Practical Approaches to Infrastructure Depreciation for 'Not for Profit' Entities

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1.0 INTRODUCTION

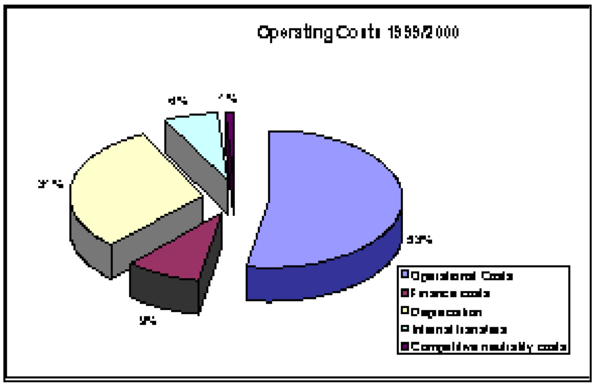
This paper describes the current practices used in the calculation of depreciation of infrastructure assets held by Australian 'not for profit' entities such as local governments and water authorities. Practical methods for the assessment of condition of infrastructure assets have been developed. The assessed condition is used (along with other appropriate external influences) to review useful lives for each asset class and to estimate remaining useful life in accordance with the requirements of the appropriate Australian Accounting standards.

2.0 DEPRECIATION

2.1 The Bottom Line

- Depreciation expense can representative over 70% of the operating costs of a utility businesses

The following example illustrates the impact on the bottom line of depreciation expense. As shown, in Figure 2.1, after operating costs, depreciation expense is the next most significant business cost. Each percentage variation in depreciation expense has approximately double the impact on the operating surplus/deficit.



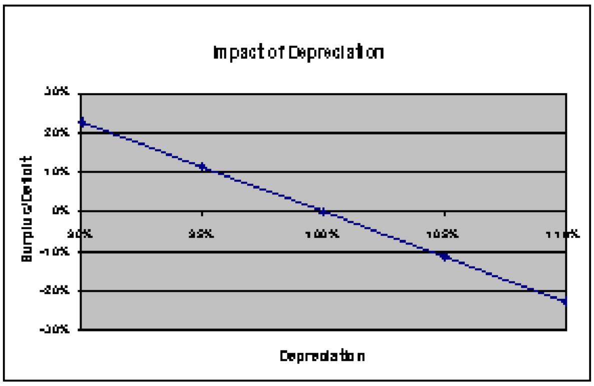


Figure 2.1 Example of Impact of Depreciation

- Variations in estimates useful lives, rates of consumption of service potential (depreciation) or residual value of infrastructure can have a major impact on the operating surplus/deficit of an entity.

2.2 Impact on Pricing

- In regulated industries, depreciation expense can have a significant impact on pricing.

Regulated utilities have to justify price increases to industry regulators. Renewal annuities are being used as well as depreciation as the measure of asset consumption utilized in pricing models. Figure 2.2 illustrates this concept.

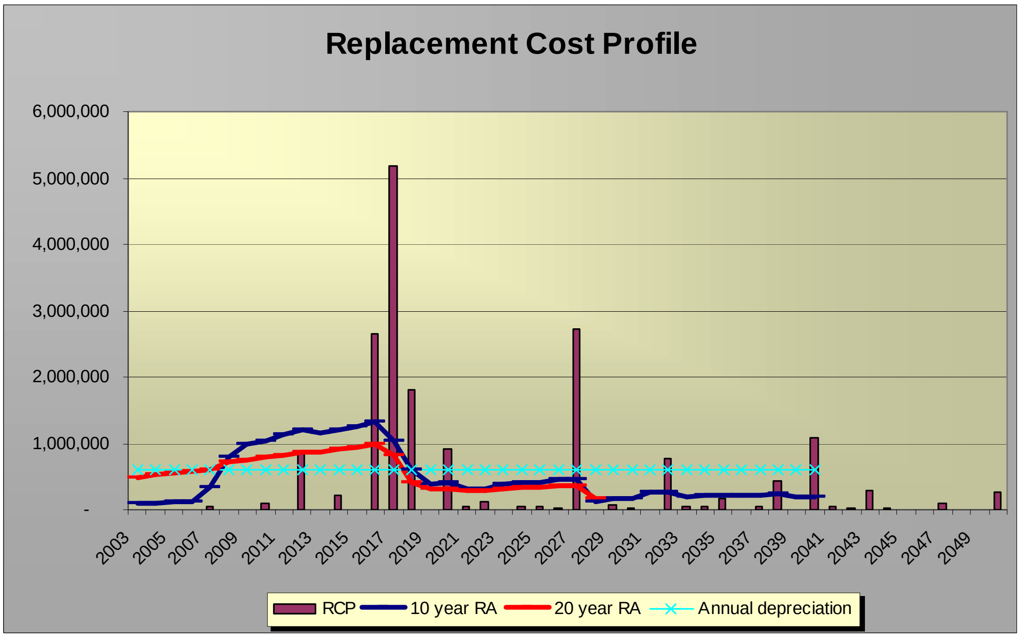


Figure 2.2 Example Replacement Profile and Replacement Annuity

2.3 Australian Accounting Standards

The Australian Accounting profession has adopted the International Financial and Reporting Standards (IFRS) for all reporting periods commencing on or after 1 January 2005. For the valuation of infrastructure assets entities the appropriate standards are:

- **AASB 116** "Property Plant and Equipment"
- **AASB 136** "Impairment of Assets"

The valuer undertaking replacement cost valuation needs to answer the following six key questions to comply with the requirements of AASB116 and AASB 136:

1. What is the estimated replacement cost of the economic benefits provided by the asset?
2. What is the appropriate useful life for the asset in its environment[1] ?
3. What is the estimated time until the next major renewal event or the asset is discarded (RUL)?

[1] Physical, operating and regulatory.

4. Does the depreciation method used reflect the predicted pattern of consumption of the asset's future economic benefits?
5. At renewal or disposal, what is the projected residual value?
6. Is there any evidence of impairment of the asset?

2.3.1 Definitions[2]

A '**not for profit**' entity is an entity whose principal objective is not the generation of profit.

Carrying amount is the amount at which an asset is recognised after deducting any accumulated depreciation and accumulated impairment losses.

Cost is the amount of cash or cash equivalents paid or the fair value of the other consideration given to acquire an asset at the time of acquisition or construction or, where applicable, the amount attributed to that asset when initially recognised in accordance with the specific requirements of other Australian Accounting Standards.

Depreciable amount is the cost of an asset, or other amount substituted for cost, less its residual value.

Depreciation is the systematic allocation of the depreciable amount of an asset over its useful life.

Depreciated replacement cost is valued at the cost of replacing the future economic benefits from that asset, adjusted to reflect the condition of the asset being currently valued.

Design standard of service is the target adopted by the designer for the infrastructure to deliver the required services over the estimated useful life. It needs to anticipate and allow for the natural deterioration processes. When an asset deteriorates below the current adopted standard of service it needs to be renewed or replaced.

Fair value is the amount for which an asset could be exchanged between knowledgeable, willing parties in an arm's length transaction. For infrastructure assets where no market exists, the item is rarely sold (except as part of a continuing business), fair value is estimated using either a depreciated replacement cost or a discounted cash flow approach.

Impairment loss is the amount by which the carrying amount of an asset exceeds its recoverable amount.

Recoverable amount of an asset is the higher of its fair value less costs to sell and its value in use.

Replacement cost can be determined **either** as the cost per unit of future economic benefit of the most appropriate modern replacement facility, adjusted for any differences in production capacity, utility and useful life, **or** as the cost of reproducing or replicating the future economic benefits of the asset.

[2] AASB116 and Queensland Treasury Non-Current Asset Policies

Residual value of an asset is the estimated amount that a an entity would currently obtain from disposal of the asset, after deducting the estimated costs of disposal, if the asset were already of the age and condition expected at the end of its useful life.

Standard of services or performance standards[3] describe what the asset users want the asset to do and are used to describe the service level intervention target adopted as the current appropriate target to be met for the asset at a point in time.

Useful life is:

(a) the period over which an asset is expected to be available for use by the entity; or

(b) the number of production or similar units expected to be obtained from the asset by an entity.

2.3.2 Measurement at Recognition

An item of property, plant and equipment that qualifies for recognition as an asset, shall be measured at its cost. For 'not for profit' entities, where an asset is acquired at no cost, or for a nominal cost, the cost is its fair value as of the date of acquisition.

2.3.3 Measurement after Recognition

For each class of assets, an entity chooses either the cost model or the revaluation model as its accounting policy and shall apply that policy to an entire class of property, plant and equipment.

The cost model requires that after recognition of an asset, an item of property, plant and equipment shall be carried at its cost less any accumulated depreciation and any accumulated impairment losses.

The revaluation model requires that after recognition as an asset, an item of property, plant and equipment whose fair value can be measured reliably shall be carried at a revalued amount, being its fair value at the date of the revaluation less any subsequent accumulated depreciation and subsequent accumulated impairment losses.

If an item of property, plant and equipment is revalued, the entire class of property, plant and equipment to which the asset belongs shall be revalued.

2.3.4 Depreciation

AASB116 requires that each significant part of an item of property, plant and equipment is depreciated separately. Infrastructure assets are broken down into significant components with similar physical and operating characteristics. A separate useful life is applied to each component and they are depreciated separately.

The depreciable amount of an asset is allocated on a systematic basis over its useful life. The residual value and the useful life of an asset are to be reviewed at least at the end of each annual reporting period and, if expectations differ from previous

[3] In the longer term, the performance standard can be higher or lower than the original design standard. If no changes occur to demand or external requirements, the performance standard will be lower than design standard to allow for deterioration over the asset life. If because of changes in the external requirements or the demand has changed and a higher standard than the original design standard is now required, the asset has effectively failed and will need to be eventually augmented or replaced.

estimates, and if impacts on the carrying amount are significant, appropriate adjustments to accounts are made.

The depreciable amount of an asset is determined after deducting its residual value. The future economic benefits (service potential) embodied in an asset are consumed by an entity principally through its use. However, other factors, such as technical or commercial obsolescence and wear and tear while an asset remains idle, often result in the diminution of the economic benefits that might have been obtained from the asset.

The depreciation method used should reflect the predicted pattern of consumption of the asset's future economic benefits. The depreciation method should be reviewed at least at the end of each annual reporting period and, if there has been a significant change in the expected pattern of consumption of the future economic benefits embodied in the asset, the method shall be changed to reflect the changed pattern.

A variety of depreciation methods can be used to allocate the depreciable amount of an asset on a systematic basis over its useful life. The entity selects the method that most closely reflects the expected pattern of consumption of the future economic benefits embodied in the asset. That method is applied consistently from period to period unless there is a change in the expected pattern of consumption of those future economic benefits. In the absence of any specific evidence of the pattern of consumption of future economic benefits, straight-line depreciation method is the most commonly used for infrastructure assets.

2.3.5 Impairment

On an annual basis, each entity needs to review the current recoverable amount of its assets in accordance with AASB 136 " Impairment of Assets". That Standard explains how an entity reviews the carrying amount of its assets, how it determines the recoverable amount of an asset, and when it recognises, or reverses the recognition of, an impairment loss.

2.4 Infrastructure Useful Life

For infrastructure assets, useful life is defined in terms of the asset's expected utility to the entity. The estimation of the useful life of the asset is a matter of judgement based on the experience of the entity with similar assets.

There are many ways that an infrastructure asset can fail[4]. That is, there is a different useful life for each mode of failure. In practice, the total life[5] of an asset is the shorter of:

- The physical life of the asset, given normal maintenance.
- The economic life of the asset – that is, where the cost of retaining the asset exceeds the cost of renewal/replacement.
- The life determined by asset capacity compared to predicted demand.
- The technological life of the asset.
- The legal life.

[4] Failure in asset management terminology means failing to do what they user wants the asset to do at a point in time.
[5] This represents the point at which some form of intervention takes place.

- The life determined by the impact of the adopted customer service standards[6].

Estimates of economic useful life are usually made for assets of the same type, which are subject to the same environmental[7] conditions. When assessing individual assets, this life should be adjusted to reflect local factors. Estimates of remaining useful life are undertaken based on an assessment of individual assets[8].

The Accounting standards require that in determining economic useful life of a depreciable asset, consideration must be given to expected physical wear and tear (asset factors), obsolescence, and legal or other limits (non-asset factors) on the use of the asset.

Specifically the following factors need to be considered in determining the useful life (and remaining useful life) of an asset:

(a) expected usage of the asset. Usage is assessed by reference to the asset's expected capacity or physical output.
(b) expected physical wear and tear, which depends on operational factors such as the number of shifts for which the asset is to be used and the repair and maintenance programme, and the care and maintenance of the asset while idle.
(c) technical or commercial obsolescence arising from changes or improvements in production, or from a change in the market demand for the product or service output of the asset.
(d) legal or similar limits on the use of the asset, such as the expiry dates of related leases.
(e) Current capacity versus predicted demand

The useful life of an asset is defined in terms of the asset's expected utility to the entity. The asset management policy of the entity may involve the disposal of assets after a specified time or after consumption of a specified proportion of the future economic benefits embodied in the asset. Therefore, the useful life may be shorter than the economic life. The estimation of the useful life of the asset is a matter of judgement based on the experience of the entity with similar assets.

Estimates of economic useful life for different asset classes are traditionally based on a consensus of 'expert' opinion. In determining the useful life for a particular infrastructure asset, the valuer needs to assess the likely impact of expected physical wear and tear (and maintenance program to be adopted) and other factors on that particular asset. The variation caused by the influence of these factors will mean that the life of individual assets within a particular asset group may be less than or greater than a mean value.

In summary factors that the valuer needs to consider in assessing useful and remaining useful life, include:

- Expected changes in regulatory and or environmental requirements;
- Expected changes in technology;

[6] Estimated time until the asset performance is less than the adopted standards of service. Can be zero for existing assets if standards have been increased above the original design.
[7] Physical, operating and regulatory.
[8] In practice, network assets are grouped by age and environment.

- Expected changes in demand[9] for the services; and/or
- Expected changes in operating conditions.

Any changes needs to be "reasonably likely" to be taken into consideration by the valuer in the estimation of useful life and remaining useful life and the reasons should be documented in the valuation report. eg if it is known that a water main will be decommissioned in 5 years, remaining useful life is 5 years regardless of the condition of the asset.

2.4.1 Age and Material Profiles

Having old assets is not a problem in itself. However, as shown in Figure 2.3 as assets age, the probability of failure increases. Figure 2.3 gives pipe survivor curves for various water and sewerage pipeline materials based on literature research. It is the interaction between the pipe survival characteristics, pipe age and the customer service standards (in terms of pipe breaks and chokes), which determines the intervention point and the "life" of the asset.

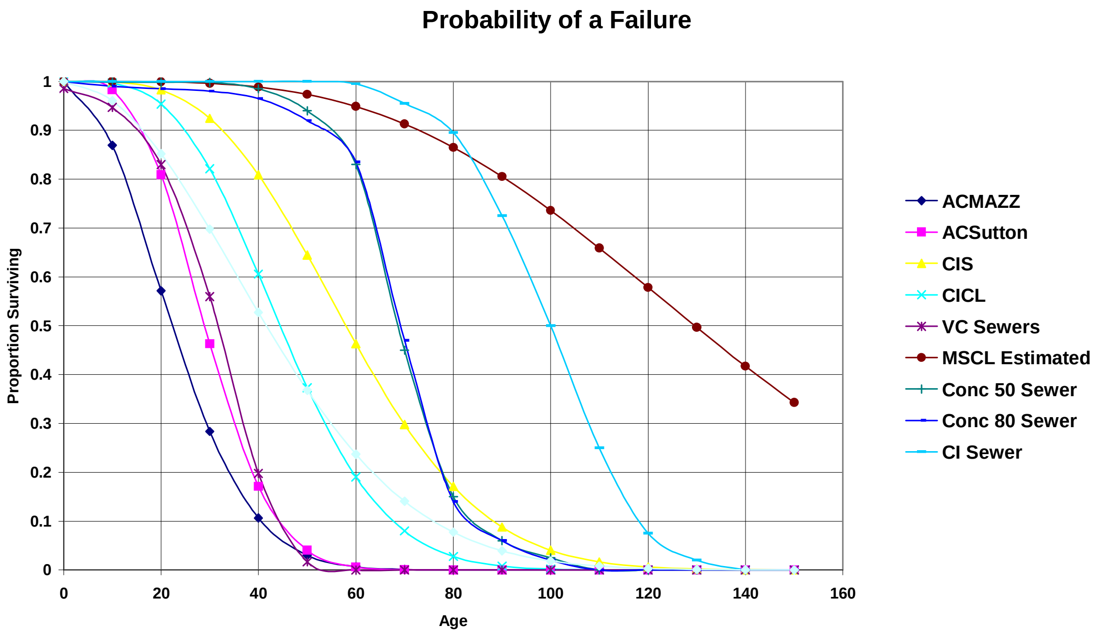


FIGURE 2.3 : Pipe Survivor Curves

2.4.2 Customer Service Targets

Before setting any customer standard, it is important that the full financial implications on the authority and its customers are clearly understood. Higher standards will require earlier intervention and effectively reduce asset lives. Customers need to understand the trade-off between standards and delivery costs. In the longer term, increases in prices may change community opinion on the appropriateness of

[9] If the asset is oversize for the current demand and this is expected to continue, adjustments should also be made to current cost to reflect the fact that a smaller capacity would be installed on replacement. This process is called optimisation. Note that where assets are a minimum size for 'non demand' reasons such as ease of maintenance, the capacity and current cost should not be de-rated.

customer service standards and trade-off may eventuate between maintaining the price of services and relaxing customer service standards

Asset factors impact on all performance indicators. For example, the key performance criteria for water mains, which impacts on asset lives, include water discontinuity, main breaks, water quantity and unaccounted for water. For sewerage, the key criterion is the number of chokes and environmental impact. The number of main breaks per 100km is a common performance standard adopted by many water authorities. Figure 2.4 shows the performance against this criterion varies by authority and the weighted average age of the pipeline network. To ensure that the number of breaks is kept below the customer standard targets, the model predicts that the pipe age profile needs to be managed with an ongoing injection of new mains or replacement of existing mains. This injection can come from new development or the replacement of existing mains.

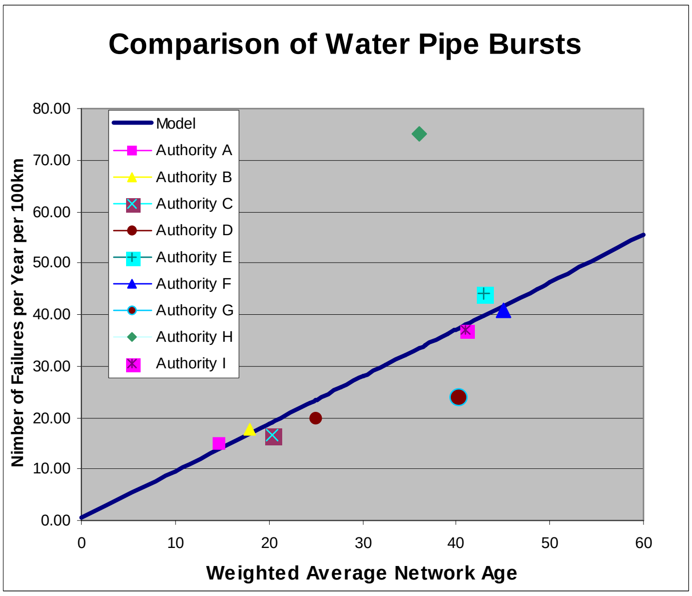


FIGURE 2.4 : Impact of Network Age

2.4.3 Economic Life

The economic life of a section of infrastructure is reached when the cost of replacement is less than the cost of continuing to repair it. Using calibrated local decay curves, replacement models can be developed to assist with the prediction of useful life and remaining useful life for each asset group. The replacement model assesses when a section of infrastructure should be replaced based on factors such as repair costs and historical frequency of breaks, commercial loss (based on the number of customers affected), replacement cost, discount rate, the likely rate of increase in failures in the future (defined by the decay curve) and the social cost to the community through loss of service caused by asset deterioration. Figure 2.5 illustrates the concept.

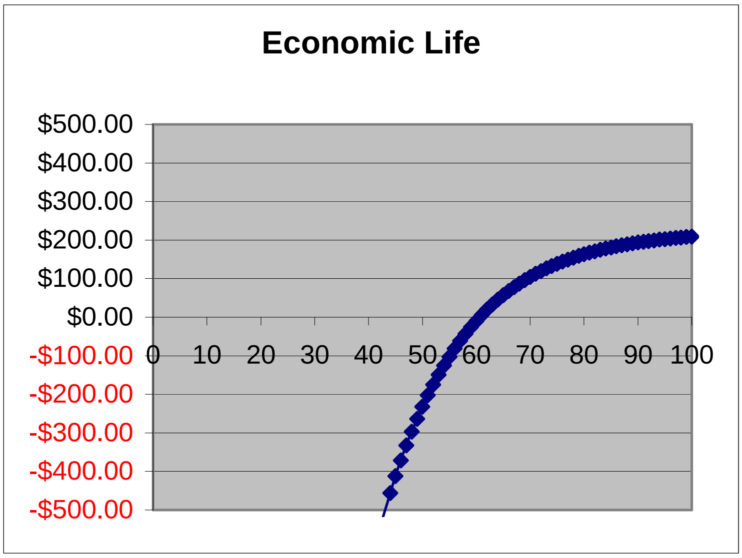


FIGURE 2.5 : Determination of Economic Life

2.4.4 Technological Life

There is constant change in the type of materials used for infrastructure. On replacement, obsolete infrastructure materials such as asbestos cement and cast iron, would be replaced with their modern equivalent such as uPVC or ductile iron. Modern infrastructure systems also incorporate different technology than current systems. For example, more pump stations in lieu of deep sewers, sewer relining instead of replacement and use of pressure pumps instead of elevated reservoirs. These factors do impact on estimates of current costs. However, only the existing system is considered when determining useful and remaining lives.

2.4.5 Other Factors

Infrastructure deterioration (and asset life) is influenced by other factors including:

- Soil type and characteristics;
- Soil moisture profile;
- Groundwater height and quality; and
- Operating pressure

2.5 Remaining Useful Lives

Determination of remaining useful life (RUL) (or remaining economic benefits) is a critical input in the determination of depreciated replacement value.

Determining remaining useful life for each identified asset is a key step in the valuation process.

Factors to be considered by the valuer include:

- Asset age (if known);
- Asset current and projected condition;
- Adopted customer service standards;

- Expected maintenance programs;
- Legal, regulatory, or environmental constraints;
- Change in demand patterns; and
- Impact from other developments

Age has been widely used to date with little assessment of the other factors because of its simplicity.

Age alone should only be used in the absence of asset condition and performance data. There are many other factors such as design, construction, maintenance, load and environment that will affect how an asset deteriorates and the ultimate life achieved. Advanced asset management utilises knowledge of deterioration modelling to assess asset factors. The wider adoption of customer service standards is also impacting on useful and remaining useful lives.

The performance of an asset over time depends on variables that are not often directly related to the primary response mechanisms. Environmental factors such as design, construction, climate and loading have a major influence. Assessing asset condition is the most practical available method for assessing the current ability of an asset to perform its primary function and to determine the remaining useful life. Under extreme climatic conditions (fire and flood), asset condition can change dramatically.

Detailed field inspections are undertaken to identify and confirm assets, identify any redundant or obsolete assets, apply a condition rating to each asset (in accordance with a condition scale (Table 1.0) and estimate condition based remaining useful life.

TABLE 1.0 : Condition Rating Scale

Scale	Description of Overall Condition	Remaining Useful Life
1	Very Good	100%
2	Good	75%
3	Fair	50%
4	Poor	25%
5	Very Poor	0%

The condition of the asset indicates its remaining useful life. Condition 1 implies that the asset is in perfect condition and that the remaining useful life is the same as the economic useful life used by council. Condition 2 indicates that the remaining useful life of the asset is 75% of the economic useful life of the asset and so on. Condition scale and condition based RUL% are listed in Table 2.0.

Condition assessment has three important outputs:

1. an indication of how the infrastructure assets are contributing to the current performance (level of service) in achieving the designated standards of service;

2. the determination of depreciated replacement costs, the rate of consumption of service potential (depreciation), residual life for valuation purposes; and

3. input into the strategic asset management process and, in particular, the prioritisation of renewal programs.

Typically in undertaking condition assessment a list of key attribute data for each asset type whose combined condition will give a good representation of the overall condition of that asset. For example, the attributes and condition indicators that would give a good indication of the overall condition of a pump would be flow, vibration, noise, temperature, presence of leaks and appearance. Ideally there should be between 3 and 6 parameters for each asset type.

Each parameter is given a weighting dependent on how important that parameter is in determining the overall condition rating of the asset. These weightings are based on past experience.

The Total Condition Score is the sum of (the parameter condition scores multiplied by the parameter weighing). This will give a total Condition Score out of 100.

For example, with an asset that has parameters A, B and C the condition score = (condition A x weighting A) + (condition B x weighting B) + (condition C x weighting C).

The following criteria is used to determine the Overall Condition Rating:

Total Condition Score	Overall Condition Rating
20 – 30	1. Excellent/As New
31 – 50	2. Good Condition
51 – 70	3. Fair Condition
71 – 90	4. Poor Condition
91 – 100	5. Unserviceable

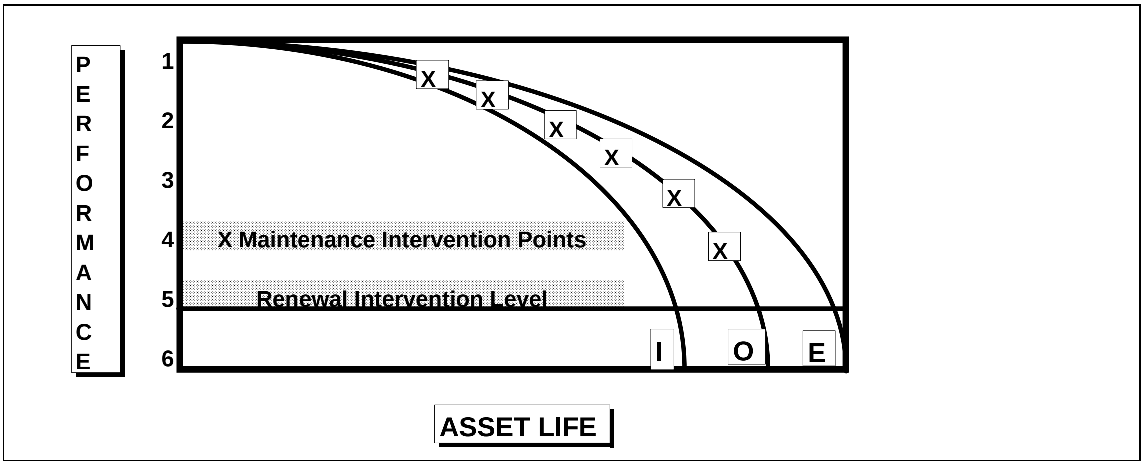
A critical step is relating the condition score to remaining life or service potential. This needs to be done by observing assets in specific classes at different stages of their life cycle.

2.6 Consumption Pattern of Future Economic Benefits

AASB116 requires that the depreciation method used should reflect the pattern in which the asset's future economic benefits are expected to be consumed by the entity. The Asset Manager's and the Asset Accountant's need to work in tandem to ensure that the depreciation pattern adopted is appropriate. Some of the tools used by the Asset Manager such as deterioration modelling, failure modelling and condition assessment are useful to determine when intervention will be necessary either by renewal or disposal. However, it is important to understand the difference between the pattern of asset deterioration and the pattern of consumption of future economic benefits (depreciation).

2.6.1 Asset Managers Perspective - Pattern of Asset Deterioration

One of the main objectives of Strategic Asset Management is to minimise the whole of life cost of an asset while maintaining service standards. To achieve this objective, intervention points need to be determined for maintenance and renewal activities. Infrastructure assets deteriorate gradually over time and ultimately fail.[10] Apart from "demand"[11] obsolescence driven by functional, technical and commercial factors (who's effects are independent of time) the rate of deterioration or "wear and tear" is determined by various environmental factors under which the infrastructure asset operates. The impact of these factors may cause the rate of deterioration over time to be non-uniform and to vary from the expected. It is not possible to define the economic life of an infrastructure asset without reference to the adopted maintenance strategy (including both routine and repairs/renewals). The adopted maintenance strategy is defined as "optimal" if its adoption maintains at least the required level of service for the lowest annualised "whole of life" costs. The "optimal" strategy will need to be determined for each infrastructure asset based upon the influences of its particular local environmental factors. Depending on the level of maintenance received, individual assets may suffer failure well short of the average asset life or significantly exceed the nominated useful life. This concept is illustrated by Figure 2.6



Maintenance Level I (inadequate) O (Optimal) E (excessive)

FIGURE 2.6: Asset Deterioration and Maintenance

Maintenance ensures that the asset service capacity continues to be available for users. The objective of maintenance is to ensure that that assets continue to do what their users want them to do. In practice this requires ensuring that the performance or service level provided by the asset stays above the minimum standard required by the user. Note however, that maintenance cannot prevent the inexorable underlying decline of assets and eventually when the performance falls below the performance level that the user requires, asset renewal is required. For example, any physical asset will deteriorate even without any use. Bitumen roads for example oxidise and break-up overtime even without traffic. Infrastructure assets (unless they become commercially or technically obsolete) are not so much replaced as renewed. For example, bitumen reseals renew the running surface of roads by replacing the existing bitumen, which oxidises over time.

The following case example drawn from "Reliability-centred Maintenance" by John Moubray explains the underlying principles of how engineering type assets deteriorate and are maintained.

[10] Refer section on Failure modes.
[11] Changes in demand for the service provided by the infrastructure asset caused by economic, technological, regulatory or operating conditions.

The objective of maintenance is to ensure that assets continue to do what their users want them to do. The extent to which any user wants any asset to do anything can be defined by a minimum standard of performance. If we could build an asset which could deliver that minimum performance without deteriorating in any way, then that would be the end of the matter. The machine would run continuously with no need for maintenance. However, in the real world, things are not that simple. The laws of physics tell us that any organized system, which is exposed to the real world, will deteriorate. The end result of this deterioration is total disorganization (also known as 'chaos' or 'entropy'), unless steps are taken to arrest whatever process is causing the system to deteriorate. For instance, the pump in Figure 2.7 is pumping water into a tank from which the water is drawn at a rate of 800 litres/minute. One process that causes the pump to deteriorate (failure mode) is impeller wear. This happens regardless of whether it is pumping acid or lubricating oil and regardless of whether the impeller is made of titanium or mild steel. The only question is how fast it will wear to the point that it can no longer deliver 800 litres/minute.

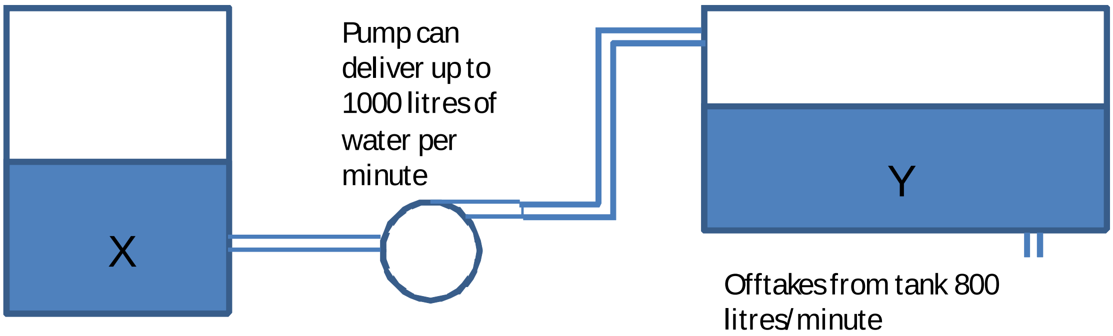


Figure 2.7 Initial capability vs desired performance

So if deterioration is inevitable, it must be allowed for. This means that when any asset is put into service, it must be able to deliver more than the minimum standard of performance desired by the user. What the asset is able to deliver is known as the initial capability or design standard. Figure 2.8 illustrates how the 'margin for deterioration' is built into engineering assets. To ensure that the pump does what its users want it to over the asset life (deliver 800 lites/minute), the system designers must specify a pump, which has an initial built-in capability of 1000 litres/minute.

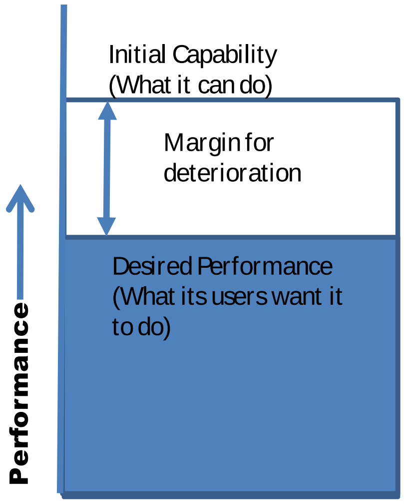


Figure 2.8 Allowing for deterioration

This means that performance can be defined in two ways, as follows:

- *Desired performance (what the user wants the asset to do)*
- *Built-in capability or design standard (what it can do)*

Maintenance ensures that assets continue to fulfil their intended functions, either by ensuring that their capability remains above the minimum standard desired by the user or by restoring something approaching the initial capability if it drops below this point.

When considering the question of restoration, bear in mind that:

- *The initial capability of any asset is established by its design and by how it is made*
- *Maintenance can only restore the asset to this initial level of capability – it cannot go beyond it*

Such assets are maintainable. as illustrated in Figure 2.9. On the other hand, if the desired performance exceeds the initial capability, no amount of maintenance can deliver the desired performance. In other words, such assets are not maintainable.

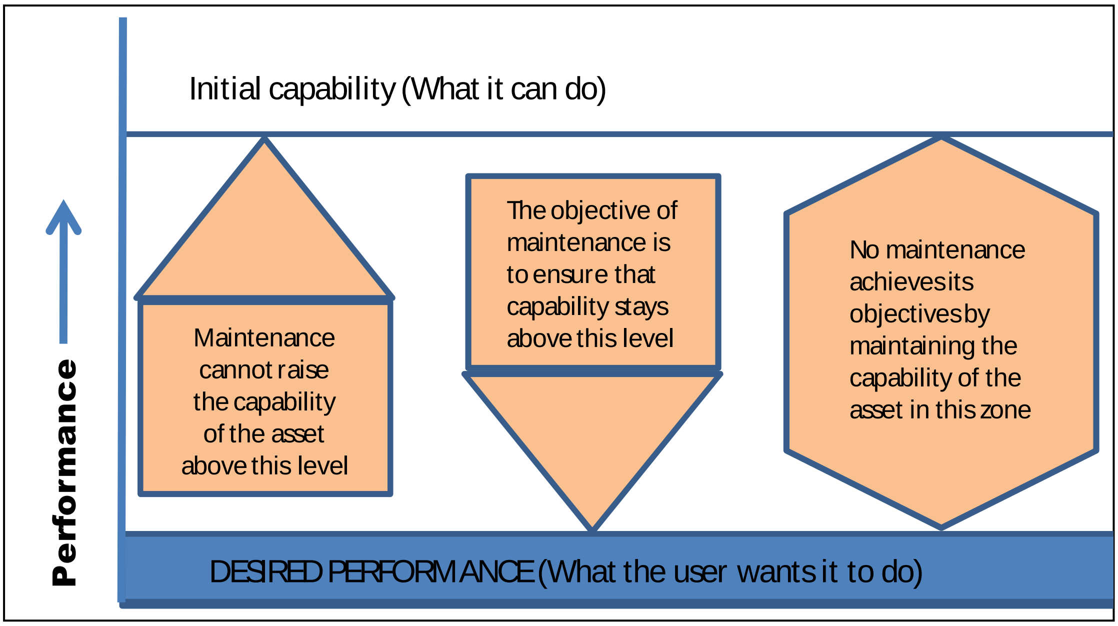


Figure 2.9 A maintainable asset

2.6.2 Condition and Performance

One of the most widely used asset management tools is condition assessment. Condition assessment is utilised to measure where assets are in their life cycle. Condition is concerned with the assessment of the current structural integrity and physical characteristics of the asset and is independent of the standard of service or level of performance required. An asset can be in a very poor condition but still be performing adequately right up to the point of failure because the standard of service required is well within the capacity of the asset. In contrast, an asset can be in excellent physical condition but be a poor performer if the standard of service required is close to the design capacity. It all depends upon what underlying physical characteristics are required to deliver the standard of service and how much "buffer" has been allowed in the original asset design to allow for deterioration.

2.6.3 Accountant's Perspective - Pattern of Consumption of Future Economic Benefits (depreciation)

Important issues for the asset accountant include:

- The future economic benefits embodied in an asset are consumed by an entity principally through its use. However, other factors, such as technical or commercial obsolescence and wear and tear while an asset remains idle, often result in the diminution of the economic benefits that might have been obtained from the asset.
- To account for the economic benefits provided by the existing asset used up to the balance date, the current cost needs to be written down to reflect the future economic benefits available at the balance date.
- A forward estimate is also required of the projected decline in future economic benefits over the following accounting period. This estimate is called depreciation.
- These calculations require estimates of remaining useful life and useful life.

- The determination of fair value and projected depreciation is based on the depreciation model, which best represents the pattern of consumption of future economic benefits

When we design an asset we adopt a design standard commensurate with the anticipated service demands.

Future Economic Benefits = Rate of service delivery (capacity) * useful life

That is, we anticipate the total demand over time. For example for a road, accumulated traffic flow is estimated from current or predicted demand, with a designated travel speed, nominated flow rate and reliability of supply[12].. The resulting asset represents future economic benefits to be consumed over the life of the asset.

A case study of a toll road is provided in Appendix A. Future economic benefits are estimated form the projected toll revenue. Figure 2.10 illustrates that the toll traffic demand will grow over a period of time. However, because of wear and tear and asset deterioration, the capacity to supply services will decline over time. Demand is effectively limited by the ability of the asset to deliver at a point in time. Note that capacity not used at a point in time is gone forever. As a road deteriorates it gets rougher and ruts. Vehicle operating costs increase. Useful life is determined when the road capacity or condition falls below the designated intervention level. In this example, 1500 vpd or condition index of 4. The effective useful life of the asset at this point (Figure 2.10) is 20 years. This is the point where the condition of the asset just delivers the required road capacity. The condition of an asset above the intervention point does not influence the production of future economic benefits. Rehabilitation or replacement is required at this point.

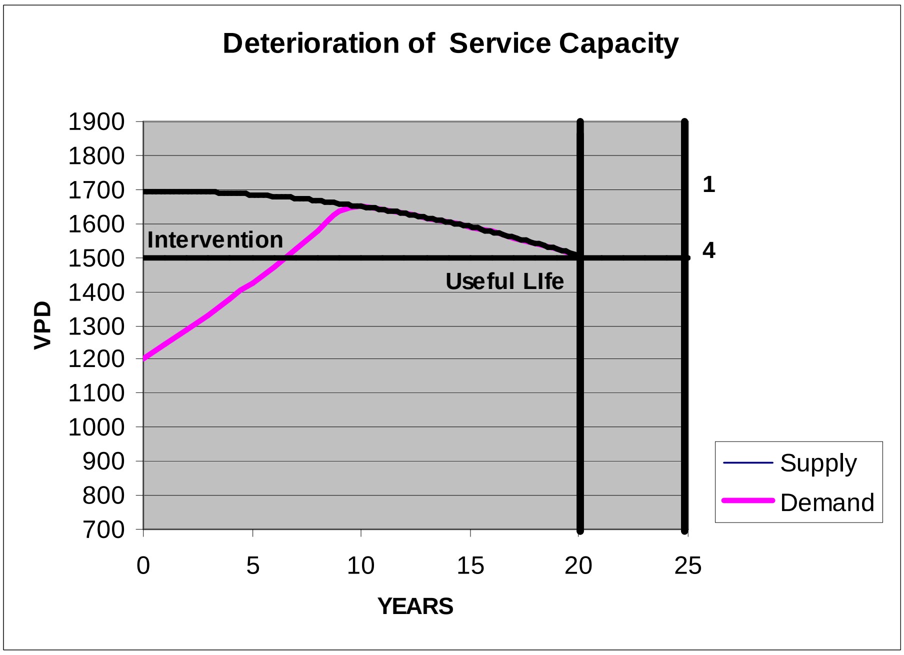


Figure 2.10 Asset Deterioration

[12] These become the Standards of Service adopted in the Customer's Charter.

The pattern of consumption of economic benefits of an infrastructure asset depends critically on what service it is providing and how this is measured. In practice, there are only three possible patterns of consumption:

- Fixed allocations over time
- Allocation based on "unit of output"
- Varying allocations over time

Fixed allocations per unit of time are called "straight-line" depreciation methods. These assume that the economic benefits embodied in the asset or the component is consumed evenly over its useful life. Time varying allocations imply that the consumption of economic benefits vary with time. This requires a systematic basis for determining how the pattern of consumption changes with time. One example of this approach is proposed by Prabhu and Edgerton in their Asset Management Consumption Model.

Figure 2.11 shows different possible patterns of the consumption of future economic benefits for the toll road.

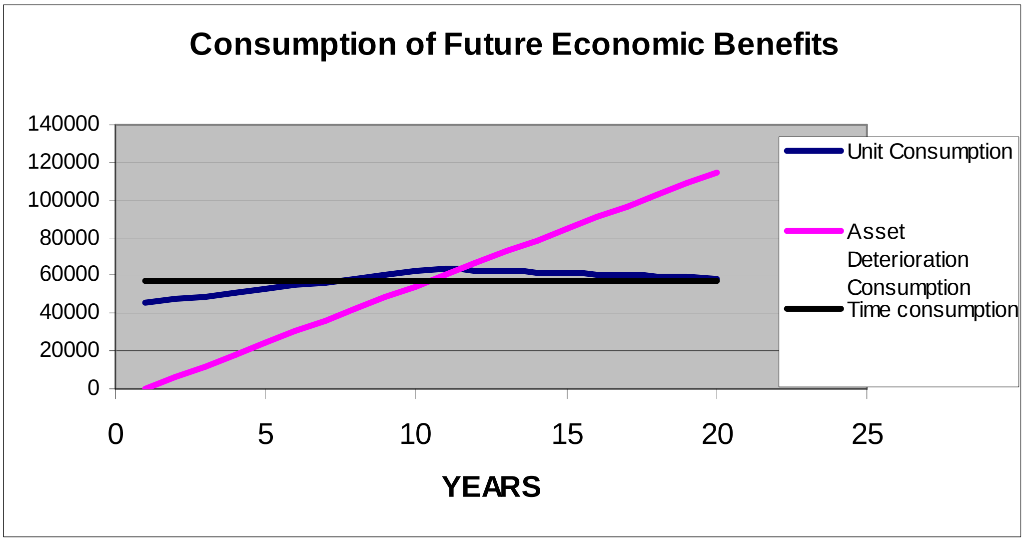


Figure 2.11 Depreciation Patterns

Both the unit based consumption model and the time based consumption model produce a uniform pattern of consumption. The unit based consumption best represents high traffic roads and the time based consumption best represents light trafficked roads. The asset based deterioration model produces a pattern of consumption increasing over time as the asset deteriorates.

The Victorian Department for Victorian Communities publication "Accounting for non-current physical assets under AASB116 'Property, plant and equipment'-A guide 2006" provides a good commentary on this debate.

It is argued that asset condition trends or asset deterioration models can be used to indicate how the economic benefits embodied in an asset are being consumed over time. However, this requires there to be equivalence between condition and economic benefit – for example, that an asset in good condition uses up less economic benefit per unit of time than one in poor condition. Condition data is used primarily to determine remaining life (duration) to renewal or replacement. It is also *used over time to verify or vary initial estimates of total useful life by comparing the actual rate of degradation with the expected or planned rate. It is not clear however, that an asset rated in good condition at one point in time and the same asset later rated in fair condition provides any less or more economic benefit per unit of time. A trafficable road in the first year of its life can be argued to provide the same service potential in its 50th year of life – it allows commuters to get safely from A to B. Consequently, methods that vary depreciation over time to reflect an asset's condition require a clear rationale and demonstrable explicit linkages to the rate of consumption of economic benefits.*

It is argued by Prabhu and Egerton that the pattern of asset deterioration best represents the pattern of consumption of economic benefits. The concept is illustrated in Figure 2.12.

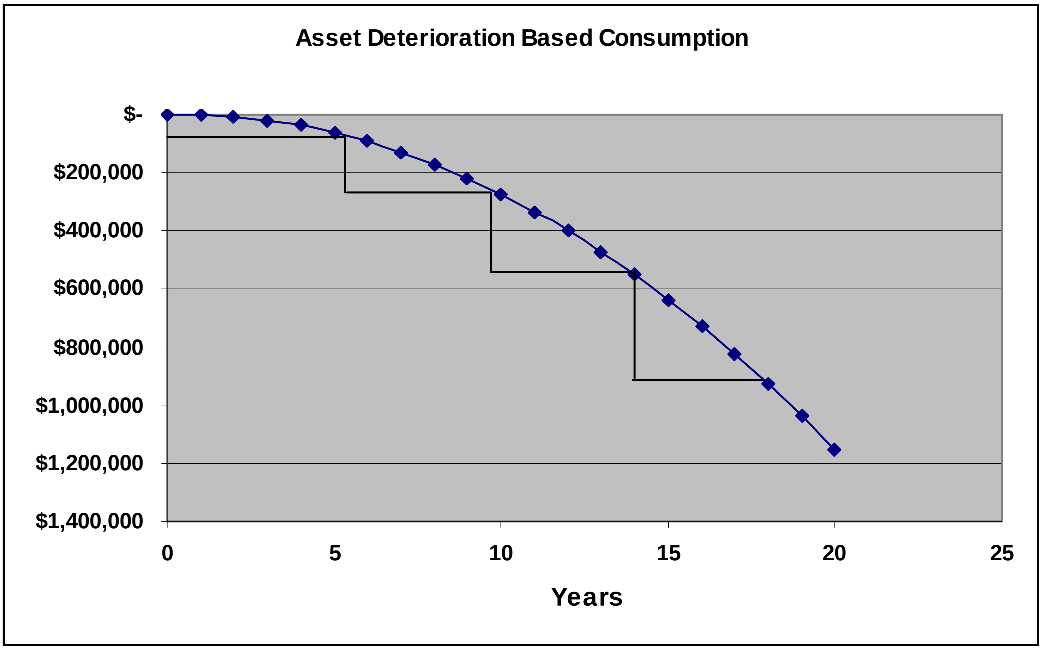


Figure 2.12 Asset Based Deterioration Pattern

However, it has been argued in this paper and in the Victorian guide, that the pattern of deterioration of asset deterioration of infrastructure assets is not necessarily relevant for the determination of the pattern of consumption of future economic benefits. This is because of the 'built in' margin for deterioration characteristic of infrastructure assets.

Using the pattern of asset deterioration as the predictor of the future pattern of consumption of future economic benefits for infrastructure assets can lead to errors in the calculation of fair value and estimates of deterioration if the nexus between asset deterioration and the pattern of consumption of economic benefits has not been established.

3.0 CONCLUSIONS

The valuer undertaking replacement cost valuation needs to answer the following six key questions to comply with the requirements of AASB116 and AASB136:

1. What is the estimated replacement cost of the economic benefits provided by the asset?
2. What is the appropriate useful life for the asset in its environment[13] ?
3. What is the estimated time until the next major renewal event or the asset is discarded (RUL)?
4. Does the depreciation method used reflect the predicted pattern of consumption of the asset's future economic benefits?
5. At renewal or disposal, what is the projected residual value?
6. Is their any evidence of impairment of the asset?

This paper discusses practical approaches that have been developed to the estimation of depreciation of infrastructure assets for 'not for profit' entities. Methodologies have been developed to estimate 'fair value', useful life and remaining useful life utilising condition assessment techniques to meet the requirements of Australian Accounting Standards. All of the methodologies are compatible with best practice asset management planning.

One of the most widely used asset management tools is condition assessment. Condition assessment is utilised to measure where assets are in their life cycle. Condition is concerned with the assessment of the current structural integrity and physical characteristics of the asset and is independent of the standard of service or level of performance required. An asset can be in a very poor condition but still be performing adequately right up to the point of failure because the standard of service required is well within the capacity of the asset. In contrast, an asset can be in excellent physical condition but be a poor performer if the standard of service required is close to the design capacity. It all depends upon what underlying physical characteristics are required to deliver the standard of service and how much "buffer'' has been allowed in the original asset design to allow for deterioration.

The paper highlights the difference between the pattern of asset deterioration and the pattern of consumption of future economic benefits (depreciation). The pattern of asset deterioration tends to be non uniform while the pattern of consumption of future economic benefits for infrastructure assets tends to be uniform reflecting the delivery of services over time. For infrastructure assets, measuring condition and modelling deterioration can assist with the calculation of depreciation by determining when the asset condition will deteriorate to the point where the asset cannot continue to deliver the service. Before the point of intervention, the pattern of asset deterioration is not directly related to the pattern of consumption of future economic benefits. The pattern of asset deterioration is not in itself an estimate of depreciation. The assessed condition is used (along with other appropriate external influences) to review useful lives for each asset class and to estimate remaining useful life for each asset in accordance with the requirements of the appropriate Australian Accounting standards. The estimates of useful life, remaining useful life and current replacement cost are then used to calculate depreciation.

[13] Physical, operating and regulatory.

4.0 REFERENCES

Australian Government Australian Accounting Standards Board "Accounting Standard – Property , Plant and Equipment", AASB116 July 2004

Australian Government Australian Accounting Standards Board "Accounting Standard – Impairment of Assets", AASB136 July 2004

John Moubray "Reliability-centred Maintenance" Butterworth/Heinemann 2nd Edition

Prabhu and Edgerton "Asset Management Consumption Model", October 2007

Victorian Department for Victorian Communities publication "Accounting for non-current physical assets under AASB116 'Property, plant and equipment'-A guide", 2006

Appendix A Case Study Toll Road Calculation of the Pattern of Consumption of Future Economic Benefits

Useful Life	20	**Initial traffic**	1200	VPD	**Expected future economic benefits**	$ 10,950,000	**Intervention Capacity**	1500	VPD
Replacement Cost	$ 10,000,000	**Residual Value**	$ 8,849,558	**Depreciable Amount**	$ 1,150,442				

Age Years	Traffic Growth Growth 3.49%	**Demand**	Economic Benefits Consumed based on units $	Economic Benefits Consumed based on time $	Economic Benefits Consumed based on asset deterioration $	Road Capacity vpd **Supply**	Intervention Capacity VPD **Intervention**	**Condition**
0	1	1200				1695	1500	**1**
1	1.034881852	1242	$ 46,018	$ 57,522	$ -	1695	1500	
2	1.070980449	1285	$ 47,623	$ 57,522	$ 6,055	1694	1500	
3	1.108338231	1330	$ 49,284	$ 57,522	$ 12,110	1692	1500	
4	1.146999121	1376	$ 51,003	$ 57,522	$ 18,165	1689	1500	
5	1.187008575	1424	$ 52,782	$ 57,522	$ 24,220	1685	1500	
6	1.228413633	1474	$ 54,623	$ 57,522	$ 30,275	1680	1500	**2**
7	1.271262977	1526	$ 56,529	$ 57,522	$ 36,330	1674	1500	
8	1.315606984	1579	$ 58,501	$ 57,522	$ 42,385	1667	1500	
9	1.361497793	1634	$ 60,541	$ 57,522	$ 48,440	1659	1500	
10	1.408989358	1650	$ 62,653	$ 57,522	$ 54,495	1650	1500	
11	1.458137517	1640	$ 63,274	$ 57,522	$ 60,550	1640	1500	
12	1.509000055	1629	$ 62,891	$ 57,522	$ 66,605	1629	1500	**3**
13	1.561636772	1617	$ 62,469	$ 57,522	$ 72,660	1617	1500	
14	1.616109556	1604	$ 62,009	$ 57,522	$ 78,714	1604	1500	
15	1.672482451	1590	$ 61,510	$ 57,522	$ 84,769	1590	1500	
16	1.730821737	1575	$ 60,973	$ 57,522	$ 90,824	1575	1500	
17	1.791196005	1559	$ 60,398	$ 57,522	$ 96,879	1559	1500	
18	1.85367624	1542	$ 59,785	$ 57,522	$ 102,934	1542	1500	
19	1.918335901	1524	$ 59,133	$ 57,522	$ 108,989	1524	1500	
20	1.985251011	1505	$ 58,442	$ 57,522	$ 115,044	1505	1500	**4**
21	Toll = $1/vehicle		$ 1,150,442		$ 1,150,442		1500	
22	As a road deteriorates, it gets rougher and ruts which restricts capacity and increases vehicle operating costs						1500	
23	Useful life is determined when the road capacity falls below the intervention capacity and or condition.						1500	
24							1500	
25							1500	