



Transport for NSW Cost-Benefit Analysis Guide

This guide applies to all agencies within the NSW
Transport cluster

Evaluation & Assurance
Group Finance & Investment
Corporate Services

Foreword

Customers are at the centre of everything we do at Transport for NSW (TfNSW). We're delivering the largest transport infrastructure program this nation has ever seen – \$55.6 billion of investment over four years to 2022-23 for game-changing projects like Sydney Metro, light rail, motorways and road upgrades.¹ The investment decisions we make today will deliver benefits to the community for decades to come.

When making investments for the people of NSW we need to use an evidence-based approach which considers all costs and benefits. Cost-benefit analysis (CBA) does exactly that. It balances a complex set of community considerations against limited resources and is the government's key tool for promoting value-for-money decision-making.

The Transport for NSW Cost-Benefit Analysis Guide (Guide) sets out the principles, concepts, methodology and procedures to use when conducting CBA for NSW Transport cluster initiatives. Importantly, the Guide steps through a robust framework for decision-making, as well as how to organise and present the evidence that supports them. It is supported by a suite of products including user-friendly models and recommended economic parameter values.

The Guide aligns project evaluation to Future Transport Strategy 2056 outcomes, promoting their consideration from project conception. The use of this guide is encouraged to ensure we consistently put value-for-money and outcomes for the community at the centre of our expenditure decisions.

The Guide is being continuously improved. Values are updated annually and methods periodically reviewed. We welcome all feedback that can help us improve this document. Please direct this to the TfNSW Evaluation and Economic Advisory team at: EconomicAdvisory@transport.nsw.gov.au

¹ NSW Treasury 2019-20 Budget Paper, Chapter 5

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1 Introduction

1.1 Cost-benefit analysis

Cost-benefit analysis (CBA) is the preferred evaluation method of the NSW Government and the NSW Transport cluster. It is a required part of a business case to support funding proposals, in line with NSW Government policy. It aims to measure the full impacts - economic, social and environmental - of a decision on the NSW community, including individuals, firms and the government. CBA considers both qualitative and quantitative impacts of an initiative and estimates the costs and benefits, wherever practicable, in monetary terms.

CBA measures the incremental costs and benefits involved in an initiative, relative to a situation without the proposed action.

1.2 Objective of this document

The NSW Transport cluster needs to make robust expenditure decisions – decisions that are maintaining and evolving the transport network and delivering benefits to the community of NSW for decades to come. The Transport for NSW Cost-Benefit Analysis Guide² (Guide) provides a consistent, best-practice framework to help the NSW Transport cluster conduct evaluations.

This document is intended to support clear thinking, good judgement and informed decision-making. It includes recommendations for CBA as part of business cases within the NSW Transport cluster, but is not intended to enforce blind compliance with a particular approach where it is not applicable. It is meant to guide, support, complement and enhance, rather than replace, the user's independent thought and understanding.

1.3 Alignment to other guidance documents

This document should be read in conjunction with the [Future Transport 2056 Strategy](#), which sets the 40 year vision, direction and outcomes for transport in NSW, and will guide transport investment over the longer term. It promotes flexibility and agility in the investment planning process, which should be reflected across the investment and planning approach, including in the CBA.

This document aligns with the high-level guidance in NSW Treasury's [NSW Government Guide to Cost-Benefit Analysis](#) and provides specific advice tailored to transport initiatives.

The Australian Government coordinates a national approach to project assessment, with the States and Territories, through the [Australian Transport Assessment and Planning \(ATAP\) Guidelines](#). ATAP aims to provide nationally consistent and best practices guidelines and recommendations, although these may not always be appropriate in the NSW context.

For initiatives seeking Federal Government funding, it is recommended that the [Infrastructure Australia Assessment Framework](#) (IAAF), the ATAP guidelines and this document be read in conjunction. Projects seeking federal funding need to align with IAAF. Requirements for smaller projects may differ.

² This document was previously the 'Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives' (often referred to as the 'Guidelines').

[The Notes on Administration for Land Transport Infrastructure Projects](#) provide administrative guidance for managing projects to be funded under the National Partnership Agreement.

1.4 How to use this document

The Guide is a framework for conducting CBA for transport initiatives and forms part of a suite of products. The target audience for the Guide is management, senior project representatives and project teams. This document is not targeted towards experienced CBA practitioners - who may find themselves familiar with much of its content. However, key recommendations the CBA practitioner needs to comply with can be found throughout this document in **bold text** for ease of use.

Other CBA guidance products are tailored towards CBA practitioners, such as the [TfNSW Economic Parameter Values](#) (previously Appendix 4 of the Principles and Guidelines: Economic Appraisal of Transport Investments and Initiatives), and can be found on the TfNSW website.

Table 1: Structure of this document

Section	Key Audience	Focus
2. Why is a cost-benefit analysis needed?	Senior project representatives	What is needed and why
3. The scope of a cost-benefit analysis	Those new to CBA or refreshing knowledge	Core concepts for cost benefit analysis, common concepts and issues, and an overview of the process for undertaking CBA Recommendations for CBA practitioners to be aware of are in bold text
4. Cost-benefit analysis concepts	Project teams and CBA practitioners	
5. The key steps in doing a cost-benefit analysis		
6. Common mistakes and issues		
7. When to ask for help		

Feedback or questions regarding the Guide should be directed to the Transport for NSW (TfNSW) Evaluation and Economic Advisory team at: EconomicAdvisory@transport.nsw.gov.au

2 Why is a cost-benefit analysis needed?

CBA is a NSW Government compliance requirement for establishing value-for-money within a major business case. It is also good practice for supporting informed decision-making.

2.1 What is cost-benefit analysis?

CBA considers the economic, social and environmental costs and benefits of an initiative. It measures them in monetary terms, wherever practicable, and determines if the benefits outweigh the costs. It aims to measure the full impact of the initiative on the community of NSW, including firms, individuals and government. When costs or benefits do not have a readily observable monetary value, CBA valuation principles are used to estimate the impact of the initiative.

2.2 What is a business case?

A CBA is a crucial component of a business case. A business case is a documented proposal to meet the Government's objectives that is used to inform an expenditure or policy decision. A CBA provides evidence to support the narrative in a business case about why change is needed and why a particular option is proposed.

A business case is a management tool, used as a "living document", which is developed and updated to reflect the priorities of investment stages – from making a case for change at the concept stage all the way through to benefit realisation and post-implementation review.

Ideally, the business case will move from the assessment of a long list of alternative solutions (options) in the strategic business case to consideration of two to three detailed options in the final business case. CBA is an important part of the process for assessment and selection of preferred options as the project team moves through this process.

For further information refer to the TfNSW Business Case Guide.

2.3 When is a cost-benefit analysis required?

CBA is a necessary part of compliance with government assurance as well as funding approval requirements for major initiatives. Compliance requirements for NSW Transport cluster initiatives are outlined in **Table 2**.

Table 2: Compliance requirement for CBA

Government entity	Compliance requirement
NSW Transport cluster	A CBA is required to ensure value-for-money, to meet external assurance and funding requirements, to manage internal resources and risks, and to seek internal funding.
NSW Treasury	A CBA is required for initiatives covered by NSW Treasury's Cost-Benefit Analysis guidelines, Business Case guidelines and NSW Gateway Policy, including capital expenditure \geq \$10M, ICT and major recurrent expenditure.
NSW Cabinet	A CBA, as part of a business case, is required for major policy and expenditure decisions.
Infrastructure Australia (IA)	A business case is required for initiatives of national significance \geq \$100m. An assured business case is required for Cabinet funding approval*.

Source: NSW Treasury, Infrastructure Australia, Department of Premier and Cabinet. Note: The requirements in this table are under review by a number of Government entities and may change in the future.

* A CBA is a critical component of a business case

However, CBA brings value to a project and should not be thought of as simply a compliance exercise. Project teams will find that a CBA brings value to the: development of options; management of delivery; and assessing benefits realisation.

Even for smaller project when a CBA is not a compliance requirement, providing evidence of thinking about value-for-money for the customer, monetising costs and benefits and evaluating a wide range of options is good practice. It helps ensure an initiative delivers value-for-money for the community of NSW in line with NSW Government and NSW Transport cluster strategies and objectives.

A CBA is required for all major investment decisions. This is still the case when a single or limited number of options are asked to be considered, for example in an election commitment. In such situations, government decisions should be implemented but a CBA ensures project risks are diligently identified, superior solutions are not overlooked, benefits are documented and a basis created for ex-post evaluation and improvements to future initiatives.

Further information can be found in the [NSW Government Business Case Guidelines](#) and [INSW Project Assurance](#). For information on the internal processes at TfNSW contact the Assurance team in Corporate Services or the TfNSW Investment Priorities team in Strategic Investments.

2.4 What is a CBA used for?

The CBA informs the selection of a preferred option in a business case. It also demonstrates whether a project is value-for-money and should be considered for further investigation or funding.

A CBA should demonstrate that the preferred option is aligned to the NSW Government and NSW Transport cluster strategic objectives. Future Transport 2056 provides a framework for planning and investment to support a modern, innovative transport network. The CBA can be used to quantify the impacts that a project will have towards achieving these outcomes.

The CBA is also a critical part of NSW Government compliance and assurance process; for example, passing through INSW Gates 1, 2 and 6.³ At each of these stages, the CBA will be assessed to ensure it is fit for purpose and may be required to address minor issues or undergo major rework in order for the project to proceed.

NSW Transport cluster project teams should engage early and often in CBA and business case development to ensure they meet the relevant compliance requirements of the responsible stakeholders.

³ [INSW Gateway Reviews](#): range of options analysed (Gate 1), ability of the preferred option to meet the service need (Gate 2), benefits realised (Gate 6).

3 The scope of a cost-benefit analysis

The CBA should reflect NSW Government and NSW Transport cluster strategies. The size and detail in the CBA should be scaled to the risk, value and complexity of the initiative.

3.1 Ensuring strategic alignment with Future Transport 2056

The CBA must align with Future Transport 2056. The Future Transport Strategy outlines the NSW Government’s vision for transport in NSW and provides the frameworks and planning approaches to achieve them.

The Future Transport Strategy acknowledges the vital role transport plays in land use and the economic development of towns and cities. It includes plans that shift the focus away from individual modes of transport and toward integrated solutions. It also focuses on the role of transport in the character of a place and its community.

This has implications for the development of business cases and CBA. It impacts the transport problems to be solved and the types of solutions that are considered. Importantly, the CBA should be linked to achieving one or more of the six outcomes listed in the Future Transport Strategy (**Figure 1**).

Figure 1: Outcomes – The Future Transport Strategy



Source: p15, [Future Transport Strategy](#), March 2018, TfNSW

While the Future Transport 2056 sets the 40 year vision, the [10 Year Blueprint](#) lays out where we need to focus in order to best respond to the challenges and opportunities we are seeing and lays out our desired outcomes, ambitions and strategic priorities for the next 10 years. Refer to the [10 Year Blueprint](#) page 24 for details on 10 year ambitions and key things to measure.

Refer to the TfNSW Business Case Guide for further guidance on alignment of the investment proposal to the Future Transport Strategy outcomes.

3.1.1 A flexible and agile planning process

The Future Transport Strategy sets the 40 year vision guiding transport investment over the long-term. The strategy promotes flexibility and agility in the investment planning process by emphasising five activities:

- **Optionality:** business cases need to test a range of scenarios, as well as embedding flexibility into the design of infrastructure projects
- **Short-term goals for long-term change:** the initial focus should always consider changes in services, policy, demand management or technology with shorter lead times – and without significant capital investment
- **Collaborating with our customers and stakeholders:** project development should include embedding continuous and close consultation with industry, the technology sector, customers and communities to maximise benefits
- **Committing to continuous improvement:** the Future Transport Strategy 2056 is a ‘living’ strategy that allows adjustment and changes as needed
- **Planning for outcomes:** transport planning will move away from individual modes and focus on delivering flexible, integrated solutions for customers and the broader community.

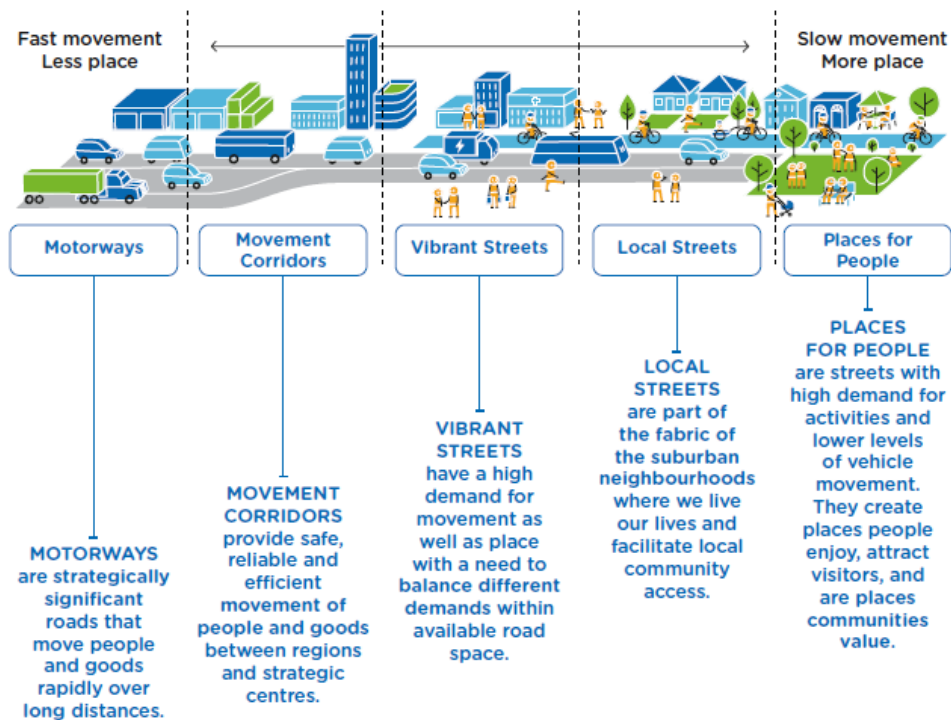
Flexibility and agility need to be built into the investment planning approach and reflected in the CBA. This includes a shift towards multi-modal, customer-focused outcomes that consider movement and place, rather than single mode, single solution approaches.

The CBA should also reflect the impacts of changing transport technologies on the NSW community. For example, increased use of connected and autonomous vehicles (CAVs) may have implications on realising future safety and sustainability benefits estimated in a CBA.

3.1.2 The movement and place framework

Movement and Place is a key process for understanding places and transport’s contribution to their success. The Future Transport 2056 Strategy includes the Movement and Place Framework. The Movement and Place Framework is a tool to manage the transport network so that it supports safe, efficient and reliable journeys while enhancing the liveability of places (**Figure 2**).

Figure 2: The Movement and Place Framework



Source: p85, [Future Transport Strategy](#), March 2018, TfNSW

The Movement and Place Framework acknowledges corridors and places as both a destination and as a means to move people and goods. For a CBA, it impacts the potential options being considered as well as the types of costs and benefits which are included in the analysis.

There are several ways to quantify the benefits of place making, including the assessment of improved land value and urban amenity. However, further research and guidance is required to improve the consistency with which place making benefits are quantified by CBA practitioners.

TfNSW will release a technical note on placemaking considerations for a CBA as one of the supporting documents to the Guide.

3.2 Determining the scope of analysis

The CBA should be fit for purpose as a tool for investment decision-making. The level of analysis, the documentation that is required, and the number of options considered in a CBA depends on:

- the scale, type and reason of the initiative
- the level of uncertainty with relation to the costs, delivery and outcomes
- the stage in the planning and assessment process the initiative is at
- the time and resources available to develop alternatives
- the clarity of the link between the benefits from the initiative and the specified outcomes.

The level of analysis can be reduced to align with the value and risk of the initiative. For example, for a smaller project, input data may be from a traffic count rather than a simulated forecast.

3.2.1 Determining the base case

CBA compares the costs and benefits of doing something (i.e. the project options) against a base case (the 'business as usual' or 'do minimum' scenario).

The base case is a realistic assessment of what would be done in the absence of the project case. It is not a 'worst case' or 'do nothing' option, and should include a reasonable level of the expenditure required to maintain the existing level of service. This will generally include not only relevant initiatives that are already committed and funded, but also carefully consider the minimum initiatives that are needed to maintain the level of service in an area – particularly in areas impacted by rapid population growth.

Specifying the base case is important because it impacts on the attribution of estimated benefits and costs to the project options being assessed. A poorly specified base case will bias the assessment of the project options, compromise the analysis and distort the investment decision being made.

Additional guidance to assist with specifying the base case for a transport CBA can be found in **Section 5.3.1**.

3.2.2 Determining the project options

As a general guide, **there should be a minimum of three alternatives to the base case considered for major investments (≥\$10 million) at the strategic business case stage, and two to three alternatives at the final business case stage. For smaller projects, at least two alternatives, preferably more, should be considered.** It is recommended that a range (long list) of alternatives are represented in terms of technology, mode, demand, or timing. Only technically and economically feasible options should be considered for detailed analysis.

Additional guidance to assist with specifying the determining project option can be found in **Section 5.3.2**.

3.3 Determining a preferred option

The most common measure for comparing options is the Benefit Cost Ratio (BCR), which shows the relationship between total costs and benefits, with a value over 1.0 indicating a project results in a net benefit to the community. An equally important key measure is the Net Present Value (NPV), measures the extent to which the total benefits to the community are larger or smaller than the total costs to the community of the project.

The BCR and the NPV should both be considered to determine the preferred option. CBA is an important tool to assist in decision-making but should not prevent flexibility where other factors are considered important to the community. This includes qualitative factors and other considerations, such as equity concerns.

3.4 Additional resources

3.4.1 Other strategies and priorities

Future Transport 2056 is the primary strategy document for the NSW Transport cluster. However, other strategy documents exist which may help to inform the strategic alignment of business cases and CBA, including:

- the [NSW State Infrastructure Strategy 2018-2038](#) that sets out the Government's infrastructure vision over the next 20 years, across all sectors
- the [Greater Sydney Region Plan](#) for transforming Greater Sydney into three distinct but connected cities
- the [Greater Sydney Commission's five District Plans](#) which act as a guide for implementing the three-cities vision
- the [Regional Development Framework](#) that provides an overall government vision for services and infrastructure in regional NSW
- the [Premier and State Priorities - a vision for New South Wales](#) which includes priorities for all NSW government agencies
- the [10 Year Blueprint](#) which lays out the desired outcomes, ambitions and strategic priorities for the next 10 years.

3.4.2 Other CBA guidance

The basic theory, principles and approach to CBA are well established and recognised across NSW government and the NSW Transport cluster. General guidance can be found in the sources below, in textbooks⁴ and widely available on the internet. While informed by theory and practice from other guidelines, this document differs from other sources as it is focused on the practical application of CBA to decisions in the NSW Transport cluster.

⁴ For example: Boardman et. al. (2018) Cost-Benefit Analysis: Concepts and Practice

Table 3: Supporting guidance and framework

Document	Owner	Focus
NSW Government Guide to Cost-Benefit Analysis	NSW Treasury	Applied across the NSW Government, including the NSW Transport cluster, and has broader recommendations on the application of CBA.
Investor Assurance (Gateway)	NSW Treasury/ Infrastructure NSW	Gateway is assurance, independent of the project team. There are three Gateway Coordination Agencies (GCAs) who each have developed relevant frameworks: <ul style="list-style-type: none"> • Infrastructure NSW (INSW) for capital investments • the Department of Finance Services and Innovation (DFSI) for ICT investments • NSW Treasury for major recurrent expenditure.
Infrastructure Australia Assessment Framework (IAAF)	Infrastructure Australia	Initiatives seeking Federal Government funding must align to the IAAF. The IAAF sets out the process IA uses to consider initiatives for inclusion in the Infrastructure Priority List.
Australian Transport Assessment and Planning Guidelines	Transport and Infrastructure Council	ATAP provides a comprehensive framework for planning, assessing and developing transport systems and related initiatives. The ATAP Guidelines have been referred to for best-practice throughout this document. ATAP aims to be nationally consistent, however some recommendations may not be appropriate in the NSW context.

4 Cost-benefit analysis concepts

This chapter explains concepts and principles commonly used in CBA, and how they apply to transport initiatives. It also provides an illustrative example which demonstrates many of the concepts.

4.1 Cost-benefit analysis concepts

There is a view that CBA, and economics in general, focuses on the theoretical and abstract rather than on practical considerations. This is not so. A CBA involves a structured way of thinking about, measuring and presenting evidence to support an informed decision.

Based on applied microeconomics and welfare economics, the CBA approach finds monetary values to support pragmatic decisions about what is in the best interests of the community.

4.1.1 Opportunity cost

Opportunity cost is the value forgone by society from using a resource in its next best alternative use. The opportunity cost of making a decision is the value of the second best option, which would have been chosen if the preferred option was not taken. For example, the value of a commuter's travel time is linked to what else they could have been doing - the additional income they could have earned from working, or the enjoyment they could have had from leisure.

4.1.2 Resource cost

CBA uses the resource cost, which is the opportunity cost of resources used, measured from the point of view of society as a whole. Differences between perceived and resource costs arise when, for a given cost, the opportunities forgone are different for the individual incurring the cost than for society as a whole.

Perceived costs reflect the costs taken into account for decision making, e.g. the behavioural costs used in demand modelling. Taxes, subsidies, tariffs, externalities, and non-competitive pricing can all cause resource costs to differ from perceived costs. CBA uses resource costs to determine the net benefit to the community, and so excludes taxes and subsidies, which are financial transfers that do not reflect actual changes in welfare. CBA practitioners must also incorporate externality impacts (e.g. air pollution, greenhouse gas emissions, noise) into the measures of consumer and producer surplus in order to capture the full resource costs of a project.

CBA practitioners must occasionally correct for the differences between perceived and resource costs to ensure that only real welfare changes, and not transfers, are included in the CBA. These adjustments are sometimes referred to as 'resource cost corrections'.

4.1.3 Sunk Cost

Sunk costs are past costs that cannot be recouped. Because CBA is about decisions being made now about the future, past costs that cannot be changed are considered to be irrelevant and as such **sunk costs are not included**. Even if a large amount has been spent in the past on developing an option it will not be preferred if a better option is now available, or the benefits of continuing no longer outweigh the remaining costs. For example if a rail freight line is under construction but the industry it is to

support becomes uneconomic and no longer justifies the remaining costs, construction should cease.

4.1.4 Valuation principles

The **values used in CBA can be based on either observed market prices, estimated from people's behaviour or found by surveying** and asking people what they value.

In a competitive market the price of a good or service should represent the value placed on it by a consumer. Market-based valuations can provide much of the information required in a CBA for a transport initiative, particularly for estimating cost.

Where a competitive market price is not available then valuation methods can be used to find the consumers' willingness-to-pay (WTP). WTP is the amount an individual would be willing to pay for a good or service or to avoid an undesirable outcome. For example, a reduction in travel time for a commuter means they can spend more time at work or on leisure activities but the value a commuter places on reduced travel time does not have a readily available market price.

The stated preference method asks people for their preferences through surveys. Done carefully, this provides a measure of what the community values. For example, stated preference surveys are used to value travel time savings, to value seating over standing on public transport, and the cost of having to change modes as part of a trip (for example from train to bus).

Revealed preference methods examine consumers' behaviour to estimate their WTP. For example, the price premium on house prices in a suburb near a railway station, compared to a similar suburb away from rail transport, could reveal how much people value and are willing to pay to live near a rail link. Similarly, the amount of time and cost people are willing to spend to travel to a remote national park can reveal how much they value the park. Done carefully with appropriate data revealed preference methods can be used in a CBA to measure what the community values.

4.1.5 Referent group

The referent group is a group of individuals deemed by the decision-maker to be relevant for the purpose of CBA. For NSW Transport cluster CBA analysis the **referent group is the community of NSW**, consistent with NSW Treasury guidelines.

In practical terms, all parties are considered in the CBA. Given the nature of the economic activity and transport patterns in NSW, it is expected that some interstate and overseas parties will be involved in most projects. However, for the majority of initiatives these impacts will not be material and explicitly specifying the referent group and excluding non-NSW parties will not be required.

The referent group only needs to be explicitly investigated for projects which involve significant costs and benefits to non-NSW parties (this may include cross-border, interstate, international and non-traditional transport projects).

4.1.6 Transport modelling and forecasting

Transport models provide forecasts of future travel. These forecasts are important inputs into the CBA and may determine the majority of the economic benefits of a project. Modelling is done to forecast impacts under the base case and options and needs to be both internally consistent and aligned with strategic forecasts.

In NSW, there are several transport models used as inputs to CBA. These include:

- Sydney Strategic Travel Model (STM)
- Public Transport Project Model (PTPM)
- Sydney Strategic Motorway Planning Model (SMPM)
- Enhanced Train Crowding Model (ETCM).

There is also a more general road traffic model for Sydney greater metro area which is the Strategic Traffic Forecasting Model (STFM) housed in TfNSW Network Asset Intelligence (NAI).

For further information refer to **5.4.1**.

4.1.7 Appraisal period

The **appraisal period of a CBA should reflect the expected economic life of an asset or initiative** (including the initial development and delivery time). The expected economic life of the asset is the operating phase of the asset until an asset needs replacement or the cost of operation exceeds the benefits it delivers.

The NSW Government CBA Guide recommends a practical asset life of 20-30 year appraisal period for major new capital expenditure across NSW Government. In practice transport assets typically last a lot longer than this. The appraisal period can be assessed on a case-by-case basis depending on the nature and economic life of an initiative. ICT projects may have short lives of 3-5 years.

The Evaluation and Assurance team can advise on proposals adopting appraisal periods beyond the NSW Government Guide's recommended 20-30 years, to check the plausibility of data and assumptions over longer time periods. For long lived assets such as rail, tunnel and bridge infrastructure, an appraisal period of 50 years may be more appropriate. A residual value based on replacement cost or the present value of future benefits can also be included in the final year of the appraisal period. **CBA should not use an appraisal period greater than 50 years.**

For recurrent expenditure, agencies are advised to seek advice as the relevant analysis period could range from a year, for an ongoing program, to multiple years if there is a known project end date.

The appraisal period start date is measured from the completion of capital works, or from the start of full operations, and should be kept consistent between all alternative options that are assessed. Costs and benefits incurred before the appraisal period begins should still be included in the CBA at their current opportunity cost, provided they are not sunk costs.

For projects seeking federal funding, the IAAF requires a justification for the proposed asset life evaluation period that involves long-term modelling of the transport network.

4.1.8 Real prices, escalation and inflation

CBA values should be calculated and reported in real prices (with inflation impacts removed). That is, excluding increases in prices due to inflation. This is because inflation is a change in the unit of measure, the value of money, not in underlying values. Inflation causes costs and benefits that occur later to appear artificially higher. A CBA should specify the common base year on which real dollar values will be compared, for example real 2019 dollars.

In some cases real costs and benefits need to be adjusted for changes in relative values where a specific input or output price is expected to change at a rate significantly different from the general inflation rate. In such cases the CBA should document the assumptions used.

4.1.9 Social discount rate

The discount rate adjusts for people's preference to consume goods and services today, rather than in the future. Discounting allows for decisions to be made today about initiatives that have costs and benefits in the future. This discounting is separate from adjustments made for inflation, which should be done before discounting cash flows.

TfNSW, in alignment with NSW Government guide to cost-benefit analysis, recommends a central or reference discount rate of 7 per cent (in real terms) with sensitivity testing undertaken at 3 per cent and 10 per cent. Projects seeking Federal Government funding, should also check IA's recommended real discount rates and sensitivity range.

A standard 7 per cent discount rate allows for consistent comparison across NSW government initiatives, and values of 3 per cent and 10 per cent represent a meaningful range to test whether the outcome of a CBA is very sensitive to the choice of discount rate.

The nature of a project is also important to consider when using discount rate sensitivity testing to inform a decision. The narrative supporting the decision on a project with a short term and a commercial focus may place considerable focus on the upper 10 per cent discount rate outcome. The narrative supporting the decision for major projects which have long lives, large impacts and a strategic focus may place more emphasis on the project's value to society in the future, as reflected in the lower 3 per cent discount rate values and BCR.

The social discount rate only reflects systematic, unavoidable market risk. Should a project have a higher degree of risk than another, this should be reflected in the quantification of costs and benefits using expected values.

4.1.10 Discounted Cash Flow and Present Values

A CBA requires costs and benefits to be evaluated on a common basis. This requires discounting future values to present values to allow a comparison of values over time from a common base year.

Discounted Cash Flows are streams of costs and benefits which have been converted into present values through removing the impact of inflation, adjusting for price escalation and discounting using a social discount rate. This allows for comparison of options where the costs and benefits occur at different points in time.

For CBA, present values are used to calculate both the BCR of an initiative and the NPV, which are decision criteria used to compare options and assess value-for-money once a CBA has been undertaken.

4.1.11 Net Present Value and Benefit Cost Ratio

The NPV and BCR show, for a given discount rate, when the benefits exceed the costs of an initiative. **Where the NPV and BCR result in a different ranking of alternative project options, the preferred portfolio approach is to rank options based on the BCR.**

The NPV is the sum of the discounted project benefits that have been valued, less discounted project costs. An initiative may be worthwhile if the NPV is positive, indicating that it results in an overall benefit to the community. The NPV can be used in comparing projects, but should be viewed together with the overall size of the initiative, risk and non-quantified factors.

The BCR is generally expressed as the ratio of the present value of benefits to the present value of costs. Based on the assumptions made and data available, a BCR greater than 1.0 indicates that the project results in a net benefit to the community.

The existence of funding constraints and mutually exclusive options should be considered when comparing NPV and BCR results.

4.1.12 The cost-benefit analysis as a living document

Ideally, a CBA should be a living document updated as projects, risks and circumstances evolve and change. A CBA, and the business case it informs, are a compliance requirement to support an investment decision and obtain funding for a project. However a compliance view limits the value CBA can add to the Transport cluster and the community of NSW.

The CBA process should help shape and document a decision being made and continue to support a decision in delivery and in operation (including benefits realisation management). A CBA and business case should be updated to reflect material changes in assumptions, scope, timing costs and benefits.

4.1.13 Financial appraisal

A business case contains both a financial appraisal and a CBA. It is important not to confuse them. The financial appraisal measures only the direct effects on an organisation's investment portfolio and includes financial, rather than economic, costs and benefits.

Financial appraisals are useful for all types of initiatives, including proposals that do not generate significant revenue streams, to understand the direct financial impacts on the organisation and state budgets. For further detail refer to [NSW Government Business Case Guidelines](#).

The results of a CBA alone are not sufficient to ensure a project will proceed. Ensuring financial sustainability of a project is an essential consideration and should influence the development and choice of options in a CBA.

Ensuring financial sustainability requires having a view about the longer term impact of the project on the cluster cost and revenue base and its opportunities to contribute to an improved cost recovery level within the cluster in addition to delivering customer outcomes. Refer to the TfNSW Business Case Guide for further guidance on financial sustainability.

4.1.14 Depreciation and interest

Depreciation and interest payments are not relevant to a CBA. This is because using a discounted cash flow approach removes the need to include financing charges. These concepts are relevant to the financial appraisal analysis.

4.2 Concepts in practice – a road congestion example

The starting point for any transport CBA is identifying the problem. This hypothetical example considers a bridge reaching its capacity which is experiencing increasing congestion in peak hour.

Analysis of the traffic crossing the bridge reveals that commuters spend an additional 15 minutes in traffic every morning due to the congestion – time that could have been spent eating breakfast with the kids, or finishing off a report in the office. Because these things have been given up to accommodate the additional travel time, they are the **opportunity cost** of the extra time needed to get across the bridge.

A project team is formed to investigate solutions that will decrease congestion. These solutions are not infrastructure or mode-specific, and include building a new bridge, adding a toll, or improving bus services and active transport connections for communities on each side of the bridge. When reviewing previous work done, they find that a geological survey of the river bed was undertaken to test feasibility for a new bridge at a significant cost. Because the costs of this investigation cannot be recouped, they are considered **sunk costs** and are not included in the CBA.

To compare the three alternatives, they choose a consistent **appraisal period** of thirty years for the CBA, reflecting the long asset life of the new bridge option. All the alternatives are assessed with the same appraisal period. The team uses **transport modelling** to estimate the transport network outcomes under a business as usual scenario (the base case) as well as the three alternatives over the entire appraisal period.

The demand modelling suggests that the options will impact travel times and mode choice for users across the city, not just those using the bridge, because they lead to widespread changes in travel behaviour. The benefits and disbenefits for all NSW community members (**the referent group**) are estimated, even if they never use the bridge in the base case or alternative options.

The team calculate the benefits of each option using estimates of the value of travel time taken from [TfNSW Economic Parameter Values \(EPV\)](#), which are based on willingness to pay surveys undertaken several years prior. These need to be **escalated** to 2019 dollars so that they are consistent with the **real prices** used in the rest of the CBA. Other research is used to value the lower convenience of having to travel in buses versus private vehicles, in line with CBA **valuation principles**.

Capital and operating cost estimates are prepared for the base case and alternative options. Two sets of costs are prepared – real cost estimates for the economic analysis, and nominal costs including **inflation** to be used in the **financial appraisal**, to inform funding decisions.

With transport demand and cost data available, the project team has enough information to undertake the CBA, using a **discounted cash flow** model to assess the capital and operating costs, and the economic, social, and environmental benefits for all years in the appraisal period.

While one alternative delivers benefits in the early years of the appraisal, the others have much higher benefits later on. A **social discount rate** of 7 per cent, reflecting the time value of money, is used to convert all values into a comparable **NPV**, so that all options can be compared on an equal basis in discounted, real 2019 dollars.

In this hypothetical example, the improved bus services have the highest **BCR** and is selected as the preferred option for a Final Business Case.

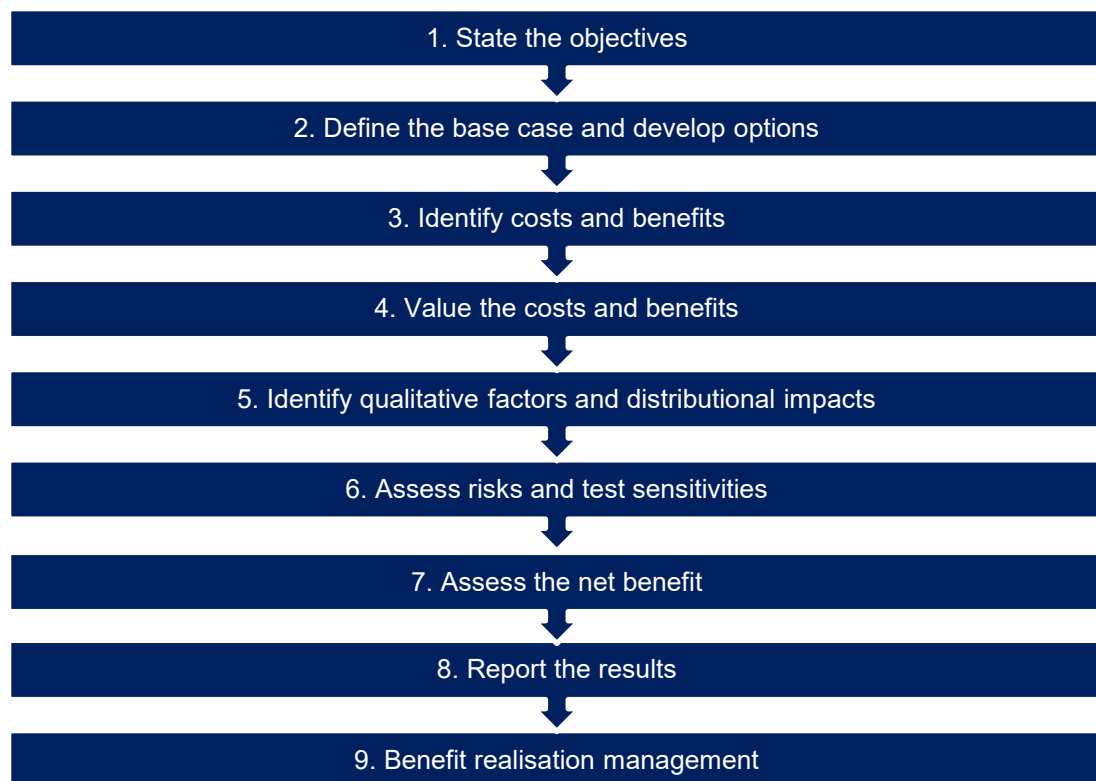
5 The key steps in doing a cost-benefit analysis

Following a structured CBA process ensures the analysis is robust and meets the requirements of the NSW Transport cluster.

5.1 The cost-benefit analysis process

The steps involved in a CBA are shown in **Figure 3**. While the process is shown in sequential steps it should be viewed as a logical sequence rather than a strict ordering of activities. A CBA, in coordination with the business case and project development, may evolve through many iterations, moving between and revisiting steps as the project matures.

Figure 3: The cost-benefit analysis process



Source: TfNSW based on NSW Treasury (2017).

5.2 Step 1: State the objectives

5.2.1 Define the case for change

Any evaluation of a proposed initiative should begin by defining the problem that the project is designed to alleviate. In order to justify an initiative, it is important to have a clear understanding of the need for investment, as this will help to inform the project objectives and range of potential options.

In some cases a project team will have a solution in mind before conducting the CBA. However, before a solution is chosen it is important to first:

- consider the outcomes for the customer which the project is trying to achieve
- consider how the project fits with the strategic direction of the NSW Transport cluster
- define the problem to identify the size of the issue, any timing considerations, and to gather evidence for a case for change
- an Investment Logic Map (ILM) can be prepared which will assist in defining the objectives of the project based on an understanding of the problems intended to be solved. This helps to ensure that the proposed project will deliver the forecast benefits identified in this business case. For further guidance refer to [Transport Benefit Realisation Management Guidelines](#).

5.2.2 State the project objectives and ensure alignment to Future Transport 2056 Strategy

Once a problem statement has been articulated, the evaluation of a proposed initiative should consider the project's objectives. When stating the objective, it is important to specify outcomes (reduced congestion, travel time savings, increase in mode choice options or services) rather than outputs (more vehicles supplied) or inputs (e.g. the building of so many kilometres of road).

In some cases the objective of a proposed project may appear to be self-evident; nevertheless, a project's objective must be explicitly stated and aligned with the NSW Government's strategic direction. It is important that all transport projects align with one or more of the outcomes outlined in The Future Transport Strategy:

- Customer Focused: Customer experiences are seamless, interactive and personalised, supported by technology and data
- Successful places: The liveability, amenity and economic success of communities and places are enhanced by transport
- A strong economy: The transport system powers NSW's future \$1.3 trillion economy and enables economic activity across the state
- Safety and performance: Every customer enjoys safe travel across a high performing, efficient network
- Accessible services: Transport enables everyone to get the most out of life, wherever they live and whatever their age, ability or personal circumstances
- Sustainability: The transport system is economically and environmentally sustainable, affordable for customers and supports emissions reductions.

5.2.3 Scope the proposal and determine the level of evaluation needed

Often the solution to a problem can involve many components. It is important to determine the level of aggregation to use in the CBA. For example, the upgrade of a rail corridor can include adding car parks and changes to the bus network.

In these circumstances it is the evaluation of the overall project which is critical, not just an evaluation of the individual components. However, if the analysis is too aggregated, some components of the project may be justified not on their own merit but because of the combined benefits of other components.

Clearly understanding the objective/s of the project, and exploring alternative options to meet the objective should inform how aggregated projects should be and the strategic alignment of the individual components.

All expenditures necessary for the achievement of the project's objective need to be in the evaluation. This includes multi-modal impacts, for example arterial roadworks

may also cause changes to public transport operating costs, which would need to be reflected in the CBA.

5.3 Step 2: Define the base case and develop options

5.3.1 Specify the base case

CBA compares the costs and benefits of doing something (i.e. the project options) against a base case (the 'business as usual' or 'do minimum' scenario). The base case is important because it impacts on the attribution of estimated benefits and costs to the project options being assessed. A poorly specified base case will bias the assessment of the project options, compromise the analysis and distort the investment decision being made.

Care should be taken to specify a realistic base case in the CBA. The base case is not a 'worst case' or 'do nothing' option, and should include a reasonable estimate of the expenditure required to maintain the existing level of service. This will generally include, at a minimum, relevant initiatives that are already committed and funded. It should reflect expected changes to population growth and distribution, government policy, and technology. For example, including expected increases in Electric Vehicle use may be an important consideration when specifying the base case for particular initiatives.

Defining the base case transport network and land use assumptions are particularly important for transport projects, as they can have material implications for the CBA results. Accountability to a project sponsor for correctly specifying these assumptions is held by the project manager, but should be informed by relevant guidance from TfNSW Evaluation & Economic Assurance, Infrastructure NSW, NSW Treasury, and Infrastructure Australia, as well as advice from demand modelling and CBA practitioners.

It is not sufficient for project managers to adopt publically available information without assessing whether that information is current and suitable for use in the base case. Clear thinking and good judgement should inform decision-making when specifying the base case for a NSW Transport cluster CBA. For example, broad assumptions from NSW Government land use forecasts or transport network strategies may not necessarily be appropriate for use in particular projects. NSW Treasury, Infrastructure Australia, and Australian Transport Assessment and Planning Guidelines provide additional guidance to assist with specifying the base case for a transport CBA (**Table 4**).

Table 4: Guidance for specifying the base case

Category	Guidance
General definition of the base case	<ul style="list-style-type: none"> • A 'real world assessment' of what would be done in the absence of the project case (IAAF and ATAP). • The scenario in which current arrangements are maintained (Productivity Commission). • The 'business-as-usual' or 'keep safe and operational' situation (IAAF). • In general, the base case will be a 'no policy change' scenario (NSW Treasury).
Cost requirements	<ul style="list-style-type: none"> • Be of modest cost (IAAF). • Include ongoing maintenance of associated assets for structural integrity and public safety (ATAP). • Not include significant asset enhancement, save where incremental capacity enhancements may need to be assumed in order to obtain realistic future demand estimates within the technical limitations of transport models (IAAF). • May involve deferral of replacement and continued maintenance and/or eventual replacement with a new asset of comparable standard to that being replaced (NSW Treasury).
Service level requirements	<ul style="list-style-type: none"> • Maintains the existing service levels possible, or avoids further degradation in service levels (IAAF). • The option that is most effective at maintaining level of service at least cost (ATAP).
Other network investments	<ul style="list-style-type: none"> • Include relevant initiatives elsewhere in the network where funding for those initiatives is approved, committed or expected (ATAP). • Includes any known and funded changes to infrastructure or services that will have occurred in the absence of the project case (IAAF).
Base case land use	<ul style="list-style-type: none"> • Base case and project case land use may differ where there is a land use response to an infrastructure investment (IAAF). • Good understanding of exogenous land use forecasts (e.g. from NSW Department of Planning, Industry & Environment) is required when specifying land use inputs. If exogenous forecasts already consider the provision of future transport infrastructure, they may be more appropriate for use in the project case rather than the base case (IAAF).

Source: TfNSW based on NSW Treasury, Infrastructure Australia Assessment Framework (IAAF), and the Australian Transport Assessment and Planning Guidelines (ATAP), Productivity Commission

For further reference to TfNSW Transport Performance and Analytics (TPA) list of major projects assumed for strategic modelling purposes, contact TPA@transport.nsw.gov.au

5.3.2 Specify the project options

As a general guide, **there should be a minimum of three alternatives to the base case considered for major investments (≥\$10 million) at the strategic business case stage, and two to three alternatives at the final business case stage. For smaller projects, at least two alternatives, preferably more, should be considered.** It is recommended that a range of alternatives are represented in terms of technology, mode, demand, or timing. Only technically and economically feasible options should be considered in the analysis.

Project options should be innovative and consider multimodal approaches as well as movement and place. The Future Transport 2056 Strategy encourages the use of scenario testing to discover solutions. For any transport problem there will be a range of potential solutions. For example, road congestion can be eased through: building wider roads, encouraging a mode shift to public transport, smart road infrastructure to manage congestion 'hot spots', or encouraging road users to re-time their discretionary travel.

For major projects, a long list of potential options should be developed in the strategic business case. An iterative approach should be adopted to reduce the number of options. Initially, high-level analysis can be used to screen out the least promising options, with increasing levels of accuracy used in the analysis as the process continues.

The short list of options should reflect NSW Government and the NSW Transport cluster strategic policy, and particularly outcomes identified in Future Transport 2056 Strategy. Within the business case, this strategic direction should be used to articulate a case for change and when determining the corresponding objectives of the initiatives. The business case objectives should then be reflected in the options and in the CBA.

As with the base case, poor specification of project options will compromise the analysis and distort the investment decision being made.

A CBA should consider a range of realistic options. This process is important as it encourages the project team to think creatively about a solution. It is not sufficient to only assess a single option or even a few options, or only consider one option in-depth and other options superficially.

5.4 Step 3: Identify costs and benefits

To systematically identify impacts, specific costs and benefits can be disaggregated into different categories. The identified costs and benefits should relate directly to the changes outlined in the project option. **Table 5** presents common costs and benefits found in transport initiatives, and a detailed list of benefits is provided in **Appendix A**.

Increasingly, non-traditional benefits are being included in CBA such as the impacts of a transport initiative on movement and place. It is important to ensure that these non-traditional benefits represent real increases in welfare and not the transfer of initial benefits from one party to another.

Table 5: Common transport cost and benefit items

Category	Item
Benefits	
User benefits	travel time savings vehicle operating cost savings reliability improvements reduced crowding
Social benefits	environmental externalities health benefits from active transport safety benefits decongestion benefits
Government benefits	incremental fare-box revenue avoided capital costs avoided recurrent costs residual value
Disbenefits	additional crowding increased walk or transfer time
Other benefits	wider economic benefits land value uplift option values and non-use values improvements to place
Costs	
Capital costs	direct construction costs asset replacement costs major periodic maintenance site remediation
Recurrent costs	operating costs maintenance costs

Source: TfNSW based on NSW Treasury, Infrastructure Australia, and the Transport and Infrastructure Council.

5.4.1 Undertake transport modelling

In almost all cases a proposed transport initiative will be designed to address customer demand. For this reason, transport modelling or forecasting is frequently needed to determine the impacts of an initiative on customer usage and therefore pivotal in providing monetised inputs to the CBA.

Transport models provide forecasts of future travel. These forecasts are important inputs into the CBA and may determine the majority of the economic benefits of a project. Forecasts must be done for the base case and options and needs to be both internally consistent and aligned with strategic forecasts. Forecasts do not always require a complex transport model – for some smaller projects, simple forecasts may be projected from base travel data, using assumed changes in population or trip incidence.

Different types of transport models may produce estimates of travel demand (e.g. the desired amount and location of travel from transport users, unconstrained by network capacity) or of traffic (e.g. the operational performance of a highway up to its maximum capacity).

In NSW, there are several transport models used as inputs to CBA. These include the Sydney Strategic Travel Model (STM), the Public Transport Project Model (PTPM), the Sydney Strategic Motorway Planning Model (SMPM), and the Enhanced Train Crowding Model (ETCM). There is also a more general road traffic model for Sydney

greater metro area which is the Strategic Traffic Forecasting Model (STFM) housed in TfNSW Network and Asset Intelligence (NAI).

Many of these models produce estimates of travel for an AM peak period only - where this is the case, CBA practitioners must use 'expansion' factors to estimate the impacts for a full day, and 'annualisation' factors to estimate the impact for the entire year. The choice and application of different factors is a major assumption for the CBA (guidance for this can be found in the [TfNSW Economic Parameter Values](#)). Transport models may only be used to forecast travel at a selection of points in the future, and the results for other years must be interpolated or extrapolated in order to estimate benefits for the full appraisal period.

Transport modelling questions, as well as questions on network assumptions, are best answered by TfNSW Transport Performance and Analytics (TPA) in the Customer, Strategy and Technology Division.

5.5 Step 4: Value the costs and benefits

5.5.1 Value the incremental cost of the project

A robust CBA needs comprehensive and accurate cost estimates that are able to be easily and clearly traced, replicated and updated. These expenses are generally estimated by a quantity surveyor, construction economist, or cost manager.

The standard for cost estimation can be found in the [Cost Estimation Guidance](#) by the Australian Government of Department of Infrastructure, Transport, Cities and Regional Development (DITCRD). For large projects, especially those seeking federal funding, DITCRD's cost estimation guidance should be followed and requires highly accurate estimates, including probabilistic cost estimation and itemised costing from first principles.

The cost estimates used in a CBA differ from the cost estimates used in a financial appraisal. CBA uses real costs, discounted to present values using the social discount rate. Financial appraisals tend to report costs in nominal dollars and may use a different discount rate to the CBA.

5.5.1.1 Level of accuracy

The NSW Government recommends the use of probabilistic modelling approaches to be informed by actual experience of project managers, service delivery officers, legal or other experts who are able to identify and place a value on salient risks (NSW Treasury 2017).

In practice, the accuracy of project estimates should increase during the decision-making process in keeping with available information about the project options. At the planning stage, estimates are likely to be less accurate than final out-turn costs. While early estimates may not be as accurate as final cost, planning estimates are generally accurate in relative terms so they provide a reasonable basis for the ranking and initial screening of options.

The cost of gaining greater accuracy should also be considered. For early stage investigations and unfunded transport projects the amounts spent on accurate cost estimations should be enough to support an informed choice and not necessarily be definitive.

For projects not seeking federal funding, **where possible TfNSW recommends that expected value should be used for the CBA as a preference over the P50 value but estimates at P50 value can be used in the CBA.** The project risk profile, life cycle phase, delivery strategy and the expertise available to the project team also need to be considered in deciding on the accuracy of cost estimates.

Cost estimates in a CBA should be clear in stating the level of coverage, completeness and accuracy involved, with particular care exercised in the public release of cost estimates that are preliminary or likely to be revised.

5.5.2 Value the incremental benefits of the project

In CBA, an economic benefit is any positive or negative consequence to the lives of a person in the referent group that will result from the project.⁵ When determining the value of a benefit, the principle guide is the dollar amount that individuals would be willing to pay for them. In some cases individuals do not accurately perceive prices, or do not perceive all of the costs or benefits of a good – where this is the case, resource costs for an impact may be determined using another approach.

A large body of academic research and practical guidance exists that provides standard, accepted approaches to the valuation of transport impacts. For NSW Transport cluster CBAs, the [TfNSW Economic Parameter Values \(EPV\)](#), provides recommended values appropriate for the NSW context.

5.6 Step 5: Identifying qualitative factors and distributional impacts

5.6.1 Undertake distributional analysis

Distributional analysis looks at the impact of the initiatives on equality in the community. For example, improved public transport in remote areas could reduce travel cost and improve access to education for isolated communities but be more expensive than improvements in city suburbs.

TfNSW supports undertaking distribution analysis as a supplementary information in a CBA. A CBA should present distributional analysis whenever possible to supporting an informed decision.⁶

Distributional analysis is important when equity and distributional impacts are a key part of the policy objectives being addressed. It is also desirable where a project is large, data is available and expertise exists to do the analysis. For initiatives seeking Federal funding, equity and distributional impacts must be considered but may not need to be quantified.

The distribution analysis can help shape a project option, such as who should pay the costs of an initiative, but transfers and the incidence (where costs and benefits ultimately sit) needs to be considered.

The use of distributional weights is not recommended in the calculation of the NPV or BCR, in line with NSW Treasury guidance.

5.6.2 Identify qualitative factors

A CBA should use dollars as a common unit of comparison wherever practicable. Wherever possible, qualitative benefits should also be included. This gives

⁵ This definition differs to the definition of a benefit when conducting Benefit Realisation Management (BRM). In BRM, a benefit is the improvement resulting from an outcome perceived as an advantage by one or more stakeholders, which contributed towards achievement of one or more of the program / project objectives. A disbenefit can be described as an unavoidable negative consequence of change.

⁶ See [NSW Treasury's cost-benefit analysis guide 2017](#), p17 and 52 for instance, on the need for this analysis

decision-makers a comprehensive understanding of the proposed initiative and allows qualitative factors to be assessed against any differences in monetised costs and benefits. While often challenging, monetising and quantifying impacts makes the choices more transparent and allows benefit and costs to be tracked and managed.

Qualitative factors to consider may include real or perceived benefits that are difficult to accurately measure, or impacts that are not yet defined accurately enough to enable quantification. However, if a qualitative factor is the principal reason for a choice then effort should be made to quantify a result or discuss implied values in the sensitivity analysis.

5.7 Step 6: Assess risks and test sensitivities

All infrastructure projects have risk, even after risk mitigation measures have been applied. A CBA should include an understanding of the risks and uncertainties involved in the decision being made.

Understanding risk and uncertainty needs to be a central element of a CBA, rather than an add-on after central estimates are calculated. Risk assessment involves identifying risk factors, as well as estimating their consequence and likelihood.

Key steps in a risk assessment include:

- determining a range of values of risk factors and uncertainties
- calculating the effects on the decision criteria (NPV and BCR)
- testing the interrelationships and key assumptions.

Risk can be included in a CBA by deterministic or probabilistic methods. The deterministic method is a simple approach that applies a percentage to either individual cost elements or to the aggregate cost estimate. The probabilistic method uses Monte Carlo simulation to assess contingency requirements. Monte Carlo simulation generates a very large sample of possible project outcomes and the frequency of occurrence of each.

TfNSW, in line with the NSW Government, recommends the use of probabilistic modelling approaches to be informed by actual experience of project managers, service delivery officers, legal or other experts who are able to identify and place a value on salient risks (NSW Treasury, 2017). Monte Carlo Analysis methodology can be used for high-risk projects in addition to sensitivity testing. The best method may be influenced by the project risk profile, life cycle phase, delivery strategy and the expertise available to the project team.

Sensitivity analysis should show where risks and opportunities exist to change options and improve outcomes. Deterministic approaches, such as looking at a 10 per cent change in costs, need to also be considered in regard to how they will impact decision criteria, if lower risk options should be preferred or a preferred option needs to be changed to mitigate risk.

If Federal funding is sought, specific requirements apply and should be checked. For further detail see the [Guidance Note 3A Probabilistic Contingency Estimation](#) by DITCRD.

5.8 Step 7: Assess the net benefit

The key decision criteria for a transport CBA are the BCR and the NPV. This is also informed by other qualitative considerations.

5.8.1 Calculate the net present value

NPV is the difference between the present value of benefits and the present value of costs. A positive net present value indicates that the project is likely to have economic merit.

The NPV can be used to compare mutually exclusive options for the same initiative, alternative combinations of related initiatives (where implementation of one affects the benefits and/or costs of another), and alternative timings for the same initiative.

$$NPV = \sum_{t=0}^n \frac{(B_t - C_t)}{(1 + r)^t}$$

t is time in years

n is number of years during which benefits and costs are included

r is the discount rate

B_t is benefits minus disbenefits in year *t*

C_t is infrastructure capital and operating costs in year *t*

5.8.2 Calculate the benefit cost ratio

The **BCR** is calculated by dividing the present value of benefits by the present value of costs. An initiative is potentially worthwhile if the BCR is greater than one, that is, the present value of benefits is greater than the present value of costs. The BCR is also used to rank initiatives.

$$BCR = \frac{\sum_{t=0}^n \frac{B_t}{(1 + r)^t}}{\sum_{t=0}^n \frac{C_t}{(1 + r)^t}}$$

t is time in years

n is number of years during which benefits and costs are included

r is the discount rate

B_t is the benefits minus disbenefits in year *t*

C_t is infrastructure capital and operating costs in year *t*

5.9 Step 8: Report the results

The CBA results should be used as part of the narrative informing the decision being made in a business case. Key results should be represented in a results table similar to the example provided below:

Table 6: Example CBA results table

Category	Item	Option 1	Option 2
Benefits			
User benefits	travel time savings		
	vehicle operating cost savings		
	reliability improvements		
	reduced crowding		
Social benefits	health benefits from active transport		
	safety benefits		
	environmental externalities		
Other benefits	incremental fare-box revenue		
	residual value		
Total	Total benefits		
Costs			
Capital	direct construction costs		
	major periodic maintenance		
Recurrent	operating costs		
Total	Total costs		
Results			
NPV	Net Present Value		
BCR	Benefit-Cost Ratio		

The following should also be presented:

- the conclusion and recommendation of the CBA
- an itemised list of the PV of all benefits and costs
- key parameters and assumptions
- sensitivity analysis on the assumptions, risks and uncertainty
- sensitivity analysis on the discount rates at 3% and 10%
- qualitative benefits or costs
- distributional impacts, where possible.

The size and detail of a CBA will vary depending on the risk and value of the decision being addressed. However, useful information to assist decision makers compare the base case and options include:

- supporting tables
- charts demonstrating discounted cash flows and NPV values
- the difference between the value of options.

When calculated, wider economic benefits (WEBs) should not be included in the core results but form part of the sensitivity analysis.

5.9.1 Recommend a preferred option

The preferred option is identified by:

- comparing options by NPV and BCR
- comparing results of sensitivity analysis
- assessing the qualitative factors for each option.

In general, for a CBA for transport initiatives the monetised benefits of the project should be greater than or equal to the cost of the project. If major factors are not able to be monetised and risks and uncertainty quantified, then informed judgement is still required to determine the preferred option.

5.10 Step 9: Benefits realisation management

Applying rigour in the development of a CBA, as outlined above, allows TfNSW to manage delivery of benefits throughout a project and monitor if expected benefits were realised after the project has been completed.

It allows the project sponsor and benefit owner to understand if the project achieved its intended outcomes, solved the problems it proposed it would, or had unexpected consequences.

If a project did not meet its intended outcomes the reasons should be documented and incorporated into lessons for future investment decisions.

The following guides are useful benefit realisation tools:

- INSW Gate 6 Assurance Review
- NSW Government Program Evaluation Guidelines
- Infrastructure Australia Assessment Framework
- Transport Benefit Realisation Management Guidelines.

6 Common mistakes and issues

The following are common mistakes to avoid when conducting a CBA. Early engagement with the CBA process in project development is recommended to avoid these or other issues.

6.1 Unclear objectives and missing options

It is important to clearly state the objectives of the project. The CBA should have a strong narrative describing why government action is needed. If the objective is not correctly stated the options considered and the decision made may not deliver the desired outcomes.

It is not sufficient to consider a narrow set of options, or to include poorly scoped options that were never intended to be seriously considered. Doing this restricts the NSW Transport cluster's ability to deliver value-for-money to customers. Missing options can include: non-infrastructure solutions, alternative modes, active transport, information and education campaigns, timing and staging differences, pricing, technology solutions, behavioural change and demand management.

6.2 Setting the base case

Specifying the base case is important because it impacts on the attribution of estimated benefits and costs to the project options being assessed. A poorly specified base case will bias the assessment of the project options, compromise the analysis and distort the investment decision being made.

There are several ways that a poorly specified base case may impact the CBA. Use of a 'do nothing' or 'worst case' base case may unrealistically exaggerate the problem a project is intended to solve, making the project appear better value-for-money than it really is.

Inaccurate base case population or transport network inputs may impact the CBA by reducing or increasing demand for a new service, leading to an inaccurate patronage forecast. This may sway whether a project is economically viable.

6.3 Optimism bias and justification versus evaluation

A cognitive bias is a systematic pattern of deviation from norm or rationality in judgment (Haselton, et al., 2005). A common cognitive bias for project proponents is optimism bias which unintentionally advantages a preferred option over credible alternatives. The most appropriate way of addressing this issue, particularly for projects that have not been undertaken before, is to ensure that the cost and benefit assumptions and data used are reasonable by comparing them with actual data from similar, recently completed projects.

Ways to avoid cognitive bias when developing transport initiatives include: thinking in terms of outcomes, exploring a wide range of option early in development, and avoiding the preferring of an option without the necessary evidence.

6.4 Transfers, netting and double counting

Care is needed to avoid double counting and to ensure any potential transfers are netted out. Explicitly including a cost in one area of the analysis can require an

offsetting change in benefits in another area. For example, a fare or a toll is a cost to a customer but a revenue benefit to the supplier and therefore needs to be netted out.

Because taxes are transfers from customers and businesses to government they are normally excluded from CBA analysis. Subsidies should also be excluded.

Costs and benefits can be transferred between parties. For example, the benefits of travel time savings for commuters can be transferred to landlord in higher rents on properties near new transport links. Counting both travel time savings and higher land values may involve double counting.

6.5 Confusing real, nominal, and discounted prices

A CBA is undertaken on a real basis, without inflation, at the present point in time (i.e. real cash flows and real social discount rates are used). This is because CBA is concerned with comparing community welfare on a consistent basis over time.

Within a business case economic, financial, and budgeting numbers can be used in the same document. These numbers have different purposes and are calculated on a different basis so are not like-for-like. It is good practice to always make clear the basis for an amount provided, for example \$10 million (real, 2019).

6.6 Separating stocks and flows

Even when measured in common units (real NPV) stocks and flows need to be differentiated and compared carefully. This distinction is made in the accounting concepts of profit and loss and balance sheet but can be confused in economic analysis. This could involve comparing an increase in annual revenues (change in a flow) or an increase in the size of an asset (a change in a stock). New jobs during construction are a flow but in operation and maintenance an increase in the stock of jobs. Difficulties arise if stocks and flows are added together or if a stock is compared against a flow.

6.7 Misalignment of scope, costs, and benefits

The costs and benefits included in the CBA should reflect the scope of the project as outlined in the business case. Infrastructure or service changes needed in order to realise the economic benefits should be included in both the CBA costs and the business case. Similarly, benefits should not be included in the CBA unless they are clearly aligned to an outcome of the business case and are the direct result of a scoped item.

6.8 Confusing costs and benefits

Sometimes there is confusion over whether something is a cost or a benefit. Increased local employment can be seen as a benefit for a regional community but is a cost to a project. A CBA uses the NSW community as the referent group for determining costs and benefits but allows for different perspectives to be incorporated in distributional analysis, sensitivity testing and the narrative attached to a business case.

6.9 Treatment of disbenefits

Whether a negative value is treated as a cost or disbenefits can have a material impact on the BCR, and may even change the preferred option; the NPV however will remain constant. The preferred approach is to treat impacts resulting from the projects as 'benefits', regardless of whether they are positive or negative. For

example, a road project may have negative environmental impacts if it results in more car use – these impacts should be included as a disbenefit, rather than as a cost.

6.10 Use of marginal and average values

Average values are commonly used in making most comparisons and decisions. However CBA decisions are usually about incremental changes compared to a base case and so marginal values, the values attached to changes, should be used. Similarly to changes in stocks and flows confusion can occur over average and marginal values and a CBA needs to be specific and internally consistent about how marginal costs and benefits are treated.

6.11 Failing the newspaper, pub and super tests

A CBA can appear to be theoretical but in essence it is about evidence to support an informed decision.

The analysis in a CBA may potentially to be involved in a Parliamentary inquiry, Audit Office of NSW review, media story or public debate. It is worthwhile applying the 'newspaper' or 'pub' test to reflect how the analysis would appear to a reasonable and informed person.

When doing or reviewing a CBA would you be willing to defend your decision, to family, friends or media if it appeared in a local paper? This includes: the choice of preferred option; cost and benefits of the preferred option compared to alternatives; the process used to make the decision; and the cost of developing the CBA, the business case and making the decision.

For the super test, ask whether you would be happy with the decision and decision-making process if your superfund was invested in this initiative, or if you were a shareholder investing for the long-term.

7 When to ask for help

Because it measures and values different things using different means, the economic perspective in a CBA is not the same as an engineering, accounting or project management view. This section explains when those unfamiliar with economics or CBA or faced with particular technical issues may benefit from assistance.

7.1 Where and when advice is most useful in the CBA process

The best time to get advice is early on in the process of doing a CBA. Issues only identified during a review, particularly for a final business case, can be difficult, time consuming and costly to address. This is particularly true of setting assumptions, establishing the base case and ensuring appropriate options are explored.

Asking for help to supplement advice in this guide can be useful for initiatives where:

- the objective is unclear or multiple objectives are involved
- options need to be developed or expanded – particularly non infrastructure, multi-modal, behavioural, timing or staging approaches
- identifying, measuring and valuing of benefits is difficult
- the base case is complex or hard to specify
- an initiative has network, placemaking, city shaping, national building or wider economic benefit (WEB) impacts
- assets have long lives (over 30 years)
- overseas or interstate users are a significant part of the project
- new technology is involved
- Federal funding is sought.

7.2 Who to ask

The Evaluation and Economic Advisory team supports investment decisions by providing frameworks, tools and advice that support informed decision-making.

It provides consistent economic evaluation values that can be used in mainstream transport projects. Part of the team's role is to also understand and value impacts of initiatives not typically found in mainstream transport projects. Greater emphasis on place making in business cases, a key focus of Future Transport 2056, is one of the focus areas for further work.

Resources and advice, including experience from recent CBA, is available by contacting the Transport's Evaluation and Economic Advisory team at:

EconomicAdvisory@transport.nsw.gov.au.

A. Typical transport benefits

The table below provides a summary of commonly estimated transport benefits. Further detail on the estimation of these benefits can be found in [TfNSW Economic Parameter Values \(EPV\)](#).

Benefit	Description
Travel time savings	Travel time savings refers to the benefits of faster travel as a result of a transport initiative. It is valued by multiplying the time savings with the value of travel time.
Vehicle Operating Costs (VOC) savings	VOC refers to the variable costs incurred to operate a vehicle. VOCs are incurred on both roads and public transport and include basic running costs such as fuel, repairs, maintenance, depreciation and other additional running costs. VOCs vary by operating conditions, such as road surface, gradient and vehicle speed. VOC savings occur when a project improves traffic flow or operational efficiencies.
Reliability benefits	Travel time reliability refers to the variability (typically measured using variations around the mean) of a user's travel time. Reliability benefits occur when there is a reduction in travel time variations as a result of a transport improvement project. Variability of travel (or unreliability) is an economic cost on travellers, so a reduction in journey time variations will result in reliability benefits.
Amenity benefits	Amenity benefits are improvements to the existing environment. Amenity benefits are measured by improvements to the customer's rating of station/vehicle quality attributes, such as seating, information, cleanliness and lighting and in vehicle attributes such as air conditioning, design, on board information and announcements.
Active transport benefits	Active transport such as cycling and walking can result in reduced congestion and better health outcomes.
Fare-box revenue	Fare-box revenue is the additional revenue generated through the public transport network as a result of the transport initiative. This is due to users changing their route, mode, frequency or destination.
Accessibility for different levels of mobility	Accessibility infrastructure, such as lifts and ramps, can significantly improve the lives of people with different levels of mobility.
Environmental externalities	An externality is a consequence of an economic activity experienced by unrelated third parties. For example, building cyclepaths could lead to people switching from driving cars to cycling. Reduced use of private vehicles leads to reduced carbon emissions, and decrease in air, water, and noise pollution which benefits members of the community who do not use the cyclepath. Details on the full range of environmental benefits can be found in TfNSW Economic Parameter Values (EPV) .
Safety benefits	A significant benefit of transport initiatives is increased safety. Safety benefits are estimated by comparing the crash or casualty reduction in the base case with each option, which is valued by crash cost values.

De-crowding and decongestion benefits	Overcrowding at stations or on-board vehicles can create discomfort for users. Changes in on board crowding (e.g. increasing service frequency or introducing new services) can be measured using multipliers which penalise travel time in a more crowded environment. Road projects can also generate decongestion for the broader network.
Avoided costs	Avoided costs are those that are incurred in the base case but not in the project case. Avoided costs can be calculated by the reduction in recurrent costs when the project is operational compared to the base case. For example, an upgrade to a road could result in reduced routine maintenance costs.
Residual value	Residual value refers to the components of the investment (e.g. assets) that have significant life remaining at the end of the evaluation period, meaning that the assets still have the capacity to accrue benefits. Residual value captures this remaining capacity as a benefit.
Wider economic benefits	Wider economic benefits are indirect improvements to economic welfare from transport and urban development proposals. They are captured in CBA as a sensitivity analysis. The main types of wider economic benefits are agglomeration economies, output change in imperfectly competitive markets and tax revenues from labour markets.
Land value uplift	Land value uplift is capitalisation of the impacts of a transport investment into land values. As a general principle, it is preferable to estimate the direct user benefits rather than estimate the proportion of those benefits that are transferred to land or property owners. Caution should be applied to avoid double counting with other benefits such as travel time savings when quantifying this benefit.
Infrastructure and service delivery savings	This is the core infrastructure to service residential property, including the connection of water, stormwater, sewerage, gas, electricity, roads, information and communications technology etc. One of the key benefits from urban renewal may be the costs of providing services in more dense developments rather than less dense developments.

B. Glossary

Term	Definition
Amenity	A desirable or useful feature or facility of a building or place.
Annualisation factor	A factor used to estimate the impacts of a transport project for a full year, based on transport modelling undertaken for an average weekday or average day.
Assumption	Something that is outside the responsibility of the project and is therefore a given. It is accepted as a correct position to take in relation to the project development process.
Base case	The base case is the projected costs and benefits without the proposed initiative. It is the point that the project case is compared to. The base case is usually defined as “do nothing” or a more appropriately “do minimum”.
Benefit (CBA definition)	In CBA, an economic benefit is any positive or negative consequence to the lives of a person in the referent group that will result from the project.
Benefit (Benefit realisation management definition)	In BRM, a benefit is the improvement resulting from an outcome perceived as an advantage by one or more stakeholders. A dis-benefit can be described as an unavoidable negative consequence of change. Benefits can be either quantifiable (monetised in economics or measured in performance) or qualitative.
Benefit cost ratio	The BCR is calculated by dividing the present value of benefits by the present value of costs. An initiative is potentially worthwhile if the BCR is greater than one, that is, the present value of benefits is greater than the present value of costs.
Consumer price index	The standard measure of inflation is the Consumer Price Index (CPI). CPI is a measure of changes, over time, in retail prices of a constant basket of goods and services representative of consumption expenditure by resident households in Australian metropolitan areas.
Consumer surplus	Consumer surplus is the benefit derived when the actual price the consumer pays is lower than the highest price a consumer is prepared or willing to pay.
Contingency	Contingency provisions are funds allocated within a cost estimate to cover the cost of unplanned activities or risks that are necessary to deliver project outcomes and require additional funds.
Discount rate	People prefer to consume goods and services now, rather than in the future. In general, even after adjusting for inflation, people would prefer to have \$1 now, rather than \$1 in 30 years' time. As the impacts included in CBA are presented in monetary terms, all monetised costs and benefits arising in the future need to be adjusted to take account for this preference, known as 'social time preference'. Discounting is the technique used to perform this adjustment.
Distributional impacts	The impact of costs and benefits as they vary in their effect across different parts of the community.
Escalation	Escalation takes into account the changes in costs from the base date of the estimate to some future period, generally the completion of construction.
Evaluation period	The evaluation period is the initial period of capital investment and the asset life. The asset life is the expected period of time an asset remains useful.

Expansion factor	A factor used to estimate the impacts of a transport project for a full day or weekday, based on transport modelling undertaken for peak hour periods.
Externalities	An externality is the impact of an economic activity on third parties. For example, building cycle paths could lead to people switching from driving cars to cycling. Reduced use of private vehicles leads to reduced carbon emissions, and decrease in air, water, and noise pollution which benefits members of the community who do not use the cycle path.
Financial appraisal	Financial appraisal is a method of assessing the extent to which the project will generate revenues to meet its financial obligations and achieve financial sustainability with cost recovery measures. Financial appraisals are also useful for projects that do not generate significant revenue streams to understand the direct financial impacts on the entity due to cash outflows from the costs of a project.
Inflation	A general increase in prices and fall in the purchasing value of money.
Market prices	In economics, market price is the price for which a good or service is offered in the marketplace.
Market based valuation	Benefits and costs should be valued at market prices when possible. For example, the cost of acquiring an asset can be valued based on the cost of replacing the asset at current market prices.
Net present value	NPV is the difference between the present value of benefits and the present value of costs. A positive net present value indicates that the project has economic merit.
Non-Market based valuation	Market-based valuations usually provide much of the information required for CBA. Other methods are required if a competitive market price is not available. In these cases, non-market based valuations, such as revealed or stated methods of valuation may be required.
Recurrent costs	Recurrent costs are incurred when the project is operational. There are several operating and maintenance costs to consider. For example, routine maintenance such as surface patching and vegetation management, labour costs, utility services and coordination costs with the overall transport network.
Opportunity cost	Opportunity cost is the value forgone by society from using a resource in its next best alternative use. It reflects market prices where there is an absence of market failure. Where market failure exists, appropriate adjustments are required to estimate the true resource cost.
Parameters	A parameter is a constant in a function that determines the specific form of the function but not its general nature. In CBA, parameters are used to set consistent valuations of benefits. For example, in 2019 the parameter value of private travel time is \$17.72 per hour. This means that time saved on private travel should be multiplied by \$17.72 per hour to calculate travel time savings.
Placemaking	Refers to the development and management of the built environment to influence the character or experience of places. Successful placemaking either preserves or enhances the character of our public spaces, making them more accessible, attractive, comfortable and safe.
Producer surplus	Producer surplus is the benefit derived when the market price is higher than the price the producer is willing to accept.

Real prices	The real price is one which has been adjusted for inflation. For example, say the price of a good is \$1 in 2000, in 2002 the price of the good is \$1.10 (an increase of 10%). If during this period inflation had risen by 20%, then the real price of the product would have fallen.
Referent group	The referent group is a group of individuals deemed by the decision-maker to be relevant for the purpose of CBA.
Residual value	Residual value refers to the components of the project that have significant life remaining at the end of the appraisal period.
Resource cost	Resource cost is the opportunity cost of resources used, measured from the point of view of society as a whole. It excludes indirect taxes and subsidy.
Revealed preference methods	Revealed preference methods derive consumers' WTP through examining their behaviour. For example, the price a person is willing to pay to travel to the beach could reveal how much they value it.
Stated preference	Stated preference methods ask individuals to self-report their preferences or valuations using surveys.
Subsidy	A sum of money granted by the state or a public body to help keep the price of a good or service low.
Willingness-to-pay	WTP is the maximum amount an individual would be willing to pay for a good or service or to avoid an undesirable outcome.

C. List of acronyms

Acronyms	Full wording
ATAP	Australian Transport Assessment and Planning Guidelines
BCR	Benefit Cost Ratio
BRM	Benefit Realisation Management
CBA	Cost Benefit Analysis
CPI	Consumer price index
DCS	Department of Customer Services
DITCRD	Department of Infrastructure, Transport, Cities and Regional Development
ETCM	Enhanced Train Crowding Model
IA	Infrastructure Australia
IAAF	Infrastructure Australia Assessment Framework
ICT	Information and communication technology
IIAF	Infrastructure Investor Assurance Framework
INSW	Infrastructure New South Wales
NAI	Network and Asset Intelligence
NPV	Net Present Value
NSW	New South Wales
PTPM	Public Transport Project Model
PV	Present value
SMPM	Sydney Strategic Motorway Planning Model
STM	Sydney Strategic Travel Model
TfNSW	Transport for New South Wales
TPA	Transport Performance Analytics
VOC	Vehicle operating cost
WTP	Willingness to pay
WEBs	Wider Economic Benefits

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