TRANSPORT AND INFRASTRUCTURE COUNCIL

Australian Transport Assessment and Planning Guidelines

O5 Economic Appraisal in the Setting of Standards

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At a glance

- This guidance covers the setting of standards in transport. It discusses the important role that economic analysis, primarily cost–benefit analysis, can play — highlighting the trade-off between benefits and costs within the broader policy context of standard setting, which usually involves a range of both economic and non-economic considerations
- Ultimately decisions on standards are examples of policy choices made by governments – accordingly Chapter 2 of ATAP F1 provides background for this guidance.
- Transport agencies set standards for a range of infrastructure design elements including for example road widths, rail track and road pavement strengths, levels and quality of service and asset life.
- Standards are a means for agencies to improve and control the infrastructure design and delivery processes, to improve the efficiency of those processes and to project corporate knowledge and experience.
- Infrastructure elements have a greater chance of being economically efficient if the design elements they incorporate are also economically efficient.
- The guidance provides decision rules for deciding when a proposed standard change is economically justified, and for identifying the economically best standards level. It does this for cases where budgets are unconstrained and constrained
- Examples of how economic appraisal could be used in standard setting are also provided

1. Introduction

This part of the Guidelines considers the use of standards in transport.

Its primary purpose is to highlight how economic analysis, primarily cost-benefit analysis (CBA), can play a role in standard setting, allowing for trade-offs between benefits and costs associated with achieving standards to be understood. It does this, however, within the broader policy context of standard setting – which usually involves a range of both economic and non-economic considerations. This guidance will assist practitioners required to undertake assessments of the introduction of, or changes in, standards in transport.

Ultimately decisions on standards are examples of policy choices made by governments. Accordingly users of this part of the Guidelines should also familiarise themselves with the following complementary discussions:

- Chapter 2 of ATAP F0.1 Policy Choices and System Planning
- Section 1.2 NGTSM Volume 5 (ATC 2006).

Transport agencies and governments set standards for a range of infrastructure design elements including for example:

- Road width including lane and shoulder width
- Rail axle loads
- Pavement strength and roughness
- Flood immunity
- Horizontal and vertical alignment (road and rail)
- Curve widening and taper lengths
- Tunnel cross-section including horizontal and vertical clearances
- Public transport station/stop quality
- Heavy vehicle rest area spacing
- Level of service
- Quality of service
- Asset life, e.g. bridge life.

Some of these are discussed further in Chapter 3.

Standards serve a number of purposes for infrastructure:

- Supporting the achievement of objectives such as safety, user satisfaction, efficiency and equity
- Projecting corporate knowledge and experience regarding the best way to deliver infrastructure initiatives
- Ensuring consistency in service levels across transport networks
- Improving the efficiency of infrastructure design and delivery processes
- Providing controls against the ‘gold plating’ of infrastructure assets – if based on a level of justification.

Notwithstanding the important role that standards play in infrastructure agencies, standard setting is not without its challenges:

- Variations in external factors throughout infrastructure agency networks – such as topography, land use, climate and traffic volumes – can limit the applicability of standards. The variations make it hard to have a single standard as different standard levels are justified in different parts of the network
- Related to the point above, in some settings, standards may be impracticable due to cost; for example horizontal curvature standards when applied in mountainous terrain or width for volume standards if they call for duplication in dense urban areas
- The data needed to inform standard setting can necessitate costly and sometimes inconclusive research
- Standard setting involves both economic and non-economic effects, increasing the difficulty of decision-making.[1]

Despite these complexities, economic analysis can play a role in informing standards setting. It can:

- Identify cases where an improvement in a standard is economically justified
- Identify the economically best scale of improvement in standard
- Highlight standards that have costs significantly disproportionate to their benefits, that is, they are not economically justified. In these instances, agencies and policy makers might consider:
  - Assessing a reduction in standard
  - Whether the objectives that the standard pursues might be more efficiently achieved by other means. For example, in outlying parts of metropolitan areas, personalised transport options such as subsidised taxis may be more economically efficient than late night train, tram or bus services.
- In addition, infrastructure initiatives are more likely to be economically justified if the standards that guide those initiatives are themselves economically justified.

Chapter 2 discusses the broad context, the need for assessment and outlines the ATAP assessment model.

Chapter 3 presents a high level discussion outlining the CBA criteria for identifying economically justified and economically best standards. It then illustrates application to a number of cases of standards in transport.

Chapter 4 provides a discussion of some non-economic considerations that practitioners will encounter.

[1] A useful discussion of the issues and challenges in standards setting is contained in BTE (1980).

2. Context

2.1 Considerations in standard setting

Across the transport sector, and across jurisdictions, a wide range of considerations influence the setting of standards:

- Historical settings and decisions – which usually vary across jurisdictions for similar conditions
- Jurisdictional goals, transport system objectives and targets (see ATAP Part T1) – economic, social and environmental
- Community expectations – expressed directly through public forums and indirectly through political processes – including equity considerations[2]
- Customer service criteria such as accessibility, service levels and reliability
- Operational considerations such as feasible design, construction and maintenance options for infrastructure, and their associated cost, efficiency and risk aspects
- The occurrence of extreme events, such as floods, and their impact on community perceptions, preferences and expectations
- Costs to users and transport agencies
- Government policy choices.

All of these, and other factors, influence governments in making decisions about standards. Whilst the primary focus of this paper is on how economic considerations can play a role in standards setting, it is important to recognise from the outset that many non-economic factors have a strong influence in such decisions.

Minimum standards

Sometimes governments choose to set 'minimum standards'. That is, it is deemed appropriate for the standard to remain at or above a minimum level. For example, road lane widths below a specified amount would create extreme safety problems, leading to a certain width being specified a minimum. As another example, a jurisdiction may decide that, for social equity reasons, rural areas should be provided with minimum standards that would otherwise not be economically justified. These would be delivered through community service obligations.

The setting of minimum standards is a policy decision open to each jurisdiction. The arguments for and against setting different levels of minimum standards will be viewed differently in each jurisdiction, reflecting the social, economic and political setting of each jurisdiction. The assessment approach outlined below does, however, provide the basis for presenting information to decision makers about the benefits and costs of standard setting proposals, including those that involve minimum standards.

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[2] Austroads (2002) and Austroads (2018) provide guidance in engaging the community in the setting of standards.

2.2 The need for assessment

The need for the assessment of standards arises for a number of reasons.

Existing standards

- A standard may have been set a long time ago, and will reflect historical thinking, expectations and decisions. In some cases the original basis for introducing the standard, and the justification for it, may no longer be known or well understood. In such situations, a case could be made for a reconsideration of the merit and level of the existing standard
- Over time, various socio-economic aspects are likely to change – population, employment, activity patterns, user preferences and behaviours, technology – are likely to grow or change. This can impact the suitability of standards
- Public or community discussion leads to a proposal for the introduction of, or change in, a standard.

No existing standards

- In some situations, there may be no existing standards. This may be the case with innovation leading to a sudden emergence of new technologies, e.g. the emergence of personal travel service technologies such as electric bikes or Uber, and the emergence of automated vehicles. Initially such technologies may arise in an unregulated manner, with no standards specified. As time passes, various aspects of operation may highlight the need for the introduction of standards in one or more operational aspects

In each of the above situations, the need for assessment, or reassessment, of standards may arise.

2.3 ATAP assessment of changes in standards

The ATAP assessment model outlined in Section 3.3 in ATAP Part F3 provides the basis for assessing all initiatives, including proposals for the introduction of, or changes in, standards. The model consists of:

- Clarification of relevant jurisdictional goals, transport system objectives and targets – It is important to be clear about which of these relate to changes in standards from early in an assessment
- Consideration of strategic merit / alignment – The degree of strategic alignment of making changes to standards should be assessed
- Use of CBA and the Appraisal Summary Table (AST). The AST provides the mechanism for presenting all the appraisal results—monetised and non-monetised—in a single location.

  The ATAP appraisal methodology recognises that all benefits and costs—monetised and non-monetised—are relevant to the appraisal of initiatives. It facilitates this through use of the AST, in which monetised and non-monetised benefits and costs are presented side-by-side – see Part F3 Chapter 3.
- Bringing together all aspects of the assessment into a Business Case (see ATAP Part F4).

3. Cost-benefit analysis in transport infrastructure standards

Chapter 2 discussed the context for standard setting and the ATAP approach to assessment, in which CBA plays an important role. Within that broad context, this chapter discusses the application of CBA in transport standard setting situations. Section 3.1 provides an overview of CBA criteria. The subsequent sections then illustrate the application of CBA as outlined in section 3.1 to a range of transport examples. The list of examples is meant to be illustrative rather than comprehensive – many other examples exist. For other cases of standards in transport, the same style of thinking can be applied.

3.1 Overview

In the ATAP assessment model discussed in section 2.3, CBA plays the important role of highlighting for the decision maker the trade-off between benefits and costs of changes to standards. These involve changes in infrastructure agency costs and user costs (in the roads context) or between track owner and train operator costs (in the rail context).

ATAP Part T2 provides guidance on how to undertake CBA of transport initiatives. The principles and methodology outlined there apply equally here.

In the appraisal of standards, two styles of CBA application are relevant:

1. **A specific change in standard** – This is applicable where a proposal has been made for a specific change in standard, e.g. to reduce speed limits within local centres from 60 km/h to 40 km/h
2. **Incremental changes in standard** – This approach considers changing a standard as a number of increments of change. For the example of the proposal to reduce the speed limit in a local centres, a number of successive 5 km/h reductions could be considered: 60 to 55 to 50 to 45 to 40. This incremental analysis approach is required if the economically best (i.e. most economically efficient, or economic optimum) standard level is to be identified. It is also necessary when considering intermediate options related to a specific proposed change.

It is important to note that when a specific change in standard is proposed, part of that change may be economically unjustified. That will be the case if the change takes the standard above the economically best level. Assessing a range of standard levels, by incremental analysis, provides a more refined method of assessment, allowing the best economic outcome to be identified.

3.1.1 Specific change in standard

As outlined in ATAP T2, if there is no budget constraint, a proposed change in standard is economically justified if:

$$\textit{No budget constraint:} \quad NPV > 0, \text{ i.e. } BCR > 1$$

Typically, however, the availability of funding is limited, and a budget constraint therefore applies. All initiatives must then compete for the limited funds, including standards improvements. In this situation, as indicated in ATAP Part T2, initiatives should be ranked by BCR and implemented in descending order until the budget is exhausted. If a standard is raised, drawing funds from the budget, the initiatives forgone would be those with the lowest BCRs in the ranking, that would otherwise be implemented. The BCR of the initiative with the lowest BCR represents the opportunity cost of funds. For the purposes of spending decisions for smaller initiatives taken separately from the allocation of the bulk available funds, it is convenient to designate a hurdle or cut-off BCR below which initiatives will not be funded. McLean (1993) refers to the cut-off BCR as the BCR of the marginal or last initiative in an infrastructure agency's investment program.

Applying this logic in standard setting, when the budget is constrained, a proposed change in standard is economically justified if:

$$\textit{Budget constraint exists:} \qquad BCR > \textit{cut-off } BCR$$

Note that the cut-off BCR drops to 1 when there is no budget constraint.

3.1.2 Incremental changes in standard

The incremental analysis approach is outlined in ATAP Part T2 section 10.6. It is necessary if the economically best standard is to be identified. It entails the use of incremental CBA to compare costs and benefits of successively higher standards until the economically best standard is identified.

The method involves a series of steps as outlined below and illustrated numerically in Table 1:

- Start with an existing level of a standard, or alternatively with a basic level of the standard
- Consider a number of progressively higher levels of the standard.

  For example, a road lane may currently be 2.4 metres. An incremental analysis could consider increases in lane width of a given increment, say 0.1 metres. The standard level options would therefore be 2.4m, 2.5m, 2.6m, 2.7m, 2.8m, 2.9m, 3.0m, etc
- For each standard level option as a Project Case, and the fixed Base Case of the starting standard level (2.4m in the road lane width example), calculate the benefits and costs
- For each standard level option, calculate the incremental BCR (IBCR) as follows.

$$IBCR = \frac{PV(B_{i+1} - OC_{i+1}) - PV(B_i - OC_i)}{PV(IC_{i+1}) - PV(IC_i)}$$

  where :

  - the subscripts *i* and *i+1* represent standard level options where option *i+1* is the option with the higher investment cost
  - $PV(B_i - OC_i)$ is the present value of the time stream of benefits minus the increase in operating/ maintenance costs (which may be negative if the option saves operating or maintenance costs) of option *i*
  - $PV(IC_i)$ is the present value of the time stream of the increase in investment costs of option *i*

Table 1: Incremental CBA numerical illustration – Road lane widths

Option	Base Case width (m)	Project Case width (m)	B ($m)	OC($m)	IC($m)	IBCR
1	2.4	2.5	100	10	50	$\frac{(100-10)-(0-0)}{(50-0)} = \frac{90}{50} = 1.8$
2	2.4	2.6	190	20	100	$\frac{(190-20)-(100-10)}{(100-50)} = \frac{80}{50} = 1.6$
3	2.4	2.7	270	30	150	$\frac{(270-30)-(190-20)}{(150-100)} = \frac{70}{50} = 1.4$
4	2.4	2.8	340	40	200	$\frac{(340-40)-(270-30)}{(200-150)} = \frac{60}{50} = 1.2$
5	2.4	2.9	400	50	250	$\frac{(400-50)-(340-40)}{(250-200)} = \frac{50}{50} = 1.0$
6	2.4	3.0	450	60	300	$\frac{(450-60)-(400-50)}{(300-250)} = \frac{40}{50} = 0.8$

Each successive increment is economically worthwhile provided:

$$\textit{No budget constraint:} \qquad IBCR > 1$$

$$\textit{Budget constraint exists:} \qquad IBCR > \textit{cut-off BCR:}$$

The economically best increment is as follows:

No budget constraint: The highest cost increment that has IBCR > 1.

Budget constraint exists: The highest cost increment that has IBCR > cut-off BCR.

For the numerical example in Table 1, the economically best lane width is:

- With no budget constraint: Option 4 – lane width of 2.8m. This is the highest cost increment with IBCR > 1
- With a budget constraint, and cut-off BCR (say) 1.5: Option 2 – lane width 2.6m. This is the highest cost increment with IBCR > cut-off BCR. Investment in a higher lane width standard would yield an IBCR < cut-off BCR, which means that a better economic return can be obtained by investing those additional funds in other initiatives.

The remaining sections of this chapter discuss a number of cases of transport standards, outlining the associated benefits and costs and how the above CBA-thinking can be used.

3.2 Road width for volume standards

Width for volume standards provide a simple example of the use of CBA in standard setting. If road width is increased, the benefits would include reduced congestion and crash risk, established from research. The costs would consist of the capital cost of the wider road, as well as any change in agency maintenance costs.

For a given traffic volume, a proposed increase in road width can be assessed by comparing the benefits and costs of the increase. The increase is economically worthwhile if BCR > cut-off BCR (see section 3.1.1).

In addition, the economically best road width can be found by undertaking an incremental analysis (see section 3.1.2). For successively higher widths, estimate costs, benefits and IBCR. The economically best width is the highest cost increment where IBCR > cut-off BCR.

Sensitivity testing should be undertaken for a range of likely traffic volumes with variations for terrain type (e.g. flat, undulating and mountainous), heavy vehicle proportions (e.g. 5%, 15% and 30%) and posted speeds[3].

A similar process can be carried out for shoulder width although the relevant benefits would be safety and agency maintenance cost (reductions in the costs of maintaining seal edges and unsealed shoulders).

Another consideration is whether the road is expected to cater for cyclists. This will affect road width options, costs and benefits.

3.3 Bridge life

Austroads (2018a) recommends a default bridge service life of 100 or up to 150 years if statistical variation in construction quality is to be accommodated (see Austroads (2018b)). Factors that can limit bridge life include:

- Deterioration of materials related to internal reactions in the concrete and/in severe environmental conditions (for example extreme heat affecting the joints of bridges)
- Poor construction practice
- Repeated load effects (fatigue)
- Severe overloading causing cracking, deterioration or yield
- Flooding, scour or debris loads
- Ground movements (Austroads 2018a).

A service life longer than 100 to 150 years would involve:

- Cost changes – Greater up-front capital costs, and reduction in periodic bridge maintenance and inspection costs
- User benefits - Savings in road user delay costs when inspection and maintenance are being carried out.

[3] When the speed limit constrains base case speed, width improvements are less likely to yield user benefits.

- Savings arising from the deferral of bridge replacement.

For each level of use (measured in terms of number of vehicles, number of trains, axle passes etc), a proposed increase in economic life will be economically justified if the associated benefits are greater than the costs, resulting in BCR > cut-off BCR.

The economically best bridge life standard would be that which minimised the total of agency lifecycle costs and user costs in present value terms.

On very low volume rural roads where agency costs could be larger than road user costs, a cost minimisation criterion could result in a bridge standard that is lower than minimum engineering life, axle load or safety standards. In these circumstances non-economic criteria are likely to prevail or alternatively the bridge might not be built or replaced[4].

In principle, for each bridge standard (in terms of bridge life) whole of life agency and road user costs would be calculated including agency maintenance and bridge replacement costs and costs of user delay during bridge replacement.

A limitation of this method is the requirement sometimes for many cycles of bridge replacement to be analysed. Three cycles would be required if a 50 year bridge life was being compared with a 300 year bridge life (ie 5 replacements of the bridge with a 50 year life). A better way (see section 2.4 of ATAP T2) is to convert the present value of total lifecycle cost (agency and user costs) to an annuity over the life of each bridge. The economically efficient bridge life would be the one with the lowest annual cost as expressed by the respective values of the annuities. The annuity is:

$$A = PV\left[\frac{r}{1-(1+r)^{-n}}\right]$$

where

A is the annuity

PV is the present value to be converted to an annuity

r is the real discount rate

n the number of years over which the annuity is incurred.

For example, assuming a 4% discount rate, a bridge with 50-year life and a present value of $100 million of construction and maintenance costs would be equivalent to an annuity of $\$4.66m = \$100m \times \left[\frac{0.04}{1-(1+0.04)^{-50}}\right]$. To be the more economic option, a bridge with a 300-year life would require a present value of costs not more than $116.37 million, which is the present value of costs with the same annual value over 300 years, $\$4.66m = \$116.37m \times \left[\frac{0.04}{1-(1+0.04)^{-300}}\right]$.

[4] In some circumstances simple causeways (with very low flood immunity) might be provided instead of a bridge.

The difficulty with this analysis is in knowing whether in some circumstances bridges will outlive their usefulness. This is least likely in mature, rural areas with slow population growth. It is most likely in fast growing urbanised regions where road realignment or augmentation to accommodate traffic growth could result in some road assets being made redundant.

The effect of this possible redundancy would be to reduce the residual value of the bridge. With a 100-year bridge service life a 30-year analysis period and a $50 million construction cost, the residual value at the end of the normal 30-year analysis period would be $35 million. The present value of that residual value at a 7% discount rate would be $4.6 million. Were there to be a 50% chance that the bridge would be redundant (bypassed) by year 30, the residual value would reduce to $2.3 million. Hence this allowance for redundancy would reduce the benefits of the new bridge. Note that this adjustment to the residual value would only be made as part of a probabilistic risk assessment. ATAP T2 discusses residual values in Chapter 3 and probabilistic risk assessment in Chapter 11.

3.4 Level of service (urban)

3.4.1 Road

Engineers use the concept of level of service (LOS) in the peak hour or hours to relate road capacity and road service quality. The lower the level of service (in worsening order from A to F) the lower the traffic speed in mid-block sections and the longer the delay at intersections (Transportation Research Board 2015, Austroads 2018c). (In rural settings width for volume standards are effectively equivalent to LOS standards).

In urban settings the derivation of LOS standards at the network level is complicated by the complexity of network interactions. As a result, the calculation of the benefits and costs of any proposed changes in level of service provision (and any calculation of the economically best level) will be case-specific. It will be affected by a complex combination of case-specific factors including existing road layout, traffic volume and composition, intersection/interchange layouts, distances between intersections/interchanges and upgrade costs.

Where assessment of specific proposed changes in urban levels of service are undertaken, the change should be assessed by calculating the associated benefits and costs, with the proposed change justified if BCR > cut-off BCR (see section 3.1.1). The benefits will be the change in road user costs (travel time and vehicle operating cost savings) and the cost will be the associated investment costs.

Conceptually, the economically best LOS for a range of traffic volumes could be established for intersections and mid-blocks by undertaking an incremental CBA (see section 3.1.2) of moving progressively from the lowest level of service (F) to the highest (A). In practice however, the application of this approach in high volume urban settings would be complicated by potentially large differences between areas or sites in the capital costs of moving from one LOS to the next.

3.4.2 Public transport frequency

Frequency is an important quality attribute in the provision of public transport services. Improvements in public transport service frequency can reduce average user wait times and also increase patronage.

An increase in service frequency with result in benefits:

- Reduced average waiting costs for existing public transport trips[5]
- Increase in consumer surplus for new public transport trips (diverted from other modes and newly generated)
- Reduced user costs to remaining users of the road network
- Reduction in external safety and environmental costs.

The associated costs would be:

- Up-front capital costs of additional buses, trains and trams
- Increased operating and maintenance costs.

In the off peak, the additional costs might well be confined to additional operating costs of fuel, driver hours, repairs and maintenance and road/track wear, and public transport vehicle maintenance costs. In the peaks the capital costs of additional buses and rollingstock and possibility road, station/stop and terminal capacity might need to be allowed for.

A proposed service frequency increase is economically justified if the benefits outweigh the costs, resulting in BCR > cut-off BCR (see section 3.1.1).

For given patronage volumes, the economically best service frequency can be identified through an incremental analysis of progressively higher increases in service frequency (see section 3.1.2). The economically best outcome will be the highest cost increment with IBCR ≥ cut-off BCR.

3.5 Public transport station/stop standards

Another area of standards in public transport involves the quality elements of facilities, e.g. better seating, full weather protection and lighting, user information system, security, pick-up and drop-off areas). Improvements in these quality elements will be benefit the public transport users.

Standard practice in transport appraisal is to value improvements in these quality elements in terms of an 'equivalent time saved' measure. In other words a cleaner stop is equivalent in value to a specified reduction in travel time, which is expressed in monetary terms using the dollar value of time savings (ATAP Part M1, TfNSW 2018). Chapter 5 of ATAP Part M1 presents such recommended values for use by practitioners.

To be economically justified, a specific proposed improvement must results in i.e. BCR > cut-off BCR (see section 3.1.1).

The economically best level of quality can be determined by incremental analysis (see section 3.1.2). Start with a basic standard of station or stop which might incorporate basic seating, weather protection and signage. The benefits and costs of progressively higher standards are then be estimated. The economically best standard is found at the highest cost standard with IBCR ≥ cut-off BCR. Higher standards will tend to be associated with higher trip volumes because benefits are closely related to trip numbers.

[5] Service reliability is also important, otherwise unexpected wait time occur.

3.6 Highway rest areas

Rest areas on intercity highways and rural roads play and important part in managing driver fatigue and in providing spaces for motorists to otherwise pull off the road to, for example, check directions or check that their load is secure. They are critical for heavy vehicle drivers who are required by law to take work breaks at specified time intervals. Rest areas provide truck drivers with safe places to park their vehicles while they have their rest breaks. Rest areas also have a role to play in managing fatigue risk for light vehicle drivers.

The level of rest areas provision is defined by the spacing between rest areas. The spacing reduces as:

- We move up the road hierarchy from low volume rural arterial roads to major intercity highways
- Traffic volume increases.

So for example a high volume national highway would have closer rest area spacing than a lower volume lower order highway.

The economic justification of changes in rest areas spacing would be determined by:

- The crash record and in particular the clustering of fatigue crashes on the relevant road link
- The crash reduction ‘footprint’ of rest areas, which would be established by research (in other words, the length of road over which rest areas affect fatigue crash incidence) and the size of the crash reduction factor attributable to rest area provision
- Changes in the costs of providing rest areas.

Rest area standards should be established according to ranges of traffic volume because all things being equal, total fatigue risk on a road section will be a direct function of traffic volume. A further refinement would be to vary standards according to the percentage of heavy vehicles in the traffic stream.

Assuming that crash reduction factors were available for a range of rest area spacings:

- The economic merit of a specific change in rest area spacing would be based on the benefits and costs of the change, and is economically justified if BCR > cut-off BCR (see section 3.1.1)
- Incremental CBA would be used to identify the economically best spacing for each traffic volume and heavy vehicle percentage range (see section 3.1.2). The economically best spacing is the highest cost spacing with IBCR ≥ cut-off BCR.

Road agencies might choose to adopt some minimum rest area spacing on low volume arterial roads to meet community expectations for safety or to promote long distance road-based tourism (see section 4 following).

4. Influence of non-economic considerations

The above discussion of the use of CBA relies on being able to monetise benefits and costs. Some inputs to the CBA of standard changes are readily amenable to monetisation, including crash risk and cost, delay costs, road or track user costs, agency capital and maintenance costs. Others are less tractable in economic terms including community expectations, which means they need to be considered alongside the CBA results.

In addition, some of these factors may be subject to hard constraints, in other words there may be some level at which a standard becomes non-negotiable for the agency and for political decision makers due to the perceived severity of consequences. Examples could include:

- Flood immunity on major inter-city arterials, where flooding impacts would be high due to the density of human activity
- Road and rail bridge design standards that provide wide buffers, or safety margins, against catastrophic failure.

Community expectations or considerations of equity will sometimes influence adopted service standards. Examples could include:

- Provision of basic seating at public transport bus/light rail stops
- Providing basic seating on public transport for the aged and people with disabilities
- Ensuring that average walking distances to a public transport service consider the needs of the aged and the young
- Provision of on-site security at larger public transport stations
- Providing minimum public transport services late at night
- Ensuring minimum levels of flood immunity on some rural roads
- Ensuring road width for volume standards on low volume rural roads or

In setting standards, the implementation of those mandates can be considered as fulfilling community service obligations (CSO). Taplin (1980)[6] discusses some of the issues in integrating CSOs into economic appraisal of standards.

Where traffic volumes or patronage volumes are high it will be easier to provide a level and quality of service that meet the objectives of being equitable, being economically efficient and meeting community expectations. However, in low demand situations, it is more difficult to achieve all these objectives, with trade-offs likely.

[6] Taplin in referring to the gap between 'politically' determined and economically determined road standards noted that
"In arguing that these deviations may result from proper assessment of those objectives of government which are not embraced by present evaluations. I am prepared to entertain either of two alternative views. One view is that there are matters of importance to Australians and their governments which should be taken into account in road investment decisions but which cannot readily be covered by economic evaluation and optimisation techniques. The other view is that these other matters might simply involve the revelation of values and preferences not yet included in the economic assessment processes; in principle, they should be just as much a part of economic assessment as the things directly counted."

In the roads context, some arterial roads can carry traffic volumes in the low hundreds of vehicles per day. Providing standards in terms of, for example, road ride quality, shoulder condition, rest area provision and flood immunity similar to those on arterial roads carrying thousands of vehicles per day will be challenging to justify economically. In the public transport context, providing acceptable service frequencies in outlying metropolitan areas or in regional centres, or providing services late at night may be difficult to justify economically. Nonetheless, such outcomes may be expected by the community and warranted on equity and other social policy grounds. In all these circumstances, minimum standards may be adopted by government on equity grounds, or in response to community expectations (expressed directly or indirectly through the political process) or some combination of both, that are greater than economically justified standards.

Where adopted, minimum standards could represent an appropriate starting point for establishing higher-than-minimum standards where activity volumes warrant. In effect, the minimum standard would be the Base Case in an incremental CBA (as outlined in section 3.1.2) to establish the economically best standard. This approach is suitable when the minimum standard is below the economically best standard.

If the minimum standard is above the economic best standard, and one wanted to find the economically best standard, implement the following approach. Start the incremental CBA with an arbitrarily low standard as the Base Case, e.g. a single lane unsealed road; two or three hourly night time public transport frequencies; one day a week freight train services; etc. Then progressively work upwards by increasing the standard.

Section 1.2 of NGTSM Volume 5 (ATC 2006) provides a more detailed discussion of economic and non-economic considerations in standards setting..

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