposals are rare, there is little danger of cumulative effects causing later problems if this is not done. The decision to immediately reflect the disposal in maintenance and operations budget and programme forecasts will depend on the significance of the disposal.

LINKS WITH RENEWALS AND REHABILITATION

The effects and responses for renewals are likely to be similar to those affecting maintenance and operations. It is necessary to review all FWPs to ensure aspects or elements of the disposed asset are not included in forecast renewals.

LINKS WITH NON-ROADING WORKS

The same principles apply here as have already been canvassed in previous sub-sections of 3.2.

In some cases the needs of other utility operators may prevent the demolition of an asset or its sale to a third party, instead requiring disposal to the utility operator so it can continue to meet that utility's needs.

3.2.5 Non-roading works

The Utilities Access Act 2010 requires non-roading utilities to be consulted over works that affect or may affect them. It is also in the RCA's interest to consult these organisations, as failure to do so may result in work that reduces the road assets' effective useful life. For example, a reconstructed footpath could be dug up a year or two later to renew a water main.

The National Code of Practice for Utility Operators' Access to Transport Corridors (November 2011[5]) is a statutory means of compliance with the Act.

3.3 FUNDING PLANNING

Funding is different from financial forecasts and budgets, although approved budgets are often described as "approved funding". In this context funding is consideration of where the finance to meet the financial forecasts will come from.

Funding pressures and shocks to finance infrastructure investment have historically arisen through a combination of factors:

- Lack of basic information on past performance and asset condition inhibiting prediction of future asset performance and asset failures
- Lack of detailed information on the past costs of maintaining and renewing assets, such as analysis of maintenance sub categories
- No robust assessment of maintenance or renewal gaps
- Assets valued at historic cost – because there is no revaluation regime – so consumption of assets (depreciation) is either not considered or it is understated
- Short-term budgets that do not signal long-term funding issues
- Budgets based on cash forecasts and cash availability rather than being not accrual based
- Ignoring the effects of increased asset stock on operating and maintenance forecasts
- Funding allocated to new projects to the detriment of maintaining and renewing the existing asset stock
- Lack of transparency in consulting with potential funders and lack of transparency in the disclosure of likely funding amounts
- Reluctance by decision makers to face funding issues.

To reduce the likelihoods of these events occurring and their severities the financial manager and the asset manager need to project future revenue or funding sources and cash flows alongside the financial forecast[6] . Note that this is a combined effort, not the sole responsibility of the asset manager. For New Zealand Local Authorities the two principal sources of funding for roading are rates and NZTA financial assistance, often incorrectly called "subsidy". The processes for NZTA financial assistance and calculation of expected levels of financial assistance are detailed in its Planning Programme and Funding Manual[7].

[5] *http://www.nzuag.org.nz/national-code/CodeNov11.pdf checked 24 May 2012*

[6] *IIMM*

In broad terms, in any local government operation, rates must fund all expenses that are not met from other sources which, in addition to NZTA financial assistance, include:

- Development Contributions received to facilitate works to offset the immediate effects of land development levied under the Local Government Act 2002
- Financial Contributions received to facilitate works to offset the wider effects of significant land development on the road network and levied under the Resource Management Act
- Fees and charges
- Borrowing.

Although projection of future funding needs is the joint duty of asset managers and financial planners, in practice, the roading asset manager will usually be required to forecast:

- NZTA Financial assistance receipts
- Income from Financial Contributions that is being used to meet some of the costs of the development work detailed in the relevant resource consents
- Income from Development Contributions being used to meet some of the costs of the network development work detailed in the relevant resource consents.

The budgeting continuum in Section 2.8.1 describes the linkages between funding (budgets), asset condition, budgets and LoS.

3.3.1 Forecasting NZTA Financial Assistance

NZTA advises all local authorities of the financial assistance rates at which it will support their road maintenance, renewal and improvement works. The Agency has also adopted a practice of capping the total amount of financial assistance it will provide in each year of a three-year cycle; this is tied to Treasury forecasting cycles. The net effect of this cap is that financial assistance rates will differ from the published percentage figures, especially in years two and three of the forecasts as inflation affects "subsidisable" costs but not the financial assistance cap.

The net effect of these two factors is that the asset manager should:

- Develop the forecast financial assistance income on a line-by-line basis, relating each element of the forecast to a specific group of financially assisted works
- Cap the calculated financial assistance at the advised amount for the three years it has been determined by the NZTA
- Forecast the full value of financial assistance, at current agreed rates, for the balance of the forecast period.

3.3.2 Forecasting financial and development-contribution incomes

The laws, case-law and regulations around Financial Contributions and Development contributions are restrictive. Their net effect is, in summary, that the finance collected may only be used for the purposes detailed in the consents and the resulting works must be completed within specified time frames. As these moneys are usually held by local authorities in trust accounts or similar until they are required, the total amounts currently available can be ascertained relatively simply. The total amounts of Financial Contributions due are detailed in the individual Resource Consents and in the case of Development Contributions, in the detail of the Council resolutions authorising them.

[7] http://nzta.govt.nz/resources/planning-programme-funding-manual/index.html *Checked: 25 May 2012*

The asset manager should include the income associated with each financial contribution work and each development contribution work in the financial forecasts. It is good practice to identify each work and each income line separately so that the elements of each work can be related and any changes are simplified.

3.3.3 Forecasting income from fees and charges

The most common fee or charge that is likely to be encountered in this context is Corridor Access and Road Opening fees, although there are many authorities that do not charge for these. The way income from fees and charges is handled in the financial and funding forecasts will depend on the organisation's policies; whether they are used to directly offset the costs of managing and supervising the road openings or whether they are part of "general income" which is used to offset total expenditure. Another likely source of income is outdoor parking, where this is under the jurisdiction of the roading unit.

Regardless of how the organisation treats income, it remains good practice to separately forecast the costs and incomes associated with each area for which fees and charges are received.

3.3.4 Forecasting loans

This area is best left to the financial staff. If asked to do such forecasts the asset manager should immediately seek advice and assistance from them.

3.3.5 Other aspects of planning funding of roading activities

All roading authorities will have financial, forecasting and consultation policies and possibly by-laws that address:

- Sustainability
- Intergenerational equity
- Transparency
- Fairness
- Defensibility
- Consultation and engagement with iwi, other communities, community groups, key stakeholders and other interested parties and government agencies
- Risk and uncertainty
- Value for money.

These policies should be read, understood, followed, and be incorporated as appropriate into asset management practices.

4. Developing an asset management plan

The AMP is a described in the IIMM as an "Asset Management enabler". This is an appropriate and accurate description. AMPs) are not an end in themselves; they are developed to facilitate the goal of AM:

» *The provision of the required LoS to present and future customers in the most cost effective manner.*

This objective and these Road Transportation Asset Management Guidelines emphasise the paramount position of LoS. They are the keys to the successful development and implementation of good AM practices and AMPs. They are also the foundation upon which all recommendations, conclusions, decisions and budgets developed in the AMP should be based.

AMPs are not necessarily one document; they may span several volumes or can even occupy entire bookcases. Their essential feature is that they establish what, when, why and how assets are to be acquired, maintained, renewed and disposed of to provide the required LoS and the expected costs to current and future customers.

PLAN FOR PLAN REVISION

An AMP should be written keeping in mind the need to change it frequently to reflect the above changes. Adopting a structure, document formatting and writing practices that will simplify updating will return significant benefits.

One example of this is providing source information with all charts and tables that are prepared in other documents such as spread sheets. This can be done with a formula that returns text such as that below Figure 2.3 1.

Another good practice is to structure the plan so that it does not need to be rewritten in its entirety whenever changes are necessary to a specific section or sections. However, it is rare that changes to one part of the AMP will not affect parts of the Lifecycle Management Plan, financial plan and the executive summary. This is one reason for splitting the Lifecycle Management Plan into discrete sections covering each element of the lifecycle (maintenance, renewal etc.) and risk. It is also beneficial to have the Financial Plan as a stand-alone section so that annual changes to inflation forecasts can be easily incorporated.

4.2 IDENTIFYING EXPECTED OUTPUTS AND OUTCOMES

The high and intermediate level outcomes of sound AM planning are listed in Section 1.4. These outcomes lead to the following expected outputs and outcomes of AMPs.

4.2.1 Organisational recognition

- The AMP is approved and adopted by the governing body, board or council. This includes their approval of the AM Improvement section of the plan.
- The AMP is the key planning tool for its assets and is the sole source of asset information for organisation's strategic plans/LTP
- AMPs are up to date and reflect the current demands on and needs for the assets they cover
- AMPs are implemented through operational plans, and discrepancies are formally reported
- Financial programmes, budgets and forecasts will reflect the forecasts developed in AMPs and adopted by the organisation
- Budget changes required by financial constraints or required to meet unanticipated new requirements will be worked through the AM planning process before adoption, so future maintenance and renewal implications and the full effects on present and proposed LoS can be considered.

4.2.2 Levels of service

- LoS required of the asset are clearly linked to the strategic/community outcomes of the organisation
- Customer LoS are understood at Board/Council level, by all members of the executive management team and by customers and are supported by technical LoS
- Customer LoS are adopted at Board/Council level after:
  - Evaluating of LoS options
  - Undertaking consultation on LoS options with the community and other relevant stakeholders (using consultation processes which meet industry recognised standards)
- Customer LoS and standards are promulgated in a 'Customer Charter' or equivalent public document
- LoS for significant aspects of the roading/transportation are detailed in the organisations LTP and AMPs
- The AMPs of each significant service reflect and are based on the agreed LoS, including technical performance measures which underpin the customer agreed LoS and standards
- Technical LoS are soundly based and understood by all practitioners, designers, maintainers, contractors and others working on the network
- LoS are SMART
- Achievement or otherwise of LoS is:
  - Gauged through use of SMART performance and condition measures, key performance indicators (KPIs) and key performance measures (KPMs) that are evaluated and reassessed regularly and often; i.e. performance and condition measures, KPIs and KPMs are SMARTER
  - Reported to the public at regular fixed intervals, at least annually.

4.2.3 Asset knowledge

There is a reliable physical inventory of assets at both an individual asset level and at a network level, including:

- Physical attributes such as location, material and age
- Systematic monitoring and analysis of physical condition
- Systematic measurement of asset performance (including utilisation/capacity)
- The remaining useful lives of assets.

The assets' financial description is linked to the physical description, with the ability to aggregate and disaggregate information, and meet the requirements of:

- Financial Reporting Standards
- Valuation Standards augmented by the NZ Depreciation and Valuation Guidelines.

4.2.4 Growth management (positive or negative)

Gaps between current service capacities/capabilities and those required to meet current and future LoS are understood and documented

- Demand forecasts for each network/facility are based on the latest growth forecasts and at least cover a 10-year period
- Demand forecasts include analysis of the different factors that comprise demand
- The sensitivities of asset development (new works) programmes to demand changes are understood
- There is clear differentiation between the need for works to provide for growth and those required to provide for changes LoS.

4.2.5 Risk management

Critical assets and associated risks are identified and risk management strategies developed using risk management principals and techniques.

- AM decisions always recognise and apply the principles of integrated risk management; specifically:
  - Risk management practices are aligned with ISO 31000 (formerly AS/NZS 4360), and industry good practice such as the NZ Local Government Handbook for risk management
  - Asset risk management is integrated with other corporate risk management processes
- Asset risk management encompasses:
  - Identifying risk management strategies for all critical assets
  - Risk assessments and mitigation plans for engineering lifelines/lifeline utilities, which will include reference to the organisation's disaster recovery and business continuity plans
  - Establishing links to asset maintenance and replacement strategies.

4.2.6 Optimised decision-making

- Optimised Decision-Making techniques (ODM) are used throughout all lifecycle management process and to develop solutions to fill these gaps using an asset development and/or disposal programmes
- ODM is the basis of robust and defensible options for asset treatments and developments that achieve optimal costs over their life cycles and the network's lifecycle, including:
  - Applying appropriate economic evaluation tools (or other organisation endorsed prioritisation systems) in developing short-term project lists
  - Using predictive modelling techniques to provide defensible long-term financial forecasts
- Evaluation and ranking of options for significant capital investment decisions is based on suitable criteria.

4.2.7 Financial forecasts

- AM Planning translates the physical aspects of planned maintenance, renewal and new work into financial terms for at least the ensuing 10 years and in a manner that is fair, consistent and transparent.
- The forecasts include sufficient information to enable decline in service potential (depreciation) of an asset to be measured. (Guidance on depreciation is included in the NZ Valuation and Depreciation Guidelines.)
- AM Planning translates the physical aspects of planned operational, maintenance, renewal, new and disposal works into financial terms generally over the timeframe in which the asset network must deliver services. These financial forecasts are:
  - In detail for the first three years of the programme
  - In outline for the next seven years of the programme
  - In less specific terms over the period for which the organisation has a strategic plan
- The compilation of financial forecasts in the AMP is consistent, reliable and provable and these forecasts are reflected in the organisation's financial plans and budgets
- Forecasts' sensitivities to potential significant changes in assumptions are analysed and discussed in the AMP and spreads of forecast expenditures are included where and as appropriate.

4.2.8 Planning assumptions and confidence levels

AMPs:

- List all the assumptions and provisos under which the plan and financial forecasts are developed
- Note key assumptions regarding am planning in the organisation's strategic plans
- List all assumptions and provisos
- State the degrees of confidence in and reliability of the data underpinning the AMP, differentiating between critical and non-critical assets. In particular this will cover:
  - The asset inventory
  - Data on asset condition
  - Data on asset performance
  - Demand/growth forecasts
- On the basis of these indications, provide a level of precision for, or confidence in, the expenditure forecasts for the asset network.

4.2.9 AM improvement programmes

AMPs, and overarching AM strategies are be formally revised at least every three years, and the timing of these revisions is linked to the organisation's strategic planning cycles.

- AM planning is seen as a constantly evolving process, with underpinning AM systems constantly providing better information
- The improvement plan comments generally on achievements against the previous plan, and formally reports against that plan's KPIs
- AM planning states what needs to be done to improve AM processes and techniques:
  - The Improvement Programme outlines
  - The weak areas
  - How weak areas will be addressed
  - The timeframe over which the improvements will occur
  - The resources (people and financial) needed
  - KPIs for monitoring AM improvement
- AM planning is undertaken by suitably qualified and experienced people
- The AMP and the planning processes are independently peer reviewed.

4.3 STEPS IN PREPARING AN AMP

Of all the steps, the most important is Step 6, Use the AMP, followed by Step 7, Update the AMP.

STEP 1: IDENTIFY OBJECTIVES

Before you can create a successful AMP, determine:

- Who is the audience, board, council, management, technical staff, public, all of these?
- What will each section of the audience want to know and what will they need to know?
- What level of AMP are you aiming for - Minimum, Core, Intermediate or Advanced?
- What the key corporate assumptions, financial parameters and growth forecasts, are.
- How the AMP will link with corporate objectives and drive operational ones.

The needs of the target audience should be combined with your communication objectives - what you want the reader to know. Having identified and resolved any conflicts between what the target audience wants to know and what you want them to know, you are ready to begin.

STEP 2: DECIDE THE APPROACH

The approach can be as general or as detailed as you wish. Identify areas that should be more detailed, based on your audience and objectives.

Initially, you will need to consider whether to develop an early "first cut" AMP based on existing information; or to focus on improving underlying data and processes and delay the development of the first AMP. Subsequent versions or revisions of the AMP will build on and develop the earlier versions and may adopt a different approach more compatible with the organisation's AM maturity.

STEP 3: DEVELOP THE AMP STRUCTURE OR TEMPLATE

The outline can be as general or as detailed as you wish. Identify the level of detail required, based on your audience and objectives.

A decision is also required on the AMPs scope and structure – whether to group assets to make it easier to present asset information, lifecycle tactics and the issues affecting their management, or to separate them by asset type, such as roading, structures, drainage and signs, making it easier to understand how each asset type is managed and developed.

Other factors influencing this decision include:

- The number and value of assets
- Whether the assets are managed in similar ways
- Scale of maintenance and operational costs
- Where the assets are in their life cycle
- The structure of management and service delivery contracts
- The requirements of the LGA 2002.

Section 4.4 below describes a suggested AMP structure.

STEP 4: WRITE THE AMP

In preparing the AMP, consider:

- Who will write each section?
- The order of plan preparation will depend on the data and information available, the sophistication of your Asset Management processes and your experience in preparing AMPs
- It may be necessary to research many areas before there is sufficient information to write a section. At this initial stage, use the most readily available information, such as hard copy records, historical reports, and staff knowledge.
- Further investigation may be required, but do not become "bogged down" in extensive research and analysis, or waiting to collect additional data. Once the plan is completed, there will be a clearer picture of the most important data to collect for the next version. Make use of the Improvement Plan for recording future needs.
- If information is unavailable, make the best assumptions you can based on the current information you have, write the plan on this basis, clearly state these assumptions (keep notes on assumptions during the plan preparation) and the level of confidence in the underlying information. The plan is a "living document" and will be updated.
- After you have prepared the rest of the main body of the document, prepare initial drafts of prospective financial statements and cash flow projections.
- The last element of an AMP to be prepared is the Executive Summary. Plan to make this a standalone document that clearly summarises the main elements of the AMP.

STEP 5: REVIEW THE AMP

Once the draft AMP is complete:

- Review it
- Consider its ability to meet specific disclosure and other legislative requirements
- Consider whether the plan improvement section is complete
- Consider having an independent person with expertise in asset management review the AMP.

STEP 6: USE THE AMP

This is the most important step – the AMP is worthless if it is not used:

- Refer to it regularly
- Make it the prime source of information on the management of the asset, including the place where approved budgets and programmes are to be found and copies of strategies influencing the asset are stored
- Implement the AM Improvement Plan.

STEP 7: UPDATE THE AMP

As AMPs are dynamic documents they must be updated periodically to maintain relevance. Update AMPs:

- When key assumptions or strategies change
- Whenever there is any other appreciable change that affects the asset, such as changes in legislation or adoption of a new policy
- After the adoption of each long term plan and budget.

Plans should be written with a view to changing them frequently to reflect these sorts of changes. As objectives or customer expectations change or AM systems improve, update the plan to reflect those changes.

AM improvement activities that will be incorporated into future plans should be on-going between plan updates.

4.4 SUGGESTED AMP STRUCTURE

There is no single correct way to structure AMPs and many organisations have adopted formats that suit their individual needs or preferences. Whatever structure is followed, the AMP should be fully integrated into the corporate business planning framework and contain sufficient information to support and justify the long term works programmes and financial forecasts that are a key output of AM planning.

A suitable structure should provide a logical flow through the AM process from defining what is required (in terms of meeting levels of service and changing demands) through the AM strategies and decision making processes to the financial implications and business AM strengthening initiatives.

If the AMP has many different audiences, a tiered Plan may be appropriate. For example, the Executive Summary targeted at Board/Elected Members/Public, the main body of Plan for Management and appendices available for technical staff and contractors. The following content is principally sourced from section 4.2.6 of the IIMM 2011 edition but it does contain additional detail from previous editions of the IIMM and from experience in writing AMPs.

It is a good idea to liaise with finance and other engineering and non-engineering staff to ensure that the key AMP outputs (levels of service, expenditure forecasts, etc.) are in a consistent format and can be easily incorporated into financial budgeting and strategic planning processes.

4.4.1 Executive summary[8]

It is useful if the executive summary is a brief stand-alone document, aimed at a non-technical reader, which provides an overview of the levels of service, growth forecasts, key AM issues, significant works programmes and financial forecasts.

Some authorities describe the Executive Summary as the AMP and adopt it as such, with the sections described below becoming supporting appendices to the Plan, This has the advantage of reducing the overall size of the AMP itself, with consequent advantages to many readers It is a valid methodology but care needs to be taken that the AMP is not too summarised. The Executive Summary should include:

- The AMPs purpose
- The intended audience and target level of AM maturity
- Corporate objectives
- Corporate assumptions
- Asset description
- LoS
- Future demand
- Lifecycle management plan
- Financial summary
- AM practices
- Monitoring and improvement programme.

[8] *It is not normal practice to give the Executive Summary a section number.*

4.4.2 Section 1: Introduction

The Introduction provides an overview of all the elements of the network assets within the plan. It should also provide readers with a sound justification for the organisation owning and operating the assets covered, and the reasons for preparing the AMP.

- Background:
  - Purpose of the Plan
  - The intended audience and target level of AM maturity
  - Relationship with other planning documents
  - Infrastructure assets included in the Plan
  - Key stakeholders in the Plan
  - Organisation structure
  - Corporate assumptions.
- Goals and objectives of asset ownership, including reasons and justification for asset ownership and links to organisation vision, mission, goals and objectives
- Plan framework
- Core and advanced AM maturity and limitations of this plan.

4.4.3 Section 2: Levels of service and delivery standards

LoS are essentially the standards for delivery – customer and technical service LoS and performance measures. This section of the plan identifies the current LoS being provided, confirms the basis for their adoption and describes how the LoS expectations of customers will be met.

Asset managers are not completely free to decide what to include, as the Local Government Act 2002 has some requirements that affect what is included in an AMP:

- Section 2 of Schedule 10 states:

2. A long-term plan must, in relation to each group of activities of the local authority,—…

(d) include …—

(i) in detail in relation to each of the first 3 financial years covered by the plan; and

(ii) in outline in relation to each of the subsequent financial years covered by the plan.

- Section 4 of the schedule states:

4 A long-term plan must, in relation to each group of activities of the local authority, include a statement of the intended levels of service provision that specifies—

(a) any performance measures specified in a rule …

(b) the performance measures that the local authority considers will enable the public to assess the level of service …; and

(c) the performance target or targets set by the local authority for each performance measure; and

(d) any intended changes to the level of service …; and

(e) the reason for any material change to the cost of a service.

The LoS section should include:

- The services provided
- Who uses or has interests in these services customers (including customer segmentation) and stakeholder's strategic and corporate goals
- Customer research and expectations – how the LoS were developed
- Legislative requirements

- Current LoS
- Desired/proposed LoS and associated performance measures. It can be useful to include charts or tables showing the performance history
- If not included elsewhere in the AMP, performance against agreed LoS.

Local authority AMPs should include this information in sufficient detail to meet the requirements of the LGA 2002 detailed above.

4.4.4 Section 3: Future demand

This section should provide details of growth forecasts that affect the management and utilisation of assets. Its objective is to identify factors and trends influencing demand for an asset and the effects of these on the asset management and utilisation. Examples of factors and trends that may affect the future demand for an asset include:

- Basic increases in demand – population growth, traffic growth, traffic type
- Changes in unit demand – higher propensity to travel
- Changes in customer expectations – faster vehicles, more safety, less delay, smoother travel, better signs.

The effect of the trends is quantified in terms of the effect on the growth of the network and the need to either increase or decrease infrastructure, or implement non-asset solutions through demand management.

The future demand section should include:

- Demand drivers – factors influencing demand - anticipated changes in customer expectations, changes in technology, population changes, economic changes, etc.
- Demand forecasts – details of projected growth or decline of demands on services
- Demand impacts on assets – ability of system to cope and changes in demand for the existing facilities
- Demand management plan – how the changed demand will be met including through new facilities and demand management
- Asset programmes to meet demand – major programmes or investigations and costs.

4.4.5 Section 4: Risk management

Although the IIMM suggests risk management be included in the Lifecycle Management section of the AMP many practitioners include it as a separate section because of its significance and the influences risk management has on the decisions made in the Lifecycle section.

Infrastructure risk management is the process of identifying risks than may affect the on-going delivery of services by that infrastructure. The Risk Management Plan should include:

- Broad risk management strategies
- Risk context (probability, consequence, risk-rating tables)
- Summary of significant risks (the actual rating will depend on your corporate classification system) and management strategies
- Either a reference to details in Risk Register/Risk Management Plan etc, or a risk analysis should be included. It should cover asset failure risks, operational risks, natural hazards, environmental risks and organisational risks. The template identified in NZS 4360 (Risk Management Standard) should be followed.

The discussion on Risk in Section 2.7 above and the RIMS," Best-practice Guidelines for risk management on road networks", linked from that section provide good background for preparing a Risk Management Plan.

4.4.6 Section 5: Lifecycle management

Lifecycle Management Plans are the "heart" of the AMP and cover the management strategies used to provide the desired LoS, taking into account the future changes in demand. The Lifecycle Management section should outline how the assets are managed and operated to deliver the agreed LoS at the lowest lifecycle costs. It may be necessary to divide the network into separate geographic service areas (e.g. urban and rural roads) and/or to focus on each significant group (e.g. pavements, bridges, culverts, drainage, lighting etc.).

ORGANISATION OF THE LIFECYCLE MANAGEMENT SECTION

The two usual ways to present this information are by:

- Arranging it by asset element
- Arranging it by asset activity.

The approach adopted will be determined by the organisation.

Asset element

This is the more traditional approach. Each sub-asset of element of the asset is discussed in a logical order and everything that is done in managing that element is detailed. For example:

- Pavements
- Carriageway surface
  - Maintenance and operations
  - Renewal
  - New surfaces
  - Disposal
- Base course
- Sub-base
- Formation
- Drainage.

Asset activity

This approach, which has largely been developed since the introduction of the Local Government Act 2002, is to consider all the activities that take place on the network and then describe those aspects of the management of the sub-asset management. For example:

- Maintenance and operations
  - Formation
  - Pavement
  - Carriageway surface
  - Sealed surfaces
  - Metal surfaces.
- Renewals
  - Formation
  - Pavement
  - Carriageway surface
  - Sealed surfaces
  - Metal surfaces
- New works
  - Sub-categories as above
- Disposals
  - Sub-categories as above.

CONTENT OF THE LIFECYCLE MANAGEMENT SECTION

Background data

There are two common approaches to including asset data. One is to describe the network and its high-level overview data in a separate section, usually immediately before or after the LoS section. This approach "paints a picture" of either the assets available to provide the LoS, or the assets used to provide the LoS, and depends on whether the data comes before or after the LoS section. If this approach is used, the Lifecycle Management section can then supplement it with greater levels of detail and analysis of the asset data. The second approach is to provide the summary-level data in the early part of lifecycle section with greater levels of detail and analysis provided as the section progresses. This includes:

- Physical parameters (including asset numbers)
- General comments on the assets used, including a description of asset system, what it comprises, the land it is on, critical assets
- How the system works
- The asset mix, ages, sizes, materials, locations, and current issues
- Summary of total asset parameters in table or graph formats, i.e. age distribution, size, what the assets are worth (asset valuations) etc.
- An overall plan of asset system or network.

Asset capacity and performance

- Design capacity, actual measured capacity and current utilisation of assets. Summary of details and statistics (e.g. percentage and distribution of assets under-capacity if known) related to the target LoS.
- Refer to location of detailed information (e.g. traffic data, inventory information, calculations and analyses).

Asset condition

- Summary of current asset condition, based on the best information currently available
- Brief details on how condition is monitored
- Age and condition information and/or profile graphs.

Asset valuations

If they are not included in the AMPs Financial Summary section, the following asset valuation information should be included:

- Valuation summary by key component – replacement cost, depreciated replacement cost DRC, and annual depreciation
- Description of valuation method
- Basis for determining effective lives used for valuation
- Key assumptions made in preparing valuation
- Explanation for major changes from previous valuations.

Historical data

- Summary of historical data available, its type and location
- Relevant historical financial information (historical trends etc.).

Infrastructure risk management plan

If there is not a separate Risk Management Section in the AMP then risk management should be covered here.

AM lifecycle strategies and plans

Each of the sub-sections should have clear and obvious links to the analyses described above, to asset condition and performance and with the plans and other interventions developed.

Routine operations and maintenance

Routine operations and maintenance are the normal day-to-day works that are necessary to keep assets operating, including instances where portions of the asset fail and need immediate repair to make the asset operational again. This sub-section should include discussion of:

- Operations and Maintenance Strategies
  - Describing the maintenance and operations strategies and methods used to deliver the required LoS. This should include how the divisions between planned and reactive maintenance tasks are optimised
  - Describing how maintenance tasks are prioritised
  - Discussing the risks, including LoS risks, associated with alternative maintenance standards

- Operations and Maintenance Plan
  - Outlining the decision-making process for planned and reactive maintenance
  - Discussing trends (e.g. issues, past spend, complaints)
  - Listing assumptions and uncertainties underlying and in the programme
  - Summarising future costs
    - Local authorities in New Zealand are required to forecast their financial needs in detail for the first three years of each long-term plan and in outline for the balance[9]. Forecasts should provide the information in sufficient detail to meet this need.
    - A forecast operations and maintenance costs for planned and reactive work should be included
    - Any deferred maintenance should be identified and included and the associated risk identified.

Asset renewal and replacement

Asset renewal and replacement is major work which restores, rehabilitates, replaces or renews an existing asset to its original capacity or to a state in which it can deliver its original LoS, but is not designed to increase its capacity or the LoS it delivers. This sub-section should include discussion of:

- Renewal strategies
  - Describing the decision-making process for asset renewals including how they are identified and prioritised and to what standards assets are replaced (e.g. types of failure, options for treatment, risk, etc.)
  - Describing the renewal strategies, methods to meet required LoS
  - Discussing the risks, including LoS risks, associated with alternative renewal standards
- The Renewal Plan, detailing:
  - The forecast renewal/replacement programme based on projected ends of life. Costs and projects should be in detail for the first three years of each long-term plan and in outline for the balance[10];
  - Identifying and including any deferred renewals
  - The assumptions and uncertainties in the programme.

Creation, acquisition and augmentation

Creation or acquisition of new assets and improvements in LoS are described in numerous ways. In this section all are covered by the term "new works". New works are those that create a new asset that did not previously exist, to upgrade or improve an existing asset beyond its existing capacity to provide a new or improved LoS. New works may result from growth, social or environmental needs or decisions to improve the LoS to existing customers. This sub-section should include discussion about:

- Asset creation/capital investment strategies, including:
  - The asset creation decision-making processes
  - Descriptions of any specific strategies or methods to meet anticipated improvements in LoS, including how the needs for new or augmented assets are identified and prioritised, and to what standards they are built

[9] *LGA 2002 Schedule 10 Clauses 2 and 5.*

[10] *LGA 2002 Schedule 10 Clauses 2 and 5.*

- Descriptions of any Demand Management Strategies or practices and the place of demand management in reducing, deferring or removing the need to create new assets
- Details of the risks, including LoS risks, associated with alternative asset creation strategies and standards, including demand management
- Descriptions of the formal procedures used to rank asset creation/acquisition projects
- Outlines of the methods and practices used to ensure that new assets created by, or for (e.g. by land developers) the organisation best meet its needs and are completed on time to the required standard and cost. These should cover:
  - Value management during design phase; procedures and criteria for assessment of design options (including consideration of lifecycle costs, optimised renewal decision making and risk assessment)
  - Project management procedures project review
  - Quality assurance and audit trails for design and project management
  - Risks associated with alternatives and how these will be managed

- The Asset Creation/Augmentation Plan, detailing:
  - Assumptions and uncertainties in the programme
    - The forecast Asset Improvement Programme including:
    - The forecast Asset Improvement Programme. Costs and projects should be in detail for the first three years of each long-term plan and in outline for the balance[11]
    - Future needs for acquisition and/or purchase of assets based on demand forecasts
    - Identifying how the costs of new assets will be funded.

Disposal plan

Disposal is any of the activities associated with removal of an asset from service or removal of the LoS provided by an asset, including decommissioning, sale, demolition, relocation or permanent reduction in LoS. This sub-section should include discussion of:

- Asset disposal strategies, including:
  - Details of any legislative constraints on asset disposal (e.g. Road Stopping legislation)
  - Descriptions of any asset disposal strategies or methods to meet anticipated improvements in LoS
  - Descriptions of how disposals are identified, prioritised and approved
  - Details of any disposals driven by demand management strategies, including summaries of each justification
  - Descriptions of the risks, including LoS risks, associated with each disposal and the alternatives to it
  - A discussion of the methods used to ensure that disposal of an asset does not create problems or additional unanticipated costs for the organisation or its customers. These should cover:
    - Procedures and criteria for assessment of options (including consideration of direct and indirect costs, maintenance of public health and public safety, optimised decision making and assessment of the risks associated with the proposed disposal, its alternatives and how these risks will be managed;

[11] *LGA 2002 Schedule 10 Clauses 2 and 5.*

- Project management procedures, project review, quality assurance and audit trails as applicable;

- Asset Disposal Plan including:
  - Discussion of the disposals planned, covering the factors resulting from consideration of the strategy's factors
  - Demonstration of the needs to dispose of assets and description of the standards to against which each disposal is assessed
  - Identification of how disposal of assets will be funded and how any net income will be treated
  - The forecast Asset Disposal Programme including:
    - Forecast disposals of assets including timing, costs and income. Costs and projects should be in detail for the first three years of each long-term plan and in outline for the balance[12]
    - Identification of how the costs of asset disposals will be funded.

4.4.7 Section 6: Financial summary

Local authorities' financial forecasts are governed by the LGA 2002. The NZTA's Highway and Network division has similar requirements under the Government Roading Powers Act 1989[13] and all RCA's have to comply with The NZTA's procedures and requirements established under the Land Transport Management Act 2003.

This section should contain the financial requirements resulting from information presented in previous sections. As AMPs become more advanced, various LoS and cost scenarios may be included. As detailed above, local authorities are required to prepare and publish their programmes in detail for three years and in outline for the balance of the Long Term Plan period (at least a further seven years). These published programmes should be linked to the lifecycle management plans and cover operational, maintenance, renewal, creation and disposal costs. Detail should include the following. The asset valuation may be included here rather than in the Lifecycle Management section.

SUMMARY OF RELEVANT FINANCIAL POLICIES

This should inform the reader of the relevant financial policies that influence the management of and accounting for the assets covered by the Plan. It should include:

- Financial management policies (depreciation, disposals, etc.)
- Funding policies:
  - Debt/revenue funding
  - User charges
  - Development contributions.

FUNDING STRATEGY

This should include:

- Provide details of how expenditure will be treated financially (e.g. capitalisation policies) and funded.
- Describe how and by whom any needs to smooth out variations in cash flow are determined and implemented.

[12] *LGA 2002 Schedule 10 Clauses 2 and 5.*

[13] *Formerly the Transit NZ Act 1989*

FINANCIAL STATEMENTS AND PROJECTIONS

These should be prepared for in detail for the first three years and in outline for at least a further seven years and include:

- Cash flow forecasts by year, in formats (e.g. maintenance, renewal and new works) that meet the requirements and needs of the organisation's finance managers
- Revenue/income forecast. If revenue is not included in the financial forecasts in the Lifecycle Management Plans, a revenue forecast should be included
- Breakdown of expenditure by service groups
- Trends from the previous two to three years
- Although the LGA does not require the effects of inflation to be included in financial forecasts, the Auditor General does. Section 2.8.2 above discusses a practical way of meeting this need while retaining the advantages of a constant-dollar budget.

VALUATION FORECASTS

These should include:

- Forecasts of the future value of asset and a description of the valuation methodology used to develop these
- Forecasts of depreciation.

KEY ASSUMPTIONS MADE IN FINANCIAL FORECASTS

These should include:

- The key assumptions made in preparing the forecasts, the confidence levels associated with those assumptions and the risks if these assumptions change
- Readers should understand the accuracy of the information presented as well as receiving an insight as to how the organisation intends to improve the accuracy of future financial forecasts

Advanced AMPs may also include a sensitivity analysis quantifying variations in the forecasts resulting from possible scenarios relating to key assumptions.

4.4.8 Section 7: AM practices, plan monitoring and the AM improvement plan

The AM Practices, Plan Improvement and Monitoring section describes, identifies and prioritises the tasks that will contribute to the improvement of the organisation's AM practices. It must not be confused with the Asset Improvement Plan which describes new works/development/asset improvements. It should give the reader an understanding of:

- How AM decisions are made
- Current asset management performance
- Proposed improvements to AM systems and practices that will address deficiencies or improve the level of confidence in the AMP
- The programme for implementing the improvements – i.e., the AM Improvement Plan.
- The AM Improvement Plan itself should give the reader an understanding of how and when AM practices will be improved, and the resources required to do so. It should also:
- Provide details on planning for monitoring the performance of the AMP and of any improvements to AM systems that will improve the level of confidence in the AMP

- Detail the Improvement Programme listing:
  - The actions proposed
  - Resources required
  - Priorities and timings
  - Responsibilities for each improvement.

This section should, like all the other programmes in the AMP, be in detail for the first three years and in outline for the balance of the programme.

Suggested contents include:

- Current and desired states of AM processes, data, systems and performance
  - Management practices
  - The customer interface
  - Contract management
  - Support processes needed to support effective lifecycle AM
  - Data collection and analysis
  - System monitoring and reporting
  - Key systems (AMIS, GIS, SCADA, etc.)
  - Quality assurance, including works, contract management, data collection and all other aspects of asset management
- AM Performance (as distinct from the performance of the assets themselves):
  - Describing how the effectiveness of the AMP will be measured (AM Performance Measures)
  - Showing achieved AM performance against the measures detailed. It can be useful to include charts or tables showing the performance history
- Monitoring and Review Procedures
  - Procedures and timetable for performance reporting
  - AMP review cycle (three-yearly review of AMP)
- Timetable for external audit and review (of process, data integrity, LoS)
- Improvement Plan
  - Prioritised summary of all the improvements identified for the Plan, including improvements to content, and data availability, accuracy and confidence
  - Improvement Programme including details of actions proposed, resources required, timings and responsibility for each improvement outlined in the summary. This programme should, like all the other programmes in the AMP, be in detail for the first three years and outline for the balance of the programme.

Asset Management Improvement is discussed further in Section 6 below.

4.4.9 Section 8: References

References should be recorded in sufficient detail so that future users will be able to access the information without difficulty. They may be recorded in a separate appendix or as footnotes. The method chosen should be the one that best supports their purpose. Do not overlook the necessity of including the source/location details for all tables and charts prepared on spreadsheets, as failure to do this can cause considerable problems when revising or updating the plan in future.

4.4.10 Section 9: Appendices

Appendices may include:

- LoS reviews/market research
- Capital expenditure programmes
- Asset data (condition, valuation etc.)
- Relevant strategic/tactical plans
- Demand management strategies
- Operating procedures
- Emergency response plans
- Contract information
- Detailed risk analysis
- Project sheets for AM improvement tasks
- Any other detailed or associated material the author feels should be incorporated in the AMP but is too detailed or long to include in the text itself.

5. Implementing asset management plans and managing changes to assets

5.1 IMPLEMENTATION

There are two extremely important steps required to implement any infrastructural AMP. They are to:

- Adopt the Plan
- Use it.

5.1.1 Adoption

While an AMP can be useful to the writer as soon as it is written, its usefulness and influence are severely limited if does not have any status as a corporate document. As soon as it is adopted the AMP it has the status of "Corporate Policy" and its ability to influence what and why decisions are made and how they affect the assets is significantly increased. Its procedures and forecasts gain similar status and the AMP itself becomes an authoritative reference.

Most experienced asset managers therefore consider it essential for AMPs to be put before the board of directors or full council for debate and adoption.

5.1.2 Use

All the work and effort put into preparing and adopting an AMP is wasted unless it is used. "Use it" is therefore the most important step in the whole process:

- Refer to it regularly
- Make it the prime source of information on the management of the asset, including the place where approved budgets and programmes are to be found and copies of strategies influencing the asset are stored
- Ensure that LoS are incorporated into maintenance contracts, renewal contracts and contracts for new and improvement works at the earliest possible opportunities. If it is practical and possible to do so, introduce any necessary contractual changes by way of variations rather than waiting for the next contract to start
- Implement the AM Improvement Plan.

5.1.3 Changes to assets

Individual assets and the data describing them are subject to continuous change, through wear and tear, maintenance activities, renewal, the creation of new works and improvements by the asset owner or by others.

As good accurate asset information is necessary for AM it is essential that the RCA puts in place sound, practical procedures for the timely, accurate and efficient collection of all the data that has changed and all the new data it needs as a result of these changes. It is useful to prepare a standard document detailing data requirements.

It is also important to determine when updated data will be collected. The most common options are:

- On occurrence
- At fixed intervals, often annually, in batches.

Batch-collection is often promoted as being more efficient, and this can be the case if non-local contracted staff are used, but the apparent efficiencies of this approach tend to be offset by:

- The issues caused by having incorrect data while waiting for the updates to occur. These include:
  - Imprecise and non-documented details of new assets that must nevertheless be maintained and managed
  - Incorrect condition details and other attributes for existing assets. These may result in unnecessary despatches to fix issues that have been resolved
- The efficiencies possible by using modern technologies such as 'Pocket RAMM' to simplify and expedite the data collection processes, allowing local staff to collect data and to do so quickly and without the necessity for extensive planning and preparation.

In addition to recording visible data, it is essential the necessary information is collected on hidden assets and invisible asset data. This should include items such as layer or material thickness, retaining walls supporting the road but not readily apparent from it, creation dates, material source or type, manufacturer and model numbers (especially for assets such as lighting and traffic signals, ornamental bollards, guard-rail terminals etc.).

5.1.4 Vested assets

These are the assets that are created by others and become the RCA's property when the development is handed over. It is too late to object to the design or other non-conforming aspects of a vested work when it is complete and being handed over. To avoid problems caused by the creation of sub-standard or "gold-plated"[14] assets, it is essential that the asset manager or a trusted delegate be included in the subdivision/vested asset approval process at all stages, including:

- Concept discussions
- Examination of proposals
- Vetting of resource and planning consent applications before submission
- Statutory and other approvals
- Checking and approval of detailed construction drawings and all specifications
- All construction supervision
- Inspections at practical completion
- Final inspections at the end of the maintenance periods.

Achieving this level of involvement, and the goals it seeks, can be significantly assisted by adopting the AMP at the highest possible level in the organisation.

[14] *These are often marketing ploys, such as fancy ornamental walls, expensive streetlights, fancy footpath finishes and use of asphaltic concrete on road surfaces that would normally perform quite adequately under chip seal.*

6. Continuous improvement

Most RCAs have moved, or are moving, towards advanced AM. Basic AM, based on current LoS, no longer meets legislative requirements or Audit NZ guidelines for many activities, especially roading. Advanced AM moves to incorporate service level reviews and optimising strategies, including predictive modelling, risk management, and optimised decision making.

This said, it may not be appropriate or cost-effective for an authority to attain and maintain full Advanced AM capabilities. The level of AM maturity adopted by an organisation and reflected in its AMPs and practices should be appropriate, practical and affordable. In the United States the Association of American State Highway Officials (AASHTO) has adopted a more finely graduated scale of AM maturity than the "Basic and Advanced" one that has developed in New Zealand. It may be helpful to consider the AASHTO scale when looking at the appropriate level of AM maturity an organisation aspires to. Its AM maturity levels are:

Table 6 1: AASHTO AM maturity scale.

AM MATURITY SCALE LEVEL	GENERALISED DESCRIPTION
Initial	No effective support from strategy, processes, or tools. There can be lack of motivation to improve.
Awakening	Recognition of a need, and basic data collection. There is often reliance on heroic effort of individuals.
Structured	Shared understanding, motivation, and co-ordination. Development of processes and tools.
Proficient	Expectations and accountability drawn from AM strategy, processes, and tools.
Best Practice	AM strategies, processes, and tools are routinely evaluated and improved.

To achieve proficient or advanced AM organisations need to be able to demonstrate the following:

- Knowledge of asset ownership;
- Knowledge of LoS
- Ability to predict future demand from customers
- Knowledge of physical condition of assets
- Knowledge of performance of assets
- Knowledge of current utilisation and ultimate capacity
- Ability to predict failure modes of assets
- Ability to analyse alternative treatment options
- Ability to rank works based on economic analysis
- Ability to rationalise works based on available budget
- Ability to develop and revise strategic objectives for each asset
- Ability to optimise operations and maintenance activities.

To achieve best practice status an organisation must be among the leaders in these areas.

AM maturity does not suddenly change in significant steps, as might be suggested by Table 6 1. Rather, it happens continually and often un-noticed. It is therefore necessary to plan the management of changes to management practices, just as we plan for the management of the changes that occur to the assets themselves.

6.1 FORMAL AMP REVIEW

A powerful method for driving and influencing changes in an AMP to bring it up to date with an organisation's current practices and align it more closely with its goals is to carry out a formal structured review of the AMP and AM Practices.

There are a number of proprietary systems that form the bases for these evaluations. The following table is indicative of the AM elements assessed. In the example illustrated there are five or more criteria examined for each asset element, in each of which current practice and the organisation's desired practice are scored and can be assessed against a benchmark.

Table 6.1 1: Typical AMP review elements.

ASSET CATEGORY	ASSET ELEMENT
Asset Knowledge	Asset Categorisation
	Asset Life Data
	Capacity Data
	Condition Data
	Financial Data
	Location Data
	Operations and Maintenance (O&M)Data
	Performance Data
	Physical Attributes Data
	Risk Management Data
Asset Management Plan	AMP AM Practices and Improvement to them
	AMP Asset Data and Descriptions
	AMP Demand Forecasting and Management
	AMP General
	AMP LoS
	AMP Lifecycle Strategies
	AMP Long Term Financial Plans

ASSET CATEGORY	ASSET ELEMENT
Asset Management Practices	CAPEX Contract Management
	CAPEX Evaluation
	Design Processes
	O & M Contract Management
	O & M Monitoring
	O & M Plans
	O & M Strategy and Analysis
	Project Identification and Prioritisation
Business Culture	Innovation
	LoS Management
	Managing for Quality
	Risk Management
	Senior Leadership
	Social Responsibility
Human Resources	Employee Education and Training
	Employee Involvement
	Employee Performance and Recognition
	Employee Satisfaction
	HR Planning and Management
Information Systems	Advanced AM Systems
	Asset Register System
	Capacity or Utilisation Models
	Maintenance Management System
	Spatial Information System
Legislative Compliance	AM Practices
	Community Outcomes
	Financial
	Growth and Demand
	Improvement Plan
	Levels of Service
	Life Cycle Management
	Risk

ASSET CATEGORY	ASSET ELEMENT
Organisational Tactics	AM Improvement
	AM Responsibilities
	AM Training and Skills
	Commercial Tactics
	Corporate Objectives
	Corporate Sponsorship and Commitment
	Funding Strategy
	Legislative Compliance
Strategic Planning Processes	Community Outcomes
	Demand Forecasting Processes
	Failure Prediction
	Optimised Decision Making
	Risk Management Strategy
	Service Level Reviews
	Sustainability

Even if this level of external review is not undertaken it can be useful for another asset manager in the organisation or one in a friendly outside organisation to review the AMP before a rewrite is undertaken.

The output of any plan review should be either an agreed, or at least a suggested, list of improvements or changes to the reviewed plan, with immediate and longer term changes identified and the latter prioritised for inclusion in the revised AM Improvement Plan.

6.2 IMPROVEMENT OF AM PLANS AND PRACTICES

AMPs are dynamic documents and must be updated periodically to maintain relevance. Each AMP should be updated:

- As your objectives or customer expectations change
- As your AM systems improve
- When key assumptions or strategies change
- Whenever there is any other appreciable change that affects the asset, such as changes in legislation or adoption of a new policy
- To prepare the financial plans for inclusion in each Long Term Plan and budget
- To match adopted financial programmes when these are different to those in the AMP
- When there are other significant changes to the organisation's goal, objectives, operating environment – including the legal environment in which it works, or financial situation
- Ideally, in advance of major long-term maintenance contracts, so that the most appropriate LoS can be included in the contract documents without variation.

AM improvement activities that will be incorporated into future plans should be continual between plan updates.

6.2.1 Asset maintenance, renewal and construction practice changes

Changes to why work is carried out, what is done and when, are themselves areas of continuous change. Many potential changes are claimed to reduce lifecycle costs but these claims need to be subject to rigorous scrutiny before adoption. Often, if achievement of lower lifecycle costs is not possible when the technology or practice is introduced, it can be achieved as it matures and initial costs decline. It is therefore essential for both contractors and asset managers to keep abreast of changes to practices, materials and equipment to allow the appropriate reaction at the most suitable time.

6.2.2 AM Improvement considerations

A typical improvement plan is developed through consideration of the following steps or processes:

- Current and desired states of AM processes, data and systems
  - Management practices
  - Customer interfaces
  - Contracts management
  - Quality assurance
  - Support processes:
  - Key systems (AMIS, GIS, SCADA, etc.)
  - Data collection
  - System monitoring
- AMP
  - Content
  - Layout
  - Data availability, accuracy and confidence
- AM Performance
  - AM Performance Measures outlining how the effectiveness and performance of the AM system will be measured
  - Achieved AM performance against the measures detailed. It can be useful to include charts or tables showing the performance history
- Monitoring and Review Procedures
  - Procedures and timetable for performance reporting
  - AMP review cycle
  - Timetable for external audit and review (of process, data integrity, LoS).

Consideration of these issues provides the inputs to the AMP Improvement Plan, which is described in Section 4.4.8.

Section 4.6 of the IIMM contains more detail on continuous improvement of AM practices and procedures.